SINAMICS G120D

Frequency converter with Control Unit: CU250D-2

and Power Module: PM250D

Operating Instructions · 01/2013

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SINAMICS G120D
Frequency converter with control units CU250D-2

Operating Instructions

Edition 01/2013, Firmware V4.6

01/2013, FW V4.6
A5E03371458A AB

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.

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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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Ⓟ 04/2013 Technical data subject to change

Changes in this manual

Important changes with respect to the Manual, Edition 04/2012

New functions in firmware V4.6	In Chapter
Firmware update	Upgrading firmware (Page 280) Firmware downgrade (Page 282)

An overview of all new and modified functions in Firmware V4.6 can be found in section New and extended functions (Page 317).

Revised descriptions	In Chapter
Ramp-function generator • Rounding times extended • Change to ramping times during operation	Ramp-function generator (Page 130)

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1 Safety notes

Use for the intended purpose

The frequency converter described in this manual is a device for controlling an asynchronous low-voltage motor. The converter is designed for installation in electrical installations or machines.

It has been approved for industrial and commercial use on industrial networks. Its use in public line supplies requires a different configuration and/or additional measures.

The technical specifications and information about connection conditions are indicated on the rating plate and in the operating instructions.

⚠DANGER

Danger to life when live parts are touched

Touching live parts can result in death or severe injury.

Note the following:

- Only work on electrical equipment if you are qualified to do so.
- When carrying out any work, always comply with the country-specific safety rules.

Follow the six steps to ensure safety:

1. Prepare for shutdown and inform team members who will be affected by the procedure.
2. Switch off the machine so that it is in a no-voltage state:
   – Switch off the machine.
   – Wait until the discharge time specified on the warning labels has elapsed.
   – Check that it really is in a no-voltage condition, from phase conductor to phase conductor and phase conductor to protective conductor.
   – Check that all auxiliary circuits are also in a no-voltage state.
   – Ensure that the motor cannot move.
3. Identify all other dangerous energy sources, e.g. compressed air, hydraulic systems or water.
4. Isolate or neutralize all hazardous energy sources by closing switches, grounding or short-circuiting or closing valves, for example.
5. Lock out all energy sources to prevent reclosing.
6. Make sure that the machine is completely locked out ... and that you have the right machine!

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

⚠ WARNING

Danger to life when live parts are touched on damaged devices

Hazardous voltages can be present at the housing or exposed components on damaged devices.

- Ensure compliance with the limit values specified in the technical specifications during transport, storage and operation.
- Do not use any damaged devices.
- The components must be protected against conductive contamination (e.g. by installing them in a cabinet with degree of protection IP54B to EN 60529).

  Assuming that conductive contamination at the installation site can definitely be excluded, a lower degree of cabinet protection may be permitted.

⚠ WARNING

Danger to life due to unexpected movement of machines when using mobile wireless devices or mobile phones

Using mobile radios or mobile phones with a transmit power > 1 W closer than approx. 2 m to the frequency converter may cause the devices to malfunction, affecting the functional safety of machines and, therefore, putting people at risk or causing material damage.

- Switch off mobile radios and mobile telephones when you are close to the converter.

NOTICE

Damage due to electric fields or electrostatic discharge

Electric fields or electrostatic discharge can result in malfunctions as a result of damaged individual components, integrated circuits, modules or devices.

- Package, store, transport and send the electronic components, modules or devices only in the original product packaging or in other suitable materials, e.g. conductive foam rubber or aluminum foil.
- Only touch components, modules and devices if you are grounded by means of one of the following measures:
  - Wearing an ESD armband or
  - Wearing ESD shoes or ESD grounding straps in ESD areas with conductive flooring
- Only place electronic components, modules or devices on conductive surfaces (table with ESD surface, conductive ESD foam, ESD packaging, ESD transport container, for example).

CAUTION

Risk of burns due to touching hot surfaces

During operation and for a short time after the frequency converter shuts down, the surface of the device can reach a high temperature. Touching the surface of the converter can cause burns.

- Do not touch the device during operation.
- After shutting down the converter, wait for the device to cool down before touching it.

Residual risks of power drive systems

The control and drive components of a drive system are approved for industrial and commercial use in industrial line supplies. Their use in public line supplies requires a different configuration and/or additional measures.

These components may only be operated in closed housings or in higher-level control cabinets with protective covers that are closed, and when all of the protective devices are used.

These components may only be handled by qualified and trained technical personnel who are knowledgeable and observe all of the safety instructions on the components and in the associated technical user documentation.

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

1. Unintentional movements of driven machine components during commissioning, operation, maintenance, and repairs caused by, for example:
   - Hardware defects and/or software errors in the sensors, controllers, actuators, and connection technology
   - Response times of the controller and drive
   - Operating and/or ambient conditions outside of the specification
   - Condensation / conductive contamination
   - Parameterization, programming, cabling, and installation errors
   - Use of radio devices / cellular phones in the immediate vicinity of the controller
   - External influences / damage

2. In the event of a fault, exceptionally high temperatures, including an open fire, as well as emissions of light, noise, particles, gases, etc. can occur inside and outside the inverter, e.g.:
   - Component malfunctions
   - Software errors
   - Operating and/or ambient conditions outside of the specification
   - External influences / damage

   Inverters of the Open Type / IP20 degree of protection must be installed in a metal control cabinet (or protected by another equivalent measure) such that the contact with fire inside and outside the inverter is not possible.
3. Hazardous shock voltages caused by, for example:
   - Component malfunctions
   - Influence of electrostatic charging
   - Induction of voltages in moving motors
   - Operating and/or ambient conditions outside of the specification
   - Condensation / conductive contamination
   - External influences / damage
4. Electrical, magnetic and electromagnetic fields generated in operation that can pose a risk to people with a pacemaker, implants or metal replacement joints, etc. if they are too close.
5. Release of environmental pollutants or emissions as a result of improper operation of the system and/or failure to dispose of components safely and correctly.

Note

The components must be protected against conductive contamination (e.g. by installing them in a control cabinet with degree of protection IP54 according to IEC 60529 or NEMA 12).

Assuming that conductive contamination at the installation site can definitely be excluded, a lower degree of cabinet protection may be permitted.

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

Introduction 2

2.1 About this manual

Who requires the operating instructions and what for?

These operating instructions primarily address fitters, commissioning engineers and machine operators. The operating instructions describe the devices and device components and enable the target groups being addressed to install, connect-up, set, and commission the converters safely and in the correct manner.

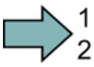
What is described in the operating instructions?

These operating instructions provide a summary of all of the information required to operate the converter under normal, safe conditions.

The information provided in the operating instructions has been compiled in such a way that it is sufficient for all standard applications and enables drives to be commissioned as efficiently as possible. Where it appears useful, additional information for entry level personnel has been added.

The operating instructions also contain information about special applications. Since it is assumed that readers already have a sound technical knowledge of how to configure and parameterize these applications, the relevant information is summarized accordingly. This relates, e.g. to operation with fieldbus systems and safety-related applications.

What is the meaning of the symbols in the manual?

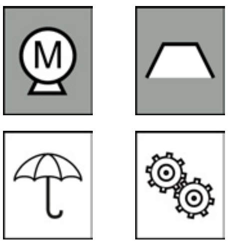


An operating instruction starts here.

This concludes the operating instruction.

The following text applies to the Basic Operator Panel BOP-2.

The following text applies if you are using a PC with STARTER.



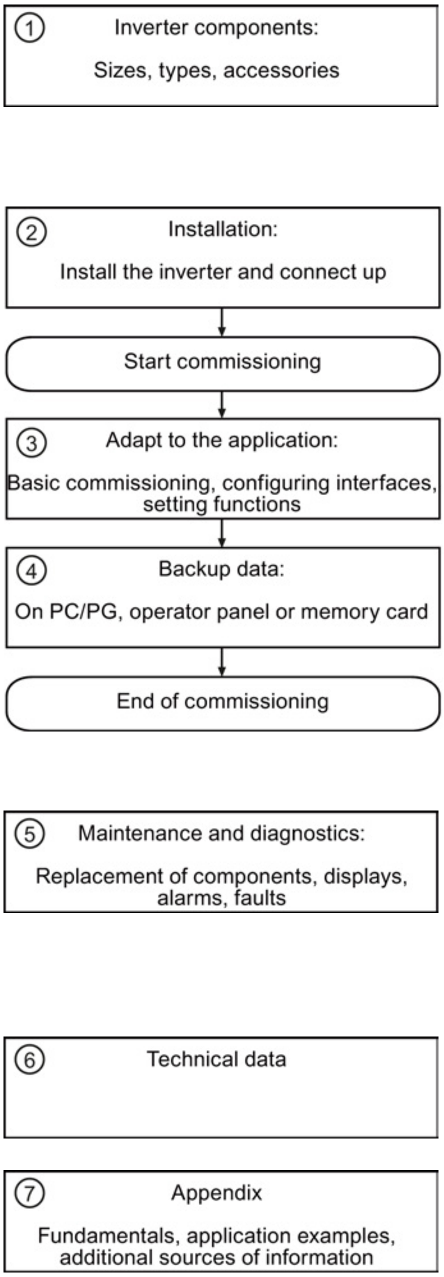
Examples for the symbols of the inverter functions.

The description of the corresponding inverter function starts with one of these symbols.

See also: Overview of the converter functions (Page 115).

2.2 Guide through this manual

In this manual, you will find background information on your inverter, as well as a full description of the commissioning procedure:



① Here you will find information about the hardware of your inverter and the commissioning tools:

- Description (Page 19)

② • Mechanical Installation (Page 25)

All information relating to the commissioning of your inverter is located in the following chapters:

③
- Commissioning guidance (Page 47)
- Basic commissioning with STARTER (Page 57)
- Set functions (Page 115)
- Adapt inputs and outputs (Page 67)

④ • Backing up and transferring settings using memory card (Page 248)

⑤ Information regarding the maintenance and diagnostics of your inverter is located in the following chapters:

- Spare parts - external fan (Page 267)
- Alarms, faults and system messages (Page 287)

⑥ The most important technical data for your inverter is located in this chapter:

- Technical data (Page 311)

⑦ The appendix contains some background information and explanatory examples:

- Appendix (Page 317)

Description

3

3.1 SINAMICS G120D CU250D-2 Inverter

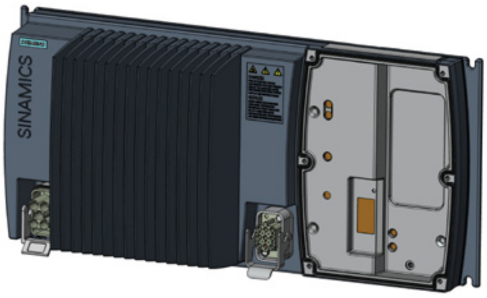
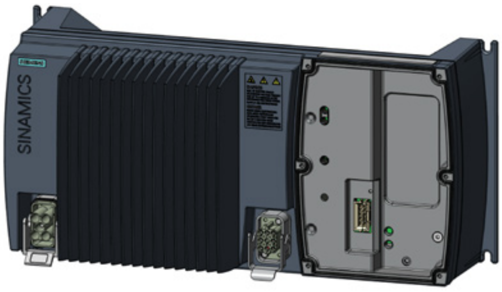
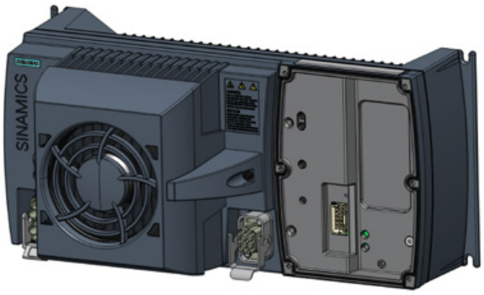
Overview

The SINAMICS G120D is a converter for controlling the position of a drive. The converter consists of two parts, the Control Unit (CU) and the Power Module (PM).

Table 3- 1 CU250D-2 Control Units

	Designation	Interface	Encoder type	Order number
	CU250D-2 DP-F	PROFIBUS PROFISAFE	HTL Encoder SSI Absolute Encoder	6SL3546-0FB21-1PA0
	CU250D-2 PN-F	PROFINET PROFISAFE	HTL Encoder SSI Absolute Encoder	6SL3546-0FB21-1FA0
	CU250D-2 PN-F [PP]	PROFINET PROFISAFE Push-Pull connections	HTL Encoder SSI Absolute Encoder	6SL3546-0FB21-1FB0

Table 3- 2 PM250D Power Modules

	Frame size	Rated output power	Rated output current	Order number
		based on High Overload (HO)		
	FSA	0.75 kW	2.2 A	6SL3525-0PE17-5AA1
		1.5 kW	4.1 A	6SL3525-0PE21-5AA1
	FSB	3.0 kW	7.7 A	6SL3525-0PE23-0AA1
	FSC	4.0 kW	10.2 A	6SL3525-0PE24-0AA1
		5.5 kW	13.2 A	6SL3525-0PE25-5AA1
		7.5 kW	19.0 A	6SL3525-0PE27-5AA1

3.2 Commissioning tools

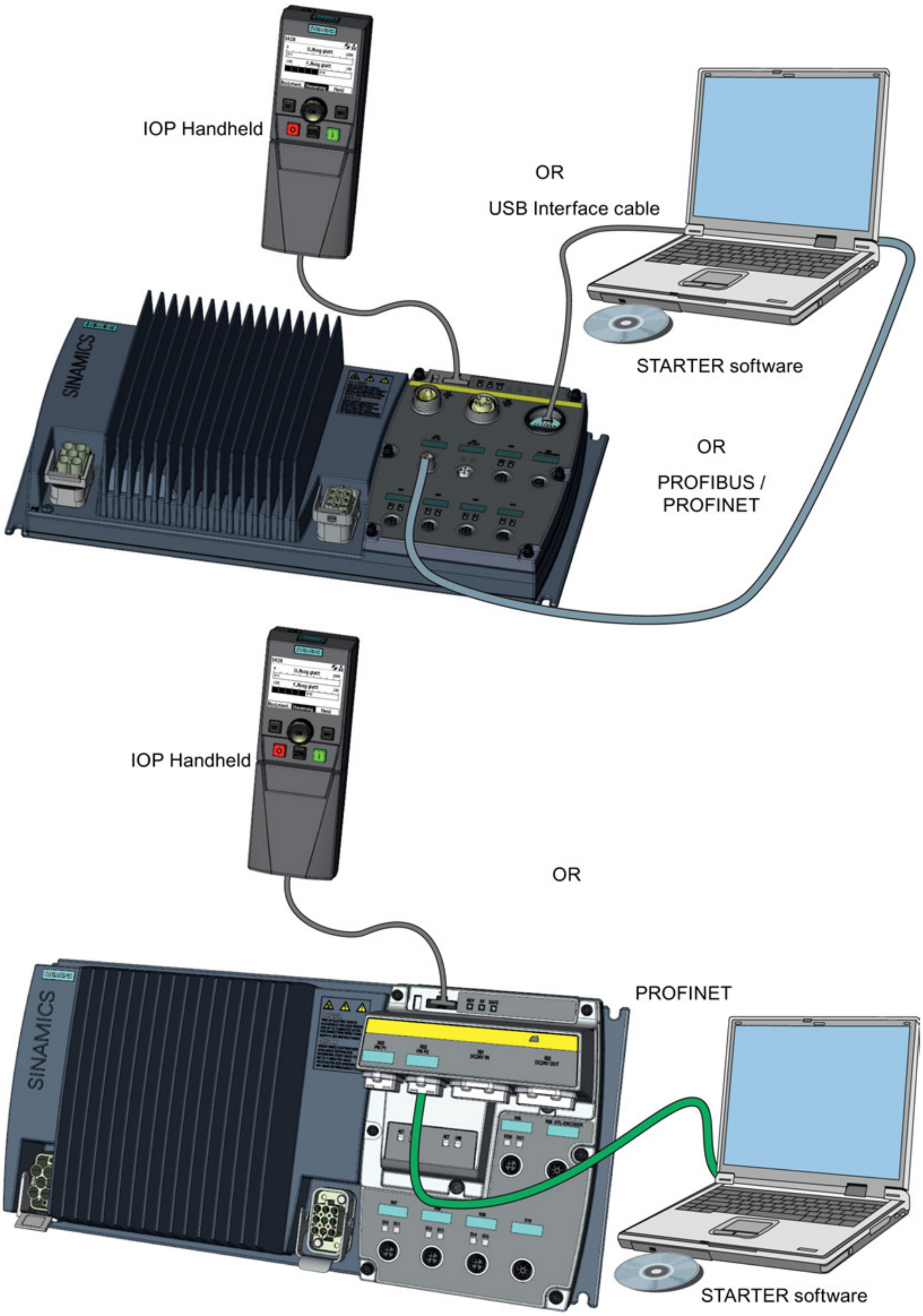


Figure 3-1 Commissioning tools - PC or IOP Handheld Kit

Table 3- 3 Components and tools for commissioning and data backup

Component or tool			Order number
Operator Panel	IOP Handheld		6SL3255-0AA00-4HA0
STARTER	Commissioning tool (PC software)		You obtain STARTER on a DVD (Order number: 6SL3072-0AA00-0AG0) and it can be downloaded: Download STARTER (http://support.automation.siemens.com/WW/view/en/26233208)
PC Connection Kit	Comprising STARTER DVD and USB cable.		6SL3255-0AA00-2CA0
	Optional memory card for storing and transferring the inverter settings	SD card	6ES7954-8LB00-0AA0
		MMC card	6SL3254-0AM00-0AA0

3.3 General layout SINAMICS G120D CU250D-2

The locations and description of the various interface connections on the Control Units (CU) - CU250D-2 including the Power Module (PM) PM250D are detailed in the diagram and table below.

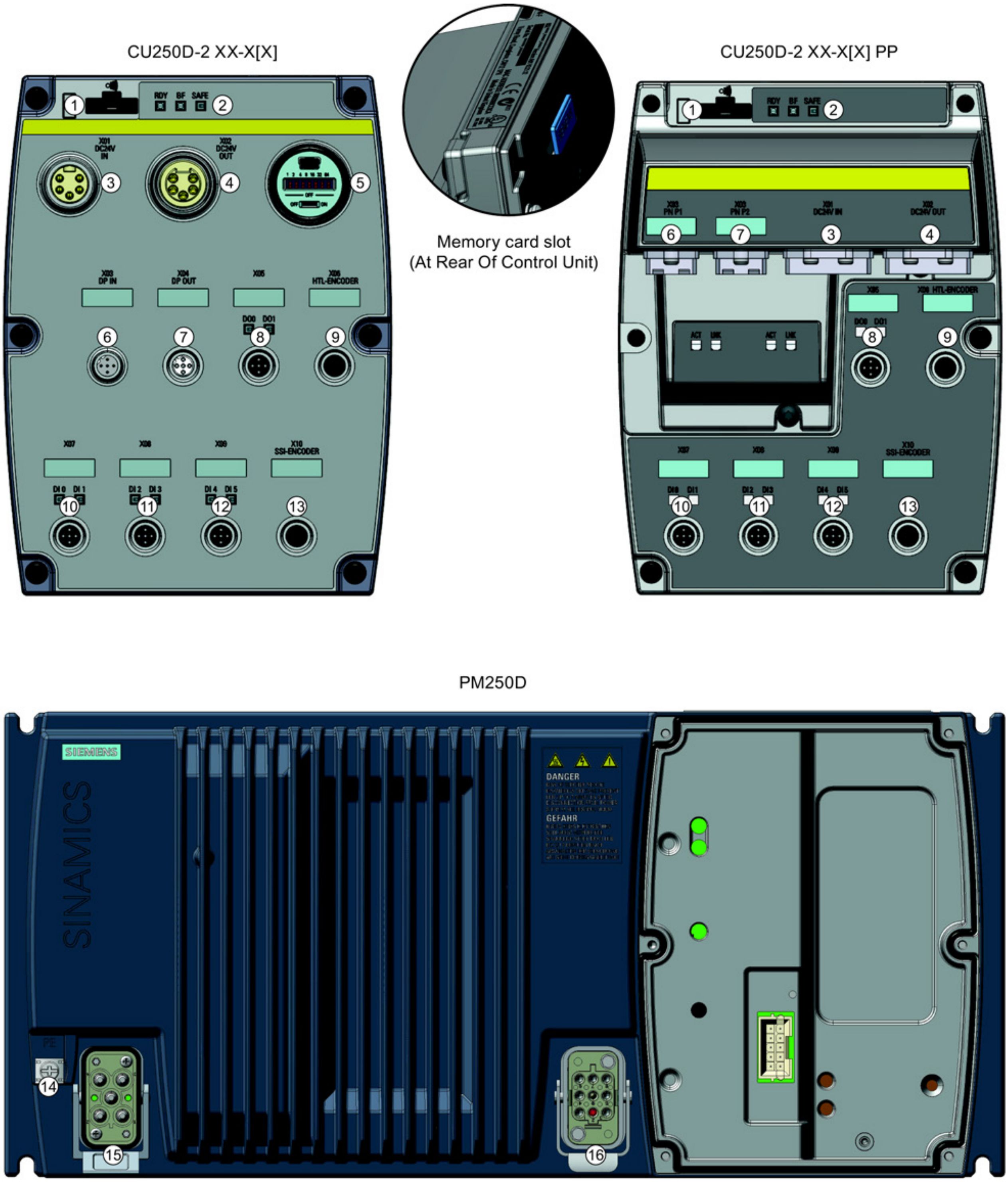


Figure 3-2 SINAMICS G120D CU250D-2 Variants and PM250D

Table 3- 4 Description of interfaces

No.	Description	No.	Description
①	Optical PC connection	⑨	HTL Encoder connection
②	Status LEDs	⑩	Digital Inputs 0 and 1
③	24 V DC supply IN	⑪	Digital Inputs 2 and 3
④	24 V DC supply OUT	⑫	Digital Inputs 4 and 5
⑤	USB connection, Address DIP-switch (PROIFBUS) and Bus termination switch	⑬	SSI Encoder connection
⑥	PROFIBUS IN or PROFINET P1	⑭	PE grounding terminal
⑦	PROFIBUS OUT or PROFINET P2	⑮	Mains supply connection
⑧	Digital Outputs 0 and 1	⑯	Motor, brake and temperature sensor connections

Installation 4

4.1 Mechanical Installation

4.1.1 Drill pattern SINAMICS G120D

Drill pattern and dimensions

The inverter has an identical drill pattern for all frame sizes. The drill pattern, depth and tightening torques are shown in the diagram below.

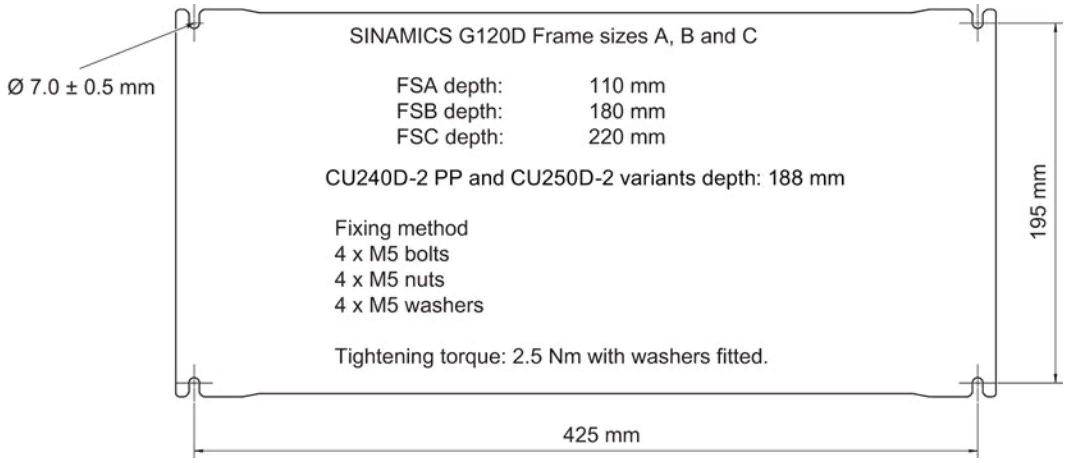


Figure 4-1 SINAMICS G120D drill pattern

Mounting orientation

The inverter has been designed to be table-mounted or side-mounted, it cannot be mounted upside-down. The minimum clearance distances are as follows:

- Side-by-side - no clearance distance is required
- Above and below the inverter 150 mm (5.9 inches).

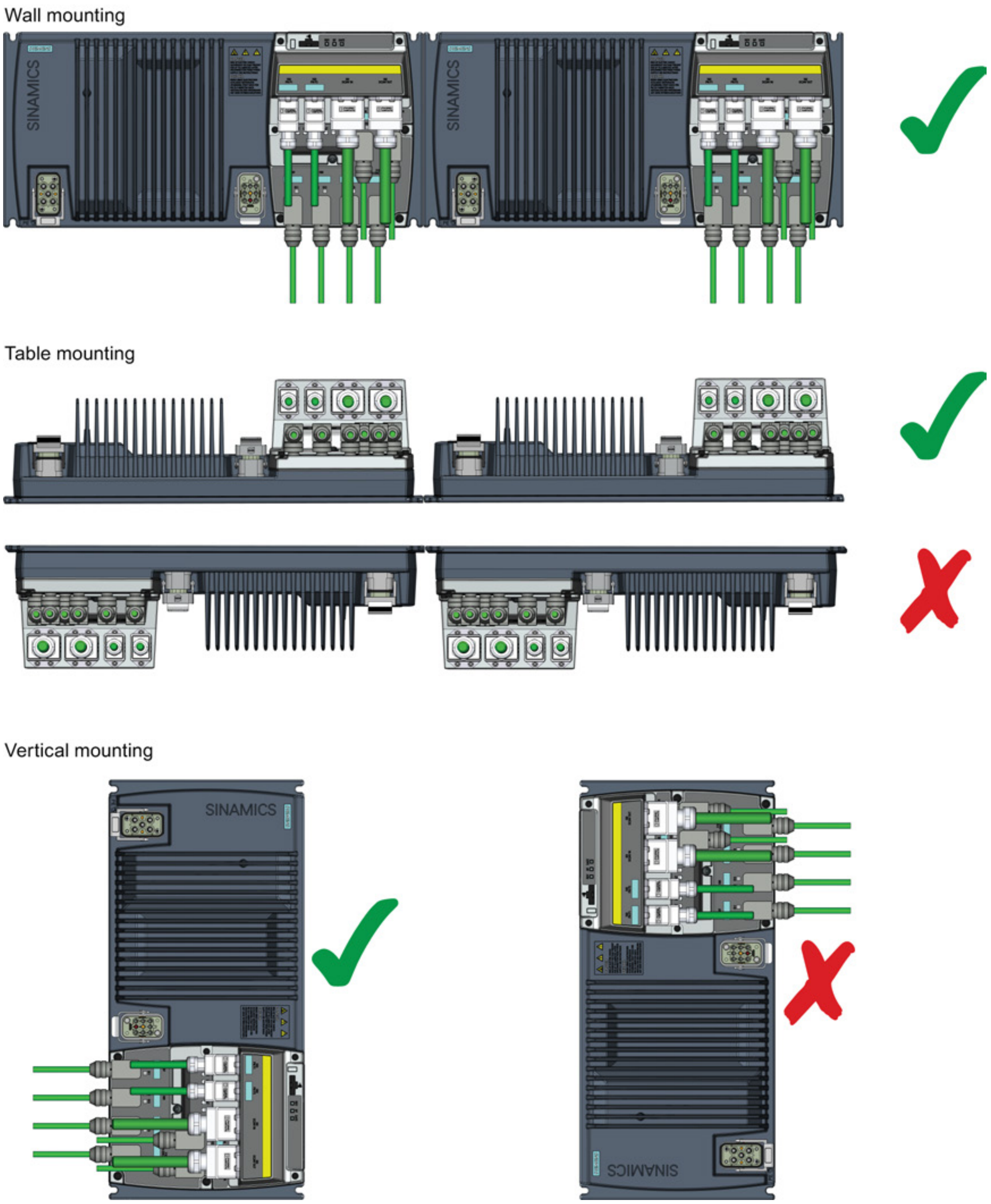


Figure 4-2 Correct Inverter orientation

Vertical mounting

In some applications it may be advantageous to mount the Inverter vertically as shown in the figure above. If the Inverter is mounted in the vertical position, the output current of the Inverter must be reduced to prevent overheating of the Inverter, this is known as derating the Inverter. There are two methods that can be used to prevent overheating of the Inverter, they are:

Reduce output current

If you are using the same size of Inverter and Motor, that is, for example, a 1.5 kW Inverter and a 1.5 kW motor, the output current from the Inverter must be reduced. This is accomplished using the parameter P0640. The parameter P0640 defines the motor overload current limit, as a percentage of the rated motor current. The output current needs to be reduced by 20%. setting P0640 to 80 limits the output current from the Inverter to a maximum of 80% of the rated motor current.

Oversize the Inverter

If you are using, for example, a 3.0 kW motor and a 3.0 kW Inverter and the derating by 20% adversely affects the application; then oversizing the Inverter will provided a solution to the problem. The motor will remain a 3.0 kW motor but an Inverter of the next highest power rating is used; in this case, a 4.0 kW Inverter.

The Inverter is derated using parameter P0640 = 80, but the increased power rating of the Inverter will allow the application to run as required.

Ambient temperature

When using the Inverter in the vertical position, including the derating, the ambient temperature limit of 40°C must under no circumstances be exceeded.

4.2 Electrical Installation

NOTICE
Material damage from inappropriate supply system V_t > 1% Operating the converter on an inappropriate supply system can cause damage to the converter and other loads. • Only operate the converter on supply systems with $V_t \leq 1\%$.

4.2.1 SINAMICS G120D Electrical data

Power Module specifications - 3AC 380 V ... 500 V ± 10 %

Table 4- 1 Rated Output, Input and Fuses

Product	Frame size	Rated output		HO		Fuse	
				Rated output current	Rated input current		3NA3…
6SL3525-…		kW	hp	A	A	A	Type
0PE17-5AA1	A	0.75	1	2.2	2.1	10	803 -
0PE21-5AA1	A	1.5	1.5	4.1	3.8	10	803 -
0PE23-0AA1	B	3	4	7.7	7.2	16	805 -
0PE24-0AA1	C	4	5	10.2	9.5	20	807 -
0PE25-5AA1	C	5.5	7.5	13.2	12.2	20	807 -
0PE27-5AA1	C	7.5	10	19	17.7	32	812 -

Standby current

The PM250D Power Module has a unique standby current characteristic which needs to be taken into account when calculating the requirements of the line supply.

The standby current is the current that the Power Module requires when the Inverter is in the ready-to-run mode. This means that the Inverter is powered-up but the motor is not running. The phenomenon of capacitive reactive current standby occurs in all Power Modules and Inverters with filter capacitors on the line side.

In applications were a number of Inverters are connected to one line supply and where only a small proportion of the Inverters will be running at any one time, the standby currents in the non-running Inverters must be considered when calculating the size of the conductors and selecting the correct protective devices on the line supply of the system.

The following table gives examples of the current drawn by the different Power Modules at different line supply voltages and frequencies.

Table 4- 2 Standby currents for the PM250D Power Modules

Power Module (PM250D)	Standby current (A)					
	50 Hz			60 Hz		
	380 V	400 V	415 V	380 V	440 V	480 V
0.75 - 1.5 kW	0.6	0.63	0.66	0.7	0.8	0.91
3.0 - 4.0 kW	2.2	2.32	2.40	2.7	3.2	3.33
5.5 - 7.5 kW	2.9	3.05	3.15	3.5	4.0	4.40

For more comprehensive information on the standby current, please read the following FAQ:

Standby currents for PM250D (http://support.automation.siemens.com/WW/view/en/31764702)

4.2.2 Connections and cables

Connections and cables

⚠ DANGER

Danger of electrical shock by touching the pins in the motor terminal box

The temperature sensor and motor holding brake connections are at DC link negative potential. Touching the pins in the motor terminal box can lead to death due electrical shock.

- Keep the motor terminal box closed whenever the mains is applied to the converter.
- Insulate the cables that are not used.
- Use appropriate insulation on the cables.

NOTICE

Damage of the converter by disconnecting the motor during operation

The converter can be damaged if the motor is disconnected during operation.

- Do not place any kind of switch or contactor between the converter and the motor.

Cable lengths

The maximum cable lengths for all the inverters are shown in the table below.

Table 4- 3 Maximum cable lengths

Cable	Screening	Max. length
Motor*	Screened	15 m (49 ft)
	Unscreened	30 m (98 ft)
Temperature sensor*	Screened	15 m (49 ft)
	Unscreened	30 m (98 ft)
Motor holding brake*	Screened	15 m (49 ft)
	Unscreened	30 m (98 ft)
Digital inputs	Unscreened	30 m (98 ft)
Digital outputs	Unscreened	30 m (98 ft)
Encoder (SSI and HTL)	Screened	30 m (98 ft)

*The motor, temperature sensor and motor holding brake connections are all carried in a single cable which is connected to the Power Module using a Harting connector.

Outline block diagram

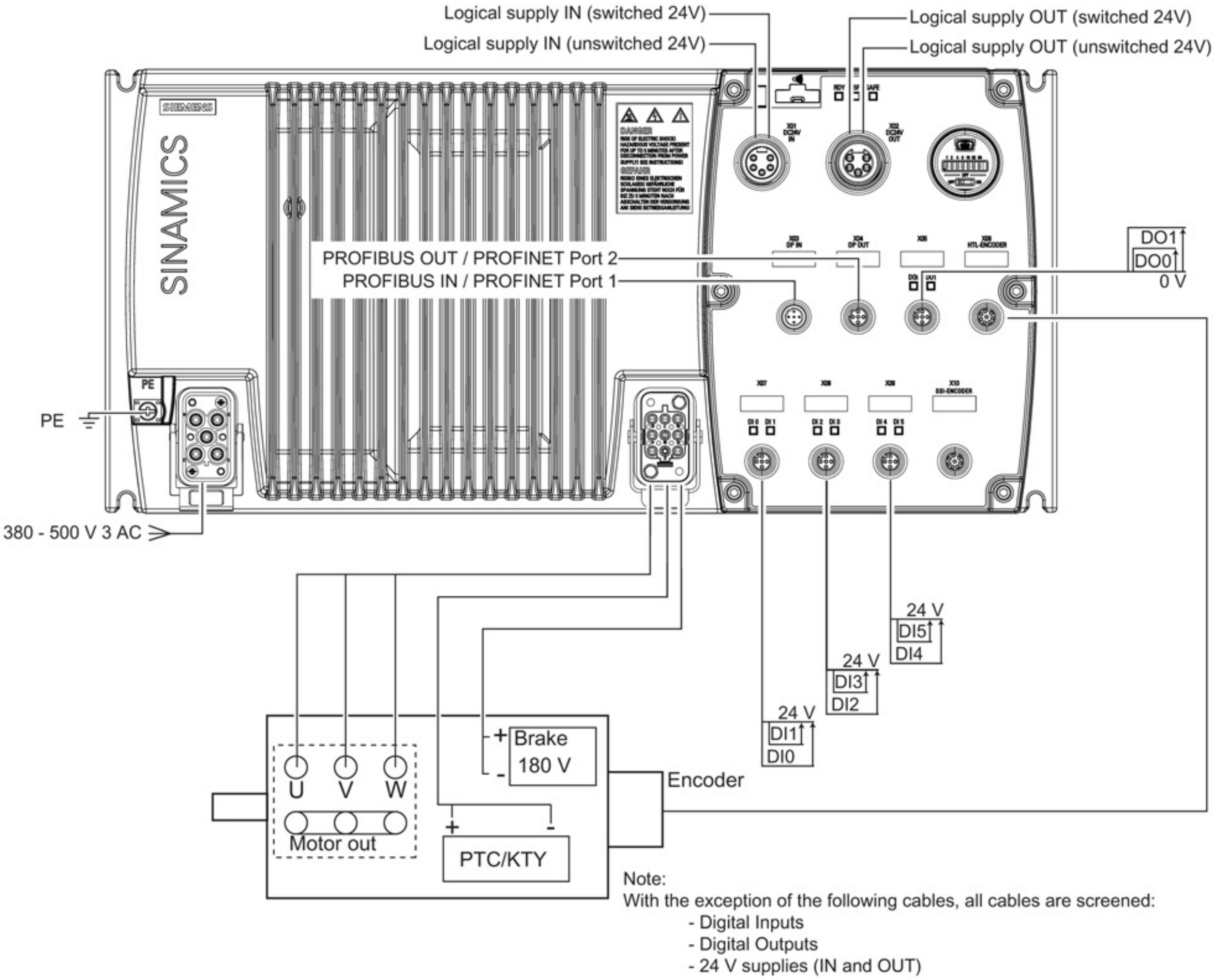


Figure 4-3 Outline block diagram SINAMICS CU250D-2 and PM250D

Note

Brake voltage

The brake output of the Inverter is designed to be connected directly to the coil of the brake within the motor, that is, no rectifier module is required within the motor. For operation on a 400 V AC supply the brake should be rated for approximately 180 V DC (400 V AC with rectifier). The UL approved current rating for the brake output is 600 mA.

Cable, connectors and tools specifications

The detailed specifications for the cables, connectors and tools required to manufacture the necessary cables for the SINAMICS G120D are listed in the following tables. The connections that are detailed in this section relate to the physical connections that exist on the Inverter. Information for the preparation and construction of the individual connectors have separate detailed instructions delivered with the ordered parts, direct from the manufacturers. Use 75 °C copper wire only.

Note

NFPA compatibility

These devices are intended only for installation on industrial machines in accordance with the "Electrical Standard for Industrial Machinery" (NFPA79). Due to the nature of these devices they may not be suitable for installation accordance with the "National Electrical Code" (NFPA70).

Table 4- 4 Tools

	Order number
Crimp tool (Q8/0 and Q4/2)	3RK1902-0AH00
Removal tool (Q8/0)	3RK1902-0AJ00
Removal tool (Q4/2)	Harting part number 0999-000-0305
No special tools are required for the Control Unit connectors	

Table 4- 5 Control unit connectors

Connector	Order number	
	Straight connector	**Right-angle connector**
Power input (7/8")	6GK1905-0FB00	3RK1902-3DA00
Power Output (7/8")	6GK1905-0FA00	3RK1902-3BA00
PROFIBUS In (M12)	6GK1905-0EB00	3RK1902-1DA00
PROFIBUS Out (M12)	6GK1905-0EA00	3RK1902-1BA00
PROFINET Port 1 and Port 2 (M12)	6GK1901-0DB20-6AA0	3RK1902-2DA00
Encoder (M12)	Via KnorrTec: Knorrtec (http://www.knorrtec.de/index.php/en/company-profile/siemens-solution-partner)	
Digital input and output (M12)	3RK1902-4BA00-5AA0	3RK1902-4DA00-5AA0

Table 4- 6 Push-Pull variant PROFINET and POWER connectors

Connector	Order number
Power plug	6GK1907-0AB10-6AA0
RJ45 PROFINET	6GK1901-1BB10-6AA0

Table 4- 7 Mains connector

Power rating	cable size	Order number
0.75 kW … 1.50 kW	2.5 mm^2 (14 AWG)	3RK1911-2BE50
3.00 kW … 4.00 kW	4 mm^2 (12 or 10 AWG)	3RK1911-2BE10
5.50 kW … 7.50 kW	6 mm^2 (10 AWG)	3RK1911-2BE30

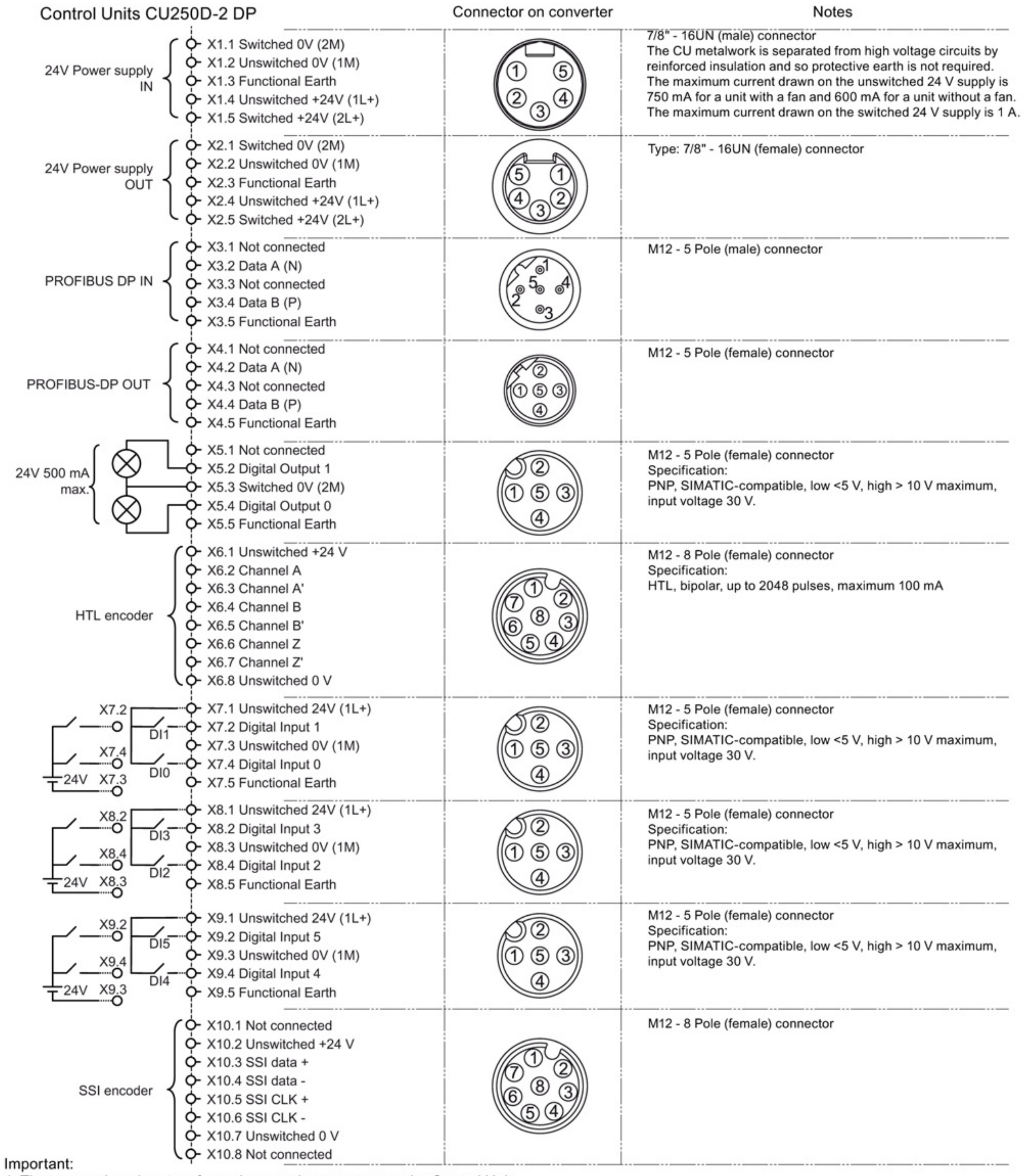
Motor connector including temperature sensor and motor holding brake order:

via solution partner: Solution partner (https://www.automation.siemens.com/solutionpartner/partnerfinder/Partner-Finder.aspx?lang=en)

Connection and terminal diagrams

The connection diagrams given in this manual show the actual physical connections on the Control Unit. Different manufacturers of mating connectors may have differing pinout arrangements and it is essential that when making-up the necessary cables and connectors that the connections match those given in the connection diagrams.

For example, the orientation of the key-notch on the control Unit connector may not match the key-notch on the mating cable connector being constructed, in this instance the pin numbers on the connector being made needs to be ignored to allow the correct orientation and wiring of the connector to ensure a proper match to the connector on the Control Unit.



Important:
1. The connection pinouts refer to the actual connectors on the Control Unit.
2. The 24 Vdc supply must be Class 2 or limited in voltage/current to ensure no excessive voltage/current can be drawn by the CU.

Figure 4-4 G120D CU250D-2 PROFIBUS terminal diagram

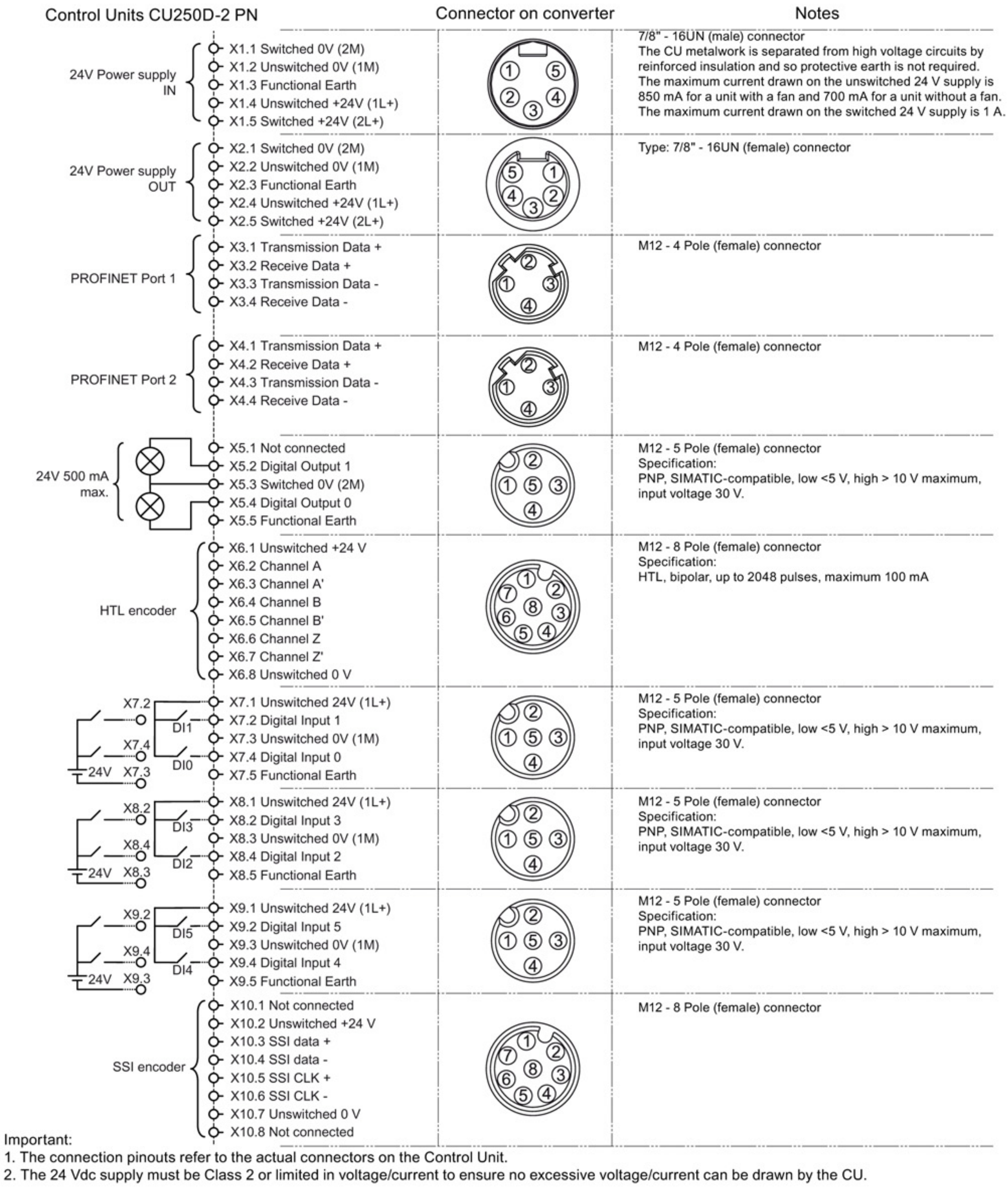
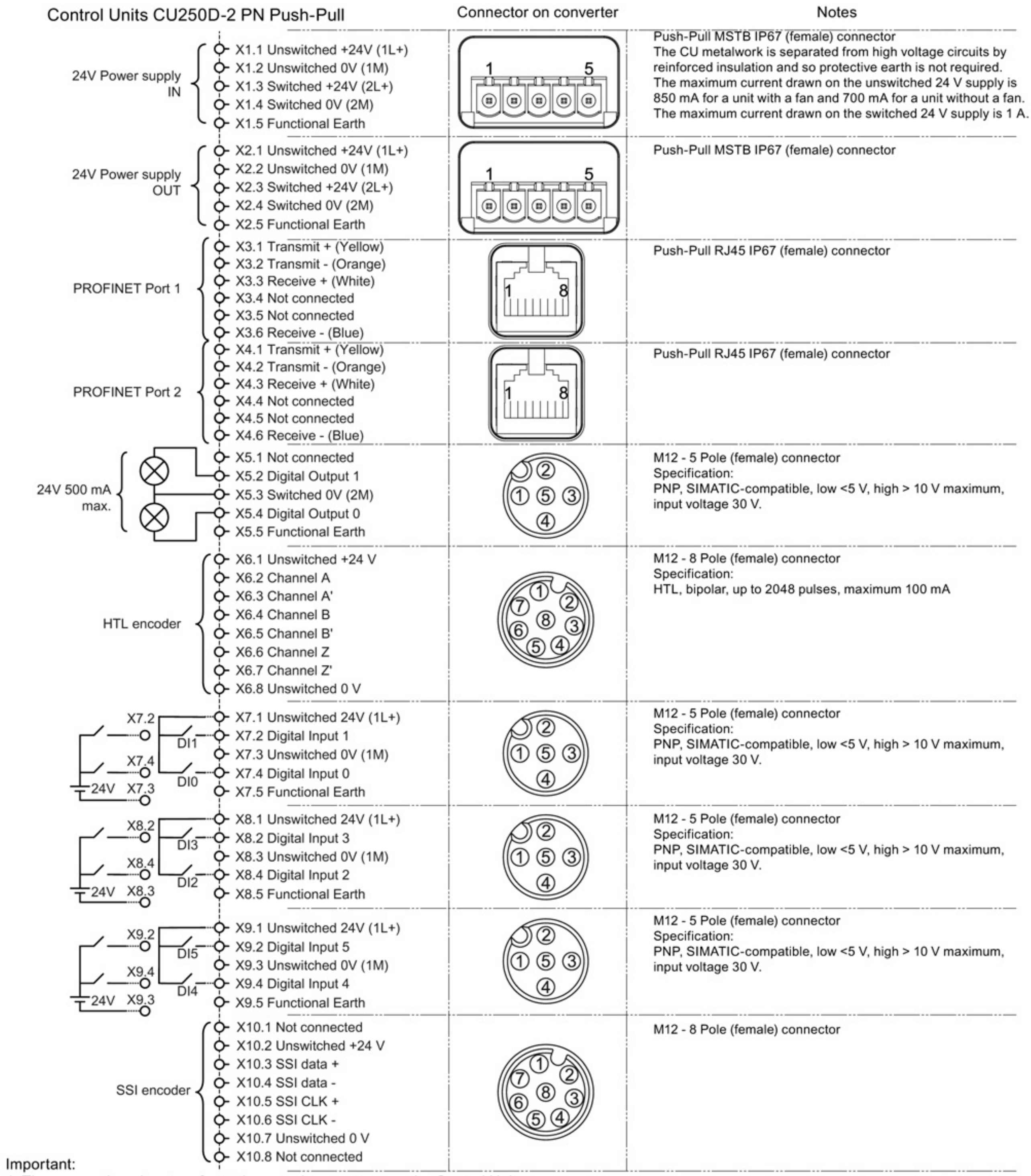


Figure 4-5 G120D CU250D-2 PROFINET terminal diagram



Important:
1. The connection pinouts refer to the actual connectors on the Control Unit.
2. The 24 Vdc supply must be Class 2 or limited in voltage/current to ensure no excessive voltage/current can be drawn by the CU.

Figure 4-6 G120D CU250D-2 PROFINET Push-Pull terminal diagram

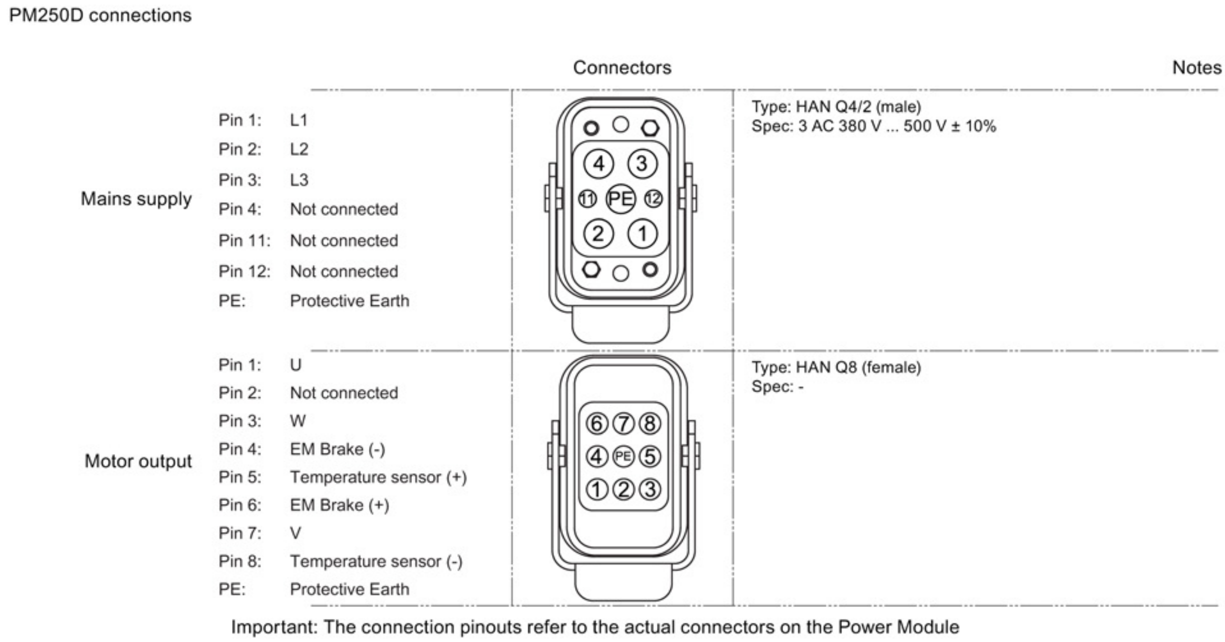


Figure 4-7 PM250D connections diagram

4.2.3 Grounding the inverter

It is essential that the inverter is grounded correctly to avoid sporadic trips and unpredictable EMC problems occurring during the operation of the inverter.

Grounding measures

Grounding the inverter and the connectors

- Ground the inverter via the PE connection in the mains supply connector.
- Ground the connectors as shown in the diagram below.
  Although the line supply and motor cable connectors are of a different type, the principle of grounding them is the same.

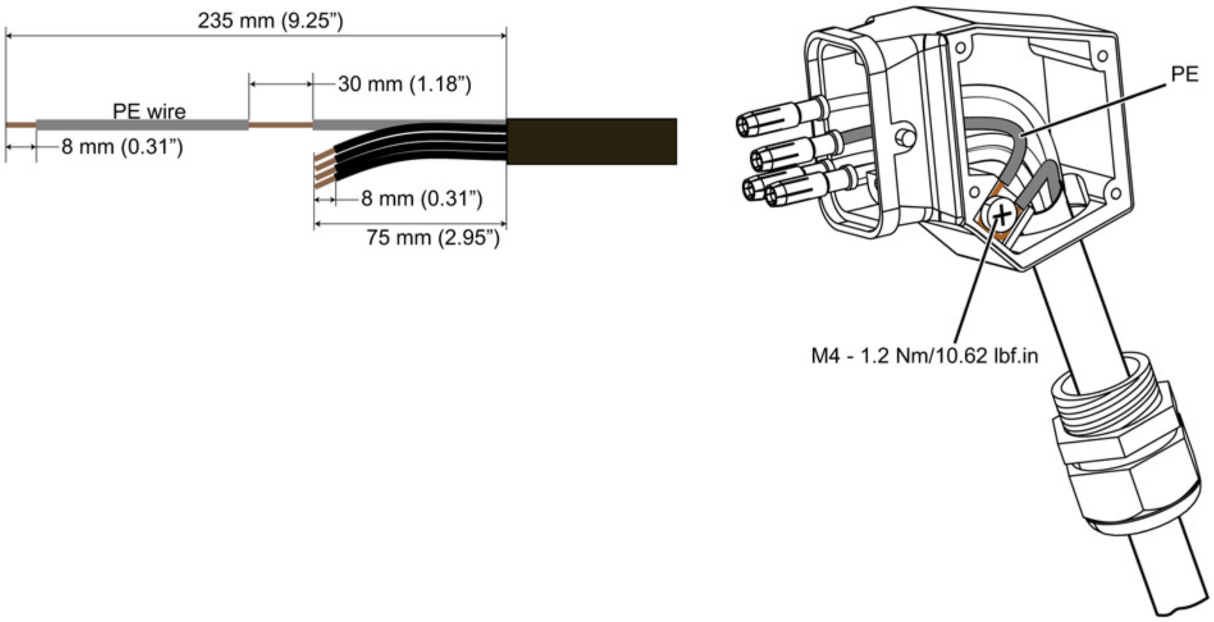


Figure 4-8 Grounding the line supply and motor connectors

Grounding the inverter housing

- Connect the PE terminal on the left-hand side of the inverter to the metal frame it is mounted on.
  Use a short wire connection preferably.
- Clean the connection to the steel construction from paint or dirt.
- Use a ring clamp to terminate the cable to ensure a good physical connection which is resistant to accidental disconnection.

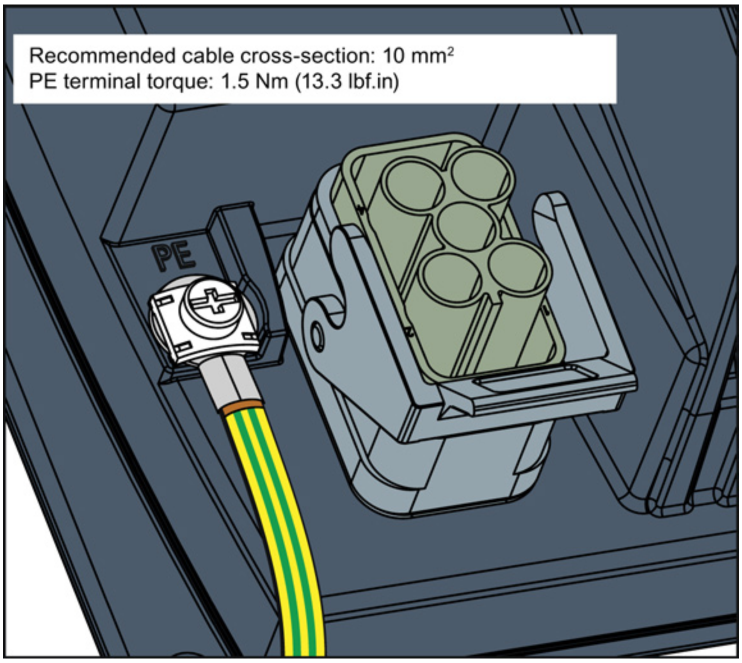


Figure 4-9 Grounding the inverter housing

EMC cable glands

Where cable glands are used within the installation of the system, it is recommended that EMC glands are used.

An example of an EMC cable gland is given in the figure below. The cable gland also provides protection to the IP68 standard when fitted correctly.

Figure 4-10 Example of a Blueglobe EMC cable gland

Brass-nickel plated EMC cable gland with metric thread as per EN50262. IP68 protection with up to 15 bar pressure.

Connection thread/length			Clamping range without inlet max/min [mm]	Clamping range max/min [mm]	Spanner width SW * E	Order No.
A	D [mm]	C [mm]				
M16 x 1.5	6.0	29	11 … 7	9 … 7	20 x 22.2	bg216mstri
M20 x 1.5	6.5	29	14 … 9	12 … 7	24 x 26.5	bg220mstri
M25 x 1.5	7.5	29	20 … 13	16… 10	30 x 33	bg255mstri
M32 x 1.5	8.0	32	25 … 20	20 … 13	36 x 39.5	bg232mstri

4.2.4 Connections and interference suppression

All connections should be made so that they are permanent. Screwed connections on painted or anodized metal components must be made either by means of special contact washers, which penetrate the isolating surface and establish a metallically conductive contact, or by removing the isolating surface on the contact points.

Contactor coils, relays, solenoid valves, and motor holding brakes must have interference suppressors to reduce high-frequency radiation when the contacts are opened (RC elements or varistors for AC currentoperated coils, and freewheeling diodes for DC current-operated coils). The interference suppressors must be connected directly on each coil.

4.2.5 Basic EMC Rules

Measures to limit Electromagnetic Interference (EMI)

Listed below are the necessary measures that must be taken to ensure the correct installation of the Inverter within a system, which will minimize the effect of EMI.

Cables

- Keep all cable lengths to the minimum possible length; avoid excessive cable lengths.
- Route always signal and data cables, as well as their associated equipotential bonding cables, in parallel and with as short a distance as possible.
- Don't route signal and data cables and line supply cables in parallel to motor cables.
- Signal and data cables and line supply cables should not cross motor cables; if crossing is necessary, they should cross at an angle of 90 °.
- Shield signal and data cables.
- Route particularly sensitive signal cables, such as setpoint and actual value cables, with optimum shield bonding at both ends and without any interruptions of the shield.
- Ground spare wires for signal and data cables at both ends.
- Route all power cables (line supply cables, as well as motor cables) separately from signal and data cables. The minimum distance should be approximately 25 cm. Exception: hybrid motor cables with integrated shielded temperature sensor and brake control wires are allowed.
- Shield the power cable between inverter and motor. We recommend shielded cables with symmetrical three-phase conductors (L1, L2, and L3) and an integrated, 3-wire, and symmetrically arranged PE conductor.

Cable shields

- Use shielded cables with finely stranded braided shields. Foil shields are not suitable since they are much less effective.
- Connect shields to the grounded housings at both ends with excellent electrical conductivity and a large contact area.
- Bond the cable shields to the plug connectors of the inverter.
- Don't interrupt cable shields by intermediate terminals.
- In the case of both, the power cables and the signal and data cables, the cable shields should be connected by means of suitable EMC shield clips or via electrically conductive PG glands. These must connect the shields to the shield bonding options for cables and the unit housing respectively with excellent electrical conductivity and a large contact area.
- Use only metallic or metallized connector housings for shielded data cables (e. g. PROFIBUS cables).

4.2.6 Equipotential bonding

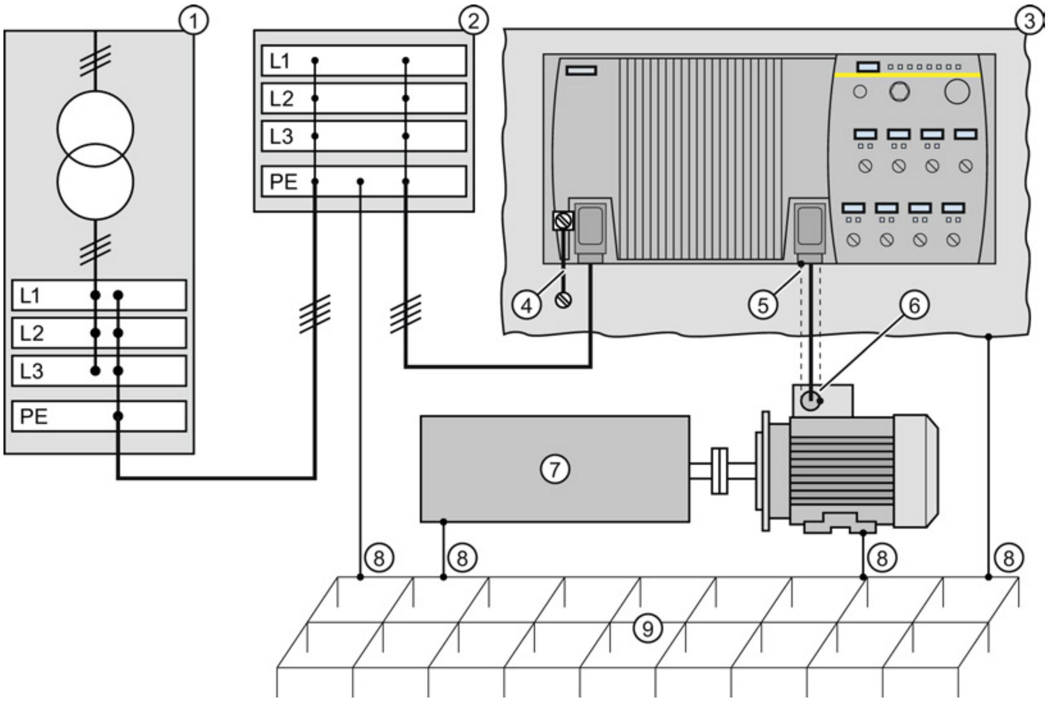
Grounding and high-frequency equipotential bonding measures

Equipotential bonding within the drive system has to be established by connecting all electrical and mechanical drive components (transformer, motor and driven machine) to the grounding system. These connections are established by means of standard heavy-power PE cables, which do not need to have any special high-frequency properties.

In addition to these connections, the inverter (as the source of the high-frequency interference) and the motor must be interconnected with respect to the high-frequency point of view:

1. Use a shielded motor cable.
2. Connect the cable shield both to the motor connector on the inverter and to the motor terminal box.
3. Use a short grounding connection from the PE terminal on the inverter to the metal frame.

The following figure illustrates all grounding and high-frequency equipotential bonding measures using an example.



① Transformer
② Second level distribution with PE equipotential bonding
③ Metal frame
④ Short connection from the PE terminal to the metal frame.
⑤ Electrical connection of motor cable shield and connector body.
⑥ Electrical connection of motor cable shield and motor terminal box via electrically conductive PG gland.
⑦ Driven machine
⑧ Conventional grounding system.
- Standard, heavy-power PE conductors without special high-frequency properties.
- Ensures low frequency equipotential bonding as well as protection against injury.

⑨ Foundation ground

Figure 4-11 Grounding and high-frequency equipotential bonding measures in the drive system and in the plant

For general rules for EMC compliant installation see also: EMC design guidelines (http://support.automation.siemens.com/WW/view/en/60612658/0/en)

4.2.7 Cable protection

Cable protection for individual converters

If you individually protect a converter, then you must protect the converter feeder cable using a fuse.

Table 4- 8 Individual fuse protection

Rated power	Power Module	Frame size	Fuse		Circuit-breaker
0.75 kW	6SL3525-0PE17-5AA1	FSA	10 A	3NA3803	3RV1021-1JA10
1.5 kW	6SL3525-0PE17-5AA1	FSA	10 A	3NA3803	3RV1021-1JA10
3 kW	6SL3525-0PE17-5AA1	FSB	16 A	3NA3805	3RV1021-4AA10
4 kW	6SL3525-0PE17-5AA1	FSC	20 A	3NA3807	3RV1021-4BA10
5.5 kW	6SL3525-0PE17-5AA1	FSC	20 A	3NA3807	3RV1021-4BA10
7.5 kW	6SL3525-0PE17-5AA1	FSC	32 A	3NA3812	3RV2021-4PA10

UL-approved circuit-breakers or UL-approved fuses must be used in North America. For additional information, please refer to Catalog D31.

Installation with power bus

For installations with several converters, the converters are normally supplied from a 400 V power bus using T distributors.

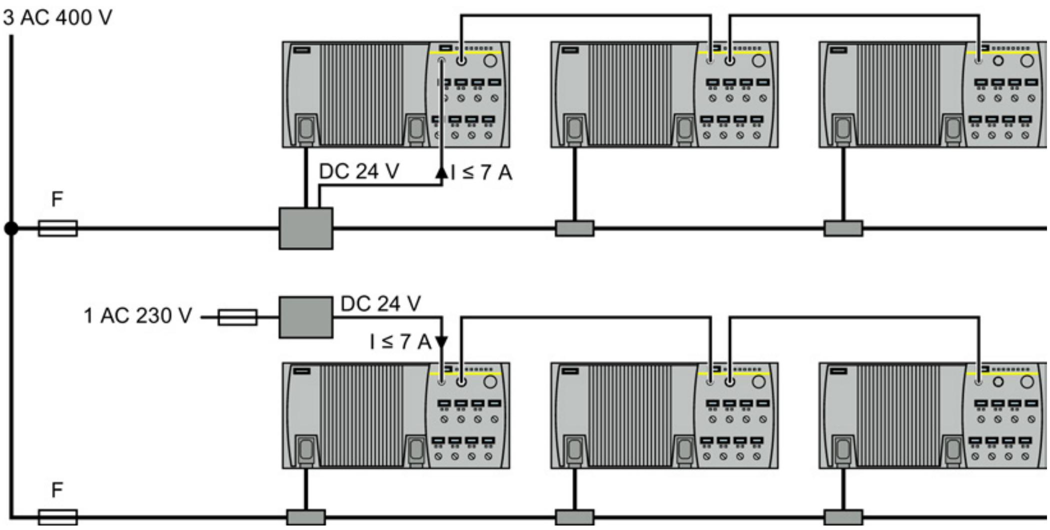


Figure 4-12 Converter supplied via a power bus

The following options are available for the 24 V supply of the converter:

1. A T distributor with integrated power supply unit supplies the 24 V.
   Advantage: Low installation costs.
2. An external power supply unit supplies the 24 V.
   Advantage: You can disconnect the 400 V without interrupting the 24 V supply and therefore without interrupting the fieldbus communication of the converter.

The converter can conduct a maximum current of 7 A through its 24 V connector.

Cable protection

Cable protection depends on the following conditions:

- Cable routing type.
- Limit values of the cables and system components, e.g. the T distributor.
- Country-specific guidelines.

If no other restrictions apply, then select the power bus fusing according to the following table.

Table 4- 9 Maximum fusing of the power bus

Rated power of the smallest converter connected to the power bus	Maximum permissible fusing [1]		Circuit-breaker
0.75 kW	32 A	3NA3812	3RV1031-4FA10
1.5 kW	32 A	3NA3812	3RV1031-4FA10
3 kW	32 A	3NA3812	3RV1031-4FA10
4 kW	35 A	3NA3814	3RV1031-4FA10
5.5 kW	45 A	3NA3820	3RV1031-4HA10
7.5 kW	63 A	3NA3822	3RV1041-4KA10

[1] The values do not apply to installations conforming to UL specifications.

Example

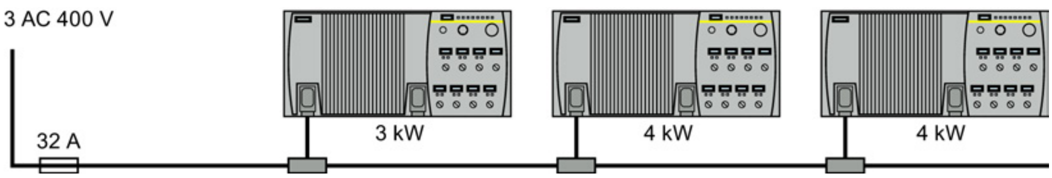


Figure 4-13 Fusing several converters connected to a power bus

The maximum permissible fusing of 32 A is based on the converter with the lowest rated power of 3 kW.

If the converters are never simultaneously in operation, then also lower cable cross-sections are permissible and smaller fuses are required.

4.2.8 Connecting the PROFINET interface

Industrial Ethernet Cables and cable length

Listed in the table below are the recommended Ethernet cables.

Table 4- 10 Recommended PROFINET cables

	Max. Cable Length	Order Number
Industrial Ethernet FC TP Standard Cable GP 2 x 2	100 m (328 ft)	6XV1840-2AH10
Industrial Ethernet FC TP Flexible Cable GP 2 x 2	85 m (278 ft)	6XV1870–2B
Industrial Ethernet FC Trailing Cable GP 2 x 2	85 m (278 ft)	6XV1870–2D
Industrial Ethernet FC Trailing Cable 2 x 2	85 m (278 ft)	6XV1840–3AH10
Industrial Ethernet FC Marine Cable 2 x 2	85 m (278 ft)	6XV1840–4AH10

Cable screening

The screen of the PROFINET cable must be connected with the protective earth. The solid copper core must not be scored when the insulation is removed from the core ends.

4.2.9 Finding a suitable setting for the interfaces

The inputs and outputs of the frequency inverter and the fieldbus interface have specific functions when set to the factory settings.

When you put the frequency inverter into operation, you can change the function of each of its inputs and outputs and the setting of the fieldbus interface.

To make the setting process easier, the inverter has various predefined assignments (macros).

Only the inputs and outputs whose functions change by selecting a specific assignment, are shown on the following pages.

Procedure

1
2

To select one of the inverter's pre-assigned settings, proceed as follows:

1. Think about which of the input and output functions you are using in the application.
2. Find the I/O configuration (macro) that best suits your application.
3. Note the macro number of the corresponding default setting.

   You must set this macro number when putting the frequency inverter into operation.

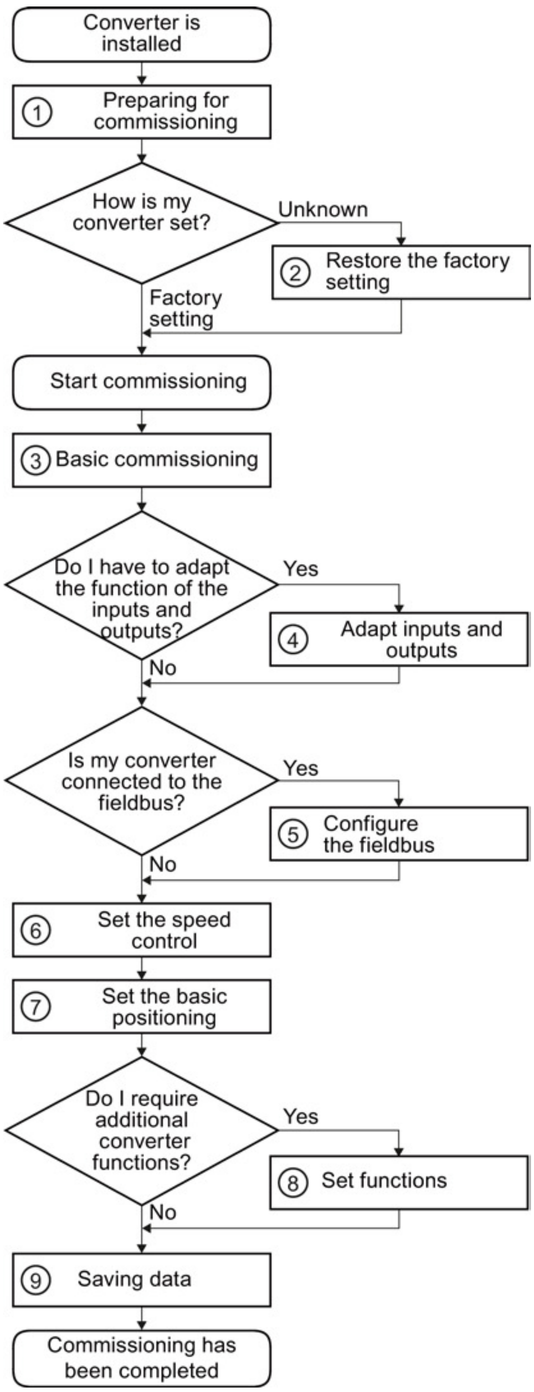
You have found the appropriate inverter pre-assignment.

Macro 26: Basic positioner via inputs and outputs; factory settings	**Macro 27: Basic positioner via fieldbus**
X7.4 DI 0 ON/OFF1 X7.2 DI 1 --- X8.4 DI 2 Acknowledge X8.2 DI 3 EPos jog 1 X9.4 DI 4 EPos jog 2 X9.2 DI 5 EPos jog type X10.3 AI 0 --- X5.4 DO 0 Fault X5.2 DO 1 Warning DI 5 = LOW: Incremental jogging DI 5 = HIGH: Jog velocity	PROFIdrive telegram 111 X7.4 DI 0 --- X7.2 DI 1 --- X8.4 DI 2 --- X8.2 DI 3 --- X9.4 DI 4 --- X9.2 DI 5 --- X10.3 AI 0 --- X5.4 DO 0 Fault X5.2 DO 1 Warning

Commissioning 5

5.1 Commissioning guidance

The converter must match the motor and the drive application to be able to optimally operate and protect the motor. We recommend a certain procedure when commissioning your converter.



Explanation of the commissioning steps:

① Prepare commissioning (Page 48)

② Restoring the factory setting (Page 56)

③ Basic commissioning with STARTER (Page 57) orOperator Panel

④ Adapt inputs and outputs (Page 67)

⑤ Configure field bus (Page 71)

⑥ Motor control (Page 135)

⑦ Basic positioner (Page 145)

⑧ Set functions (Page 115)

⑨ Data backup and series commissioning (Page 247)

5.2 Prepare commissioning

Overview

Before starting commissioning, you must answer the following questions:

- What data does my converter have?

  → SINAMICS G120D CU250D-2 Inverter (Page 19).
- What is the data for the connected motor?

  → Collecting motor data (Page 48).
- Which interfaces of the converter are active?

  → Wiring example for the factory settings (Page 50).
- Via which converter interfaces does the higher-level controller operate the drive?
- How is my converter set?

  → Factory setting of the inverter control (Page 52).
- What technological requirements must the drive fulfill?

  → Introduction, V/f control, vector control (Page 53).

  → Defining additional requirements for the application (Page 54).

5.2.1 Collecting motor data

Which motor is connected to the inverter?

If you are using the STARTER commissioning tool and a Siemens motor, you only need the motor order number. Otherwise, note down the data on the motor rating plate.

In which region of the world is the motor used?

- Europe IEC: 50 Hz [kW]
- North America NEMA: 60 Hz [hp] or 60 Hz [kW]

How is the motor connected?

Pay attention to the connection of the motor (star connection [Y] or delta connection [Δ]). Note the appropriate motor data for connecting.

What is the operating temperature of the motor?

For commissioning you need the motor environmental temperature if it varies from 20° C.

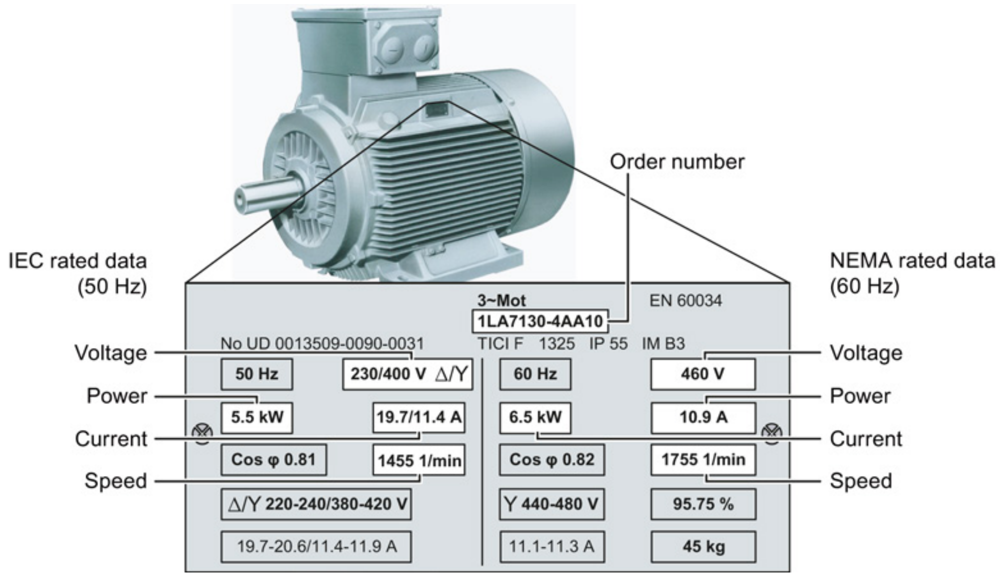


Figure 5-1 Motor data of the rating plate

5.2.2 Wiring example for the factory settings

To ensure that the factory setting can be used, you must wire your drive as shown in the following example.

Factory pre-assignment of the interfaces on the drive

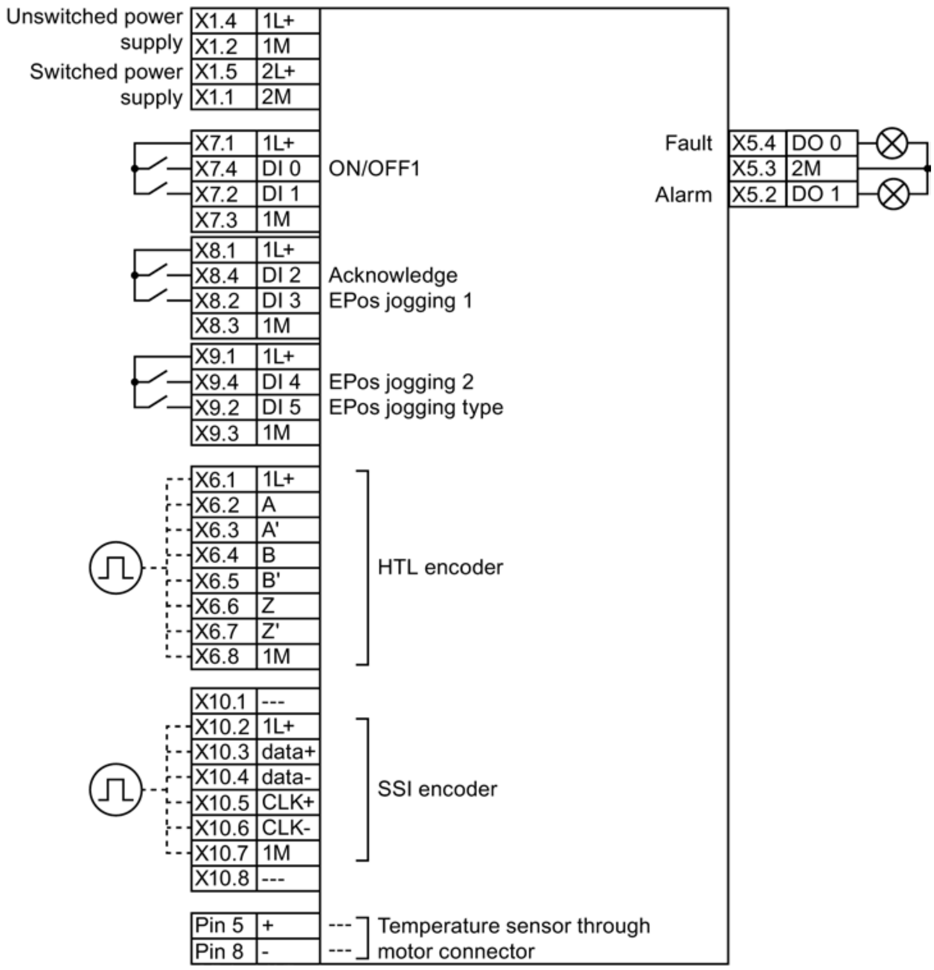


Figure 5-2 Wiring according to the factory setting of the drive

5.2.3 Which motor fits the converter?

The converter is preset on a motor at the factory as shown in the figure below.

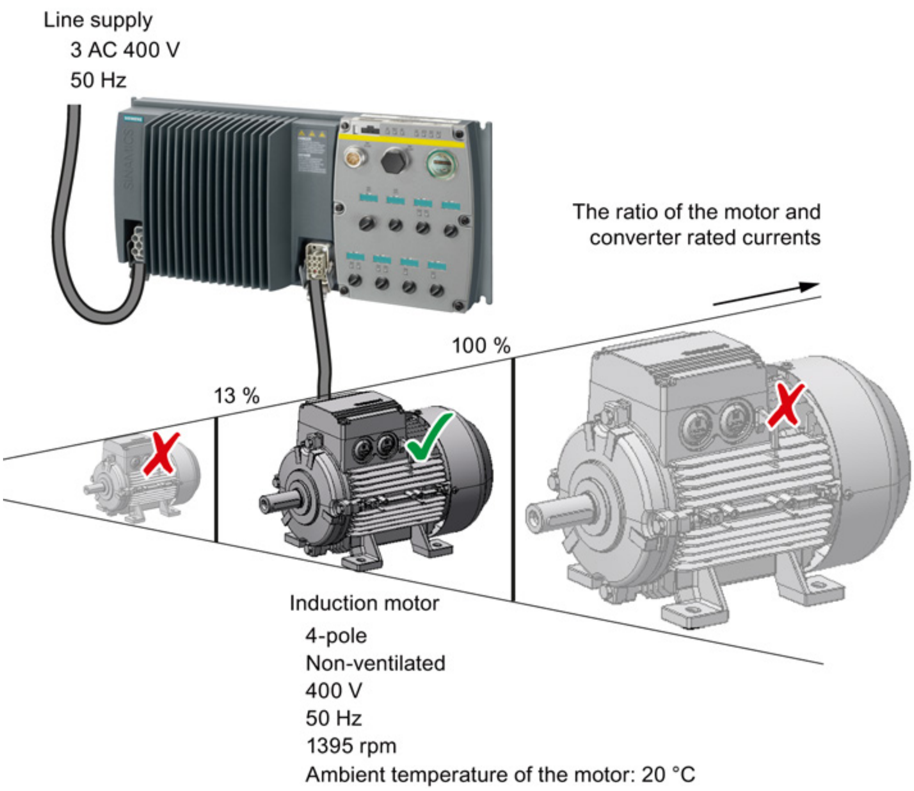


Figure 5-3 Motor data factory settings

The rated current of the motor must be in the range 13% to 100% of the rated converter current.
Example: With a converter with the rated current 10.2 A, you may operate induction motors whose rated currents are in the range 1.3 A to 10.2 A.

5.2.4 Factory setting of the inverter control

Switching the motor on and off

The inverter is set in the factory so that after it has been switched on, the motor accelerates up to its speed setpoint in 10 seconds (referred to 1500 rpm). After it has been switched off, the motor also brakes with a ramp-down time of 10 seconds.

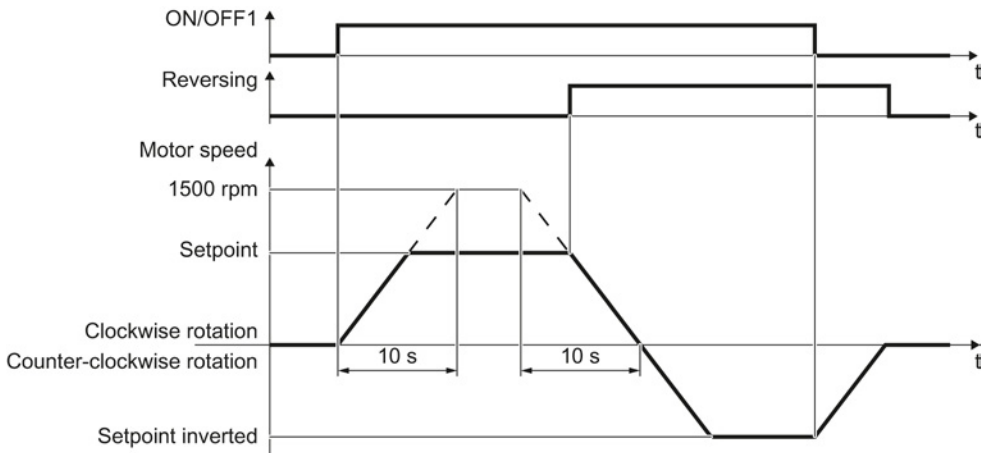


Figure 5-4 Switching on and switching off the motor and reversing in the factory setting

Switching the motor on and off in the jog mode

For inverters with PROFIBUS interface, operation can be switched over using digital input DI 3. The motor is either switched on and off via PROFIBUS – or operated in the jog mode via its digital inputs.

For a control command at the respective digital input, the motor rotates with ±150 rpm. The ramp-up and ramp-down times are also 10 seconds, referred to 1500 rpm.

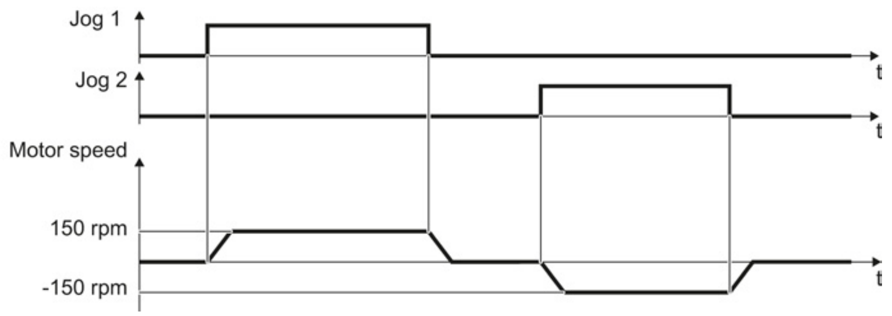


Figure 5-5 Jogging the motor in the factory setting

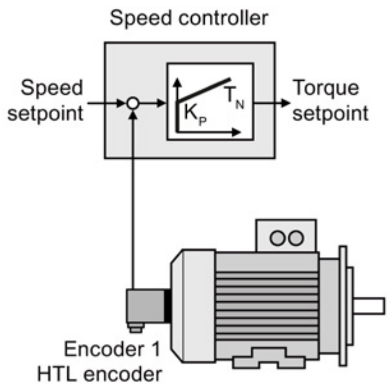
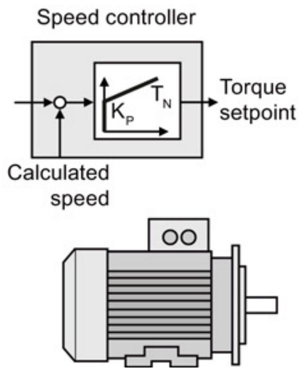
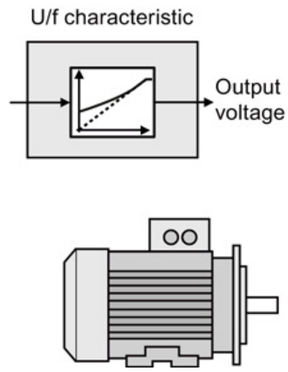
5.2.5 Introduction, V/f control, vector control

Specifying the control mode

The converter has three open-loop control and closed-loop control modes for induction motors:

- Open-loop control with U/f-characteristic (U/f control)
- Field-oriented control (sensorless vector control)
- Speed control (vector control with encoder)

The control modes have different degrees of suitability when it comes to controlling a position-controlled axis:

<table>
<tr><th>Vector control with encoder</th><th>Sensorless vector control</th><th>U/f control</th></tr>
<tr><td>
</td><td>
</td><td>
</td></tr>
<tr><td>With the position control, provides the best results</td><td>Limited functionality of the position control.
• Low accuracy
• Travel to fixed stop is not possible</td><td>Not recommended in conjunction with position control.
• Low accuracy
• Low dynamic response
• Travel to fixed stop is not possible</td></tr>
</table>

It is not permissible to use vector control in the following cases:

- If the motor is too small in comparison to the inverter (the rated motor power may not be less than one quarter of the rated inverter power)
- If several motors are connected to one inverter
- If a power contactor is used between the inverter and motor and is opened while the motor is powered up
- If the maximum motor speed exceeds the following values:

Inverter pulse frequency	2 kHz			4 kHz and higher		
Pole number of the motor	2-pole	4-pole	6-pole	2-pole	4-pole	6-pole
Maximum motor speed [rpm]	9960	4980	3320	14400	7200	4800

5.2.6 Defining additional requirements for the application

What speed limits should be set? (Minimum and maximum speed)

- Minimum speed - factory setting 0 [rpm]
  The minimum speed is the lowest speed of the motor independent of the speed setpoint. A minimum speed is, for example, useful for fans or pumps.
- Maximum speed - factory setting 1500 [rpm]
  The converter limits the motor speed to this value.

What motor ramp-up time and ramp-down time are needed for the application?

The ramp-up and ramp-down time define the maximum motor acceleration when the speed setpoint changes. The ramp-up and ramp-down time is the time between motor standstill and the maximum speed, or between the maximum speed and motor standstill.

- Ramp-up time - factory setting 10 s
- Ramp-down time - factory setting 10 s

5.2.7 Encoder assignment

Description

The converter offers three options of allocating encoders to the closed-loop control on the motor and load side.

Position controller operates with SSI encoder, speed controller with HTL encoder

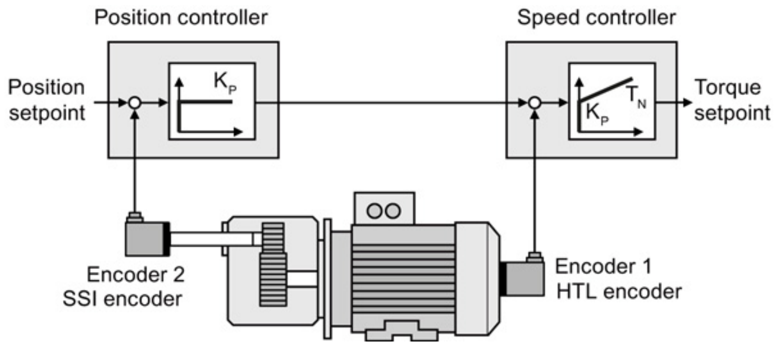


Figure 5-6 SSI encoder on the load side for the position controller, HTL encoder on the motor axis for the speed controller

Compared to the other options, the encoder assignment provides this configuration with the best control results.

Position and speed controllers operating with HTL encoder

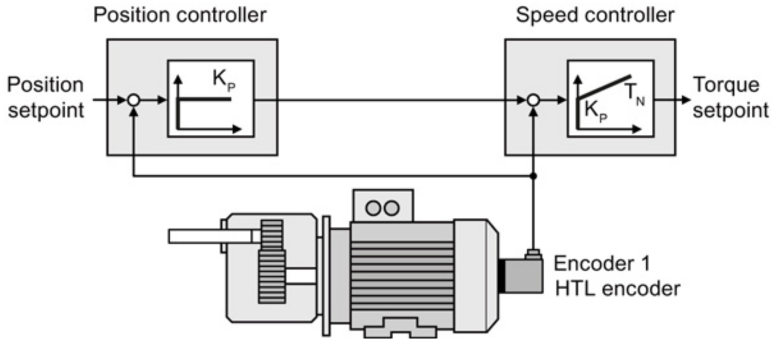


Figure 5-7 HTL encoder on the motor axis for position and speed controllers

Advantage: Favorably-priced solution.

Disadvantage: Depending on the gear ratio, restrictions regarding the accuracy of the position control.

Position controller operates with SSI encoder, speed controller without an encoder

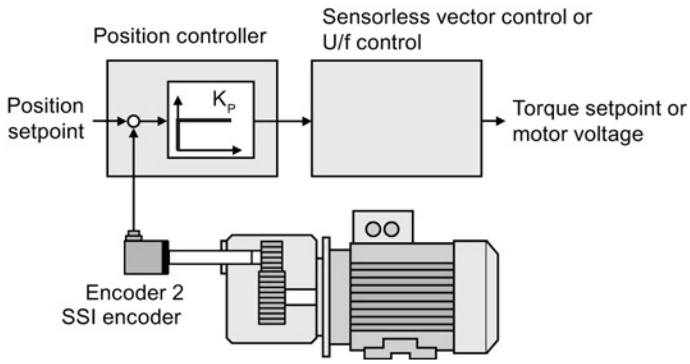


Figure 5-8 SSI encoder on the load side for the position controller, speed controller without an encoder

Advantage: Favorably-priced solution.

Disadvantages:
- Restrictions regarding the accuracy and dynamic performance of the position control
- Travel to fixed stop is not possible.

5.3 Restoring the factory setting

There are cases where something goes wrong when commissioning a drive system e.g.:

- The line voltage was interrupted during commissioning and you were not able to complete commissioning.
- You got confused during the commissioning and you can no longer understand the individual settings that you made.
- You do not know whether the inverter was already operational.

In cases such as these, reset the inverter to the factory settings.

Resetting the safety functions to the factory settings

If the safety functions are enabled in your inverter, then the safety function settings are password-protected. You must know the password to reset the safety function settings.

Procedure

Proceed as follows to restore the safety function settings in the inverter to the factory settings:

	
1. Go online 2. Call the safety functions screen form 3. In the "Safety Integrated" screen form, press the button for restoring the factory setting.	1. Set p0010 = 30 Activate reset settings. 2. p9761 = … Enter the password for the safety functions 3. Start the reset with p970 = 5 When the inverter has reset the settings, p0970 = 0.
4. Switch off the inverter power supply.	
5. Wait until all LEDs on the inverter go dark.	
6. Switch on the inverter power supply again.	

You have restored the safety function settings of your inverter to the factory settings.

Restoring the factory setting

1
2

Note

The communication settings and the settings of the motor standard (IEC/NEMA) are retained even after restoring the factory setting.

1. Go online
2. on the button

1. In the "Parameter" menu, select the according entry.
2. Confirm the reset using the OK key.

5.4 Basic commissioning with STARTER

STARTER and STARTER screen forms

STARTER is a PC-based tool to commission Siemens inverters. The graphic user interface of STARTER supports you when commissioning your inverter. Most inverter functions are combined in screen forms in STARTER.

The STARTER screen forms that are shown in this manual show general examples. You may therefore find that a screen contains more or fewer setting options than are shown in these instructions. A commissioning step may also be shown using an inverter other than the one you are using.

Overview: Commission the inverter in the online mode

We recommend that you commission the inverter using STARTER in the online mode. STARTER offers two options of going online with an inverter:

- Via the USB interface
- Via PROFIBUS or PROFINET

Precondition

You require the following to commission the inverter using STARTER:

- A pre-installed drive (motor and inverter)
- A computer with Windows XP or Windows 7, on which STARTER V4.3 or higher is installed.

  You can find updates for STARTER in the Internet under: Download STARTER (http://support.automation.siemens.com/WW/view/en/10804985/133100)

Procedure

Proceed as follows to carry out the basic commissioning of the inverter online using STARTER:

1. Adapt the inverter and PC interfaces:
   - Go online via USB
   - Go online via PROFINET

     Configure the communication between inverter and PC: Configuring the PROFINET communication with STEP 7 (Page 336).
2. Create a STARTER project (Page 61).
3. Go online and commission the inverter using the wizards (Page 62).

This means that you have completed the basic commissioning.

5.4.1 Adapting interfaces

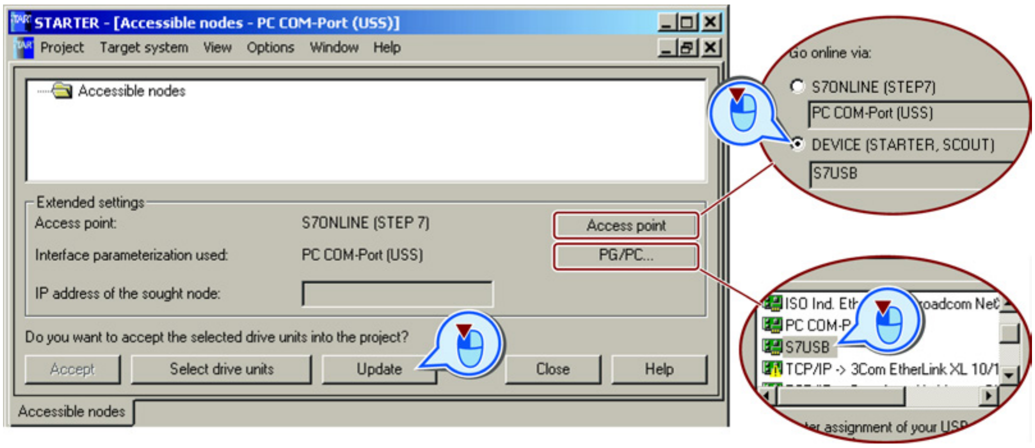
5.4.1.1 Adapting the USB interface

Procedure

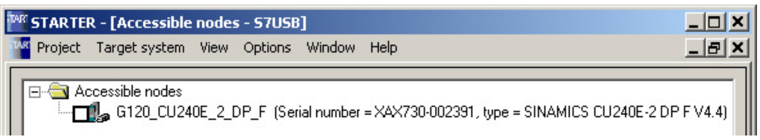
Proceed as follows to set the USB interface:

1. Switch on the converter power supply and connect the converter to the PC via USB.
2. The USB drivers are installed if you are connecting the converter and PC together for the first time. Windows 7 automatically installs the drivers without you having to take any action. For older Windows versions, acknowledge the corresponding screen forms with OK.
3. Start the STARTER commissioning software.
4. If you are using STARTER for the first time, you must check the USB interface setting. To do this, click in STARTER on ("Accessible nodes").
   If the interface is appropriately set, then the "Accessible nodes" screen form lists the converters, which are connected via the USB interface. In this case, go to Point 7.
   If incorrectly set, then the "No additional nodes found" message is displayed.

5. Acknowledge this message, and set the "Access point" to "DEVICE (STARTER, Scout)" and the "PG/PC interface" to "S7USB".



6. Then click on "Update". The connected converters are now displayed in "Accessible nodes".



7. Close this screen form without selecting the converter(s) that has/have been found.
8. Create your STARTER project (Page 61).

You have set the USB interface.

5.4.1.2 Adapting the PROFINET interface

If you commission the inverter with STARTER via PROFINET, then you must correctly address your PC and allocate STARTER the interface via which it goes online with the inverter.

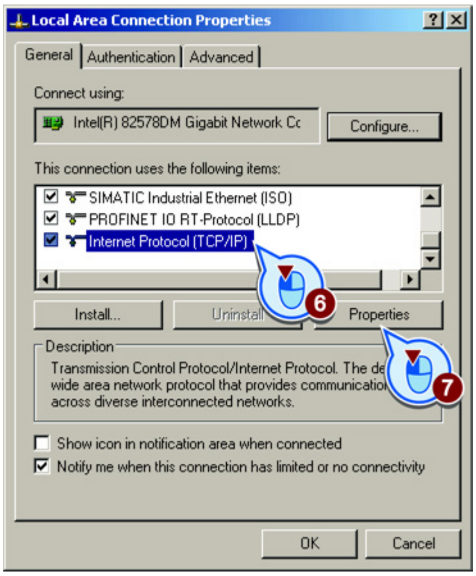
Procedure

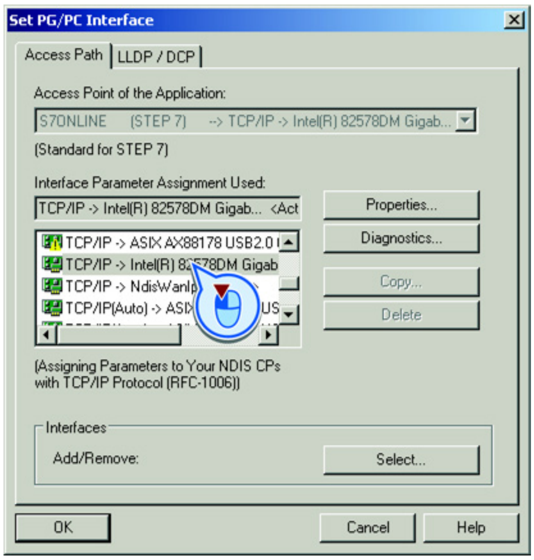
To address the inverter, proceed as follows:

1. Establish the bus connection.

   See Section Communication via PROFINET (Page 71))
2. From the control panel, assign the IP address and the subnet mask address to your computer:
3. Go to "Start/Settings/Control Panel".
4. Select "Network Connections".
5. Right-click to open the properties window of the LAN connection.
6. In this window, select "Internet Protocol (TCP/IP)".
7. Select "Properties".
8. Set 192.168.0.100 as the IP address of the supervisor and 255.255.255.0 as subnet mask.

   In the company network it is possible that the IP address and the subnet mask have different values. You can obtain these values from your network administrator.
9. Open the SIMATIC Manager.
10. Assign the TCP/IP interface to "Intel(R) PRO/100 VE Network Connection" via "Tools/PG/PC interface".





You have allocated your computer the IP address and the address of the subnet mask, and defined the PC interface via which STARTER goes online with the inverter.

Commissioning using STARTER

The following interfaces - which are control unit dependent - are available:

Table 5- 1 Connection possibilities for STARTER

Type	**USB**	**PROFIBUS**	**PROFINET**
PC connected to CU using	USB cable	PROFIBUS interface	PROFINET interface
Interface	Mini-USB	M12 - 5 pole connector	M12 - 4 pole connector
Restrictions	-	up to 125 slaves	None

In the following the commissioning via USB is described.

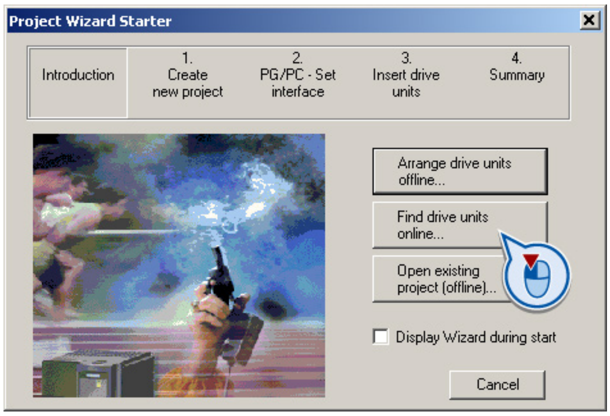
5.4.2 Generating a STARTER project

Creating a STARTER project using project wizards

Procedure

To create a project with the STARTER project Wizards, proceed as follows:

1. Using "Project / New with wizard" create a new project.
2. To start the wizard, click on "Search online for drive units ...".
3. Follow the instructions of the Wizard, and set everything that you require for your particular project.

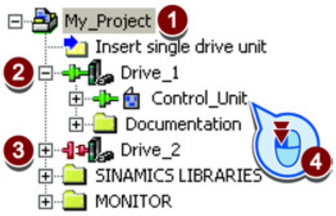


You have created your STARTER project.

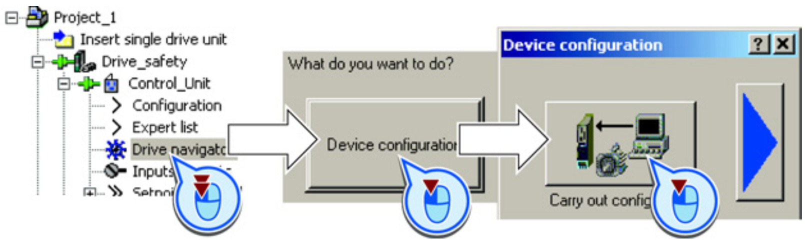
5.4.3 Go online and start wizard for basic commissioning

Procedure

Proceed as follows to start the basic commissioning online with the converter:



1. Select your project and go online: .
2. Select the device or the devices with which you wish to go online.
3. Download the hardware configuration found online in your project (PG or PC). STARTER shows you which converter it is accessing online and which offline:
   ② The converter is online
   ③ The converter is offline
4. When you are online, double-click on "Control Unit".
5. Start the wizard for basic commissioning.



You are online and have started basic commissioning.

5.4.4 Carry-out basic commissioning

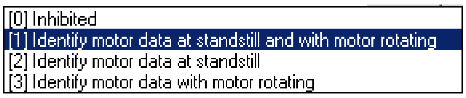
Procedure

Proceed as follows to carry out basic commissioning:

1.	☑ Control structure	Select the control mode. See also Section: U/f control or speed control?
2.	☑ Defaults of the setpoin	Select the default setting of the converter interfaces. See also Section: Finding a suitable setting for the interfaces (Page 45).
3.	☑ Drive setting	Select the application for the converter: Low overload for applications that only require a low dynamic performance, e.g. pumps or fans. High overload for applications requiring a high dynamic performance, e.g. conveyor systems.
4.	☑ Motor	Select your motor.
5.	☑ Motor data	Enter the motor data according to the rating plate of your motor. If you have selected a motor based on its order number, the data has already been entered.

6. ☑ Drive functions

If you have set the "Speed control" control mode, then we recommend setting "[1] Identify motor data at standstill and with motor rotating".



With this setting, the converter optimizes its speed controller.

If one of the following cases is applicable, select the setting "[2] Identify motor data at standstill":

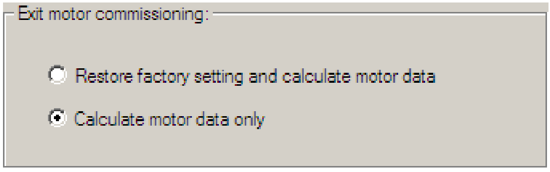
- You have selected "Speed control" as control mode, however the motor cannot freely rotate, e.g. for mechanically limited traversing sections.
- You have set "V/f control" as control mode.

7. ☑ Important parameters

Set the most important parameters to suit your application.

8. ☑ Calculation of the motc

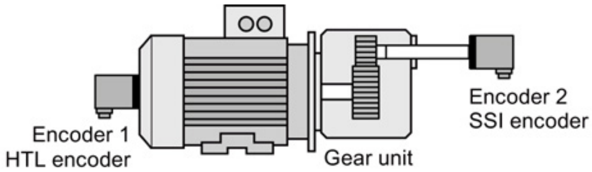
We recommend the setting "Calculate motor data only".



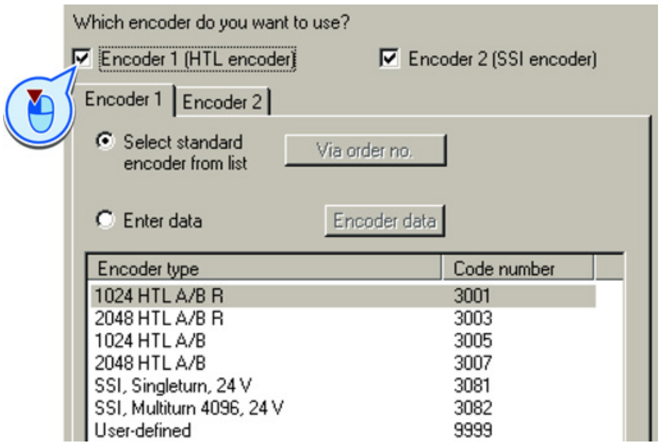
9. ☑ Encoder

The converter can evaluate up to two encoders (see also Section: Encoder assignment (Page 54)):

1. An HTL encoder on the motor shaft.
   The HTL encoder can be used for position sensing as well as for speed measurement for the speed controller.
2. An encoder with an SSI interface on the load side.
   You can use the SSI encoder only for position sensing.

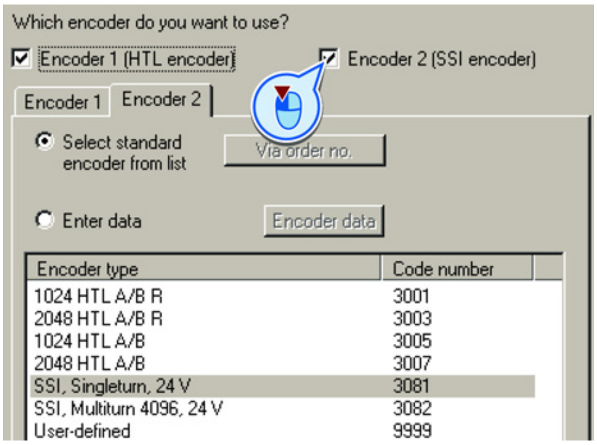


If you use an HTL encoder, either select one of the standard encoders or enter the encoder data, also see section: Setting a non standard HTL encoder (Page 328).

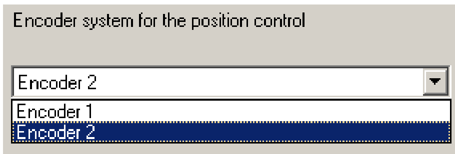


…R: Encoder with zero mark

If you use an SSI encoder, either select one of the standard encoders or enter the encoder data, also see section: Setting a non standard SSI encoder (Page 329).

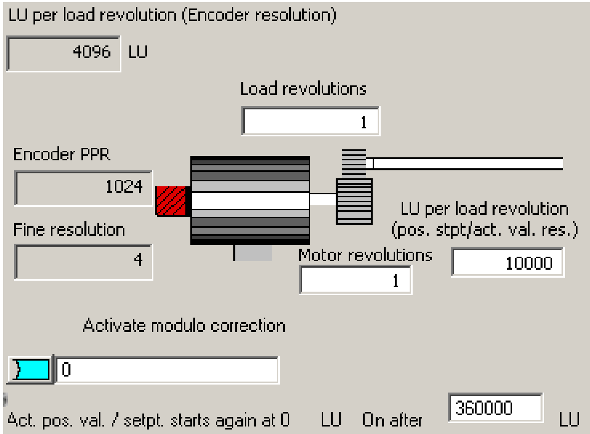


10. Measurement system — Select the encoder that you use for position sensing.

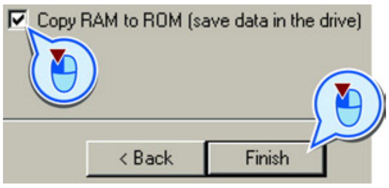


11. 

You may skip this screen initially. The settings are explained in the context of commissioning of the basic positioner in the section: Basic positioner (Page 145).



12. Set the check mark for "RAM to ROM (save data in the drive)" in order to save your data in the converter so that it is not lost when the power fails ①.



13. Close basic commissioning ②.

You have entered all of the data that is necessary for the basic commissioning of your converter.

5.4.5 Identifying motor data

Preconditions

- In the basic commissioning, you have selected the motor identification (MOT ID). In this case, after the basic commissioning has been completed, the converter issues the alarm A07991.
- The motor has cooled down to the ambient temperature.

  If the motor is too hot, the motor data identification will provide incorrect values and the closed-loop speed control will become unstable.

⚠ DANGER

Risk of injury or material damage as a result of machine movements when switching on the motor

Switching on the motor for identification purposes may result in hazardous machine movements.

Secure dangerous machine parts before starting motor data identification:

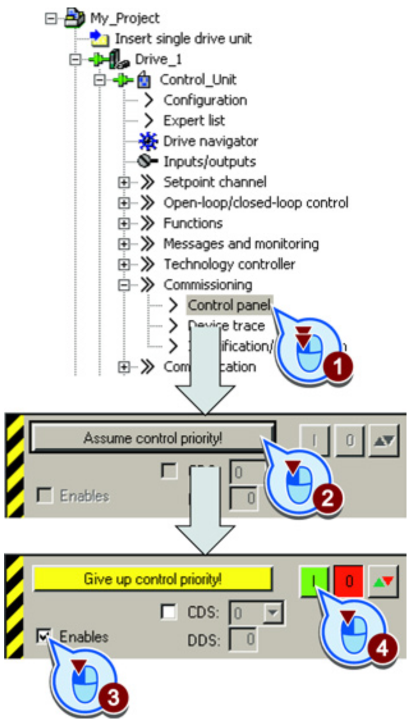
- Before switching on, check that no parts are loose on the machine or can be spun out.
- Before switching on, ensure that nobody is working on the machine or located within its working area.
- Secure the machine's work area against unintended access.
- Lower hanging/suspended loads to the floor.

Procedure

To initiate motor data identification and optimization of the motor control, proceed as follows:

1. Open by double-clicking on the control panel in STARTER.
2. Assume master control for the converter.
3. Set the "Enable signals"
4. Switch on the motor.

   The converter starts the motor data identification. This measurement can take several minutes. After the measurement, the converter switches off the motor.
5. Relinquish the master control after the motor data identification.
6. Click the Save (RAM to ROM) button.



You have now completed motor data identification and optimization.

Self-optimization of the closed-loop control

If you have also selected a rotating measurement with self-optimization of the speed control in addition to the motor data identification, then you must switch on the motor again as described above and wait for the optimization run to be completed.

6 Adapt inputs and outputs

This chapter describes how you adapt the function of individual inputs and outputs of the inverter.

If you adapt the function of an input or output, you overwrite the settings made during the basic commissioning.

See also the following chapter:

- Commissioning (Page 47)
- Finding a suitable setting for the interfaces (Page 45)
- Interconnect signals in the converter (Page **Fehler! Textmarke nicht definiert.**)

Figure 6-1 Internal interconnection of the inputs and outputs

6.1 Digital inputs

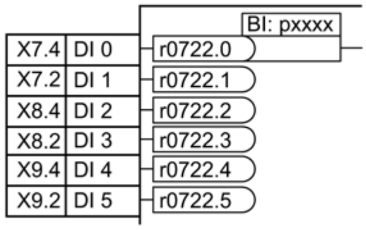
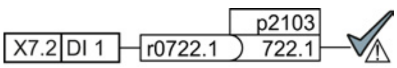
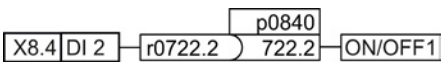
Digital inputs	Changing the function of the digital input
	Interconnect the status parameter of the digital input with a binector input of your choice. Binector inputs are marked with "BI" in the parameter list of the List Manual.

Table 6- 1 Binector inputs (BI) of the inverter (selection)

BI	Significance	BI	Significance
p0810	Command data set selection CDS bit 0	p1036	Motorized potentiometer, setpoint, lower
p0840	ON/OFF1	p1055	Jog bit 0
p0844	OFF2	p1056	Jog bit 1
p0848	OFF3	p1113	Setpoint inversion
p0852	Enable operation	p1201	Flying restart enable signal source
p0855	Unconditionally release holding brake	p2103	1. Acknowledge faults
p0856	Enable speed controller	p2106	External fault 1
p0858	Unconditionally close holding brake	p2112	External alarm 1
p1020	Fixed speed setpoint selection bit 0	p2200	Technology controller enable
p1021	Fixed speed setpoint selection bit 1	p3330	Two-wire/three-wire control, control command 1
p1022	Fixed speed setpoint selection bit 2	p3331	Two-wire/three-wire control, control command 2
p1023	Fixed speed setpoint selection bit 3	p3332	Two-wire/three-wire control, control command 3
p1035	Motorized potentiometer, setpoint, raise		

A complete list of the binector outputs is provided in the List Manual.

Table 6- 2 Examples:

	With operator panel	In STARTER
Acknowledge fault with digital input 1 	Set p2103 = 722.1	Go online and choose "Inputs/Outputs". Change the function of the input via the according screen form.
Switch-on motor with digital input 2 	Set p0840 = 722.1	

Advanced settings

You can debounce the digital input signal using parameter p0724.

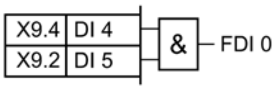
For more information, see the parameter list and the function block diagrams 2210 ff of the List Manual.

6.2 Fail-safe digital input

This manual describes the STO safety function with control using a fail-safe input. Additional safety functions, additional fail-safe digital inputs, the fail-safe digital output of the converter and the control of the safety functions using PROFIsafe are described in the Safety Integrated Function Manual.

Defining a fail-safe digital input

The converter combines digital inputs DI 4 and DI 5 to form a fail-safe digital input.

Pins of the fail-safe digital input	Function
	You must enable STO to select the STO safety function (Basic Safety) via FDI 0. Further information can be found in section Fail-safe function Safe Torque Off (STO) (Page 228).

What devices can be connected?

The fail-safe input is designed for the following devices:

- Connection of safety sensors, e.g. emergency stop command devices or light curtains.
- Connection of pre-processing safety relays, e.g. fail-safe controllers.

Signal states at the fail-safe input

The inverter expects signals with the same state at its fail-safe input:

- High signal: The safety function is deselected.
- Low signal: The safety function is selected.

Special measures for wiring of a fail-safe input

The inverter evaluates deviations in the two signals of the fail-safe input. The inverter thus detects, for example the following faults:

- Cable break
- Defective sensor

The inverter cannot detect the following faults:

- Cross-circuit of the two cables
- Short-circuit between signal cable and 24 V power supply

You have the following options to reduce the risk of damaged cables during operation of your machine or plant:

- Use shielded cables with grounded shield.
- Lay signal cables in steel pipes.

These special types of cable routing are normally required only if the cables are laid over larger distances, e.g. between remote control cabinets.

Examples of connecting a fail-safe input can be found in Section: Connecting fail-safe digital inputs (Page 352).

6.3 Digital outputs

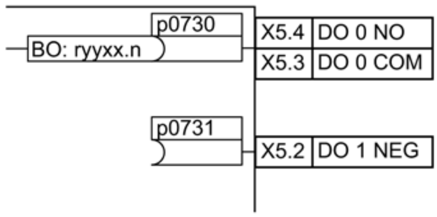
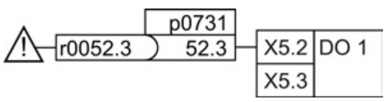
Digital output	Changing the function of the digital output
	Interconnect the digital output with a binector output of your choice. Binector outputs are marked with "BO" in the parameter list of the List Manual.

Table 6- 3 Binector outputs of the inverter (selection)

0	Deactivating digital output	r0052.9	Process data control
r0052.0	Drive ready	r0052.10	f_actual >= p1082 (f_max)
r0052.1	Drive ready for operation	r0052.11	Alarm: Motor current/torque limit
r0052.2	Drive running	r0052.12	Brake active
r0052.3	Drive fault active	r0052.13	Motor overload
r0052.4	OFF2 active	r0052.14	Motor CW rotation
r0052.5	OFF3 active	r0052.15	Inverter overload
r0052.6	Closing lockout active	r0053.0	DC braking active
r0052.7	Drive alarm active	r0053.2	f_actual > p1080 (f_min)
r0052.8	Setpoint/actual value discrepancy	r0053.6	f_actual ≥ setpoint (f_setpoint)

A complete list of the binector outputs is provided in the List Manual.

Table 6- 4 Example:

	With operator panel	In STARTER
Signal fault via digital output 1. 	Set p0731 = 52.3	Go online and choose "Inputs/Outputs". Change the function of the output via the according screen form.

Advanced settings

You can invert the signal of the digital output using parameter p0748.

For more information, see the parameter list and the function block diagram 2241 of the List Manual.

7 Configure field bus

7.1 Communication via PROFINET

The Control Unit provides the following functions

- IRT without isochronous mode
- MRP Media redundancy, not bumpless with 200 ms
  Precondition: Ring topology
- MRPD Media redundancy, bumpless
  Precondition: IRT and the ring topology created in the control
- Diagnostic alarms According to error classes specified in the PROFIdrive profile. See Activate diagnostic messages via STEP 7 (Page 341).
- Device replacement without removable data storage medium Precondition: Topology created in the control
- Shared Device Only for Control Units with fail-safe functions (see Safety Function Manual)

The Control Units have two RJ45 sockets, which you can use to implement a line topology. You can implement all topologies by using switches.

Additional information on PROFINET in the Internet

General information about PROFINET can be found at Industrial Communication (http://support.automation.siemens.com/WW/view/en/19292127).

The configuration of the functions is described in the PROFINET system description (http://www.automation.siemens.com/mcms/automation/en/industrial-communications/profinet/Pages/Default.aspx) manual.

7.1.1 What do you need for communication via PROFINET?

Check the communication settings using the following table. If you answer "Yes" to the questions, you have correctly set the communication settings and can control the converter via the fieldbus.

Questions	Answer/description	Example
Is the converter correctly connected to the PROFINET?	See: Connect the converter to PROFINET (Page 72)	
Do the IP address and device name in the converter and controller match?	See Configuring communication to the control (Page 72)	See Configuring the controller and converter in HW Config (Page 337)
Is the same telegram set in the converter as in the higher-level controller?	Set the telegram in the converter, see: Select telegram – procedure (Page 73)	See: Configuring the controller and converter in HW Config (Page 337)
Are the signals that the converter and the controller exchange via PROFINET correctly interconnected?	PROFIdrive-compliant interconnection in the converter, see: PROFIdrive profile for PROFIBUS and PROFINET (Page 77)	See: STEP 7 program examples (Page 343)

7.1.2 Connect the converter to PROFINET

Connecting up

Connect the converter and your PG/PC to the control system using sockets X03 and X04.

The position of the connectors, their assignment as well as information on the required plugs and tools can be found in section: Connections and cables (Page 29).

7.1.3 Configuring communication to the control

Loading GSDML

In order to establish communication between the inverter and control system via PROFINET, you need the device file of the inverter "GSDML" for your control. You can then configure the communication.

Procedure

1
2

Proceed as follows to load the GSDML of the inverter:

Load the GSDML of the inverter into the PROFINET-Controller, i.e. into your control system. You can load the GSDML of your inverter in two ways:

- You can find the GSDML of the SINAMICS inverter on the Internet (http://support.automation.siemens.com/WW/view/en/22339653/133100).
- The GSDML is saved in the inverter. If you insert the memory card in the inverter and set p0804 = 12 , the GSDML will be written to the /SIEMENS/SINAMICS/DATA/CFG folder on the memory card as a compressed file (PNGSD.ZIP).

  Unpack the GSDML before you use the device file.

You have loaded the GSDML of the inverter.

7.1.4 Select telegram – procedure

Precondition

In the basic commissioning, you have selected a setting with fieldbus.

See also Section: Finding a suitable setting for the interfaces (Page 45).

Procedure

Proceed as follows to set a specific telegram in the inverter:

Using STARTER or an operator panel, set parameter p0922 to the appropriate value.

You have set a specific telegram in the inverter.

Table 7- 1 Parameters for setting the telegram

<table>
<tr><th>Parameter</th><th colspan="2">Description</th></tr>
<tr><td>p0015</td><td colspan="2">Macro drive unit
Configure the interface in basic commissioning, and select a telegram. See also the section: Finding a suitable setting for the interfaces (Page 45).</td></tr>
<tr><td rowspan="2">p0922</td><td colspan="2">PROFIdrive Telegram selection (factory setting: free telegram configuration with BICO)
Set the send and receive telegram, see Cyclic communication (Page 77)</td></tr>
<tr><td>7:
9
110:
111:
999:</td><td>Standard telegram 7, PZD-2/2
Standard telegram 9, PZD-10/5
SIEMENS telegram 110, PZD-12/7
SIEMENS telegram 111, PZD-12/12
See Extend telegrams and change signal interconnection (Page 91).</td></tr>
</table>

7.1.5 Activating diagnostics via the control

The converter provides the functionality to transmit fault and alarm messages (diagnostic messages) to the higher-level control according to the PROFIdrive error classes.

The functionality must be selected in the higher-level control (see example ofSTEP 7) and activated by powering up.

7.2 Communication via PROFIBUS

7.2.1 What do you need for communication via PROFIBUS?

Check the communication settings using the following table. If you answer "Yes" to the questions, you have correctly set the communication settings and can control the inverter via the fieldbus.

Questions	Description	Examples
Is the inverter correctly connected to the PROFIBUS?	See Section: Connect the converter to PROFIBUS (Page 74).	---
Have you configured the communication between the inverter and the higher-level controller?	See Section: Configuring communication to the control (Page 74)	See also Section: Configuring the PROFIBUS communication with STEP 7 (Page 333).
Do the addresses in the inverter and the higher-level controller match?		
Is the same telegram set in the higher-level controller and in the inverter?	Adapt the telegram in the inverter. See Section: Select telegram – procedure (Page 76).	
Are the signals that the inverter and the controller exchange via PROFIBUS correctly interconnected?	Adapt the interconnection of the signals in the controller to the inverter. For the PROFIdrive-compliant interconnection in the inverter, see also Section: PROFIdrive profile for PROFIBUS and PROFINET (Page 77).	See also Section: STEP 7 program examples (Page 343).

7.2.2 Connect the converter to PROFIBUS

Connecting up

Connect the converter and your PG/PC to the control system using sockets X03 and X04.

The position of the connectors, their assignment as well as information on the required plugs and tools can be found in section: Connections and cables (Page 29).

7.2.3 Configuring communication to the control

To configure communication between the inverter and control system, you generally require the description file GSD of the inverter.

When STEP 7 and STARTER are installed, you do not need GSD.

Procedure

Proceed as follows to configure communication to the control system using GSD:

1. Obtain the GSD file of the inverter.
   You have two options:
   - You can find the GSD of the SINAMICS inverter on the Internet (http://support.automation.siemens.com/WW/view/en/22339653/133100).
   - The GSD is saved in the inverter. If you insert the memory card in the inverter and set p0804 = 12 , the inverter writes the GSD to the /SIEMENS/SINAMICS/DATA/CFG folder on the memory card.
2. Import the GSD into the configuring tool of your control system.
3. Configure the communication between the control and the inverter in your control. n

You have configured the communication to the control system.

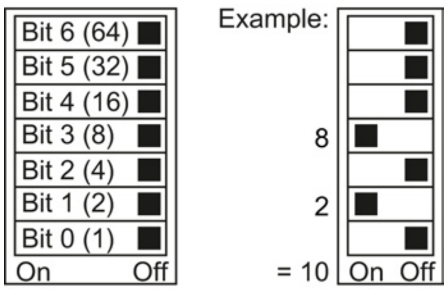
7.2.4 Setting the address

You set the PROFIBUS address of the inverter using the address switch on the Control Unit, using parameter p0918 or in STARTER.

Using parameter p0918 (factory setting: 126) or using STARTER, you can only set the address, if all address switches are set to "OFF" (0) or "ON" (1).

If you have specified a valid address using the address switches, this address will always be the one that takes effect and parameter p0918 cannot be changed.

Valid address range: 1 … 125



Procedure

To change the bus address, proceed as follows:

1. Set the address using one of the subsequently listed options:
   - using the address switches
   - with an operator panel using p0918
   - in STARTER using screen form "Control Unit/Communication/Fieldbus", or using the expert list with p0918
2. Switch on the inverter power supply and, if being used, the 24 V supply for the Control Unit.
3. Switch on the voltages again after all LEDs at the inverter have gone dark.

This means that you have changed the bus address.

7.2.5 Select telegram – procedure

Precondition

In the basic commissioning, you have selected a setting with fieldbus.

See also Section: Finding a suitable setting for the interfaces (Page 45).

Procedure

Proceed as follows to set a specific telegram in the inverter:

Using STARTER or an operator panel, set parameter p0922 to the appropriate value.

You have set a specific telegram in the inverter.

Table 7- 2 Parameters for setting the telegram

Parameter	Description	
p0015	**Macro drive unit** Configure the interface in basic commissioning, and select a telegram. See also the section: Finding a suitable setting for the interfaces (Page 45).	
p0922	**PROFIdrive Telegram selection** (factory setting: free telegram configuration with BICO) Set the send and receive telegram, see Cyclic communication (Page 77)	
	7: 9 110: 111: 999:	Standard telegram 7, PZD-2/2 Standard telegram 9, PZD-10/5 SIEMENS telegram 110, PZD-12/7 SIEMENS telegram 111, PZD-12/12 See Extend telegrams and change signal interconnection (Page 91).

7.3 PROFIdrive profile for PROFIBUS and PROFINET

7.3.1 Cyclic communication

The send and receive telegrams of the converter for cyclic communication are structured as follows:

PZD01	PZD02	PZD03	PZD04	PZD05	PZD06	PZD07	PZD08	PZD09	PZD10	PZD11	PZD12

Telegram 7, positioning operation with block selection

STW1	SATZ ANW
ZSW1	AKT SATZ

Telegram 9, positioning operation with direct input

STW1	SATZ ANW	STW2	MDI_TARPOS	MDI_VELOCITY	MDI_ ACC	MDI_ DEC	MDI_ MOD
ZSW1	AKT SATZ	ZSW2	XIST_A				

Telegram 110, positioning operation with extended control and status functions

STW1	SATZ ANW	POS_ STW	STW2	OVER RIDE	MDI_TARPOS	MDI_VELOCITY	MDI_ ACC	MDI_ DEC	MDI_ MOD
ZSW1	AKT SATZ	POS_ ZSW	ZSW2	MELDW	XIST_A				

Telegram 111, positioning operation with extended functions

STW1	POS_ STW1	POS_ STW2	STW2	OVER RIDE	MDI_TARPOS	MDI_VELOCITY	MDI_ ACC	MDI_ DEC	Free
ZSW1	POS_ ZSW1	POS_ ZSW2	ZSW2	MELDW	XIST_A	NIST_B	WARN_ CODE	FAULT_ CODE	Free

Telegram 999, open interconnection

STW1	Telegram length is configurable for receive data
ZSW1	Telegram length is configurable for send data

Figure 7-1 Telegrams for cyclic communication - Position control

Table 7- 3 Explanation of the abbreviations

Abbreviation	Explanation
STW1 ZSW1	Control word 1 Status word 1 see Control and status word 1 (Page 80)
STW2 ZSW2	Control word 2 Status word 2 see Control and status word 2 (Page 82)
SATZANW	Selection of traversing block see Control word block selection (Page 89)
AKTSATZ	Currently selected traversing block
MDI_TARPOS	Position setpoint for direct setpoint input (MDI)
XIST_A	Actual position value (32 bits)
OVERRIDE	Speed setpoint
MELDW	Status word for messages see Status word messages (Page 90)
NIST_B	Actual speed value (32 bits)
frei	Freely interconnectable
MDI_VELOCITY	MDI velocity
MDI_ACC	MDI acceleration
MDI_DEC	MDI deceleration
MDI_MOD	Selection of positioning mode with direct setpoint input (MDI) see Control word MDI mode (Page 90)
POS_STW	Control word for basic positioner
POS_ZSW	Status word for basic positioner
POS_STW1	Control word 1 for basic positioner
POS_ZSW1	Status word 1 for basic positioner see Control and status word 1 for the positioner (Page 85)
POS_STW2	Control word 2 for basic positioner
POS_ZSW2	Status word 2 for basic positioner see Control and status word 2 for the positioner (Page 87)
WARN_CODE	Number of the actual alarm
FAULT_CODE	Number of the actual fault

Interconnection of the process data

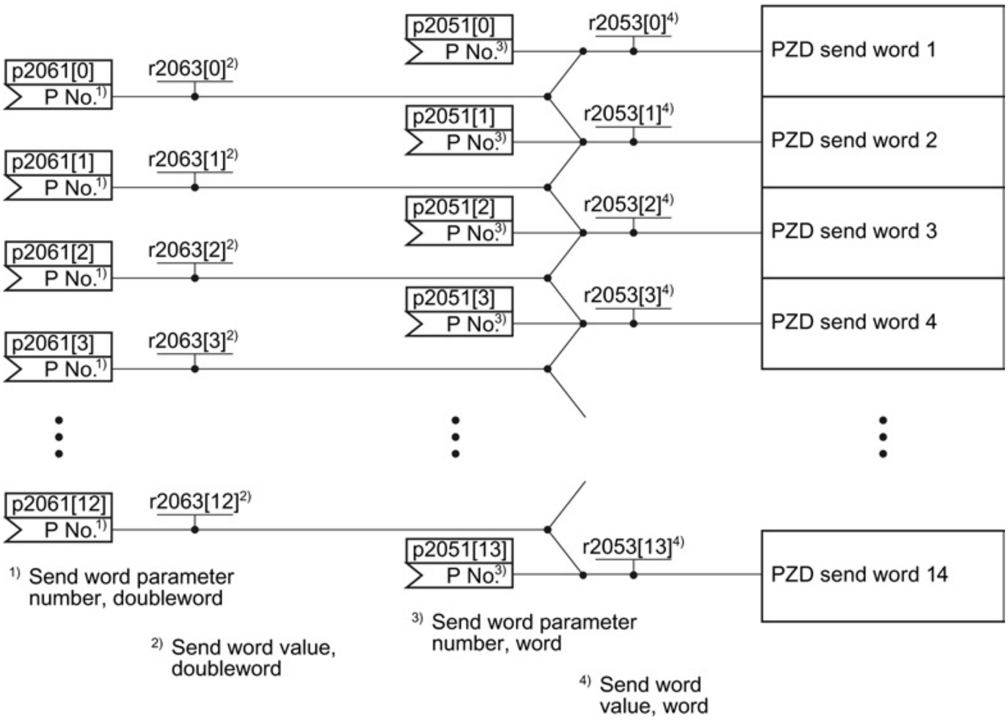


Figure 7-2 Interconnection of the send words

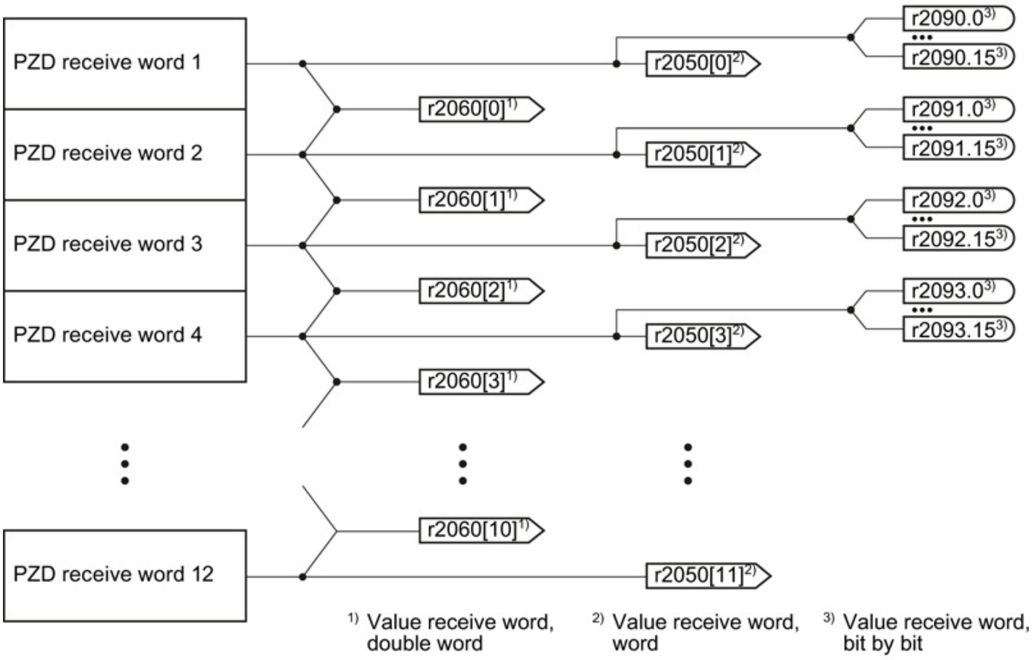


Figure 7-3 Interconnection of the receive words

If you require an individual telegram for your application, you can adapt one of the pre-defined telegrams using the parameters p0922 and p2079. For details, please refer to the List Manual, function diagrams 2420 and 2472.

7.3.1.1 Control and status word 1

Control word 1 (STW1)

Table 7- 4 Control word 1 for active basic positioner

Bit	Meaning	Comments	P No.
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.	
1	0 = OFF2	Switch off motor immediately, then the motor coasts to a standstill.	p0844[0] = r2090.1
	1 = No OFF2	It is possible to switch on the motor (ON command).	
2	0 = Quick stop (OFF3)	Quick stop: the motor brakes with the OFF3 ramp-down time p1135 down to standstill.	p0848[0] = r2090.2
	1 = No quick stop (OFF3)	It is possible to switch on the motor (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 = Reject traversing job	Axis brakes down to standstill with the maximum deceleration. Converter rejects the actual traversing block.	p2641 = r2090.4
	1 = Do not reject traversing task	Axis can be started or travel to position setpoint.	
5	0 = Intermediate stop	Axis brakes down to standstill with the specified deceleration override. Converter remains in the actual traversing block.	p2640 = r2090.5
	1 = No intermediate stop	Axis can be started or continue to travel to position setpoint.	
6	0 → 1: Activate traversing job	The converter starts axis travel to the setpoint position.	p2631 = r2090.6
	0 → 1: Setpoint transfer MDI		p2650 = r2090.6
7	0 → 1: = Acknowledge faults	Acknowledge fault in the converter. If the ON command is still active, the converter switches to "closing lockout" state.	p2103[0] = r2090.7
8	1 = jogging bit 0	Jogging 1	p2589 = r2090.7
9	1 = jogging bit 1	Jogging 2	p2590 = r2090.7
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	0 = Stop referencing	---	p2595 = r2090.11
	1 = Start referencing	The converter does not start referencing.	
12	Reserved		
13	0 → 1: External block change	The axis goes to the next traversing block.	p2633 = r2090.13
14, 15	Reserved		

Status word 1 (ZSW1)

Table 7- 5 Status word 1 when the basic positioner is active

Bit	Meaning		Comments	P No.
	Telegram 110	Telegram 111		
0	1 = Ready to start		Power supply is switched on; electronics initialized; pulses are inhibited.	p2080[0] = r0899.0
1	1 = Ready		Motor is switched on (ON command = 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 present		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 = Closing lockout active		It is only possible to switch on the motor after an OFF1 command and an additional ON command.	p2080[6] = r0899.6
7	1 = Alarm present		Motor remains switched on; no acknowledgment necessary.	p2080[7] = r2139.7
8	1 = Following error in tolerance		The actual difference between the actual position and the position setpoint is within the permissible tolerance p2546.	p2080[8] = r2684.8
9	1 = Control requested		The automation system is requested to accept the control from the converter.	p2080[9] = r0899.9
10	1 = Position setpoint reached		The axis has reached the position setpoint.	p2080[10] = r2684.10
11	1 = Reference point set		The axis is referenced.	p2080[11] = r2684.11
12	0 → 1 = Acknowledgement, traversing block active		---	p2080[12] = r2684.12
13	1 = Axis is at a standstill		The absolute speed is less than p2161.	p2080[13] = r2199.0
14	Reserved	1 = Axis accelerates	---	p2080[14] = r2684.4
15	Reserved	1 = Axis brakes	---	p2080[15] = r2684.5

7.3.1.2 Control and status word 2

Control word 2 (STW2)

Table 7- 6 Control word 2 and interconnection in the converter

Bit	Meaning	Comments	Interconnection	
			Telegram 9	Telegrams 110, 111
0	Drive data set selection DDS, bit 0		p0820[0] = r2092.0	p0820[0] = r2093.0
1	Drive data set selection DDS, bit 1		p0821[0] = r2092.1	p0821[0] = r2093.1
1 to 6	Reserved			
7	1 = Parking axis selection		p0897 = r2092.7	p0897 = r2093.7
8	1 = Travel to fixed stop		p1545[0] = r2092.8	p1545[0] = r2093.8
9 to 15	Reserved			

Status word 2 (ZSW2)

Table 7- 7 Control word 2 and interconnection in the converter

Bit	Meaning	Description	Interconnection
0	1 = Drive data set DDS effective, bit 0		p2081[0] = r0051.0
1	1 = Drive data set DDS effective, bit 1		p2081[1] = r0051.1
2 to 4	Reserved	---	
5	1 = Alarm class bit 0	Only for internal diagnostics when using a SIMOTION control.	p2081[5] = r2139.11
6	1 = Alarm class bit 1		p2081[6] = r2139.12
7	1 = Parking axis active	---	p2081[7] = r0896.0
8	1 = Travel to fixed stop	---	p2081[8] = r1406.8
9	Reserved	---	
10	1 = Pulses enabled	Motor switched on	p2081[10] = r0899.11
11 to 15	Reserved	---	p2081[11] = r0835.0

7.3.1.3 Control and status word for the positioner

Positioning control word (POS_STW)

Table 7- 8 POS_STW and interconnection with parameters in the converter

Bit	Meaning	Comments	P No.
0	1 = Follow-up mode	The converter continuously corrects the position setpoint to follow the position actual value.	p2655[0] = r2092.0
1	1 = Set reference point	The converter accepts the reference point coordinate in its position actual value and setpoint.	p2596 = r2092.1
2	1 = Reference cam active	The load is currently on the reference cam.	p2612 = r2092.2
3	Reserved	---	---
4			
5	1 = Incremental jogging active	If the jogging command is active, the converter positions the load by the specified traversing path in a positive or negative direction.	p2591 = r2092.5
	0 = Jogging velocity active	If the jogging command is active, the converter positions the load with the jog velocity in the direction of the beginning or end of the traversing range.	
6…15	Reserved	---	---

Positioning status word (POS_ZSW)

Table 7- 9 POS_ZSW and interconnection with parameters in the converter

Bit	Meaning	Comments	P No.
0	1 = Follow-up mode active	The converter is in the follow-up mode.	p2084[0] = r2683.0
1	1 = Velocity limiting is active	The converter limits the velocity of the axis.	p2084[1] = r2683.1
2	1 = Setpoint is stationary	During a positioning operation, the setpoint no longer changes.	p2084[2] = r2683.2
3	1 = Position setpoint reached	The axis position is within the positioning window.	p2084[3] = r2684.3
4	1 = Axis traverses forwards	The axis traverses in the positive direction.	p2084[4] = r2683.4
	0 = Axis is stationary or traverses backwards	---	
5	1 = Axis traverses backwards	The axis traverses in the negative direction.	p2084[5] = r2683.5
	0 = Axis is stationary or traverses forwards	---	
6	1 = Software limit switch, minus actuated	The load is outside the permitted traversing range.	p2084[6] = r2683.6
7	1 = Software limit switch, plus actuated		p2084[7] = r2683.7
8	1 = Position actual value ≤ cam switching position 1	Feedback of the software cams in the converter.	p2084[8] = r2683.8
	0 = Cam switching position 1 passed		
9	1 = Position actual value ≤ cam switching position 2		p2084[9] = r2683.9
	0 = Cam switching position 2 passed		
10	1 = Direct output 1 active	The converter sets these signals in the actual traversing block.	p2084[10] = r2683.10
11	1 = Direct output 2 active		p2084[11] = r2683.11
12	1 = Fixed stop reached	The axis is at the fixed stop	p2084[12] = r2683.12
13	1 = Fixed stop clamping torque reached	The axis is at the fixed stop and has reached the clamping torque.	p2084[13] = r2683.13
14	1 = Travel to fixed stop active	The converter moves the axis to a fixed stop.	p2084[14] = r2683.14
15	Reserved	---	---

7.3.1.4 Control and status word 1 for the positioner

Positioning control word 1 (POS_STW1)

Table 7- 10 POS_STW1 and interconnection in the converter

<table>
<tr><th>Bit</th><th colspan="2">Meaning</th><th>Comments</th><th>P No.</th></tr>
<tr><td>0</td><td colspan="2">Traversing block selection, bit 0</td><td rowspan="4">Selecting the traversing block</td><td>p2625 = r2091.0</td></tr>
<tr><td>1</td><td colspan="2">Traversing block selection, bit 1</td><td>p2626 = r2091.1</td></tr>
<tr><td>2</td><td colspan="2">Traversing block selection, bit 2</td><td>p2627 = r2091.2</td></tr>
<tr><td>3</td><td colspan="2">Traversing block selection, bit 3</td><td>p2628 = r2091.3</td></tr>
<tr><td>4 to 7</td><td colspan="2">Reserved</td><td>---</td><td>---</td></tr>
<tr><td rowspan="2">8</td><td colspan="2">0 = Relative positioning is selected</td><td>The converter interprets the position setpoint as the position setpoint relative to the start position.</td><td rowspan="2">p2648 = r2091.8</td></tr>
<tr><td colspan="2">1 = Absolute positioning is selected</td><td>The converter interprets the position setpoint as absolute position setpoint relative to machine zero point.</td></tr>
<tr><td>9</td><td rowspan="3"></td><td>01 = Absolute positioning for rotary axis in the positive direction</td><td rowspan="3">Selection of the positioning type for a rotary axis.</td><td>p2651 = r2091.9</td></tr>
<tr><td rowspan="2">10</td><td>10 = Absolute positioning for rotary axes in negative direction</td><td rowspan="2">p2652 = r2091.10</td></tr>
<tr><td>00, 11 = Absolute positioning for a rotary axis through the shortest distance</td></tr>
<tr><td>11</td><td colspan="2">Reserved</td><td>---</td><td>---</td></tr>
<tr><td rowspan="2">12</td><td colspan="2">1 = Continuous acceptance</td><td>The converter accepts position setpoint changes immediately.</td><td rowspan="2">p2649 = r2091.12</td></tr>
<tr><td colspan="2">0 = MDI block change with control word 1, bit 6</td><td>The converter accepts a changed position setpoint with the signal change 0 → 1 of control word 1, bit 6. See also Section: Control and status word 1 (Page 80).</td></tr>
<tr><td>13</td><td colspan="2">Reserved</td><td>---</td><td>---</td></tr>
<tr><td rowspan="2">14</td><td colspan="2">1 = Select Set up</td><td rowspan="2">Toggling the axis operating mode between "Set up" and "Positioning", see also Section: Direct setpoint input (MDI) (Page 197).</td><td rowspan="2">p2653 = r2091.14</td></tr>
<tr><td colspan="2">0 = Select positioning</td></tr>
<tr><td rowspan="2">15</td><td colspan="2">1 = Activate MDI</td><td rowspan="2">The converter receives its position setpoint from an external control.</td><td rowspan="2">p2647 = r2091.15</td></tr>
<tr><td colspan="2">0 = Deactivate MDI</td></tr>
</table>

Positioning status word 1 (POS_ZSW1)

Table 7- 11 POS_ZSW1 and interconnection in the converter

Bit	Meaning	Comments	P No.
0	Active traversing block bit 0 (2^0)	Number of the currently selected traversing block.	p2083[0] = r2670[0]
1	Active traversing block bit 1 (2^1)		p2083[1] = r2670[1]
2	Active traversing block bit 2 (2^2)		p2083[2] = r2670[2]
3	Active traversing block bit 3 (2^3)		p2083[3] = r2670[3]
4	Active traversing block bit 4 (2^4)		p2083[4] = r2670[4]
5	Active traversing block bit 5 (2^5)		p2083[5] = r2670[5]
6	Reserved	---	---
7			
8	1 = STOP cam minus active	The axis is currently located at a STOP cam.	p2083[08] = r2684[13]
9	1 = STOP cam plus active		p2083[09] = r2684[14]
10	1 = Jogging active	The converter is in the jogging mode.	p2083[10] = r2094[0]
11	1 = Reference point approach active	The converter is presently executing a reference point approach.	p2083[11] = r2094[1]
12	1 = Flying referencing active	The converter references when passing the reference cam.	p2083[12] = r2684[1]
13	1 = Traversing block active	The converter receives its position setpoint from a traversing block.	p2083[13] = r2094[2]
14	1 = Set up active	The axis is in the "Set up" operating mode.	p2083[14] = r2094[4]
15	1 = MDI active 0 = MDI inactive	The converter receives its position setpoint from an external control.	p2083[15] = r2670[15]

7.3.1.5 Control and status word 2 for the positioner

Positioning control word 2 (POS_STW2)

Table 7- 12 POS_STW2 and interconnection with parameters in the converter

Bit	Meaning	Comments	P No.
0	1 = Activate follow-up mode	The converter continuously corrects the position setpoint to follow the position actual value.	p2655[0] = r2092.0
1	1 = Set reference point	The converter accepts the reference point coordinate in its position actual value and setpoint.	p2596 = r2092.1
2	1 = Reference cam active	The axes is currently located at the reference cam.	p2612 = r2092.2
3	Reserved	---	---
4			
5	1 = Incremental jogging active	If the jogging command is active, the converter positions the axis by the specified traversing path in a positive or negative direction.	p2591 = r2092.5
	0 = Jogging velocity active	If the jogging command is active, the converter positions the axis with the jog velocity in the direction of the beginning or end of the traversing range.	
6	Reserved	---	---
7			
8	1 = Selects referencing using flying referencing	Select the referencing type.	p2597 = r2092.8
	0 = Selects referencing via the reference point approach		
9	1 = Starts reference point approach in negative direction	Select the start direction for automatic referencing.	p2604 = r2092.9
	0 = Starts reference point approach in positive direction		
10	1 = Selects probe 2	Edge of the probe input, with which the converter references its actual position value.	p2510[0] = r2092.10
	0 = Selects probe 1		
11	1 = Probe falling edge	Select the edge of the probe input, with which the converter references its actual position value.	p2511[0] = r2092.11
	0 = Probe, rising edge		
12	Reserved	---	---
13			
14	1 = Software limit switch active	The converter evaluates its software limit switch.	p2582 = r2092.14
15	1 = STOP cams active	Converter evaluates the stop cams.	p2568 = r2092.15

Positioning status word 2 (POS_ZSW2)

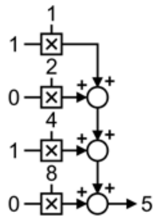
Table 7- 13 POS_ZSW2 and interconnection with parameters in the converter

Bit	Meaning	Comments	P No.
0	1 = Follow-up mode active	The converter is in the follow-up mode.	p2084[0] = r2683.0
1	1 = Velocity limiting is active	The converter limits the velocity of the axis.	p2084[1] = r2683.1
2	1 = Setpoint is stationary	During a positioning operation, the setpoint no longer changes.	p2084[2] = r2683.2
3	1 = Print index outside outer window	The discrepancy between the actual position and the reference point was greater than permitted during flying referencing.	p2084[3] = r2684.3
4	1 = Axis traverses forwards	The axis traverses in the positive direction.	p2084[4] = r2683.4
	0 = Axis is stationary or traverses backwards	---	
5	1 = Axis traverses backwards	The axis traverses in the negative direction.	p2084[5] = r2683.5
	0 = Axis is stationary or traverses forwards	---	
6	1 = Software limit switch, minus actuated	The axis is outside the permitted traversing range.	p2084[6] = r2683.6
7	1 = Software limit switch, plus actuated		p2084[7] = r2683.7
8	1 = Position actual value ≤ cam switching position 1	Feedback of the cam sequencer in the converter.	p2084[8] = r2683.8
	0 = Cam switching position 1 passed		
9	1 = Position actual value ≤ cam switching position 2		p2084[9] = r2683.9
	0 = Cam switching position 2 passed		
10	1 = Direct output 1 active	The converter sets these signals in the actual traversing block.	p2084[10] = r2683.10
11	1 = Direct output 2 active	See also paragraph: Traversing blocks (Page 183)	p2084[11] = r2683.11
12	1 = Fixed stop reached	The axis is at the fixed stop	p2084[12] = r2683.12
13	1 = Fixed stop clamping torque reached	The axis is at the fixed stop and has reached the clamping torque.	p2084[13] = r2683.13
14	1 = Travel to fixed stop active	The converter moves the axis to a fixed stop.	p2084[14] = r2683.14
15	1 = Traversing command active	Feedback signal indicating as to whether the converter is currently moving the axis.	p2084[15] = r2684.15
	0 = Axis stationary		

7.3.1.6 Control word block selection

Block selection

Table 7- 14 Block selection and interconnection in the converter

Bit	Meaning	Comments		P No.
0	Block selection, bit 0	Example for selecting traversing block number 5:		p2625 = r2091.0
1	Block selection, bit 1			p2626 = r2091.1
2	Block selection, bit 2			p2627 = r2091.2
3	Block selection, bit 3			p2628 = r2091.3
4…14	Reserved			
15	0 = Deactivate MDI	Switching from traversing blocks to direct setpoint input.		p2647 = r2091.15
	1 = Activate MDI			

Actual traversing block

Table 7- 15 Feedback signal of the actual traversing block

Bit	Meaning	Comments	P No.
0	Actual traversing block, bit 0	---	p2081[0] = r2670.0
1	Actual traversing block, bit 1		p2081[1] = r2670.1
2	Actual traversing block, bit 2		p2081[2] = r2670.2
3	Actual traversing block, bit 3		p2081[3] = r2670.3
4…14	Reserved		
15	0 = MDI active	---	p2081[15] = r2670.15
	1 = MDI not active		

7.3.1.7 Control word MDI mode

Table 7- 16 Selection of the MDI mode and interconnection with parameters in the converter

Bit	Meaning	Comments	P No.
0	0 = Relative positioning is selected	The converter interprets the position setpoint as the position setpoint relative to the start position.	p2648 = r2094.0
	1 = Absolute positioning is selected	The converter interprets the position setpoint as absolute position setpoint relative to machine zero point.	
1	01 = Absolute positioning for rotary axis in the positive direction	Selection of the positioning type for a rotary axis.	p2651 = r2094.1
2	10 = Absolute positioning for rotary axes in negative direction		p2652 = r2094.2
	00, 11 = Absolute positioning for a rotary axis through the shortest distance		
3…15	Reserved		

7.3.1.8 Status word messages (MELDW)

Table 7- 17 Status word for messages and interconnection with parameters in the converter

Bit	Meaning	Description	P No.
0	0 = Ramp-function generator active	The motor is presently accelerating or braking	p2082[0] = r2199.5
	1 = Ramp-up/ramp-down completed	Speed setpoint and actual speed are the same.	
1	1 = Torque utilization [%] < torque threshold value 2 (p2194)	---	p2082[1] = r2199.11
2	1 = |n_act| < speed threshold value 3 (p2161)	---	p2082[2] = r2199.0
3	1 = |n_act| speed threshold value 2 (p2155)	---	p2082[3] = r2197.1
4, 5	Reserved		
6	1 = No motor overtemperature alarm	The motor temperature is within the permissible range.	p2082[6] = r2135.14
7	1 = No alarm, thermal power unit overload	The converter temperature is within the permissible range.	p2082[7] = r2135.15
8	1 = Speed setpoint - actual value deviation within tolerance t_on	Speed setpoint and actual speed are within the permissible tolerance range p2163.	p2082[8] = r2199.4
9, 10	Reserved		
11	1 = Controller enable	The speed controller is enabled.	p2082[11] = r0899.8
12	1 = Drive ready	The converter is ready to be switched on.	p2082[12] = r0899.7
13	1 = Pulses enabled	The motor is switched on.	p2082[13] = r0899.11
14, 15	Reserved		

7.3.1.9 Function block FB283

Overview

The function block FB283 is an interface block that simplifies the connection of the converter with EPos to a SIMATIC S7 control via PROFIBUS / PROFINET.

The block FB283 transfers all of the required drive process data. It is particularly suitable for controlling the EPOS functions of the SINAMICS G120; it can also be used as a pure speed-controlled drive.

In addition, the FB283 provides the following functions:

- Reading and writing parameters in the converter.
- Reading out the fault buffer of the converter.
- Transferring up to 16 traversing blocks when a function is initiated.
- Reading or writing a maximum of any 10 parameters with one job, e.g. for product adaptation.

A project example and a description of the FB283 can be found on the Internet: FB283 (http://support.automation.siemens.com/WW/view/en/25166781).

7.3.1.10 Extend telegrams and change signal interconnection

Following selection of a telegram, the converter interconnects the corresponding signals with the fieldbus interface. The converter protects this interconnection against changes.

Extend telegram

If you want to extend a telegram, you have to do the following:

Table 7- 18 Procedure

<table>
<tr><th>Parameter</th><th colspan="2">Description</th></tr>
<tr><td rowspan="2">p0922 = 999</td><td colspan="2">PROFIdrive telegram selection</td></tr>
<tr><td>999:</td><td>Free telegram configuration with BICO</td></tr>
<tr><td rowspan="2">p2079</td><td colspan="2">PROFIdrive PZD telegram selection extended
Set the suitable telegram:</td></tr>
<tr><td>7:
9
110:
111:</td><td>Standard telegram 7, PZD-2/2
Standard telegram 9, PZD-10/5
SIEMENS telegram 110, PZD-12/7
SIEMENS telegram 111, PZD-12/12</td></tr>
<tr><td colspan="3">Now you can extend the telegram by interconnecting the PZD send words and PZD receive words with signals of your choice.</td></tr>
</table>

For further information refer to the function block diagrams 2468 and 2470 of the List Manual.

Change the signal interconnection of the telegram

If you want to change the signal interconnection or extend telegrams, you have to do the following:

Table 7- 19 Procedure

Parameter	Description	
p0922 = 999	**PROFIdrive telegram selection**	
	999:	Free telegram configuration with BICO
p2079 = 999	**PROFIdrive PZD telegram selection extended**	
	999:	Free telegram configuration with BICO
Now you can freely interconnect all signals of the fieldbus interface.		

For further information refer to the function block diagrams 2468 and 2470 of the List Manual.

7.3.1.11 Slave-to-slave communication

"Direct data exchange" is sometimes called "slave-to-slave communication" or "data exchange broadcast". Here, slaves exchange data without any direct involvement of the master.

Example: An inverter uses the actual speed value of another inverter as its speed setpoint.

Definitions

- **Publisher:** Slave, which sends data for direct data exchange.
- **Subscriber:** Slave, which receives the data for direct data exchange from the publisher.
- **Links and access points** define the data that is used for direct data exchange.

Restrictions

- Direct data exchange in the current firmware version is only possible for inverters with PROFIBUS communication.
- A maximum of 12 PZDs are permissible for each drive.
- To a publisher, a maximum of 4 links are possible.

Procedure

To configure direct data exchange, proceed as follows:

1. In the control, define:
   - Which inverters operate as publisher (sender) or subscriber (receiver)?
   - Which data or data areas do you use for direct data exchange?
2. In the inverter, define:

   How does the subscriber process the data transferred using direct data exchange?

You have configured direct data exchange.

See also Section: Configuring slave-to-slave communication in STEP 7 (Page 350).

7.3.2 Acyclic communication

7.3.2.1 Acyclic communication

You can communicate with the inverter both cyclically and acyclically via PROFIBUS and PROFINET.

The inverter supports the following types of acyclic communication:

- Reading and writing parameters via "data set 47" (up to 240 bytes per write or read request)
- Reading-out profile-specific parameters
- Data exchange with a SIMATIC panel (**H**uman **M**achine **I**nterface)

You can find a STEP 7 program example for acyclic data transfer in Section STEP 7 program example for acyclic communication (Page 346).

7.3.2.2 Reading and changing parameters via data set 47

Reading parameter values

Table 7- 20 Request to read parameters

Data block	Byte n	Bytes n + 1	n
Header	**Reference** *01 hex ... FF hex*	**01 hex**: Read request	0
	01 hex	**Number of parameters (m)** *01 hex ... 27 hex*	2
Address, parameter 1	**Attribute** *10 hex:* Parameter value *20 hex:* Parameter description	**Number of indexes** *00 hex ... EA hex* (for parameters without index: 00 hex)	4
	Parameter number *0001 hex ... FFFF hex*		6
	Number of the 1st index *0000 hex ... FFFF hex* (for parameters without index: 0000 hex)		8
	…		…
Address, parameter 2	…		…
…	…		…
Address, parameter m	…		…

Table 7- 21 Inverter response to a read request

Data block	Byte n	Bytes n + 1	n
Header	**Reference** (identical to a read request)	**01 hex**: Inverter has executed the read request. **81 hex**: Inverter was not able to completely execute the read request.	0
	01 hex	**Number of parameters (m)** (identical to the read request)	2
Values, parameter 1	**Format** 02 hex: Integer8 03 hex: Integer16 04 hex: Integer32 05 hex: Unsigned8 06 hex: Unsigned16 07 hex: Unsigned32 08 hex: FloatingPoint 10 hex OctetString 13 hex TimeDifference 41 hex: Byte 42 hex: Word 43 hex: Double word 44 hex: Error	**Number of index values** or - for a negative response - **number of error values**	4
	Value of the 1st index or - for a negative response - **error value 1** You can find the error values in a table at the end of this section.		6
	…		…
Values, parameter 2	…		
…	…		
Values, parameter m	…		

Changing parameter values

Table 7- 22 Request to change parameters

Data block	Byte n	Bytes n + 1	n
Header	**Reference** *01 hex ... FF hex*	**02 hex**: Change request	0
	01 hex	**Number of parameters (m)** *01 hex ... 27 hex*	2
Address, parameter 1	**10 hex**: Parameter value	**Number of indexes** *00 hex ... EA hex* (00 hex and 01 hex have the same significance)	4
	Parameter number *0001 hex ... FFFF hex*		6
	Number of the 1st index *0001 hex ... FFFF hex*		8
	…		…
Address, parameter 2	…		
…	…		…
Address, parameter m	…		
Values, parameter 1	**Format** *02 hex:* Integer 8 *03 hex:* Integer 16 *04 hex:* Integer 32 *05 hex:* Unsigned 8 *06 hex:* Unsigned 16 *07 hex:* Unsigned 32 *08 hex:* Floating Point *10 hex* Octet String *13 hex* Time Difference *41 hex:* Byte *42 hex:* Word *43 hex:* Double word	**Number of index values** *00 hex ... EA hex*	
	Value of the 1st index		
	…		
Values, parameter 2	…		
…	…		
Values, parameter m	…		

Table 7- 23 Response, if the inverter has executed the change request

Data block	Byte n	Bytes n + 1	n
Header	**Reference** (identical to a change request)	**02 hex**	0
	01 hex	**Number of parameters** (identical to a change request)	2

Table 7- 24 Response if the inverter was not able to completely execute the change request

Data block	Byte n	Bytes n + 1	n
Header	**Reference** (identical to a change request)	**82 hex**	0
	01 hex	**Number of parameters** (identical to a change request)	2
Values, parameter 1	**Format** 40 hex: Zero (change request for this data block executed) 44 hex: Error (change request for this data block not executed)	**Number of error values** 00 hex or 02 hex	4
	Only for "Error" - **error value 1** You can find the error values in the table at the end of this section.		6
	Only for "Error" - **error value 2** Error value 2 is either zero, or it contains the number of the first index where the error occurred.		8
Values, parameter 2	...		
...	…		…
Values, parameter m	...		

Table 7- 25 Error value in the parameter response

Error value 1	Significance
00 hex	**Illegal 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	**Lower or upper value limit exceeded** (change request with a value outside the value limits)
03 hex	**Incorrect subindex** (access to a parameter index that does not exist)
04 hex	**No array** (access with a subindex to non-indexed parameters)
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 resetting** (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)
09 hex	**Description data not available** (access to a description that does not exist, parameter value is available)
0B hex	**No master control** (change request but with no master control)
0F hex	**Text array does not exist** (although the parameter value is available, the request is made to a text array that does not exist)
11 hex	**Request cannot be executed due to the operating state** (access is not possible for temporary reasons that are not specified)
14 hex	**Inadmissible value** (change request with a value that is within the limits but which is illegal for other permanent reasons, i.e. a parameter with defined individual values)
15 hex	**Response too long** (the length of the actual response exceeds the maximum transfer length)
16 hex	**Illegal parameter address** *(illegal or unsupported value for attribute, number of elements, parameter number, subindex or a combination of these)*
17 hex	**Illegal format** (change request for an illegal or unsupported format)
18 hex	**Number of values not consistent** *(number of values of the parameter data to not match the number of elements in the parameter address)*
19 hex	**Drive object does not exist** (access to a drive object that does not exist)

Error value 1	Significance
6B hex	No change access for a controller that is enabled.
6C hex	Unknown unit.
6E hex	Change request is only possible when the motor is being commissioned (p0010 = 3).
6F hex	Change request is only possible when the power unit is being commissioned (p0010 = 2).
70 hex	Change request is only possible for quick commissioning (basic commissioning) (p0010 = 1).
71 hex	Change request is only possible if the inverter is ready (p0010 = 0).
72 hex	Change request is only possible for a parameter reset (restore to factory setting) (p0010 = 30).
73 hex	Change request possible only during commissioning of the safety functions (p0010 = 95).
74 hex	Change request is only possible when a technological application/unit is being commissioned (p0010 = 5).
75 hex	Change request is only possible in a commissioning state (p0010 ≠ 0).
76 hex	Change request is not possible for internal reasons (p0010 = 29).
77 hex	Change request is not possible at download.
81 hex	Change request is not possible at download.
82 hex	Transfer of the control authority (master) is inhibited by BI: p0806.
83 hex	Desired interconnection is not possible (the connector output does not supply a float value although the connector input requires a float value)
84 hex	Inverter does not accept a change request (inverter is busy with internal calculations. See parameter r3996 in the inverter List Manual. See also Section: Further information (Page 360))
85 hex	No access methods defined.
86 hex	Write access only during commissioning of the data records (p0010 = 15) (operating status of the inverter prevents a parameter change.)
87 hex	Know-how protection active, access locked
C8 hex	Change request below the currently valid limit (change request to a value that lies within the "absolute" limits, but is however below the currently valid lower limit)
C9 hex	Change request above the currently valid limit (example: a parameter value is too large for the inverter power)
CC hex	Change request not permitted (change is not permitted as the access code is not available)

Other application examples

See also: Reading and writing parameters via PROFIBUS (http://support.automation.siemens.com/WW/view/en/8894584).

7.4 PROFIenergy profile for PROFINET

7.4.1 PROFIenergy

The non-proprietary PROFIenergy profile provides the following functions:

- switches off plant or plant sections in non-operational periods
- monitors the energy flow
- signals the plant or system state

PROFIenergy functions of the inverter

The higher-level control transfers commands to the inverter acyclically. The following commands and queries are available for the control:

Control commands

- Start_Pause
  Signal for the start and duration of a pause
- End_Pause
  Signal for the return into the productive state

Status queries

- PEM_Status
  Actual device status: Energy-saving mode or productive state
- Query_Measurement
  Energy usage

Basic settings in the inverter

Parameter p5611 defines the responses to the PROFIenergy command "Start_Pause".

Enabling PROFIenergy	p5611.0 = 0	Yes	
	p5611.0 = 1		No
For "Start_Pause", the drive initiates OFF1	p5611.1= 0		No
	p5611.1= 1	Yes	
Transition into the energy-saving mode from S4	p5611.2 = 0		No
	p5611.2 = 1	Yes	

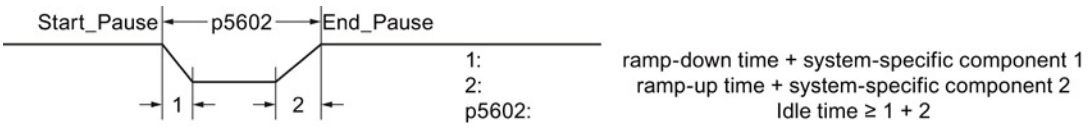
Table 7- 26 Dependency on the settings of p5611.0 … p5611.2

Bit 0	Bit 1	Bit 2	
0	0	0	Energy-saving mode enabled. • Display in r5613 • no additional "automatic" responses. • Set the responses to PROFIenergy commands on the inverter side.
1	0/1	0/1	Energy-saving mode not enabled. No response to PROFIenergy commands from the control
0	1	0	Energy-saving mode enabled with the following responses: • Display in r5613 • OFF1 is set if the "Start_Pause" command is received from the control. – The command is immediately effective in the inverter states "switching on inhibited" (S1) or "ready to start" (S2). – In the "operation" state (S4), OFF1 only becomes effective if the inverter has been brought into the "switching on inhibited" (S1) or "ready to start" (S2) state as a result of other commands, either from the control or inverter side. • The inverter cannot be switched on as long as the "Start_Pause" command is present. The OFF1 command is withdrawn with "End_Pause".
0	1	1	Energy-saving mode enabled with the following responses: • Display in r5613 • OFF1 is set if the "Start_Pause" command is received from the control. The command is immediately effective in the inverter states "switching on inhibited" (S1), "ready to start" (S2), "ready" (S3) and operation (S4). • With the "End_Pause" command, the pulses are re-enabled and the motor starts, if one of the states "ready" (S3) or "operation" (S4) is present.

Additional settings and displays

Settings

- Minimum pause time: p5602
  is the time that the machine requires to change into the energy-saving mode and back into the production mode.



- Maximum pause time: p5606
- Signal source to set the inverter into state S1 (switching on inhibited): p5614
  (e.g. p5614 = 722.0, means that you bring the inverter into the "switching-on inhibited" state via DI0).
- Reset the energy usage display to 0: p0040

Displaying

Display value	in the inverter	in the PROFIenergy profile
Power output at the motor shaft	r0032 in kW	ID 34 in W
Power factor	r0038	ID166
Balance from the energy drawn and fed back	r0039[1], in kWh	ID 200 in Wh
Interconnectable display of the PROFIenergy state	r5613	---
Energy saved - with respect to the adjustable characteristic (p3320 … p3329)	r0041	---

7.5 Communication via EtherNet/IP

Via EtherNet/IP you can enter commands and setpoints, read-out status information and actual values, change parameter values and reset faults.

Process data (setpoints, actual values, etc.) are transferred in EtherNet/IP using assemblies. In addition to the assemblies, there are objects that you can use to set the communication. The objects and assemblies supported by the inverter are described in Section Supported objects (Page 104)

7.5.1 Connect converter to Ethernet/IP

The Control Units have two RJ45 sockets for connection to the control system, which you can use to implement a line topology. You can implement all topologies by using switches.

We recommend the following connector with order number: 6GK1901-1BB10-2Ax0 for connecting an EtherNet cable.

Instructions for assembling the SIMATIC NET Industrial Ethernet FastConnect RF45 Plug 180 can be found on the Internet under product information " "Assembly instructions for SIMATIC NET Industrial Ethernet FastConnect RJ45 Plug (http://support.automation.siemens.com/WW/view/en/37217116/133300)".

Procedure

1
2

To connect the inverter to a control system via Ethernet, proceed as follows:

1. Connect the inverter to the control system via an Ethernet cable.
2. Either
   create a generic I/O module (Page 113) in your control system for cyclic data exchange between the control system and the inverter
   or
   load the EDS file of the ODVA into the control system. You can find the file in the internet at:
   (http://www.odva.org/Home/CIPPRODUCTCOMPLIANCE/DeclarationsofConformity/EtherNetIPDOCs/tabid/159/lng/en-US/Default.aspx) .

You have connected the inverter to the control system via EtherNet/IP.

See also Section: Interfaces, connectors, switches, control terminals and LEDs on the CU (Page 23).

Routing and shielding the Ethernet cable

Information can be found on the Internet: EtherNet/IP guidelines (http://www.odva.org/Home/ODVATECHNOLOGIES/EtherNetIP/EtherNetIPLibrary/tabid/76/lng/en-US/Default.aspx).

Commissioning the inverter in an EtherNet/IP network

To commission the inverter, using STARTER you must access the inverter via the USB interface. To do this, connect the computer to the inverter via the USB interface. See also Basic commissioning with STARTER (Page 57).

7.5.2 What do you need for communication via Ethernet/IP?

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 inverter via the fieldbus.

- Is the inverter correctly connected to the EtherNet/IP?
- Is the EDS file (http://support.automation.siemens.com/WW/view/en/48351511) installed in your control system?
- Have the bus interface and IP address been correctly set?
- Have the signals that the inverter and the control system exchange been correctly interconnected?

7.5.3 Communication settings for Ethernet/IP

General communication settings

In order to be able to communicate with a higher-level control system via EtherNet/IP, you must set parameter p2030 = 10.

Further, you must set the following data:

• IP address	in p8921	currently valid value in r8931
• Subnet mask	in p8923	currently valid value in r8933
• Default gateway	in p8922	currently valid value in r8932
• Name of station	in p8920	currently valid value in r8930

These parameters apply if p2030 = 10 is set, for EtherNet/IP, even if the parameter name indicates PROFINET.

Modified addresses only become effective if you switch-off the inverter and switch it on again; this includes any external 24 V supply that is being used.

Additional settings for communication via EtherNet/IP

Setting the communication profile

The inverter has two communication profiles

- p8980 = 0: SINAMICS profile (factory setting)
  A drive profile defined by Siemens for EtherNet/IP based on PROFIdrive
- p8980 = 1: ODVA AC/DC drive profile
  A drive profile defined by the ODVA organization

Telegram selection

You select the telegram using p0922.

You can select any of the listed telegrams if you are working with the SINAMICS profile.

If you use the AC/DC profile of the ODVA, select the standard telegram, p0922 = 1. You cannot work with the EDS file if you wish to use the assemblies described in Section Supported objects (Page 104). In this case, you must integrate the inverter into your control system.

Setting the bus monitoring time

You set the bus monitoring using parameter p8840 in the inverter.

If you set this parameter to 0, the inverter continues to operate even if the bus develops a fault condition. If you set a time ≠ 0, then the inverter switches off with F08501 "Setpoint timeout" if the control system does not issue any signals within this time.

7.5.4 Additional settings if you are working with the AC/DC profile

If you change the following settings in the inverter by accessing the appropriate parameters, you must switch-off the inverter and switched it on again in order that these changes become effective. The changes become immediately effective when making the changes via the control system with objects 90 hex or 91 hex.

Setting the off response for the motor

You set the standard off response for the inverter using parameter p8981:

- p8981 = 0: OFF1 (factory setting), also corresponds to the setting in the SINAMICS profile
- p8981 = 1: OFF2

You can find details on OFF1 and OFF2 in section Inverter control (Page 117)

Setting the speed and torque scaling

You scale the speed and torque display using parameter p8982 or p8983. Setting range: 2^5 to 2^{-5}.

Displaying the maximum process data that can be transferred (PZD)

- r2067[0] maximum interconnected PZD length - receiving
- p2067[1] maximum interconnected PZD length - sending

7.5.5 Supported objects

EtherNet/IP objects supported by the G120

Object class		Object name	Objects required	ODVA objects	SINAMICS objects
hex	dec				
1 hex	1	Identity object	x		
4 hex	4	Assembly object	x		
6 hex	6	Connection Manager object	x		
28 hex	30	Motor Data Object		x	
29 hex	31	Supervisor Object		x	
2A hex	42	Drive Object		x	
32C hex	44	Siemens Drive Object			x
32D hex	45	Siemens Motor Data Object			x
90 hex	144	Parameter object			x
91 hex	145	Parameter object free access (DS47)			x
F5 hex	245	TCP/IP Interface object [1)]	x		
F6 hex	246	Ethernet Link object 1)	x		
401 hex … 43E hex	1025 … 1086	Parameter object			x

1) these objects are part of the EtherNet/IP system management.

ODVA AC/DC assembly

Number		required/ optional	Type	Name
hex	dec			
14 hex	20	Required	Sending	Basic Speed Control Output
15 hex	21	Optional	Sending	Extended Speed Control Output
16 hex	22	Optional	Sending	Speed and Torque Control Output
17 hex	23	Optional	Sending	Extended Speed and Torque Control Output
18 hex	24	Optional	Sending	Process Control Output
19 hex	25	Optional	Sending	Extended Process Control Output
46 hex	70	Required	Receiving	Basic Speed Control Input
47 hex	71	Optional	Receiving	Extended Speed Control Input
48 hex	72	Optional	Receiving	Speed and Torque Control Input
49 hex	73	Optional	Receiving	Extended Speed and Torque Control Input
4A hex	74	Optional	Receiving	Process Control Input
4B hex	75	Optional	Receiving	Extended Process Control Input

Assembly Basic Speed Control, Instance Number: 20, type: Output

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0						Fault Reset		RUN Forward
1								
2	Speed Reference (Low Byte)							
3	Speed Reference (High Byte)							

Assembly Basic Speed Control, Instance Number: 70, type: Input

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0						Running Forward		Faulted
1								
2	Speed Actual (Low Byte)							
3	Speed Actual (High Byte)							

Assembly Basic Speed Control with parameter assembly, Instance Number: 120, type: Output

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0						Fault Reset		RUN Forward
1								
2	Speed Reference (Low Byte)							
3	Speed Reference (High Byte)							
4	Data Out 1 Value (Low Byte)							
5	Data Out 1 Value (High Byte)							
6	Data Out 2 Value (Low Byte)							
7	Data Out 2 Value (High Byte)							
8	Data Out 3 Value (Low Byte)							
9	Data Out 3 Value (High Byte)							
10	Data Out 4 Value (Low Byte)							
11	Data Out 4 Value (High Byte)							
12	Data Out 5 Value (Low Byte)							
13	Data Out 5 Value (High Byte)							
14	Data Out 6 Value (Low Byte)							
15	Data Out 6 Value (High Byte)							
16	Data Out 7 Value (Low Byte)							
17	Data Out 7 Value (High Byte)							
18	Data Out 8 Value (Low Byte)							
19	Data Out 8 Value (High Byte)							
20	Data Out 9 Value (Low Byte)							
21	Data Out 9 Value (High Byte)							
22	Data Out 10 Value (Low Byte)							
23	Data Out 10 Value (High Byte)							

Assembly Basic Speed Control with parameter assembly, Instance Number: 170, type: Input

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0						Running Forward		Faulted
1								
2	Speed Actual (Low Byte)							
3	Speed Actual (High Byte)							
4	Data In 1 Value (Low Byte)							
5	Data In 1 Value (High Byte)							
6	Data In 2 Value (Low Byte)							
7	Data In 2 Value (High Byte)							
8	Data In 3 Value (Low Byte)							
9	Data In 3 Value (High Byte)							
10	Data In 4 Value (Low Byte)							
11	Data In 4 Value (High Byte)							
12	Data In 5 Value (Low Byte)							
13	Data In 5 Value (High Byte)							
14	Data In 6 Value (Low Byte)							
15	Data In 6 Value (High Byte)							
16	Data In 7 Value (Low Byte)							
17	Data In 7 Value (High Byte)							
18	Data In 8 Value (Low Byte)							
19	Data In 8 Value (High Byte)							
20	Data In 9 Value (Low Byte)							
21	Data In 9 Value (High Byte)							
22	Data In 10 Value (Low Byte)							
23	Data In 10 Value (High Byte)							

Assembly Extended Speed Control, Instance Number: 21, type: Output

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0		NetRef	Net CtrL			Fault Reset	RUN Reverse	RUN Forward
1								
2	Speed Reference (Low Byte)							
3	Speed Reference (High Byte)							

Assembly Extended Speed Control, Instance Number: 71, type: Input

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	At Reference	Ref From Net	Crtl From Net	Ready	Running Reverse	Running Forward	Warning	Faulted
1	Drive State							
2	Speed Actual (Low Byte)							
3	Speed Actual (High Byte)							

Assembly Extended Speed Control with parameter assembly, Instance Number: 121, type: Output

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0		NetRef	Net CtrL			Fault Reset	RUN Reverse	RUN Forward
1								
2	Speed Reference (Low Byte)							
3	Speed Reference (High Byte)							
4	Data Out 1 Value (Low Byte)							
5	Data Out 1 Value (High Byte)							
6	Data Out 2 Value (Low Byte)							
7	Data Out 2 Value (High Byte)							
8	Data Out 3 Value (Low Byte)							
9	Data Out 3 Value (High Byte)							
10	Data Out 4 Value (Low Byte)							
11	Data Out 4 Value (High Byte)							
12	Data Out 5 Value (Low Byte)							
13	Data Out 5 Value (High Byte)							
14	Data Out 6 Value (Low Byte)							
15	Data Out 6 Value (High Byte)							
16	Data Out 7 Value (Low Byte)							
17	Data Out 7 Value (High Byte)							
18	Data Out 8 Value (Low Byte)							
19	Data Out 8 Value (High Byte)							
20	Data Out 9 Value (Low Byte)							
21	Data Out 9 Value (High Byte)							
22	Data Out 10 Value (Low Byte)							
23	Data Out 10 Value (High Byte)							

Assembly Extended Speed Control with parameter assembly, Instance Number: 171, type: Input

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	At Reference	Ref From Net	Ref From Net	Ready	Running Reverse	Running Forward	Warning	Faulted
1	Drive State							
2	Speed Actual (Low Byte)							
3	Speed Actual (High Byte)							
4	Data In 1 Value (Low Byte)							
5	Data In 1 Value (High Byte)							
6	Data In 2 Value (Low Byte)							
7	Data In 2 Value (High Byte)							
8	Data In 3 Value (Low Byte)							
9	Data In 3 Value (High Byte)							
10	Data In 4 Value (Low Byte)							
11	Data In 4 Value (High Byte)							
12	Data In 5 Value (Low Byte)							
13	Data In 5 Value (High Byte)							
14	Data In 6 Value (Low Byte)							
15	Data In 6 Value (High Byte)							
16	Data In 7 Value (Low Byte)							
17	Data In 7 Value (High Byte)							
18	Data In 8 Value (Low Byte)							
19	Data In 8 Value (High Byte)							
20	Data In 9 Value (Low Byte)							
21	Data In 9 Value (High Byte)							
22	Data In 10 Value (Low Byte)							
23	Data In 10 Value (High Byte)							

Assembly Basic Speed and Torque Control , Instance Number: 22, type: Output

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0						Fault Reset		RUN Forward
1								
	Speed Reference (Low Byte)							
3	Speed Reference (High Byte)							
4	Torque Reference (High Byte)							
5	Torque Reference (High Byte)							

Assembly Basic Speed and Torque Control , Instance Number: 72, type: Input

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0						Running Forward		RUN Forward
1								
2	Speed Actual (Low Byte)							
3	Speed Actual (High Byte)							
4	Torque Actual (High Byte)							
5	Torque Actual (High Byte)							

Assembly Basic Speed and Torque Control with parameter assembly , Instance Number: 122, type: Output

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0						Fault Reset		RUN Forward
1								
2	Speed Reference (Low Byte)							
3	Speed Reference (High Byte)							
4	Torque Reference (High Byte)							
5	Torque Reference (High Byte)							
6	Data Out 1 Value (Low Byte)							
7	Data Out 1 Value (High Byte)							
8	Data Out 2 Value (Low Byte)							
9	Data Out 2 Value (High Byte)							
10	Data Out 3 Value (Low Byte)							
11	Data Out 3 Value (High Byte)							
12	Data Out 4 Value (Low Byte)							
13	Data Out 4 Value (High Byte)							
14	Data Out 5 Value (Low Byte)							
15	Data Out 5 Value (High Byte)							
16	Data Out 6 Value (Low Byte)							
17	Data Out 6 Value (High Byte)							
18	Data Out 7 Value (Low Byte)							
19	Data Out 7 Value (High Byte)							
20	Data Out 8 Value (Low Byte)							
21	Data Out 8 Value (High Byte)							
22	Data Out 9 Value (Low Byte)							
23	Data Out 9 Value (High Byte)							
24	Data Out 10 Value (Low Byte)							
25	Data Out 10 Value (High Byte)							

Assembly Basic Speed and Torque Control with parameter assembly , Instance Number: 172, type: Input

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
						Running Forward		Faulted
1								
2	Speed Actual (Low Byte)							
3	Speed Actual (High Byte)							
4	Torque Actual (High Byte)							
5	Torque Actual (High Byte)							
6	Data In 1 Value (Low Byte)							
7	Data In 1 Value (High Byte)							
8	Data In 2 Value (Low Byte)							
9	Data In 2 Value (High Byte)							
10	Data In 3 Value (Low Byte)							
11	Data In 3 Value (High Byte)							
12	Data In 4 Value (Low Byte)							
13	Data In 4 Value (High Byte)							
14	Data In 5 Value (Low Byte)							
15	Data In 5 Value (High Byte)							
16	Data In 6 Value (Low Byte)							
17	Data In 6 Value (High Byte)							
18	Data In 7 Value (Low Byte)							
19	Data In 7 Value (High Byte)							
20	Data In 8 Value (Low Byte)							
	Data In 8 Value (High Byte)							
22	Data In 9 Value (Low Byte)							
23	Data In 9 Value (High Byte)							
24	Data In 10 Value (Low Byte)							
25	Data In 10 Value (High Byte)							

Extended Speed and Torque Control, Instance Number: 23, type: Output

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0		NetRef	Net CtrL			Fault Reset	RUN Reverse	RUN Forward
1								
2	Speed Reference (Low Byte)							
3	Speed Reference (High Byte)							
4	Torque Reference (High Byte)							
5	Torque Reference (High Byte)							

Extended Speed and Torque Control, Instance Number: 73, type: Input

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	At Reference	Ref From Net	Crtl From Net	Ready	Running Reverse	Running Forward	Warning	Faulted
1	Drive State							
2	Speed Actual (Low Byte)							
3	Speed Actual (High Byte)							
4	Torque Actual (High Byte)							
5	Torque Actual (High Byte)							

Basic Speed and Torque Control with parameter assembly, Instance Number: 123, type: Output

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0		NetRef	Net CtrL			Fault Reset	RUN Reverse	RUN Forward
1								
2	Speed Reference (Low Byte)							
3	Speed Reference (High Byte)							
4	Torque Reference (High Byte)							
5	Torque Reference (High Byte)							
6	Data Out 1 Value (Low Byte)							
7	Data Out 1 Value (High Byte)							
8	Data Out 2 Value (Low Byte)							
9	Data Out 2 Value (High Byte)							
10	Data Out 3 Value (Low Byte)							
11	Data Out 3 Value (High Byte)							
12	Data Out 4 Value (Low Byte)							
13	Data Out 4 Value (High Byte)							
14	Data Out 5 Value (Low Byte)							
15	Data Out 5 Value (High Byte)							
16	Data Out 6 Value (Low Byte)							
17	Data Out 6 Value (High Byte)							
18	Data Out 7 Value (Low Byte)							
19	Data Out 7 Value (High Byte)							
20	Data Out 8 Value (Low Byte)							
21	Data Out 8 Value (High Byte)							
22	Data Out 9 Value (Low Byte)							
23	Data Out 9 Value (High Byte)							
24	Data Out 10 Value (Low Byte)							
25	Data Out 10 Value (High Byte)							

Basic Speed and Torque Control with parameter assembly, Instance Number: 173, type: Input

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	At Reference	Ref From Net	Crtl From Net	Ready	Running Reverse	Running Forward	Warning	Faulted
1	Drive State							
2	Speed Actual (Low Byte)							
3	Speed Actual (High Byte)							
4	Torque Actual (High Byte)							
5	Torque Actual (High Byte)							
6	Data In 1 Value (Low Byte)							
7	Data In 1 Value (High Byte)							
8	Data In 2 Value (Low Byte)							
9	Data In 2 Value (High Byte)							
10	Data In 3 Value (Low Byte)							
11	Data In 3 Value (High Byte)							
12	Data In 4 Value (Low Byte)							
13	Data In 4 Value (High Byte)							
14	Data In 5 Value (Low Byte)							
15	Data In 5 Value (High Byte)							
16	Data In 6 Value (Low Byte)							
17	Data In 6 Value (High Byte)							
18	Data In 7 Value (Low Byte)							
19	Data In 7 Value (High Byte)							
20	Data In 8 Value (Low Byte)							
21	Data In 8 Value (High Byte)							
22	Data In 9 Value (Low Byte)							
23	Data In 9 Value (High Byte)							
24	Data In 10 Value (Low Byte)							
25	Data In 10 Value (High Byte)							

7.5.6 Create generic I/O module

For certain control systems, you cannot use the EDS file provided by the ODVA. In these cases, you must create a generic I/O module in the control system for the cyclic communication.

Procedure

Proceed as follows to create a generic I/O module:

1. In your control system, via "New module" create a new "I/O module", "Generic" type.
2. In the control system, enter the lengths for the process data for cyclic communication, which you have selected in STARTER, r2067[0] (input), r2067[1] (output), for example: Standard telegram 2/2.
3. In STARTER, set the same values for IP address, Subnet Mask, Default Gateway and the Name of Station as in the control system (see Communication settings for Ethernet/IP (Page 102))

You have created a generic I/O module for cyclic communication with the inverter.

Set functions

8

Complete the following commissioning steps before you set the converter functions:

- Commissioning (Page 47)
- If necessary: Communication via PROFIBUS (Page 74)
- If necessary: Adapt inputs and outputs (Page 67)

8.1 Overview of the converter functions

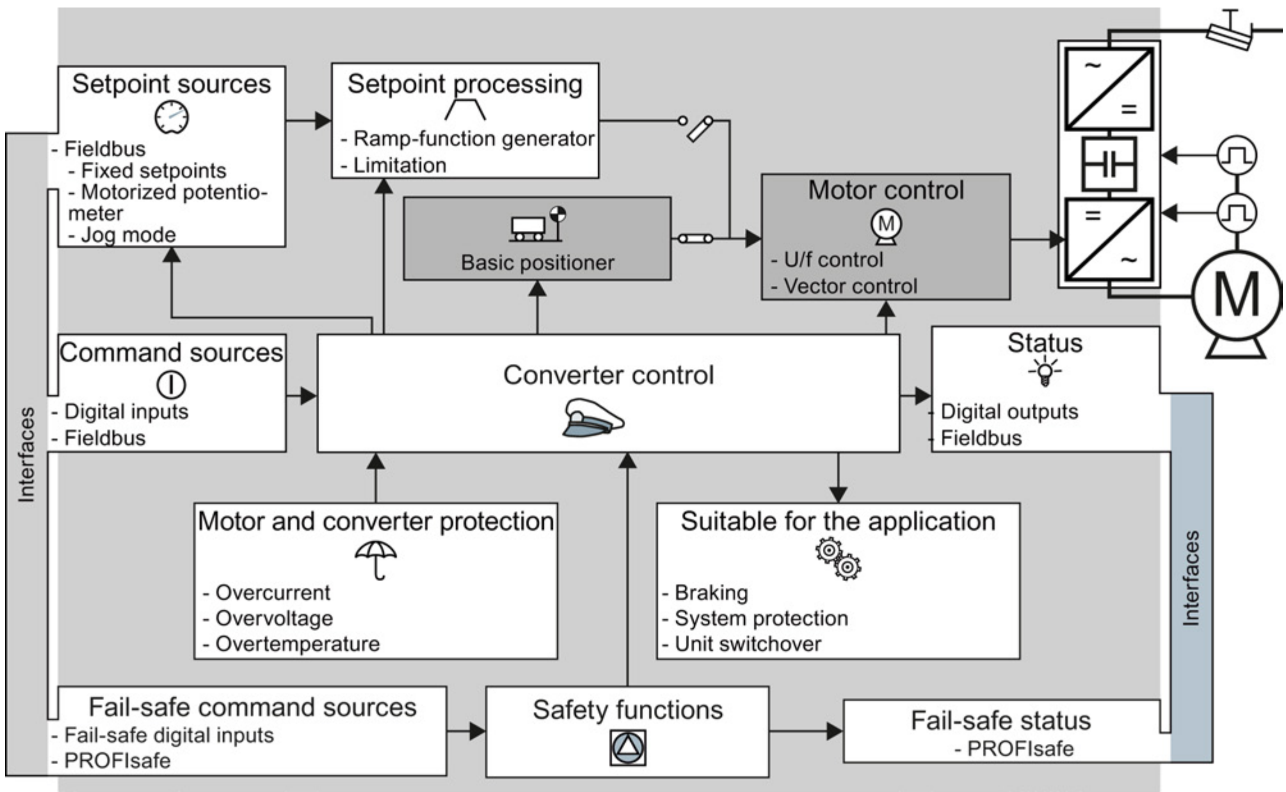
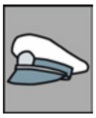
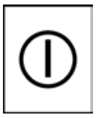
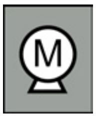
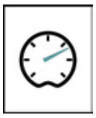
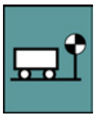
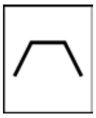
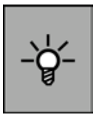
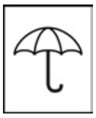
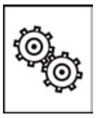


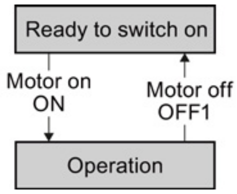
Figure 8-1 Overview of converter functions

Functions, which you need to set in any application with position control		**Functions, which you only require in special applications or which you must adapt**	
The functions that you must set in every application with position control are shown in a dark color in the function overview above.		The functions whose parameters you only need to adapt when actually required are shown in white in the function overview above.	
	**Converter control** is responsible for all of the other converter functions. Among other things, it defines how the converter responds to external control signals. Inverter control (Page 117)		The **command source** defines where the control signals are received from to switch on the motor, e.g. via digital inputs or a fieldbus. Adapt inputs and outputs (Page 67)
	The **motor closed-loop control** ensures that the motor follows the speed setpoint. Motor control (Page 135)		The **setpoint source** defines how the speed setpoint for the motor is specified, e.g. via a fixed setpoint or the fieldbus. Setpoint sources (Page 122)
	The **basic positioner** traverses an axis with position control to a target position. Basic positioner (Page 145)		You only require **setpoint processing**if you operate the converter without position controller, which means you only operate it in the speed controlled mode. Setpoint calculation (Page 128)
	The **status messages** provide digital and analog signals at the Control Unit outputs or via the fieldbus. Examples include the current speed of the motor or fault message issued by the converter. Adapt inputs and outputs (Page 67) Configure field bus (Page 71)		The **protection functions** avoid overloads and operating states that could cause damage to the motor, converter and driven load. The motor temperature monitoring, for example, is set here. Protection functions (Page 203)
			Functions **suitable to the application** permit, for example, the control of a motor holding brake. Application-specific functions (Page 209)
			The **safety functions** are used in applications that must fulfill special requirements in terms of functional safety. Fail-safe function Safe Torque Off (STO) (Page 228)

8.2 Inverter control

After switching on the supply voltage, the inverter normally goes into the "Ready to switch on" state. In this state, the inverter waits for the command to switch-on the motor:

- The inverter switches on the motor with the ON command. The inverter changes to the "Operation" state.
- After the OFF1 command, the inverter brakes the motor with the ramp-down time of the ramp-function generator. The inverter switches off the motor once standstill has been reached. The inverter is again "ready to start".



Inverter states and commands for switching the motor on and off

In addition to the OFF1 command, there are other commands that are used to switch off the motor:

- OFF2 - the inverter immediately switches off the motor without first braking it.
- OFF3 - this command means "quick stop". After OFF3, the inverter brakes the motor with the OFF3 ramp-down time. After reaching standstill, the inverter switches off the motor. The command is frequently used for exceptional operating situations where it is necessary to brake the motor especially quickly. Collision protection is a typical application for this function.

The following diagram shows the internal sequence control of the inverter when switching the motor on and off.

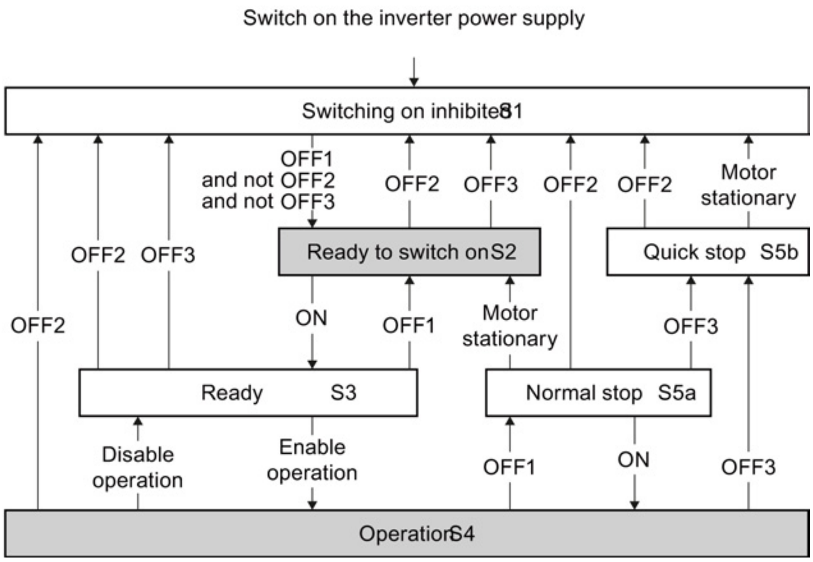


Figure 8-2 State overview of the inverter

Table 8- 1 Explanation of the inverter states

State	Explanation
Switching on inhibited (S1)	In this state, the inverter does not respond to the ON command. The inverter goes into this state under the following conditions: • ON was active when switching on the inverter. Exception: When the automatic start function is active, ON must be active after switching on the power supply. • OFF2 or OFF3 is selected.
Ready to switch on (S2)	This state is required to switch on the motor.
Ready (S3)	The inverter waits for the operating enable. If the inverter is controlled via a fieldbus, then you must set the operating enable in a control word bit. If the inverter is exclusively controlled via its digital inputs, then the operating enable signal is automatically set in the factory setting.
Operation (S4)	The motor is switched on.
Normal stop (S5a)	The motor was switched off with OFF1 and brakes with the ramp-down time of the ramp-function generator.
Fast stop (S5b)	The motor was switched off with OFF3 and brakes with the OFF3 ramp-down time.

8.2.1 Running the motor in jog mode (JOG function)

The "Jog" function is typically used to slowly move a machine part, e.g. a conveyor belt.

With the "Jog" function, you switch the motor on and off using a digital input. When the motor is switched on, it accelerates to the jogging setpoint. There are two different setpoints available, e.g. for motor counter-clockwise rotation and clockwise rotation.

The same ramp-function generator acts on the setpoint as for the ON/OFF1 command.

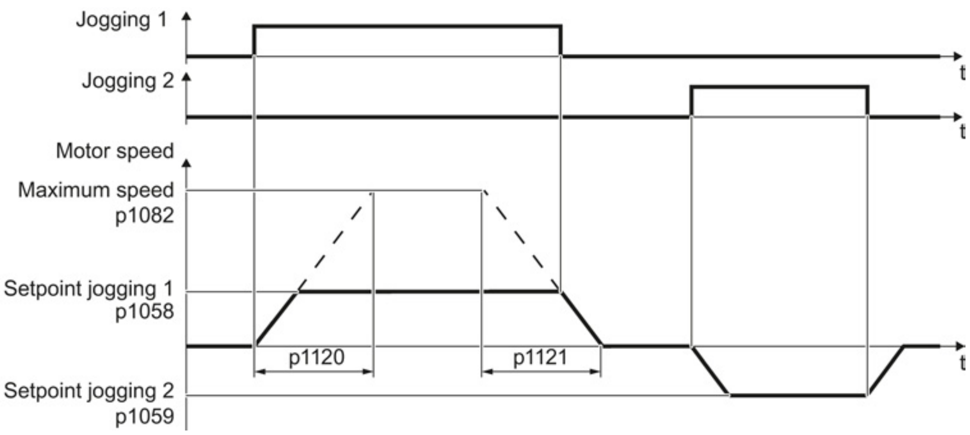
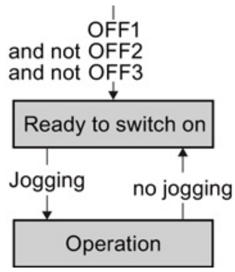


Figure 8-3 Behavior of the motor when "jogging"

The inverter must be ready to start before you issue the "Jog" control command. If the motor is already switched on, then the "Jog" command has no effect.



Setting jogging

Parameter	Description	
p1058	**Jogging 1 speed setpoint** (factory setting 150 rpm)	
p1059	**Jogging 2 speed setpoint** (factory setting -150 rpm)	
p1082	**Maximum speed** (factory setting 1500 rpm)	
p1110	**Inhibit negative direction**	
	=0: Negative direction of rotation is enabled	=1: Negative direction of rotation is inhibited
p1111	**Inhibit positive direction**	
	=0: Positive direction of rotation is enabled	=1: Positive direction of rotation is inhibited
p1113	**Setpoint inversion**	
	=0: Setpoint is not inverted	=1: Setpoint is inverted
p1120	**Ramp-function generator ramp-up time** (factory setting 10 s)	
p1121	**Ramp-function generator ramp-down time** (factory setting 10 s)	
p1055 = 722.0	**Jog bit 0:** Select jogging 1 via digital input 0	
p1056 = 722.1	**Jog bit 1:** Select jogging 2 via digital input 1	

8.2.2 Switching over the inverter control (command data set)

In several applications, the inverter must be able to be operated from different, higher-level control systems.

Example: Switchover from automatic to manual operation

You control the motor either from a central control system, via fieldbus or from a local control panel.

Command data set (CDS)

This means that you can set the inverter control in various ways and toggle between the settings. For instance, as described above, the inverter can either be operated via a fieldbus or via the terminal strip.

The settings in the inverter, which are associated with a certain control type of the inverter, are called command data set.

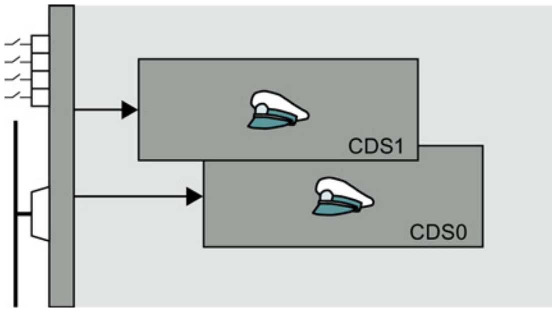


Figure 8-4 Different inverter control using several command data sets (CDS)

You select the command data set using parameter p0810. To do this, you must interconnect parameter p0810 with a control command of your choice, e.g. a digital input.

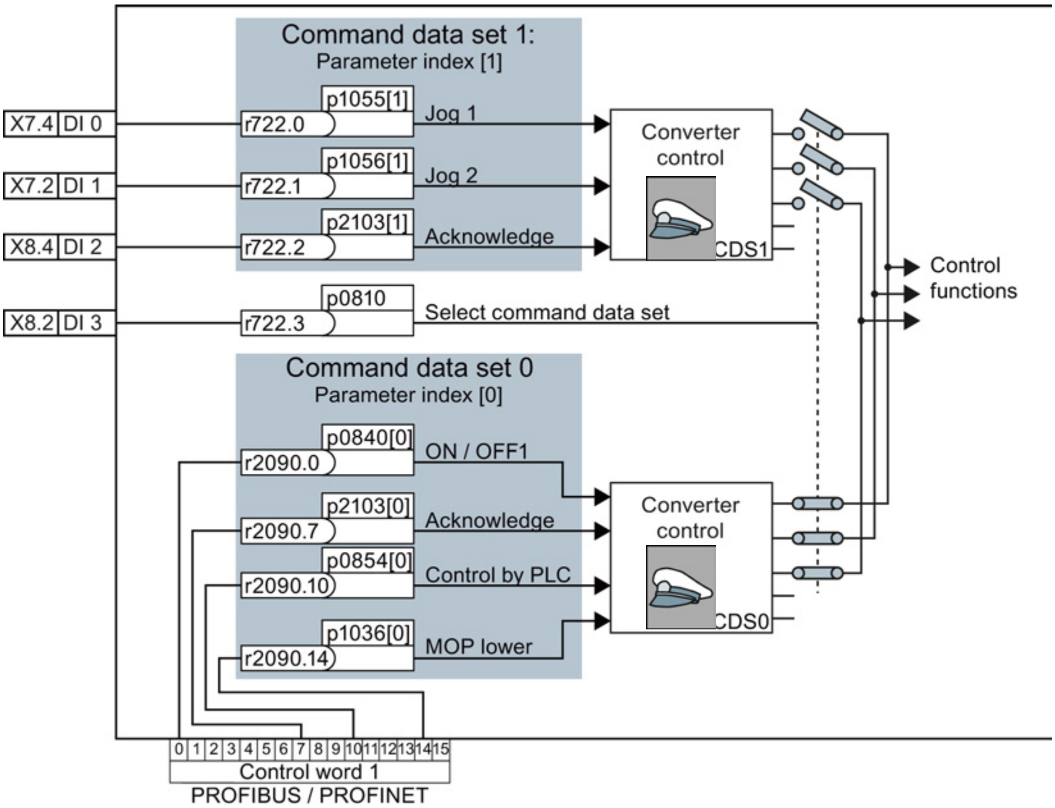


Figure 8-5 Example for the various command data sets

In the above example, use digital input 3 to switch from one control system of the converter via digital inputs to a control system via the fieldbus.

An overview of all the parameters that belong to the command data sets is provided in the List Manual.

Note

The converter requires approx. 4 ms to switch over the command data set.

Advanced settings

If you require more than two command data sets, then define the number of command data sets (2, 3 or 4) using parameter p0170.

Table 8- 2 Defining the number of command data sets

Parameter	Description
p0010 = 15	**Drive commissioning:** Data sets
p0170	**Number of command data sets** (factory setting 2) p0170 = 2, 3 or 4
p0010 = 0	**Drive commissioning:** Ready
r0050	**Displaying the number of the CDS that is currently active**

You require two bits to be able to make a clear selection for more than two command data sets.

Table 8- 3 Selecting a command data set

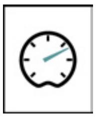
Parameter	Description
p0810	**Command data set selection CDS bit 0**
p0811	**Command data set selection CDS bit 1**
r0050	**Displaying the number of the CDS that is currently active**

A copy function is available making it easier to commission more than one command data set.

Table 8- 4 Parameters for copying the command data sets

Parameter	Description
p0809[0]	**Number of the command data set to be copied (source)**
p0809[1]	**Number of the command data set to which the data is to be copied (target)**
p0809[2] = 1	**Copying is started** Once copying has been completed, the converter sets p0809[2] to 0.

8.3 Setpoint sources



You only have to set the setpoint source if you operate the converter without basic positioner, i.e. you only operate it in the speed-controlled mode.

If you operate the converter in the speed-controlled mode, you must set the source for the main setpoint of the motor speed.

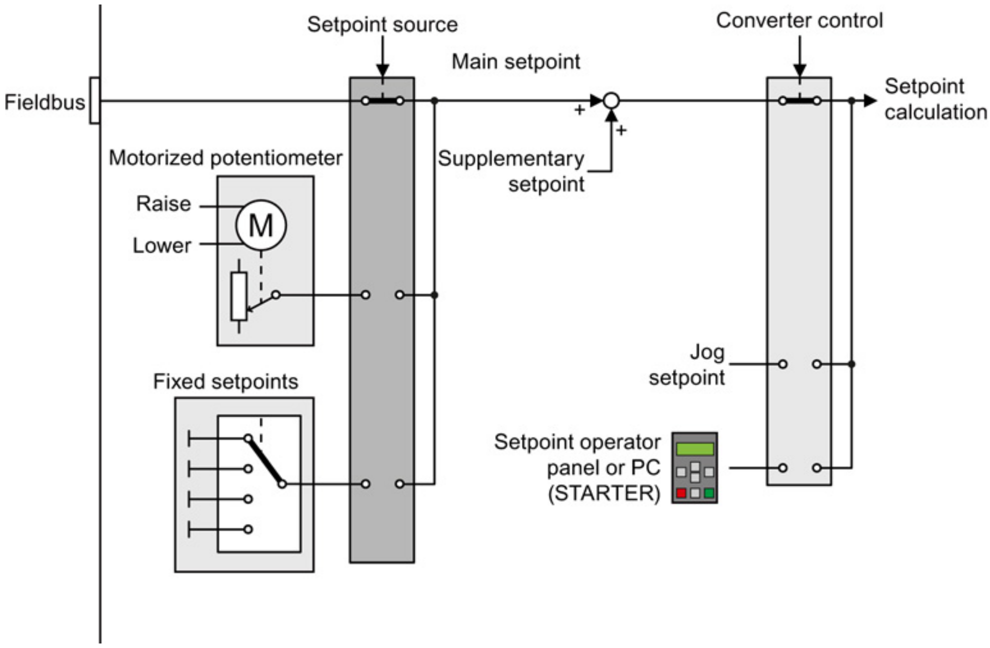


Figure 8-6 Setpoint sources for the converter

You have the following options when selecting the source of the main setpoint:

- Converter fieldbus interface.
- Motorized potentiometer simulated in the converter.
- Fixed setpoints saved in the converter.

You have the same selection options when selecting the source of the supplementary setpoint.

Under the following conditions, the converter switches from the main setpoint to other setpoints:

- When jogging is active.
- When controlling from an operator panel or the STARTER PC tool.

In the basic commissioning, you have already selected a setpoint source. See also the section: Finding a suitable setting for the interfaces (Page 45).

However, you can change this setting. The setpoint sources will be described in more detail on the following pages.

8.3.1 Specifying the motor speed via the fieldbus

If you enter the setpoint via a fieldbus, you must connect the converter to a higher-level control. For additional information, see Section Configure field bus (Page 71).

Interconnecting the fieldbus with the main setpoint

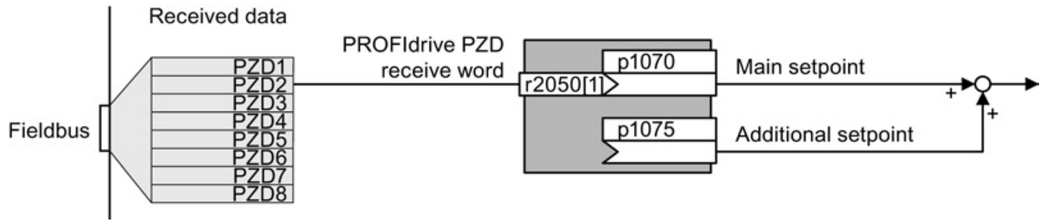


Figure 8-7 Fieldbus as setpoint source

Most standard telegrams receive the speed setpoint as a second process data PZD2.

Table 8- 5 Setting the fieldbus as setpoint source

Parameter	Remark
p1070 = 2050[1]	**Main setpoint** Interconnect the main setpoint with process data PZD2 from the fieldbus.
p1075 = 2050[1]	**Additional setpoint** Interconnect the additional setpoint with process data PZD2 from the fieldbus.

8.3.2 Motorized potentiometer as setpoint source

The "Motorized potentiometer" function emulates an electromechanical potentiometer The output value of the motorized potentiometer can be continually set using the "up" and "down" control signals.

Interconnecting the motorized potentiometer (MOP) with the setpoint source

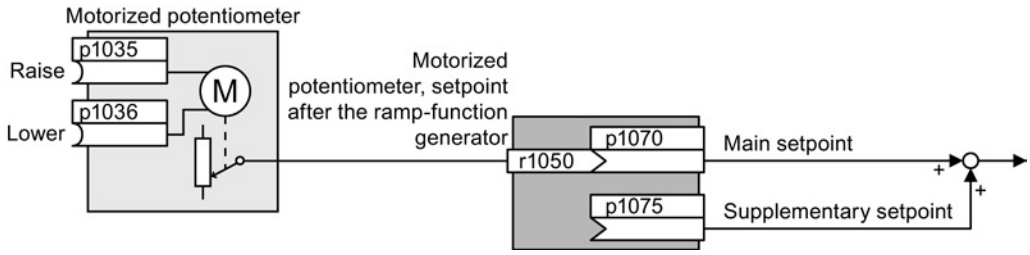


Figure 8-8 Motorized potentiometer as setpoint source

Table 8- 6 Basic setup of motorized potentiometer

Parameter	Description
p1047	**MOP ramp-up time** (factory setting 10 s)
p1048	**MOP ramp-down time** (factory setting 10 s)
p1040	**MOP start value** (factory setting 0 rpm) Defines the start value [rpm], which is effective when first switching on the motor.

Table 8- 7 Setting the MOP as setpoint source

Parameter	Remark
p1070 = 1050	**Main setpoint** Interconnecting the main setpoint with MOP.
p1035	**Motorized potentiometer, increase setpoint** (factory setting 0) Interconnect this signal, for example with a digital input of your choice: p1035 = 722.1 (digital input 1)
p1036	**Motorized potentiometer, decrease setpoint** (factory setting 0) Interconnect this signal, for example with a digital input of your choice.

Adapting the behavior of the motorized potentiometer

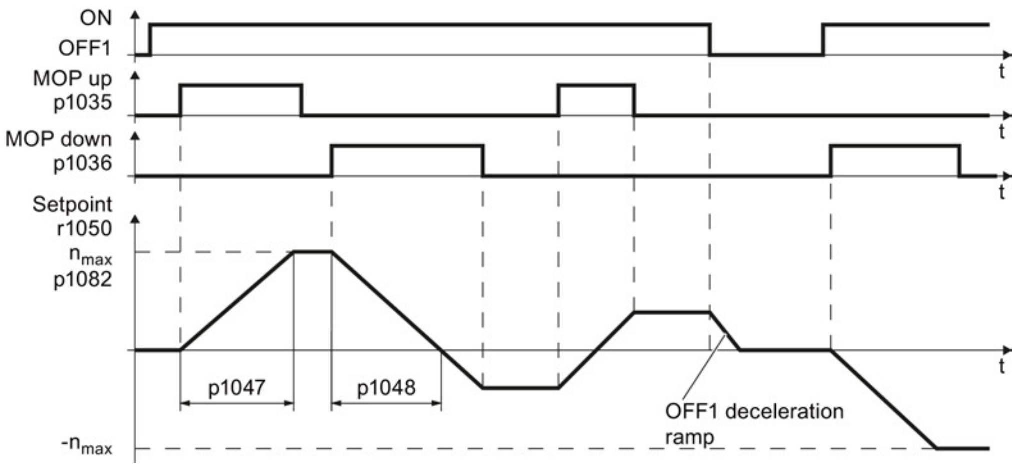


Figure 8-9 Function chart of motorized potentiometer

Table 8- 8 Extended setup of motorized potentiometer

Parameter	Description
p1030	**MOP configuration** (factory setting 00110 bin) **Parameter value with four independently adjustable bits 00 … 03** **Bit 00:** Save setpoint after switching off motor 0: After the motor is switched on, p1040 is specified as the setpoint 1: Setpoint is saved after the motor is switched off and set to the saved value once it is switched on **Bit 01:** Configure ramp-function generator in automatic mode (1-signal via BI: p1041) 0: Without ramp-function generator in the automatic mode (ramp-up/ramp-down time = 0) 1: With ramp-function generator in the automatic mode In manual mode (0-signal via BI: p1041) the ramp-function generator is always active **Bit 02:** Configure initial rounding 0: Without initial rounding 1: With initial rounding. Using the initial rounding function it is possible to enter very small setpoint changes **Bit 03:** Store setpoint in power-independent manner 0: No power-independent saving 1: Setpoint is saved in the event of a power failure (bit 00 = 1) **Bit 04:** Ramp-function generator always active 0: Setpoint is only calculated with enabled pulses 1: The setpoint is calculated independent of the pulse enable.
p1037	**MOP maximum speed** (factory setting 0 rpm) Automatically pre-assigned when commissioning
p1038	**MOP minimum speed** (factory setting 0 rpm) Automatically pre-assigned when commissioning
p1044	**MOP setting value** (factory setting 0) Signal source for the setting value.

For more information about the motorized potentiometer, refer to function diagram 3020 in the List Manual.

8.3.3 Fixed speed as setpoint source

In many applications after switching on the motor, all that is needed is to run the motor at a constant speed or to switch between different speeds.

Example: After it has been switched on, a conveyor belt only runs with two different velocities.

Interconnecting the fixed speeds with a main setpoint

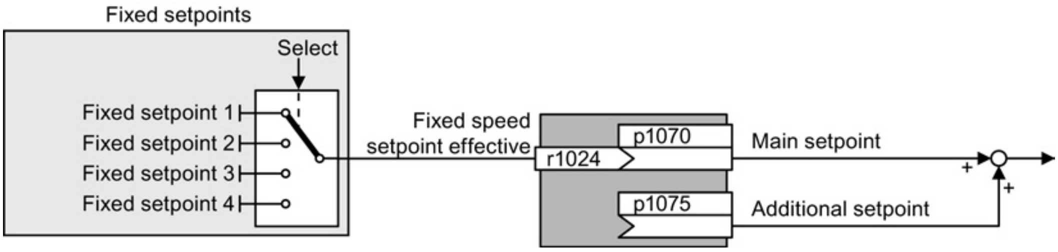


Figure 8-10 Fixed speeds as setpoint source

Table 8- 9 Setting the fixed speed as a setpoint source

Parameter	Remark
p1070 = 1024	**Main setpoint** Interconnecting the main setpoint with fixed speeds.
p1075 = 1024	**Additional setpoint** Interconnecting the additional setpoint with fixed speeds

Select direct or binary fixed setpoint

The inverter has up to 16 different fixed setpoints. The superior controller selects the appropriate fixed setpoints via digital inputs or the field bus.

The inverter distinguishes between two methods for selecting the fixed setpoints:

1. Direct selection:
   You set four different fixed setpoints. By adding one or more of the four fixed setpoints, up to 16 different resulting setpoints are obtained.
   Direct selection is the most suitable method for controlling the inverter via the digital inputs.

   Additional information about direct selection can be found in function diagram 3011 in the List Manual.
2. Binary selection:
   You set 16 different fixed setpoints. You precisely select one of these fixed setpoints by a combination of four selection bits.
   The binary selection is the suitable method of controlling the inverter via a field bus.
   Additional information about binary selection can be found in function diagram 3010 of the List Manual.

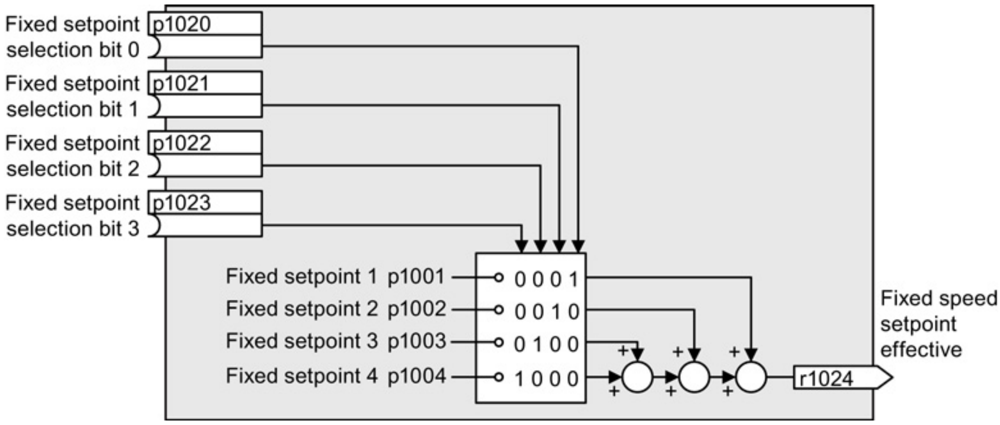


Figure 8-11 Simplified function diagram for directly selecting fixed setpoints

Example: Select two fixed setpoints directly

The motor is to operate at two different speeds as follows:

- The signal on digital input 0 switches the motor on and accelerates it to 300 rpm.
- The signal at digital input 1 accelerates the motor to 2000 rpm.

Table 8- 10 Settings for the example

Parameter	Description
p1001 = 300.000	**Fixed speed setpoint 1** in [rpm]
p1002 = 2000.000	**Fixed speed setpoint 2** in [rpm]
p0840 = 722.0	**ON/OFF1:** Switch on motor with digital input 0
p1070 = 1024	**Main setpoint:** Interconnect the main setpoint with the fixed speed setpoint.
p1020 = 722.0	**Fixed speed setpoint selection bit 0:** Interconnect fixed setpoint 1 with digital input 0 (DI 0).
p1021 = 722.1	**Fixed speed setpoint selection bit 1:** Interconnect fixed setpoint 2 with DI 1.
p1016 = 1	**Fixed speed setpoint mode:** Select direct selection of the fixed setpoints.

Table 8- 11 Resulting fixed setpoints for the example above

Fixed setpoint selected by	Resulting setpoint
DI 0 = LOW	Motor stops
DI 0 = HIGH and DI 1 = LOW	300 rpm
DI 0 = HIGH and DI 1 = HIGH	2300 rpm

8.4 Setpoint calculation

8.4.1 Overview of setpoint preparation

You only have to set the setpoint processing if you operate the converter without basic positioner, i.e. you only operate it in the speed-controlled mode.

The setpoint can be modified as follows using the setpoint processing:

- Invert setpoint to reverse the motor direction of rotation (reversing).
- Inhibit positive or negative direction of rotation, e.g. for conveyor belts, pumps or fans.
- Minimum speed to avoid standstill when the motor is switched on.
- Limit to a maximum speed to protect the motor and mechanical system.
- Ramp-function generator to accelerate and brake the motor with an optimum torque.

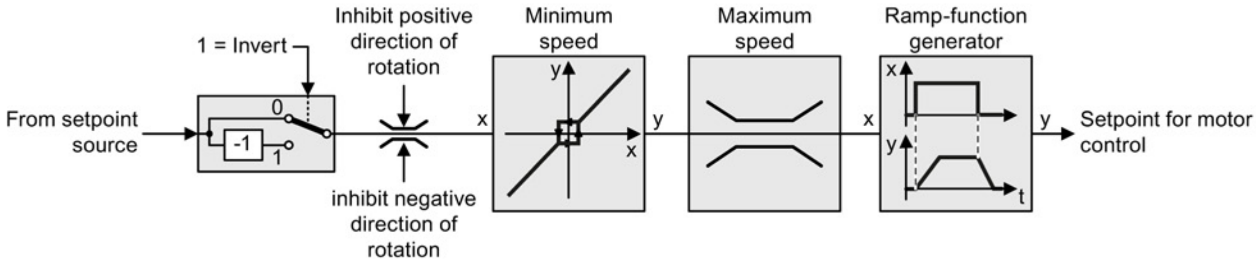


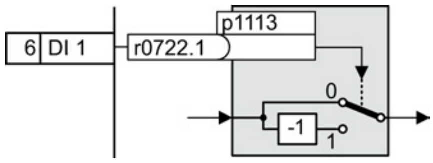
Figure 8-12 Setpoint processing in the inverter

8.4.2 Invert setpoint

Procedure

Proceed as follows to invert the setpoint:

Interconnect parameter p1113 with a binary signal, e.g. digital input 1.



You have inverted the setpoint.

Table 8- 12 Examples of settings to invert the setpoint

Parameter	Remark
p1113 = 722.1	**Setpoint inversion** Digital input 1 = 0: Setpoint remains unchanged. Digital input 1 = 1: Inverter inverts the setpoint.
p1113 = 2090.11	Invert setpoint via control word 1, bit 11.

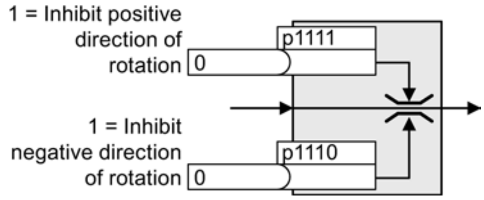
8.4.3 Inhibit direction of rotation

In the factory setting of the inverter, both motor directions of rotation are enabled.

Procedure

Proceed as follows to permanently lock a direction of rotation:

Set the corresponding parameter to a value = 1.



You have permanently locked the appropriate direction of rotation.

Table 8- 13 Examples of settings to inhibit the direction of rotation

Parameter	Remark
p1110 = 1	**Inhibit negative direction** Negative direction is permanently inhibited.
p1110 = 722.3	**Inhibit negative direction** Digital input 3 = 0: Negative direction of rotation is enabled. Digital input 3 = 1: Negative direction of rotation is inhibited.

8.4.4 Minimum speed

Function

The converter prevents continuous motor operation at speeds < minimum speed.

Speeds, where the absolute value is less than the minimum speed, are only possible when accelerating or braking.

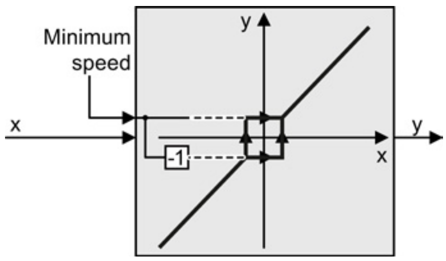


Table 8- 14 Setting the minimum speed

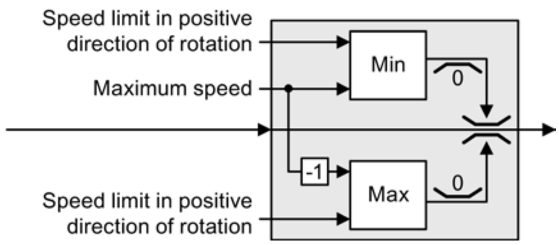
Parameter	Description
p1080	Minimum speed

8.4.5 Maximum speed

Function

The maximum speed limits the speed setpoint range for both directions of rotation.

The converter generates a message (fault or alarm) when the maximum speed is exceeded.



The maximum speed also acts as a reference value for several other functions, e.g. the ramp-function generator.

If you must limit the speed depending on the direction of rotation, then you can define speed limits for each direction.

Table 8- 15 Parameters for minimum and maximum speed

Parameter	Description
p1082	**Maximum speed** (factory setting 1500 rpm)
p1083	**Speed limit, positive direction of rotation** (factory setting 210,000 rpm)
p1086	**Speed limit, negative direction of rotation** (factory setting -210,000 rpm)

8.4.6 Ramp-function generator

The ramp-function generator in the setpoint channel limits the rate that the speed setpoint changes. As a consequence the motor accelerates and brakes more softly, reducing the stress on the mechanical system of the driven machine.

The ramp-function generator is not active if the technology controller in the inverter specifies the speed setpoint.

You can select between two different ramp-function generator types:

- Extended ramp-function generator

  The extended ramp-function generator limits acceleration and jerk.

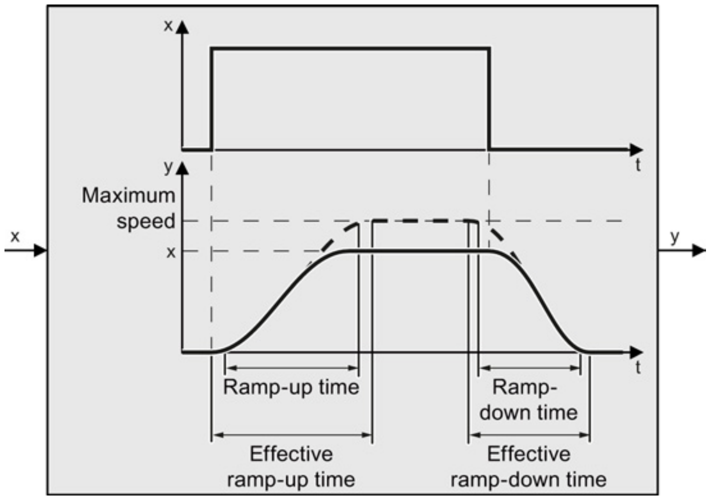
- Basic ramp-function generator

  The basic ramp-function generator limits the acceleration, however not the rate the acceleration changes (jerk).

Extended ramp-function generator

The ramp-up and ramp-down times of the extended ramp-function generator can be set independently of each other. The optimum times that you select depend on your particular application in question and can range from just a few 100 ms (e.g. for belt conveyor drives) to several minutes (e.g. for centrifuges).

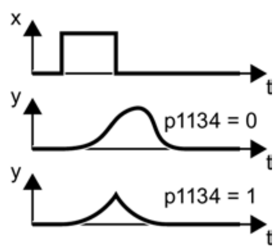
Initial and final rounding permit smooth, jerk-free acceleration and braking.



The ramp-up and ramp-down times of the motor are increased by the rounding times:

- Effective ramp-up time = p1120 + 0.5 × (p1130 + p1131).
- Effective ramp-down time = p1121 + 0.5 × (p1130 + p1131).

Table 8- 16 Additional parameters to set the extended ramp-function generator

Parameter	Description	
p1115	**Ramp-function generator selection** (factory setting: 1) Select ramp-function generator: 0: Basic ramp-function generator 1: Extended ramp-function generator	
p1120	**Ramp-function generator, ramp-up time** (factory setting 10 s) Accelerating time in seconds from zero speed up to the maximum speed p1082	
p1121	**Ramp-function generator, ramp-down time** (factory setting 10 s) braking time in seconds from the maximum speed down to standstill	
p1130	**Ramp-function generator initial rounding time** (factory setting: 0 s) Initial rounding for the extended ramp-function generator. The value applies for ramp up and ramp down.	
p1131	**Ramp-function generator final rounding time** (factory setting: 0 s) Final rounding for the extended ramp-function generator. The value applies for ramp up and ramp down.	
p1134	**Ramp-function rounding type** (factory setting: 0) 0: Continuous smoothing 1: Discontinuous smoothing	
p1135	**OFF3 ramp-down time** (factory setting 0 s) The quick stop (OFF3) has its own ramp-down time.	

Parameter	Description
p1136	**OFF3 initial rounding time** (factory setting: 0 s) Initial rounding for OFF3 for the extended ramp-function generator.
p1137	**OFF3 final rounding time** (factory setting: 0 s) Final rounding for OFF3 for the extended ramp-function generator

You can find more information in function diagram 3070 and in the parameter list of the List Manual.

Setting the extended ramp-function generator

Procedure

Proceed as follows to set the extended ramp-function generator:

1. Enter the highest possible speed setpoint.
2. Switch on the motor.
3. Evaluate your drive response.
   - If the motor accelerates too slowly, then reduce the ramp-up time.

     An excessively short ramp-up time means that the motor will reach its current limiting when accelerating, and will temporarily not be able to follow the speed setpoint. In this case, the drive exceeds the set time.
   - If the motor accelerates too fast, then extend the ramp-up time.
   - Increase the initial rounding if the acceleration is jerky.
   - We recommend that you set the final rounding to the same value as the initial rounding.
4. Switch off the motor.
5. Evaluate your drive response.
   - If the motor decelerates too slowly, then reduce the ramp-down time.

     An excessively short ramp-down time means that the motor will temporarily not be able to follow the speed setpoint. Depending on the Power Module being used, the reason for this is that either the motor current limit has been reached, or there is a risk of an excessively high inverter DC link voltage.

     In any case, the drive exceeds the set time.
   - If the motor decelerates too quickly, then extend the ramp-down time.
6. Repeat steps 1 … 5, until you are satisfied with your drive response.

You have set the extended ramp-function generator.

Basic ramp-function generator

When compared to the extended ramp-function generator, the basic ramp-function generator has no rounding times.

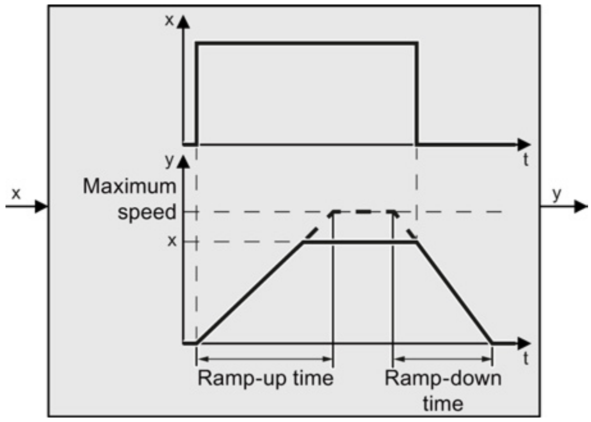


Table 8- 17 Parameters for setting the ramp-function generator

Parameter	Description
p1115 = 0	**Ramp-function generator selection** (factory setting: 1) Select ramp-function generator: 0: Basic ramp-function generator 1: Extended ramp-function generator
p1120	**Ramp-function generator, ramp-up time** (factory setting 10 s) Accelerating time in seconds from zero speed up to the maximum speed p1082
p1121	**Ramp-function generator, ramp-down time** (factory setting 10 s) braking time in seconds from the maximum speed down to standstill
p1135	**OFF3 ramp-down time** (factory setting 0 s) The quick stop (OFF3) has its own ramp-down time.

Changing the ramp-up and ramp-down times in operation

Using a scaling factor, the ramp-up and ramp-down times of the ramp-function generator can be changed in operation. You have the following options of entering a scaling value:

- Using an analog input
- Using a fieldbus

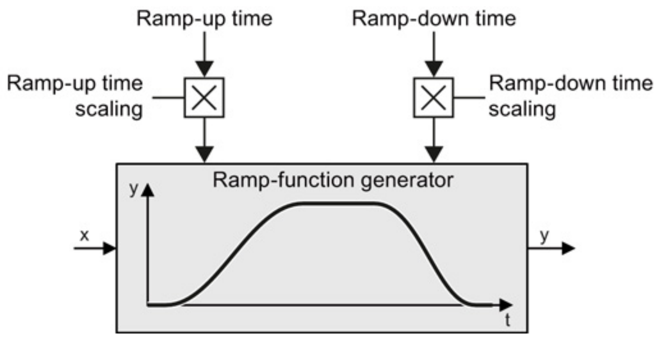


Table 8- 18 Parameters for setting the scaling

Parameter	Description
p1138	**Up ramp scaling** (factory setting: 1) Signal source for scaling the up ramp.
p1139	**Down ramp scaling** (factory setting: 1) Signal source for scaling the down ramp.

Example

In the following example, the higher-level control sets the ramp-up and ramp-down times of the inverter via PROFIBUS.

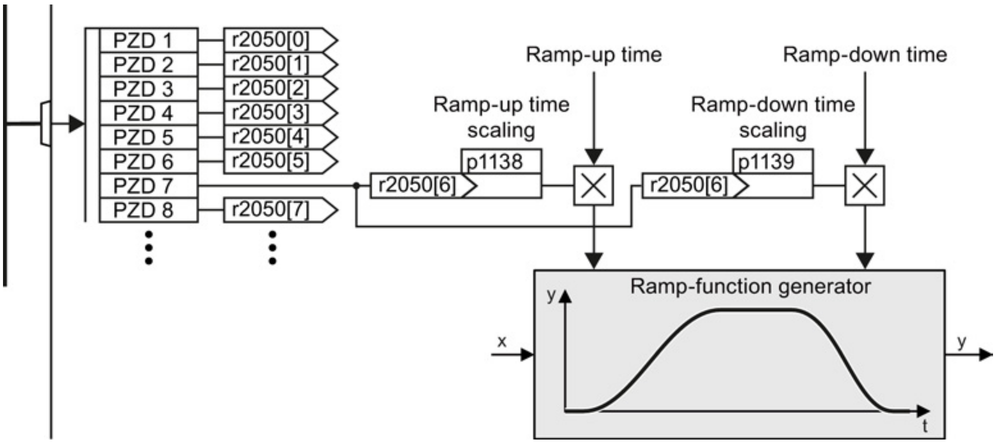


Figure 8-13 Example for changing the ramp-function generator times in operation

Preconditions

- You have commissioned the communication between the inverter and the control system.
- Free telegram 999 has been set in the inverter and in your higher-level control system. See also Section: Extend telegrams and change signal interconnection (Page 91).
- The controller sends the scaling value to the inverter in PZD 7.

Procedure

To interconnect the scaling of the ramp-up and ramp-down times with PZD receive word 7 from the fieldbus in the inverter, proceed as follows:

1. Set p1138 = 2050[6].

   This means that you have interconnected the scaling factor for the ramp-up time with PZD receive word 7.
2. Set p1139 = 2050[6].

   This means that you have interconnected the scaling factor for the ramp-down time with PZD receive word 7.

The inverter receives the value for scaling the ramp-up and ramp-down times via PZD receive word 7.

8.5 Motor control

We recommend that you use vector control with encoder for a position-controlled axis. See also the section: Introduction, V/f control, vector control (Page 53).

8.5.1 V/f control

U/f control sets the voltage at the motor terminals on the basis of the specified speed setpoint.

The relationship between the speed setpoint and stator voltage is calculated using characteristic curves. The required output frequency is calculated on the basis of the speed setpoint and the number of pole pairs of the motor (f = n * number of pole pairs / 60, in particular: f_{max} = p1082 * number of pole pairs / 60).

The inverter provides the two most important characteristics (linear and square-law). User-defined characteristic curves are also supported.

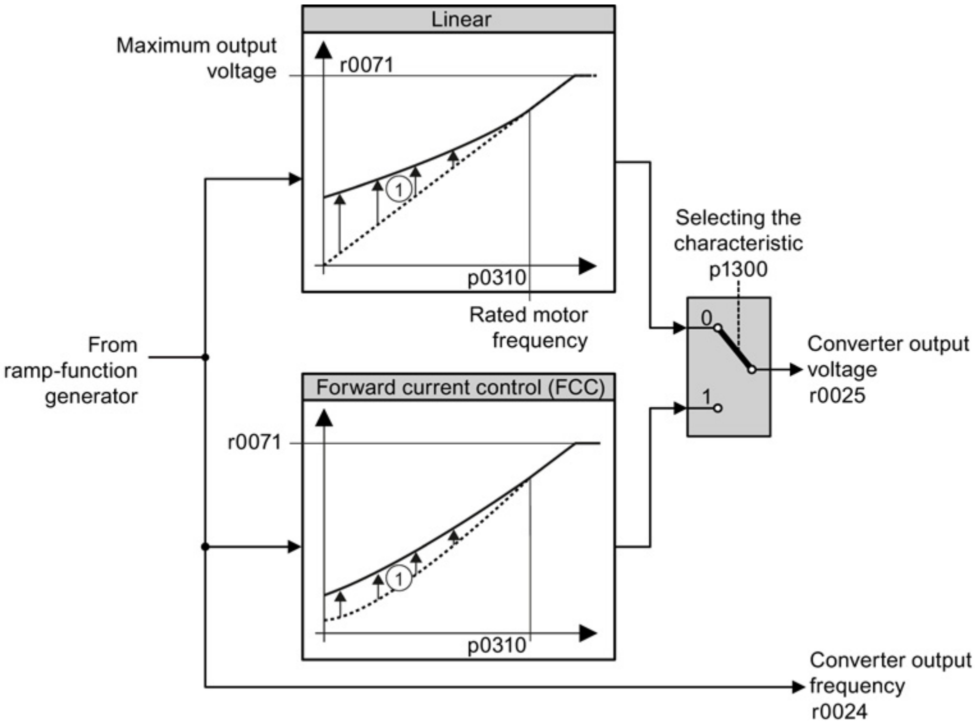
U/f control is not a high-precision method of controling the speed of the motor. The speed setpoint and the speed of the motor shaft are always slightly different. The deviation depends on the motor load.

If the connected motor is loaded with the rated torque, the motor speed is below the speed setpoint by the amount of the rated motor slip. If the load is driving the motor (i.e. the motor is operating as a generator), the motor speed is above the speed setpoint.

Parameter p1300 sets the characteristic curve.

8.5.1.1 Characteristics of V/f control

The converter has several U/f characteristics. Based on the characteristic, as the converter increases in frequency the motor voltage rises.



① The voltage boost of the characteristic improves motor behavior at low speeds. The voltage boost is effective when frequencies < rated frequency

Figure 8-14 U/f characteristics of the converter

The converter increases its output voltage – also above the motor rated speed up to the maximum output voltage. The higher the line voltage, the greater the maximum converter output voltage.

If the converter has reached its maximum output voltage, then it can only increase its output frequency. From this point onwards, the motor is operated in field weakening; this means that the available torque linearly decreases with increasing speed.

The value of the motor voltage at a rated motor frequency depends, amongst other things, on the following values:

- Ratio between the sizes of the converter and motor
- Line voltage
- Line impedance
- Current motor torque

You can find the maximum possible motor voltage based on input voltage in the technical specifications (see also section Technical data (Page 311)).

8.5.1.2 Selecting the V/f characteristic

Procedure

- Select the appropriate characteristic and set parameter p1300.

- Go online with STARTER.
- Select the U/f characteristic curve in one of the screen forms "Speed controller" or "U/f control".

Table 8- 19 U/f characteristics

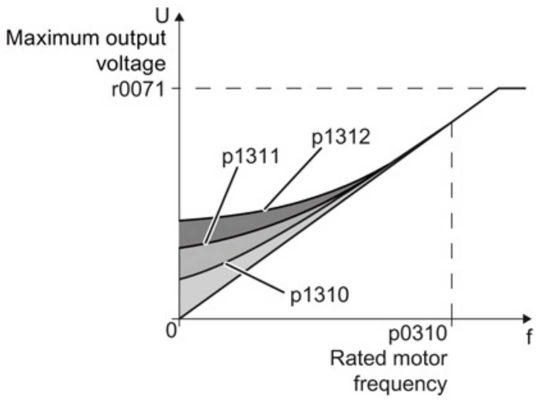
Requirement	Application examples	Remark	Characteristic	Parameter
The required torque is independent of the speed	Conveyor belts, roller conveyors, chain conveyors, eccentric worm pumps, compressors, extruders, centrifuges, agitators, mixers	-	Linear	p1300 = 0
		The inverter equalizes the voltage drops across the stator resistance. Recommended for motors with a low power rating. Precondition: You have set the motor data according to the rating plate and have performed the motor identification after the basic commissioning.	Linear with Flux Current Control (FCC)	p1300 = 1

Additional information on U/f characteristics can be found in the parameter list and in the function diagrams 6300 ff of the List Manual.

8.5.1.3 Optimizing with a high break loose torque and brief overload

Setting the voltage boost for U/f control

The voltage boost acts on every U/f characteristic. The adjacent diagram shows the voltage boost using a linear characteristic as example.



Procedure

Proceed as follows to set the voltage boost:

Only increase the voltage boost in small steps. Excessively high values in p1310 ... p1312 can cause the motor to overheat and switch off (trip) the inverter due to overcurrent.

1. Power-up the motor with an average speed.
2. Reduce the speed to just a few revolutions per minute.
3. Check whether the motor rotates smoothly.
4. If the motor does not rotate smoothly, or even remains stationary, increase the voltage boost p1310 until you are satisfied with the motor behavior.
5. Accelerate the motor to the maximum speed with maximum load and check as to whether the motor follows the setpoint.
6. If, when accelerating, the motor stalls, increase the voltage boost p1311 until the motor accelerates to the maximum speed without any problems.

To achieve satisfactory motor behavior, you must increase the parameter p1312 only in applications with a significant breakaway torque.

You will find more information about this function in the parameter list and in function diagram 6300 of the List Manual.

You have set the voltage boost.

Parameter	Description
p1310	**Permanent voltage boost** (factory setting 50%) Compensates voltage drops as a result of long motor cables and the ohmic losses in the motor.
p1311	**Voltage boost when accelerating** (factory setting 0%) Provides additional torque when the motor accelerates.
p1312	**Voltage boost when starting** (factory setting 0%) Provides additional torque, however, only when the motor accelerates for the first time after it has been switched on ("break loose torque").

8.5.2 Closed loop speed control

Sensorless vector control

Using a motor model, the speed control calculates the load and the motor slip. As a result of this calculation, the inverter controls its output voltage and frequency so that the motor speed follows the setpoint, independent of the motor load.

Speed control is possible without directly measuring the motor speed and is therefore also called "sensorless vector control".

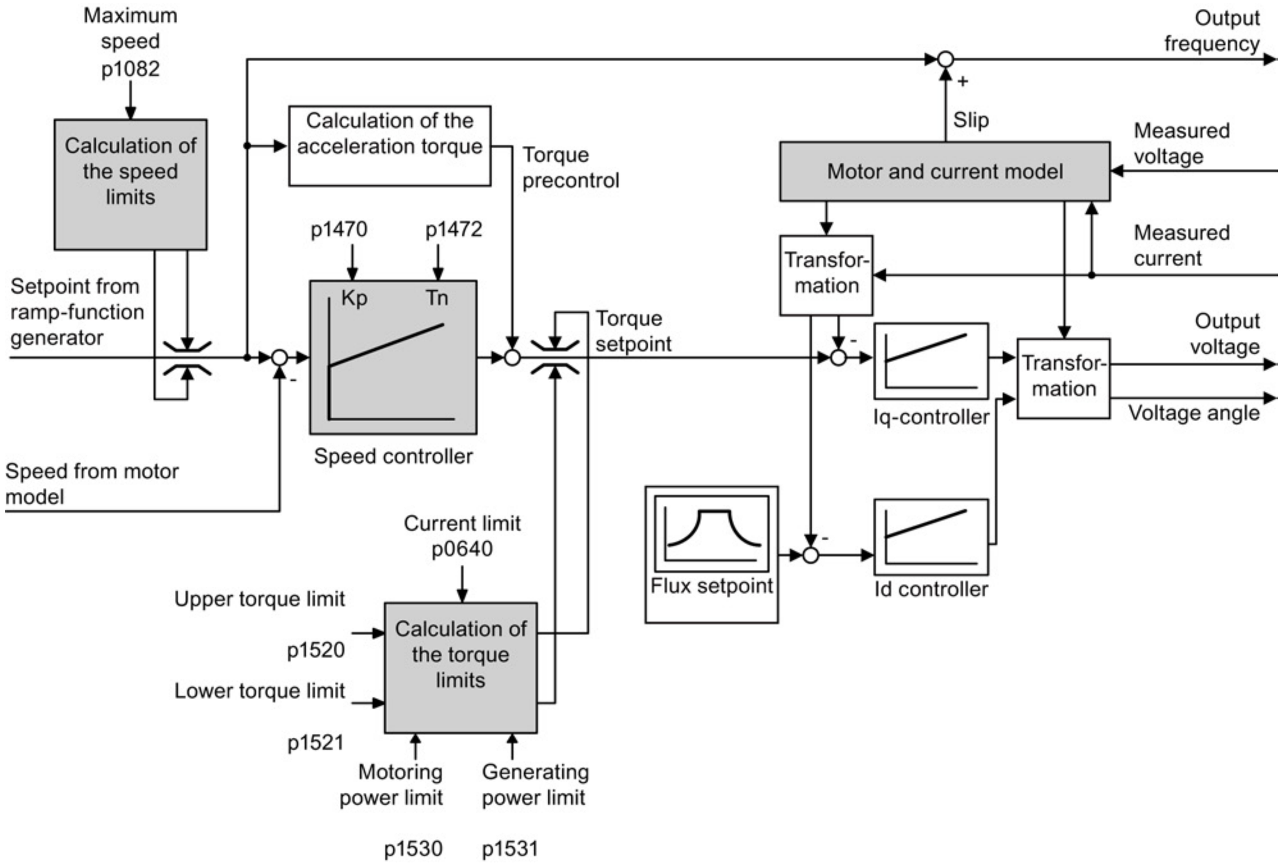


Figure 8-15 Simplified function diagram of sensorless vector control

Vector control with encoder

Vector control with encoder differs from sensorless vector control only due to the fact that the converter does not calculate the speed, but measures it instead.

8.5.2.1 Checking the encoder signal

If you use an encoder to measure the speed, you should check the encoder signal before the encoder feedback is active.

Procedure

- Set the control mode "encoderess vector control":

  - Set p1300 = 20.

  - Go online with STARTER.
  - Select speed control without encoder in the "Speed controller" or "V/f control" mask.

- Switch-on the motor with an average speed.
- Compare parameters r0061 (speed encoder signal in Hz) and r0021 (calculated speed in Hz) regarding the sign and absolute value.
- If the signs do not match, invert the speed encoder signal: Set p0410 = 1.
- If the absolute values of the two values do not match, check the setting of p0408 and the encoder wiring.

8.5.2.2 Select motor control

Speed control is already preset

To achieve a good controller response, you must adapt the elements marked in gray in the figure in the overview diagram above. If you selected speed control as control mode in the basic commissioning, you will already have set the following:

- The maximum speed for your application.
- The motor and current model: If the motor data in the inverter correspond to the motor data on the rating plate, then the motor and current model in the inverter are correct and the vector control can operate satisfactorily.
- The inverter calculates the torque limits matching the current limit that you have set for the basic commissioning.
  Regardless of it, you can also set additional positive and negative torque limits or limit the power of the motor.
- The inverter has a preset speed controller with self-optimization (rotating measurement).
  If you want to continue to optimize this setting, follow the instructions further down in this chapter.

Select encoderless vector control

Procedure

Proceed as follows to select encoderless vector control:

	
1. In the "Parameters" menu, go to p1300 2. Set p1300 = 20.	1. Go online 2. Select speed control without encoder in the "Speed controller" or "U/f control" mask.

You have selected encoderless vector control.

Select vector control with encoder

Procedure

- Set p1300 = 21.

- Go online with STARTER.
- Select speed control with encoder in the "Speed controller" or "V/f control" mask.

8.5.2.3 Re-optimize the speed controller

In the following cases you will need to manually optimize the speed controller:

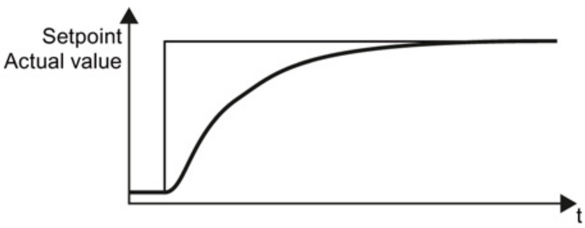
- Your application does not permit self-optimization because the motor cannot rotate freely.
- You are dissatisfied with the result of the inverter self-optimization.
- The inverter interrupted the self-optimization with a fault.

Procedure

To manually optimize the speed controller, proceed as follows:

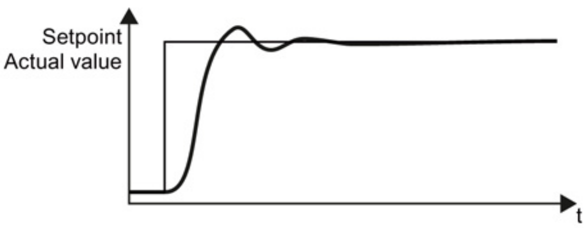
	
1. Set the ramp-up and ramp-down times of the ramp-function generator p1120 = 0 and p1121 = 0. 2. Set the pre-control of the speed controller p1496 = 0. 3. Enter a setpoint step and observe the associated actual value. 4. Optimize the speed controller by changing controller parameters K_P and T_N until the drive runs optimally (see the diagrams below). – K_P = p1470 – T_N = p1472 5. Set the ramp-up and ramp-down times of the ramp-function generator p1120 and p1121 back to their original value. 6. Set the pre-control of the speed controller p1496 = 100%.	1. Go online, and in the "Ramp-function generator" screen form, set the times = 0 . 2. Go online, and in the "Speed controller" screen form, set the pre-control = 0 . 3. Enter a setpoint step and monitor the associated actual value, e.g. using the trace function in STARTER. 4. Go online and optimize the controller in the "Speed controller" screen form by changing the controller parameters K_P and T_N until the drive runs optimally (refer to the diagrams below). 5. Set the ramp-up and ramp-down times of the ramp-function generator back to their original value. 6. Set the pre-control of the speed controller back to 100%.

You have optimized the speed controller.



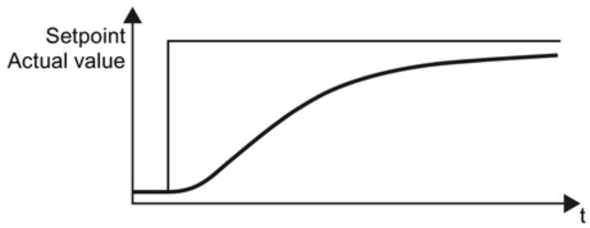
Optimum control response for applications that do not permit any overshoot.

The actual value approaches the setpoint, without any significant overshoot.



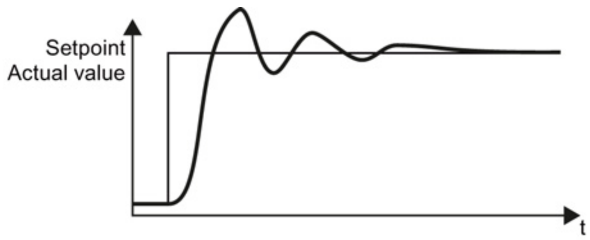
Optimum control response for fast correction and quick compensation of noise components.

The actual value approaches the setpoint and slightly overshoots (maximum 10% of the setpoint step).



The actual value only slowly approaches the setpoint.

- Increase the proportional component K_P and reduce the integration time T_N.



The actual value quickly approaches the setpoint, but overshoots too much

- Decrease the proportional component K_P and increase the integration time T_N.

8.5.3 Operating the converter without position controller

Converter factory setting

In the factory setting of the converter, the basic positioner supplies the setpoint for the speed controller. Although other sources for the setpoint are available in the converter, they are however locked.

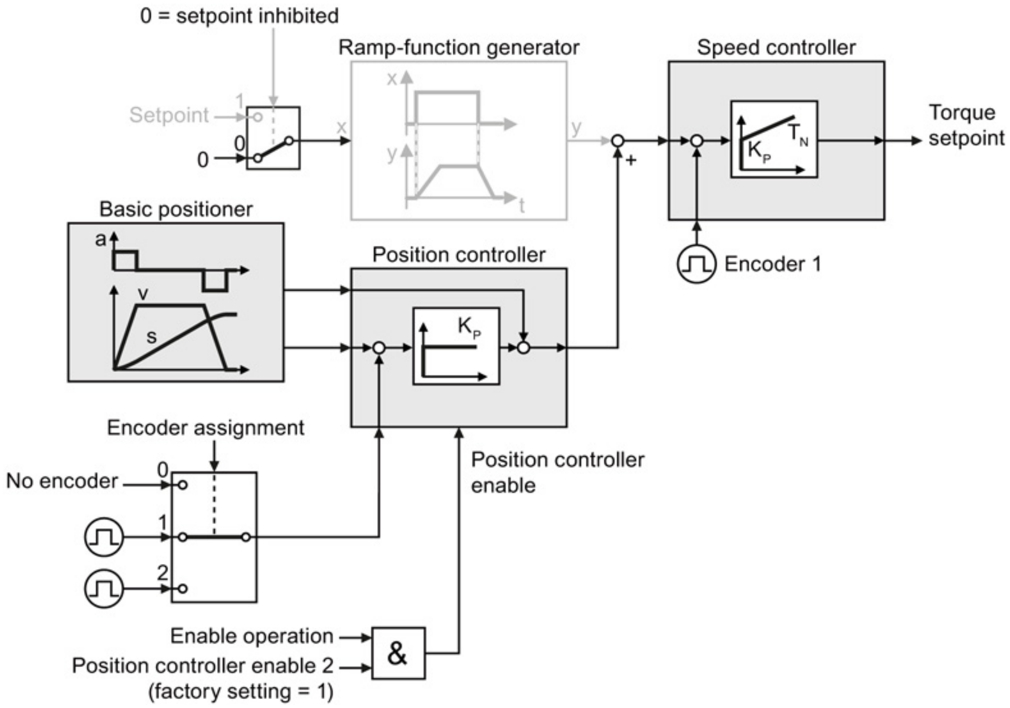


Figure 8-16 Setpoint input for the speed controller in the factory setting of the converter

Operating the converter without position controller

If you want to always operate the converter without the position control, you must inhibit the position controller and enable another source for the setpoint.

Procedure:

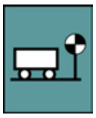
- Inhibit the position controller.
  Set parameter p2550 = 0, e.g. using the STARTER "Position controller" screen.
- Enable the setpoint.
  Set parameter p1142 = 1, e.g. using the STARTER "Ramp-function generator" screen.
- Delete the encoder assignment of the position controller.
  Set parameter p2502 = 0, e.g. using the expert list in STARTER.
- If disturbing alarms occur in operation, which refer to the encoder, then you can suppress these. See also the section: Alarms, faults and system messages (Page 287).

Table 8- 20 Parameters to changeover from position controller to speed controller

Parameter	Meaning
p1142	**Enable setpoint/inhibit setpoint** (factory setting: 0)
p2502	**Encoder assignment** (factory setting: 1)
p2550	**Position controller enable 2** (factory setting: 1)

8.6 Basic positioner

Overview



Position control means controlling the position of an axis. An "axis" is a machine or system component that comprises the converter with active position control and the driven mechanical system.

The basic positioner (EPOS) calculates the traversing profile for the time-optimized traversing of the axis to the target position.

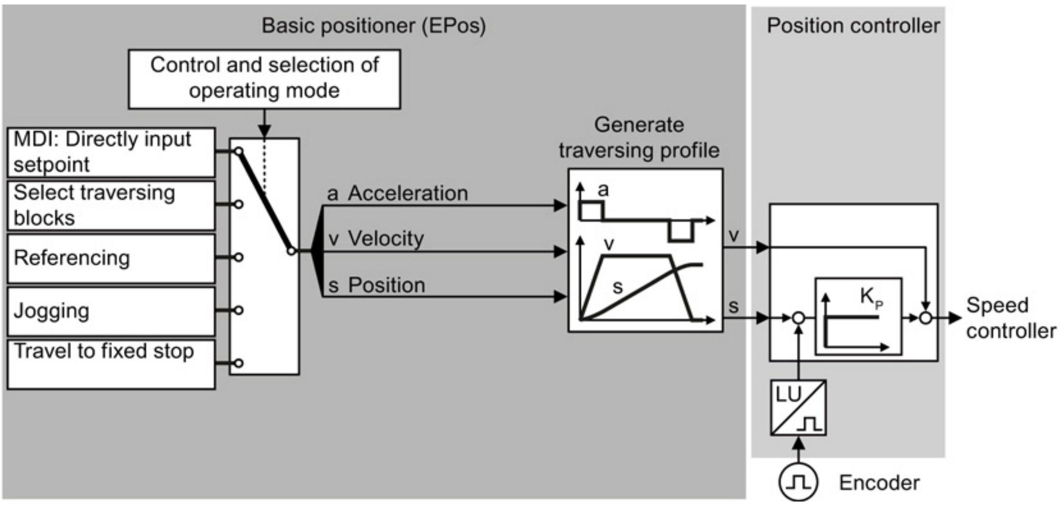


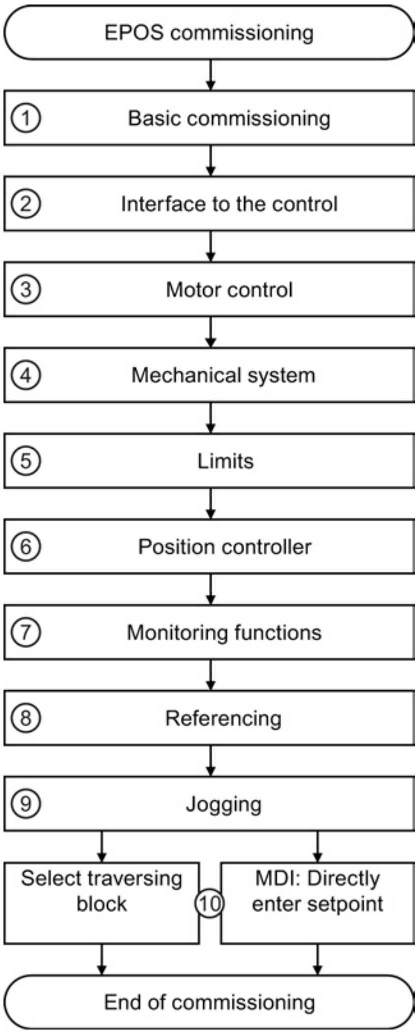
Figure 8-17 Basic positioner and position control

The basic positioner has the following operating modes:

- Direct setpoint input (MDI): The external control specifies the position setpoint for the axis.
- Traversing block selection: Position setpoints are saved in different traversing blocks in the converter. The external control selects a traversing block.
- Referencing: Referencing establishes the reference of the position measurement in the converter to the machine.
- Jogging: This function is used to incrementally traverse the axis (Set up).
- Travel to fixed stop: The converter positions the axis with a defined torque against a mechanical fixed stop.

8.6.1 Commissioning sequence

We recommend that you commission the basic positioner using the "STARTER" tool.
Downloading: Commissioning tools (Page 21).



① Assign encoders to the axes (Page 47)

② Set the communication via the fieldbus (Page 74)

③ Optimize the speed control (Page 135)

④ Normalize the encoder signal (Page 147)

⑤ Set the axis traversing range (Page 154)

⑥ Optimizing the position controller (Page 156)

⑦ Set the positioning accuracy (Page 161)

⑧ Establish the reference to the machine zero point (Page 166)

⑨ Setup the axis (Page 180)

⑩ Save and call the traversing blocks in the converter (Page 183)

or

Enter a position setpoint from the external control via fieldbus (Page 197)

8.6.2 Normalize the encoder signal

8.6.2.1 Define the resolution

Distance unit (LU): the resolution of the position actual value in the converter

The converter calculates the position actual value of the axis using the neutral position unit LU (Length Unit). The distance unit LU is independent of whether the converter controls e.g. the position of an elevating platform or the angle of rotary table.

Firstly, for your application define the required resolution. In other words: Which distance or angle corresponds to the length unit (LU)?

The following rules apply when selecting the distance unit LU:

1. The higher the resolution of the distance unit LU, the higher the accuracy of the position control.
2. If you select a resolution that is too high, then the converter cannot represent the position actual value over the complete axis traversing range. The converter responds with a fault in the case of an overflow when representing the number.
3. The resolution of the distance unit LU should be less than the maximum resolution that is obtained from the resolution of the distance-encoder.

Normalize the encoder signal

Preconditions

- You are online with the STARTER .
- You have selected the "Mechanical system" screen.
- You have defined the required resolution for your particular application (e.g. 1 LU ≙ 1 µm or 1 LU ≙ 1/1,000° (1 millidegree).

Procedure

To normalize the encoder signal, proceed as follows:

1. Enable the settings so they can be edited.
2. Enter the gear ratio of the axis. Load revolutions.
3. Motor revolutions

   Unknown gear ratio
   If you do not know the gear ratio, then you must measure the ratio, for example by manually rotating the motor and counting the load revolutions.
   Example: After 5 motor revolutions, the load has turned through 37 °. The ratio is therefore 37 ° / (5 × 360 °). You must then enter the following values into STARTER:

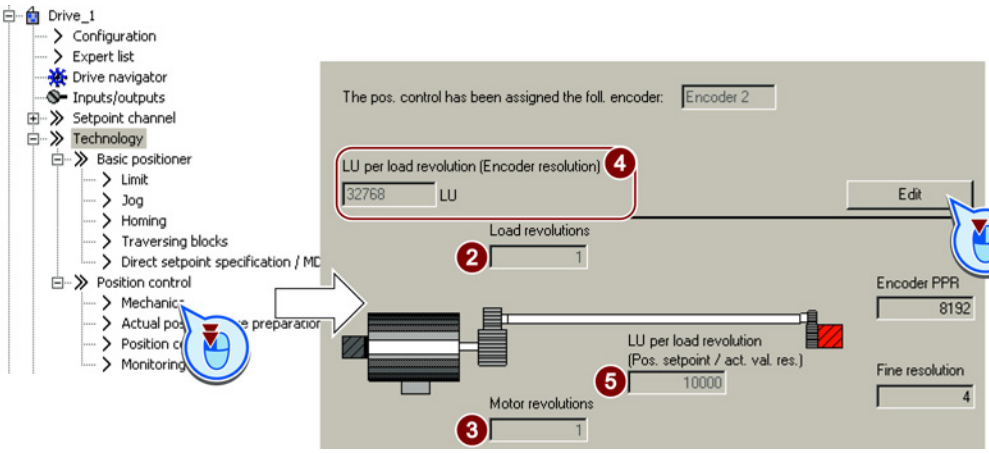
   – ② 37 [load revolution]

   – ③ 1800 [motor revolution]

4. Check the maximum resolution based on your encoder data.

   With SSI encoders, the STARTER displays an excessive value. Encoder resolution = ¼ × displayed value.

5. Calculate:
   Value = 360 ° / required resolution, e.g. 360 °/ 0.1 ° = 3600.
   Enter this value into STARTER.



You have normalized the encoder signal.

Parameter	Meaning	
p2502	**Encoder assignment**	
	0	No encoder
	1	Encoder 1
	2	Encoder 2
p2503	**Length unit LU per 10 mm**	
p2504	**Motor/load motor revolutions**	
p2505	**Motor/load load revolutions**	
p2506	**Length unit LU per load revolution**	

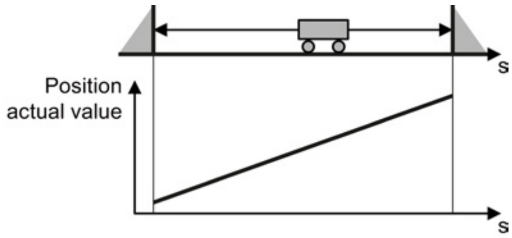
8.6.2.2 Modulo range setting

Description

Linear axis

A linear axis is an axis whose traversing range is limited in both motor directions of rotation by the mechanical system of the machine, e.g.:

- Stacker crane
- Elevating platform
- Tilting station
- Gate/door drive

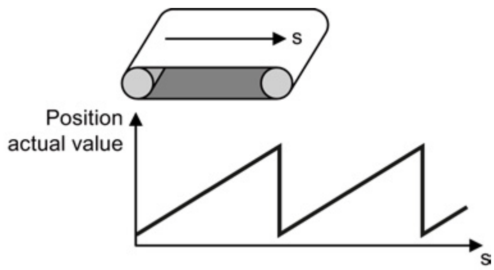


The converter maps the complete traversing range to the position actual value.

Modulo axis

A modulo axis is an axis with an infinite traversing range, e.g.:

- Rotary table
- Conveyor belt
- Roller conveyor



The converter maps the modulo range on the position actual value. If the load position leaves the modulo range, then the value range of the position actual value repeats in the converter.

Setting the modulo range

Preconditions

- You are online with the STARTER .
- You have selected the "Mechanical system" screen.

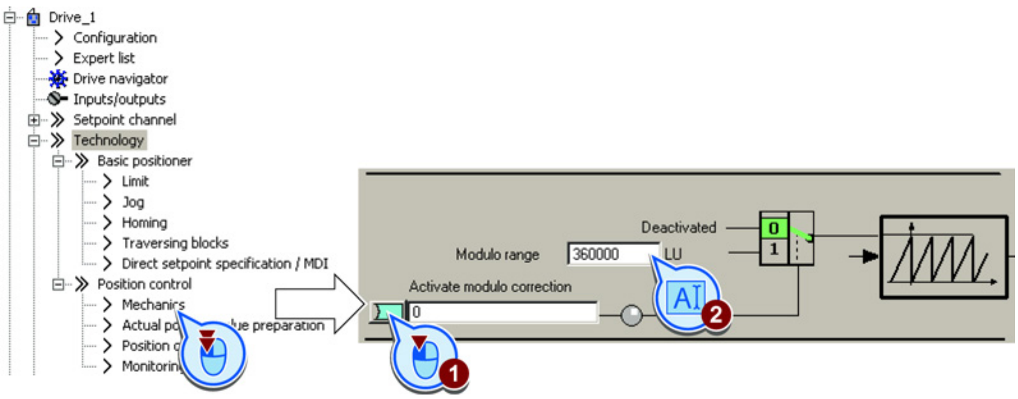
Procedure

To set the modulo range, proceed as follows:

1. Enable the modulo correction.
2. Define the modulo range.

   Example 1: In the case of a rotary table, one load revolution corresponds to 3600 LU. In this case, the modulo correction is also 3600.

   Example 2: For a roller conveyor, 100 motor revolutions corresponds to one production cycle. For a resolution of 3600 LU per motor revolution, the modulo range is 360000 LU.



You have now set the modulo range.

Parameter	Meaning
p2576	**Modulo offset, modulo range**
p2577	**Modulo correction activation (signal = 1)**
r2685	**Offset value**

8.6.2.3 Checking the actual position value

After normalization of the encoder signal you should check the actual position value.

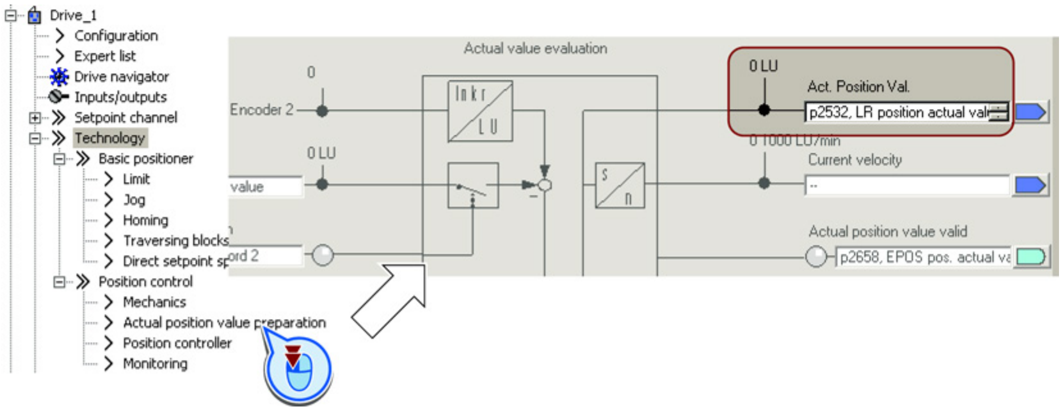
Preconditions

- You are online with the STARTER .
- You have selected the screen for "Actual value processing".

Procedure

To ensure that the converter calculates the actual position value correctly, you must check the following:

- There must be no overflow of the actual position value in the entire traverse range. The converter can show as a maximum the value range of -2147483648 … 2147483647. If this maximum value is exceeded, the converter reports fault F07493.
- If you have defined a modulo range, the converter resets the actual position value after passing through the range.



You have now checked the calculation for the actual position value.

Parameter	Meaning
r2521[0]	Position actual value for position control

8.6.2.4 Setting the backlash

Description

Backlash (also called play, dead travel on reversing etc.) is the distance or the angle that a motor must travel through when the direction of rotation reverses until the axis actually moves in the other direction.

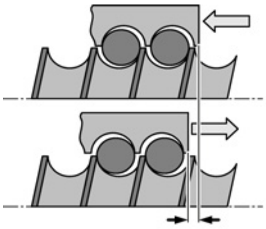


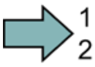
Figure 8-18 Backlash in a spindle

With the appropriate setting, the converter corrects the positioning error caused by the backlash when reversing.

The converter corrects the backlash under the following condition:

- For an incremental encoder, the axis must be referenced.
  See also section: Referencing (Page 166).
- For an absolute encoder, the axis must be adjusted.
  See also section: Absolute encoder adjustment (Page 179).

Measuring backlash



Procedure

To measure the backlash, proceed as follows:

1. Move the axis to position A in the machine. Mark this position in the machine and note down the actual position value in the converter, see also Section: Checking the actual position value (Page 151).
2. Move the axis a little bit more in the same direction.
3. Move the axis in the opposite direction until the actual position value in the converter shows the same value as at position A. Due to the backlash when reversing, the axis is now at position B.
4. Measure the position difference Δ = A - B in the machine.

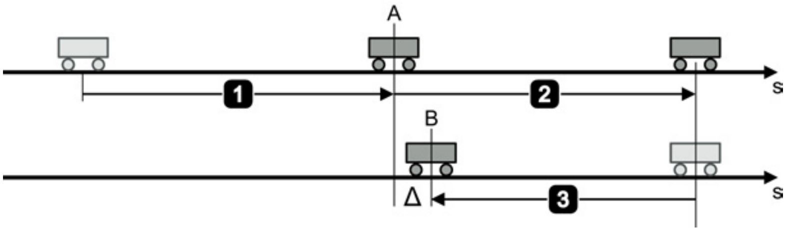


Figure 8-19 Measuring backlash

You have measured the backlash.

Correcting backlash

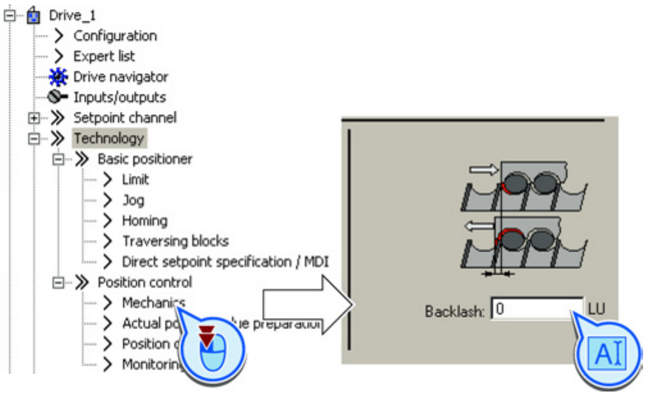
Requirements

You have selected the "Mechanical system" screen.

Procedure

To correct the measured backlash, set the following:

- If the axis has not traveled far enough, then set a positive backlash.
- If the axis has traveled too far, then set a negative backlash.



You have corrected the backlash.

Parameter	Meaning
p2583	**Backlash compensation**
r2685	**Offset value**

8.6.3 Limiting the positioning range

Description

Positioning range for linear axes

The converter limits the positioning range of a linear axis using a software limit switch. The converter only accepts position setpoints that lie within the software limit switches.

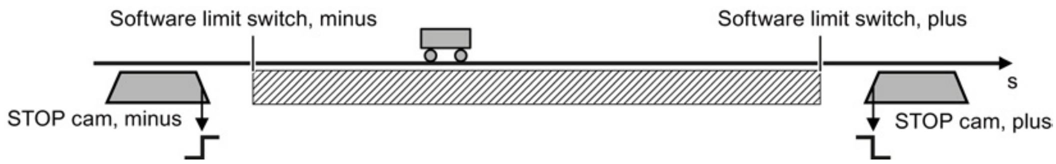


Figure 8-20 Limiting the positioning range of a linear axis

In addition, using its digital inputs, the converter evaluates signals from stop cams. When passing a STOP cam, the converter responds – depending on the setting – either with a fault or an alarm.

Fault as response

When passing the STOP cam, the inverter brakes the axis with the OFF3 ramp-down time, switches the motor off, and reports the fault F07491 or. F07492. To switch the motor on again, you must do the following:

- Switch the motor off (OFF1).
- Acknowledge the fault.
- Move the axis away from the STOP cam, e.g. using the jogging function.

Alarm as response

When passing the STOP cam, the converter brakes the axis with the maximum deceleration (see Section: Limiting the traversing profile (Page 159)), maintains the axis in closed-loop control and outputs alarm A07491 or A07492. In order to bring the axis back into the valid traversing range, you must move the axis from the STOP cam, e.g. using the jogging function.

Setting the limits of the positioning range

Precondition

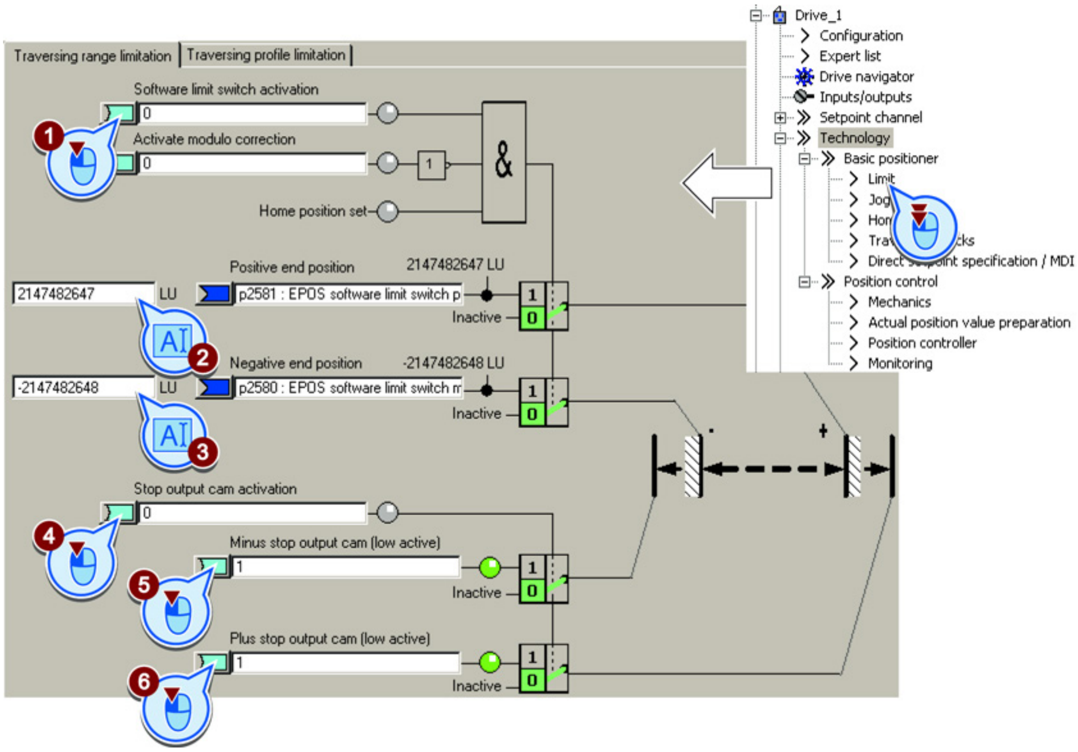
You have selected the "Limit" screen.

Procedure

To set the limits of the positioning range, proceed as follows:

1. Enable the software limit switch.
2. Move the axis to the positive limit position in your machine. Set the position of the software limit switches to the actual position value.

3. Move the axis to the negative limit position in your machine. Set the position of the software limit switches to the actual position value.
4. Enable the STOP cams.
5. Interconnect the signal of the STOP cam minus with the corresponding signal of your machine.
   Signal = 0 means an active STOP cam.
6. Interconnect the signal of the STOP cam plus with the corresponding signal of your machine.



You have now set the limits of the positioning range.

Parameter	Meaning
p2568	STOP cam activation
p2569	STOP cam, minus
p2570	STOP cam, plus
p2578	Software limit switch, minus signal source
p2579	Software limit switch, plus signal source
p2580	Software limit switch, minus
p2581	Software limit switch, plus
p2582	Software limit switch activation
r2683.6	Software limit switch, minus actuated
r2683.7	Software limit switch, plus actuated
r2684.13	STOP cam minus active
r2684.14	STOP cam plus active

8.6.4 Setting the position controller

8.6.4.1 Precontrol and gain

Preconditions and constraints

Before you optimize the position controller, the closed-loop drive speed control must be optimally set.

Dynamic response and accuracy of the closed-loop position control depend heavily on the lower-level closed-loop or open-loop control or the motor speed:

- Position control in connection with an optimally set vector control with speed encoder provides the best results.
- Position control with encoderless vector control (sensorless vector control, SLVC) provides satisfactory results for most applications. We recommend that you use a speed encoder for hoisting/lifting applications.
- If you operate the position control with the U/f control of drive, then you must take into account some significant reduction in closed-loop control performance and precision.

Position controllers in hoisting gear

U/f control is not suitable for vertical axes, such as elevating platforms or hoisting gear used in high-bay racking units, as the axis generally cannot reach the target position as a result of the limited precision of the U/f control.

Description

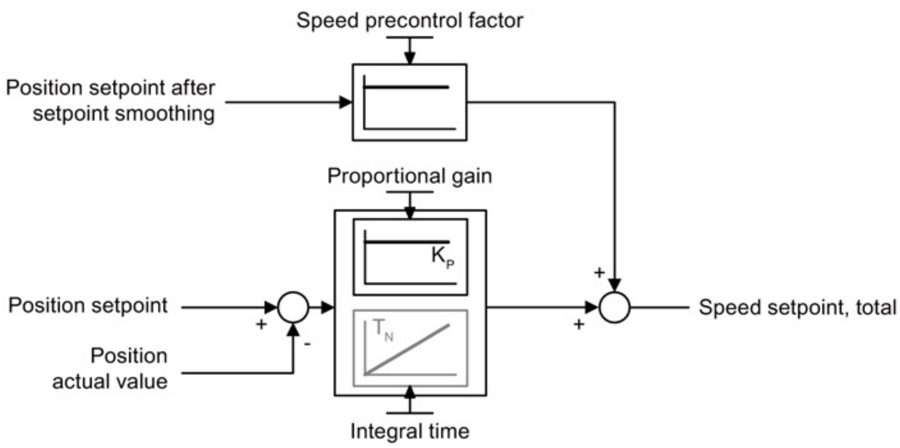


Figure 8-21 Position controller with precontrol

If the speed control of the converter has an encoder to feedback the actual speed, then deactivate the integral component T_N of the position controller.

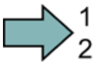
If you use the position control together with the encoderless vector control (SLVC, SensorLess Vector Control), the positioning accuracy may be inadequate. With active integral time, positioning accuracy improves.

8.6.4.2 Optimizing the position controller

To optimize the position controller, you must move the axis with the position control and assess the control performance. How you move an axis using the STARTER is described below.

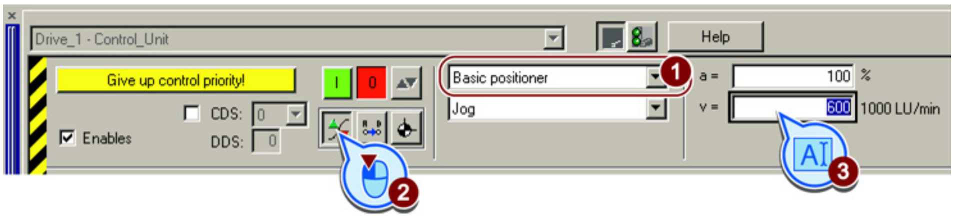
Optimizing the position controller

Procedure



To optimize the position controller, proceed as follows:

1. In the control panel, select the operating mode "Basic positioner".
2. Click the "Jog" button.
3. Enter a speed setpoint.



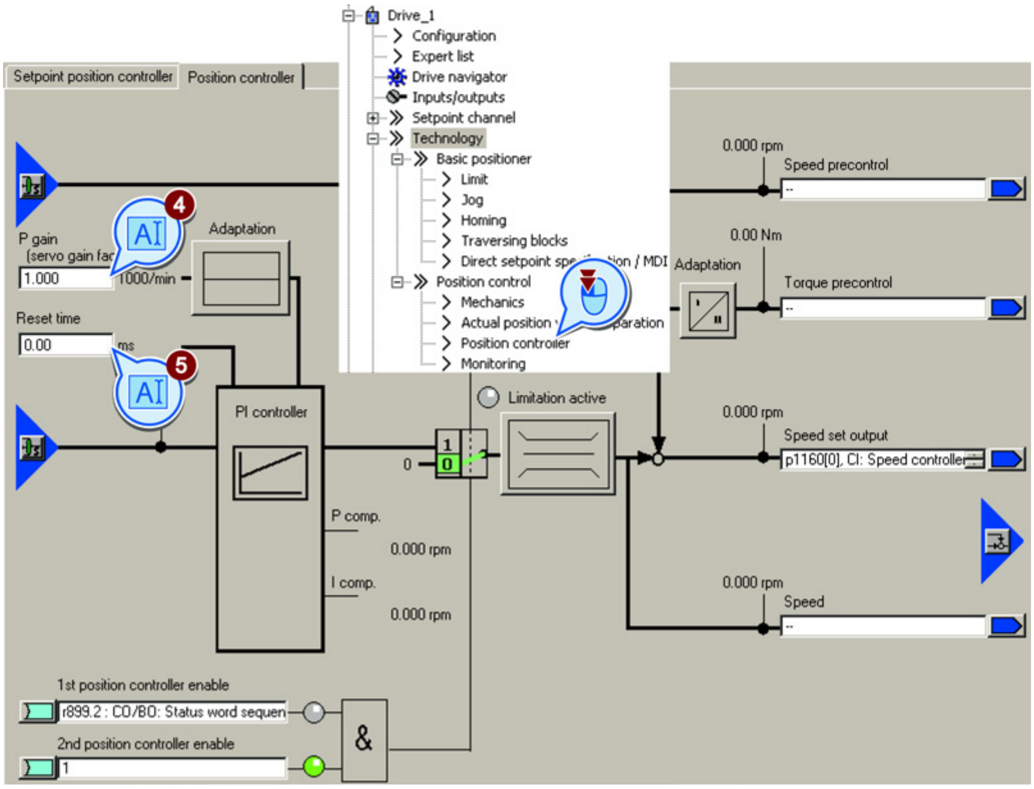
4. Adjust the proportional gain.

   Assess the controller characteristics:

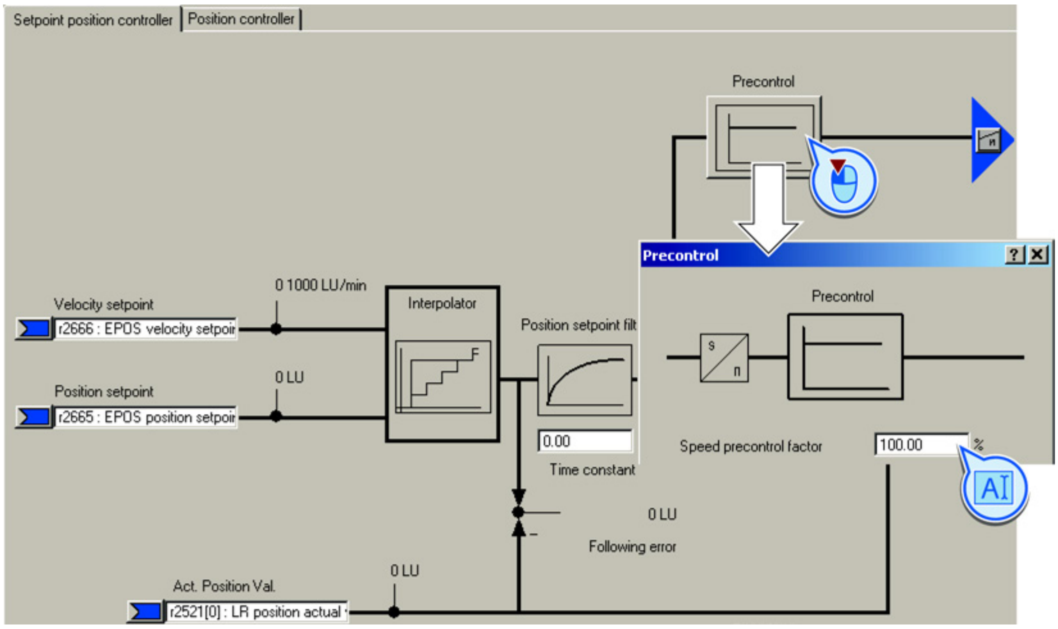
   – If the motor is running unevenly, the controller is unstable. In this case, reduce the proportional gain ④ of the position controller.

     If the closed-loop control is stable, but you are still dissatisfied with the control dynamics, then increase the position controller proportional gain. Then check the stability of the controller.
5. Adjust the integral time.

   Start with an integral time of 100 ms, and test your setting by traversing the axis with the active position controller using the "jog" function.
   Lower integral times increase the control dynamics but can, however, result in unstable controller characteristics.



6. Following controller optimization, set the precontrol of the position controller to 100%.



7. Check the controller characteristics again.

You have optimized the position controller.

Parameter	Meaning
p2534	**Speed precontrol factor**
p2538	**Proportional gain / Kp**
p2539	**Integral time / Tn**
p2731	**Signal = 0: activate position controller**

Advanced settings

If you permanently activate the integral time of the position controller, the characteristics of the position control change as follows:

- The following error while positioning goes to zero.
- When positioning the axis, it tends to overshoot; this means that the axis briefly moves beyond the target position.

8.6.4.3 Limiting the traversing profile

Description

The converter calculates the traversing profile when positioning from specified values for velocity, acceleration and jerk (= acceleration change with respect to time).

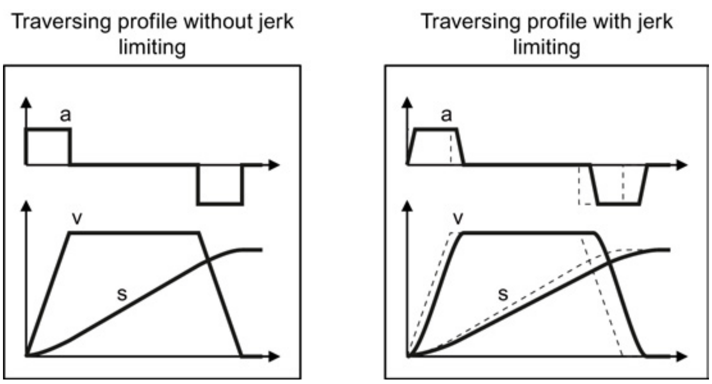


Figure 8-22 Example: Effect of jerk limiting

If the axis must traverse more slowly or must accelerate at a lower rate or "softly", then you must set the relevant limits to lower values. The lower that one of the limits is, the longer the converter needs to position the axis.

Setting the traversing profile limitation

Precondition

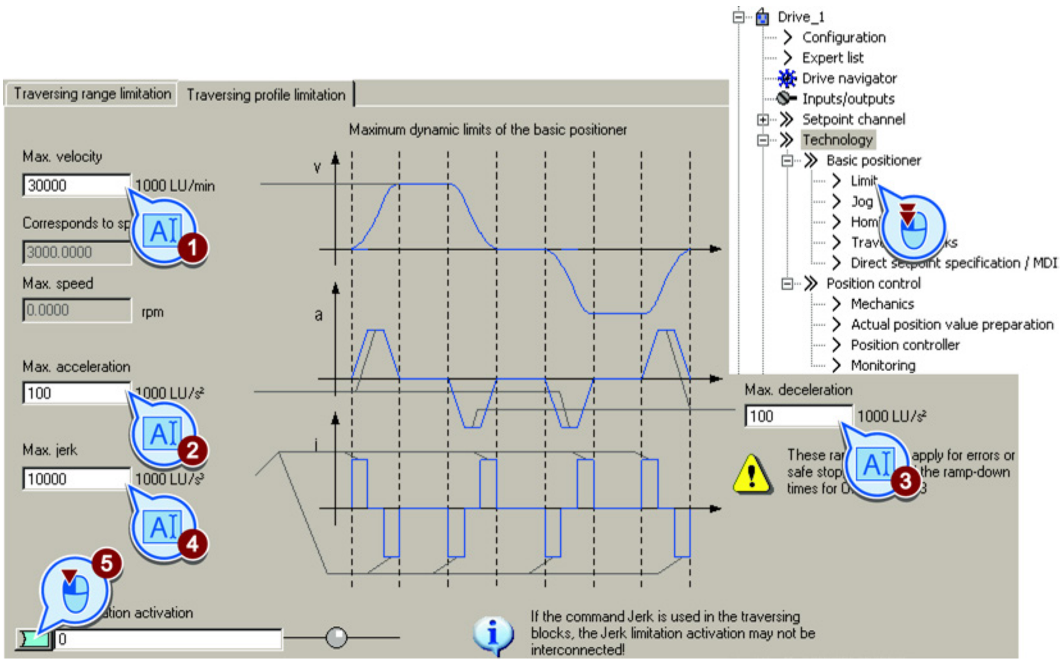
You have selected the "Limit" screen and the "Traversing profile limitation" tab.

Procedure

To set the limitation of the traversing profile, proceed as follows:

1. Set the maximum velocity with which the converter may position the axis.
2. Set the maximum acceleration.
3. Set the maximum delay.

   The "override" in the traversing blocks or for the direct setpoint input refers to the values ② and ③.
4. Reduce the maximum jerk, if you require softer acceleration and braking.
5. For permanent jerk limiting, set this signal to 1.



You have now set the limitation of the traversing profile.

Parameter	Meaning
p2571	**Maximum velocity**
p2572	**Maximum acceleration**
p2573	**Maximum deceleration**
p2574	**Jerk limiting**
p2575	**Activating jerk limiting** 1 signal: Jerk limiting is active

8.6.5 Setting the monitoring functions

8.6.5.1 Standstill and positioning monitoring

Description

As soon as the setpoint for the position within a positioning operation no longer changes, then the converter sets the "Setpoint stationary" signal to 1. With this signal, the converter starts to monitor the position actual value:

- As soon as the axis has reached the positioning window, the converter signals that the target has been reached, and maintains the axis in closed-loop control.
- If the axis does not come to a standstill within the standstill monitoring time, the converter reports fault F07450.
- If the axis does not enter the positioning window within the positioning monitoring time, the converter reports fault F07451.

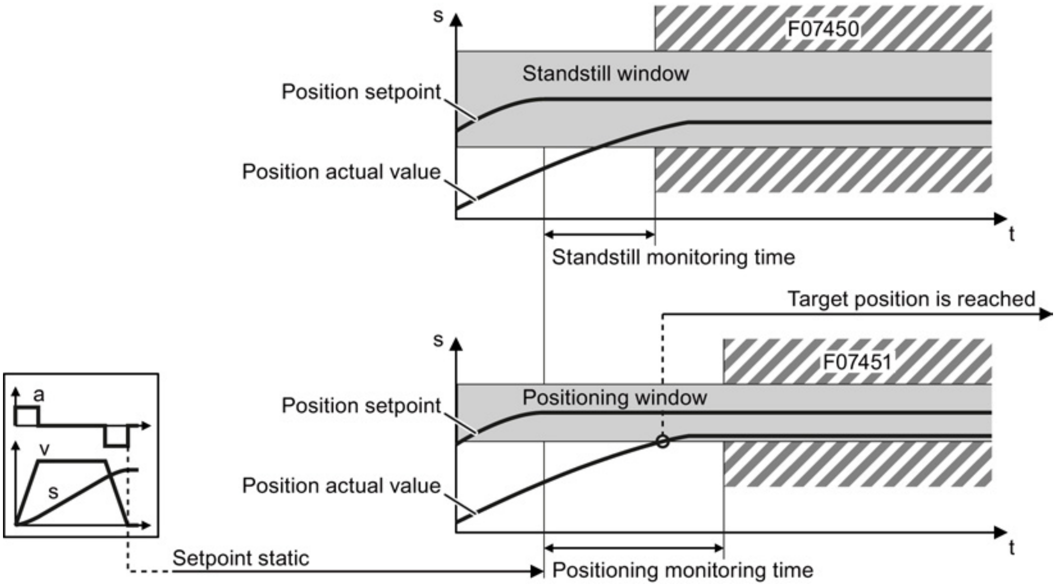


Figure 8-23 Standstill monitoring and positioning monitoring

Setting standstill monitoring and positioning monitoring

Precondition

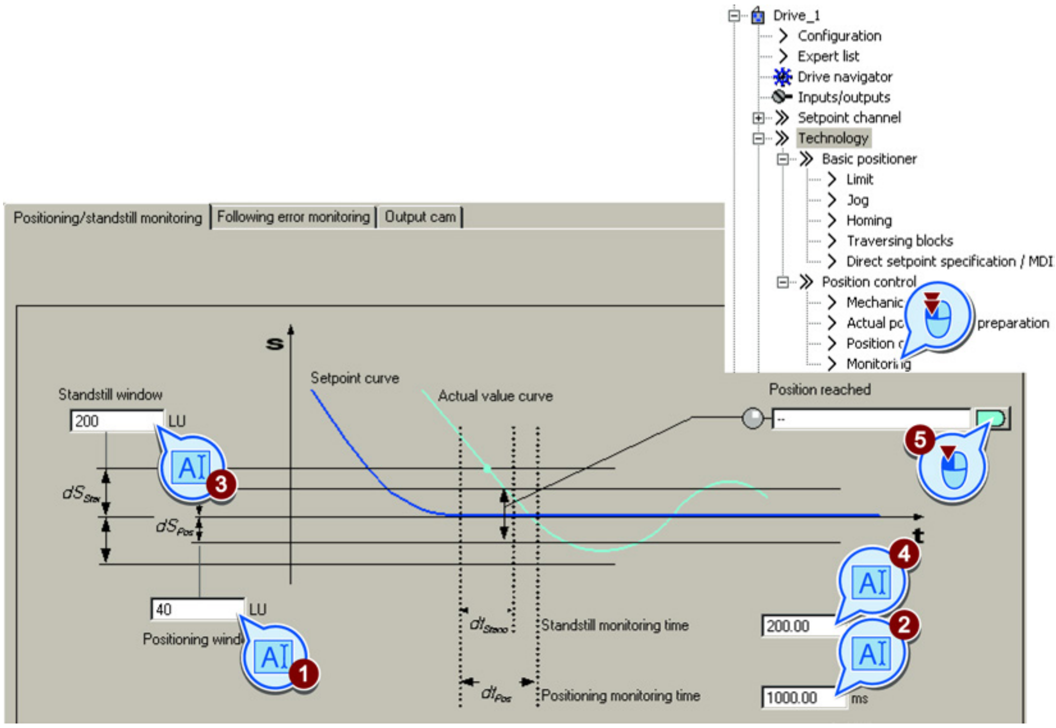
You have selected the "Monitoring" screen and the "Position monitoring" tab.

Procedure

To set the standstill and positioning monitoring, proceed as follows:

1. Set the required positioning accuracy.
2. Set the time within which the axis must be positioned.
3. Set the required standstill window.

   The standstill window must be larger than the positioning window.
4. Set the time within which the axis must be at standstill.
5. Define the signal "Target position reached" as a message to a higher-level control.



You have now set the standstill and position monitoring.

Parameter	Meaning
p2542	Standstill window (target position ±p2542)
p2543	Standstill monitoring time
p2544	Positioning window (target position ±p2544)
p2545	Positioning monitoring time

8.6.5.2 Following error monitoring

Description

The following error is the deviation between the position setpoint and the position actual value while the converter is positioning the axis.

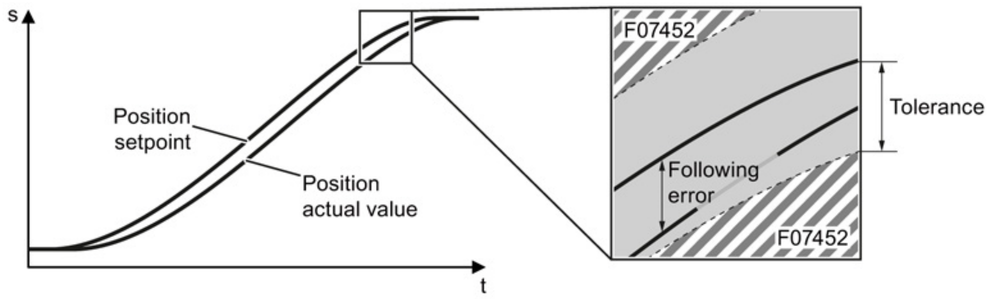


Figure 8-24 Monitoring the following error

The converter reports fault F07452 if the following error is too high. If you set the tolerance to 0, monitoring is deactivated.

Setting following error monitoring

Precondition

You have selected the "Monitoring" screen and the "Following error monitoring" tab.

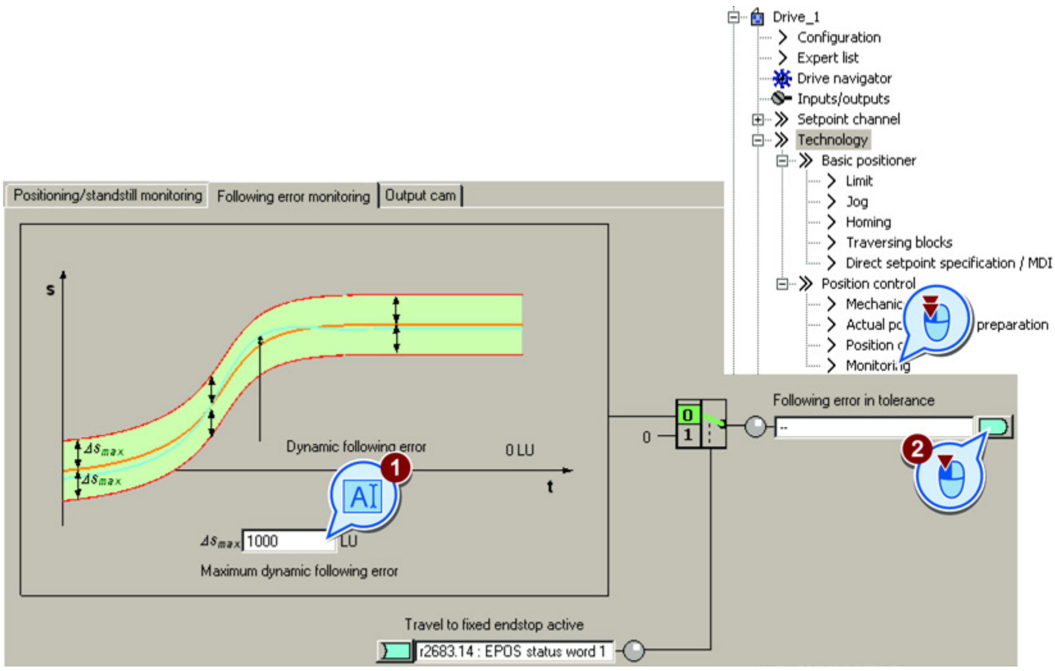
Procedure

To set the monitoring of the following error, proceed as follows:

1. Set the monitoring window.

   Start with the factory setting value.

   Test your setting by positioning the axis at maximum velocity, e.g. from the control panel. If the converter stops the travel with fault F07452 , you will need to either increase the monitoring window or increase the dynamics of the position controller.
2. If you want to evaluate the message in your higher-level control, interconnect this signal with, for example, a status bit in the fieldbus telegram.



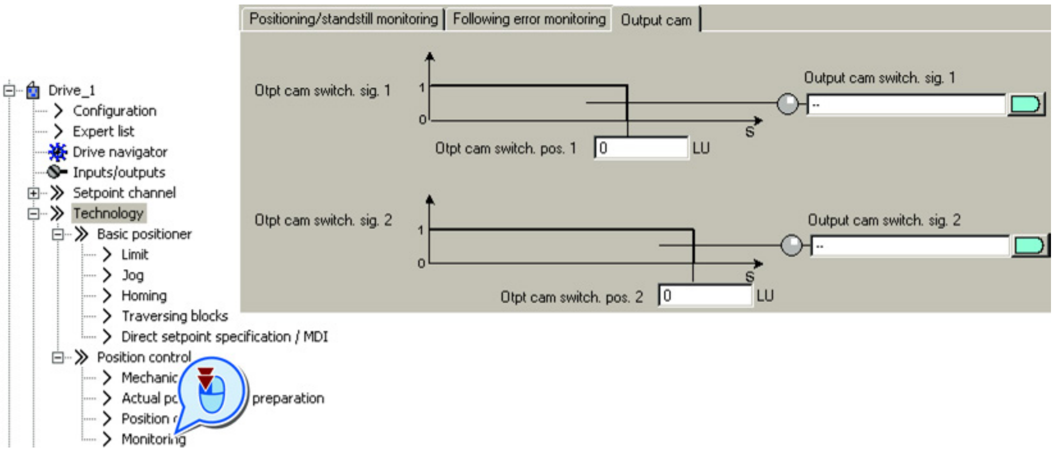
You have now set the monitoring of the following error.

Parameter	Meaning
p2546	**Dynamic following error monitoring tolerance**
r2563	**Following error, dynamic model**

8.6.5.3 Cam sequencer

Description

The converter compares the position actual value with two different positions and therefore simulates two independent cam switching signals.



If you need this function, set the cam switching position to match your particular application and appropriately interconnect the cam switching signal.

Parameter	Meaning
p2547	Cam switching position 1
p2548	Cam switching position 2
r2683.8	Position actual value <= cam switching position 1
r2683.9	Position actual value <= cam switching position 2

8.6.6 Referencing

8.6.6.1 Referencing methods

Overview

If you are using an incremental encoder for the position actual value, after the supply voltage is switched off, the converter loses its valid position actual value. After the supply voltage is switched on again, the converter no longer knows the reference of the axis position to the machine.

Referencing re-establishes the reference between the zero point of the position calculated in the converter and the machine zero point.

Absolute encoders retain their position information, even after the supply has been switched off.

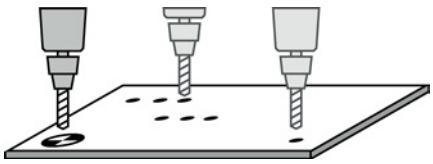
The converter offers various ways of referencing the axis:

- Reference point approach - only with incremental encoders
- Flying referencing - with all encoder types
- Set reference point - with all encoder types
- Absolute encoder adjustment - with absolute encoders

Reference point approach

The converter automatically traverses the axis to a defined reference point.

Example: A workpiece must be positioned at a starting point before machining starts.



Flying referencing

The converter corrects its position actual value while traversing and reduces errors, e.g. caused by wheel slip or a gear ratio that has not been precisely set.

Example: A pallet on a roller conveyor must be stopped at a specific position. However, the exact position of the pallet on the conveyor is only known when a sensor is passed.

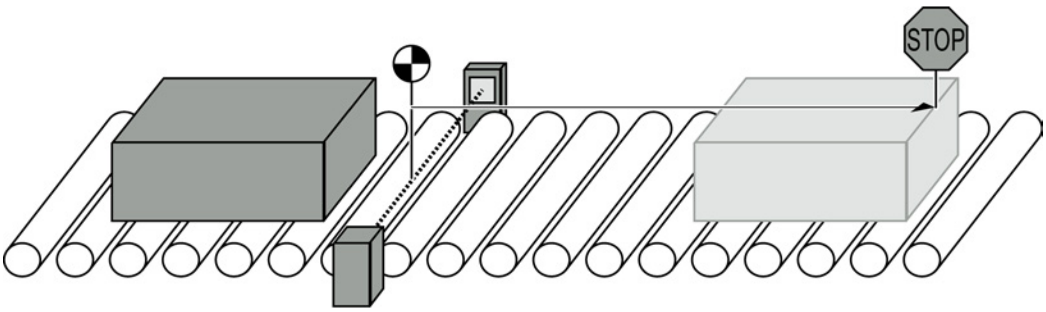


Figure 8-25 Positioning an item to be transported on a roller conveyor

Set the reference point and adjust the absolute encoder

The converter takes the reference point coordinate as the new axis position.

8.6.6.2 Setting the reference point approach

Description

A reference point approach generally consists of the following three steps:

1. Travel to reference cam.
   When it receives a signal, the axis searches in a specified direction for the reference cam.
2. Travel to zero mark.
   After reaching the reference cam, the axis changes the traversing direction and evaluates the zero mark of the encoder.
3. Travel to reference point.
   After the zero mark is reached, the axis traverses to the reference point and synchronizes the actual position value in the converter with the machine.

Step 1: Travel to reference cam

The converter accelerates the axis in the start direction to the "Approach velocity". Once the axis has reached the reference cam, in step 2, the converter switches to the reference point approach.

Reversing cams make sense if the reference cam does not extend up to the end of the traversing range. After reaching a reversing cam, the converter continues to search for the reference cam in the opposite direction.

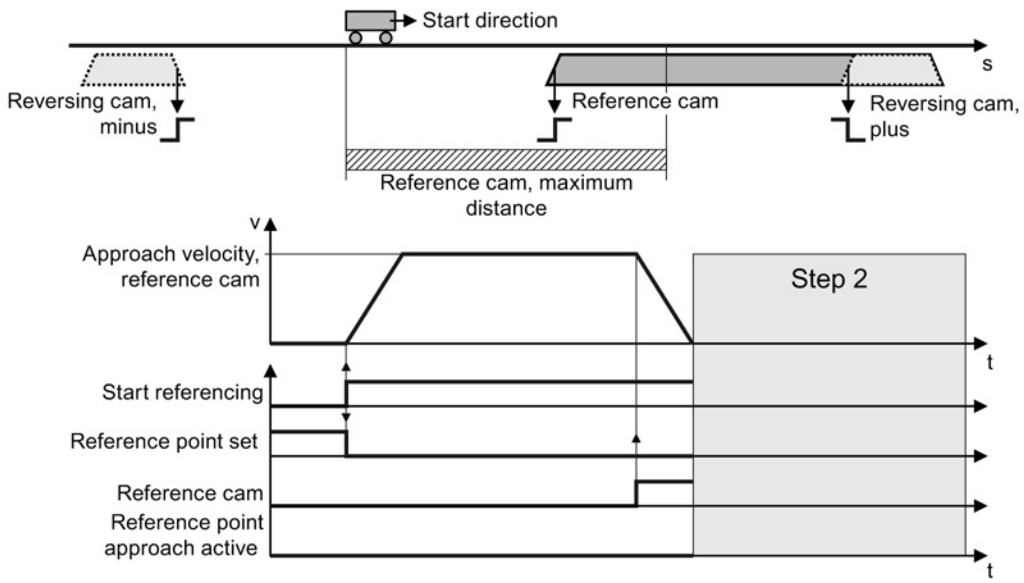


Figure 8-26 Step 1: Travel to reference cam

Under one of the following conditions, the converter skips the first step and starts with step 2:

- The axis is already at the reference cam.
- There is no reference cam available.

Step 2: Travel to zero mark

The behavior of the axis in step 2 depends on whether a reference cam is available:

- Reference cam available: When the converter reaches the reference cam, the axis accelerates *in the opposite direction to the start direction*, to the "approach velocity zero mark".
- No reference cam is available: The converter accelerates the axis *in the start direction* to the "approach velocity zero mark".

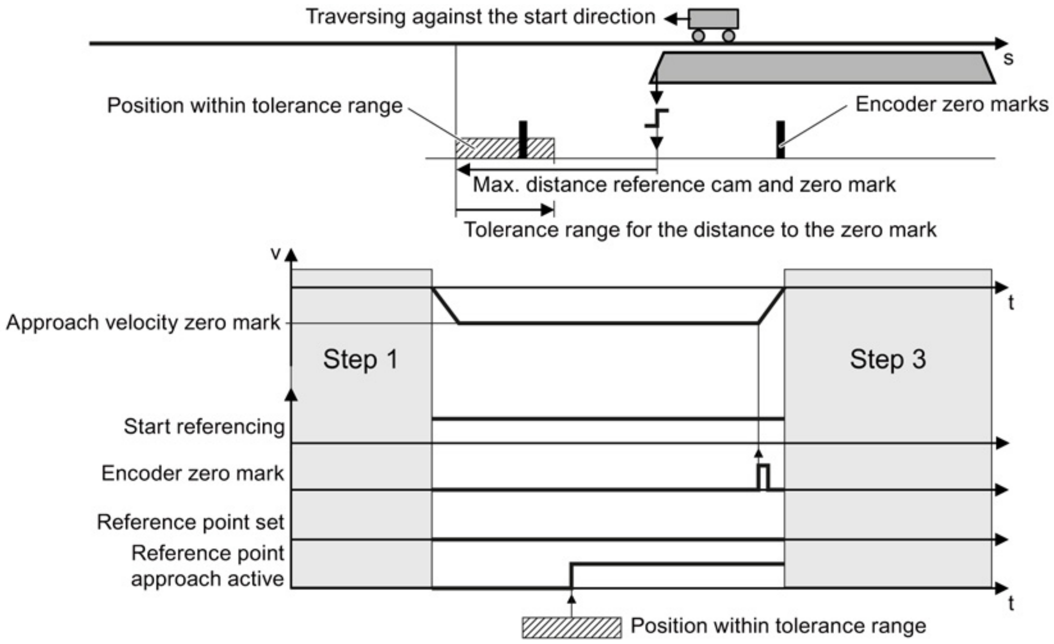


Figure 8-27 Step 2: Travel to zero mark if a reference cam is available

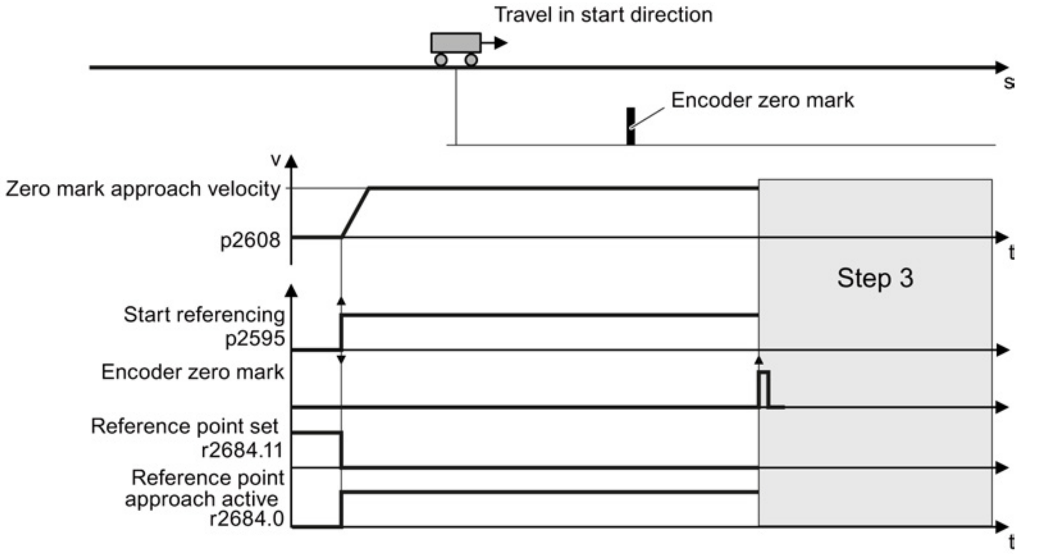


Figure 8-28 Travel to the zero mark if a reference cam is not available

Step 3: Travel to reference point

After the converter has detected a zero mark, the axis moves with the "approach velocity reference point" to the reference point coordinate.

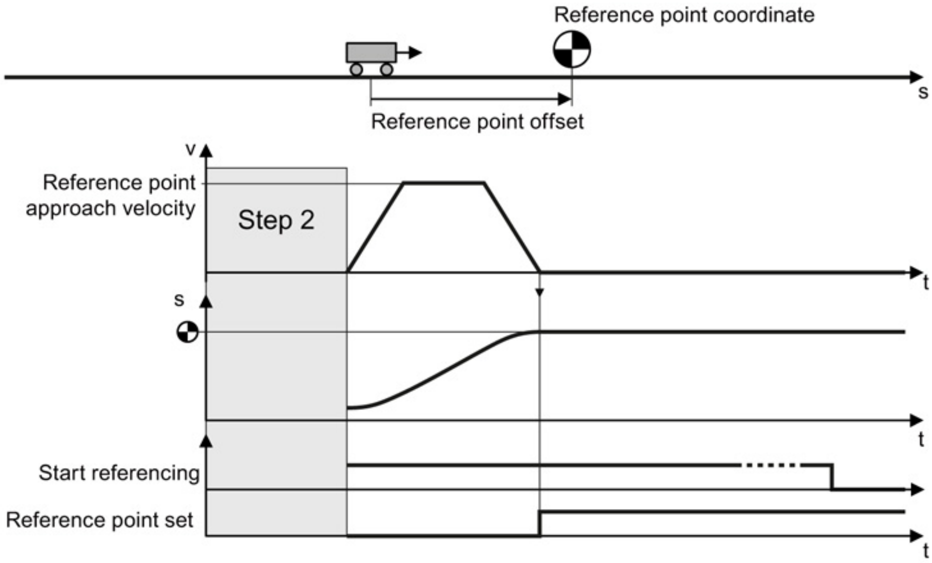


Figure 8-29 Step 3: Travel to reference point

After the load has reached the reference point coordinate, the converter sets its position setpoint and actual value to this value.

Setting the reference point approach

Preconditions

1. You have selected the "Homing" screen.
2. You have come to the settings via the button on the screen.
3. You have selected "Active homing".

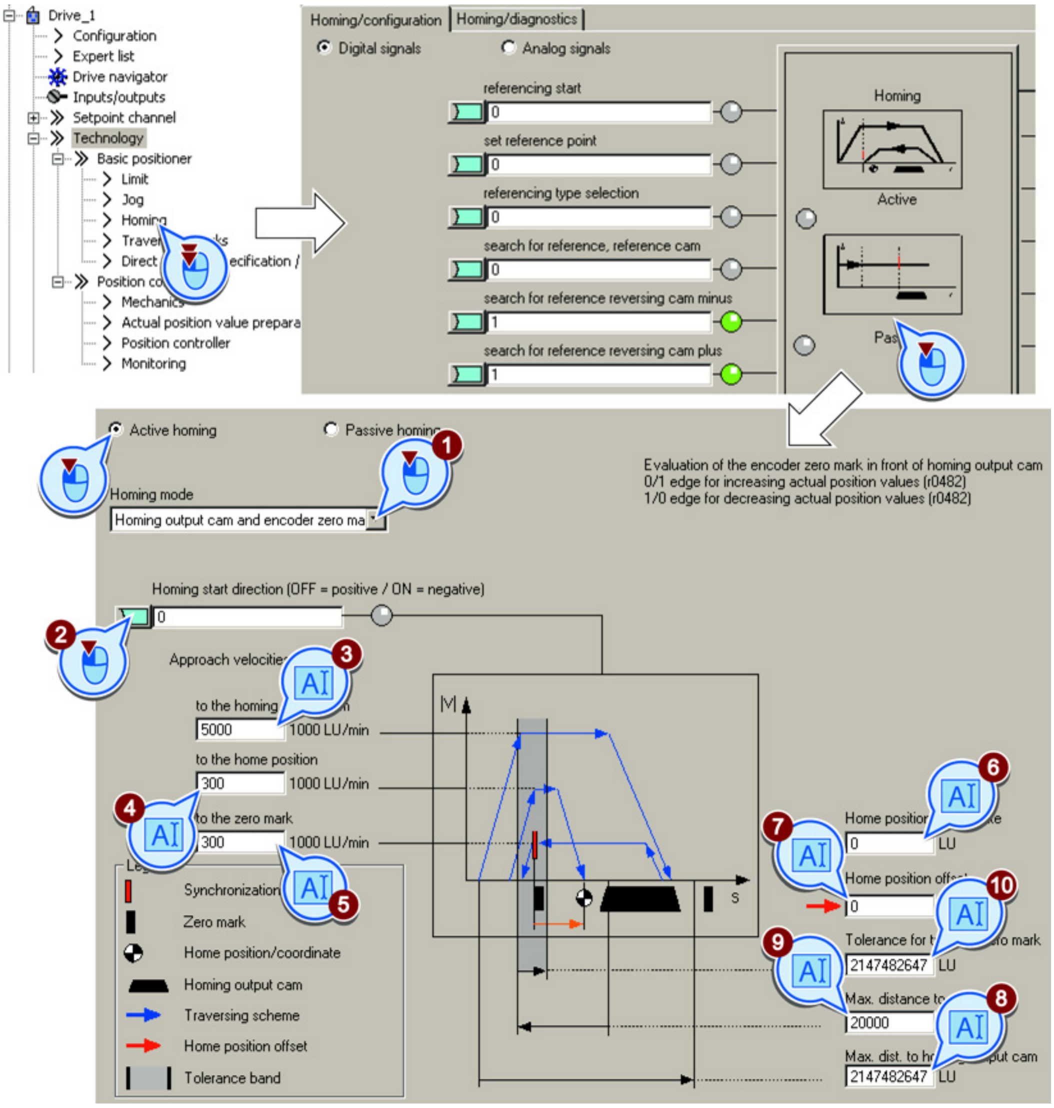
Procedure

1
2

To set the reference point approach, proceed as follows:

1. You specify the referencing mode:
   – Only using the encoder zero mark
   – With external zero mark
   – With reference cam and encoder zero mark
2. Specify the start direction.
3. Set the approach velocity to the reference cam.
4. Set the approach velocity to the reference point.
5. Set the approach velocity to the zero mark.

6. Specify the reference point coordinate.
7. Specify the reference point offset.
8. Specify the max. permissible distance to the reference cam in step 1 of active referencing.
9. If a reference cam is available: Define the maximum permitted distance to the zero mark.
10. If no reference cam is available: Define the tolerance for travel to the zero mark.
11. Close the screen form.



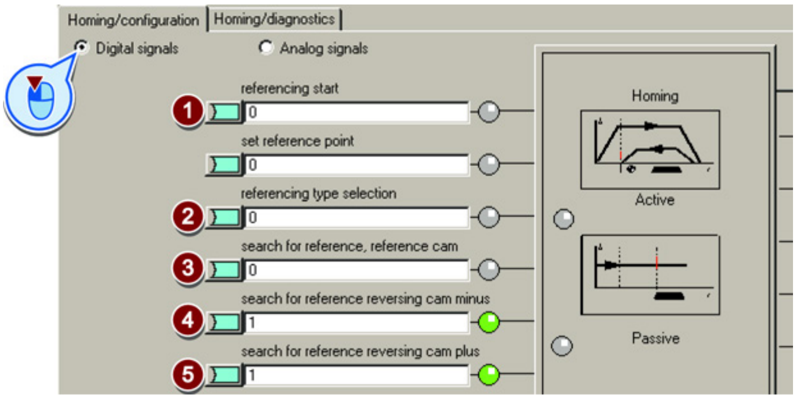
■ You have set the USB reference point approach.

Defining the digital signals for controlling referencing

Procedure

To define the digital signals for controlling, proceed as follows:

1. This signal starts the reference point approach.
2. This signal must be 0 for the reference point approach.
3. Interconnect the signal of the reference cam with the corresponding signal of your machine.
4. If you use the reversing cam minus, interconnect the reversing cams with the corresponding signals, e.g. with the fieldbus.
   0 = Reversing cams active.
5. If you use the reversing cam plus, interconnect the reversing cams with the corresponding signals, e.g. with the fieldbus.
   0 = Reversing cams active.



You have now defined the digital signals for controlling.

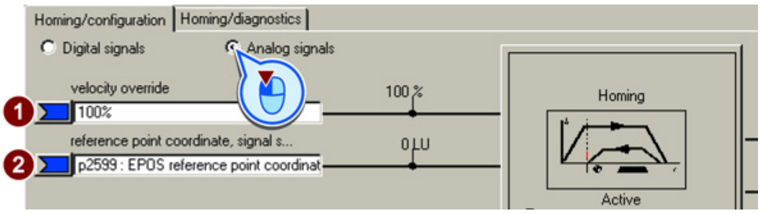
Defining the analog signals for controlling referencing

Procedure

To define the analog signals for controlling, proceed as follows:

1. Define the signal source for the velocity override.

   See also section: Direct setpoint input (MDI) (Page 197).
2. Change the source for the reference point coordinate, if necessary.



You have now defined the analog signals for controlling.

Parameter	Meaning
p2595	Start referencing
p2598	Reference point coordinate, signal source
p2599	Reference point coordinate value
p2600	Reference point approach, reference point offset
p2604	Reference point approach, start direction
p2605	Reference point approach, approach velocity, reference cam
p2606	Reference point approach reference cam, maximum distance
p2607	Reference point approach reference cam available
p2608	Reference point approach, approach velocity, zero mark
p2609	Reference point approach, max distance reference cam and zero mark
p2610	Reference point approach, tolerance band for the distance to the zero mark
p2611	Reference point approach, approach velocity, reference point
p2612	Reference point approach, reference cam
p2613	Reference point approach reversing cam, minus
p2614	Reference point approach reversing cam, plus
r2684.0	Reference point approach active
r2684.11	Reference point set

8.6.6.3 Setting the flying referencing

Description

During motion, the load passes a reference cam. The converter evaluates the reference cam signal via a suitable fast digital input, and corrects its calculated position during travel. The fast digital inputs of the converter used for flying referencing are also called probe inputs.

For flying referencing, the converter corrects the position setpoint and actual value simultaneously.

If the position actual value correction means that the axis has already passed the point where it should start braking, then the axis travels beyond the target and approaches the target from the opposite direction.

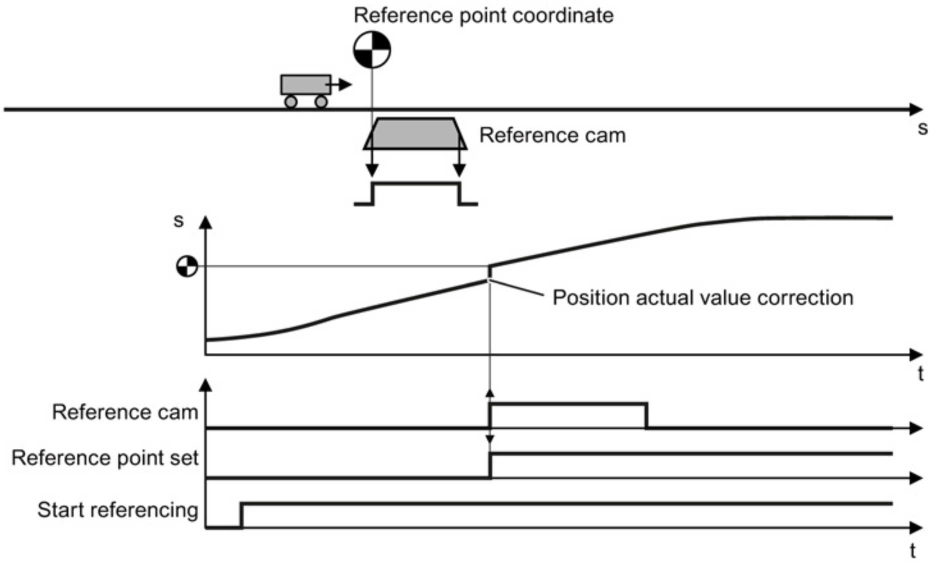


Figure 8-30 Flying referencing

The converter sets the "Reference point set" signal back to zero after its supply voltage is switched off and switched on again. The converter only corrects its position actual value for a 1 signal from "Start referencing". In this way, you can define, for example, the direction of travel when the converter is referencing.

Setting flying referencing

Precondition

1. You have selected the "Homing" screen.
2. You have come to the settings via the button on the screen.
3. You have selected "Passive homing".

Procedure

To set the flying referencing, proceed as follows:

1. Set with which edge of the reference cam signal the converter references its position actual value:
   0: Rising edge
   1: Falling edge
2. Interconnect the switchover of reference cams 1 and 2 with a signal of your choice.
3. Select the digital input with which reference cam 1 is interconnected.
4. Select the digital input with which reference cam 2 is interconnected.

   Several reference points:
   If you require several reference points for an axis, then you must do the following:

   – Assign the corresponding digital input to the respective reference point.

   – Change the reference point coordinate during operation, e.g. using the non-cyclic communication of the fieldbus.
5. Set the inner window for referencing. You deactivate the inner window with the value 0.
6. Set the outer window for referencing. You deactivate the outer window with the value 0.

   Referencing can be suppressed depending on the deviation of the actual position value:

   Inner window: For excessively small deviations, the converter does not correct its position actual value.

   Outer window: The converter signals an excessive deviation, but does not correct its position actual value.

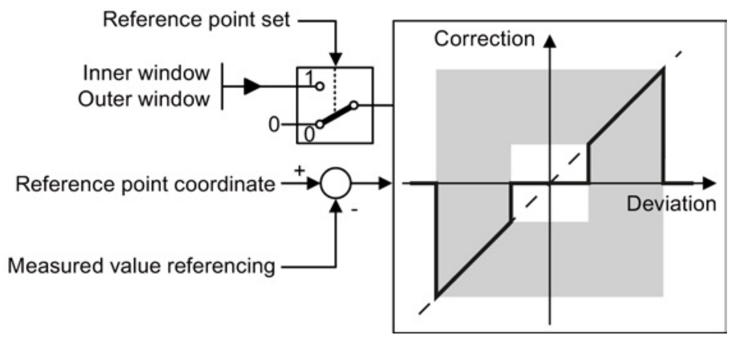


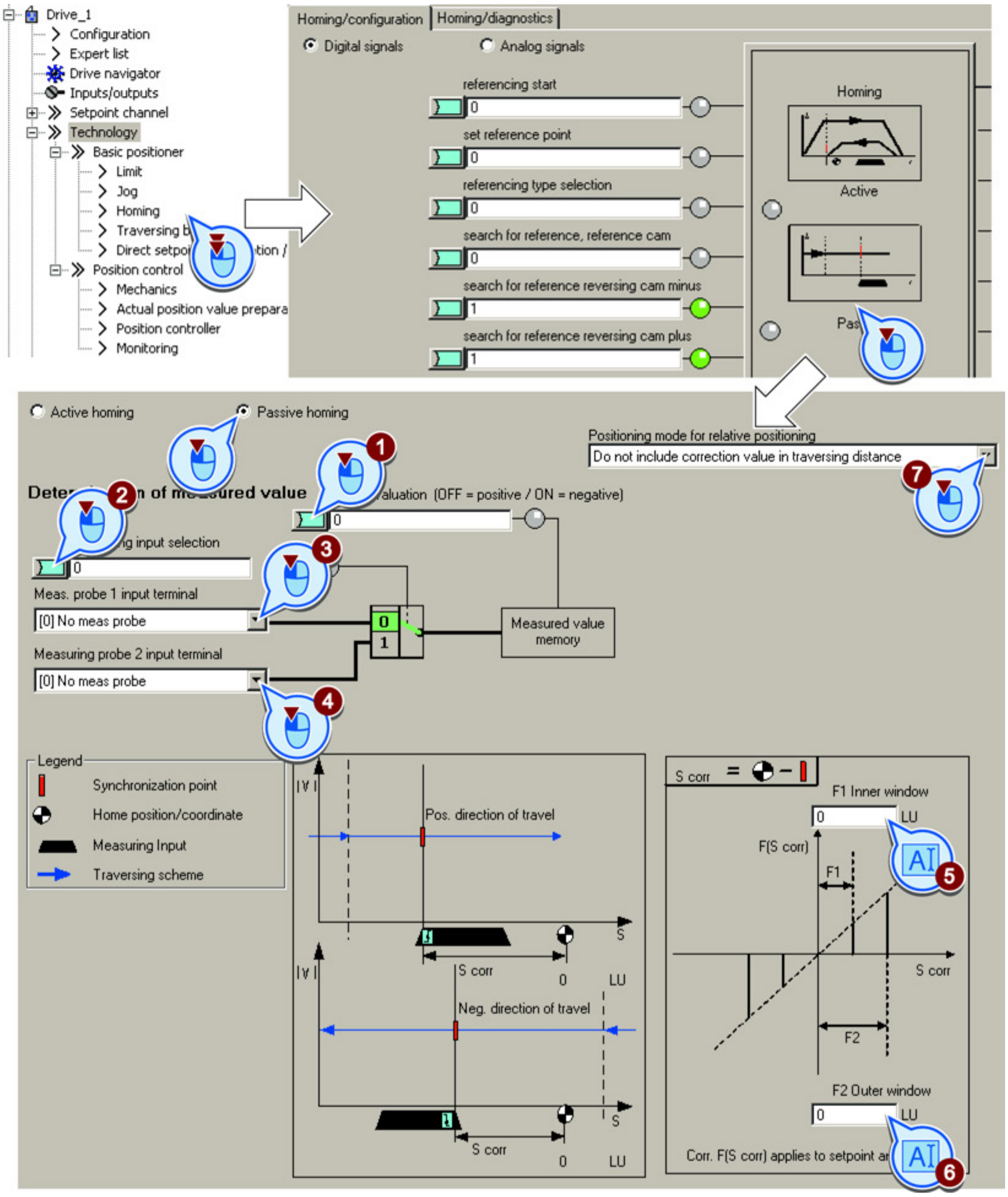
Figure 8-31 Outer and inner window for flying referencing

7. Specify the following:

   – Taking into account the offset in traversing distance: The converter corrects both the actual position as well as the setpoint. The relative traversing distance is shorter or longer by the value of the correction.
   Example: 500 LU is the axis start position. The axis should travel relatively through 1000 LU. The converter corrects the reference point during travel by 2 LU, and travels to the corrected target position 1498 LU.

– Not taking into account the correction in the traversing distance: The converter corrects both the actual position as well as the setpoint. The relative travel distance remains unchanged.
  Example: 500 LU is the axis start position. The axis should travel relatively through 1000 LU. The converter corrects the reference point during travel by 2 LU, however, moves to the old target position 1500 LU.

8. Set the reference point coordinate p2599 via the expert list in the STARTER.
9. Close the screen form.



■ You have now set flying referencing.

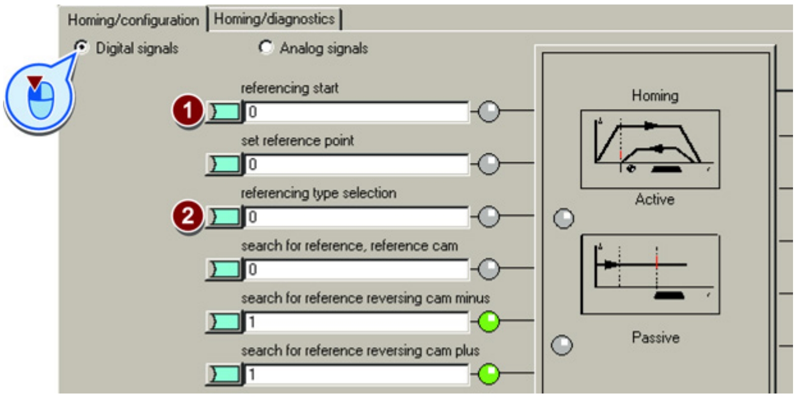
Defining the digital signals for controlling referencing

Procedure

To define the digital signals for controlling, proceed as follows:

1. This signal starts flying referencing.
2. For flying referencing, this signal must be 1.

   The other signals are of no significance for flying referencing.



You have now defined the digital signals for controlling.

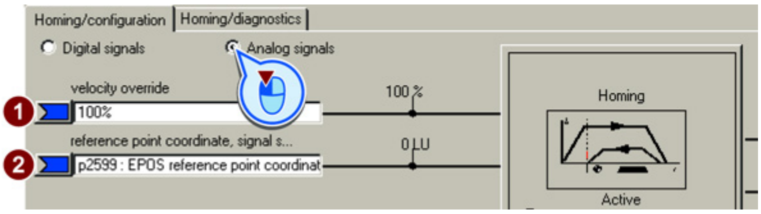
Defining the analog signals for controlling referencing

Procedure

To define the analog signals for controlling, proceed as follows:

1. Define the signal source for the velocity override.

   See also section: Direct setpoint input (MDI) (Page 197).
2. Change the source for the reference point coordinate, if necessary.



You have now defined the analog signals for controlling.

Parameter	Meaning
p2595	Start referencing
p2598	Reference point coordinate, signal source
p2599	Reference point coordinate value
p2601	Flying referencing, inner window
p2602	Flying referencing, outer window
p2603	Flying referencing, relative positioning mode

Parameter	Meaning
p2612	Reference point approach, reference cam
r2684.11	Reference point set
p2660	Measured value referencing

8.6.6.4 Set reference point

Description

Position the load, e.g. using the "jog" function, at the reference position in the machine.

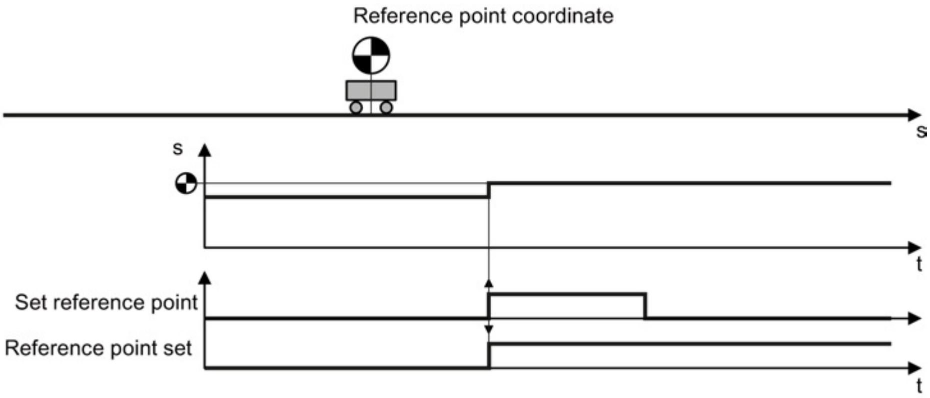


Figure 8-32 Set reference point

Activate 'set home position'

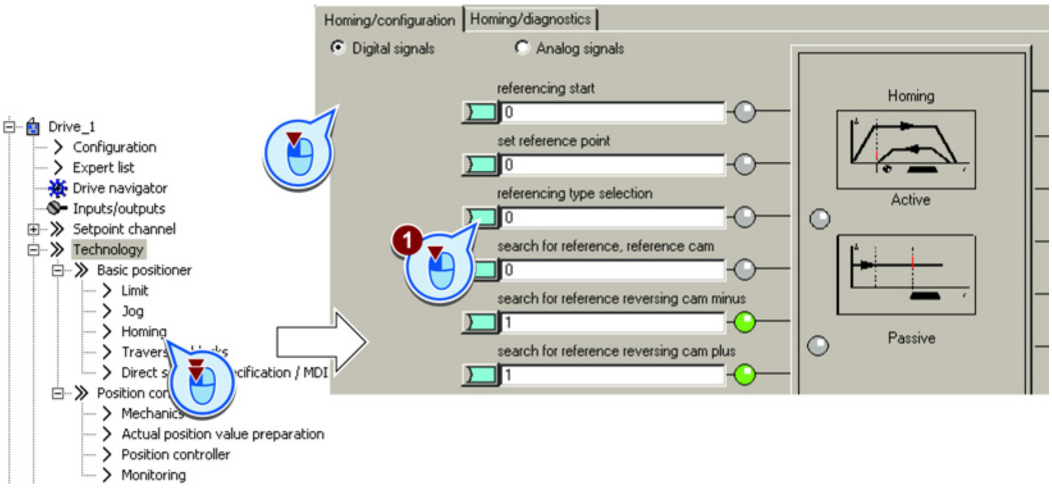
Precondition

You have selected the "Homing" screen.

Procedure

To activate 'set home position', proceed as follows:

1. Interconnect this bit with the corresponding signal of your machine.
   If the axis is stationary, with the signal change 0 → 1, the inverter sets its actual position value to the reference point coordinate.
   For this function, all of the other signals are of no significance.
2. In STARTER, proceed in the expert list and set p2599 to the reference point coordinate.



You have now activated 'set home position'.

Parameter	Meaning
p2596	Set reference point
p2598	Reference point coordinate, signal source
p2599	Reference point coordinate value
r2684.11	Reference point set

8.6.6.5 Absolute encoder adjustment

Absolute encoder adjustment

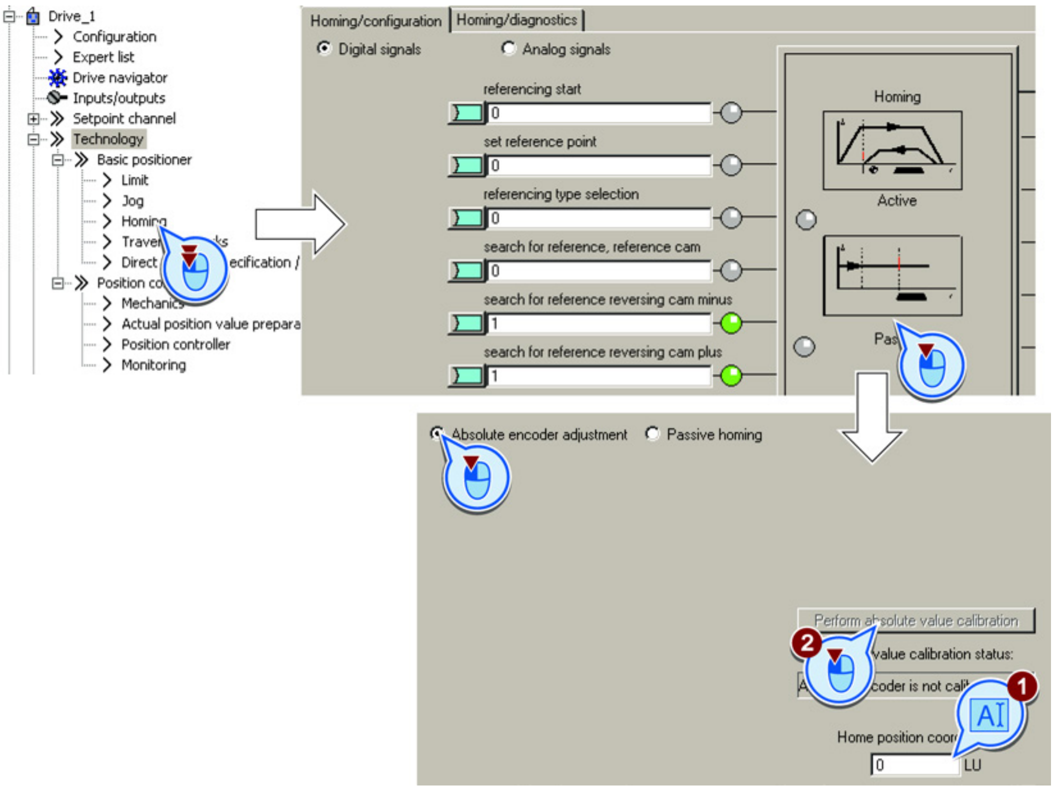
Precondition

1. You have positioned the axis (e.g. using the "jog" function) to the reference position in the machine.
2. You have selected the "Homing" screen.
3. You have come to the settings via the button on the screen.
4. You have selected "Absolute encoder adjustment".

Procedure

To adjust the absolute encoder, proceed as follows:

1. Specify the reference point coordinate.
2. Accept the reference point coordinate in the position actual value.



You have now adjusted the absolute encoder.

Parameter	Meaning	
p2598	**Reference point coordinate, signal source**	
p2599	**Reference point coordinate value**	
p2507	**Absolute encoder adjustment status**	
	0	Error has occurred in the adjustment
	1	Absolute encoder was not adjusted
	2	Absolute encoder was not adjusted and encoder adjustment was initiated
	3	Absolute encoder adjusted

8.6.7 Jogging

8.6.7.1 Jog velocity

Description

Only input a setpoint velocity for the converter for velocity jog. With the signal "Jogging 1" or "Jogging 2", the converter accelerates the axis to the relevant setpoint velocity. The converter stops the axis when the respective "Jog" signal returns to zero.

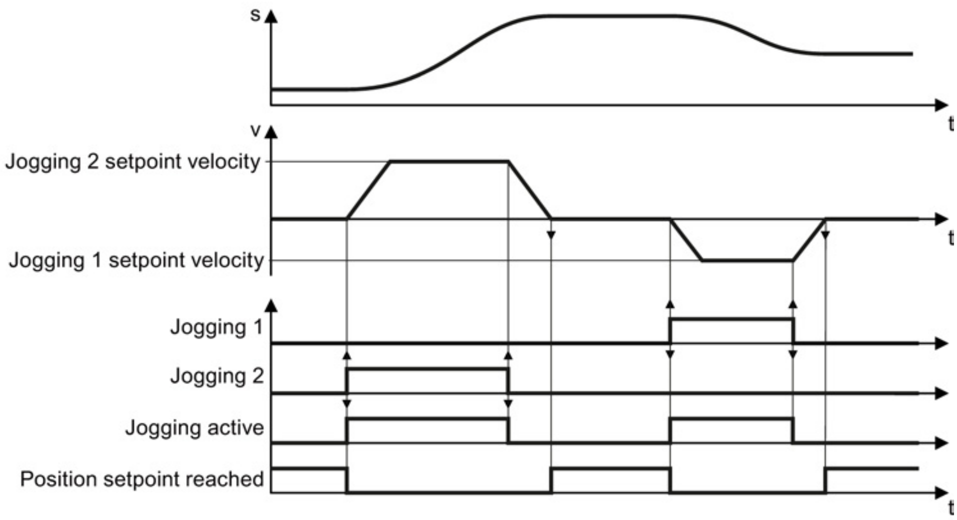


Figure 8-33 Jog velocity

8.6.7.2 Incremental jogging

Description

In the case of incremental jogging, input a relative traversing distance and a velocity setpoint into the converter. With the signals "Jogging 1" or "Jogging 2" the converter positions the axis by the respective travel path.

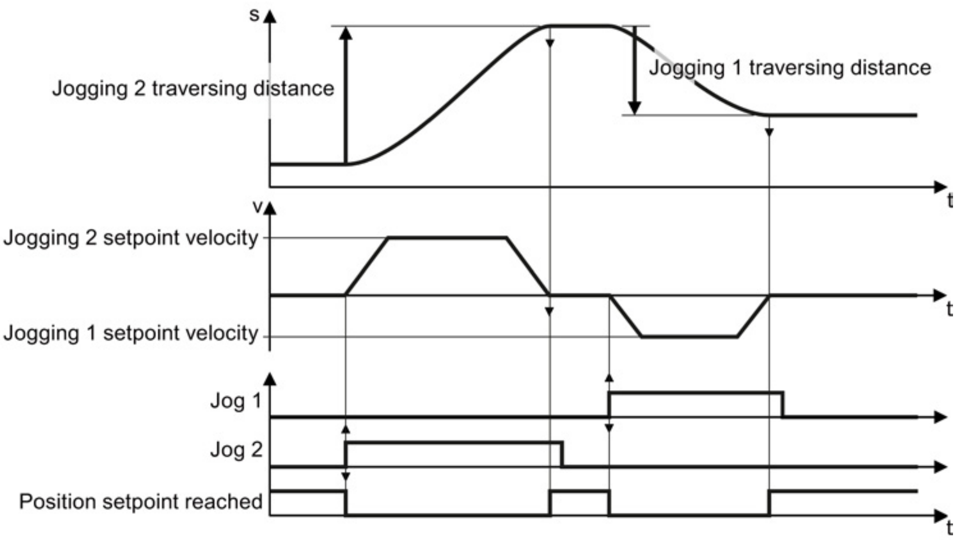


Figure 8-34 Incremental jogging

8.6.7.3 Setting jogging

Precondition

You have selected the "Jog" screen.

Procedure

To set the "jog" function, proceed as follows:

1. Interconnect the signal that defines the mode for the "jog" function.

   0: Velocity jogging

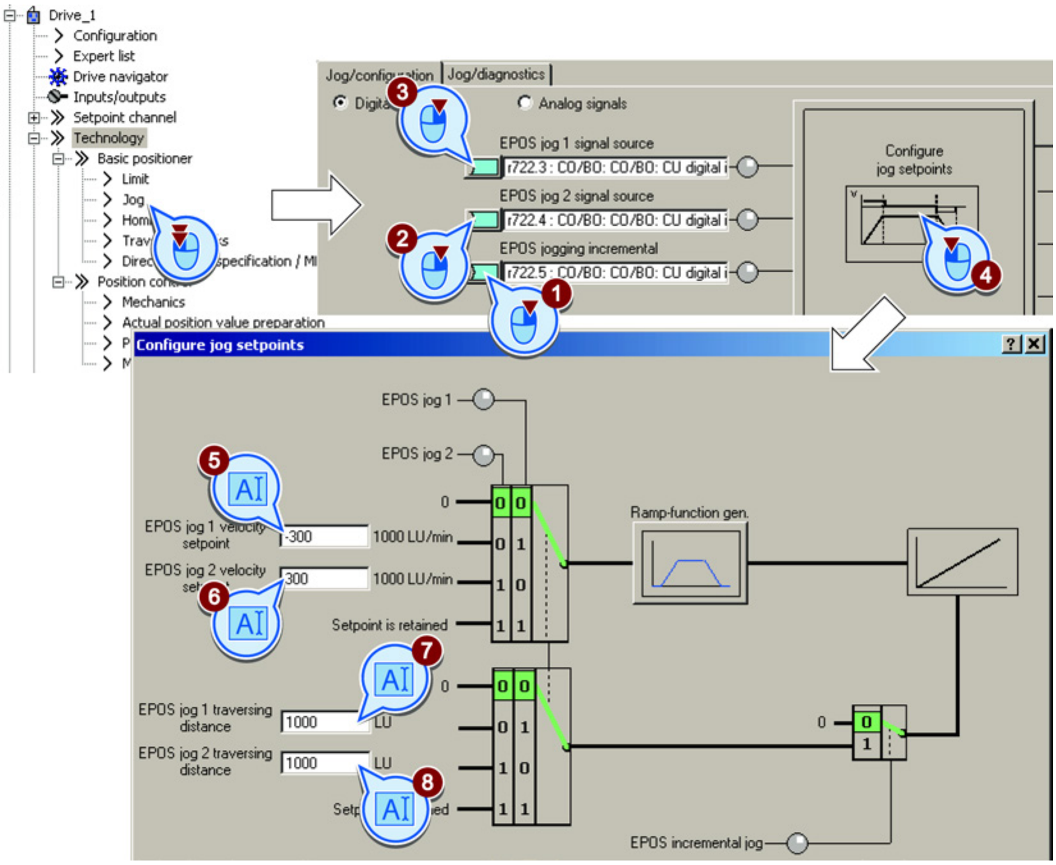
   1: Incremental jogging
2. Interconnect the signal for jogging 1.
3. Interconnect the signal for jogging 2.
4. Select the button for the other settings.
5. Set the velocities for the "jogging 1" function.
6. Set the velocities for the "jogging 2" function.

7. If you use the incremental jog, set the relative position setpoint for the "jogging 1" function.

   This value has no significance for velocity jogging.

8. If you use the incremental jog, set the relative position setpoint for the "jogging 2" function.

   This value has no significance for velocity jogging.



You have set the "jog" function.

Parameter	Meaning
p2585	Jogging 1 setpoint velocity
p2586	Jogging 2 setpoint velocity
p2587	Jogging 1 traversing distance
p2588	Jogging 2 traversing distance
p2589	Jogging 1 signal source
p2590	Jogging 2 signal source
p2591	Incremental jogging

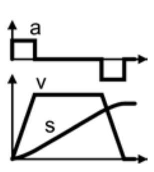
8.6.8 Traversing blocks

Description

A traversing block describes a positioning instruction for the drive.

The converter saves 16 different traversing blocks, which it normally executes one after the other. However, you can also directly select a specific traversing block or skip traversing blocks.

Table 8- 21 Components of a traversing block

<table>
<tr><th>Element</th><th colspan="3">Meaning</th></tr>
<tr><td>Number</td><td colspan="3">With this number in the range 0 to 15, every traversing block can be selected using binary-coded control signals.</td></tr>
<tr><td>Job</td><td colspan="3" rowspan="2">Positioning command: You can give the converter various commands. For some jobs, you must also specify a parameter. See the table below.</td></tr>
<tr><td>Parameter</td></tr>
<tr><td>Mode</td><td colspan="3">Positioning mode: Positioning relative to the start position or absolute to the machine zero point.</td></tr>
<tr><td>Position</td><td colspan="3">Target position</td></tr>
<tr><td>Velocity</td><td>v</td><td rowspan="3"></td><td rowspan="3">Setpoints for the traversing profile.</td></tr>
<tr><td>Acceleration</td><td>a</td></tr>
<tr><td>Braking</td><td>-a</td></tr>
<tr><td>Advance</td><td colspan="3">Jump condition to the next traversing block. See the table below.</td></tr>
</table>

Job and parameters

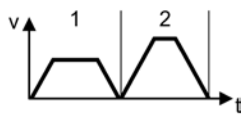
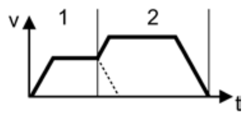
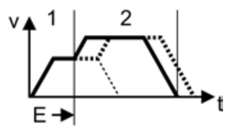
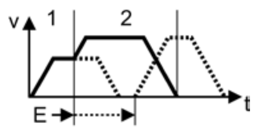
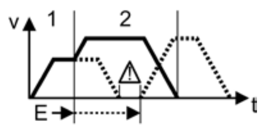
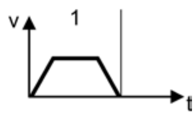
Table 8- 22 Job and parameters

Job	Parameter	Meaning
Positioning	---	• Axis absolute or relative positioning. • Rotary axis with modulo correction in a positive or negative direction, absolute positioning.
Travel to fixed stop	Force [N] or torque [0.01 Nm]	Traverse axis to a fixed stop: • Linear axis with reduced force. • Rotary axis with reduced torque. See also the section: Travel to fixed stop (Page 190).
Endless travel	---	Traverse the axis at the specified velocity to the positive or negative end of the traversing range.
Wait	Time [ms]	Wait the specified time.
Go to	Number	The converter then executes the next traversing block with the specified number.

Job	Parameter		Meaning
Set, reset	1	Set output 1	Set or reset internal signals in the converter: • Output 1: r2683.10 • Output 2: r2683.11 You can interconnect the signals with digital outputs of the converter or with bit 10 and 11 of the positioning status word of the fieldbus. See also the sections: Control and status word 2 for the positioner (Page 87)
	2	Set output 2	
	3	Set outputs 1 and 2	
Jerk	0	Inactive	Activate or deactivate jerk limiting. See also the section: Limiting the traversing profile (Page 159).
	1	active	

Conditions for advance

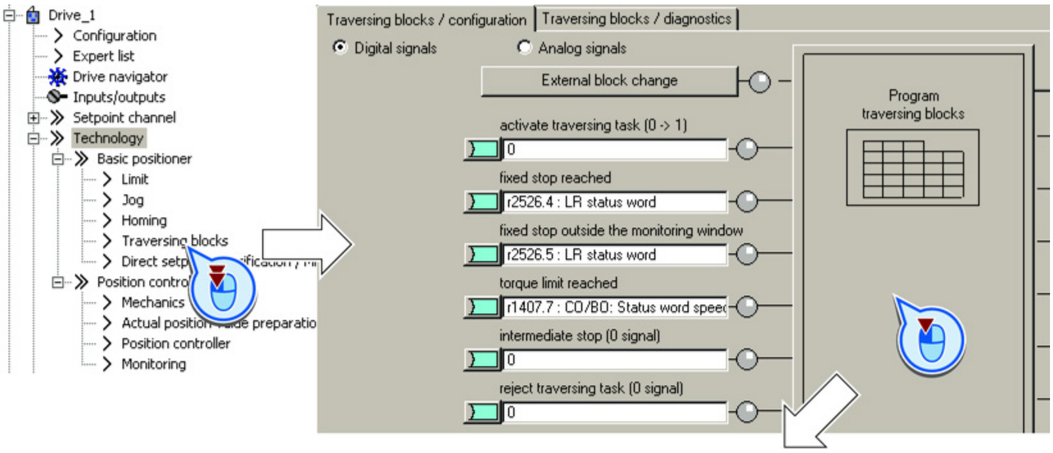
Table 8- 23 Advance: Jump condition to the next traversing block

<table>
<tr><th>Condition</th><th colspan="3">Meaning</th><th>Traversing block</th></tr>
<tr><td>CONTINUE WITH STOP</td><td colspan="3">If the axis has reached the setpoint position and has come to a standstill, the converter executes the next traversing block.</td><td></td></tr>
<tr><td>CONTINUE FLYING</td><td colspan="3">The converter goes to next traversing block at the braking instant.</td><td></td></tr>
<tr><td>CONTINUE EXTERNAL</td><td rowspan="3">At the external E signal, the converter goes to the next traversing block.</td><td colspan="2">If the E signal is not present, the drive behaves just the same as for "CONTINUE FLYING".</td><td></td></tr>
<tr><td>CONTINUE EXTERNAL WAIT</td><td rowspan="2">If the E signal is not present, the converter exits the actual traversing block and continues to wait for the signal.</td><td>---</td><td></td></tr>
<tr><td>CONTINUE EXTERNAL ALARM</td><td>As long as the axis is at a standstill, the converter signals alarm A07463.</td><td></td></tr>
<tr><td>END</td><td colspan="3">The converter exits the actual traversing block if the target position has been reached. The converter does not go to the next traversing block.</td><td></td></tr>
</table>

Programming traversing blocks

Precondition

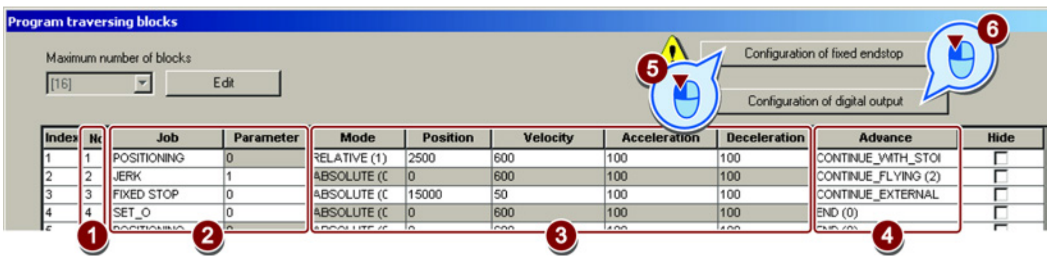
1. You have selected the "Traversing blocks" screen.
2. You select the "Program traversing blocks" button.



Procedure

To program the traversing blocks, proceed as follows:

1. Assign a unique number for each traversing block.
2. Define the command and the corresponding parameters.
3. Set the job-specific values.
4. Define the step enabling condition for the next job.
5. If you travel to a fixed stop, a button appears to make additional settings for this function. See also section: Travel to fixed stop (Page 190).
6. Click this button to interconnect the status signals of the traversing blocks, for example, with bit 10 and 11 of the positioner status word with the fieldbus.
7. When you have programmed all traversing blocks, close the screen.



You have programmed the traversing blocks.

Define digital signals for controlling

Procedure

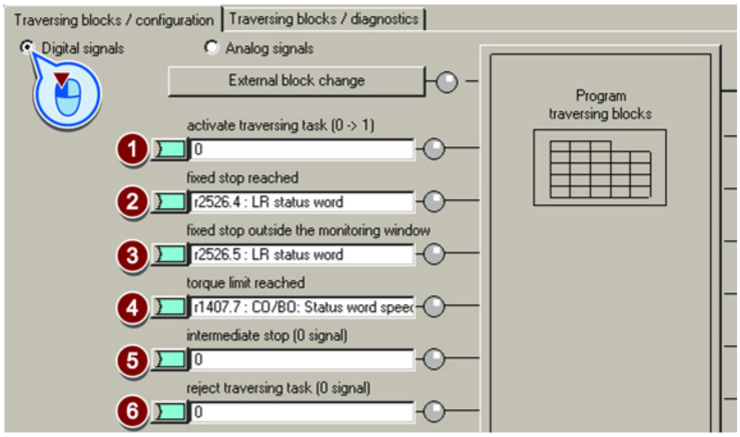
To define the digital signals for controlling the traversing blocks, proceed as follows:

1. Define the signal for the start of the traversing block.

   The signal change 0 → 1 starts the currently selected traversing block.
2. In the factory setting, this signal is interconnected with the appropriate internal signals of the converter. We recommend that you do not change this setting.
3. See ②.
4. See ②.
5. Define the signal for the settings for the intermediate stop.

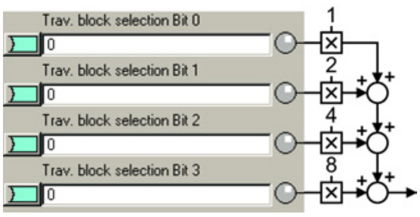
   The axis temporarily stops for the "intermediate stop" = 0 signal. The axis continues its travel with "intermediate stop" = 1. The same traversing block that was active before the stop is active. See also section: Examples (Page 195).
6. Define the signal for "reject signaling task".

   For the signal "reject traversing task" = 0, the converter stops the axis with the maximum deceleration (p2573). If you start the axis again with "Activate traversing request" = 0 → 1, the converter starts again with the currently selected traversing block.



7. Interconnect the signals for selecting the traversing block number.

   The converter reads the traversing block number as binary code.



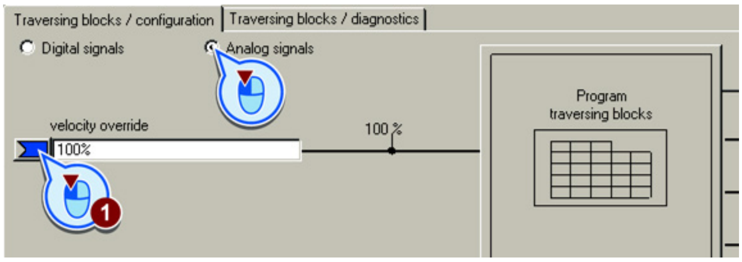
You have now defined the digital signals for controlling the traversing blocks.

Define analog signals for controlling

Procedure

To define the analog signals for controlling the traversing blocks, proceed as follows:

1. Change the signal source for the velocity override, if required.
   The velocity override refers to the velocity values you have set in the screen for programming the traversing blocks.



You have now defined the analog signals for controlling the traversing blocks.

Define an external signal for block change

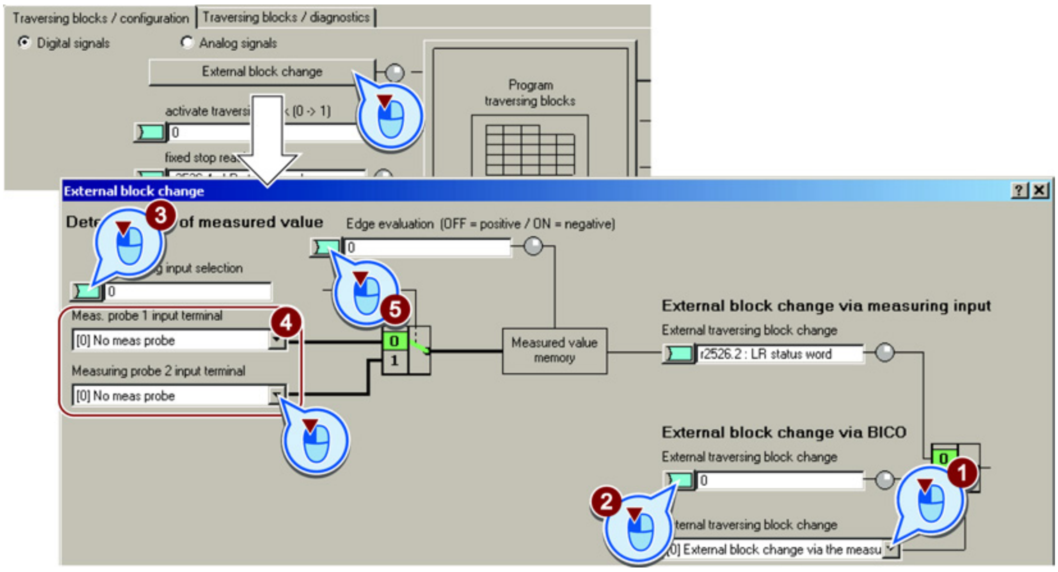
Precondition

You have selected the "External block change" button.

Procedure

To define an external signal for the block change, proceed as follows:

1. Specify whether the external signal is received via a fast digital input (probe) or from another source, e.g. via the fieldbus.
2. To initiate a block change via the machine control system, you must interconnect this signal with a signal of your choice.
3. Select the input with which cam signal 1 is interconnected.
4. Select the input with which cam signal 2 is interconnected.
5. Specify the edge with which the inverter jumps to the next traversing block:
   0: Rising edge
   1: Falling edge



You have now defined an external signal for the block change.

Parameter	Meaning			
p0488	**Probe 1, input terminal**			
p0489	**Probe 2, input terminal**			
p0581	**Probe edge**			
	0	Positive edge 0 → 1		
	1	Negative edge 1 → 0		
p2615	**Maximum number of traversing blocks**			
p2616[0…n]	**Traversing block, block number**			
p2617[0…n]	**Traversing block, position**			
p2618[0…n]	**Traversing block, velocity**			
p2619[0…n]	**Traversing block, acceleration override**			
p2620[0…n]	**Traversing block, deceleration override**			
p2621[0…n]	**Traversing block, job**			
	1	POSITIONING	6	GOTO
	2	FIXED STOP	7	SET_O
	3	ENDLESS_POS	8	RESET_O
	4	ENDLESS_NEG	9	JERK
	5	WAIT		
p2622[0…n]	**Traversing block, job parameter**			

<table>
<tr><th>Parameter</th><th colspan="3">Meaning</th></tr>
<tr><td rowspan="14">p2623[0…n]</td><td colspan="3">Traversing block, job mode
Value = 0000 cccc bbbb aaaa</td></tr>
<tr><td>cccc = 0000</td><td rowspan="4">Positioning mode</td><td>Absolute</td></tr>
<tr><td>cccc = 0001</td><td>Relative</td></tr>
<tr><td>cccc = 0010</td><td>Absolute positive (only for rotary axis with modulo correction)</td></tr>
<tr><td>cccc = 0011</td><td>Absolute negative (only for rotary axis with modulo correction)</td></tr>
<tr><td>bbbb = 0000</td><td rowspan="7">Advance condition</td><td>End</td></tr>
<tr><td>bbbb = 0001</td><td>Continue with stop</td></tr>
<tr><td>bbbb = 0010</td><td>Continue flying</td></tr>
<tr><td>bbbb = 0011</td><td>Continue external</td></tr>
<tr><td>bbbb = 0100</td><td>Continue external wait</td></tr>
<tr><td>bbbb = 0101</td><td>Continue external alarm</td></tr>
<tr><td>aaaa = 0001</td><td>Identifiers: Skip block</td></tr>
<tr><td>p2624</td><td colspan="3">Sort traversing block
To sort the traversing blocks according to their block number: p2624 = 0 → 1.</td></tr>
<tr><td>p2625</td><td colspan="3">Traversing block selection, bit 0</td></tr>
<tr><td>p2626</td><td colspan="3">Traversing block selection, bit 1</td></tr>
<tr><td>p2627</td><td colspan="3">Traversing block selection, bit 2</td></tr>
<tr><td>p2628</td><td colspan="3">Traversing block selection, bit 3</td></tr>
<tr><td>p2631</td><td colspan="3">Activate traversing block (0 → 1)</td></tr>
<tr><td rowspan="3">p2632</td><td colspan="3">External block change evaluation</td></tr>
<tr><td>0</td><td colspan="2">External block change via probe</td></tr>
<tr><td>1</td><td colspan="2">External block change via BI: p2633</td></tr>
<tr><td>p2633</td><td colspan="3">External block change (0 → 1)</td></tr>
<tr><td>p2640</td><td colspan="3">Intermediate stop (0 signal)</td></tr>
<tr><td>p2641</td><td colspan="3">Reject traversing job (0 signal)</td></tr>
<tr><td>p2646</td><td colspan="3">Velocity override</td></tr>
</table>

8.6.8.1 Travel to fixed stop

Preconditions

The "Travel to fixed stop" function is only possible with the control type vector control with encoder (VC):

"Travel to fixed stop" is not possible with the following types of control:

- V/f control
- Vector control without encoder (SLVC)

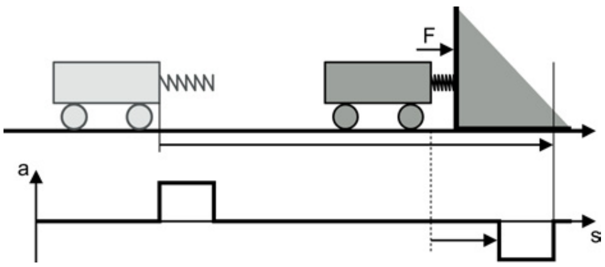
Description

With this function, the converter positions a machine part to another machine part with force locking – and presses both machine parts together with an adjustable force.

Examples:

1. A door is pressed against a frame so that it is reliably closed.
2. A rotary table is pressed against a mechanical fixed stop, in order to secure a specific alignment.

When traveling to a fixed stop, the following applies:



- You must specify the position setpoint far enough behind the mechanical fixed stop. The load must reach the mechanical fixed stop before the converter brakes the axis.
- If the start of braking point is located in front of the mechanical fixed stop, the converter cancels the travel and outputs fault F07485.
- Before starting the travel, the converter calculates the traversing profile for accelerating and braking the axis. The selected torque limit for the fixed stop has no influence on this calculation. However, the torque limit for the fixed stop reduces the available drive torque for the complete traversing distance. If the torque available for the predicted acceleration is not sufficient, then the following error is higher.
  If the following error monitoring for travel to fixed stop responds, then you must reduce the acceleration override.

Fixed stop has been reached

You have two options to define when the fixed stop is reached:

1. Fixed stop via an external sensor:
   At the fixed stop, the load actuates an external sensor. The sensor signals the converter that the fixed stop has been reached. Depending on the advance condition, the converter maintains the axis at the position with the set torque or goes to the next traversing block.
2. Fixed stop using maximum following error:
   If the axis comes into contact with the mechanical fixed stop, then the actual position value remains stationary. However, the converter still increases its position setpoint. The converter detects the fixed stop from a settable difference between the position setpoint and position actual value. Depending on the advance condition, the converter maintains the axis at the position with the set torque or goes to the next traversing block.

Example: Fixed stop using maximum following error

Table 8- 24 Traversing blocks

Ind.	No.	Job	Par.	Mode	s	v	a	-a	Advance
1	1	TRAVEL TO FIXED STOP	5	RELATIVE	10,000	10	100	100	CONTINUE WITH STOP
2	2	POSITIONING	0	ABSOLUTE	0	500	100	100	END

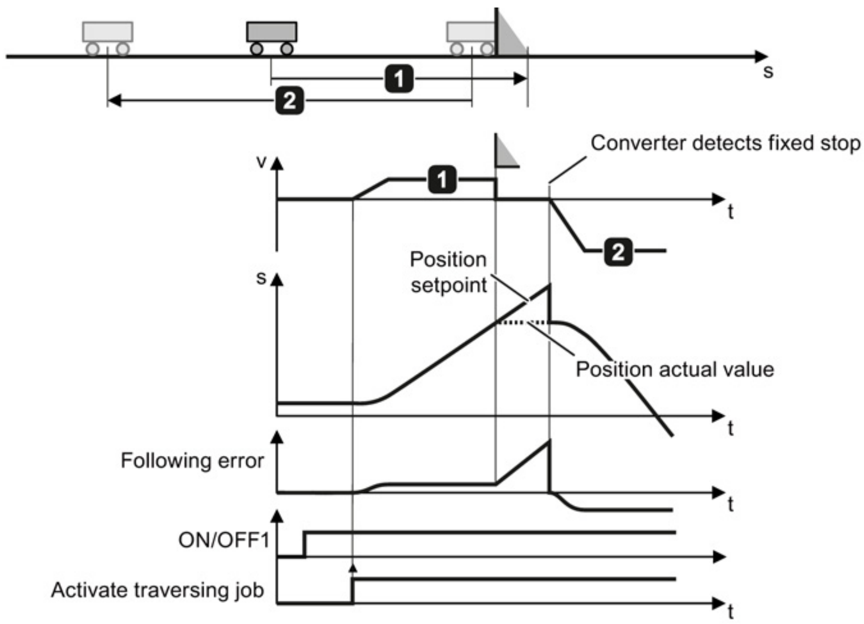
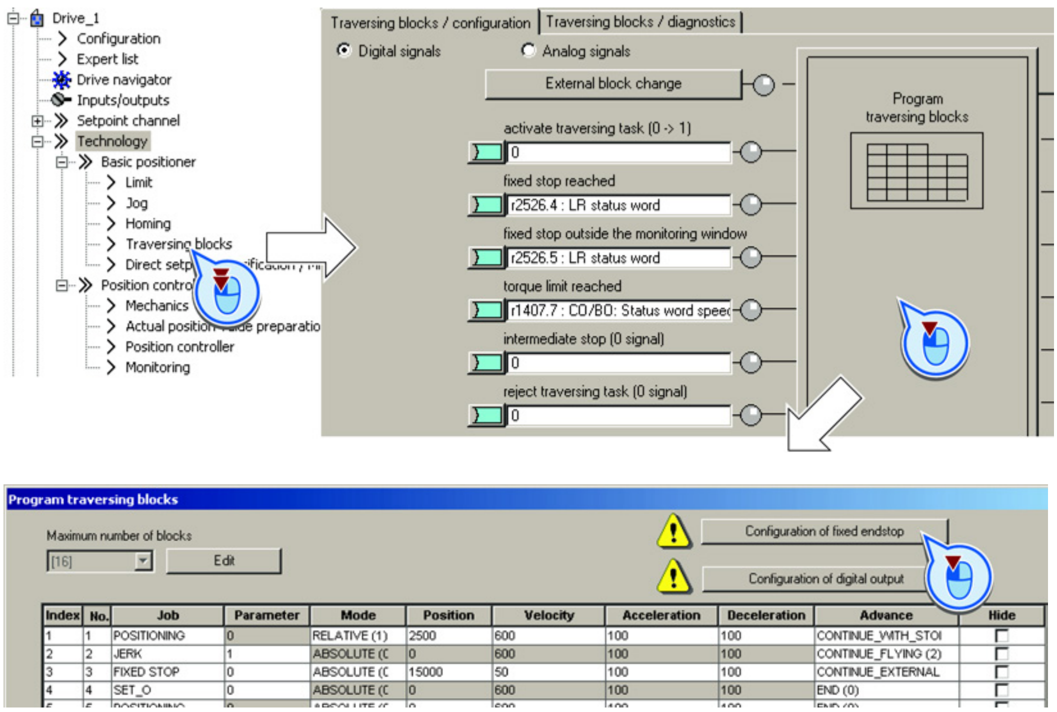


Figure 8-35 Converter detects the fixed stop using the following error

Set travel to fixed stop

Precondition

1. You have programmed "Travel to fixed stop" as traversing block.
   See also section: Traversing blocks (Page 183).
2. If you select the "Programming traversing blocks" button, the "Configuration of fixed stop" button appears.

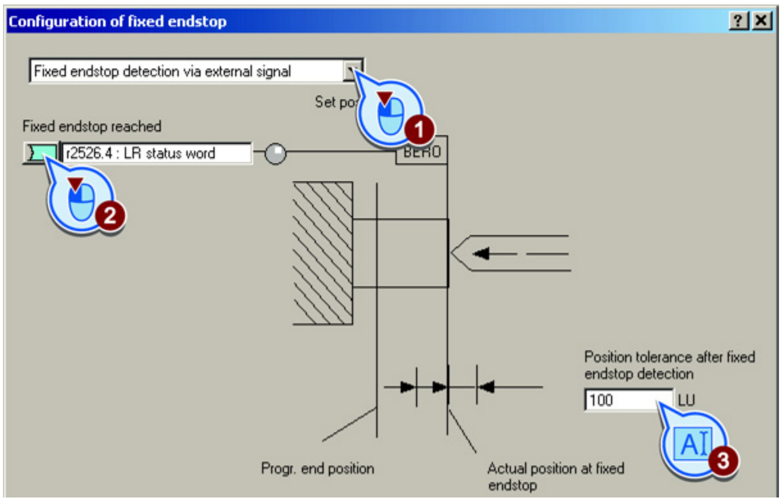


Procedure: Fixed stop using an external signal

To set "Travel to fixed stop" using an external signal, proceed as follows:

1. Select "Fixed stop using an external signal".
2. Interconnect the sensor that signals when the fixed stop is reached with this signal.
3. Set the tolerance.

   After the fixed stop is detected, the inverter monitors the actual position of the axis. If the position actual value changes by more than this distance, then the converter stops the axis and outputs fault F07484. Therefore, the converter detects that the fixed stop has "broken away"



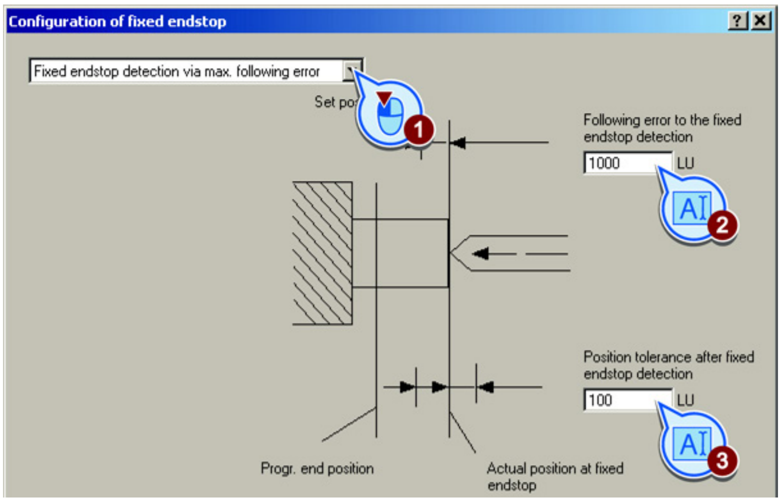
You have now set "Travel to fixed stop" using an external signal.

Procedure: Fixed stop using maximum following error

To set "Travel to fixed stop" using maximum following error, proceed as follows:

1. Select "Fixed stop using maximum following error":
2. Set the following error that the inverter uses to detect the fixed stop.
3. Set the tolerance.

   After the fixed stop is detected, the inverter monitors the actual position of the axis. If the actual position value changes by more than this distance, then the converter stops the axis and outputs fault F07484. Therefore, the converter detects that the fixed stop has "broken away"



You have now set "Travel to fixed stop" using maximum following error.

Parameter	Meaning	
p2634	**Fixed stop, maximum following error**	
p2635	**Fixed stop, monitoring window**	
p2637	**Fixed stop reached**	
	0	Fixed stop has not been reached.
	1	Fixed stop has been reached.
p2638	**Fixed stop outside the monitoring window**	
p2639	**Torque limit reached**	
	0	Torque limit has not been reached.
	1	Torque limit has been reached.

8.6.8.2 Examples

1. Example

Table 8- 25 Traversing blocks

Ind.	No.	Job	Par.	Mode	s	v	a	-a	Advance
1	1	POSITIONING	0	RELATIVE	10000	5000	100	100	CONTINUE WITH STOP
2	2	POSITIONING	0	ABSOLUTE	0	5000	100	100	END

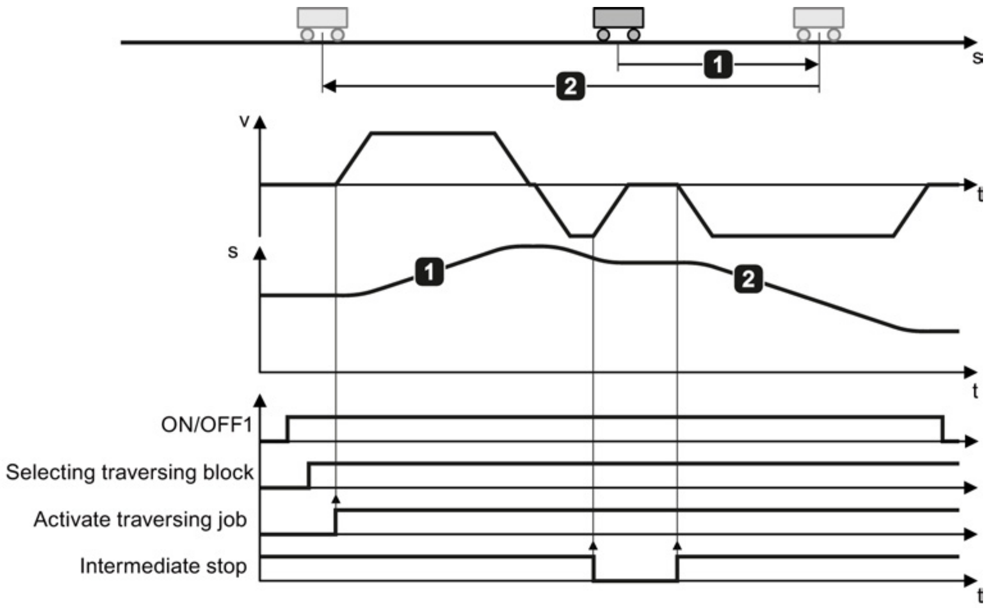


Figure 8-36 Positioning an axis using traversing blocks

2. Example

Table 8- 26 Traversing blocks

Ind.	No.	Job	Par.	Mode	s	v	a	-a	Advance
1	1	POSITIONING	0	RELATIVE	10000	2000	100	100	CONTINUE EXTERNAL ALARM
2	2	POSITIONING	0	RELATIVE	10000	5000	100	100	CONTINUE EXTERNAL ALARM
3	3	POSITIONING	0	ABSOLUTE	0	5000	100	100	END

The converter only goes to the next traversing block for the 0 → 1 change of the "External block selection" signal.

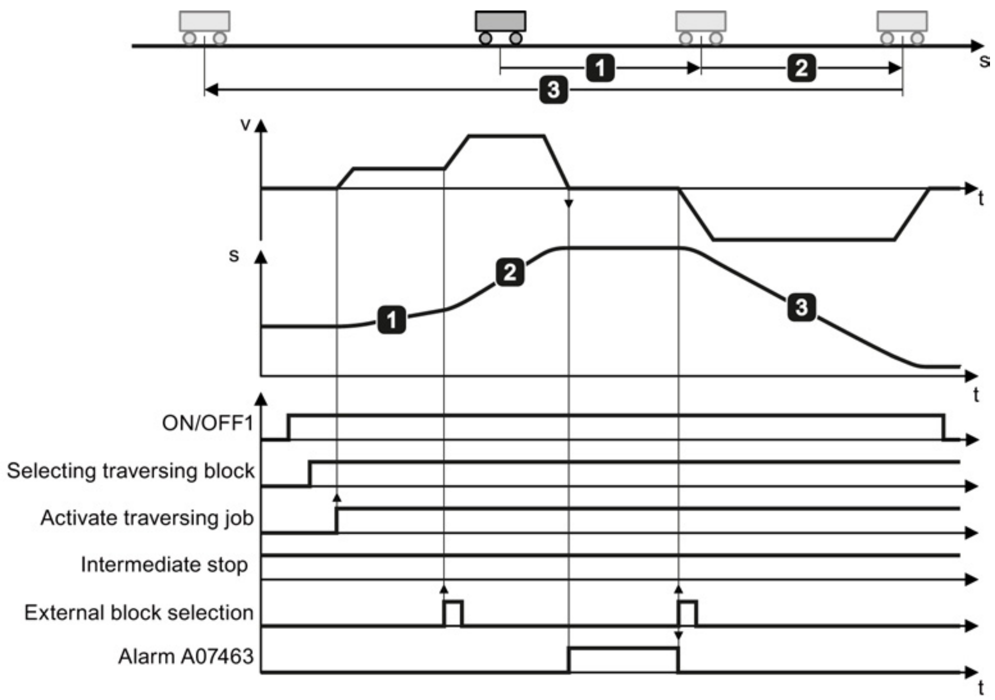


Figure 8-37 Positioning an axis using traversing blocks

8.6.9 Direct setpoint input (MDI)

Description

For direct setpoint input (MDI, Manual Data Input), a higher-level control provides the converter with the position setpoint and traversing profile.

Example 1

The higher-level control specifies the value of the setpoint either as a relative or an absolute position setpoint:

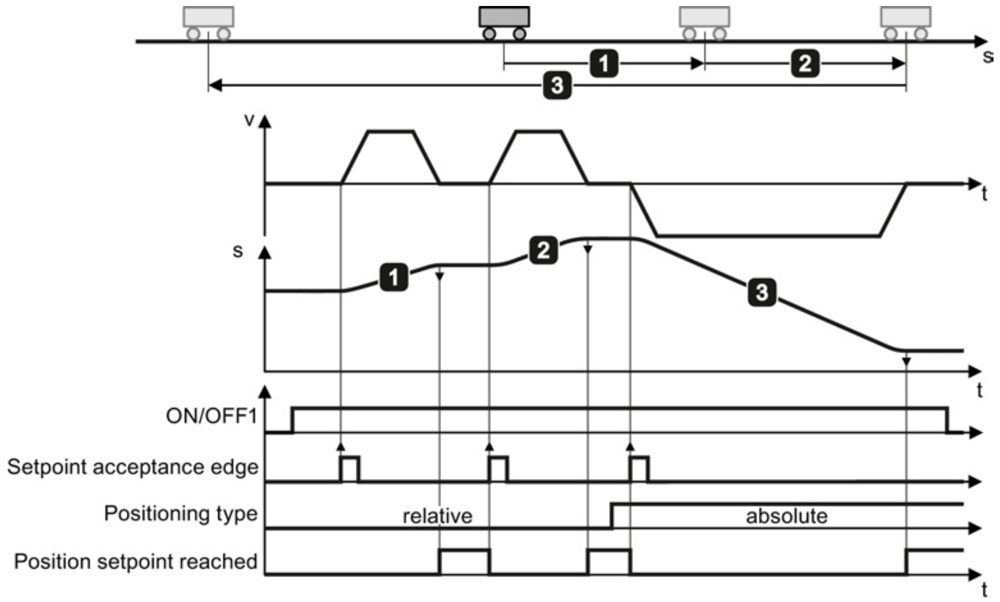


Figure 8-38 Axis with direct setpoint input (MDI) positioning

Example 2

The higher-level control selects the mode "Set-up":

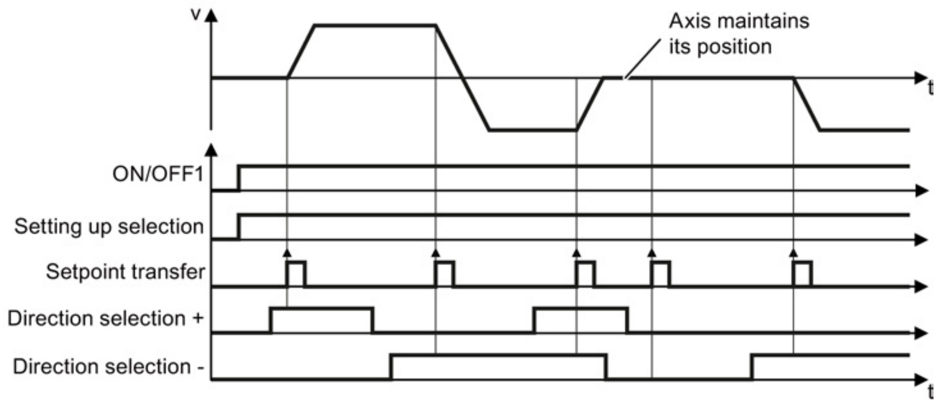


Figure 8-39 Set up axis with direct setpoint input (MDI)

Defining the digital signals for controlling direct setpoint input

Precondition

You have selected the "Direct setpoint input (MDI)" screen.

Procedure

Interconnect the signals to control the direct setpoint input using the appropriate signals from your machine control.

① Enables MDI. This bit must be = 1 if you control the converter using MDI.

② Specifies the MDI mode:
0: Positioning: Traverse the axis with position control using the target position.
1: Set up: Traverse the axis position-controlled using velocity input

While operational, the axis operating mode can be switched over from "Set up" to "Positioning".

If "Set up" is active, then the two bits ⑥ and ⑦ define the direction of travel.

③ Intermediate stop:
0: The converter stops the axis and maintains the axis in position after standstill. The actual traversing block still remains valid.
1: The axis continues the interrupted traversing block.

④ Reject traversing block:
0: The converter stops the axis and maintains the axis in position after standstill. The converter can no longer continue the actual traversing block.
1: Axis waits for a new start command.

⑤ Positioning mode:
0: Relative (see also bit ⑨).
1: Absolute (the axis must be referenced).

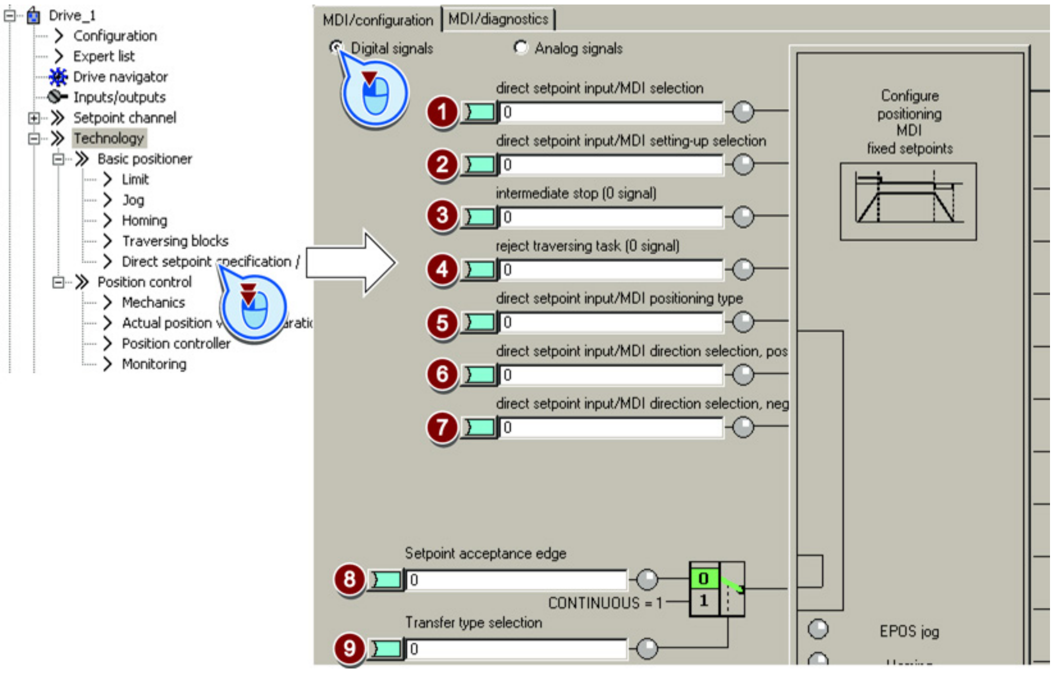
⑥ Direction selection for "Set up" (Bit ② = 1):
⑦ Bit ⑥ = 1: Positive direction.
Bit ⑦ = 1: Negative direction.
If both bits are the same, the axis stops.

These signals are only effective if, in the interface for analog signals, the value ⑥ is not interconnected. See also the table below.

⑧ Accept setpoint:
0 → 1: Start axis
Is only active, if bit ⑨ = 0.

⑨ 1: Continuous mode:
The converter continually accepts changes to the position setpoint. In this mode, relative positioning is not permitted (see bit ⑤).

0: The converter starts using bit ⑧.



You have now interconnected the digital signals for controlling the direct setpoint input.

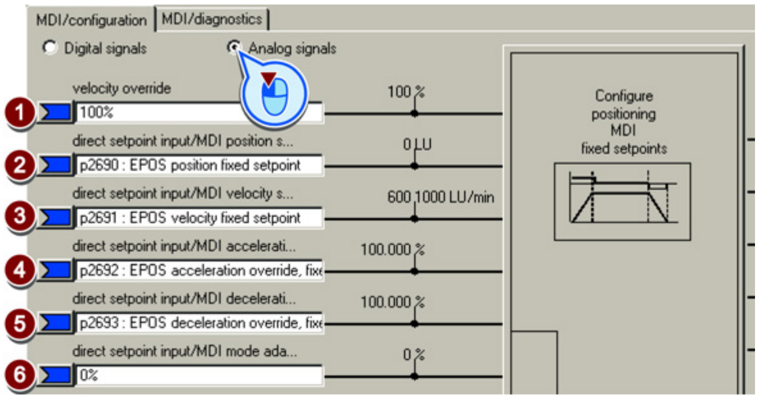
Defining the analog signals for controlling direct setpoint input

Precondition

You have selected the "Direct setpoint input (MDI)" screen.

Procedure

Interconnect the signals to control the direct setpoint input using the appropriate signals from your machine control:



① Override velocity, referred to ③

② Position setpoint

③ Velocity setpoint for the traversing profile.

④ ⑤ Acceleration override and deceleration, referred to the values of the traversing profile limitation. See also section: Limiting the traversing profile (Page 159).

⑥ **"Mode adaptation" is interconnected with a signal:**

xx0x hex	Absolute positioning.
xx1x hex	Relative positioning.
xx2x hex	Position the rotary axis in the positive direction.
xx3x hex	Position the rotary axis in the negative direction.

"Mode adaptation" is not interconnected (=0):

The signals ⑤, ⑥ and ⑦ of the upper table are effective.

You have now interconnected the analog signals for controlling the direct setpoint input.

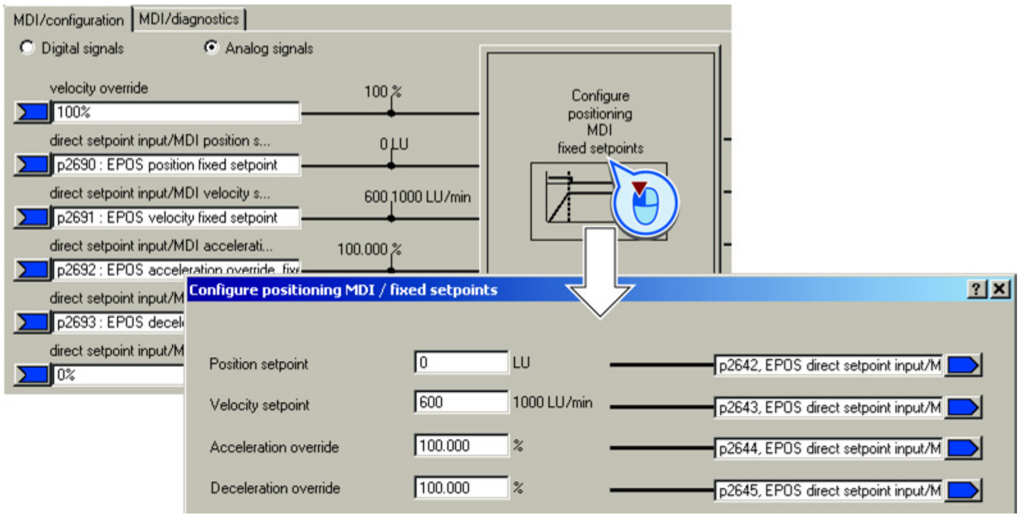
Set fixed setpoint

In some applications it is sufficient if the inverter moves the axis for each task in the same way, absolute or relative to the position setpoint. This approach can be achieved with fixed setpoints.

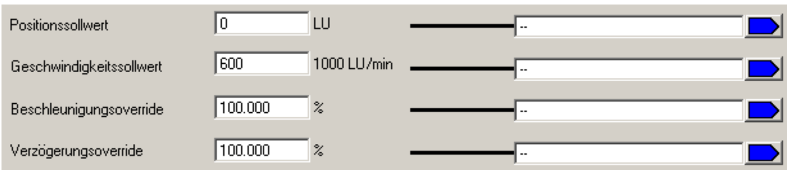
Procedure

To set the fixed setpoints, proceed as follows:

1. Select the button for configuring the fixed setpoint:



2. Set the values suitable to your application:



You have set the fixed setpoints.

Parameter	Meaning	
p2640	**Intermediate stop (0 signal)**	
p2641	**Reject traversing job (0 signal)**	
p2642	**Direct setpoint input/MDI, position setpoint**	
p2643	**Direct setpoint input/MDI, velocity setpoint**	
p2644	**Direct setpoint input/MDI, acceleration override**	
p2645	**Direct setpoint input/MDI, deceleration override**	
p2646	**Velocity override**	
p2647	**Direct setpoint input/MDI selection**	
p2648	**Direct setpoint input/MDI, positioning type**	
	0	Absolute positioning is selected
	1	Relative positioning is selected
p2649	**Direct setpoint input/MDI, acceptance method selection**	
	0	Values are accepted when p2650 = 0 → 1
	1	Continuous acceptance of values
p2650	**Direct setpoint input/MDI, setpoint acceptance, signal edge** p2650 = 0 → 1 and p2649 = 0 signal	
p2651	**Direct setpoint input/MDI, positive direction selection**	
p2652	**Direct setpoint input/MDI, negative direction selection**	
p2653	**Direct setpoint input/MDI, set up selection** Signal = 1: Set up is selected.	
p2654	**Direct setpoint input/MDI, mode adaptation**	
p2690	**Position fixed setpoint** Interconnect fixed setpoint: p2642 = 2690	
p2691	**Velocity fixed setpoint** Interconnect fixed setpoint: p2643 = 2691	
p2692	**Acceleration override fixed setpoint** Interconnect fixed setpoint: p2644 = 2692	
p2693	**Deceleration override fixed setpoint** Interconnect fixed setpoint: p2645 = 2693	

8.7 Protection functions

The frequency inverter offers protective functions against overtemperature and overcurrent for both the frequency inverter as well as the motor. Further, the frequency inverter protects itself against an excessively high DC link voltage when the motor is regenerating.

8.7.1 Inverter temperature monitoring

The inverter protects itself against overtemperature with different monitoring functions:

- I^2t monitoring (alarm A07805, fault F30005)
  The I^2t monitoring measures the actual utilization on the basis of a current reference value. Parameter r0036 [%] displays the actual utilization as a %. As long as the actual current does not exceed the reference value, then the utilization in r0036 = 0.
- Monitoring the chip temperature of the power unit (alarm A05006 - fault F30024)
  The inverter monitors the difference in temperature between the power chip (IGBT) and the heat sink. The measured values are in r0037[1] [°C].
- Heat sink monitoring (alarm A05000, fault F30004)
  The inverter monitors the heat sink temperature of the Power Module. The values are in r0037[0] [°C].

Inverter response

The inverter temperature is essentially defined by the following effects:

- the ohmic losses of the output current
- the switching losses that occur when the motor is pulsed

Parameter p0290 defines how the inverter responds to an excessively high temperature.

Parameter	Description
p0290	**Power unit overload response** (factory setting for SINAMICS G120 inverters with Power Module PM260: 0; factory setting for all other inverters: 2) Setting the reaction to a thermal overload of the power unit: 0: Reduce output current (in vector control mode) or speed (in U/f mode) 1: No reduction, shutdown when overload threshold is reached (F30024) 2: Reduce pulse frequency and output current (in vector control mode) or pulse frequency and speed (in U/f mode) 3: Reduce pulse frequency
p0292	**Power unit temperature warning threshold** (factory setting Heat sink [0] 5° C, power semiconductor [1] 15° C) The value is set as a difference to the shutdown temperature.

8.7.2 Motor temperature monitoring using a temperature sensor

You can use one of the following sensors to protect the motor against overtemperature:

- Temperature switch (e. g. bi-metal switch)
- PTC sensor
- KTY 84 sensor

Connect the motor's temperature sensor through the motor output cable on the Power Module.

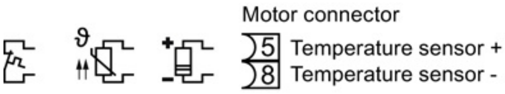


Figure 8-40 Connect the motor's temperature sensor to the Power Module

⚠ WARNING
Temperature sensor and brake module connections
The temperature sensor and brake module connections are at DC link negative potential. Appropriate precautions against touching these connections and appropriate insulation on the cables must be used. The motor terminal box must be kept closed whenever the mains is applied to the Inverter. Cables that are not used should be individually insulated and not earthed.

Temperature switch

The inverter interprets a resistance ≥ 100 Ω as being an opened temperature switch and responds according to the setting for p0610.

PTC sensor

The inverter interprets a resistance > 1650 Ω as being an overtemperature and responds according to the setting for p0610.

The inverter interprets a resistance < 20 Ω as being a short-circuit and responds with alarm A07015. If the alarm is present for longer than 100 milliseconds, the inverter shuts down with fault F07016.

KTY84 sensor

Use a KTY sensor to monitor the motor temperature and the sensor itself for wire-break or short-circuit.

NOTICE
Motor destruction through overheating
If a KTY sensor is connected with the incorrect polarity, the motor can be destroyed due to overheating, as the inverter cannot detect a motor overtemperature condition.
Connect the KTY sensor with the correct polarity.

- Temperature monitoring:
  The inverter uses a KTY sensor to evaluate the motor temperature in the range from -48° C ... +248° C.
  Use the p0604 or p0605 parameter to set the temperature for the alarm and fault threshold.
  - Overtemperature alarm (A07910):
    - motor temperature > p0604 and p0610 = 0
  - Overtemperature fault (F07011):
    The inverter switches off with fault in the following cases:
    - motor temperature > p0605
    - motor temperature > p0604 and p0610 ≠ 0
- Sensor monitoring (A07015 or F07016):
  - Wire-break:
    The inverter interprets a resistance > 2120 Ω as a wire-break and outputs the alarm A07015. After 100 milliseconds, the inverter changes to the fault state with F07016.
  - Short-circuit:
    The inverter interprets a resistance < 50 Ω as a short-circuit and outputs the alarm A07015. After 100 milliseconds, the inverter changes to the fault state with F07016.

Setting parameters for the temperature monitoring

Parameter	Description
p0335	**Specify the motor cooling** 0: Natural cooling - with fan on the motor shaft (factory setting) 1: Forced ventilation - with a separately driven fan 2: Liquid cooling 128: No fan
p0601	**Motor-temperature sensor type** 0: No sensor (factory setting) 1: PTC (→ p0604) 2: KTY84 (→ p0604, p0605) 4: Temperature switch
p0604	**Motor temperature alarm threshold** (factory setting 130° C)
p0605	**Motor temperature fault threshold** (factory setting 145° C) Setting for KTY84 sensor. The parameter has no significance for a PTC sensor.
p0610	**Motor-overtemperature response** Determines the response when the motor temperature reaches the alarm threshold p0604. 0: Alarm (A07910), no fault. 1: Alarm (A07910); current limit is reduced and timer is started. Shutdown with fault (F07011). 2: Alarm (A07910); timer is started. Shutdown with fault (F07011). 12: As for 2 but the last shutdown temperature is used to calculate the motor temperature (factory setting).
p0640	**Current limit** (input in A)

Additional information on the motor temperature monitoring can be found in function diagram 8016 of the List Manual.

8.7.3 Protecting the motor by calculating the motor temperature

The temperature calculation is only possible in the vector control mode (p1300 ≥ 20) and functions by calculating a thermal motor model.

Table 8- 27 Parameters for temperature acquisition without using a temperature sensor

Parameter	Description
p0621= 1	**Motor-temperature acquisition after restart** 0: No temperature measurement (factory setting) 1: Temperature measurement after the motor is switched on for the first time 2: Temperature measurement each time that the motor is switched on
p0622	**Magnetization time of the motor for temperature measurement after starting** *(set automatically as the result of motor data identification)*
p0625 = 20	**Ambient motor temperature** Enter the ambient motor temperature in °C at the instant that the motor data is acquired (factory setting: **20° C**). The difference between the motor temperature and motor environment (p0625) must lie within a tolerance range of approx. ± 5° C.

8.7.4 Overcurrent protection

During vector control, the motor current remains within the torque limits set there.

During V/f control, the maximum current controller (I-max controller) protects the motor and converter against overload by limiting the output current.

I-max controller operation

If an overload situation occurs, the speed and stator voltage of the motor are reduced until the current is within the permissible range. If the motor is in regenerative mode, (i.e. it is being driven by the connected machine), the I-max controller increases the speed and stator voltage of the motor to reduce the current.

Note

The converter load is only reduced if the motor torque decreases at lower speeds (e.g. for fans).

In the regenerative mode, the current only decreases if the torque decreases at a higher speed.

Settings

You only have to change the factory settings of the I-max controller if the drive tends to oscillate when it reaches the current limit or it is shut down due to overcurrent.

Table 8- 28 I-max controller parameters

Parameter	Description
p0305	**Rated motor current**
p0640	**Motor current limit**
p1340	**Proportional gain of the I-max controller for speed reduction**
p1341	**Integral time of the I-max controller for speed reduction**
r0056.13	**Status: I-max controller active**
r1343	**Speed output of the I-max controller** Shows the amount to which the I-max controller reduces the speed.

For more information about this function, see function diagram 1690 in the List Manual.

8.7.5 Limiting the maximum DC link voltage

How does the motor generate overvoltage?

An induction motor operates as a generator if it is driven by the connected load. A generator converts mechanical power into electrical power. The electrical power flows back into the inverter and causes V_{DC} in the inverter to increase.

Above a critical DC-link voltage both the inverter and the motor will be damaged. Before harmful voltages occur, the inverter switches off the connected motor with the fault

"DC-link overvoltage".

Protecting the motor and inverter against overvoltage

To the extent the application permits, the Vdc_max control prevents the DC-link voltage from reaching critical levels. The Vdc_max control increases the ramp-down time of the motor during braking, so that the motor feeds back only as little power to the inverter as is covered by the losses in the inverter.

The Vdc_max control is not suitable for applications where the motor is continuously in the generator mode. This includes, for example, cranes or applications involving braking large moments of inertia. Further information on inverter braking methods can be found in Section Braking functions of the inverter (Page 214).

There are two different groups of parameters for the Vdc_max control, depending on whether the motor is being operated with U/f control or vector control.

Table 8- 29 V_{DCmax} controller parameters

Parameter for U/f control	Parameter for vector control	Description
p1280 = 1	p1240 = 1	**V_{DC} controller or V_{DC} monitoring configuration**(factory setting: 1)1: Enable V_{DCmax} controller
r1282	r1242	**V_{DCmax} controller switch-on level** Shows the value of the DC-link voltage above which the V_{DCmax} controller is active
p1283	p1243	**V_{DCmax} controller dynamic factor** (factory setting: 100 %) scaling of the control parameters P1290, P1291 and P1292
p1294	p1254	**V_{DCmax}-controller automatic recording ON-signal level**(factory setting p1294: 0, factory setting p1254: 1)Activates or deactivates automatic detection of the switch-on levels of the V_{DCmax}controller. 0: Automatic detection disabled 1: Automatic detection enabled
p0210	p0210	**Unit supply voltage** If p1254 or p1294 = 0, the inverter uses this parameter to calculate the intervention thresholds of the V_{DCmax} controller. Set this parameter to the actual value of the input voltage.

For more information about this function, see the List Manual (function diagrams 6320 and 6220).

8.8 Application-specific functions

The inverter offers a series of functions that you can use depending on your particular application, e.g.:

- Unit changeover
- Braking functions
- Automatic restart and flying restart

Please refer to the following sections for detailed descriptions.

8.8.1 Unit changeover

8.8.1.1 Unit changeover

Description

With the unit changeover function, you can adapt the inverter to the line supply (50/60 Hz) and also select US units or SI units as base units.

Independent of this, you can define the units for process variables or change over to percentage values.

Specifically, you have the following options:

- Changing over the motor standard (Page 210) IEC/NEMA (adaptation to the line supply)
- Changing over the unit system (Page 211)

Note

The motor standard, the unit system as well as the process variables can only be changed offline.

The procedure is described in Section Switching units with STARTER (Page 211).

Note

Restrictions for the unit changeover function

- The values on the rating plate of the inverter or motor cannot be displayed as percentage values.
- Using the unit changeover function a multiple times (for example, percent → physical unit 1 → physical unit 2 → percent) may lead to the original value being changed by one decimal place as a result of rounding errors.
- If the unit is changed over into percent and the reference value is then changed, the percentage values relate to the new reference value.
  Example:
  – For a reference speed of 1500 rpm, a fixed speed of 80% corresponds to a speed of 1200 rpm.
  – If the reference speed is changed to 3000 rpm, then the value of 80% is kept and now means 2400 rpm.

Reference variables for unit changeover

p2000 Reference frequency/speed

p2001 Reference voltage

p2002 Reference current

p2003 Reference torque

r2004 Reference power

8.8.1.2 Changing over the motor standard

You change over the motor standard using p0100. The following applies:

- p0100 = 0: IEC motor (50 Hz, SI units)
- p0100 = 1: NEMA motor (60 Hz, US units)
- p0100 = 2: NEMA motor (60 Hz, SI units)

The parameters listed below are affected by the changeover.

Table 8- 30 Variables affected by changing over the motor standard

P no.	Designation	Unit for p0100 =		
		0*)	1	2
r0206	Power Module rated power	kW	HP	kW
p0307	Rated motor power	kW	HP	kW
p0316	Motor torque constant	Nm/A	lbf ft/A	Nm/A
r0333	Rated motor torque	Nm	lbf ft	Nm
r0334	Motor torque constant, actual	Nm/A	lbf ft/A	Nm/A
p0341	Motor moment of inertia	kgm^2	lb ft^2	kgm^2
p0344	Motor weight (for thermal motor type)	kg	Lb	kg
r1969	Speed_cont_opt moment of inertia determined	kgm^2	lb ft^2	kgm^2

*) Factory setting

8.8.1.3 Changing over the unit system

You change over the unit system using p0505. The following selection options are available:

- p0505 = 1: SI units (factory setting)
- p0505 = 2: SI units or % relative to SI units
- p0505 = 3: US units
- p0505 = 4: US units or % relative to US units

Note

Special features

The percentage values for p0505 = 2 and for p0505 = 4 are identical. For internal calculation and for the output of physical variables, it is, however, important whether the conversion is made to SI or US units.

In the case of variables for which changeover to % is not possible, the following applies: p0505 = 1 ≙ p0505 = 2 and p0505 = 3 ≙ p0505 = 4.

In the case of variables whose units are identical in the SI system and US system, and which can be displayed as a percentage, the following applies:
p0505 = 1 ≙ p0505 = 3 and p0505 = 2 ≙ p0505 = 4.

Parameters affected by changeover

The parameters affected by changing over the unit system are grouped according to unit. An overview of the unit groups and the possible units can be found in the List Manual in the Section "Unit group and unit selection".

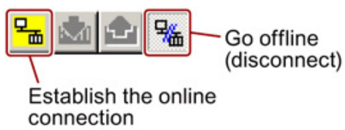
8.8.1.4 Switching units with STARTER

Precondition

The inverter must be in the offline mode in order to change over the units.

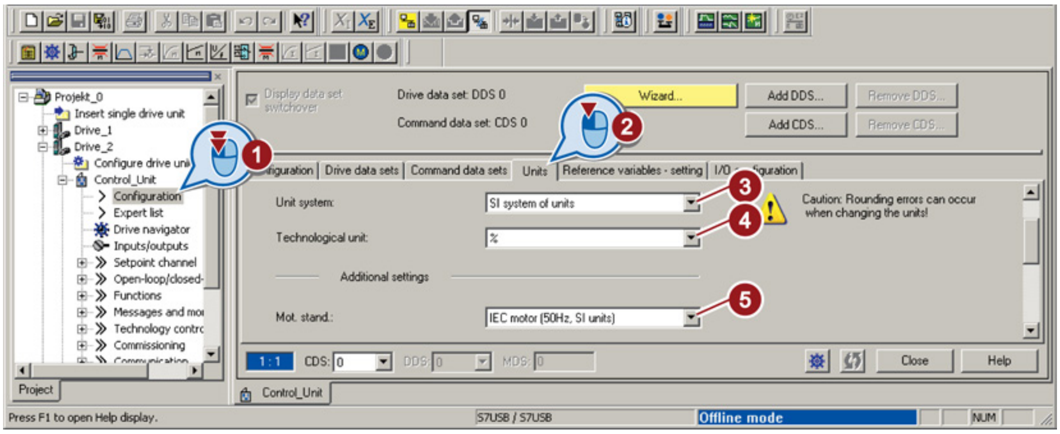
STARTER shows whether you change settings online in the inverter or change offline in the PC (Online mode / Offline mode).

You switch over the mode using the adjacent buttons in the menu bar.



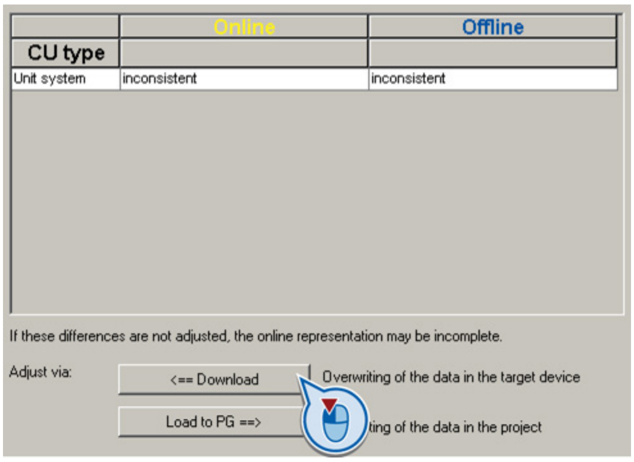
Procedure

1. Select the configuration
2. Go to the "Units" tab in the configuration screen form to change over the units.
3. Changing over the system of units
4. Select process variables of the technology controller
5. Adapting to the line supply



You have changed over the units.

- Save your settings and go online.
  In this case, the converter detects that other units or process variables have been set offline than are actually in the converter; the converter displays this in the following screen form:
- Accept these settings in the converter.



8.8.2 Energy-saving display

Background

Conventionally-controlled fluid flow machines control the flow rate using valves or throttles. In so doing, the drive operates constantly at the rated speed. The efficiency of the system decreases if the flow rate is reduced using valves or throttles. The efficiency is the lowest when valves or throttles are ompletely closed. Further, undesirable effects can occur, e.g. the formation of vapor bubbles in liquids (cavitation) or the temperature rise of the medium being pumped increases.

The inverter controls the flow rate or the pressure by varying the speed of the fluid flow machine. As a consequence, over its complete operating range, a fluid-flow machine operates close to its maximum efficiency – and especially in partial load operation, uses less energy than for valve and throttle-based controls.

Function

The energy-saving display calculates the energy saved when operating fluid-flow machines, e.g. centrifugal pumps, fans, radial and axial compressors. The energy saving display compares inverter operation with direct on line operation and throttle control.

The inverter indicates the energy saved in parameter r0041 in kWh, referred to the last 100 operating hours.

For less than 100 operating hours, the inverter interpolates the energy saving to 100 operating hours.

The inverter calculates the energy-saving based on the operating characteristic that has been saved.

Table 8- 31 Operating characteristic set in the factory

	Point 1	Point 2	Point 3	Point 4	Point 5
Power	p3320 = 25 %	p3322 = 50 %	p3324 = 77 %	p3326 = 92 %	p3328 = 100 %
Speed	p3321 = 0 %	p3323 = 25 %	p3325 = 50 %	p3327 = 75 %	p3329 = 100 %

If you require a precise value for the energy saving, then you must adapt the operating characteristic set in the factory.

Additional parameters for the energy usage display:

r0039.0: Energy usage since the last reset

r0039.1: Energy drawn since the last reset

r0039.2: Energy fed back since the last reset

p0040: Parameter to reset parameters r0039 and r0041.

r0041: Displays the saved energy since the last reset, referred to the operating characteristic, defined by parameters p3320 …p3329.

Adapting the operating characteristic

Precondition

You require the following data to calculate the system-specific operating characteristic:

- Operating characteristics of the manufacturer
  - for pumps: Delivery height and power as a function of the flow rate
  - for fans: Total pressure increase and power as a function of the flow rate
- System characteristics for 5 different flow rates.

Procedure

Proceed as follows to adapt the operating characteristic:

1. For the 5 different flow rates, calculate the delivery height requirement, referred to a pump, which is directly connected to the line supply (n = 100 %).

   To do this, set the formula for the system characteristic the same as the formula for the operating characteristic of the delivery height.

   For a correspondingly lower delivery height, you only require a correspondingly low speed.
2. Enter the speeds into parameters p3321, p3323, p3325, p3327 and p3329.
3. Based on the flow rates and the associated operating characteristic of the manufacturer, calculate the power that the pump requires for the various flow rates when connected directly to the line supply.
4. Enter the values into parameters p3320, p3322, p3324, p3326 and p3328.

You have adapted the operating characteristic, and you now obtain a precise result for the energy saving.

8.8.3 Braking functions of the inverter

A differentiation is made between mechanically braking and electrically braking a motor:

- Mechanical brakes are generally motor holding brakes that are closed when the motor is at a standstill. Mechanical operating brakes, that are closed while the motor is rotating are subject to a high wear and are therefore often only used as an emergency brake.
  If your motor is equipped with a motor holding brake, then you should use the inverter functions to control this motor holding brake, see Section Motor holding brake (Page 219).
- The motor is electrically braked by the inverter. An electrical braking is completely wear-free. Generally, a motor is switched off at standstill in order to save energy and so that the motor temperature is not unnecessarily increased.

8.8.3.1 Electrical braking methods

Regenerative power

If an induction motor electrically brakes the connected load and the mechanical power exceeds the electrical losses, then it operates as a generator. The motor converts mechanical power into electrical power. Examples of applications, in which regenerative operation briefly occurs, include:

- Grinding disk drives
- Fans

For certain drive applications, the motor can operate in the regenerative mode for longer periods of time, e.g.:

- Centrifuges
- Hoisting gear and cranes
- Conveyor belts with downward movement of load (vertical or inclined conveyors)

8.8.3.2 DC braking

DC braking is used for applications without regenerative feedback into the line supply, where the motor can be more quickly braked by impressing a DC current than along a braking ramp.

Typical applications for DC braking include:

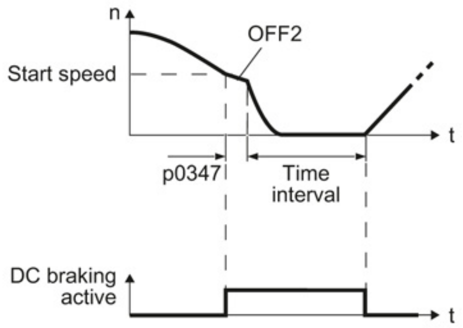
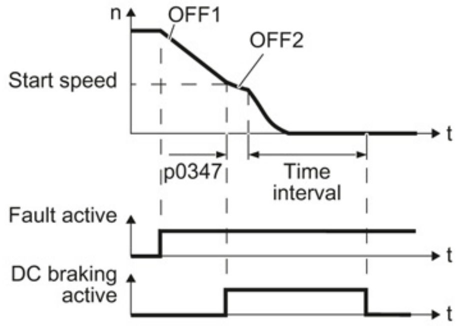
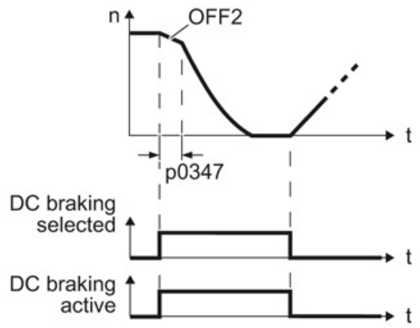
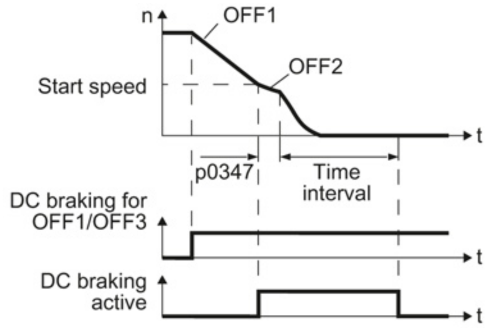
- Centrifuges
- Saws
- Grinding machines
- Conveyor belts

Function

NOTICE
Motor damage caused by overheating
The motor can overheat if it is braked for long periods of time or frequently using DC braking. This may damage the motor. • Monitor the motor temperature. • If the motor gets too hot during operation you must select another braking method or give the motor more time to cool down.

With DC braking, the inverter outputs an internal OFF2 command for the time that it takes to de-energize the motor p0347 - and then impresses the braking current for the duration of the DC braking.

The DC-braking function is possible only for induction motors.

DC braking when falling below a start speed Precondition: p1230 = 1 and p1231 = 14  	**DC braking when a fault occurs** Precondition: Fault number and fault response are assigned using p2100 and p2101 
DC braking initiated using a control command Precondition: p1231 = 4 and p1230 = control command, e.g. p1230 = 722.3 (control command via DI 3)  	**DC braking when switching off the motor** Precondition: p1231 = 5 or p1230 = 1 and p1231 = 14 

DC braking when falling below a starting speed

1. The motor speed has exceeded the starting speed.
2. The inverter activates the DC braking as soon as the motor speed falls below the starting speed.

DC braking when a fault occurs

1. A fault occurs, which initiates DC braking as response.
2. The motor brakes along the down ramp to the speed for the start of DC braking.
3. DC braking starts.

DC braking initiated by a control command

1. The higher-level control issues the command for DC braking, e.g. using DI3: p1230 = 722.3.
2. DC braking starts.

If the higher-level control withdraws the command during DC braking, the inverter interrupts DC braking and the motor accelerates to its setpoint.

DC braking when the motor is switched off

1. The higher-level control switches off the motor (OFF1 or OFF3).
2. The motor brakes along the down ramp to the speed for the start of DC braking.
3. DC braking starts.

Settings for DC braking

<table>
<tr><th>Parameter</th><th colspan="2">Description</th></tr>
<tr><td>p0347</td><td colspan="2">Motor de-excitation time (calculated after the basic commissioning)
The inverter can trip due to an overcurrent during DC braking if the de-excitation time is too short.</td></tr>
<tr><td>p1230</td><td colspan="2">DC braking activation (factory setting: 0)
Signal source to activate DC braking
• 0 signal: Deactivated
• 1 signal: Active</td></tr>
<tr><td rowspan="2">p1231</td><td colspan="2">Configuring DC braking (factory setting: 0)</td></tr>
<tr><td>0
4
5
14</td><td>No DC braking
General release for DC braking
DC braking for OFF1/OFF3
DC braking below the starting speed</td></tr>
<tr><td>p1232</td><td colspan="2">DC braking braking current (factory setting 0 A)</td></tr>
<tr><td>p1233</td><td colspan="2">DC braking duration (factory setting 1 s)</td></tr>
<tr><td>p1234</td><td colspan="2">DC braking start speed (factory setting 210000 rpm)</td></tr>
<tr><td rowspan="2">r1239</td><td colspan="2">DC braking status word</td></tr>
<tr><td>.08
.10
.11
.12
.13</td><td>DC braking active
DC braking ready
DC braking selected
DC braking selection internally locked
DC braking for OFF1/OFF3</td></tr>
</table>

Table 8- 32 Configuring DC braking when faults occur

<table>
<tr><th>Parameter</th><th>Description</th></tr>
<tr><td>p2100</td><td>Set fault number for fault response (factory setting 0)
Enter the fault number for which DC braking should be activated, e.g. p2100[3] = 7860 (external fault 1).</td></tr>
<tr><td>p2101 = 6</td><td>Fault response setting (factory setting 0)
Assigning the fault response: p2101[3] = 6.</td></tr>
<tr><td colspan="2">The fault is assigned an index of p2100. Assign the same index of p2100 or p2101 to the fault and fault response.
The inverter's List Manual lists in the "Faults and alarms" list the possible fault responses for every fault. The "DCBRAKE" entry means that it is permissible to set DC braking as response for this particular fault.</td></tr>
</table>

8.8.3.3 Braking with regenerative feedback to the line

Typical applications for braking with energy recovery (regenerative feedback into the line supply):

- Centrifuges
- Unwinders
- Cranes and hoisting gear

For these applications, the motor must brake frequently or for longer periods of time.

Pre-requisite for regenerative braking is the Power Module PM250 or PM260.

The inverter can feed back up to 100% of its power into the line supply (referred to "High Overload" base load, see Section Technical data (Page 311)).

Setting the braking with regenerative feedback to the line

Parameter	Description
Limiting the regenerative feedback for U/f control (p1300 < 20)	
p0640	**Motor overload factor** Limiting the regenerative power is not directly possible with U/f control, but can be achieved indirectly by limiting the motor current. If the current exceeds this value for longer than 10 s, the inverter shuts down the motor with fault F07806.
Limiting feedback with vector control (p1300 ≥ 20)	
p1531	**Regenerative power limit** The maximum regenerative load is entered as negative value via p1531. (-0.01 … -100000.00 kW). Values higher than the rated value of the power unit (r0206) are not possible.

8.8.3.4 Motor holding brake

The motor holding brake prevents the motor turning when it is switched off. The inverter has internal logic to optimally control a motor holding brake.

The inverter-internal control of the motor holding brake is suitable typically for horizontal, inclined and vertical conveyors.

A motor holding brake can also be useful in several applications for pumps or fans to ensure that the powered-down motor does not rotate in the wrong direction through a liquid or air flow.

Connecting the motor holding brake

The Motor Holding Brake (MHB) function of the Control Units comprise dedicated hardware and software to control the actions of the MHB on the motor which is connected to the Inverter.

The MHB is connected to the Inverter using Pin 4 - Brake (-) and Pin 6 - Brake (+) of the motor output cable of the PM250D Power Module.

⚠ WARNING
Temperature sensor and brake module connections
The temperature sensor and brake module connections are at DC link negative potential. Appropriate precautions against touching these connections and appropriate insulation on the cables must be used. The motor terminal box must be kept closed whenever the mains is applied to the Inverter. Cables that are not used should be individually insulated and not earthed.

When the motor holding brake is connected to the Inverter through the Power Module, 180 V DC are supplied to the motor holding brake and the software within the Inverter monitors the correct functioning of the brake.

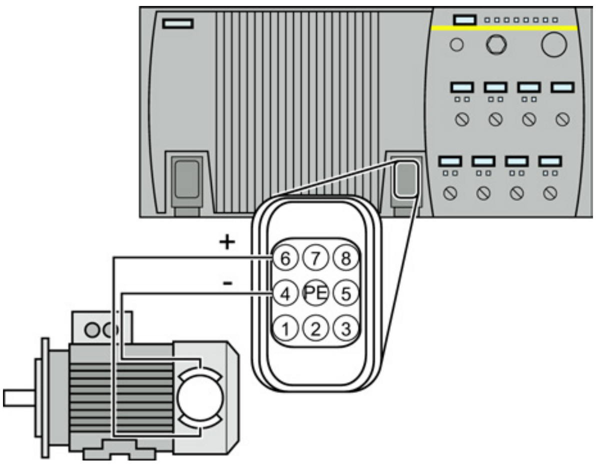


Figure 8-41 Simplied diagram of the motor holding brake connections

Function after OFF1 and OFF3 command

The converter controls the motor holding brake in the following way:

1. After the ON command (switch on motor), the converter magnetizes the motor.
2. At the end of the magnetizing time (p0346), the converter issues the command to open the brake.
3. The converter keeps the motor at a standstill until this time p1216 has ended. The motor holding brake must open within this time.
4. At the end of the brake opening time the motor accelerates to the speed setpoint.
5. After the OFF command (OFF1 or OFF3) the motor brakes to a standstill.
6. If the actual speed is less than 20 rpm, then the converter issues the command to close the brake. The motor comes to a standstill but remains switched on.
7. After the brake closing time p1217, the converter switches off the motor.
   The motor holding brake must close within this time.

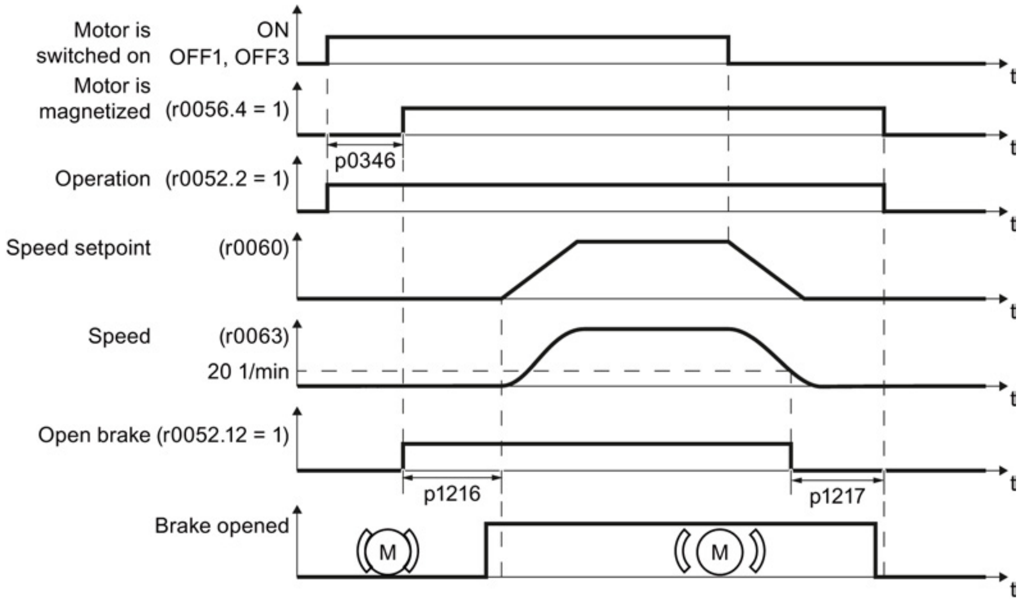


Figure 8-42 Controlling the motor holding brake when the motor is switched on and off

Function after OFF2 – or the selection of the "Safe Torque Off" (STO) safety function

For the following signals, the brake closing time is not taken into account:

- OFF2 command
- After selecting the "Safe Torque Off" (STO) safety function

After these control commands, the inverter issues the signal to immediately close the motor holding brake, independent of the motor speed.

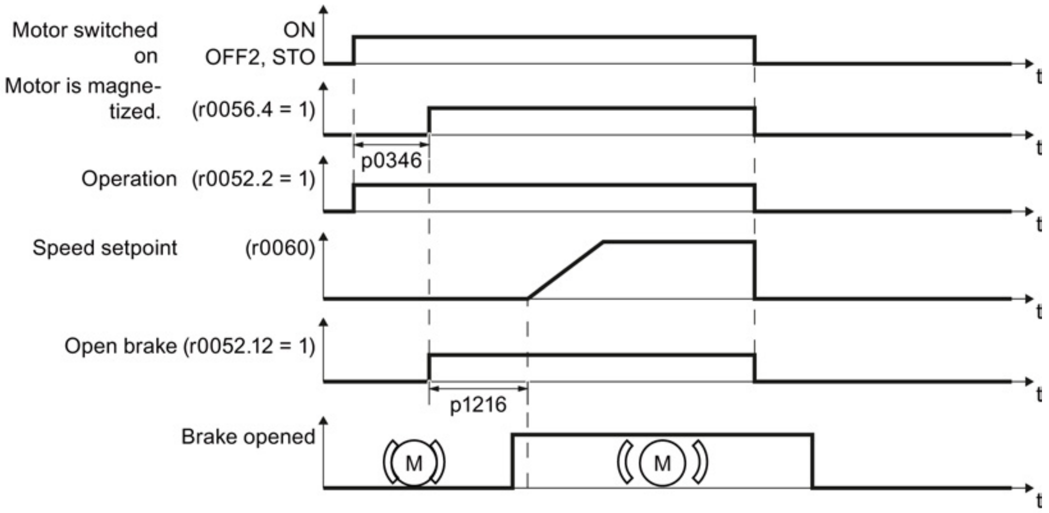


Figure 8-43 Controlling the motor holding brake after an OFF2 command or selecting STO

Commissioning a motor holding brake

DANGER

Danger to life due to falling loads

For applications such as lifting equipment, cranes or elevators, there is a danger to life if the "Motor holding brake" function is incorrectly set.

- When commissioning the "Motor holding brake" function, secure any dangerous loads, e.g. by applying the following measures:
  - Lower the load down to the floor
  - Cordon off the hazardous area so that nobody can enter it

Precondition

The motor holding brake is connected to the inverter.

Procedure

Proceed as follows to commission the "Motor holding brake" function using an operator panel.

1. Set p1215 = 1.

   The "Motor holding brake" function" is enabled.
2. Check the magnetizing time p0346; the magnetizing time is pre-assigned during commissioning and must be greater than zero.
3. Take the opening and closing times of the connected brake from the technical data for the motor holding brake.
   - Depending on the brake size, brake opening times lie between 25 ms and 500 ms.
   - Depending on the brake size, brake closing times lie between 15 ms and 300 ms.
4. Set the following parameters in the inverter to match the opening and closing times of the brake:
   - Opening time ≤ p1216.
   - Closing time ≤ p1217.
5. Switch on the motor.
6. Check the acceleration behavior of the drive immediately after the motor has been switched on:
   - If the brake opens too late, the inverter accelerates the motor against the closed brake which results in a jerky motion.

     In this case, increase the opening time p1216.
   - After opening the brake, if the motor waits too long before it accelerates the motor, then reduce the opening time p1216.
7. If the load sags after switching on the motor, then you must increase the motor torque when opening the motor holding brake. Depending on the control mode, you must set different parameters:
   - U/f operation (p1300 = 0 to 3):
     Increase p1310 step-by-step.
     Increase p1351 step-by-step.
   - Vector control (p1300 ≥ 20):
     Increase p1475 in small steps.
8. Switch off the motor.
9. Check the braking behavior of the drive immediately after the motor has been switched off:
   - If the brake closes too late, the load briefly sags before the brake closes.

     In this case, increase the closing time p1217.
   - After closing the brake, if the motor waits too long before it switches off the motor, then reduce the closing time p1217.

You have commissioned the "Motor holding brake" function.

Table 8- 33 Control logic parameters of the motor holding brake

Parameter	Description
p1215 = 1	**Enable motor holding brake** 0 Motor holding brake locked (factory setting) 3: Motor holding brake just like the sequential control, connected via BICO
p1216	**Motor holding brake opening time** (factory setting 0.1 s) p1216 > braking signal relay runtimes + brake release time
p1217	**Motor holding brake closing time** (factory setting 0.1 s) p1217 > braking signal relay runtimes + brake closing time
r0052.12	**"Open motor holding brake" command**

Table 8- 34 Advanced settings

Parameter	Description
p0346	**Magnetizing time** (factory setting 0 s) During this time the induction motor is magnetized. The inverter calculates this parameter using p0340 = 1 or 3.
p0855	**Open motor holding brake (imperative)** (factory setting 0)
p0858	**Close motor holding brake (imperative)** (factory setting 0)
p1351	**Starting frequency of motor holding brake** (factory setting 0%) Setting the frequency set value at the slip compensation output when starting with motor holding brake. When the parameter p1351 is set to > 0, slip compensation is automatically switched on.
p1352	**Starting frequency for motor holding brake** (factory setting 1351) Setting the signal source for the frequency set value at the slip compensation output when starting with motor holding brake.
p1475	**Speed controller torque set value for motor holding brake** (factory setting 0) Setting the signal source for the torque set value when starting with motor holding brake.

8.8.4 Monitor the load torque (system protection)

In many applications, it is advisable to monitor the motor torque:

- Applications where the load speed can be indirectly monitored by means of the load torque. For example, in fans and conveyor belts with too low a torque indicates that the drive belt is torn.
- Applications that are to be protected against overload or locking (e.g. extruders or mixers).
- Applications in which no-load operation of the motor represents an impermissible situation (e.g. pumps).

Load torque monitoring functions

The inverter monitors the motor torque in different ways:

- No-load monitoring
  The inverter generates a message if the motor torque is too low.
- Blocking protection
  The inverter generates a message if the motor speed cannot match the speed setpoint despite maximum torque.
- Stall protection:
  The inverter generates a message if the inverter control has lost the orientation of the motor.
- Speed-dependent torque monitoring
  The inverter measures the actual torque and compares it with a set speed/torque characteristic.

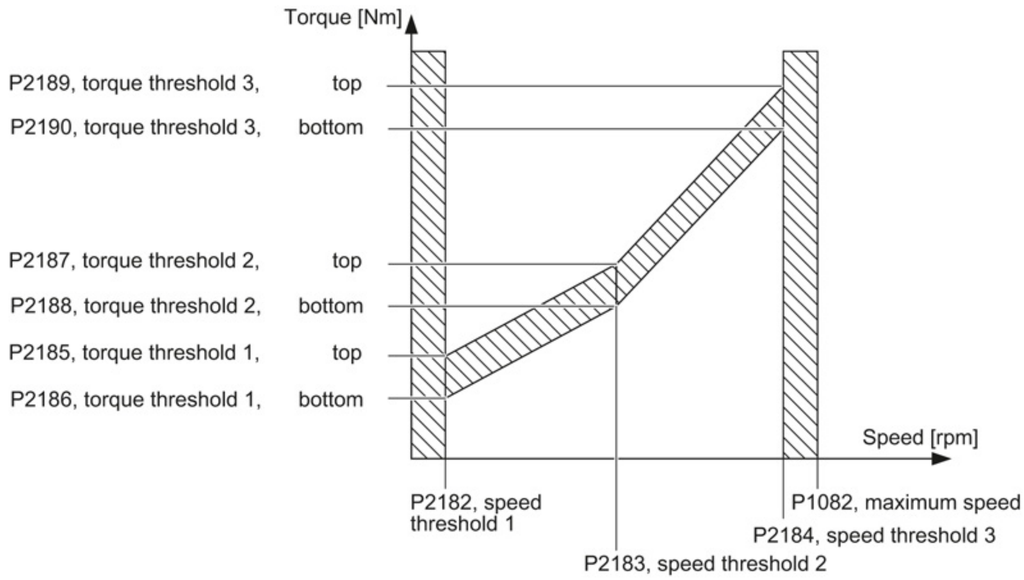


Figure 8-44 Parameters for the load torque monitoring

Table 8- 35 Parameterizing the monitoring functions

Parameter	Description
No-load monitoring	
p2179	**Current limit for no-load detection** If the inverter current is below this value, the message "no load" is output.
p2180	**Delay time for the "no load" message**
Blocking protection	
p2177	**Delay time for the "motor locked" message**
Stall protection	
p2178	**Delay time for the "motor stalled" message**
p1745	**Deviation of the setpoint from the actual value of the motor flux as of which the "motor stalled" message is generated** This parameter is only evaluated as part of encoderless vector control.
Speed-dependent torque monitoring	
p2181	**Load monitoring, response** Setting the response when evaluating the load monitoring. 0: Load monitoring disabled >0: Load monitoring enabled
p2182	**Load monitoring, speed threshold 1**
p2183	**Load monitoring, speed threshold 2**
p2184	**Load monitoring, speed threshold 3**
p2185	**Load monitoring, torque threshold 1, upper**
p2186	**Load monitoring, torque threshold 1, lower**
p2187	**Load monitoring, torque threshold 2, upper**
p2188	**Load monitoring, torque threshold 2, lower**
p2189	**Load monitoring, torque threshold 3, upper**
p2190	**Load monitoring torque threshold 3, lower**
p2192	**Load monitoring, delay time** Delay time for the message "Leave torque monitoring tolerance band"

For more information about these functions, see the List Manual (function diagram 8013 and the parameter list).

8.8.5 Speed and load failure via digital input

With this function you can directly monitor not only the motor speed but also the speed of the driven load. Examples include:

- Gearbox monitoring, e.g. in traction drives or hoisting gear
- Drive belt monitoring e.g. for conveyor belts
- Monitoring for a blocked driven load

Speed or velocity monitoring functions

There are two ways of directly monitoring speed in your application:

1. Load failure monitoring: The inverter evaluates whether the sensor signal is present.
2. Speed deviation monitoring: The inverter calculates a speed from the signal of the connected sensor and compares it with the internal motor control signal.

A signal generator is required for speed monitoring, e.g. a proximity switch. The inverter evaluates the sensor signal via a digital input.

Load failure monitoring

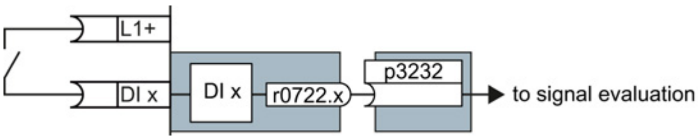


Figure 8-45 Load failure monitoring by means of a digital input

Table 8- 36 Setting load failure monitoring

Parameter	Description
p2193 = 1 to 3	**Load monitoring configuration** (factory setting: 1) 0: Monitoring is disabled 1: Torque and load failure monitoring 2: Speed and load failure monitoring 3: Load failure monitoring
p2192	**Load monitoring delay time** (factory setting 10 s) If, after the motor is switched on, the "LOW" signal is present on the associated digital input for longer than this time, a load failure is assumed (F07936)
p3232 = 722.x	**Load monitoring failure detection** (factory setting: 1) Interconnect the load monitoring with a digital input of your choice.

For more information, see the List Manual (the parameter list and function diagram 8013).

Speed deviation monitoring

The monitoring sensor is connected to digital input 1 or digital input 3.

The converter can process a pulse sequence of up to 32 kHz.

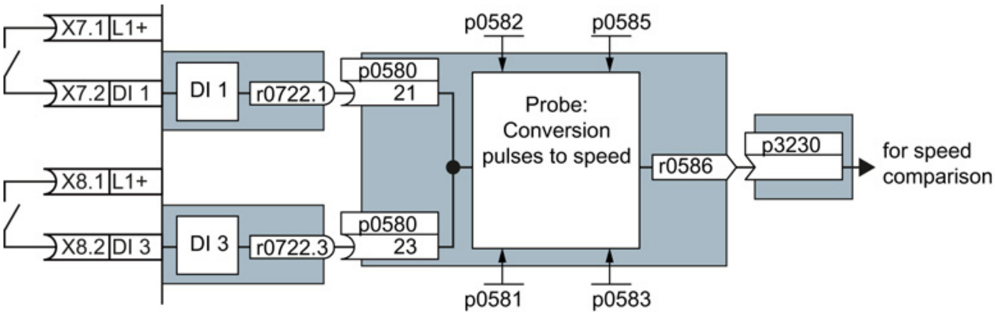


Figure 8-46 Speed deviation monitoring using digital input DI 1 or DI 3

The speed is calculated from the pulse signal of the digital input in the "probe".

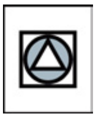
The calculated speed is compared with the actual speed value from the motor control and, if an (adjustable) deviation is detected, a response (also adjustable) is triggered.

Table 8- 37 Setting speed deviation monitoring

Parameter	Description
p2193 = 2	**Load monitoring configuration** (factory setting: 1) 2: Speed and load failure monitoring.
p2192	**Load monitoring delay time** (factory setting 10 s) Setting of the delay time for evaluating load monitoring.
p2181	**Load monitoring response** (factory setting 0) Setting of the response for evaluating load monitoring.
p3231	**Load monitoring speed deviation** (factory setting 150 rpm) Permissible speed deviation of load monitoring.
 p0580 = 21 p0580 = 23	**Probe input terminal** (Factory setting 0) Interconnect speed calculation with DI 1. Interconnect speed calculation with DI 3.
p0581	**Probe edge** (factory setting 0) Setting the edge for evaluation of the probe signal to measure actual speed value 0: 0/1 edge 1: 1/0 edge
p0582	**Probe pulses per revolution** (factory setting 1) Setting of the number of pulses per revolution.
p0583	**Maximum probe measuring time** (factory setting 10 s) Setting the maximum measuring time for the probe. If there is no new pulse before the maximum measuring time elapses, the actual speed value in r0586 is set to zero. With the next pulse, the time is restarted.
p0585	**Probe gear factor** (factory setting 1) The inverter multiplies the measured speed by the gear factor and then displays it in r0586.
p0490	**Invert probe** (factory setting 0000 bin) The 3rd bit of the parameter value inverts the input signals of digital input 3 for the probe.
p3230 = 586	**Load monitoring actual speed value** (factory setting 0) Interconnection of the speed calculation result with speed monitoring evaluation.

For more information, see the List Manual (the parameter list and function diagram 8013).

8.9 Fail-safe function Safe Torque Off (STO)

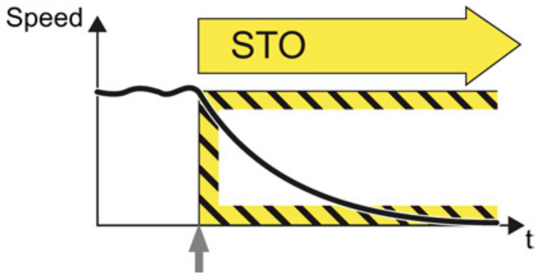


These operating instructions describe the commissioning of the STO safety function when it is controlled via a fail-safe digital input.

You will find a detailed description of all safety functions and control using PROFIsafe in the Safety Integrated Function Manual, see Section Further information on your inverter (Page 360).

8.9.1 Function description

Definition according to EN 61800-5-2:
"[…] [The inverter] does not supply any energy to the motor, which can generate a torque (or for a linear motor, a force)."



Application examples

Example	Possible solution
When the Emergency Stop button is pressed, it is not permissible that a stationary motor undesirably starts.	• Wire the Emergency Stop button with a fail-safe input. • Select STO via the fail-safe input.
A central Emergency Stop button ensures that several drives cannot unintentionally start.	• Evaluate the Emergency Stop button in a central control. • Select STO via PROFIsafe.

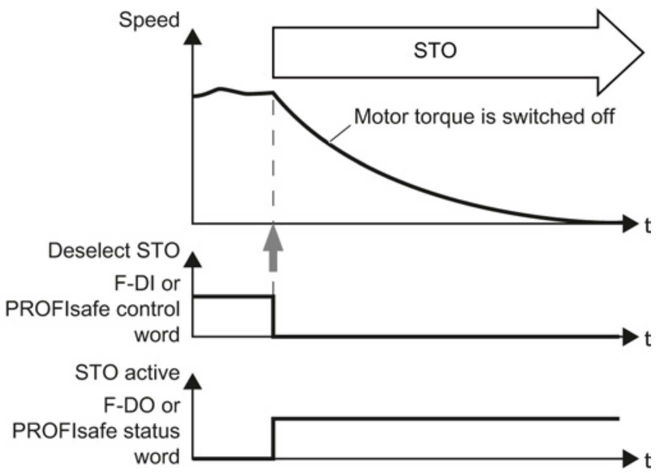
How does STO function in detail?

The inverter recognizes the selection ofSTO via a fail-safe input or via the safe communicationPROFIsafe.

The inverter then safely switches off the torque of the connected motor.

If no motor holding brake is present, the motor coasts to a standstill.

If you use a motor holding brake, the inverter closes the brake immediately after selecting STO.



8.9.2 Prerequisite for STO use

In order to use the STO safety function, the machine manufacturer should have already performed a risk assessment, e.g. in compliance with EN ISO 1050, "Safety of machinery - Principles of risk assessment". The risk assessment must confirm that the inverter is permitted for use in accordance with SIL 2 or PL d.

8.9.3 Commissioning STO

8.9.3.1 Commissioning tool

We strongly recommend that you commission the safety functions using the STARTER PC tool.

If you use STARTER for commissioning, then you set the functions using the graphic screen forms and you do not have to work with parameters. In this case, you can ignore the parameter tables in the following sections.

Table 8- 38 STARTER commissioning tool (PC software)

Download	Order number
STARTER (http://support.automation.siemens.com/WW/view/en/10804985/130000)	6SL3255-0AA00-2CA0 PC Connection Kit, includes STARTER DVD and USB cable

8.9.3.2 Protection of the settings from unauthorized changes

The safety functions are protected against unauthorized changes by a password.

Table 8- 39 Parameter

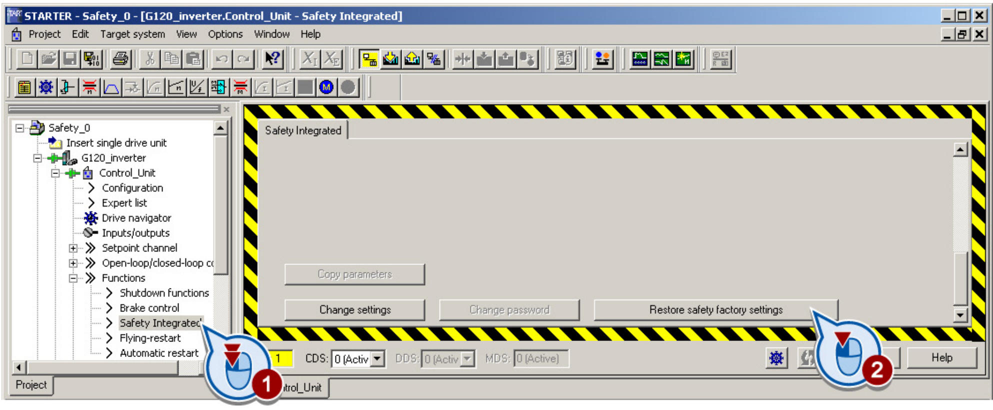
No.	Description
p9761	**Entering a password** (factory setting 0000 hex) Permissible passwords lie in the range 1 … FFFF FFFF.
p9762	**New password**
p9763	**Confirm password**

8.9.3.3 Resetting the safety function parameters to the factory setting

Procedure

To reset the safety function settings to the factory setting without changing the standard settings, proceed as follows:

1. Go online with STARTER
2. Open the screen form for the safety functions ①.



3. Press the button to restore the factory settings ②.
4. Enter the password,for the safety functions.
5. Confirm saving parameters (RAM to ROM).
6. Go offline with STARTER .
7. Switch off the inverter supply voltage.
8. Wait until all of the LED on the inverter go dark. Now switch on the inverter power supply again (power on reset).

You have restored the safety functions in the inverter to the factory settings.

Parameters	Description	
p0010	**Drive, commissioning parameter filter**	
	0	Ready
	95	Safety Integrated commissioning
p0970	**Reset drive parameters**	
	0	Inactive
	5	Starts a safety parameter reset. After the reset, the inverter sets p0970 = 0.
p9761	**Enter a password** (factory setting 0000 hex) Permissible passwords lie in the range 1 … FFFF FFFF.	
p9762	**New password**	
p9763	**Confirm password**	

8.9.3.4 Changing settings

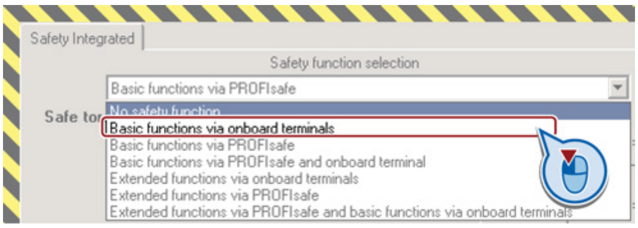
Procedure

To start commissioning the safety functions, proceed as follows:

1. Go online with STARTER.
2. In STARTER, select the fail-safe functions.
3. Select "Change settings".

Parameter	Description
p0010 = 95	**Drive commissioning parameter filter** Safety Integrated commissioning
p9761	**Enter a password** (factory setting 0000 hex) Permissible passwords lie in the range 1 … FFFF FFFF.
p9762	**New password**
p9763	**Confirm password**

4. Selecting "STO via terminal":



You have completed the following commissioning steps:

- You have started to commission the safety functions.
- You have selected the basic functions via onboard terminals of the inverter.

Table 8- 40 Parameter

Parameter	Description	
p9601	**Enable functions integrated in the drive** (factory setting: 0000 bin)	
	p9601 = 0	Safety functions integrated in the drive inhibited
	p9601 = 1	Enable basic functions via onboard terminals

The other selection options are described in the "Safety Integrated Function Manual". See also Section: Further information (Page 360).

8.9.3.5 Interconnecting the "STO active" signal

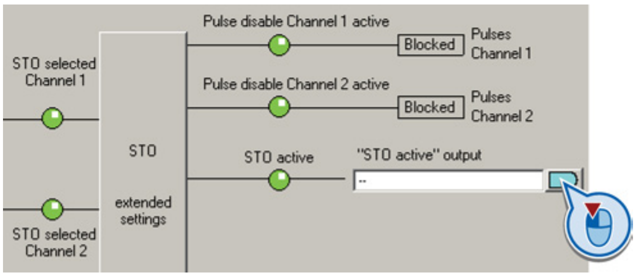
If you require the feedback signal "STO active" of the inverter in your higher-level control system, then you must appropriately interconnect the signal.

Procedure

1
2

To interconnect the "STO active" checkback signal, proceed as follows:

1. Select the button for the feedback signal.



2. In the following selection menu, select the appropriate setting for your particular application.

You have interconnected the "STO active" checkback signal. The inverter signals "STO active" to the higher-level control after STO has been selected.

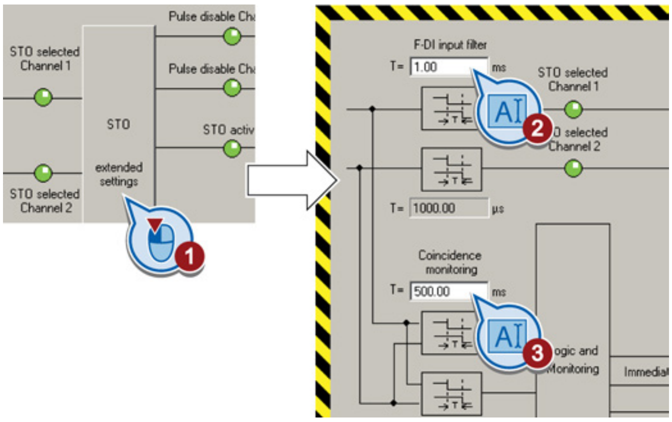
Parameter	Description
r9773.01	**1 signal**: STO is active in the drive

8.9.3.6 Setting the filter for fail-safe inputs

Procedure

To set the input filter and monitoring for simultaneous operation for a fail-safe input, proceed as follows:

1. Select the advanced settings for STO.



2. Set the debounce time for the F-DI input filter.
3. Set the discrepancy for the simultaneity monitoring.
4. Close the screen form.

You have set the input filter and the simultaneity monitoring of the fail-safe input.

Description of the signal filter

The following are available for the signal processing of the fail-safe inputs:

- A tolerance for the simultaneous monitoring.
- A filter to suppress short signals, e.g. test pulses.

A tolerance for the simultaneous monitoring

The inverter checks whether the signals at both inputs always have the same signal status (high or low).

With electromechanical sensors (e.g. emergency stop buttons or door switches), the two sensor contacts never switch at exactly the same time and are therefore temporarily inconsistent (discrepancy). A long-term discrepancy indicates a fault in the wiring of a fail-safe input, e.g. a wire break.

When appropriately set, the inverter tolerates brief discrepancies.

The tolerance time does not extend the inverter response time. The inverter selects its safety function as soon as one of the two F-DI signals changes its state from high to low.

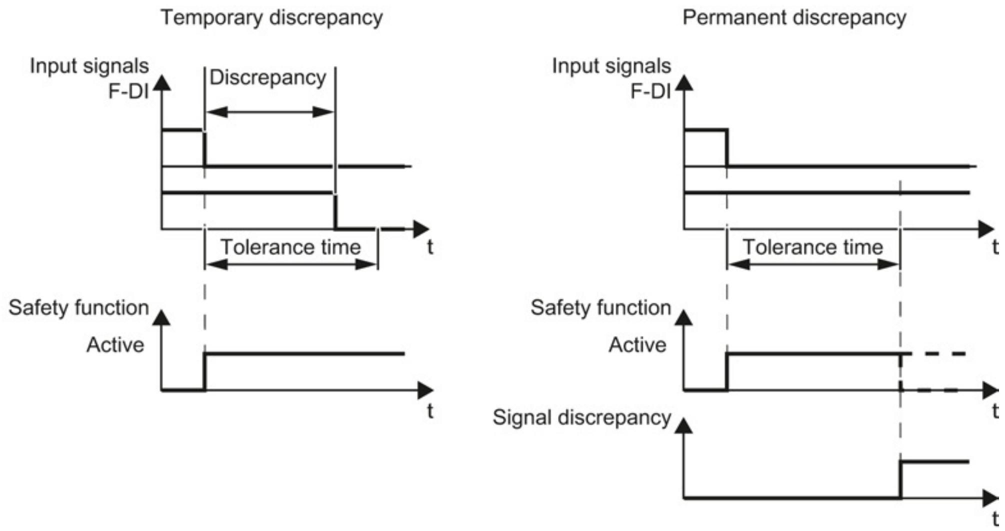


Figure 8-47 Tolerance regarding discrepancy

Filter to suppress short signals

The inverter normally responds immediately to signal changes at its fail-safe inputs. This is not required in the following cases:

- When you interconnect a fail-safe input of the inverter with an electromechanical sensor, contact bounce may result in signal changes occurring, to which the inverter responds.
- Several control modules test their fail-safe outputs using bit pattern tests (on/off tests), in order to identify faults due to either short-circuit or cross-circuit faults. When you interconnect a fail-safe input of the inverter with a fail-safe output of a control module, the inverter responds to these test signals.
  A signal change during a bit pattern test usually lasts:
  - On test: 1 ms
  - Off test: 4 ms

If the fail-safe input signals too many signal changes within a certain time, then the inverter responds with a fault.

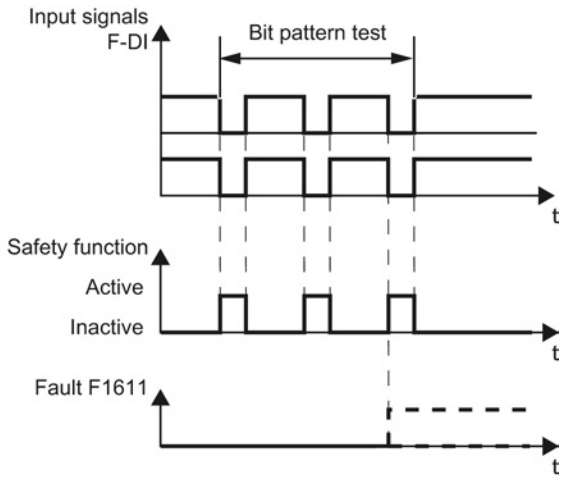


Figure 8-48 Inverter response to a bit pattern test

An adjustable signal filter in the inverter suppresses temporary signal changes using bit pattern test or contact bounce.

The filter increases the inverter response time. The inverter only selects its safety function after the debounce time has elapsed.

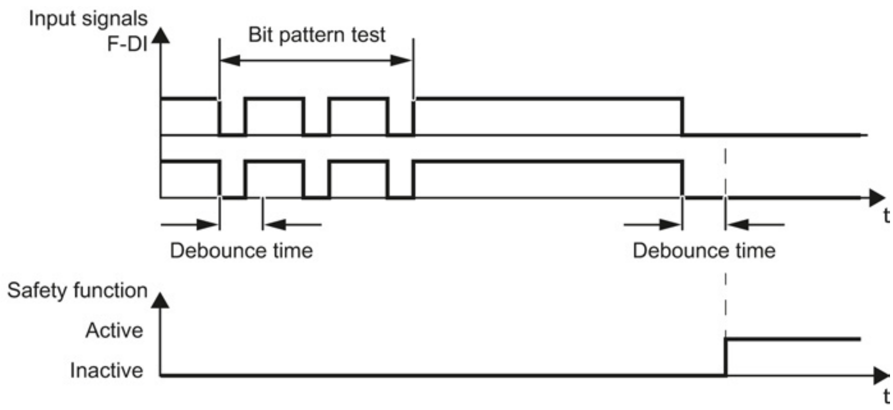


Figure 8-49 Filter for suppressing temporary signal changes

Parameter	Description
p9650	**F-DI changeover tolerance time** (factory setting: 500 ms) Tolerance time to change over the fail-safe digital input for the basic functions.
p9651	**STO debounce time** (factory setting: 1 ms) Debounce time of the fail-safe digital input for the basic functions.

Debounce times for standard and safety functions

The debounce time p0724 for "standard" digital inputs has no influence on the fail-safe input signals. Conversely, the same applies: The F-DI debounce time does not affect the signals of the "standard" inputs.

If you use an input as a standard input, set the debounce time using parameter p0724 .

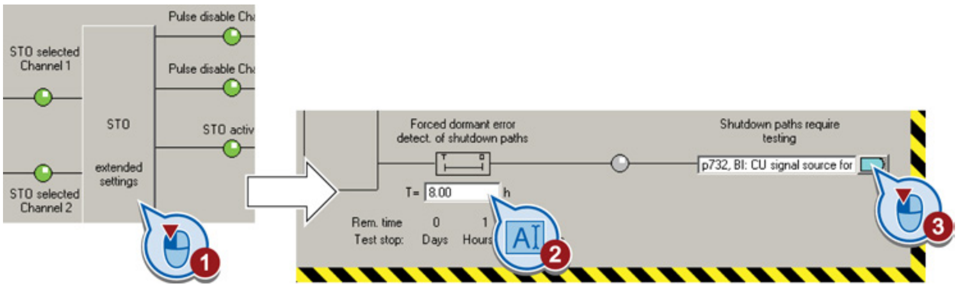
If you use an input as a fail-safe input, set the debounce time as described above.

8.9.3.7 Setting forced dormant error detection

Procedure

To set forced dormant error detection of the basic functions, proceed as follows:

1. Select the advanced settings for STO.



2. Set the monitoring time to a value to match your application.
3. Using this signal, the inverter signals that a forced dormant error detection is required.

   Interconnect this signal - for example - with a digital output of your choice.

You have set the forced dormant error detection for the basic functions.

Description of the forced dormant error detection

To meet the requirements of the standards ISO 13849-1 and IEC 61508 in terms of timely fault detection, the inverter must test its safety-related circuits regularly - at least once a year - to ensure that they are functioning correctly.

Forced dormant error detection of the basic functions

The forced dormant error detection of the basic functions is the regular self-test of the inverter that causes the inverter to check its circuits to switch-off the torque. If you use the Safe Brake Relay, for a forced dormant error detection, the inverter also checks the circuits of this option module.

The inverter executes a forced dormant error detection under the following circumstances:

- every time the supply voltage is connected.
- every time after the STOfunction has been selected.

The inverter monitors the regular forced dormant error detection.

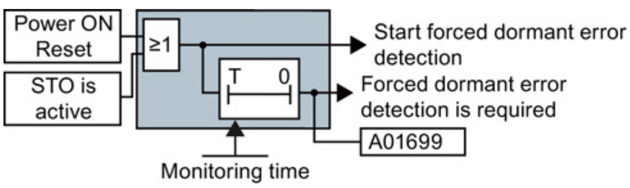


Figure 8-50 Triggering and monitoring the forced dormant error detection

Parameter	Description
p9659	**Forced dormant error detection timer** (Factory setting: 8 h) Monitoring time for the forced dormant error detection
r9660	**Forced dormant error detection remaining time** Displays the remaining time until the forced dormant error detection and testing the safety switch-off signal paths.
r9773.31	**1 signal: Forced dormant error detection is required** Signals for the higher-level control system.

Time of the forced dormant error detection

In the case of warning A01699 , you must initiate a forced dormant error detection at the next opportunity. These alarms do not affect the operation of your machine.

- Switch off the motor.
- Select function STO or switch off the inverter supply voltage temporarily and on again.

Examples for the times when forced dormant error detection is performed:

- When the drives are at a standstill after the system has been switched on.
- When the protective door is opened.
- At defined intervals (e.g. every 8 hours).
- In automatic mode (time and event dependent).

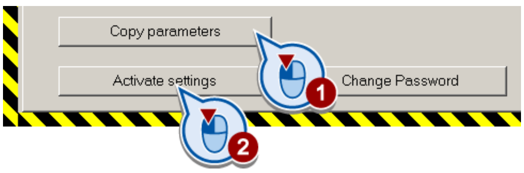
8.9.3.8 Activate settings

Activate settings

Procedure

To activate the settings for the safety functions, proceed as follows:

1. Press the "Copy parameters" button, to create a redundant image of your inverter settings.



2. Press the "Activate settings" button.
3. If the password is the factory default, you are prompted to change the password.
   If you try to set a password that is not permissible, the old password will not be changed.
4. Confirm the prompt for saving your settings (copy RAM to ROM).
5. Switch off the inverter supply voltage.
6. Wait until all LEDs on the inverter go dark (no voltage condition).
7. Switch on the inverter supply voltage again.

Your settings are now active.

Parameter	Description
p9700 = 57 hex	**SI copy function** (factory setting: 0) Start copy function SI parameter.
p9701 = AC hex	**Confirm data change** (factory setting: 0) Confirm data change overall.
p0010 = 0	**Drive commissioning parameter filter** 0: Ready
p9761	**Enter a password** (factory setting 0000 hex) Permissible passwords lie in the range 1 … FFFF FFFF.
p9762	**New password**
p9763	**Confirm password**

8.9.3.9 Checking the assignment of the digital inputs

Checking the assignment of the digital inputs

If you control the safety functions in the inverter using digital inputs, then you must check as to whether these digital inputs have been assigned other functions.

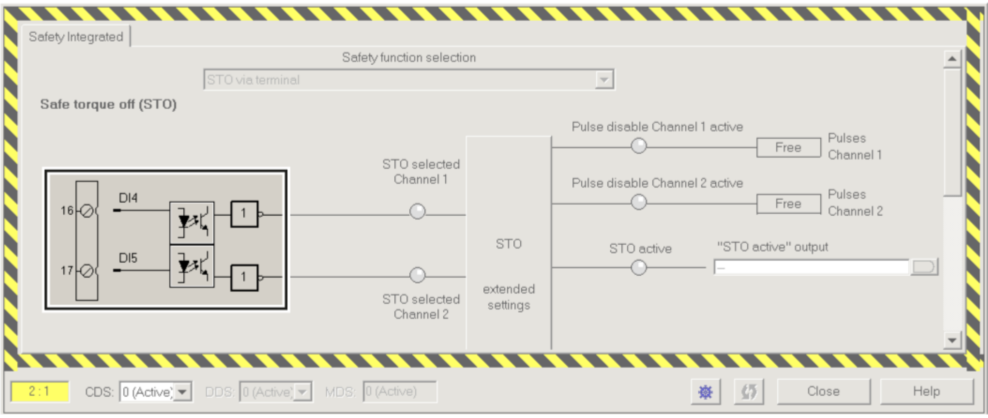


Figure 8-51 Example: Assignment of digital inputs DI 4 and DI 5 with STO

Both, the assignment of digital inputs with the selection of a safety function or with a "standard" function can lead to an unexpected behavior of the drive.

Procedure

To check the assignment of the digital inputs, proceed as follows:

1. In STARTER, select the screen form for the terminals of the digital inputs.
2. Remove all signal interconnections of the digital inputs that you wish to use as fail-safe input F-DI:

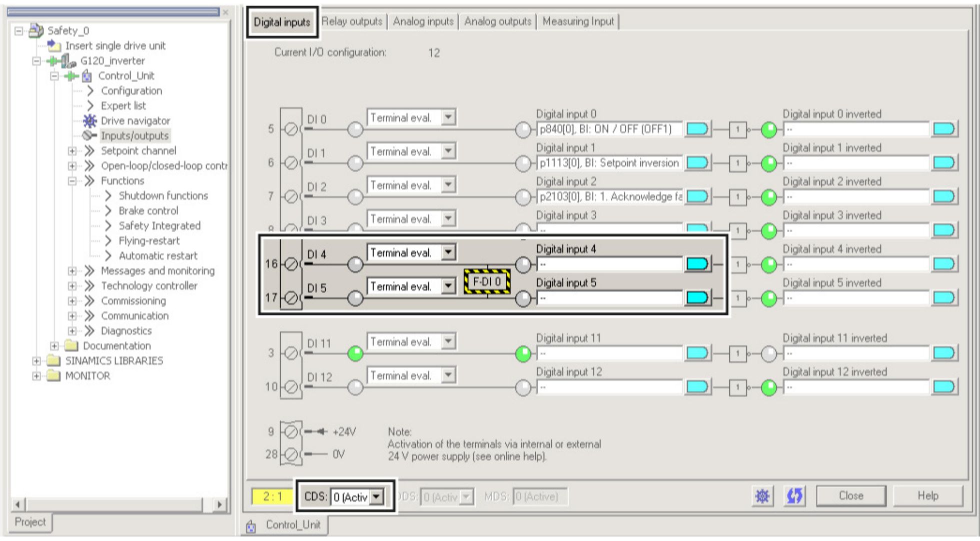


Figure 8-52 Remove pre-assignment of digital inputs DI 4 and DI 5

3. When you use the data set changeover CDS, you must delete the multiple assignment of the digital inputs for all CDS.

You have ensured that the fail-safe inputs of the safety functions do not control other functions in the inverter.

8.9.3.10 Acceptance - following completion of commissioning

Why is acceptance required?

The EC Machinery Directive and ISO 13849-1 stipulate:

- You must check safety-related functions and machine parts after commissioning.

  → Acceptance test.

- You must create an "acceptance report" showing the test results.

  → Documentation.

Acceptance test

The acceptance test comprises two parts:

- Checking whether the safety functions in the inverter are correctly set:
  - Does the speed control handle the configured application cases in the machine?
  - Do the set interface, times and monitoring functions match the configuration of the machine?
- Checking whether the safety-relevant functions in the plant or machine function correctly.

  This part of the acceptance test goes beyond the inverter acceptance test:
  - Are all safety equipment such as protective door monitoring devices, light barriers or emergency-off switches connected and ready for operation?
  - Does the higher-level control correctly respond to the safety-relevant feedback signals of the inverter?
  - Do the inverter settings match the configured safety-relevant function in the machine?

Documentation

The documentation consists of the following parts:

- Description of the safety-relevant components and functions of the machine or plant.
- Report of the acceptance test results.
- Report of the settings of the safety functions.
- Countersigned documentation.

Authorized persons

Personnel from the machine manufacturer, who, on account of their technical qualifications and knowledge of the safety functions, are in a position to perform the acceptance test in the correct manner, are authorized to carry out an acceptance.

Full acceptance tests

The full acceptance tests for the safety functions include the following:

1. Acceptance test
   - Check the safety functions in the machine or in the plant/system
2. Documentation
   - Described the safety-relevant components and functions of the machine or plant
   - Logging of the settings of the safety functions
   - Countersigning documentation

Reduced acceptance

A full acceptance test is necessary only after first commissioning. A reduced acceptance test is sufficient when safety functions are expanded.

- The reduced acceptance test is only required for the part of the machine that has been changed as a result of replacement, update or function expansion.
- The acceptance test is only required for the safety functions that you actually use.

Table 8- 41 Reduced scope of acceptance test for function expansions

<table>
<tr><th rowspan="2">Measure</th><th colspan="2">Acceptance test</th></tr>
<tr><th>Acceptance test</th><th>Documentation</th></tr>
<tr><td>Replacing the Control Unit.</td><td rowspan="4">No.
Only check the direction of rotation of the motor.</td><td>• Supplement inverter data
• Log the new checksums
• Countersignature</td></tr>
<tr><td>Replacing the Power Module.</td><td>Supplement the hardware version in the inverter data</td></tr>
<tr><td>Replacing the motor.</td><td rowspan="2">No change.</td></tr>
<tr><td>Replacing the gearbox.</td></tr>
<tr><td>Replacing safety-related peripherals (e.g. Emergency Stop switch).</td><td>No.
Only check the control of the safety functions that are influenced by the components that have been replaced.</td><td>No change.</td></tr>
<tr><td>Inverter firmware update.</td><td>No.</td><td>• Supplement firmware version in the inverter data
• Log the new checksums
• Countersignature.</td></tr>
<tr><td>Functional expansion of the machine (additional drive).</td><td>Yes.
Only check the safety functions of the new drive.</td><td>• Supplement machine overview
• Supplement inverter data
• Add function table
• Supplement limit values
• Log the new checksums
• Countersignature</td></tr>
<tr><td>Transfer of inverter settings to other identical machines by means of series commissioning.</td><td>No.
Only check the control of all of the safety functions.</td><td>• Add machine description
• Check checksums
• Check firmware versions</td></tr>
</table>

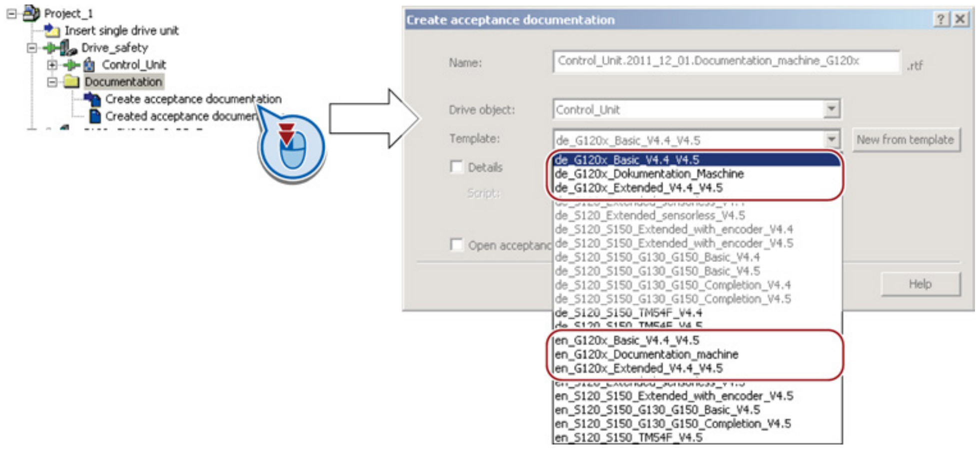
Documents for the acceptance

The STARTER provides you with a number of documents to be regarded as a recommendation for the acceptance tests of the safety functions.

Procedure

Proceed as follows to create the acceptance documentation for the drive using STARTER:

1. In STARTER, select "Create acceptance documentation":



   STARTER has templates in German and English.

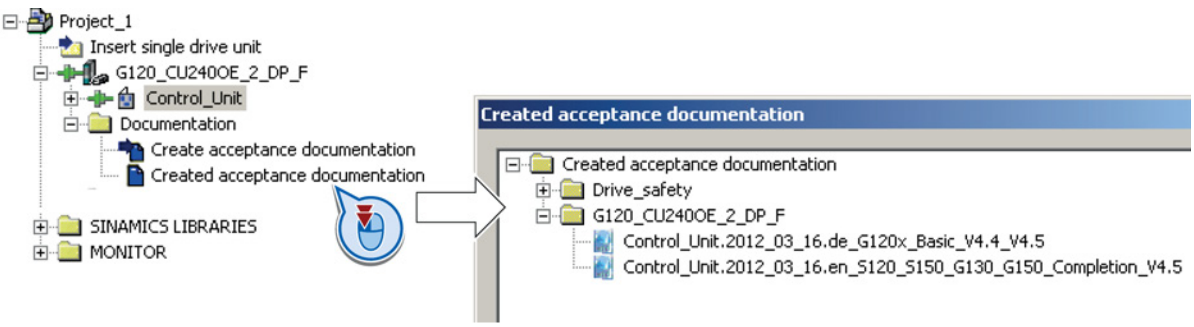
2. Select the suitable template and create a report for each drive of your machine or system:
   - Template for the machine documentation:

     de_G120x_Dokumentation_Maschine: German template.

     en_G120x_Documentation_machine: English template.
   - Report of the settings for the basic functions, from firmware version V4.4 onwards:

     de_G120x_Basicc_V4.4…: German report.

     en_G120x_Basic_V4.4…: English report.
3. You load the created reports for archiving and the machine documentation for further processing:



4. Archive the reports and the machine documentation.

You have generated the documents to accept the safety functions.

The reports and the machine documentation can also be found in the section: Documentation for the acceptance test of fail-safe functions (Page 353).

Recommended acceptance test

The following descriptions for the acceptance test are recommendations that illustrate the principle of acceptance. You may deviate from these recommendations if you check the following once you have completed commissioning:

- Correct assignment of the interfaces of each converter with the safety function:
  - Fail-safe inputs
  - PROFIsafe address
- Correct setting of the STO safety function.

Note

Perform the acceptance test with the maximum possible velocity and acceleration in order to test the expected maximum braking distances and braking times.

Note

Non-critical alarms

The following alarms are issued following each system ramp-up and are not critical for acceptance:

- A01697
- A01796

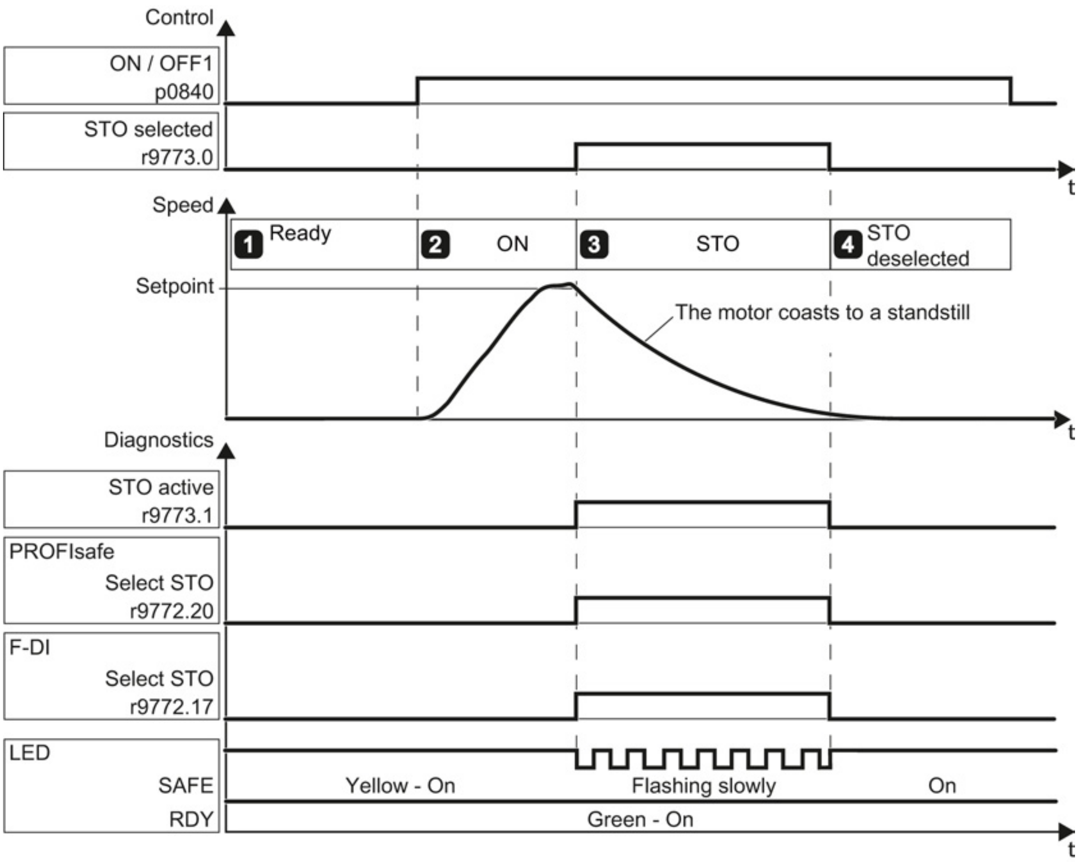


Figure 8-53 Acceptance test for STO (basic functions)

Procedure

To perform an acceptance test of the STO function as part of the basic functions, proceed as follows:

				Status
1.	**The inverter is ready**			
	• The inverter signals neither faults nor alarms of the safety functions (r0945[0…7], r2122[0…7]).			
	• STO is not active (r9773.1 = 0).			
2.	**Switch on motor**			
	2.1.	Enter a speed setpoint ≠ 0.		
	2.2.	Switch on the motor (ON command).		
	2.3.	Check that the correct motor is running.		
3.	**Select STO**			
	3.1.	Select STO while the motor is running *Test each configured activation, e.g. via digital inputs and PROFIsafe.*		
	3.2.	Check the following:		
		When controlled by PROFIsafe	For control via terminal	
		• The inverter signals the following: "STO selection via PROFIsafe" (r9772.20 = 1)	• The inverter signals the following: "STO Selection via terminal" (r9772.17 = 1)	
		• If a mechanical brake is not available, the motor coasts down. A mechanical brake brakes the motor and holds it to ensure that it remains at a standstill.		
		• The inverter signals neither faults nor alarms of the safety functions (r0945[0…7], r2122[0…7]).		
		• The inverter signals the following: "STO is selected" (r9773.0 = 1). "STO is active" (r9773.1 = 1).		
4.	**Deselect STO**			
	4.1.	Deselect STO.		
	4.2.	Check the following:		
		• STO is not active (r9773.1 = 0).		
		• The inverter signals neither faults nor alarms of the safety functions (r0945[0…7], r2122[0…7]).		

You have performed the acceptance test of the STO function.

8.10 Switchover between different settings

There are applications that require different inverter settings.

Example:

You connect different motors to one inverter. Depending on the particular motor, the inverter must operate with the associated motor data and the appropriate ramp-function generator.

Drive data sets (DDS)

Your can set several inverter functions differently and then switch over between the different settings.

The associated parameters are indexed (index 0, 1, 2 or 3). Using control commands select one of the four indexes and therefore one of the four saved settings.

The settings in the inverter with the same index are called the drive data set.

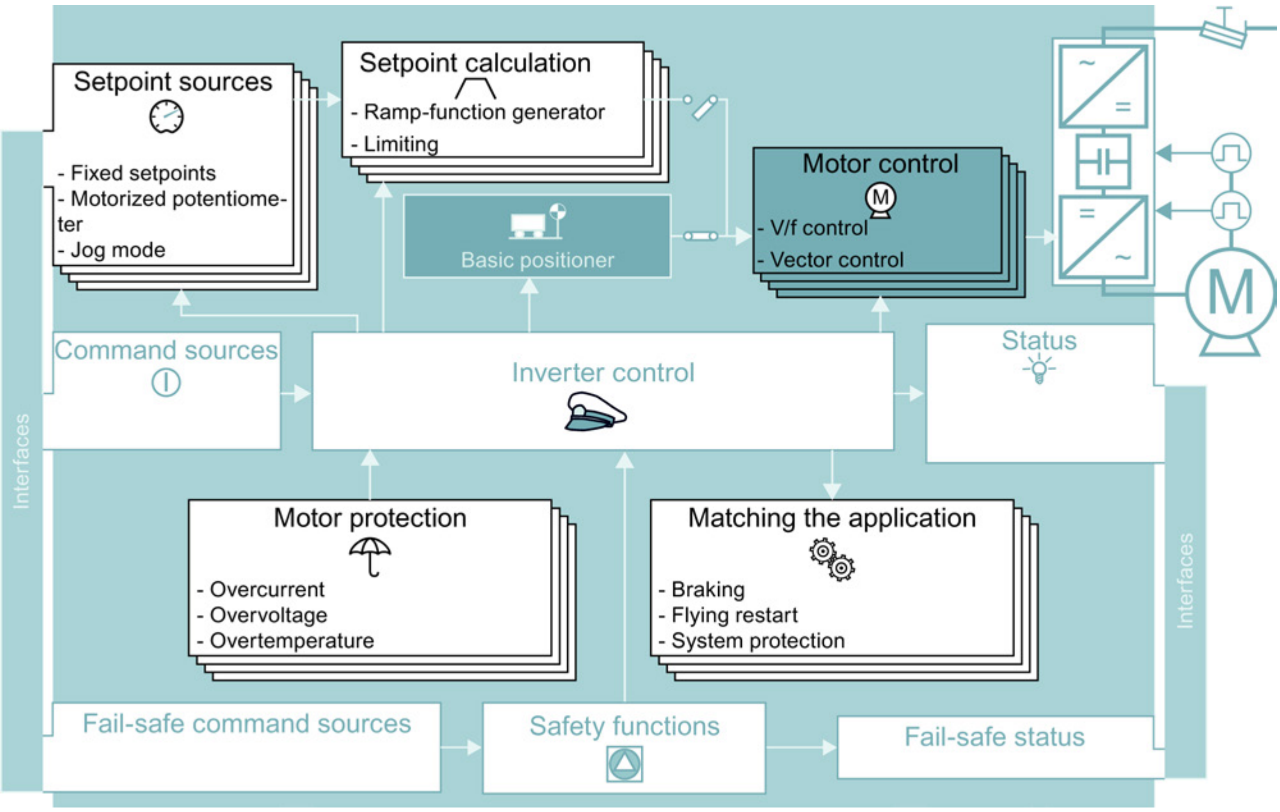


Figure 8-54 Drive data set switchover in the inverter

Using parameter p0180 you can define the number of drive data sets (1 ... 4).

Table 8- 42 Selecting the number of **drive data sets**

Parameter	Description
p0010 = 15	**Drive commissioning:** Data sets
p0180	**Drive data sets (DDS) number**(factory setting: 1)
p0010 = 0	**Drive commissioning:** Ready

Table 8- 43 Parameters for switching the drive data sets:

Parameter	Description
p0820	**Drive data set selection DDS bit 0**
p0821	**Drive data set selection DDS bit 1**
p0826	**Motor changeover, motor number** Each drive data set is assigned a motor number: p0826[0] = motor number for drive data set 0. … p0826[3] = motor number for drive data set 3. If you operate the same motor with different drive data sets, then you must enter the same motor number in every index of parameter p0826. In this particular case, you can also switch over between the different drive data sets in operation. If you operate different motors on one inverter, then the motors must be numbered in parameter p0826. In this case, you may only switch over the drive data sets in the "ready for operation" state with the motor switched-off. The switchover time is approx. 50 ms.
r0051	**Displaying the number of the DDS that is currently effective**

For an overview of all the parameters that belong to the drive data sets and can be switched, see the List Manual.

Table 8- 44 Parameters for copying the drive data sets

Parameter	Description
p0819[0]	**Source drive data set**
p0819[1]	**Target drive data set**
p0819[2] = 1	**Start copy operation**

For more information, see the List Manual (the parameter list and function diagram 8565).

9 Data backup and series commissioning

External data backup

After commissioning, your settings are saved in the inverter so that they are protected against power failure.

We recommend that you additionally back up the settings on a storage medium outside the inverter. Without backup, your settings could be lost if the inverter developed a defect (see also Replacing a Control Unit with enabled safety function (Page 272)).

The following storage media are available for your settings:

- Memory card
- PG/PC
- Operator panel

NOTICE
Data backup using operator panels with USB connection with the PG/PC is not possible
If the inverter is connected to a PG/PC via a USB cable, you can save any data on the MMC via the operator panels.
To allow you to save data on the MMC using an operator panel, you must release the USB connection between PG/PC and inverter.

Carrying out series commissioning

Series commissioning is the commissioning of several identical drives.

Procedure

You must proceed as follows to carry out series commissioning:

1. Commission the first inverter.
2. Back up the settings of the first inverter to an external storage medium.
3. Transfer the settings of the first inverter to another inverter via the storage medium.

> **Note**
>
> The control unit to which the settings are transferred must have the same order number and the same or a higher firmware version as the source control unit.

You have carried out series commissioning.

9.1 Backing up and transferring settings using memory card

What memory cards do we recommend?

We recommend that you use one of the memory cards with the following order numbers:

- MMC (order number 6SL3254-0AM00-0AA0)
- SD (order number 6ES7954-8LB01-0AA0)

Using memory cards from other manufacturers

If you use other SD or MMC memory cards, then you must format the memory card as follows:

- MMC: Format FAT 16
  - Insert the card into your PC's card reader.
  - Command to format the card:
    format x: /fs:fat (x: Drive code of the memory card on your PC)
- SD: Format FAT 32
  - Insert the card into your PC's card reader.
  - Command to format the card:
    format x: /fs:fat32 (x: Drive code of the memory card on your PC.)

Note

Limited function with memory cards from other manufacturers

Under certain circumstances, third-party memory cards do not support all functions (e.g. download). You use these cards at your own risk.

9.1.1 Saving settings to the memory card

We recommend that you insert the memory card before switching on the inverter for the first time. The Inverter then automatically ensures that the actual parameter settings are saved both in the inverter as well as on the card.

The memory card reader is located at the rear of the Control Unit in the top right-hand corner. It is necessary to insert the card before the Control Unit is fitted securely to the Power Module. Once fitted, the memory card cannot be removed without removing the Control Unit from the Power Module.

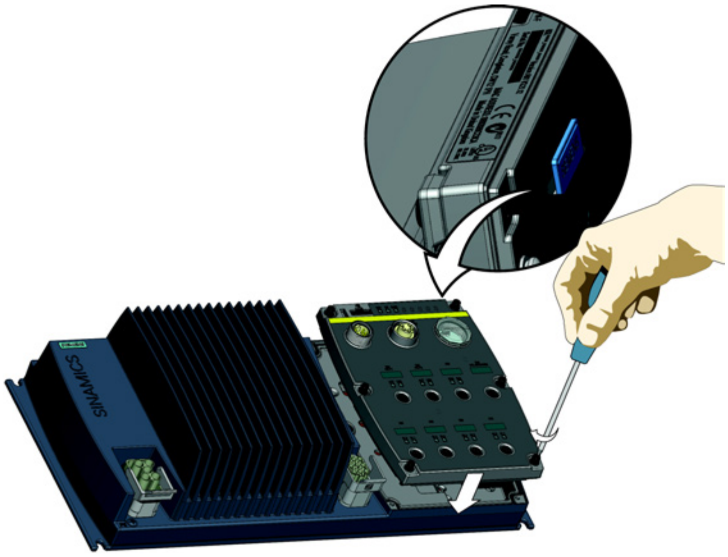


Figure 9-1 Fitting memory card in Control Unit

The following describes how you can save the Inverter parameter settings on the memory card.

If you wish to transfer the parameter setting from the converter on to a memory card (Upload), you have two options:

Automatic upload

The inverter power supply has been switched off.

1. Insert an empty memory card into the Control Unit.
2. Fit the Control Unit to the Power Module - making sure that the seals are fitted correctly and the correct tighten torque (2.0 Nm) is used to ensure the IP rating of the Inverter.
3. Connect the external 24 V supply to the Control Unit.

After the control Unit has been powered-up, the Inverter copies all modified parameters to the memory card.

Note

If the memory card is not empty and already contains parameter settings, the Inverter will take the parameter settings from the memory card. The previous setting in the Inverter will be deleted.

Manual upload

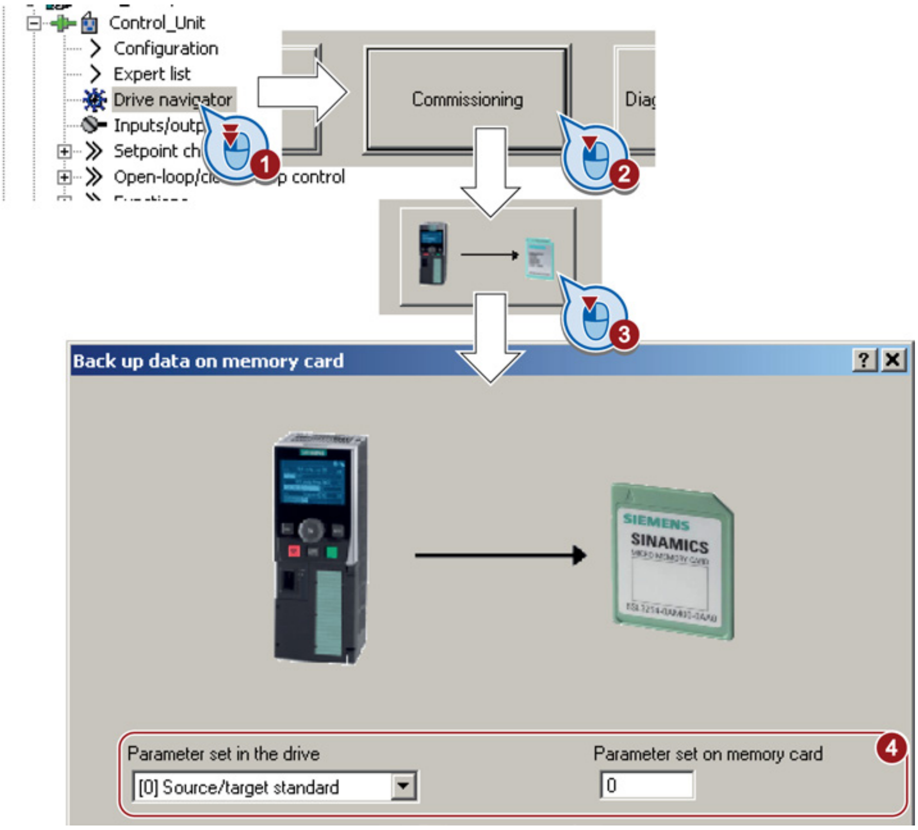
If you do not wish to powered-down the Control Unit or you do not have an empty memory card available, you will need to transfer the parameter setting to the memory card as follows:

1. The Control Unit remains powered-up from the external 24 V supply.
2. Ensure the application under the control of the Inverter is in a safe state.
3. Remove the Control Unit from the Power Module.
4. Insert the memory card into the memory card reader.
5. Fit the Control Unit to the Power Module - making sure that the seals are fitted correctly and the correct tighten torque (2.0 Nm) is used to ensure the IP rating of the Inverter.

Procedure using STARTER

Proceed as follows to manually back up your settings on a memory card:

1. Go online with STARTER, and in your drive, select the "Drive Navigator".
2. Select the "Commissioning" button.
3. Select the button to transfer the settings to the memory card.
4. Select the settings as shown in the diagram and start the data backup.
5. Close the screen forms.



You have manually backed up the settings on the memory card.

9.1.2 Transferring the settings from the memory card

If you wish to transfer the parameter settings from a memory card into the inverter (download), you have two options:

Automatic download

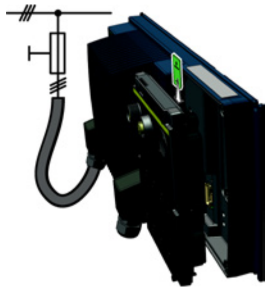
The external power supply to the Control Unit has been removed.

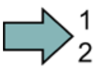
1. Remove the Control Unit from the Power Module
2. Insert the memory card containing parameter settings into the Control Unit.
3. Fit the Control Unit to the Power Module - making sure that the seals are fitted correctly and the correct tighten torque (2.0 Nm) is used to ensure the IP rating of the Inverter.
4. Connect the external 24 V supply to the Control Unit.

If the parameter data on the memory card is valid, then the inverter automatically downloads the parameter data to it's internal memory.

Procedure: Manual data transfer from a memory card

- The converter power supply has been switched on.
- Insert a memory card into the converter.



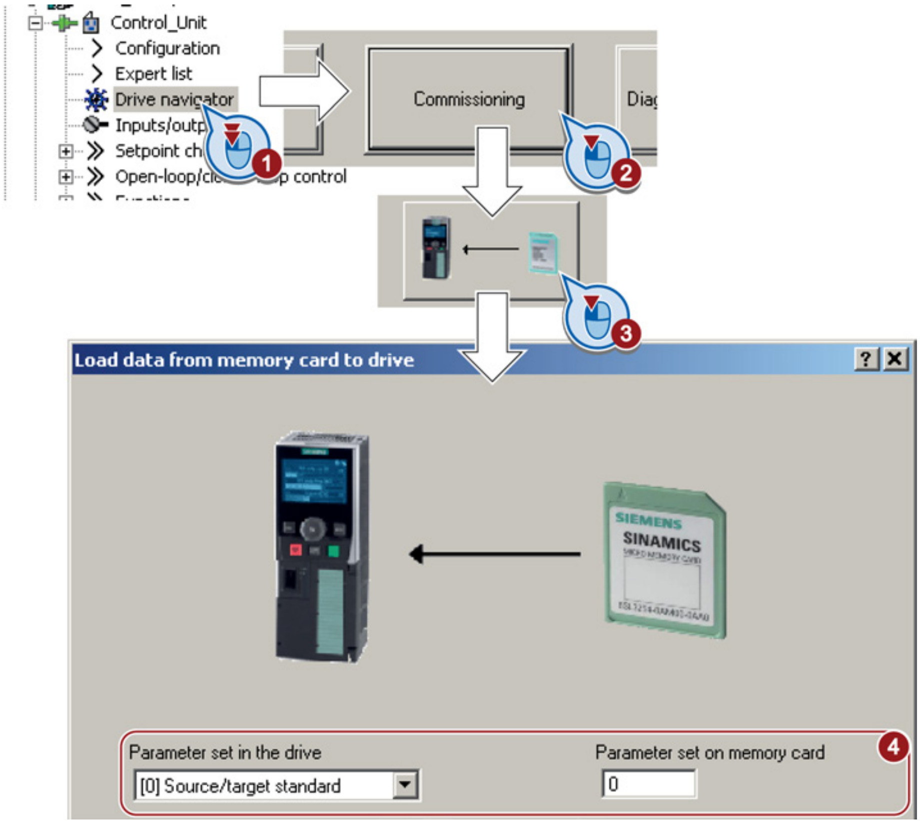


Procedure using STARTER

Proceed as follows to manually transfer your settings from a memory card:

1. Go online with STARTER, and in your drive, select the "Drive Navigator".
2. Select the "Commissioning" button.
3. Select the button to transfer the data from the memory card to the inverter.
4. Select the settings as shown in the diagram and start the data backup.
5. Close the screen forms.
6. Go offline with STARTER.

7. Switch off the inverter power supply.
8. Wait until all LED on the inverter go dark. Now switch on the inverter power supply again. Your settings only become effective after this power-on reset.



You have manually transferred the settings from the memory card.

9.1.3 Safely remove the memory card

⚠CAUTION
The files system on the memory card can be destroyed if the memory card is removed while the Inverter is powered-up without using the "safe removal" function.

To safely remove the memory card from the Control Unit the following procedure should be performed, using either STARTER or the IOP:

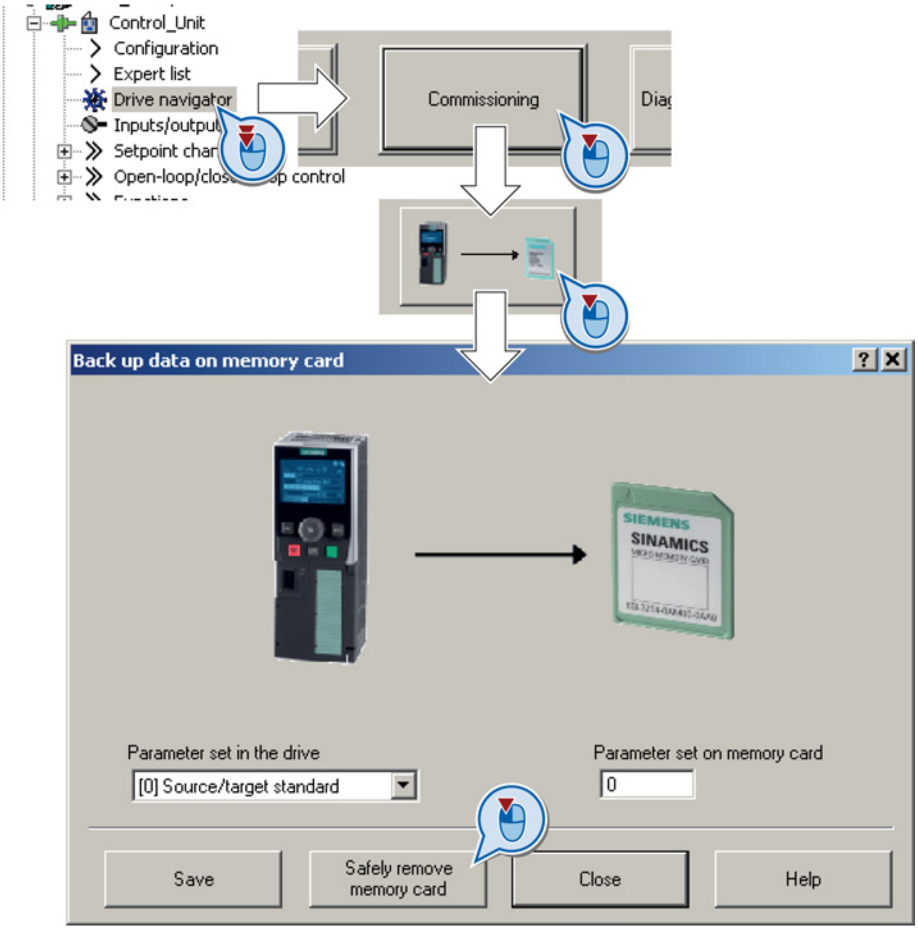
1. Set P9400 to 2.
2. Check the value of parameter P9400.
3. If P9400 = 3, it is safe to remove the memory card.
4. Remove the Control Unit for the Power Module.

5. Remove the memory card.
6. Fit the Control Unit back on the Power Module.

Procedure using STARTER

To safely remove the memory card, proceed as follows:

1. In the Drive Navigatorselect the following screen form:



2. Click on the button to safely remove the memory card.
3. You may remove the memory card from the inverter after the appropriate message has been output.

You have now safely removed the memory card.

9.2 Backing up and transferring settings via STARTER

With the supply voltage switched on, you can transfer the converter settings from the converter to a PG/PC, or the data from a PG/PC to the converter.

This requires you to have installed the STARTER commissioning tool on your PG/PC.

You will find additional information about STARTER in Chapter: Commissioning tools (Page 21).

Inverter → PC/PG

Procedure

To back up the settings, proceed as follows:

1. Go online with STARTER : .
2. Select the button "Download project to PG": .
3. To save the data in the PG, select the button: .
4. Go offline with STARTER : .

You have backed up the settings.

Procedure PC/PG → Converter

The procedure depends on whether you also transfer settings of safety functions or not.

Converter without safety functions:

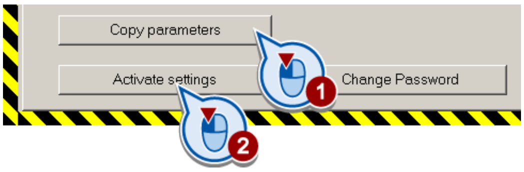
- Go online with STARTER : .
- Select the button "Download project to target system": .
- To save the data in the converter, select the "Copy RAM to ROM" button: .
- Go offline with STARTER : .

Converter with safety functions:

- ① Go online with STARTER : .
- ② Select the button "Download project to target system": .

- ③ Open the STARTER screen for the safety functions.

- ① Copy the safety function parameters.
- ② Activate the settings.



- To save the data in the converter, select the "Copy RAM to ROM" button: .
- Go offline with STARTER : .
- Switch off the converter power supply.
- Wait until all LED on the converter go dark. Now switch on the converter power supply again. Your settings only become effective after this power-on reset.

9.3 Other ways to back up settings

Description

In addition to the default setting, the converter has an internal memory for backing up three other settings.

On the memory card, you can back up 99 other settings in addition to the default setting.

You will find additional information on the Internet at: Memory options (http://support.automation.siemens.com/WW/view/en/43512514).

Table 9- 1 Backing up settings in the converter

Parameter	Description
p0970	**Reset drive parameters** Load backed-up setting (number 10, 11 or 12). The load overwrites the current setting.
p0971	**Save parameters** Back up the setting (10, 11 or 12).

Table 9- 2 Backing up additional settings on the memory card

Parameter	Description
p0802	**Data transfer with memory card as source/target** (factory setting 0) Default setting: p802 = 0 Further settings: p802 = 1 … 99
p0803	**Data transfer with device memory as source/target** (factory setting 0) Default setting: p803 = 0 Further settings: p803 = 10, 11 or 12

9.4 Write and know how protection

The inverter offers the option to protect configured settings from being changed or copied.

Write protection and know-how protection are available for this purpose.

Write protection - overview

Write protection is primarily used to prevent inverter settings from being inadvertently changed. No password is required for write protection, your settings remain unencrypted.

The following functions are excluded from the write protection:

- Activating/deactivating write protection (p7761)
- Changing the access level (p0003)
- Saving parameters (p0971)
- Safely removing the memory card (p9400)
- Access to service parameters (p3950) - only for service personnel, a password is required
- Restoring the factory setting
- Upload
- Acknowledging alarms and faults
- Switching over to the control panel
- Trace
- Function generator
- Measuring functions
- Reading out diagnostic buffer

The individual parameters that are excluded from the write protection, can be found in the List Manual in Chapter "Parameters for write protection and protection of know-how".

Know-how protection - overview

The know-how protection is used, for example, so that machine manufacturers can encrypt their configuration know-how and protect it against changes or copying.

The know-how protection is available in the following versions:

- **Know-how protection without copy protection** (possible with or without memory card)
- **Know-how protection with copy protection** (possible only with Siemens memory card)

A password is required for the know-how protection.

In case of active know-how protection, the STARTER dialog screens are locked. The expert list in STARTER shows only display parameters.

Actions that are also possible during active know-how protection

- Restoring factory settings
- Acknowledging messages
- Displaying messages
- Displaying the alarm history
- Reading out diagnostic buffer
- Switching to the control panel (complete control panel functionality: Fetch master control, all buttons and setting parameters)
- Upload (only parameters, which are accessible even though know-how protection is active)

Actions that are not possible during active know-how protection

- Download
- Export/import
- Trace
- Function generator
- Measuring functions
- Automatic controller setting
- Stationary/rotating measurement
- Deleting the alarm history

The individual parameters that are excluded from the know-how protection can be found in the List Manual in Chapter "Parameters for write protection and protection of know-how".

9.4.1 Write protection

Set write protection

Precondition

In order that you can set write protection, your inverter must be connected online with STARTER.

Activate and deactivate write protection

Procedure

Proceed as follows to activate or deactivate the write protection:

1. Select the inverter in your STARTER project with the left mouse button.
2. Open the shortcut menu with a right click.
3. Activate write protection.

   Deactivation is executed in analog.

   To make this setting permanent, you need to select "Copy RAM to ROM" . Otherwise, your settings will be lost when the inverter is switched off.

You have activated or deactivated write protection.

Points to note about restoring the factory settings

If you select "Reset to factory settings" using the button when write protection is active, the following confirmation prompt opens.

The confirmation prompt is not issued, if you select another way to restore the factory setting, e.g. using the expert list.

Note

Points to note regarding CAN, BACnet and MODBUS

Using these bus systems, parameter factory settings can be changed despite active write protection. So that write protection is also active when accessing via these fieldbuses, you must additionally set p7762 to 1.

This setting is only possible via the expert list.

9.4.2 Know-how protection

When the inverter is operated with know-how protection, please take note of the following information:

Note

Support provided by technical support for active know-how protection

In the case of active know-how protection, support by the technical support is only possible with the consent of the machine manufacturer.

Know-how protection can only be activated online.

If you have created a project offline on your computer, you must download it to the inverter and go online. Only then can you activate the know-how protection.

You cannot activate know-how protection in the project on the computer.

Know-how protection with copy protection is only possible with a Siemens memory card.

For "know-how protection with copy protection", a Siemens memory card must be plugged in!

If you try to activate the "know-how protection with copy protection" without a memory card, or with a different memory card, the message "Know-how protection for the drive unit could not be activated" is displayed.

Password check for know-how protection and Windows language settings

Please note that if the Windows language settings are changed, after activating know-how protection, faults can occur when subsequently checking the password. Therefore, only use characters from the ASCII character set for your password.

Commissioning the inverter with know-how protection

Procedure

Proceed as follows to commission an inverter with know-how protection:

1. Commission the inverter.
2. Create the exception list (Page 263).
3. Activate the know-how protection (Page 261).
4. Save the settings in the inverter by copying RAM to ROM with  or via p0971 = 1.
5. Save the project with  on the PG/PC. Also back up any other project-related data (machine type, password, etc.) that may be required for the support of the end customer.

You have commissioned the inverter with know-how protection.

9.4.2.1 Settings for the know-how protection

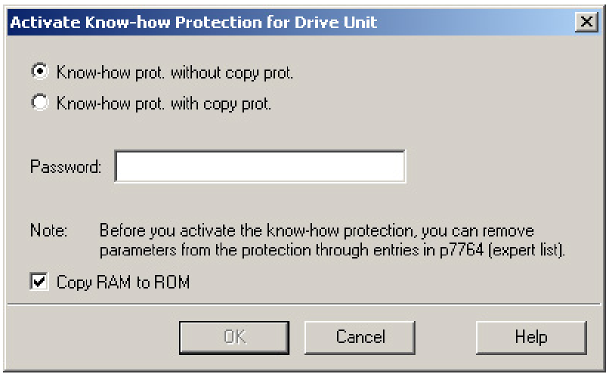
Activating know-how protection

Procedure

Proceed as follows to activate know-how protection:

1. Select the inverter in the STARTER project, and then select "Know-how protection drive unit/activate ..." in the shortcut menu (see also Write protection (Page 258)).
2. Enter your password, and confirm with OK.

   The password must consist of at least one character and can be no longer than 30 characters. All characters are permissible.

3. In this screen form "Copy RAM to ROM" has been selected in the factory. This will ensure that your settings are permanently stored.

   If "Copy RAM to ROM" is not selected, then your know-how protection settings are only saved in the volatile memory, and will no longer be available the next time the system is switched on.

You have activated know-how protection.

Backing up settings on the memory card

When the know-how protection is activated, you can save the settings via p0971 on the memory card.

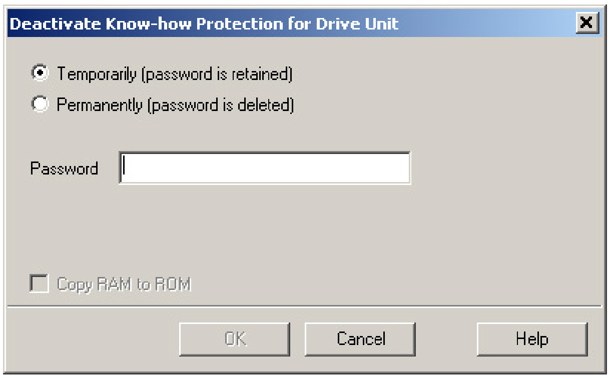
To do this, set p0971 = 1. The data is encrypted before being written to the memory card. After saving, p0971 is reset to 0.

Deactivate know-how protection, delete password

Procedure

Proceed as follows to deactivate know-how protection:

1. Select the inverter in the STARTER project, and right-click to open the dialog box "Know-how protection drive unit/deactivate …".
2. There, select the desired option.
3. Enter the password and exit the screen form with OK.



You have deactivated know-how protection.

Note

Permanently or temporarily deactivating know-how protection

Temporarily deactivating know-how protection means that know-how protection is active again after switching off and switching on. Permanently deactivating means that know-how protection is no longer active after switching off and switching on again.

Deactivating know-how protection temporarily

To temporarily deactivate the know-how protection means that you can change the settings in the inverter until you switch the inverter off and on again, or until you reactivate the know-how protection.

Finally deactivating know-how protection (delete password)

Finally deactivating the know-how protection means that you delete the password

- Immediately and finally, if you select "Copy RAM to ROM"
- Until the next OFF/ON if you do not select "Copy RAM to ROM"

Changing the password

Select the inverter in the STARTER project and open the dialog box via the shortcut menu "know-how protection drive unit/change password … ".

9.4.2.2 Creating an exception list for the know-how protection

Using the exception list, you as a machine manufacturer may make individual adjustable parameters accessible to end customers although know-how protection is active. You may define the exception list via parameters p7763 and p7764 in the expert list. Specify the number of parameters for the selection list in p7763. Assign the individual indexes to the parameter numbers of the selection list in p7764.

Procedure

Proceed as follows to change the number of parameters for the selection list:

1. Save the inverter settings via an upload ( ) on the PC/PG and go offline ( )
2. In the project on the PC, set p7763 to the desired value.
3. Save the project.
4. Go online and load the project into the inverter ( ).
5. Now make the additional settings in p7764.

You have modified the number of parameters for the selection list.

Factory setting for the exception list:

- p7763 = 1 (selection list contains precisely one parameter)
- p7764[0] = 7766 (parameter number for entering the password)

Note

Block access to the inverter as a result of incomplete exception lists

If you remove p7766 from the exception list, you can no longer enter a password and therefore no longer de-activate know-how protection.

In this case to access the inverter again, you have to reset the inverter to the factory settings.

9.4.2.3 Replacing the device with active know-how protection

Replacing devices during know-how protection without copy protection

For know-how protection without copy protection, the converter settings can be transferred to another converter using a memory card.

See also:

- Saving settings to the memory card (Page 248)
- Transferring the settings from the memory card (Page 251)

Replacing devices for know-how protection with copy protection

The know-how protection with copy protection prevents the inverter settings from being copied and passed on. This function is predominantly used by machine manufacturers.

If know-how protection with copy protection is active, the inverter cannot be replaced as described in "Replacing a Control Unit with enabled safety function (Page 272)".

However, to allow the inverter to be replaced, you must use a Siemens memory card, and the machine manufacturer must have an identical machine that he uses as sample.

There are two options for replacing the device:

Option 1: The machine manufacturer only knows the serial number of the new inverter

- The end customer provides the machine manufacturer with the following information:
  - For which machine must the inverter be replaced?
  - What is the serial number (r7758) of the new inverter?
- The machine manufacturer goes online on the sample machine.
  - deactivates the know-how protection, see Settings for the know-how protection (Page 261)
  - enters the serial number of the new inverter in p7759
  - enters the serial number of the inserted memory card as reference serial number in p7769
  - activates the know-how protection with copy protection ("Copy RAM to ROM" must be activated!), see Settings for the know-how protection (Page 261)
  - writes the configuration with p0971 = 1 to the memory card
  - sends the memory card to the end customer
- The end customer inserts the memory card and switches on the inverter.

When powering up, the inverter checks the serial numbers of the card and when there is a match, the inverter goes into the "ready to start" state.

If the numbers do not match, then the inverter signals fault F13100 (no valid memory card).

Option 2: The machine manufacturer knows the serial number of the new inverter and the serial number of the MMC

- The end customer provides the machine manufacturer with the following information:
  - For which machine must the inverter be replaced?
  - What is the serial number (r7758) of the new inverter?
  - What is the serial number of the memory card?
- The machine manufacturer goes online on the sample machine.
  - deactivates the know-how protection, see Settings for the know-how protection (Page 261)
  - enters the serial number of the new inverter in p7759
  - enters the serial number of the customer's memory card as reference serial number in p7769
  - activates the know-how protection with copy protection ("Copy RAM to ROM" must be activated!), see Settings for the know-how protection (Page 261)
  - writes the configuration with p0971 = 1 to the memory card
  - copies the encrypted project from the card to his PC
  - for example, sends it by e-mail to the end customer
- The end customer copies the project to the Siemens memory card that belongs to the machine, inserts it in the inverter and switches on the inverter.

When powering up, the inverter checks the serial numbers of the card and when there is a match, the inverter goes into the "ready to start" state.

If the numbers do not match, then the inverter signals fault F13100 (no valid memory card).

Repair 10

10.1 Spare parts - external fan

External fan for Frame Size C

Frame Size C is fitted with an external fan to provide additional cooling. Should the fan need replacing the fitting process is shown in the diagram below.

The external fan can be ordered under the part number: 6SL3500-0SF01-0AA0.

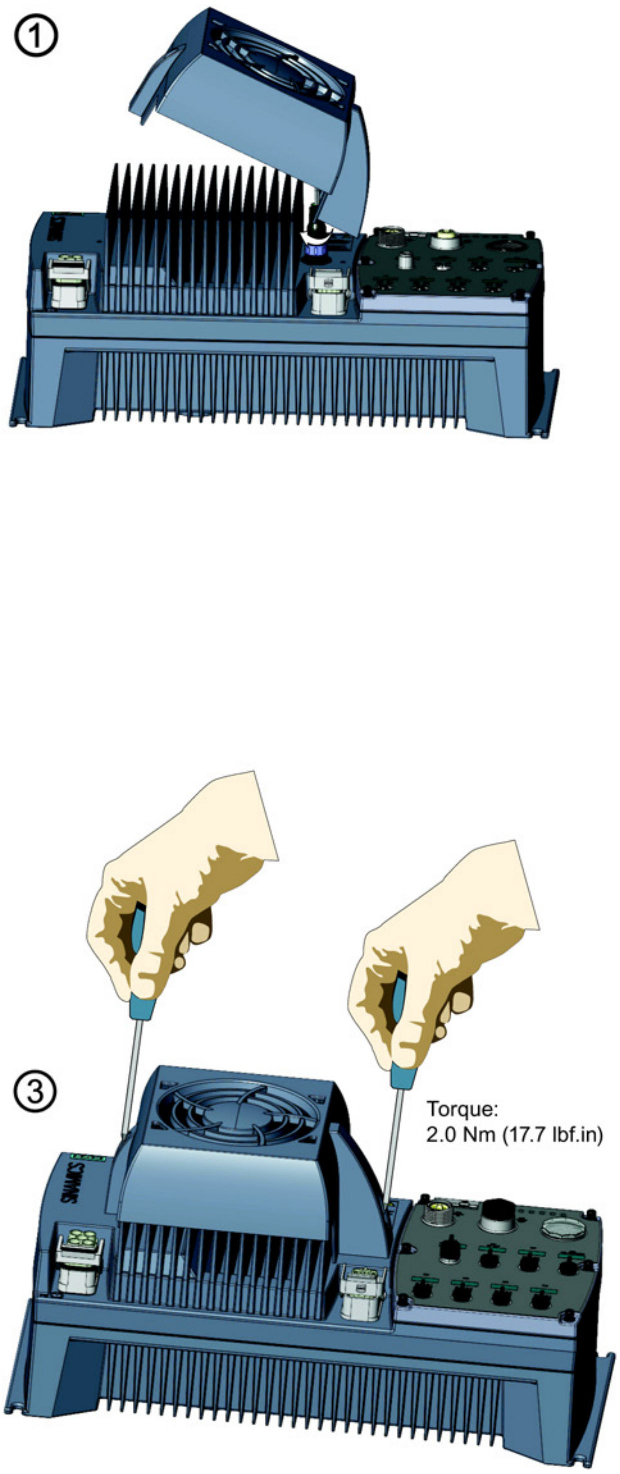


Figure 10-1 Fitting the external fan

Additional accessories

Spare covers and seals

This kit comprises all the plastic covers and seals that are used with the SINAMCS G120D Inverter. Each kit contains five complete sets. The kit can be ordered under the part number: 6SL3500-0SK01-0AA0.

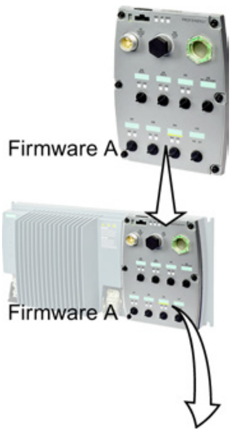
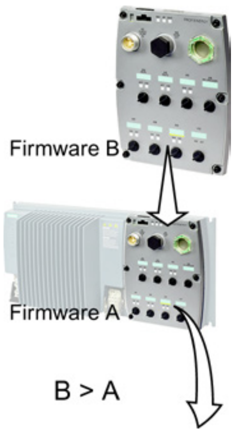
Spare fan cowl

The fan cowl can be ordered as an individual spare part under the part number: 6SL3500-0SM01-0AA0.

10.2 Overview of replacing converter components

Permissible replacement of components

In the event of a long-term function fault, you must replace the Power Module or Control Unit. The converter's Power Module and Control Unit can be replaced independently of each other.

Replacing the Power Module		Replacing the Control Unit	
Replacement: • Same type • Same power rating	Replacement: • Same type • *Higher* power rating	Replacement: • Same type • Same firmware version	Replacement: • Same type • *higher* firmware version (e.g. replace FW V4.2 by FW V4.3)
			
	Power Module and motor must be adapted to one another (ratio of motor and Power Module rated power > 1/8)	After replacing the Control Unit, you must restore the converter's settings.	

⚠ WARNING
Death or material damage Replacing converters of different types can result in an unpredictable drive response. In all cases that are not permitted according to the table above, recommission the drive after replacing an converter.

Device replacement without removable storage medium - only for communication via PROFINET

If you have created a topology in your control, you can use environment detection to replace a defective converter with a new device of the same type and with the same software release. Recommissioning is not required in this case.

You can either load the converter settings into the converter using the memory card or – if you are using a SIMATIC S7 controller with DriveES – using DriveES.

Details of the device replacement without removable storage medium can be found in the Profinet system description (http://support.automation.siemens.com/WW/view/en/19292127).

10.3 Replacing a Control Unit with enabled safety function

Replacing a Control Unit with data backup on a memory card

Procedure

To replace the Control Unit, proceed as follows:

1. Disconnect the line voltage to the Power Module and (if installed) the external 24 V supply or the voltage for the digital outputs of the Control Unit.
2. Remove the signal cables from the Control Unit.
3. Remove the defective Control Unit.
4. Mount the new Control Unit on the Power Module. The new Control Unit must have the same order number and the same or higher firmware version as the Control Unit that was replaced.
5. Remove the memory card from the old Control Unit and insert it in the new Control Unit.
6. Reconnect the signal cables of the Control Unit.
7. Connect up the line voltage again.
8. The inverter loads the settings from the memory card.
9. After loading, check whether the inverter outputs Alarm A01028.
   - Alarm A01028:

     The loaded settings are not compatible with the inverter.

     Clear the alarm with p0971 = 1 and recommission the drive.
   - No alarm A01028:

     Perform a **reduced** acceptance test.

     The reduced acceptance test is described in Section Reduced acceptance (Page 241).

You have replaced the Control Unit and transferred the safety function settings from the memory card to the new Control Unit.

Replacing a Control Unit with data backup in the PC

Procedure

To replace the Control Unit, proceed as follows:

1. Disconnect the line voltage to the Power Module and (if installed) the external 24 V supply or the voltage for the digital outputs of the Control Unit.
2. Remove the signal cables of the Control Unit.
3. Remove the defective Control Unit.
4. Mount the new Control Unit on the Power Module.
5. Reconnect the signal cables of the Control Unit.
6. Connect up the line voltage again.
7. Open the project that matches the drive in STARTER.
8. Go online and transfer the settings from the PC to the inverter by pressing the button.
   The inverter signals faults after the download. Ignore these faults, as they will be automatically acknowledged by the following steps.
9. In STARTER, select the screen form for the safety functions.
10. Select the "Change settings" button.
11. Select the "Activate settings" button.
12. Save your settings (copy RAM to ROM).
13. Switch off the inverter power supply.
14. Wait until all LED on the inverter go dark.
15. Switch on the inverter power supply again (power on reset).
16. Perform a **reduced** acceptance test, see the section Reduced acceptance (Page 241).

You have replaced the Control Unit and transferred the safety function settings from the PC to the new Control Unit.

Replacing the Control Unit with data backup in the operator panel (BOP-2 or IOP)

Procedure

To replace the Control Unit, proceed as follows:

1. Disconnect the line voltage to the Power Module and (if installed) the external 24 V supply or the voltage for the digital outputs of the Control Unit.
2. Remove the signal cables of the Control Unit.
3. Remove the defective Control Unit.
4. Mount the new Control Unit on the Power Module.
5. Reconnect the signal cables of the Control Unit.
6. Connect up the line voltage again.
7. Attach the operator panel to the Control Unit.
8. Transfer the settings from the operator panel to the inverter, e.g. via menu "EXTRAS" - "FROM BOP" in the BOP-2.
9. Wait until the transfer is complete.
10. After loading, check whether the inverter outputs alarm A01028.
    – Alarm A01028:

      The loaded settings are not compatible with the inverter.

      Clear the alarm with p0971 = 1, and recommission the drive.
    – No alarm A01028: Proceed with the next step.
11. Switch off the inverter power supply.
12. Wait until all LED on the inverter go dark.
13. Switch on the inverter power supply again (power on reset).

    The inverter signals the faults F1650, F1680, and F30680. Ignore these faults, as they will be automatically acknowledged by the following steps.
14. Set p0015 = 95.
15. Set p9761 to the safety password.
16. Set p9701 to AC hex.
17. Set p0010 to 0.
18. Ensure that the settings are protected against power failure, e.g. via menu "EXTRAS" - "RAM-ROM" in the BOP-2.
19. Switch off the inverter power supply.
20. Wait until all LED on the inverter go dark.
21. Switch on the inverter power supply again (power on reset).
22. Perform a **reduced** acceptance test, see the section Reduced acceptance (Page 241).

You have replaced the Control Unit and transferred the safety function settings from the operator panel to the new Control Unit.

10.4 Replacing the Control Unit without the safety functions enabled

Replacing a Control Unit with data backup on a memory card

Procedure

Proceed as follows to exchange the Control Unit:

1. Disconnect the line voltage to the Power Module and (if installed) the external 24 V supply or the voltage for the digital outputs of the Control Unit.
2. Remove the signal cables from the Control Unit.
3. Remove the defective Control Unit.
4. Mount the new Control Unit onto the Power Module. The new Control Unit must have the same order number and the same or a higher firmware version as the Control Unit that was replaced.
5. Remove the memory card from the old Control Unit and insert it in the new Control Unit.
6. Reconnect the signal cables of the Control Unit.
7. Connect up the line voltage again.
8. The inverter loads the settings from the memory card.
9. After loading, check whether the inverter outputs Alarm A01028.
   - Alarm A01028:

     The settings that have been loaded are not compatible with the inverter.

     Clear the alarm with p0971 = 1, and recommission the drive.
   - No alarm A01028:

     The inverter accepts the settings that have been loaded.

You have successfully replaced the Control Unit.

Replacing a Control Unit with data backup in the PC

Procedure

Proceed as follows to exchange the Control Unit:

1. Disconnect the line voltage to the Power Module and (if installed) the external 24 V supply or the voltage for the digital outputs of the Control Unit.
2. Remove the signal cables of the Control Unit.
3. Remove the defective Control Unit.
4. Mount the new Control Unit onto the Power Module.
5. Reconnect the signal cables of the Control Unit.
6. Connect up the line voltage again.
7. Open the project that matches the drive in STARTER.
8. Go online and transfer the settings from the PC into the inverter by pressing the  button.
   The inverter signals faults after the download. Ignore these faults, as they will be automatically acknowledged by the following steps.
9. Save your settings (copy RAM to ROM).

You have successfully replaced the Control Unit.

10.5 Replacing the Control Unit without data backup

If you do not backup the settings, then you must recommission the drive after replacing the Control Unit.

Procedure

To replace the Control Unit without backed-up settings, proceed as follows:

1. Disconnect the line voltage to the Power Module and (if installed) the external 24 V supply or the voltage for the digital outputs of the Control Unit.
2. Remove the signal cables of the Control Unit.
3. Remove the defective Control Unit.
4. Mount the new Control Unit on the Power Module.
5. Reconnect the signal cables of the Control Unit.
6. Connect up the line voltage again.
7. Recommission the drive.

The Control Unit replacement has been completed after the drive has been successfully commissioned.

10.6 Replacing a Power Module with enabled safety function

Procedure

To replace the Power Module, proceed as follows:

1. Disconnect the line voltage to the Power Module.
   You must not disconnect the external 24 V supply (if installed) to the Control Unit.

⚠DANGER
Risk of electric shock from touching inverter connections
After the power supply has been switched off, it takes up to 5 minutes until the capacitors in the inverter have discharged enough for the residual voltage to be non-hazardous. • Check the voltage at the inverter connections before you carry out any installation work.

2. Remove the connecting cables of the Power Module.
3. Remove the Control Unit from the Power Module.
4. Replace the old Power Module with the new Power Module.
5. Mount the Control Unit onto the new Power Module.
6. Connect up the new Power Module using the connecting cables.

NOTICE
Material damage from swapping the motor's connection lines
The direction in which the motor rotates switches if you swap the two phases of the motor line. • Connect the three phases of the motor lines in the right order. • After replacing the Power Module, check the direction in which the motor rotates.

7. Switch on the line supply and, if necessary, the 24 V supply for the Control Unit.
8. Perform a reduced acceptance test, see the Section Reduced acceptance (Page 241).

You have successfully replaced the Power Module.

10.7 Replacing a Power Module without the safety function being enabled

Procedure

Proceed as follows to exchange a Power Module:

1. Switch off the supply voltage to the Power Module.
   You do not have to switch off an external 24 V power supply for the Control Unit if one is being used.

> **DANGER**
>
> **Risk of electric shock from touching inverter connections**
>
> After the power supply has been switched off, it takes up to 5 min. until the capacitors in the inverter have discharged so that the remaining voltage is non-hazardous.
>
> Check the voltage at the inverter connections, before removing the connection cables.

2. Remove the connecting cables of the Power Module.
3. Remove the Control Unit from the Power Module.
4. Replace the old Power Module with the new Power Module.
5. Mount the Control Unit onto the new Power Module.
6. Connect up the new Power Module using the connecting cables.

> **NOTICE**
>
> **Material damage when interchanging the motor connecting cables**
>
> The direction in which the motor rotates switches if you exchange the two phases of the motor line.
>
> Connect the three phases of the motor lines in the right order.
>
> After exchanging the power module check the direction in which the motor rotates.

7. Switch on the line supply and, if being used, the 24 V supply of the Control Unit.

You have successfully replaced the Power Module.

10.8 Upgrading firmware

When upgrading firmware you replace the converter's firmware with a newer version. Only update the firmware to a newer version if you require the expanded range of functions of that newer version.

Preconditions

1. Your converter's firmware is at least version V4.5.
2. You have the memory card with the firmware for that particular converter.

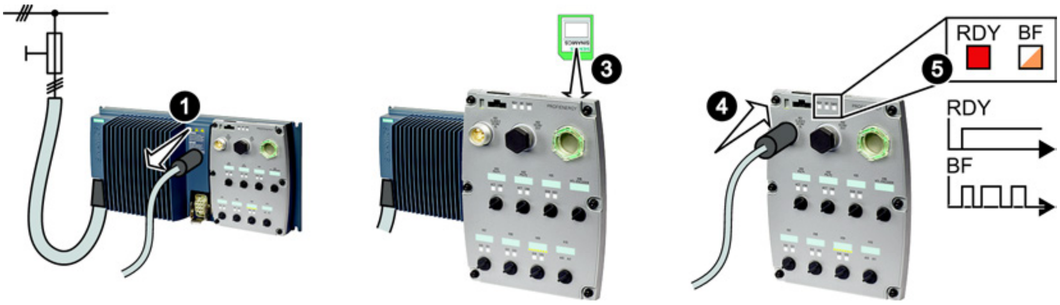
Procedure

To upgrade the converter's firmware to a newer version, proceed as follows:

1. Remove the connector for the 24 V power supply of the Control Unit.
2. Remove the Control Unit from the Power Module.
3. Insert the card with the matching firmware into the slot on the rear side of the Control Unit until you can feel it lock in place.
4. Attach the connector for the 24 V power supply of the Control Unit and switch the 24 V power on.
5. The Control Unit transfers the firmware from the memory card into its memory.

   The transfer takes between 5 and 10 minutes.

   During the transfer, the RDY LED permanently lights up in red on the Control Unit. The BF LED flashes in orange with variable frequency.



6. Once the transfer is completed, the RDY and BF LEDs flash slowly in red (0.5 Hz).

Note

Damaged firmware due to a cut to the supply voltage during transfer

A cut to the supply voltage during transfer can damage the converter's firmware.

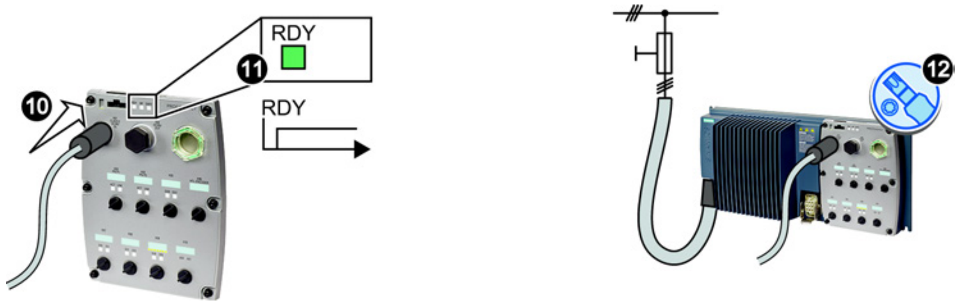
- Do not switch the converter's supply voltage off while the transfer is running.

---

7. Remove the card with the firmware from the Control Unit.
8. Switch the 24 V supply off or remove the connector for the 24 V supply from the Control Unit.

9. Wait until the LEDs on the Control Unit have gone out.

10. Reattach the connector for the 24 V supply voltage to the Control Unit and switch the 24 V supply on.
11. If the firmware upgrade was successful, the Control Unit responds after a few seconds with the RDY LED lighting up green.
12. Mount the new Control Unit on the Power Module.



You have successfully updated the converter's firmware to a newer version. When there is an upgrade your settings will be stored in the converter.

10.9 Firmware downgrade

When downgrading firmware you replace the converter's firmware with an older version. Only update the firmware to an older level if, after replacing a converter, you require the same firmware in all converters.

Precondition

1. Your converter's firmware is at least version V4.6.
2. You have the memory card with the firmware for that particular converter.
3. You have saved your settings onto a memory card, in an operator panel or on a PC.

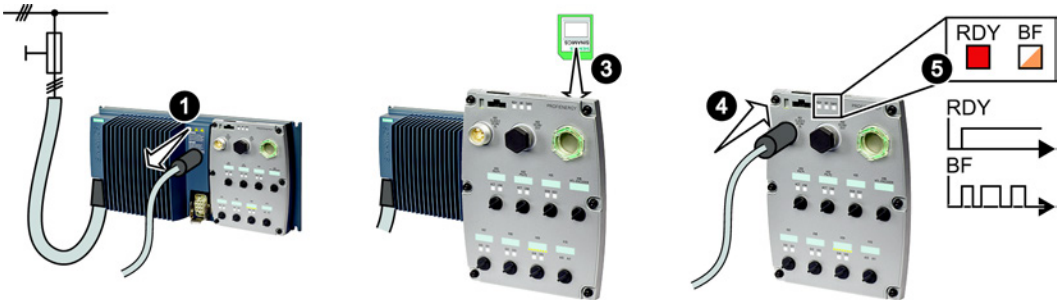
Procedure

To downgrade the converter's firmware to an older version, proceed as follows:

1. Remove the connector for the 24 V power supply of the Control Unit.
2. Remove the Control Unit from the Power Module.
3. Insert the card with the matching firmware into the slot on the rear side of the Control Unit until you can feel it lock in place.
4. Attach the connector for the 24 V power supply of the Control Unit and switch the 24 V power on.
5. The Control Unit transfers the firmware from the memory card into its memory.

   The transfer takes between 5 and 10 minutes.

   During the transfer, the RDY LED permanently lights up in red on the Control Unit. The BF LED flashes in orange with variable frequency.



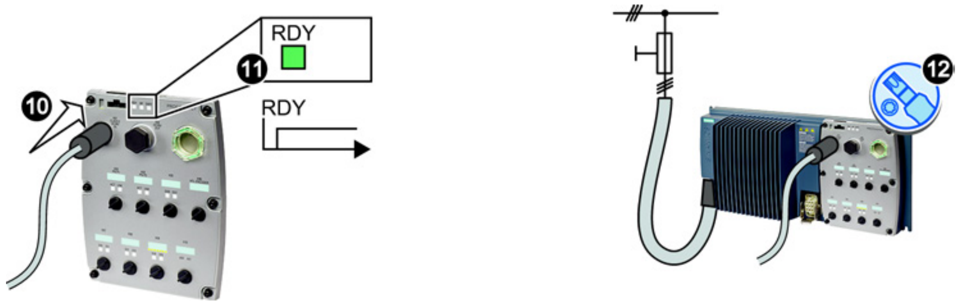
6. Once the transfer is completed, the RDY and BF LEDs flash slowly in red (0.5 Hz).

> **Note**
>
> **Damaged firmware due to a cut to the supply voltage during transfer**
>
> A cut to the supply voltage during transfer can damage the converter's firmware.
>
> - Do not switch the converter's supply voltage off while the transfer is running.

7. Remove the card with the firmware from the Control Unit.
8. Switch the 24 V supply off or remove the connector for the 24 V supply from the Control Unit.

9. Wait until the LEDs on the Control Unit have gone out.

10. Reattach the connector for the 24 V supply voltage to the Control Unit and switch the 24 V supply on.
11. If the firmware downgrade was successful, the Control Unit responds after a few seconds with the RDY LED lighting up green.



Following the firmware downgrade the converter is reset to factory settings.

12. Mount the new Control Unit on the Power Module.
13. Take your settings over from your data backup to the converter.

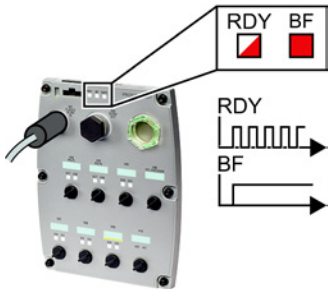
    See also section: Data backup and series commissioning (Page 247).

You have updated the converter's firmware to an older version and have adopted your saved settings in the converter.

10.10 Correcting a failed firmware upgrade or downgrade

How does the converter report a failed upgrade or downgrade?

The converter signals a failed firmware upgrade or downgrade with a quickly flashing RDY LED and a lit up BF LED.



Correcting a failed upgrade or downgrade

To correct a failed firmware upgrade or downgrade you can check the following:

- Does the firmware version fulfill the requirements of your converter?
  - For an upgrade at least V4.5.
  - For a downgrade at least V4.6.
- Have you inserted the card properly?
- Does the card contain the correct firmware?
- Repeat the appropriate procedure.

10.11 If the converter no longer responds

If the inverter no longer responds

For example, when loading an incorrect file from the memory card, the inverter can go into a state where it can no longer respond to commands from the operator panel or from a higher-level control system. In this case, you must reset the inverter to its factory setting and recommission it. This inverter state is manifested in two different ways:

Case 1

- The motor is switched off.
- You cannot communicate with the inverter, either via the operator panel or other interfaces.
- The LEDs flicker and after 3 minutes the inverter has still not powered up.

Procedure

Proceed as follows to restore the inverter factory settings:

1. Remove the memory card if one is inserted in the inverter.
2. Switch off the inverter power supply.
3. Wait until all LEDs on the inverter go dark. Then switch on the inverter power supply again.
4. Repeat steps 2 and 3 as often as required until the inverter outputs fault F01018:
5. Set p0971 = 1.
6. Switch off the inverter power supply.
7. Wait until all LEDs on the inverter go dark. Then switch on the inverter power supply again.

   The inverter now powers up with the factory settings.
8. Recommission the inverter.

You have restored the inverter factory settings.

Case 2

- The motor is switched off.
- You cannot communicate with the inverter, either via the operator panel or other interfaces.
- The LEDs flash and are dark - this process is continually repeated.

Procedure

Proceed as follows to restore the inverter factory settings:

1. Remove the memory card if one is inserted in the inverter.
2. Switch off the inverter power supply.
3. Wait until all LEDs on the inverter go dark. Then switch on the inverter power supply again.
4. Wait until the LEDs flash orange.
5. Repeat steps 2 and 3 as often as required until the inverter outputs fault F01018.
6. Now set p0971 = 1.
7. Switch off the inverter power supply.
8. Wait until all LEDs on the inverter go dark. Then switch on the inverter power supply again.

   The inverter now powers up with the factory settings.
9. Recommission the inverter.

You have restored the inverter factory settings.

Alarms, faults and system messages 11

11.1 Alarms

Alarms have the following properties:

- They do not have a direct effect in the converter and disappear once the cause has been removed
- They do not need have to be acknowledged
- They are signaled as follows
  - Status display via bit 7 in status word 1 (r0052)
  - At the Operator Panel with a Axxxxx
  - Via STARTER, if you click on TAB at the bottom left of the STARTER screen

In order to pinpoint the cause of an alarm, there is a unique alarm code and also a value for each alarm.

Alarm buffer

For each incoming alarm, the converter saves the alarm, alarm value and the time that the alarm was received.

	Alarm code	Alarm value		Alarm time received		Alarm time removed	
1. Alarm	r2122[0]	r2124[0]	r2134[0]	r2145[0]	r2123[0]	r2146[0]	r2125[0]
		I32	Float	Days	ms	Days	ms

Figure 11-1 Saving the first alarm in the alarm buffer

r2124 and r2134 contain the alarm value - important for diagnostics - as "fixed point" or "floating point" number.

The alarm times are displayed in r2145 and r2146 (in complete days) as well as in r2123 and r2125 (in milliseconds referred to the day of the alarm).
The converter uses an internal time calculation to save the alarm times. More information on the internal time calculation can be found in Chapter System runtime (Page 298).

As soon as the alarm has been removed, the converter writes the associated instant in time into parameters r2125 and r2146. The alarm remains in the alarm buffer even if the alarm has been removed.

If an additional alarm is received, then this is also saved. The first alarm is still saved. The alarms that have occurred are counted in p2111.

	Alarm code	Alarm value		Alarm time received		Alarm time removed	
1. Alarm	r2122[0]	r2124[0]	r2134[0]	r2145[0]	r2123[0]	r2146[0]	r2125[0]
2. Alarm	[1]	[1]	[1]	[1]	[1]	[1]	[1]

Figure 11-2 Saving the second alarm in the alarm buffer

The alarm buffer can contain up to eight alarms. If an additional alarm is received after the eighth alarm - and none of the last eight alarms have been removed - then the next to last alarm is overwritten.

	Alarm code	Alarm value		Alarm time received		Alarm time removed	
1. Alarm	r2122[0]	r2124[0]	r2134[0]	r2145[0]	r2123[0]	r2146[0]	r2125[0]
2. Alarm	[1]	[1]	[1]	[1]	[1]	[1]	[1]
3. Alarm	[2]	[2]	[2]	[2]	[2]	[2]	[2]
4. Alarm	[3]	[3]	[3]	[3]	[3]	[3]	[3]
5. Alarm	[4]	[4]	[4]	[4]	[4]	[4]	[4]
6. Alarm	[5]	[5]	[5]	[5]	[5]	[5]	[5]
7. Alarm	[6]	[6]	[6]	[6]	[6]	[6]	[6]
Last alarm	[7]	[7]	[7]	[7]	[7]	[7]	[7]

Figure 11-3 Complete alarm buffer

Emptying the alarm buffer: Alarm history

The alarm history traces up to 56 alarms.

The alarm history only takes alarms that have been removed from the alarm buffer. If the alarm buffer is completely filled - and an additional alarm occurs - then the converter shifts all alarms that have been removed from the alarm buffer into the alarm history. In the alarm history, alarms are also sorted according to the "alarm time received", however, when compared to the alarm buffer, in the inverse sequence:

- The youngest alarm is in index 8
- The second youngest alarm is in index 9
- etc.

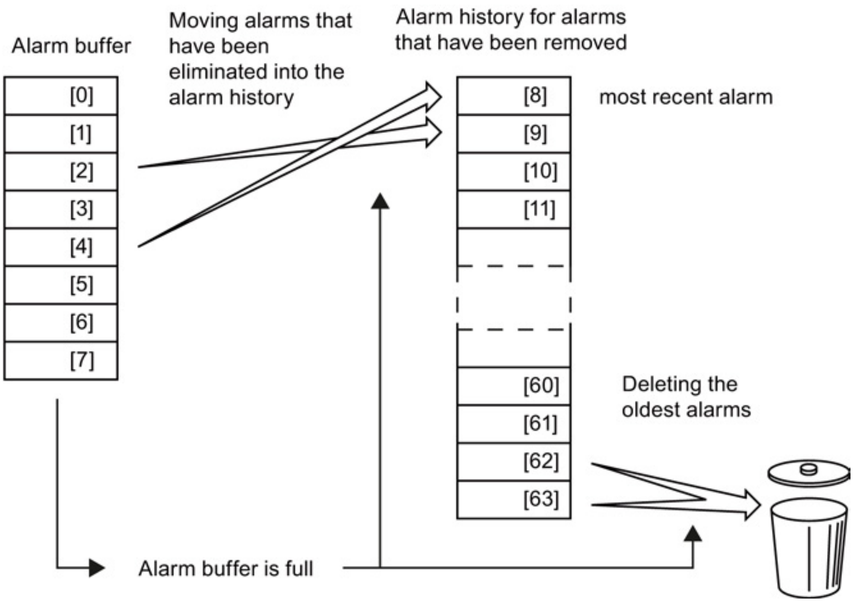


Figure 11-4 Shifting alarms that have been removed into the alarm history

Any alarms that have not been removed remain in the alarm buffer. The converter sorts the alarms and closes gaps between the alarms.

If the alarm history is filled up to index 63, each time a new alarm is accepted in the alarm history, the oldest alarm is deleted.

Parameters of the alarm buffer and the alarm history

Parameter	Description
r2122	**Alarm code** Displays the numbers of alarms that have occurred
r2123	**Alarm time received in milliseconds** Displays the time in milliseconds when the alarm occurred
r2124	**Alarm value** Displays additional information about the alarm
r2125	**Alarm time removed in milliseconds** Displays the time in milliseconds when the alarm was removed
p2111	**Alarm counter** Number of alarms that have occurred after the last reset When setting p2111 = 0, all of the alarms that have been removed from the alarm buffer [0...7] are transferred into the alarm history [8...63]
r2145	**Alarm time received in days** Displays the time in days when the alarm occurred
r2132	**Actual alarm code** Displays the code of the alarm that last occurred
r2134	**Alarm value for float values** Displays additional information about the alarm that occurred for float values
r2146	**Alarm time removed in days** Displays the time in days when the alarm was removed

Extended settings for alarms

Parameter	Description
You can change up to 20 different alarms into a fault or suppress alarms:	
p2118	**Setting the message number for the message type** Selection of the alarms for which the message type should be changed
p2119	**Setting the message type** Setting the message type for the selected alarm 1: Fault 2: Alarm 3: No message

You will find details in function diagram 8075 and in the parameter description of the List Manual.

11.2 Faults

A fault displays a severe fault during operation of the inverter.

The inverter signals a fault as follows:

- At the operator panel with Fxxxxx
- On the inverter using the red LED RDY
- In bit 3 of status word 1 (r0052)
- Via STARTER

To delete a message, you must remedy the cause of the fault and acknowledge the fault.

Every fault has a clear fault code and also a fault value. You need this information to determine the cause of the fault.

Fault buffer of actual values

The inverter saves the time, fault code and fault value for every fault it receives.

	Fault code	Fault value		Fault time received		Fault time removed	
1st fault	r0945[0]	r0949[0]	r2133[0]	r2130[0]	r0948[0]	r2136[0]	r2109[0]
		I32	Float	Days	ms	Days	ms

Figure 11-5 Saving the first fault in the fault buffer

r0949 and r2133 contain the fault value - important for diagnostics - as "fixed point" or "floating point" number.

The "fault time received" is in parameter r2130 (in complete days) as well as in parameter r0948 (in milliseconds referred to the day of the fault). The "fault time removed" is written into parameters r2109 and r2136 when the fault has been acknowledged.
The inverter uses its internal time calculation to save the fault times. More information on the internal time calculation can be found in Chapter System runtime (Page 298).

If an additional fault occurs before the first fault has been acknowledged, then this is also saved. The first alarm remains saved. The fault cases that have occurred are counted in p0952. A fault case can contain one or several faults.

	Fault code	Fault value		Fault time received		Fault time removed	
1st fault	r0945[0]	r0949[0]	r2133[0]	r2130[0]	r0948[0]	r2136[0]	r2109[0]
2nd fault	[1]	[1]	[1]	[1]	[1]	[1]	[1]

Figure 11-6 Saving the second fault in the fault buffer

The fault buffer can accept up to eight actual faults. The next to last fault is overwritten if an additional fault occurs after the eighth fault.

	Fault code	Fault value		Fault time received		Fault time removed	
1st fault	r0945[0]	r0949[0]	r2133[0]	r2130[0]	r0948[0]	r2136[0]	r2109[0]
2nd fault	[1]	[1]	[1]	[1]	[1]	[1]	[1]
3rd fault	[2]	[2]	[2]	[2]	[2]	[2]	[2]
4th fault	[3]	[3]	[3]	[3]	[3]	[3]	[3]
5th fault	[4]	[4]	[4]	[4]	[4]	[4]	[4]
6th fault	[5]	[5]	[5]	[5]	[5]	[5]	[5]
7th fault	[6]	[6]	[6]	[6]	[6]	[6]	[6]
Last fault	[7]	[7]	[7]	[7]	[7]	[7]	[7]

Figure 11-7 Complete fault buffer

Acknowledgement

In most cases, you have the following options to acknowledge a fault:

- Switch-off the inverter power supply and switch-on again.
- Press the acknowledgement button on the operator panel
- Acknowledgement signal at digital input 2
- Acknowledgement signal in bit 7 of control word 1 (r0054) for Control Units with fieldbus interface

Faults detected during the inverter-internal monitoring of hardware and firmware can be acknowledged only with switch-on and switch-off. The list of faults of the List Manual contains the note on this limited acknowledgement possibility.

Emptying the fault buffer: Fault history

The fault history can contain up to 56 faults.

The acknowledgement has no effect as long as none of the fault causes of the fault buffer have been removed. If at least one of the faults in the fault buffer has been removed (the cause of the fault has been removed) and you acknowledge the faults, then the following happens:

1. The inverter accepts all faults from the fault buffer in the first eight memory locations of the fault history (indexes 8 ... 15).
2. The inverter deletes the faults that have been removed from the fault buffer.
3. The inverter writes the time of acknowledgement of the faults that have been removed into parameters r2136 and r2109 (fault time removed).

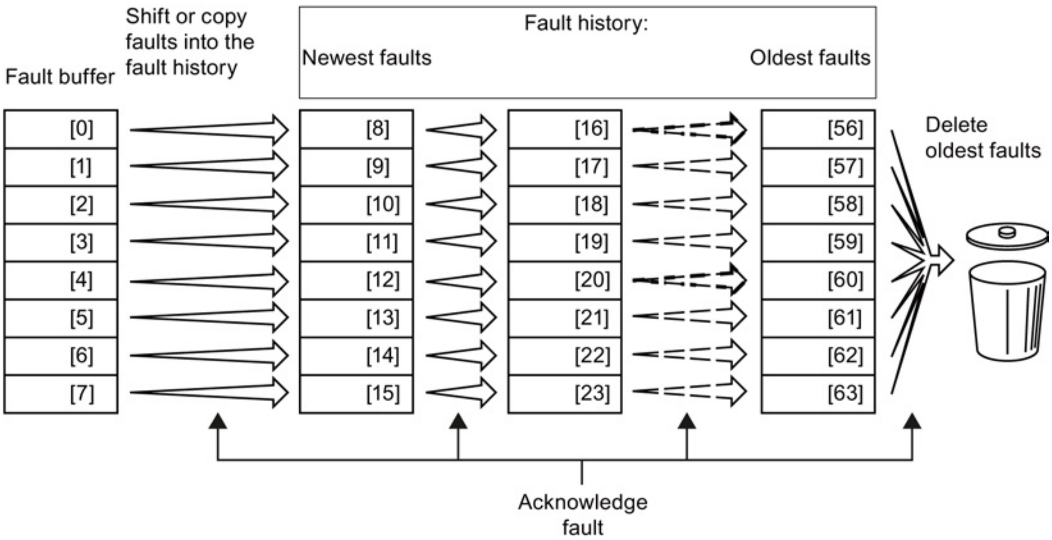


Figure 11-8 Fault history after acknowledging the faults

After acknowledgement, the faults that have not been removed are located in the fault buffer as well as in the fault history. For these faults, the "fault time coming" remains unchanged and the "fault time removed" remains empty.

If less than eight faults were shifted or copied into the fault history, the memory locations with the higher indexes remain empty.

The inverter shifts the values previously saved in the fault history each by eight indexes. Faults, which were saved in indexes 56 … 63 before the acknowledgement, are deleted.

Deleting the fault history

If you wish to delete all faults from the fault history, set parameter p0952 to zero.

Parameters of the fault buffer and the fault history

Parameter	Description
r0945	**Fault code** Displays the numbers of faults that have occurred
r0948	**Fault time received in milliseconds** Displays the time in milliseconds when the fault occurred
r0949	**Fault value** Displays additional information about the fault
p0952	**Fault cases, counter** Number of fault cases that have occurred since the last acknowledgement The fault buffer is deleted with p0952 = 0.
r2109	**Fault time removed in milliseconds** Displays the time in milliseconds when the fault occurred
r2130	**Fault time received in days** Displays the time in days when the fault occurred
r2131	**Actual fault code** Displays the code of the oldest fault that is still active
r2133	**Fault value for float values** Displays additional information about the fault that occurred for float values
r2136	**Fault time removed in days** Displays the time in days when the fault was removed

The motor cannot be switched-on

If the motor cannot be switched-on, then check the following:

- Is a fault present?
  If there is, then remove the fault cause and acknowledge the fault.
- Is p0010 = 0?
  If not, the inverter is e.g. still in a commissioning state.
- Is the inverter reporting the "ready to start" status (r0052.0 = 1)?
- Is the inverter missing enabling (r0046)?
- How does the inverter receive its setpoint and commands (p0015)?

Extended settings for faults

Parameter	Description
You can change the fault response of the motor for up to 20 different fault codes:	
p2100	**Setting the fault number for fault response** Selection of the faults for which the fault response applies
p2101	**Setting, fault response** Setting the fault response for the selected fault
You can change the acknowledgement type for up to 20 different fault codes:	
p2126	**Setting the fault number for the acknowledgement mode** Selection of the faults for which the acknowledgement type should be changed
p2127	**Setting, acknowledgement mode** Setting the acknowledgement type for the selected fault 1: Can only be acknowledged using POWER ON 2: IMMEDIATE acknowledgement after removing the fault cause
You can change up to 20 different faults into an alarm or suppress faults:	
p2118	**Setting the message number for the message type** Selection of the message for which the message type should be changed
p2119	**Setting the message type** Setting the message type for the selected fault 1: Fault 2: Alarm 3: No message

You will find details in function diagram 8075 and in the parameter description of the List Manual.

11.3 Status LED overview

LED status indicators

The Control Unit has number of dual-colour LEDs which are designed to indicate the operational state of the Inverter. The LEDs are used to indicate the status of the following states:

- General fault conditions
- Communication status
- Input and Output status
- Safety-Integrated status

The location of the various LEDs on the Control Unit are shown in the figure below.

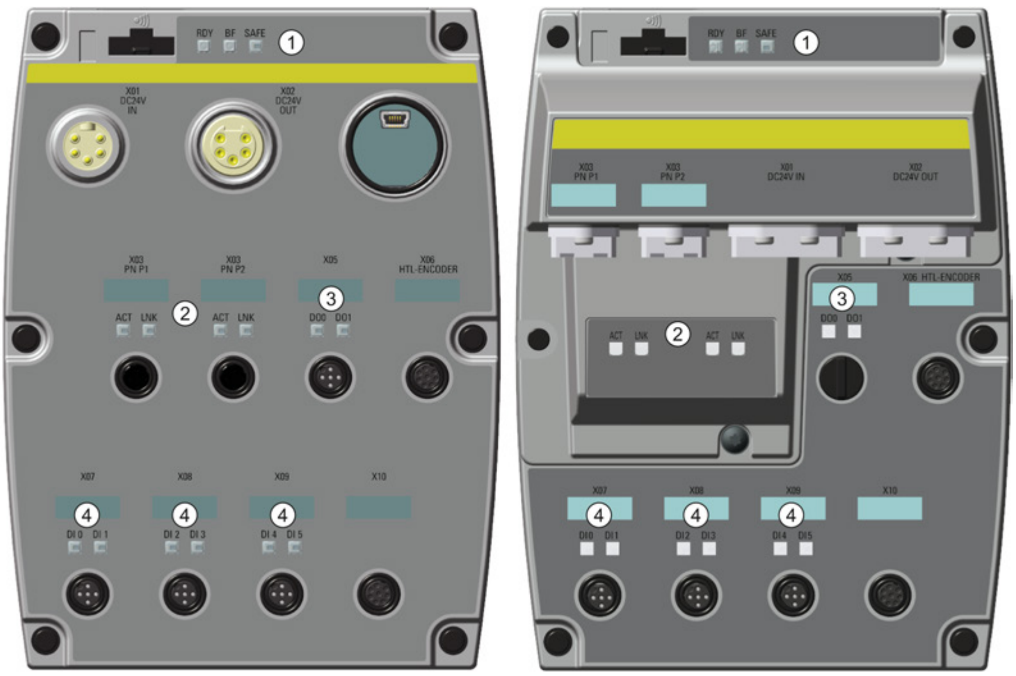
Status LEDs

① General

② PROFINET

③ Digital Output

④ Digital Inputs



CU240D-2 (PROFINET) CU250D-2 (PROFINET)

Figure 11-9 Status LED locations

Explanation of status LEDs

An explanation of the various states indicated by the LEDs are given in the tables below.

Table 11- 1 Description of general status LEDS

LED		Description of function
RDY	BF	
GREEN - On	-	Ready for operation (no active fault)
GREEN - flashing slowly	-	Commissioning or reset of factory settings
RED - on	Off	Firmware update in progress
RED - flashing slowly	RED - flashing slowly	Firmware updated is complete - power ON reset required
RED - flashing quickly	-	General fault condition
RED - flashing quickly	RED - On	Fault occurred during firmware update
RED - flashing quickly	RED - flashing quickly	Incompatible firmware or incorrect memory card

Table 11- 2 Description of PROFIBUS communications LED

BF LED	Description of function
Off	Cyclic data exchange (or PROFIBUS not in use - p2030 = 0)
RED - flashing slowly	Bus fault - configuration fault
RED - flashing quickly	Bus fault: - no data exchange - baud rate search - cannot detect the correct baud rate - no connection - the connection between the Inverter and PLC has been lost

Table 11- 3 Description of SAFE LED

SAFE LED	Description of function
YELLOW - On	One or more safety functions are enabled - but not active
YELLOW - flashing slowly	One or more safety functions are active - no safety function faults have occurred.
YELLOW - flashing quickly	The Inverter has detected a safety function fault and initiated a stop response.

Table 11- 4 Description of PROFINET communications LEDS

LED		Description of function
ACT	LNK	
On/flashing	On	Link active and data transfer active if flashing
Off	Off	Link inactive with no data transfer

Table 11- 5 Description of Digital Input and Output LEDs

DI / DO LED	Description of function
On	Input/Output connected and working
Off	Input/Output not connected or has stopped working

11.4 System runtime

By evaluating the system runtime of the inverter, you can decide whether you must replace components subject to wear such as fans, motors and gear units.

Principle of operation

The system runtime is started as soon as the Control Unit power supply is switched-on. The system runtime stops when the Control Unit is switched off.

The system runtime comprises r2114[0] (milliseconds) and r2114[1] (days):

System runtime = r2114[1] × days + r2114[0] × milliseconds

If r2114[0] has reached a value of 86,400,000 ms (24 hours), r2114[0] is set to the value 0 and the value of r2114[1] is increased by 1.

Using system runtime, you can track the sequence of faults and alarms over time. When a corresponding message is triggered, parameter values r2114 are transferred unchanged to the corresponding parameters of the alarm or fault buffer, see chapter entitled Alarms, faults and system messages (Page 287).

Parameters	Description
r2114[0]	System runtime (ms)
r2114[1]	System runtime (days)

You cannot reset the system runtime.

11.5 List of alarms and faults

Axxxxx Alarm

Fyyyyy: Fault

Table 11- 6 Faults, which can only be acknowledged by switching the converter off and on again (power on reset)

Number	Cause	Remedy
F01000	Software fault in CU	Replace CU.
F01001	Floating Point Exception	Switch CU off and on again.
F01015	Software fault in CU	Upgrade firmware or contact technical support.
F01018	Power-up aborted more than once	After this fault is output, the converter powers up with the factory settings. Remedy: Back up factory setting with p0971=1. Switch CU off and on again. Recommission the converter.
F01040	Parameters must be saved	Save parameters (p0971). Switch CU off and on again.
F01044	Loading of memory data card defective	Replace memory card or CU.
F01105	CU: Insufficient memory	Reduce number of data records.
F01205	CU: Time slice overflow	Contact technical support.
F01250	CU hardware fault	Replace CU.
F01512	An attempt has been made to establish an conversion factor for scaling which is not present	Create scaling or check transfer value.
F01662	CU hardware fault	Switch CU off and on again, upgrade firmware, or contact technical support.
F30022	Power Module: Monitoring U_{CE}	Check or replace the Power Module.
F30052	Incorrect Power Module data	Replace Power Module or upgrade CU firmware.
F30053	Error in FPGA data	Replace the Power Module.
F30662	CU hardware fault	Switch CU off and on again, upgrade firmware, or contact technical support.
F30664	CU power up aborted	Switch CU off and on again, upgrade firmware, or contact technical support.
F30850	Software fault in Power Module	Replace Power Module or contact technical support.

Table 11- 7 The most important alarms and faults of the safety functions

<table>
<tr><th>Number</th><th>Cause</th><th colspan="2">Remedy</th></tr>
<tr><td>F01600</td><td>STOP A Triggered</td><td colspan="2">STO Select and then deselect again.</td></tr>
<tr><td>F01650</td><td>Acceptance test required</td><td colspan="2">Carry out acceptance test and create test certificate.
Switch the Control Unit off and then on again.</td></tr>
<tr><td rowspan="5">F01659</td><td rowspan="5">Write task for parameter rejected</td><td colspan="2">Cause: The converter should be reset to the factory setting. The resetting of the safety functions is, however, not allowed, because the safety functions are currently enabled.
Remedy with operator panel:</td></tr>
<tr><td>p0010 = 30</td><td>Parameter reset</td></tr>
<tr><td>p9761 = …</td><td>Enter password for the safety functions.</td></tr>
<tr><td>p0970 = 5</td><td>Reset Start Safety Parameter.
The converter sets p0970 = 5 if it has reset the parameters.</td></tr>
<tr><td colspan="2">Then reset the converter to the factory setting again.</td></tr>
<tr><td>A01666</td><td>Static 1 signal atF-DI for safe acknowledgment</td><td colspan="2">F-DI to a logical 0 signal.</td></tr>
<tr><td>A01698</td><td>Commissioning mode active for safety functions</td><td colspan="2">This message is withdrawn after the Safety commissioning has ended.</td></tr>
<tr><td>A01699</td><td>Shutdown path test required</td><td colspan="2">After the next time that the "STO" function is deselected, the message is withdrawn and the monitoring time is reset.</td></tr>
<tr><td>F30600</td><td>STOP A Triggered</td><td colspan="2">STO Select and then deselect again.</td></tr>
</table>

Table 11- 8 The most important alarms and faults

Number	Cause	Remedy
F01018	Power-up aborted more than once	1. Switch the module off and on again. 2. After this fault has been output, the module is booted with the factory settings. 3. Recommission the converter.
A01028	Configuration error	Explanation: Parameterization on the memory card has been created with a different type of module (order number, MLFB). Check the module parameters and recommission if necessary.
F01033	Unit switchover: Reference parameter value invalid	Set the value of the reference parameter not equal to 0.0 (p0304, p0305, p0310, p0596, p2000, p2001, p2002, p2003, r2004).
F01034	Unit switchover: Calculation of the parameter values after reference value change unsuccessful	Select the value of the reference parameter so that the parameters involved can be calculated in the per unit notation (p0304, p0305, p0310, p0596, p2000, p2001, p2002, p2003, r2004).
F01122	Frequency at the probe input too high	Reduce the frequency of the pulses at the probe input.
A01590	Motor maintenance interval lapsed	Carry out maintenance and reset the maintenance interval (p0651).
A01900	PROFIBUS: Configuration telegram faulty	Explanation: A PROFIBUS master is attempting to establish a connection with a faulty configuration telegram. Check the bus configuration on the master and slave side.

Number	Cause	Remedy
A01910 F01910	Setpoint timeout	The alarm is generated when p2040 ≠ 0 ms and one of the following causes is present: • The bus connection is interrupted • The MODBUS master is switched off • Communications error (CRC, parity bit, logical error) • An excessively low value for the fieldbus monitoring time (p2040)
A01920	PROFIBUS: Cyclic connection interrupt	Explanation: The cyclic connection to PROFIBUS master is interrupted. Establish the PROFIBUS connection and activate the PROFIBUS master with cyclic operation.
A03520	Temperature sensor fault	Check that the sensor is connected correctly.
A05000 A05001 A05002 A05004 A05006	Power Module overtemperature	Check the following: - Is the ambient temperature within the defined limit values? - Are the load conditions and duty cycle configured accordingly? - Has the cooling failed?
F06310	Supply voltage (p0210) incorrectly parameterized	Check the parameterized supply voltage and if required change (p0210). Check the line voltage.
F07011	Motor overtemperature	Reduce the motor load. Check ambient temperature. Check the wiring and connection of the sensor.
A07012	I2t Motor Module overtemperature	Check and if necessary reduce the motor load. Check the motor's ambient temperature. Check thermal time constant p0611. Check overtemperature fault threshold p0605.
A07015	Motor temperature sensor alarm	Check that the sensor is connected correctly. Check the parameter assignment (p0601).
F07016	Motor temperature sensor fault	Make sure that the sensor is connected correctly. Check the parameterization (p0601). Deactivate the temperature sensor fault (p0607 = 0).
F07086 F07088	Unit switchover: Parameter limit violation	Check the adapted parameter values and if required correct.
F07320	Automatic restart aborted	Increase the number of restart attempts (p1211). The actual number of start attempts is shown in r1214. Increase the wait time in p1212 and/or monitoring time in p1213. Connect an ON command (p0840). Increase the monitoring time of the power unit or switch off (p0857). Reduce the wait time for resetting the fault counter p1213[1] so that fewer faults are registered in the time interval.
A07321	Automatic restart active	Explanation: The automatic restart (AR) is active. During voltage recovery and/or when remedying the causes of pending faults, the drive is automatically switched back on.
F07330	Search current measured too low	Increase search current (p1202), check motor connection.

Number	Cause	Remedy
A07400	V_{DC_max} controller active	If it is not desirable that the controller intervenes: • Increase the ramp-down times. • Deactivate the V_{DC_max} controller (p1240 = 0 for vector control, p1280 = 0 for U/f control).
A07409	U/f control, current limiting controller active	The alarm automatically disappears after one of the following measures: • Increase the current limit (p0640). • Reduce the load. • Slow down the up ramp for the setpoint speed.
A07441	Backup the position offset of the absolute encoder adjustment	This alarm automatically disappears after the offset has been saved.
F07443	Reference point coordinate not in the permissible range	Set the reference point coordinate to a lower value than specified in the fault value r0949 (interpret decimal).
F07450	Standstill monitoring has responded	After the standstill monitoring time (p2543) has expired, the drive has left the standstill window (p2542). Check whether the following is set correctly: • Position actual value inversion (p0410) • Standstill window too small (p2542)? • Standstill monitoring time too short (p2543)? • Position loop gain too low (p2538)? • Position loop gain too high (instability/oscillatory behavior, p2538)? • Mechanical overload? Other possible causes: • Connecting cable, motor/drive converter incorrect (phase missing, interchanged). • When selecting motor identification, select tracking mode (BI: p2655[0] = 1 signal).
F07451	Position monitoring has responded	When the positioning monitoring time expired (p2545), the drive had still not reached the positioning window (p2544). Check whether the following is set correctly: • Positioning window too small (p2544)? • Positioning monitoring time too short (p2545)? • Position loop gain too low (p2538)? • Position loop gain too high (instability/oscillatory behavior, p2538)? Another possible cause: Mechanical clamping.
F07452	Following error too high	The difference between the position setpoint and the actual position value (following error dynamic model, r2563) is higher than the tolerance (p2546). Possible causes: • The drive torque or accelerating capacity has been exceeded. • Position measuring system fault. • Position control sense is not correct. • Mechanical system locked. • Excessively high traversing velocity or excessively high position setpoint differences.

Number	Cause	Remedy
F07453	Position actual value processing error	Check the encoder for the actual position value processing.
A07454	Position actual value processing does not have a valid encoder	Check whether one of the following causes exists: • An encoder is not assigned for the position actual value processing (p2502 = 0). • An encoder is assigned, but no encoder data set has been assigned (p0187 = 99 or p0188 = 99 or p0189 = 99). • An encoder and an encoder data set have been assigned, however, the encoder data set does not contain any encoder data (p0400 = 0) or invalid data (e.g. p0408 = 0).
A07455	Maximum velocity limited	The maximum velocity (p2571) is too high to correctly calculate the modulo correction. Remedy: • Reduce the maximum velocity (p2571). • Increase the sampling time for positioning (p0115[5]).
A07456	Setpoint velocity limited	The actual setpoint velocity is greater than the parameterized maximum velocity (p2571), and is therefore limited. Remedy: • Check the entered setpoint velocity. • Reduce the velocity override (CI: p2646). • Increase the maximum velocity (p2571).
A07457	Combination of input signals is not permissible	An illegal combination of input signals, which are simultaneously set was detected, e.g.: • Jog 1 and jog 2 (p2589, p2590). • Jog 1 or jog 2 and direct setpoint input/MDI (p2589, p2590, p2647). • Jog 1 or jog 2 and start referencing (p2589, p2590, p2595). • Jog 1 or jog 2 and activate traversing task (p2589, p2590, p2631). • Direct setpoint input/MDI and start referencing (p2647, p2595). • Direct setpoint input/MDI and activate traversing task (p2647, p2631). • Start referencing and activate traversing task (p2595, p2631).
F07458	Reference cam not found	After starting the reference point approach, the axis has traversed through the maximum permissible distance to search for the reference cam without finding the reference cam. Remedy: • Check the "reference cam" binector input (BI: p2612). • Check the maximum permissible distance to the reference cam (p2606). • If axis does not have a reference cam, then set p2607 to 0.
F07459	No zero mark available	After leaving the reference cam, the axis traversed through the maximum permissible distance between the reference cam and zero mark without finding the zero mark. Remedy: • Check the encoder regarding the zero mark. • Check the maximum permissible distance between the reference cam and zero mark (p2609). • Use an external encoder zero mark (p0494).

Number	Cause	Remedy
F07460	End of reference cam not found	During the reference point approach, the axis, when approaching the zero mark, has reached the end of the traversing range without identifying an edge at the binector input "Reference cam" (BI: p2612). Remedy: • Check the "reference cam" binector input (BI: p2612).
A07461	Reference point not set	Reference the system
A07462	Selected traversing block number does not exist	Correct the traversing program.
A07463	External block change not requested in the traversing block	Resolve the reason why the edge is missing at binector input (BI: p2632).
F07464	Traversing block is inconsistent	Check the traversing block and, if necessary, take into consideration any alarms that are present.
A07465	Traversing block does not have a subsequent block	• Parameterize this traversing block with the step enabling condition END. • Parameterize additional traversing blocks with a higher block number and for the last block, parameterize the step enabling condition END.
A07466	Traversing block number assigned a multiple number of times	Correct the traversing blocks.
A07467	Traversing block has illegal task parameters	Correct the task parameter in the traversing block.
A07468	Traversing block jump target does not exist	• Correct the traversing block. • Add the missing traversing block.
A07469	Traversing block target position < software limit switch minus	• Correct the traversing block. • Change the software limit switch minus (CI: p2578, p2580). • Change the software limit switch plus (CI: p2579, p2581).
A07470	Traversing block target position > software limit switch plus	
A07471	Traversing block target position outside the modulo range	• Correct the target position in the traversing block. • Change the modulo range (p2576).
A07472	Traversing block ABS_POS/ABS_NEG not possible	Correct the traversing block.
A07473	Beginning of traversing range reached	Move away in the positive direction.
A07474	End of traversing range reached	Move away in the negative direction.
F07475	Target position < start of traversing range	Correct the target position.
F07476	Target position > end of traversing range	
A07477	Target position < software limit switch minus	• Correct the target position. • Change the software limit switch minus (CI: p2578, p2580). • Change the software limit switch plus (CI: p2579, p2581).
A07478	Target position > software limit switch plus	
A07479	Software limit switch, minus actuated	• Correct the target position. • Change the software limit switch minus (CI: p2578, p2580). • Change the software limit switch plus (CI: p2579, p2581).
A07480	Software limit switch, plus actuated	

Number	Cause	Remedy
F07481	Axis position < software limit switch minus	• Correct the target position. • Change the software limit switch minus (CI: p2578, p2580). • Change the software limit switch plus (CI: p2579, p2581).
F07482	Axis position > software limit switch plus	
A07483	Travel to fixed stop, clamping torque not reached	• Check the maximum torque-generating current (r1533). • Check the torque limits (p1520, p1521). • Check the power limits (p1530, p1531).
F07484	Fixed stop outside the monitoring window	In the "Fixed stop reached" state, the axis has moved outside the defined monitoring window (p2635). Remedy: • Check the monitoring window (p2635). • Check the mechanical system.
F07485	Fixed stop is not reached	In a traversing block with the FIXED STOP task the end position was reached without detecting a fixed stop. Remedy: • Check the traversing block and locate the target position further into the workpiece. • Check the "fixed stop reached" control signal (p2637). • Reduce the maximum following error window to detect the fixed stop (p2634).
A07486	Intermediate stop missing	Connect a "1" signal at the binector input "no intermediate stop/intermediate stop" (BI: p2640) and re-start motion.
A07487	Reject traversing task missing	Connect a "1" signal at the binector input "do not reject traversing task/reject traversing task" (BI: p2641) and re-start motion.
F07488	Relative positioning not possible	In the mode "direct setpoint input/MDI", for the continuous transfer (p2649 = 1), relative positioning was selected (BI: p2648 = 0 signal). Correct the selection.
A07489	Reference point offset outside window	For the function "flying referencing", the difference between the measured position at the measuring probe and the reference point coordinate is outside the parameterized window. Remedy: • Check the mechanical system. • Check the parameterization of the window (p2602).
F07490	Enable signal withdrawn while traversing	Set the enable signals.
F07491	STOP cam, minus actuated	Leave the STOP cam minus in the positive traversing direction and retract the axis to the valid traversing range.
F07492	STOP cam, plus actuated	Leave the STOP cam plus in the negative traversing direction and retract the axis to the valid traversing range.
F07493	Overflow of the value range for the position actual value	The value range (-2147483648 ... 2147483647) for representing the position actual value was exceeded. Remedy: If necessary reduce the traversing range or position resolution (p2506).
A07495	Reference function interrupted	An activated reference function (reference mark search or measuring probe evaluation) was interrupted. Possible causes: • Encoder fault • Reference mark search and measuring probe evaluation simultaneously activated (BI: p2508 and BI: p2509 = 1 signal). • Activated reference function (reference mark search or measuring probe

Number	Cause	Remedy
		evaluation) was de-activated (BI: p2508 and BI: p2509 = 0 signal).
A07496	Enable is not possible	It is not possible to enable the basic positioner as at least one signal is missing. Causes: • EPOS enable missing (BI: p2656). • Position actual value, valid feedback signal missing (BI: p2658).
F07499	Reversing cam approached with the incorrect traversing direction	Check the wiring of the reversing cam (BI: p2613, BI: p2614).
F07503	STOP cam approached with the incorrect traversing direction	Check the wiring of the STOP cam (BI: p2569, BI: p2570).
A07505	Fixed stop task for U/f/SLVC operation not possible	Change the open-loop/closed-loop control mode (p1300).
A07557 A07558	Reference point coordinate not in the permissible range	The received reference point coordinate when adjusting the encoder via connector input CI: p2599 lies outside half of the encoder range and cannot be set as actual axis position. Remedy: Correct reference point coordinate.
A07577 A07578	Measuring probe evaluation not possible	• Set the input terminal for the measuring probe (p0488, p0489 or p2517, p2518). • Reduce the frequency of the measuring pulses at the measuring probe.
A07581 A07582	Position actual value processing error	Check the encoder for the actual position value processing.
A07584 A07585	Position setting value activated	The alarm automatically disappears with BI: p2514 = 0 signal.
A07587 A07588	Position actual value processing does not have a valid encoder	An encoder data set has been assigned, however, the encoder data set does not contain any encoder data (p0400 = 0) or invalid data (e.g. p0408 = 0). Remedy: Check the drive data sets and encoder data sets.
A07593 A07594	Value range for position actual value exceeded	The value range (-2147483648 ... 2147483647) for representing the position actual value was exceeded. Remedy: Reduce the traversing range or position resolution. If required, reduce the traversing range or position resolution.
A07596 A07597	Reference function interrupted	An activated reference function (reference mark search or measuring probe evaluation) was interrupted. Possible causes: • Encoder fault • Reference mark search and measuring probe evaluation simultaneously activated (BI: p2508 and BI: p2509 = 1 signal). • Activated reference function (reference mark search or measuring probe evaluation) was de-activated (BI: p2508 and BI: p2509 = 0 signal).
F07599 F07600	Adjustment not possible	The maximum encoder value times the factor to convert the absolute position (r0483 and/or r2723) from increments to length units (LU) has exceeded the value range (-2147483648 ... 2147483647) for representing the position actual value.
F07801	Motor overcurrent	Check current limits (p0640). Vector control: Check current controller (p1715, p1717). U/f control: Check the current limiting controller (p1340 … p1346). Increase acceleration ramp (p1120) or reduce load. Check motor and motor cables for short circuit and ground fault. Check motor for star-delta connection and rating plate parameterization. Check power unit / motor combination.

Number	Cause	Remedy
		Select flying restart function (p1200) if switched to rotating motor.
A07805	Drive: Power unit overload I2t	• Reduce the continuous load. • Adapt the load cycle. • Check the assignment of rated currents of the motor and power unit.
F07806	Regenerative power limit exceeded	Increase deceleration ramp. Reduce driving load. Use power unit with higher energy recovery capability. For vector control, the regenerative power limit in p1531 can be reduced until the fault is no longer activated.
F07807	Short circuit detected	• Check the converter connection on the motor side for any phase-phase short-circuit. • Rule out that line and motor cables have been interchanged.
A07850 A07851 A07852	External alarm 1 … 3	The signal for "external alarm 1" has been triggered. Parameters p2112, p2116 and p2117 determine the signal sources for the external alarm 1… 3. Remedy: Rectify the cause of these alarms.
F07860 F07861 F07862	External fault 1 … 3	Remove the external causes for these faults.
F07900	Motor blocked	Check that the motor can run freely. Check the torque limits (r1538 and r1539). Check the parameters of the "Motor blocked" message (p2175, p2177).
F07901	Motor overspeed	Activate precontrol of the speed limiting controller (p1401 bit 7 = 1). Increase hysteresis for overspeed signal p2162.
F07902	Motor stalled	Check whether the motor data has been parameterized correctly and perform motor identification. Check the current limits (p0640, r0067, r0289). If the current limits are too low, the drive cannot be magnetized. Check whether motor cables are disconnected during operation.
A07903	Motor speed deviation	Increase p2163 and/or p2166. Increase the torque, current and power limits.
A07910	Motor overtemperature	Check the motor load. Check the motor's ambient temperature. Check the KTY84 sensor. Check the overtemperatures of the thermal model (p0626 ... p0628).
A07920	Torque/speed too low	The torque deviates from the torque/speed envelope curve. • Check the connection between the motor and the load. • Adapt the parameterization corresponding to the load.
A07921	Torque/speed too high	
A07922	Torque/speed out of tolerance	
F07923	Torque/speed too low	• Check the connection between the motor and the load. • Adapt the parameterization corresponding to the load.
F07924	Torque/speed too high	
A07927	DC braking active	Not required
A07975	Traverse to the zero mark - setpoint input expected	The alarm disappears when the zero mark is detected.

Number	Cause	Remedy
A07980	Rotary measurement activated	Not required
A07981	No enabling for rotary measurement	Acknowledge pending faults. Establish missing enables (see r00002, r0046).
A07991	Motor data identification activated	Switch on the motor and identify the motor data.
F08501	Setpoint timeout	• Check the PROFINET connection. • Set the controller to RUN mode. • If the error occurs repeatedly, check the monitoring time set (p2044).
F08502	Monitoring time, sign-of-life expired	• Check the PROFINET connection.
F08510	Send configuration data not valid	• Check the PROFINET configuration
A08511	Receive configuration data not valid	
A08526	No cyclic connection	• Activate the controller with cyclic operation. • Check the parameters "Name of Station" and "IP of Station" (r61000, r61001).
A08565	Consistency error for adjustable parameters	Check the following: • IP address, subnet mask or default gateway is not correct. • IP address or station name used twice in the network. • Station name contains invalid characters.
F08700	Communications error	A CAN communications error has occurred. Check the following: • Bus cable. • Baud rate (p8622). • Bit timing (p8623). • Master Start the CAN controller manually with p8608 = 1 after the cause of the fault has been resolved!
F13100	Know-how protection: Copy protection error	The know-how protection and the copy protection for the memory card are active. An error occurred when checking the memory card. • Insert a suitable memory card and switch the converter supply voltage temporarily off and then on again (POWER ON). • Deactivate the copy protection (p7765).
F13101	Know-how protection: Copy protection cannot be activated	Insert a valid memory card.
F30001	Overcurrent	Check the following: • Motor data, if required, carry out commissioning • Motor connection method (Y / Δ) • U/f operation: Assignment of rated currents of motor and Power Module • Line quality • Make sure that the line commutating reactor is connected properly • Power cable connections • Power cables for short-circuit or ground fault

Number	Cause	Remedy
		• Power cable length • Line phases If this doesn't help: • U/f operation: Increase the acceleration ramp • Reduce the load • Replace the power unit
F30002	DC-link voltage overvoltage	Increase the ramp-down time (p1121). Set the rounding times (p1130, p1136). Activate the DC link voltage controller (p1240, p1280). Check the line voltage (p0210). Check the line phases.
F30003	DC-link voltage undervoltage	Check the line voltage (p0210).
F30004	Converter overtemperature	Check whether the converter fan is running. Check whether the ambient temperature is in the permissible range. Check whether the motor is overloaded. Reduce the pulse frequency.
F30005	I2t converter overload	Check the rated currents of the motor and Power Module. Reduce current limit p0640. When operating with U/f characteristic: Reduce p1341.
F30011	Line phase failure	Check the converter's input fuses. Check the motor cables.
F30015	Motor cable phase failure	Check the motor cables. Increase the ramp-up or ramp-down time (p1120).
F30021	Ground fault	• Check the power cable connections. • Check the motor. • Check the current transformer. • Check the cables and contacts of the brake connection (a wire might be broken).
F30027	Time monitoring for DC link pre-charging	Check the supply voltage at the input terminals. Check the line voltage setting (p0210).
F30035	Overtemperature, intake air	• Check whether the fan is running. • Check the fan filter elements. • Check whether the ambient temperature is in the permissible range.
F30036	Overtemperature, inside area	
F30037	Rectifier overtemperature	See F30035 and, in addition: • Check the motor load. • Check the line phases
A30049	Internal fan defective	Check the internal fan and if required replace.
F30059	Internal fan defective	Check the internal fan and if required replace.
A30502	DC link overvoltage	• Check the unit supply voltage (p0210). • Check the dimensioning of the line reactor.
A30920	Temperature sensor fault	Check that the sensor is connected correctly.

Number	Cause	Remedy
F31100	Zero mark distance error	The measured zero mark distance does not correspond to the parameterized zero mark distance. Remedy: • Check that the encoder cables are routed in compliance with EMC. • Check the cable connections. • Check the encoder type (encoder with equidistant zero marks). • Adapt the parameters for the distance between zero marks (p0424, p0425). • For a signal output above a speed threshold, reduce the filter time (p0438).
F31101	Zero mark failed	
F31118	Speed difference outside tolerance	For an HTL/TTL encoder, the speed difference has exceeded the value in p0492 over several sampling cycles. • Check tachometer feeder cable for interruptions. • Check the grounding of the tachometer shielding. • Increase the maximum speed difference per sampling cycle (p0492).
A31418	Speed difference per sampling rate exceeded	
F31905	Parameterizing error	Check whether the connected encoder type matches the encoder that has been parameterized.
A31915	Configuration error	When the fine resolution Gx_XIST2 is configured, the encoder identifies a maximum possible absolute position actual value (r0483) that can no longer be represented within 32 bits. Remedy: Check the encoder data.
F32110	Serial communications error	The transfer of the serial communication protocol between the encoder and converter is faulty. Remedy: Check the hardware and the associated settings in the converter.
F32111 F32112	Absolute encoder internal error	• Check the power supply of the encoder. • Replace the encoder.
A32410	Serial communication	• Check that the encoder cables are routed in compliance with EMC. • Check the cable connections. • Replace the encoder.
A32411	Absolute encoder outputs alarms	Replace the encoder.
A32412	Error bit set in the serial protocol	• Carry out a power on reset (power off/on) for all components. • Check that the encoder cables are routed in compliance with EMC. • Check the plug connections. • Replace the encoder
A32442	Battery voltage pre-alarm	Replace the battery in the encoder.
F32905	Parameterizing error	• Check whether the connected encoder type matches the encoder that has been parameterized. • Correct the parameter specified by the fault value (r0949) and p0187.
A32915	Configuration error	When the fine resolution Gx_XIST2 is configured, the encoder identifies a maximum possible absolute position actual value (r0483) that can no longer be represented within 32 bits. Remedy: Check the encoder data.

For further information, please refer to the List Manual.

Technical data 12

12.1 Performance ratings Control Unit

Table 12- 1 Control Unit performance ratings

Feature	Specification
Operating voltage	24 V DC External supply 24 V DC ± 15% Use a power supply with protective extra-low-voltage (PELV = Protective Extra Low Voltage acc. to EN 61800-5-1): 0 V of the power supply has to be connected with low resistance to the PE of the plant.
Setpoint resolution	0.01 Hz digital; 0.01 Hz serial
Digital inputs	6 programmable digital inputs; PNP, SIMATIC-compatible, low < 5 V, high > 10 V, maximum input voltage 30 V
Digital outputs	2 programmable, 24 V DC / 0 A …0.5 A (resistive). The maximum current output is 0.5 A in total when using both or a single digital output. Update time of all DO: 2 ms
Encoder interfaces	• HTL bipolar, ≤ 2048 pulses, ≤ 100 mA, e. g. SIEMENS encoders 1XP8001-1, 1XP80X2-1X. • SSI interface. See also Encoders examples (Page 332). • Max. cable length: 30 m shielded
Temperature sensor	• PTC: Short-circuit monitoring 22 Ω, switching threshold 1650 Ω • KTY84 • Temperature sensor with dry contact
Fail-safe input	• DI 4 and DI 5 form the fail-safe digital input. • Maximum input voltage 30 V, 5.5 mA • Response time: – Typical: 5 ms + debounce time p9651 – Typical, if debounce time = 0: 6 ms – Worst-case scenario: 15 ms + debounce time – Worst case, if debounce time = 0: 16 ms • You will find the extended function data in the Safety Integrated Function Manual.
PFH	5 × 10E-8 Probability of failure of the fail-safe functions (Probability of Failure per Hour)
USB interface	Mini-B (not available on the push-pull variants of the control unit)

12.2 Performance ratings Power Module

Table 12- 2 Power Module performance ratings

Feature	Specification
Line voltage & power ranges	3 AC 380 V … 500 V ± 10 %
	High Overload: 0.75 kW … 7.5 kW (1.0 hp … 10.0 hp)
Line specification	Relative short-circuit voltage of a transformer u_k ≤ 1% The specification only refers to the total instantaneous regenerative feedback, however not to the total connected power of all of the power modules connected to the same transformer. Further information: FAQ (http://support.automation.siemens.com/WW/view/en/34189181).
Output voltage	3 AC 0 V … line volage × 0.87 (max.)
Input frequency	47 Hz … 63 Hz
Output frequency	0 Hz … 650 Hz
cos φ	0.95
Inverter efficiency	95 % … 97 %
Overload capability (HO)	2 x Nominal output current for 3 seconds followed by 1.5 x Nominal output current for 57 seconds every 300 seconds
Inrush current	Less than rated input current
Pulse frequency	4 kHz (standard); 4 kHz … 16 kHz (in 2 kHz steps)
Electromagnetic compatibility	Internal Class A filters according to EN 55011
Protection level	IP65 (when Power Module and Control Unit is fully assembled)
Temperature range	Standard CU: -10 °C … +40 °C (14 °F … 104 °F) - High Overload (HO)
	Fail-Safe CU: 0 °C … +40 °C (32 °F … 104 °F) - High Overload (HO)
Storage temperature	-40 °C … +70 °C (-40 °F … 158 °F)
Humidity	< 95% RH - non-condensing
Operational altitude	Up to 1000 m (3280 ft) above sea level without derating
Protection features	Undervoltage, Overvoltage, Overload, Ground faults, Short circuit, Stall prevention, Motor blocking protection, Motor overtemperature, Power Module overtemperature, Parameter interlock
Standards	UL, cUL, CE, C-tick
CE mark	Conformity with EC Low Voltage Directive 73/23/EEC and filtered versions also Electromagnetic Compatibility Directive 89/336/EEC
EM Brake	180 V DC (400 V half-wave rectified) 1 A maximum

12.3 SINAMICS G120D specifications

Power Module Specifications

Note

UL certified Fuses must be used

In order that the system is in compliance with UL requirements, UL listed class H, J or K fuses, circuit breakers or self-protected combination motor-controllers must be used.

Table 12- 3 Power Module Frame Sizes A and B, 3 AC 380 V … 500 V, ± 10 %

Order No.	6SL3525 -	0PE17-5AA1	0PE21-5AA1	0PE23-0AA1
Output Rating (HO)	[kW]	0.75	1.5	3
	[hp]	1	1.5	4
Output Power	[kVA]			
Rated Input Current	[A]	2.1	3.8	7.2
HO Output Current	[A]	2.2	4.1	7.7
Fuse	[A]	10	10	16
Weight (nett)	[kg]	5.5	5.5	8.5
	[lbs]	12.1	12.1	18.7
Weight (packed)	[kg]	6.5	6.5	9.5
	[lbs]	14.3	14.3	20.9

Table 12- 4 Power Module Frame Sizes C, 3 AC 380 V … 500 V, ± 10 %

Order No.	6SL3525 -	0PE24-0AA1	0PE25-5AA1	0PE27-5AA1
Output Rating (HO)	[kW]	4	5.5	7.5
	[hp]	5	7.5	10
Output Power	[kVA]			
Rated Input Current	[A]	9.5	12.2	17.7
HO Output Current	[A]	10.2	13.2	19
Fuse	[A]	20	20	32
Weight (nett)	[kg]	9.5	9.5	9.5
	[lbs]	20.9	20.9	20.9
Weight (packed)	[kg]	10.5	10.5	10.5
	[lbs]	23.1	23.1	23.1

12.4 Ambient operating conditions

Temperature

The operating temperature range is shown diagramatically in the figure below:

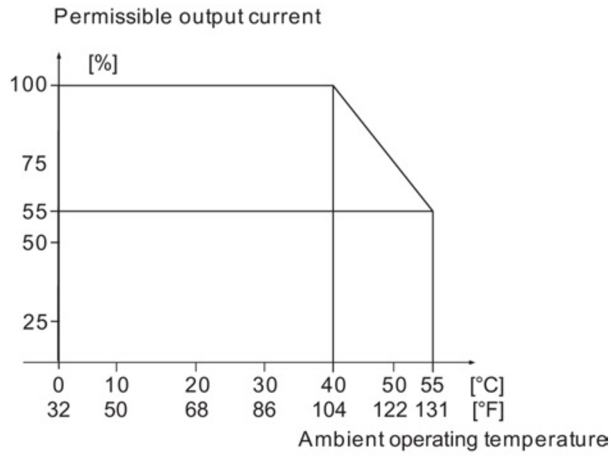


Figure 12-1 Power derating for temperature

Humidity range

Relative air humidity for the SINAMICS G120D is ≤ 95 % non-condensing.

Shock and vibration

Do not drop the SINAMICS G120D or expose to sudden shock. Do not install the SINAMICS G120D in an area where it is likely to be exposed to constant vibration.

Electromagnetic radiation

Do not install the SINAMICS G120D near sources of electromagnetic radiation.

Atmospheric pollution and water

When fully assembled the inverter has an IP65 rating. This means that the inverter is totally protected against dust and low pressure jets of water. Any unused connections should be covered with the correct sealing caps to ensure the IP65 rating.

12.5 Derating as a function of the installation altitude

Voltage

The clearance within the converter can isolate surge voltages in accordance with overvoltage category III in compliance with the EN 60664-1 regulation up to 2000 m above sea level.

At altitudes above 2000 m and below 4000 m above sea level, the converter has to be connected that at least one of the following conditions is fulfilled:

- It is connected to a TN-network with isolated star-point (not an external grounded connector)

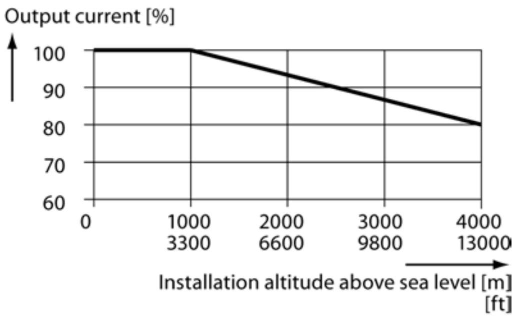
or

- it is connected through an isolating transformer that provides a TN-network with a grounded star-point.

A reduction of the line voltage is not necessary.

Note: The connected engines and power components must be considered separately.

Current



12.6 Pulse frequency and current reduction

Table 12- 5 Current reduction depending on pulse frequency

Power rating at 400 V	Frame size	Inverter current rating	Output current at pulse frequency of					
		at 4 kHz	6 kHz	8 kHz	10 kHz	12 kHz	14 kHz	16 kHz
kW		A	A	A	A	A	A	A
0.75	A	2.2	1.9	1.5	1.3	1.1	1.0	0.9
1.5	A	4.1	3.5	2.9	2.5	2.1	1.8	1.6
3	B	7.7	6.5	5.4	4.6	3.9	3.5	3.1
4	C	10.2	8.7	7.1	6.1	5.1	4.6	4.1
5.5	C	13.2	11.2	9.2	7.9	6.6	5.9	5.3
7.5	C	19	16.2	13.3	11.4	9.5	8.6	7.6

Appendix A

A.1 New and extended functions

A.1.1 Firmware version 4.5

Table A- 1 New functions and function changes in Firmware 4.5

	Function	SINAMICS					
			G120			G120D	
		G120C	CU230P-2	CU240B-2	CU240E-2	CU240D-2	CU250D-2
1	Support for the new power modules: • PM230 IP20 FSA … FSF • PM230 in a push-through FSA … FSC	-	✓	✓	✓	-	-
2	Support for the new power modules: • PM240-2 IP20 FSA • PM240-2 in push-through FSA	-	✓	✓	✓	-	-
3	New Control Units with PROFINET support	✓	✓	-	✓	✓	✓
4	Support of the PROFIenergy profile	✓	✓	-	✓	✓	✓
5	Shared device support via PROFINET	✓	✓	-	✓	✓	✓
6	Write protection	✓	✓	✓	✓	✓	✓
7	Know-how protection	✓	✓	✓	✓	✓	✓
8	Adding a second command data set (CDS0 → CDS0 … CDS1) (All other inverters have four command data sets)	✓	-	-	-	-	-
9	Position control and basic positioner	-	-	-	-	-	✓
10	Support of an HTL encoder	-	-	-	-	✓	✓
11	Support of an SSI encoder	-	-	-	-	-	✓
12	Fail-safe digital output	-	-	-	-	✓	✓

A.1.2 Firmware version 4.6

Table A- 2 New functions and function changes in Firmware 4.6

	Function	SINAMICS							
			G120					G120D	
		G120C	CU230P-2	CU240B-2	CU240E-2	CU250S-2 Vektor	CU250S-2 Servo	CU240D-2	CU250D-2
1	Support for the new Power Modules • PM240-2 IP20 FSB … FSC • PM240-2 in through-hole technology FSB ... FSC	-	✓	✓	✓	✓	✓	-	-
2	Support for the new Power Modules • PM230 in through-hole technology FSD ... FSF	-	✓	✓	✓	✓	-	-	-
3	Motor data preassignment for the 1LA/1LE motors via code number • During basic commissioning with the operator panel, set the motor data using a code number	✓	✓	✓	✓	✓	✓	✓	✓
4	Extension to communication via CANopen • CAN velocity, ProfilTorque, SDO channel for each axis, system test with CodeSys, suppression of ErrorPassiv alarm	✓	✓	-	-	✓	✓	-	-
5	Extension to communication via BACnet • Multistate value objects for alarms, commandable AO objects, objects for configuring the PID controller	-	✓	-	-	-	-	-	-
6	Communication via Ethernet/IP	✓	✓	-	✓	✓	✓	✓	✓
7	Skip frequency band for analog input • A symmetrical skip frequency band can be set for each analog input around the 0 V range.	✓	✓	✓	✓	✓	✓	✓	-
8	Changing the control of the motor holding brake	✓	-	✓	✓	✓	✓	✓	-
9	Safety function SBC (Safe Brake Control) • Secure control of a motor holding brake when using the "Safe Brake Module" option	-	-	-	-	✓	✓	-	-
10	Safety function SS1 (Safe Stop 1) without speed monitoring	-	-	-	-	✓	✓	-	-
11	Straightforward selection of standard motors • Selection of 1LA... and 1LE... motors with an operator panel using a list containing code numbers	✓	✓	✓	✓	✓	✓	✓	✓
12	Firmware update via memory card	✓	✓	✓	✓	✓	✓	✓	✓
13	Safety info channel • BICO source r9734.0...14 for the status bits of the extended safety functions	-	-	-	✓	✓	✓	✓	✓
14	Diagnostic alarms for PROFIBUS	✓	✓	✓	✓	✓	✓	✓	✓

A.2 Interconnect signals in the converter

A.2.1 Fundamentals

The following functions are implemented in the converter:

- Open-loop and closed-loop control functions
- Communication functions
- Diagnosis and operating functions

Every function comprises one or several blocks that are interconnected with one another.

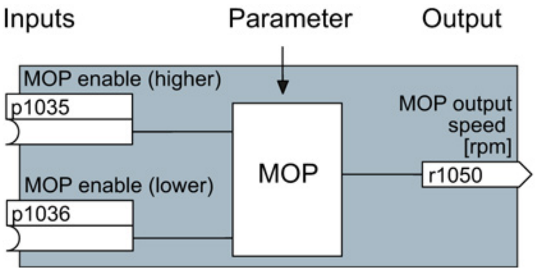


Figure A-1 Example of a block: Motorized potentiometer (MOP)

Most of the blocks can be adapted to specific applications using parameters.

You cannot change the signal interconnection within the block. However, the interconnection between blocks can be changed by interconnecting the inputs of a block with the appropriate outputs of another block.

The signal interconnection of the blocks is realized, contrary to electric circuitry, not using cables, but in the software.

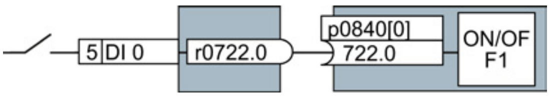


Figure A-2 Example: Signal interconnection of two blocks for digital input 0

Binectors and connectors

Connectors and binectors are used to exchange signals between the individual blocks:

- Connectors are used to interconnect "analog" signals. (e.g. MOP output speed)
- Binectors are used to interconnect "digital" signals. (e.g. 'Enable MOP up' command)

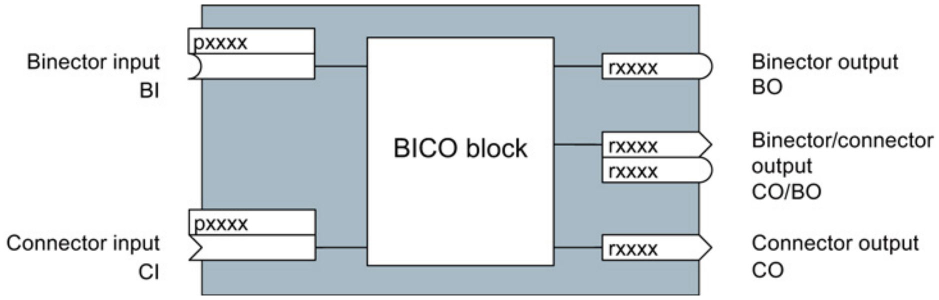


Figure A-3 Symbols for binector and connector inputs and outputs

Binector/connector outputs (CO/BO) are parameters that combine more than one binector output in a single word (e.g. r0052 CO/BO: status word 1). Each bit in the word represents a digital (binary) signal. This summary reduces the number of parameters and simplifies parameter assignment.

Binector or connector outputs (CO, BO or CO/BO) can be used more than once.

When must you interconnect signals in the converter?

If you change the signal interconnection in the converter, you can adapt the converter to a wide range of requirements. This does not necessarily have to involve highly complex functions.

Example 1: Assign a different function to a digital input.

Example 2: Switch the speed setpoint from the fixed speed to the analog input.

How much care is required when you change the signal interconnection?

Always take care when establishing internal signal interconnections. Note which changes you make as you go along since the process of analyzing them later can be quite difficult.

The STARTER commissioning tool offers signals in plain text and simplifies their interconnection.

Where can you find additional information?

- This manual is sufficient for simple signal interconnections (e.g. assigning a different function to digital inputs).
- The parameter list in the List Manual is sufficient for more complex signal interconnections.
- You can also refer to the function diagrams in the List Manual for complex signal interconnections.

A.2.2 Example

Example: Moving a basic control logic into the inverter

A conveyor system is to be configured in such a way that it can only start when two signals are present simultaneously. These could be the following signals, for example:

- The oil pump is running (the required pressure level is not reached, however, until after 5 seconds)
- The protective door is closed

To implement this task, you must insert free function blocks between digital input 0 and the command to switch on the motor (ON/OFF1).

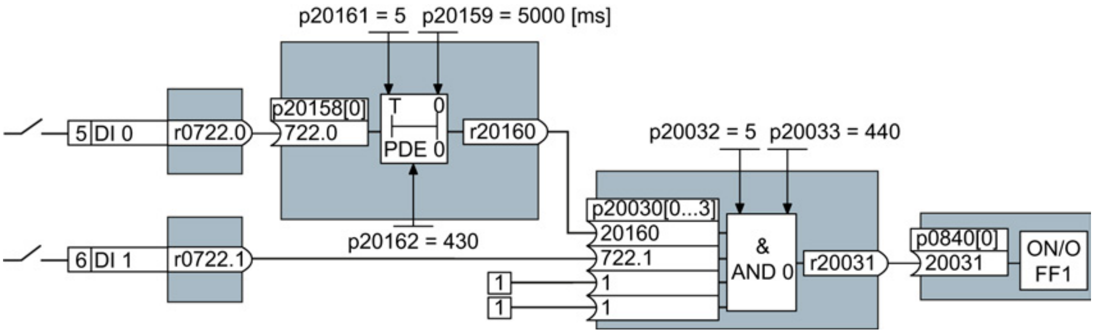


Figure A-4 Example: Signal interconnection for control logic

The signal of digital input 0 (DI 0) is fed through a time block (PDE 0) and is interconnected with the input of a logic block (AND 0). The signal of digital input 1 (DI 1) is interconnected to the second input of the logic block. The logic block output issues the ON/OFF1 command to switch-on the motor.

Setting the control logic

Parameter	Description
p20161 = 5	The time block is enabled by assigning to runtime group 5 (time slice of 128 ms)
p20162 = 430	Run sequence of the time block within runtime group 5 (processing before the AND logic block)
p20032 = 5	The AND logic block is enabled by assigning to runtime group 5 (time slice of 128 ms)
p20033 = 440	Run sequence of the AND logic block within runtime group 5 (processing after the time block)
p20159 = 5000.00	Setting the delay time [ms] of the time module: 5 seconds
p20158 = 722.0	Connect the status of DI 0 to the input of the time block r0722.0 = Parameter that displays the status of digital input 0.
p20030[0] = 20160	Interconnecting the time block to the 1st input of the AND
p20030[1] = 722.1	Interconnecting the status of DI 1 to the 2nd AND input r0722.1 = Parameter that displays the status of digital input 1.
p0840 = 20031	Interconnect the AND output to ON/OFF1

Explanation of the example using the ON/OFF1 command

Parameter p0840[0] is the input of the "ON/OFF1" block of the inverter. Parameter r20031 is the output of the AND block. To interconnect ON/OFF1 with the output of the AND block, set p0840 = 20031.

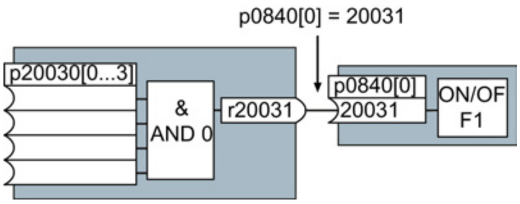


Figure A-5 Interconnecting blocks by setting p0840[0] = 20031

Principle for interconnecting blocks

Always interconnect the input (connector or binector input) with the signal source.

Note

For the basic commissioning, you determine the function of the interfaces for your converter via predefined settings (p0015).

If you subsequently select a different predefined setting for the function of the interfaces, then all interconnections that you changed will be lost.

A.3 Star-delta motor connection and application examples

Depending on your application, you can operate the motor in the star or delta connection (Y/Δ).

Examples for operating the converter and motor on a 400 V line supply

Assumption: The motor rating plate states 230/400 V Δ/Y.

Case 1: A motor is normally operated between standstill and its rated speed (i.e. a speed corresponding to the line frequency). In this case, you need to connect the motor in Y. Operating the motor above its rated speed is only possible in field weakening, i.e. the motor torque available is reduced above the rated speed.

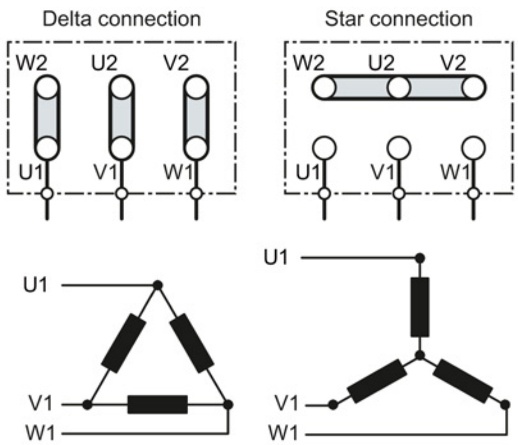
Case 2: If you want to operate the motor with the "87 Hz characteristic", you need to connect the motor in Δ.
With the 87 Hz characteristic, the motor's power output increases. The 87 Hz characteristic is mainly used with geared motors.

Before you connect the motor, ensure that the motor has the appropriate connection for your application:

Motor is connected in the star or delta configuration

With SIEMENS motors, you will see a diagram of both connection methods on the inside of the cover of the terminal box:

- Star connection (Y)
- Delta connection (Δ)



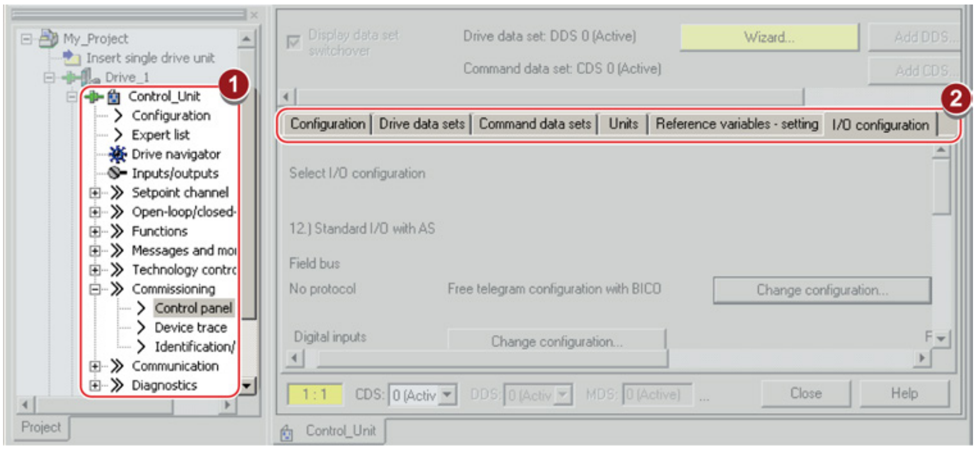
A.4 Handling STARTER

A.4.1 Change settings

After the basic commissioning, you can adapt the inverter to your application as described in the Commissioning guidance (Page 47).

STARTER offers two options:

- Change the settings using the appropriate screen forms - **our recommendation.**
  ① Navigation bar: For each inverter function, select the corresponding screen form.
  ② tabs: Switch between screen forms.
  If you change the settings using screen forms you do not need to know the parameter numbers.



- You change the settings using the parameters in the expert list.
  If you wish to change the settings using the expert list, you need to know the corresponding parameter number and its significance.

Saving settings so that they are not lost when the power fails

The inverter initially only saves changes temporarily. You must do the following so that the inverter saves your settings securely in the event of a power failure.

Procedure

Proceed as follows to save your settings in the inverter so that they are not lost when the power fails:

1. Mark the appropriate drive in the project navigator.
2. Click the Save (RAM to ROM) button.

You have saved your settings securely in the inverter in case of a power failure.

Go offline

You can now exit the online connection after the data backup (RAM to ROM) with "Disconnect from target system".

A.4.2 Optimize the drive using the trace function

Description

The trace function is used for inverter diagnostics and helps to optimize the behavior of the drive. Start the function in the navigation bar using "... Control_Unit/Commissioning/Device trace".

In two settings that are independent of one another, using you can interconnect eight signals each. Each signal that you interconnect is active as standard

You can start a measurement as often as required; the results are temporarily stored (until you exit STARTER) under the "Measurements" tab, together with the date and time. When terminating STARTER or under the "Measurements" tab, you can save the measurement results in the *.trc format.

If you require more than two settings for your measurements, you can either save the individual traces in the project or export them in the *.clg format – and if necessary, load or import.

Recording

Recording is performed in a CU-dependent basic clock cycle. The maximum recording duration depends on the number of recorded signals and the trace clock cycle.

You can extend the recording duration by increasing the trace clock cycle by multiplying with an integer factor and then accepting the displayed maximum duration with . Alternatively, you can also specify the measurement period and then calculate the trace clock cycle of STARTER using .

Recording individual bits for bit parameters

You can record individual bits of a parameter (e.g. r0722) by allocating the relevant bit using "bit track" ().

Mathematical function

Using the mathematical function () you can define a curve, for example the difference between the speed setpoint and the actual speed value.

Note

If you use the "record individual bits" or "mathematical functions" option, then this is displayed under signal No. 9.

Trigger

You can create your own start condition (trigger) for the trace. With the factory setting (default setting) the trace starts as soon as you press the button (Start Trace). Using the button , you can define another trigger to start the measurement.

Using pretrigger, set the time for the recording before the trigger is set. As a consequence, the trigger condition traces itself.

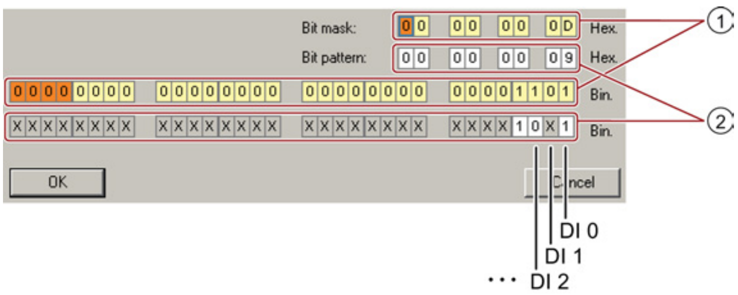
Example of a bit pattern as trigger:

You must define the pattern and value of a bit parameter for the trigger. To do so, proceed as follows:

Using , select "Trigger to variable - bit pattern"

Using , select the bit parameter

Using bin..., open the screen form in which you set the bits and their values for the start condition



① Select the bits for the trace trigger, upper row hex format, lower row binary format

② Define the bits for the trace trigger, upper row hex format, lower row binary format

Figure A-6 Bit pattern

In the example, the trace starts if DI0 and DI3 are high and DI2 is low. The state of the other digital inputs is not relevant for the start of the trace.

Further, you can either set an alarm or fault as start condition.

Display options

In this area, you can set how the measurement results are displayed.

- Measurement repetition
  This places the measurements that you wish to perform at different times above one other
- Arrange curves in tracks
  This means that you define as to whether all measured values are to be displayed with a common zero line – or whether each measured value is displayed with its own zero line.
- Measuring cursor on
  This allows you to analyze the measuring intervals in detail

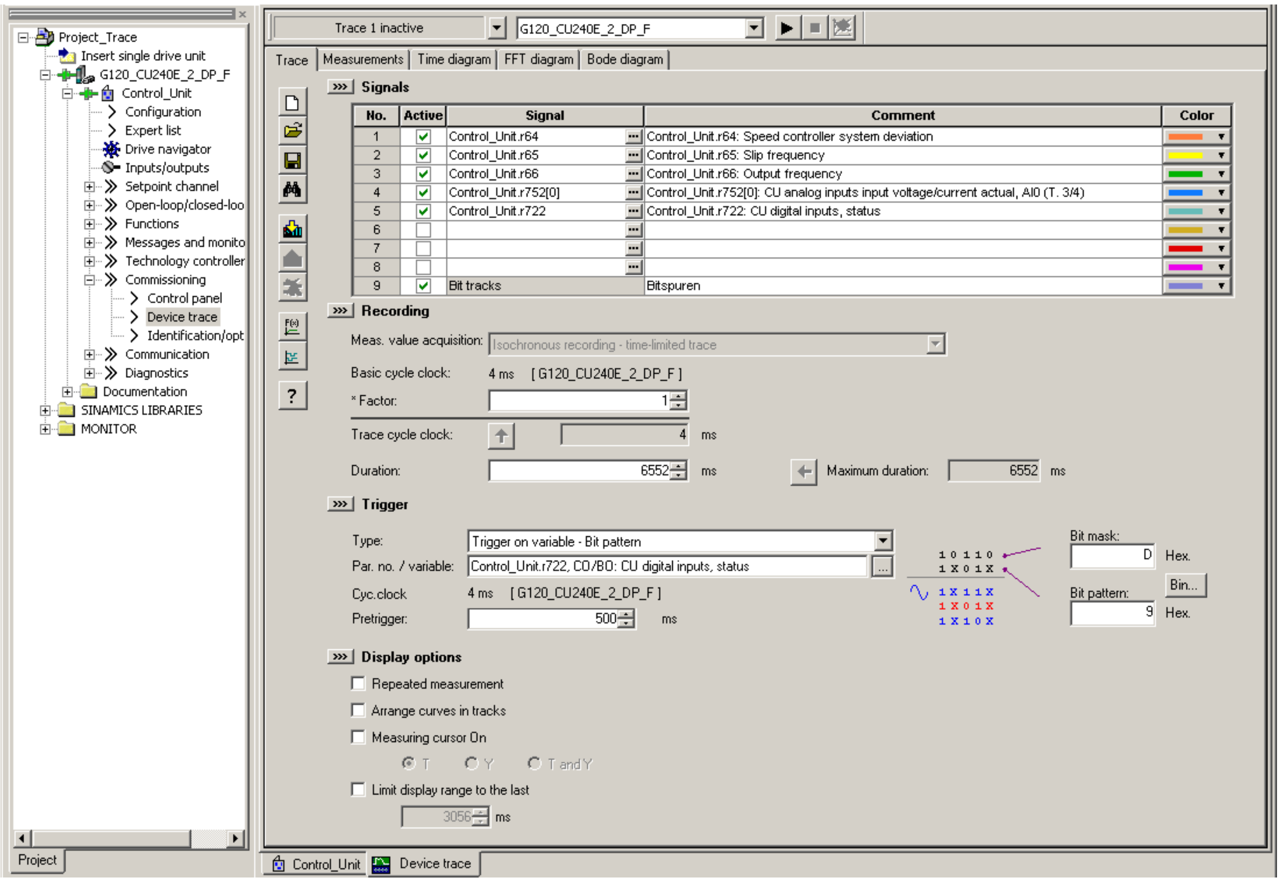


Figure A-7 Trace dialog box

A.5 Setting a non standard HTL encoder

Proceeding: manually configuring the encoder

1. Set p0010 = 4.
   This allows the encoder parameters to be accessed.
2. Configure the encoder using the table below.
3. Set p0010 = 0.

<table>
<tr><th>Parameter</th><th colspan="4">Description</th></tr>
<tr><td rowspan="4">p0400[0]</td><td colspan="4">Encoder type selection (Factory setting: 0)
Selects the encoder from the list of encoder types supported by the firmware of the Control Unit.</td></tr>
<tr><td>0</td><td>No encoder</td><td>3005</td><td>1024 HTL A/B without zero mark</td></tr>
<tr><td>3001</td><td>1024 HTL A/B with zero mark</td><td>3007</td><td>2048 HTL A/B without zero mark</td></tr>
<tr><td>3003</td><td>2048 HTL A/B with zero mark</td><td>9999</td><td>User-defined</td></tr>
<tr><td>p0408[0]</td><td colspan="4">Rotary encoder pulse No. (Factory setting: 2048)
Sets the number of encoder pulses.</td></tr>
<tr><td rowspan="3">p0410[0]</td><td colspan="4">Encoder inversion actual value (Factory setting: 0000 bin)</td></tr>
<tr><td>Bit 00</td><td colspan="3">1 signal: Invert speed actual value</td></tr>
<tr><td>Bit 01</td><td colspan="3">Not relevant for the CU240D-2</td></tr>
<tr><td>p0425[0]</td><td colspan="4">Encoder, rotary zero mark distance (Factory setting: 2048)
Sets the distance in pulses between two zero marks. This information is used for zero mark monitoring.</td></tr>
<tr><td rowspan="5">p0430[0]</td><td colspan="4">Sensor Module configuration (Factory setting: 0000 0000 0000 0000 0000 0000 0000 0000 bin)</td></tr>
<tr><td>Bit</td><td>Signal name</td><td>1 signal</td><td>0 signal</td></tr>
<tr><td>21</td><td>A one-off zero mark distance error is tolerated. In the event of a defect, the fault F3x100/F3x101 does not appear, but alarm A3x400/A3x401 does.</td><td>Yes</td><td>No</td></tr>
<tr><td>25</td><td>Switch-off encoder voltage supply during parking</td><td>Yes</td><td>No</td></tr>
<tr><td colspan="4">A bit-wise configuration is only possible if the corresponding property is also present in r0458.</td></tr>
<tr><td rowspan="10">p0437[0]</td><td colspan="4">Sensor Module configuration extended (Factory setting: 0000 0000 0000 0000 0000 1000 0000 0000 bin)</td></tr>
<tr><td>Bit</td><td>Signal name</td><td>1 signal</td><td>0 signal</td></tr>
<tr><td>00</td><td>Data logger</td><td>Yes</td><td>No</td></tr>
<tr><td>01</td><td>Zero mark edge detection</td><td>Yes</td><td>No</td></tr>
<tr><td>04</td><td>Edge evaluation bit 0</td><td>Yes</td><td>No</td></tr>
<tr><td>05</td><td>Edge evaluation bit 1</td><td>Yes</td><td>No</td></tr>
<tr><td>06</td><td>Freeze the speed actual value for dn/dt errors</td><td>Yes</td><td>No</td></tr>
<tr><td>11</td><td>Fault handling after PROFIdrive</td><td>Yes</td><td>No</td></tr>
<tr><td>12</td><td>Activate additional messages</td><td>Yes</td><td>No</td></tr>
<tr><td>26</td><td>Deselect track monitoring</td><td>Yes</td><td>No</td></tr>
<tr><td rowspan="2">p0438[0]</td><td colspan="4">Squarewave encoder filter time (Factory setting: 0.64 [μs])</td></tr>
<tr><td>0</td><td colspan="3">No filtering</td></tr>
<tr><td>p0439[0]</td><td colspan="4">Encoder ramp-up time (Factory setting: 0 [ms])</td></tr>
<tr><td>p0453[0]</td><td colspan="4">Pulse encoder evaluation zero speed measuring time (Factory setting: 1000 [ms])
If no pulses are detected from track A/B during this time, a speed actual value of zero is output.
This function is required for slow-running motors so that actual speeds close to zero can be output correctly.</td></tr>
</table>

For further information, please refer to the List Manual.

A.6 Setting a non standard SSI encoder

Proceeding: manually configuring the encoder

1. Set p0010 = 4.
   This allows the encoder parameters to be accessed.
2. Configure the encoder using the table below.
3. Set p0010 = 0.

Parameter	Description			
p0400[1]	**Encoder type selection** (Factory setting: 0) Selects the encoder from the list of encoder types supported by the firmware of the Control Unit.			
	0	No encoder		
	3081	SSI, Singleturn, 24 V		
	3082	SSI, Multiturn 4096, 24 V		
p0404[1]	**Encoder configuration effective** (Factory setting: 0000 0000 0010 0000 0000 0000 0000 0000 bin)			
	Bit	**Signal name**	**1 signal**	**0 signal**
	00	Linear encoder	Yes	No
	01	Absolute encoder	Yes	No
	02	Multiturn encoder	Yes	No
	03	Track A/B sq-wave	Yes	No
	09	SSI encoder	Yes	No
	12	Equidistant zero mark	Yes	No
	13	Irregular zero mark	Yes	No
	14	Distance-coded zero mark	Yes	No
	21	Voltage level 24 V	Yes	No
p0407[1]	**Linear encoder grid division** (Factory setting: 16000 [nm]) Sets the grid division for a linear encoder.			
p0408[1]	**Rotary encoder pulse No.** (Factory setting: 2048) Sets the number of encoder pulses.			
p0410[1]	Encoder inversion actual value (Factory setting: 0000 bin)			
	Bit 00	1 signal: Invert speed actual value		
	Bit 01	1 signal: Invert position actual value		
p0418[1]	**Fine resolution Gx_XIST1 (in bits)** (factory setting: 2) The parameter applies for the following process data: • Gx_XIST1 • Gx_XIST2 for reference mark or flying measurement The fine resolution specifies the fraction between two encoder pulses. Depending on the physical measurement principle, an encoder pulse can be broken down into a different number of fractions (e.g. squarewave encoder: 2 bit = resolution 4).			
p0419[1]	**Fine resolution absolute value Gx_XIST2 (in bits)** (factory setting: 2)			
p0421[1]	**Absolute encoder rotary multiturn resolution** (factory setting: 4096) Sets the number of rotations that can be resolved for a rotary absolute encoder.			
p0422[1]	**Absolute encoder linear measuring step resolution** (factory setting: 100 [nm]) Sets the resolution of the absolute position for a linear absolute encoder.			

<table>
<tr><th>Parameter</th><th colspan="4">Description</th></tr>
<tr><td>p0423[1]</td><td colspan="4">Absolute encoder rotary singleturn resolution (factory setting: 8192)
Sets the number of measuring steps per revolution for a rotary absolute encoder. The resolution refers to the absolute position.</td></tr>
<tr><td>p0425[1]</td><td colspan="4">Encoder, rotary zero mark distance (Factory setting: 2048)
Sets the distance in pulses between two zero marks. This information is used for zero mark monitoring.</td></tr>
<tr><td>p0426[1]</td><td colspan="4">Encoder zero mark differential distance (Factory setting: 1)
Sets the differential distance with distance-coded zero marks [signal periods].
The value corresponds to jump displacement of "zero mark with interference".</td></tr>
<tr><td>p0427[1]</td><td colspan="4">Encoder SSI baud rate (Factory setting: 100 [kHz])</td></tr>
<tr><td>p0428[1]</td><td colspan="4">Encoder SSI monoflop time (Factory setting: 30 [μs])
Sets the minimum delay time between two data transfers of the absolute value for an SSI encoder.</td></tr>
<tr><td rowspan="5">p0429[1]</td><td colspan="4">Encoder SSI configuration (Factory setting: 0000 0000 bin)</td></tr>
<tr><td>Bit</td><td>Signal name</td><td>1 signal</td><td>0 signal</td></tr>
<tr><td>00</td><td>Transfer code</td><td>Binary code</td><td>Gray code</td></tr>
<tr><td>02</td><td>Transfer absolute value twice</td><td>Yes</td><td>No</td></tr>
<tr><td>06</td><td>Data line during the monoflop time</td><td>High level</td><td>Low level</td></tr>
<tr><td rowspan="6">p0430[1]</td><td colspan="4">Sensor Module configuration (Factory setting: 0000 0000 0000 0000 0000 0000 0000 0000 bin)</td></tr>
<tr><td>Bit</td><td>Signal name</td><td>1 signal</td><td>0 signal</td></tr>
<tr><td>21</td><td>A one-off zero mark distance error is tolerated. In the event of a defect, the fault F3x100/F3x101 does not appear, but alarm A3x400/A3x401 does.</td><td>Yes</td><td>No</td></tr>
<tr><td>25</td><td>Switch-off encoder voltage supply during parking</td><td>Yes</td><td>No</td></tr>
<tr><td>27</td><td>Extrapolate position values</td><td>Yes</td><td>No</td></tr>
<tr><td colspan="4">A bit-wise configuration is only possible if the corresponding property is also present in r0458.</td></tr>
<tr><td rowspan="5">p0434[1]</td><td colspan="4">Encoder SSI error bit (Factory setting: 0)
Sets the position and level of the error bit in the SSI protocol.</td></tr>
<tr><td rowspan="3">Value = dcba</td><td>ba</td><td colspan="2">Position of the error bit in the protocol (0 ... 63).</td></tr>
<tr><td>c</td><td colspan="2">Level (0: Low level, 1: High level).</td></tr>
<tr><td>d</td><td colspan="2">State of the evaluation (0: Off, 1: On with 1 error bit, 2: On with 2 error bits ... 9: On with 9 error bits).</td></tr>
<tr><td colspan="4">Example: p0434 = 1013 → The evaluation is switched in and the error bit is at position 13 with a low level.</td></tr>
<tr><td rowspan="5">p0435[1]</td><td colspan="4">Encoder SSI alarm bit (Factory setting: 0)
Sets the position and level of the alarm bit in the SSI protocol.</td></tr>
<tr><td rowspan="3">Value = dcba</td><td>ba</td><td colspan="2">Position of the alarm bit in the protocol (0 ... 63).</td></tr>
<tr><td>c</td><td colspan="2">Level (0: Low level, 1: High level).</td></tr>
<tr><td>d</td><td colspan="2">State of the evaluation (0: Off, 1: On).</td></tr>
<tr><td colspan="4">p0435 = 1014 → The evaluation is switched in and the alarm bit is at position 14 with a low level.</td></tr>
<tr><td rowspan="5">p0436[1]</td><td colspan="4">Encoder SSI parity bit (Factory setting: 0)
Sets the position and parity of the parity bit in the SSI protocol.</td></tr>
<tr><td rowspan="3">Value = dcba</td><td>ba</td><td colspan="2">Position of the parity bit in the protocol (0 ... 63).</td></tr>
<tr><td>c</td><td colspan="2">Parity (0: even, 1: uneven).</td></tr>
<tr><td>d</td><td colspan="2">State of the evaluation (0: Off, 1: On).</td></tr>
<tr><td colspan="4">p0436 = 1015 → The evaluation is switched in and the parity bit is at position 15 with even parity.</td></tr>
</table>

<table>
<tr><th>Parameter</th><th colspan="4">Description</th></tr>
<tr><td rowspan="11">p0437[1]</td><td colspan="4">Sensor Module configuration extended (Factory setting: 0000 0000 0000 0000 0000 1000 0000 0000 bin)</td></tr>
<tr><td>Bit</td><td>Signal name</td><td>1 signal</td><td>0 signal</td></tr>
<tr><td>00</td><td>Data logger</td><td>Yes</td><td>No</td></tr>
<tr><td>01</td><td>Zero mark edge detection</td><td>Yes</td><td>No</td></tr>
<tr><td>02</td><td>Correction position actual value XIST1</td><td>Yes</td><td>No</td></tr>
<tr><td>04</td><td>Edge evaluation bit 0</td><td>Yes</td><td>No</td></tr>
<tr><td>05</td><td>Edge evaluation bit 1</td><td>Yes</td><td>No</td></tr>
<tr><td>06</td><td>Freeze the speed actual value for dn/dt errors</td><td>Yes</td><td>No</td></tr>
<tr><td>11</td><td>Fault handling after PROFIdrive</td><td>Yes</td><td>No</td></tr>
<tr><td>12</td><td>Activate additional messages</td><td>Yes</td><td>No</td></tr>
<tr><td>13</td><td>Support absolute position for incremental encoder</td><td>Yes</td><td>No</td></tr>
<tr><td></td><td>26</td><td>Deselect track monitoring</td><td>Yes</td><td>No</td></tr>
<tr><td rowspan="2">p0438[1]</td><td colspan="4">Squarewave encoder filter time (Factory setting: 0.64 [µs])</td></tr>
<tr><td>0</td><td colspan="3">No filtering</td></tr>
<tr><td>p0439[1]</td><td colspan="4">Encoder ramp-up time (Factory setting: 0 [ms])</td></tr>
<tr><td>p0446[1]</td><td colspan="4">Encoder SSI number of bits before the absolute value (Factory setting: 0)</td></tr>
<tr><td>p0447[1]</td><td colspan="4">Encoder SSI number of bits absolute value (Factory setting: 25)</td></tr>
<tr><td>p0448[1]</td><td colspan="4">Encoder SSI number of bits after the absolute value (Factory setting: 0)</td></tr>
<tr><td>p0449[1]</td><td colspan="4">Encoder SSI number of bits, filler bits (Factory setting: 1)
Sets the number of filler bits for double absolute value transfer in the SSI protocol.
This parameter is only of significance for p0429.2 = 1.</td></tr>
<tr><td>r0452[1]</td><td colspan="4">Squarewave encoder filter time display</td></tr>
<tr><td>p0453[1]</td><td colspan="4">Pulse encoder evaluation zero speed measuring time (Factory setting: 1000 [ms])
If no pulses are detected from track A/B during this time, a speed actual value of zero is output.
This function is required for slow-running motors so that actual speeds close to zero can be output correctly.</td></tr>
</table>

For further information, please refer to the List Manual.

A.7 Encoders examples

Examples

The following SSI encoders have been commissioned successfully in several applications with the CU250D-2:

Table A- 3 SSI encoders

Manufacturer	Type / order number	Details	Setting	Note
SIEMENS	6FX2001-5xS12	Singleturn encoder	p0400 = 3081	---
SIEMENS	1XP80X4-20 / 6FX2001-5xS24	Multiturn encoder	p0400 = 3082	
T&R	CEW-58, CEV-58, CEH-58, CEW-65; CEV-65	Programmable encoder	p0400 = 9999. Set the encoder data manually.	We can not guarantee the function of these encoders in any circumstance.
SICK / Stegmann	AFM60…	Single- and multiturn		
	DME4000	Laser distance measuring unit, programmable encoder		
Heidenhain	EQN 425	Multiturn		

A.8 Application examples

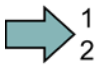
A.8.1 Configuring the PROFIBUS communication with STEP 7

Using a suitable example, the following section provides information on how you configure the communication of an inverter to a higher-level SIMATIC control system.

To configure the communication between an inverter and a SIMATIC control system, you require the SIMATIC STEP 7 software tool with HW Config.

It is assumed that you are knowledgeable about working with SIMATIC control systems and that you have a sound understanding of the STEP 7 engineering tool.

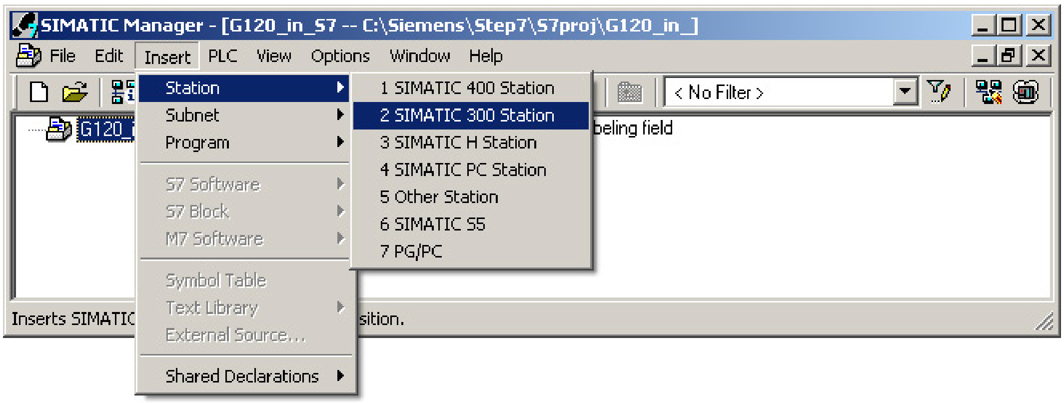
A.8.1.1 Creating a STEP 7 project and network



Procedure

In order to create a STEP 7 project, proceed as follows:

1. Create a new STEP 7 project, e.g. "G120_in_S7".
2. Insert a SIMATIC control S7 300 CPU.

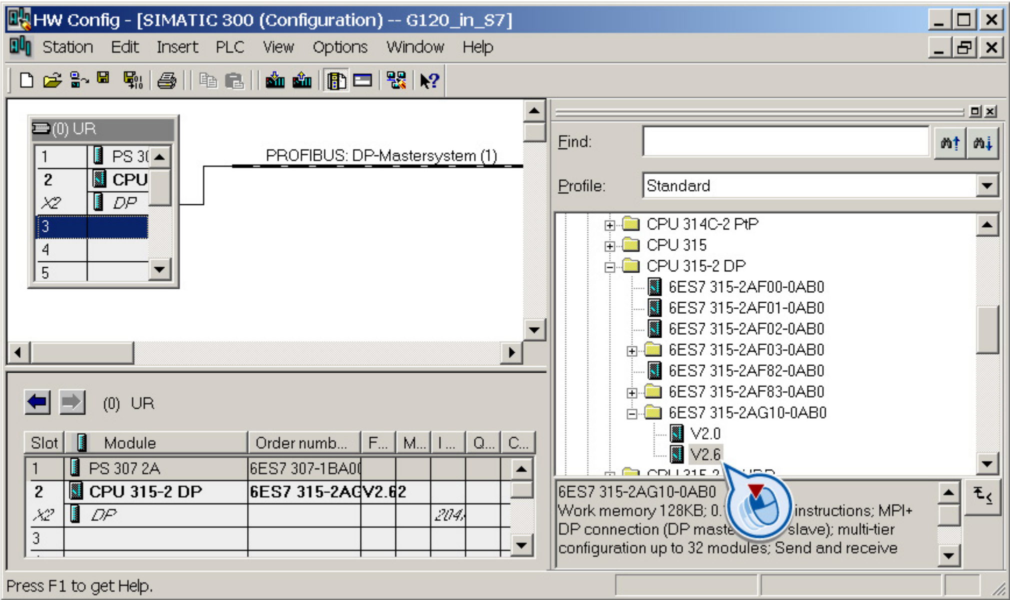


3. Select the SIMATIC 300 station in your project and open HW Config.
4. Insert an S7 300 mounting rail from the hardware catalog into your project with drag & drop.

5. Locate a power supply at slot 1 of the mounting rail and a CPU 315-2 DP control at slot 2.

   When inserting the control, HW Config opens the network setting.

6. Create a PROFIBUS DP network.



You have created a STEP 7 project with a SIMATIC control and a PROFIBUS network.

A.8.1.2 Integrating a converter into a project

The inverter can be connected to a SIMATIC control in two ways:

1. Using the inverter GSD
2. Using the STEP 7 object manager

   This somewhat more user-friendly method is only available for S7 controls and installed Drive ES Basic (see Section Commissioning tools (Page 21)).

The following section describes how to configure the inverter using the GSD.

A.8.1.3 Inserting the converter into the STEP 7 project

- Install the GSD of the converter in STEP 7 via HW Config (Menu "Options - Install GSD files").
  Once the GSD has been installed, the converter appears under "PROFIBUS DP - Additional field devices" in the hardware catalog of HW Config.

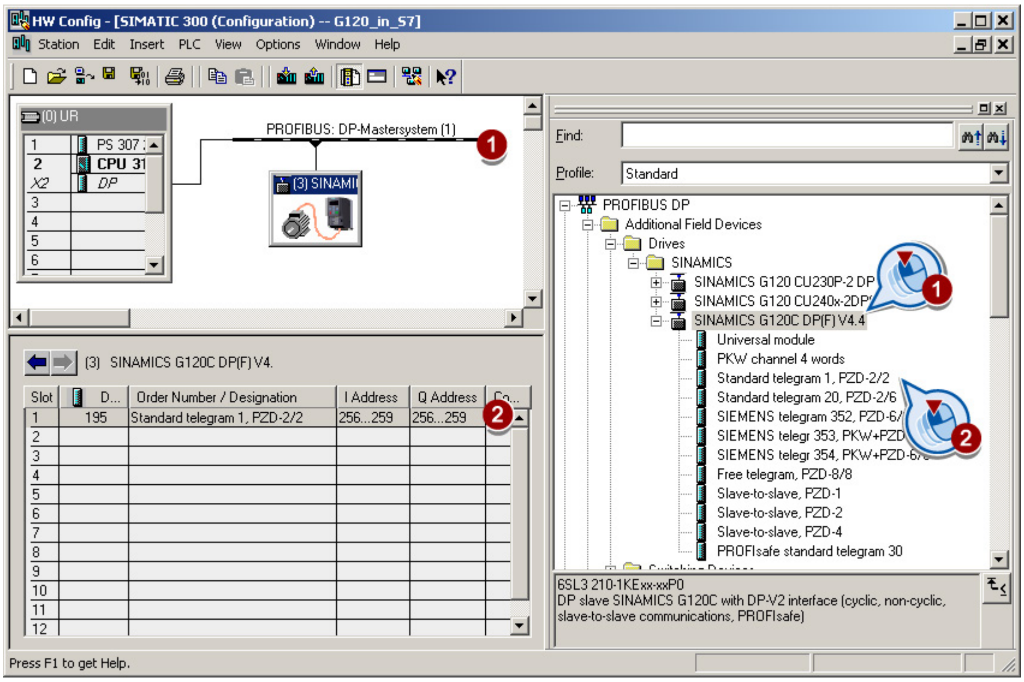


Figure A-8 Inserting a drive object

- Drag and drop the converter into the PROFIBUS network. Enter the PROFIBUS address set at the converter in HW Config.
- Insert the required telegram type from the HW Catalog to slot 1 of the converter by 'dragging and dropping'.
  More information on the telegram types can be found in Chapter Cyclic communication (Page 77).

Sequence when assigning the slots

1. PROFIsafe module (if one is used)
   Information on connecting the converter via PROFIsafe can be found in the Safety Integrated Function Manual.
2. PKW channel (if one is used)
3. Standard, SIEMENS or free telegram (if one is used)
4. Slave-to-slave module

If you do not use one or several of the modules 1, 2 or 3, configure the remaining modules starting with the 1st slot.

Cyclic communication to the inverter when using the universal module

A universal module with the following properties is not permitted:

- PZD length 4/4 words
- Consistency over the complete length

With these properties, the universal module has the same DP identifier (4AX) as the "PKW channel 4 words". The higher-level control does not establish cyclic communication with the inverter.

Workaround when using the universal module above:

- In the properties of the DP slave, change the PZD length to 8/8 bytes
- Change the consistency to "Unit".

Final steps

- Save and compile the project in STEP 7.
- Establish an online connection between your PC and the S7 CPU and download the project data to the S7 CPU.
- In the converter, select the telegram type that you configured in STEP 7 using parameter P0922.

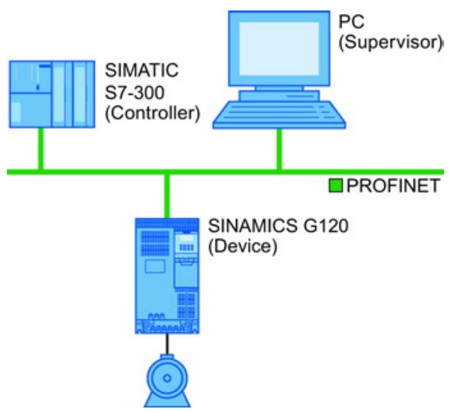
The converter is now connected to the S7 CPU. This therefore defines the communication interface between the CPU and the converter. An example of how you can supply this interface with data can be found in the next section.

A.8.2 Configuring the PROFINET communication with STEP 7

A.8.2.1 Communication via PROFINET - example

Profinet network in a line topology

The adjacent example shows the structure of a PROFINET network with one controller, one device, and one supervisor.



A.8.2.2 Configuring the controller and converter in HW Config

Using an example of a SINAMICS G120 with Control Unit CU240B-2 or CU240E-2, the procedure shows how you insert the inverter into the project.

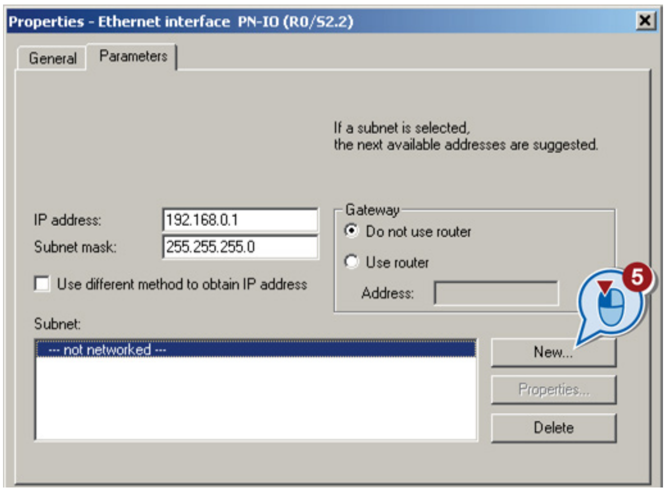
Procedure

Proceed as follows to configure communications between the inverter and the control system via PROFINET:

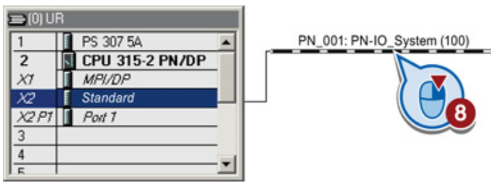
1. Open HW Config in STEP 7 via "Insert/[Station]", and create the components in accordance with your hardware structure. The following example is limited to the components that are absolutely required.
2. Build your station with a rack and power supply unit.
3. Insert the CPU.

   HW Config opens a screen form with suggestions for the next free IP address and a subnet screen form.
4. If you have configured a local area network, and are not working within a larger Ethernet network, use the proposed entries.

   Otherwise, ask your administrator about the IP addresses for the PROFINET participants and subnet mask. CPU and supervisor must have the same subnet screen form.

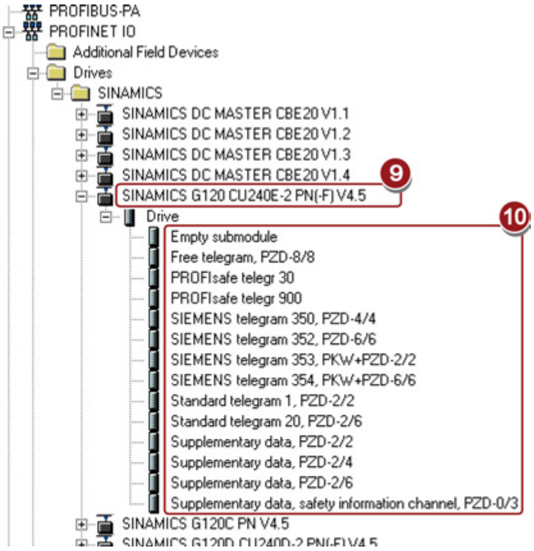


5. Use the "New" button to either create a new PROFINET subnet or select an existing one.
6. Assign a name for your PROFINET network.
7. Exit this screen form and the next one with OK.
8. Select your subnet.



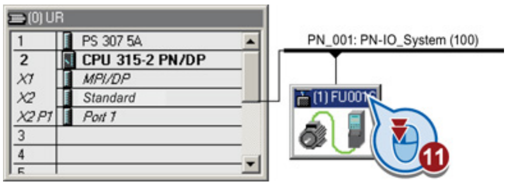
9. Using the hardware catalog, first insert the inverter using drag & drop.

10. Insert the communication telegram.



11. Open the properties window of the inverter and enter a unique and descriptive device name for the inverter.

    Using the device name, the PROFINET controller assigns the IP address when starting up.



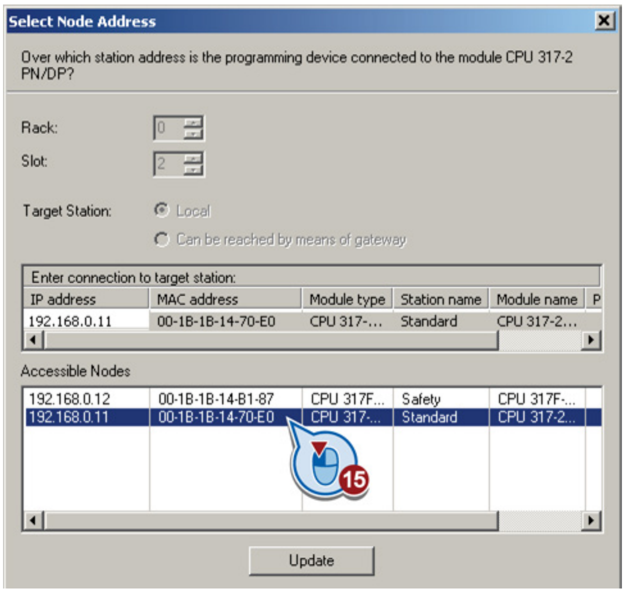
12. You will also find the proposed IP address in this screen form. If required, you can change the IP address via "Properties".

13. Save your hardware configuration with "Save and compile" ( ).

14. Load the configuration into the control unit via the button.

15. Enter the IP address of the controller.

    If you do not have the IP address readily available, you can display the participants that can be reached by clicking the "Display" button. Select the control from the list of accessible participants, and exit the screen form with OK.



16. If you have installed Drive ES Basic, open the STARTER by double-clicking the inverter symbol in the Hardware Manager and configure the inverter in the STARTER.

    In this case, STARTER automatically accepts the device name and IP address. The approach described in the following section is therefore superfluous.

17. If you are working with the GSDML, close HW Config now and create a reference for STARTER as described in the following section.

You have configured the communication between the inverter and the control unit using PROFINET .

A.8.2.3 Create a reference for STARTERS

If you have configured the inverter via GSDML, in STEP 7, you must create a reference of the inverter for STARTER, so that you can call up STARTER from STEP 7.

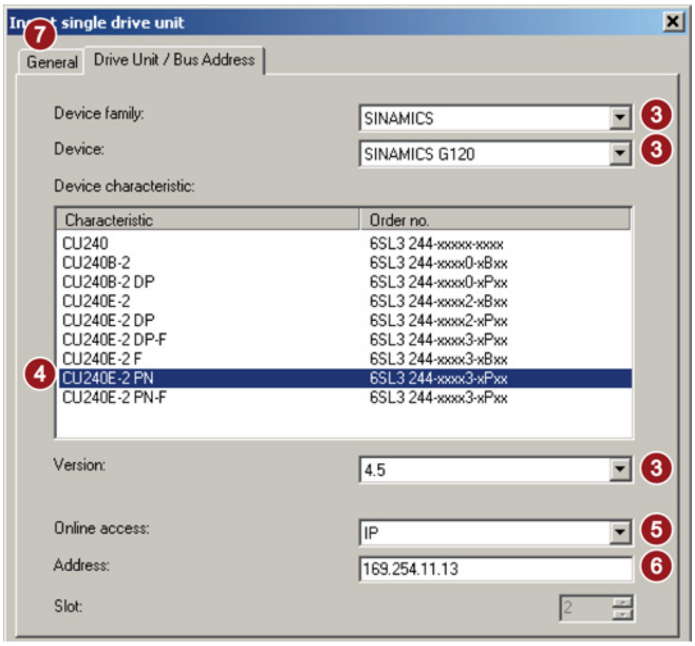
This procedure is described using the example of a SINAMICS G120 with Control Unit CU240B-2 or CU240E-2.

Procedure

Proceed as follows to create a reference of the inverter for STARTER:

1. Highlight the project in the SIMATIC manager
2. Open the "Insert single drive unit" screen form by right clicking on "Insert New Object/SINAMICS".
3. Under the "Drive device/address" tab, set the device family, device and the firmware version.
4. In the device version, select your inverter.

5. Set the online access.
6. Set the address.
7. Enter the PROFINET device name in the "General" tab.



8. Exit the screen form with OK.
9. The inverter is visible in your project.

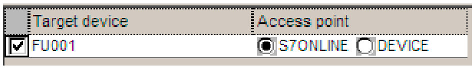
In your project, you have created an inverter reference for STARTER. You can now call STARTER from your STEP 7 project.

A.8.2.4 Call the STARTER and go online

Procedure

To call STARTER from STEP 7 and establish an online connection to the inverter, proceed as follows:

1. Highlight the inverter in the SIMATIC manager with the right mouse button.
2. Open the STARTER via "Open object".
3. Configure the inverter in STARTER and click on the Online button ( ).
4. In the following window, select the inverter and then the S7ONLINE as access point.



5. Exit the screen form with OK.

You have called STARTER from STEP 7, and have established the online connection to the inverter.

A.8.2.5 Activate diagnostic messages via STEP 7

Procedure

1
2

Proceed as follows to activate the diagnostic messages of the inverter:

1. In HW Config, select the inverter.

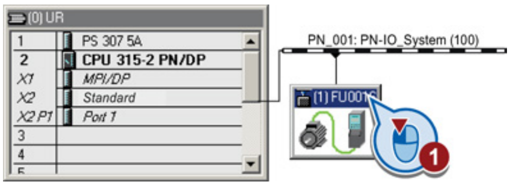
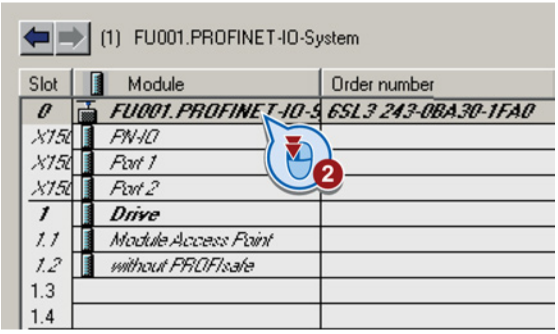
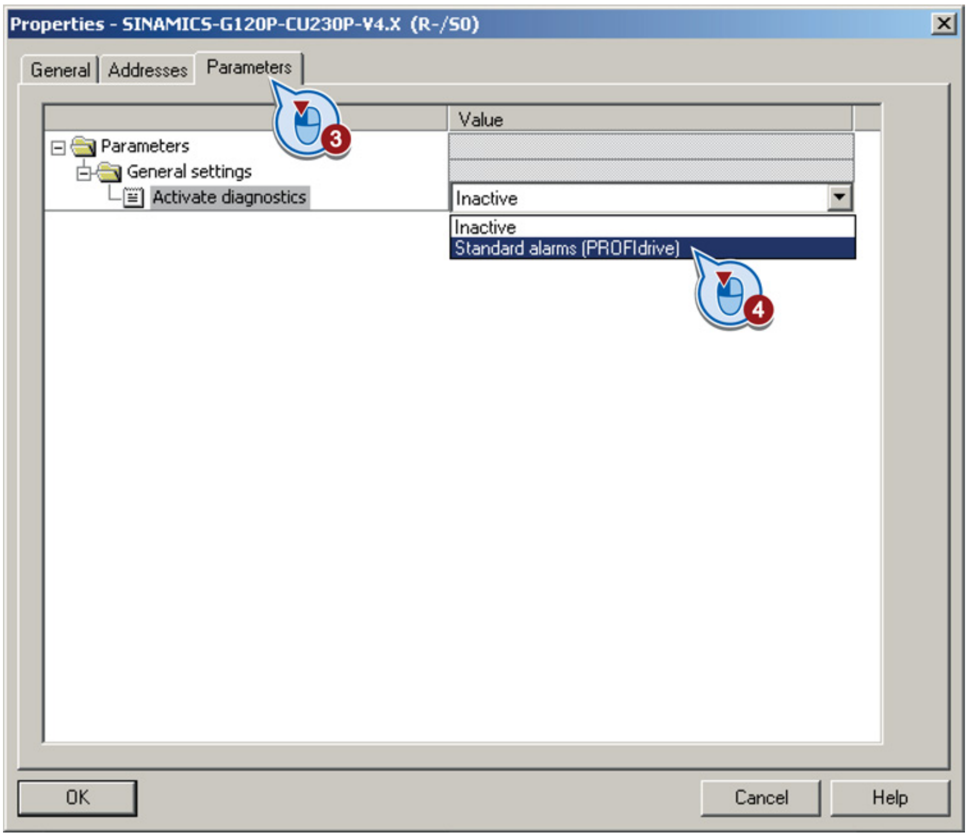


Figure A-9 Highlight inverter in HW Config

2. By double clicking on slot 0 in the station window, open the property window for the inverter's network settings.



3. Select the Parameters tab.
4. Activate the standard alarms.



You have activated the diagnosis messages.

With the next ramp-up of the controller, the diagnostic messages of the inverter are then transferred to the controller.

A.8.3 STEP 7 program examples

Data exchange via the fieldbus

Analog signals

The inverter always scales signals that are transferred via the fieldbus to a value of 4000 hex.

Table A- 4 Signal category and the associated scaling parameters

Signal category	4000 hex ≙ …	Signal category	4000 hex ≙ …
Speeds, frequencies	p2000	Power	p2004
Voltage	p2001	Angle	p2005
Current	p2002	Temperature	p2006
Torque	p2003	Acceleration	p2007

Control and status words

Control and status words consist of a high byte and a low byte. A SIMATIC control interprets words differently than the inverter: The higher and lower-order bytes are interchanged when they are transferred. See also the following program example.

A.8.3.1 STEP 7 program example for cyclic communication

Network 1: Control word 1 and setpoint

Control word 1: 047E hex Setpoint: 2500 hex

```
L    W#16#47E
T    MW      1
L    W#16#2500
T    MW      3
```

Network 2: Acknowledge fault

```
U    E       0.6
=    M       2.7
```

Network 3: Switch the motor on and off

```
U    E       0.0
=    M       2.0
```

Network 4: Write process data

```
L    MW      1
T    PAW     256
L    MW      3
T    PAW     258
```

Network 4: Read process data

Status word 1: MW 5 Actual value: MW 7

```
L    PEW     256
T    MW      5
L    PEW     258
T    MW      7
```

The controller and inverter communicate via standard telegram 1. The control specifies control word 1 (STW1) and the speed setpoint, while the inverter responds with status word 1 (ZSW1) and its actual speed.

In this example, inputs E0.0 and E0.6 are linked to the ON/OFF1 bit or to the "acknowledge fault" bit of STW 1.

Control word 1 contains the numerical value 047E hex. The bits of control word 1 are listed in the following table.

The hexadecimal numeric value 2500 specifies the setpoint frequency of the inverter. The maximum frequency is the hexadecimal value 4000 (also see STEP 7 program examples (Page 343)).

The controller cyclically writes the process data to logical address 256 of the inverter. The inverter also writes its process data to logical address 256. You define the address area in HW Config.

Table A- 5 Assignment of the control bits in the inverter to the SIMATIC flags and inputs

HEX	BIN	Bit in STW1	Significance	Bit in MW1	Bit in MB1	Bit in MB2	Inputs
E	0	0	ON/OFF1	8		0	E0.0
	1	1	OFF2	9		1	
	1	2	OFF3	10		2	
	1	3	Operation enable	11		3	
7	1	4	Ramp-function generator enable	12		4	
	1	5	Start ramp-function generator	13		5	
	1	6	Setpoint enable	14		6	
	0	7	Acknowledge fault	15		7	E0.6
4	0	8	Jog 1	0	0		
	0	9	Jog 2	1	1		
	1	10	PLC control	2	2		
	0	11	Setpoint inversion	3	3		
0	0	12	Irrelevant	4	4		
	0	13	Motorized potentiometer ↑	5	5		
	0	14	Motorized potentiometer ↓	6	6		
	0	15	Data set changeover	7	7		

See also

Inserting the converter into the STEP 7 project (Page 335)

A.8.3.2 STEP 7 program example for acyclic communication

```
OB1:    Cyclic control program

Network 1:    Reading and writing parameters

 // read parameters
        O(
        U     M      9.2
        UN    M      9.1
        )
        O(
        U     M      9.0
        UN    M      9.1
        )
        R     M      9.3

        SPB   RD

 // write parameters
        O(
        U     M      9.3
        UN    M      9.0
        )
        O(
        U     M      9.1
        UN    M      9.0
        )
        R     M      9.2

        SPB   WR
        BEA

 RD:    NOP   0
        CALL  FC     1
        BEA
 WR:    NOP   0      9.1
        CALL  FC     3
```

M9.0 Starts reading parameters

M9.1 Starts writing parameters

M9.2 Displays the read process

M9.3 Displays the write process

The number of simultaneous requests for acyclic communication is limited. More detailed information can be found under Acyclic communication (Page 93).

```
FC1:    PAR_RD

Network 1:    Parameters for reading

        L     MB       40
        T     DB1.DBB   0
        L     B#16#01
        T     DB1.DBB   1
        T     DB1.DBB   2
        L     MB       62
        T     DB1.DBB   3
  // ----------------------------------------
        L     MW       50
        T     DB1.DBW   6
        L     MB       58
        T     DB1.DBB   5
        L     MW       63
        T     DB1.DBW   8
  // ----------------------------------------
        L     MW       52
        T     DB1.DBW  12
        L     MB       59
        T     DB1.DBB  11
        L     MW       65
        T     DB1.DBW  14
  // ----------------------------------------
        L     MW       54
        T     DB1.DBW  18
        L     MB       60
        T     DB1.DBB  17
        L     MW       67
        T     DB1.DBW  10
  // ----------------------------------------
        L     MW       56
        T     DB1.DBW  24
        L     MB       61
        T     DB1.DBB  23
        L     MW       69
        T     DB1.DBW  26
```

```
Network 2:    Read request, part 1

      CALL   SFC    58
        REQ         :=M9.0
        IOID        :=B#16#54
        LADDR       :=W#16#170
        RECNUM      :=B#16#2F
        RECORD      :=P#DB1.DBX0.0 BYTE 28
        RET_VAL     :=MW10
        BUSY        :=M8.1

      U     M     8.1
      R     M     9.0
      S     M     9.2

Network 3:    Read delay after a read request

      U     M     8.1
      UN    M     9.1
      L     S5T#1s
      SS    T     1
      U     M     8.3
      R     T     1
      U     T     1
      =     M     8.2

Network 4:    Read request, part 2

      CALL   SFC    59
        REQ         :=M8.2
        IOID        :=B#16#54
        LADDR       :=W#16#170
        RECNUM      :=B#16#2F
        RET_VAL     :=MW12
        BUSY        :=M8.3
        RECORD      :=P#DB2.DBX0.0 BYTE 36

      U     M     8.3
      R     M     8.2
```

Figure A-10 Reading parameters

Note

With PROFINET standard function blocks (SFB) instead of system functions (SFC)

With acyclic communication via PROFINET, you must replace the system functions with standard function blocks as follows:

- SFC 58 → SFB 53
- SFC 59 → SFB 52

Explanation of FC 1

Table A- 6 Request to read parameters

Data block DB 1	Byte n	Bytes n + 1	n
Header	**Reference** *MB 40*	**01 hex**: Read request	0
	01 hex	**Number of parameters (m)** *MB 62*	2
Address, parameter 1	**Attribute** *10 hex: Parameter value*	**Number of indexes** *MB 58*	4
	Parameter number *MW 50*		6
	Number of the 1st index *MW 63*		8
Address, parameter 2	**Attribute** *10 hex: Parameter value*	**Number of indexes** *MB 59*	10
	Parameter number *MW 52*		12
	Number of the 1st index *MW 65*		14
Address, parameter 3	**Attribute** *10 hex: Parameter value*	**Number of indexes** *MB 60*	16
	Parameter number *MW 54*		18
	Number of the 1st index *MW 67*		20
Address, parameter 4	**Attribute** *10 hex: Parameter value*	**Number of indexes** *MB 61*	22
	Parameter number *MW 56*		24
	Number of the 1st index *MW 69*		26

SFC 58 copies the specifications for the parameters to be read from DB 1 and sends them to the inverter as a read request. No other read requests are permitted while this one is being processed.

After the read request and a waiting time of one second, the controller takes the parameter values from the inverter via SFC 59 and saves them in DB 2.

```
FC3:    PAR_WR

Network 1:    Parameters for writing

        L    MB        42
        T    DB3.DBB   0
        L    B#16#02
        T    DB3.DBB   1
        L    B#16#01
        T    DB3.DBB   2
        L    MB        44
        T    DB1.DBB   3
 // -----------------------------------------
        L    MW        21
        T    DB3.DBW   6
        L    MW        23
        T    DB3.DBW   8
        L    MW        35
        T    DB3.DBW   12
        L    MB        25
        T    DB3.DBB   10
        L    MB        27
        T    DB3.DBB   11
```

```
Network 2:    Write request:

      CALL    SFC     58
        REQ          :=M9.1
        IOID         :=B#16#54
        LADDR        :=W#16#170
        RECNUM       :=B#16#2F
        RECORD       :=P#DB3.DBX0.0 BYTE 14
        RET_VAL      :=MW10
        BUSY         :=M8.1

      U       M       8.1
      R       M       9.1
      S       M       9.3
```

Figure A-11 Writing parameters

Explanation of FC 3

Table A- 7 Request to change parameters

Data block DB 3	Byte n	Bytes n + 1	n
Header	**Reference** *MB 42*	**02 hex**: Change request	0
	01 hex	**Number of parameters** *MB 44*	2
Address, parameter 1	**10 hex**: Parameter value	**Number of indexes** *00 hex*	4
	Parameter number *MW 21*		6
	Number of the 1st index *MW 23*		8
Values, parameter 1	**Format** *MB 25*	**Number of index values** *MB 27*	10
	Value of the 1st index*MW35*		12

SFC 58 copies the specifications for the parameters to be written from DB 3 and sends them to the inverter. The inverter blocks other write jobs while this write job is running.

A.8.4 Configuring slave-to-slave communication in STEP 7

Two drives communicate via standard telegram 1 with the higher-level controller. In addition, drive 2 receives its speed setpoint directly from drive 1 (actual speed).

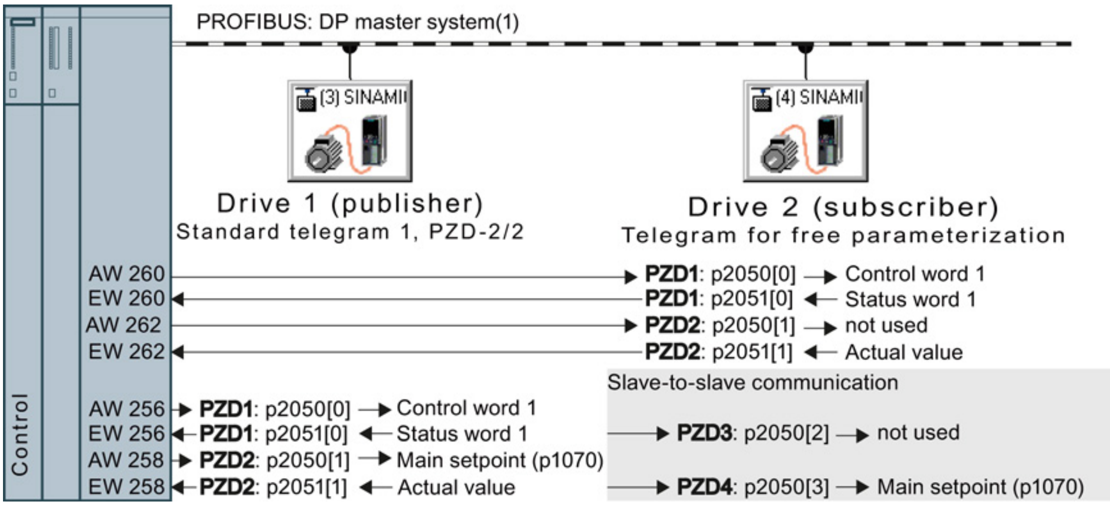
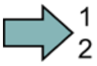


Figure A-12 Communication with the higher-level controller and between the drives with direct data exchange

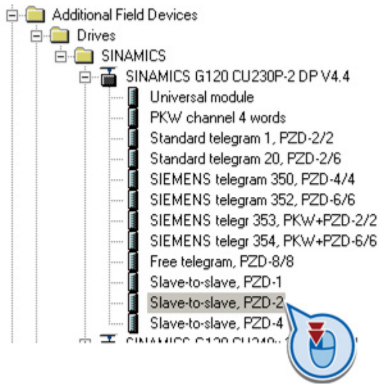
Setting direct data exchange in the control



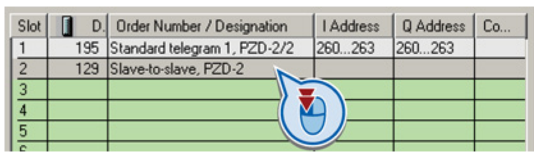
Procedure

Proceed as follows to set direct data exchange in the control:

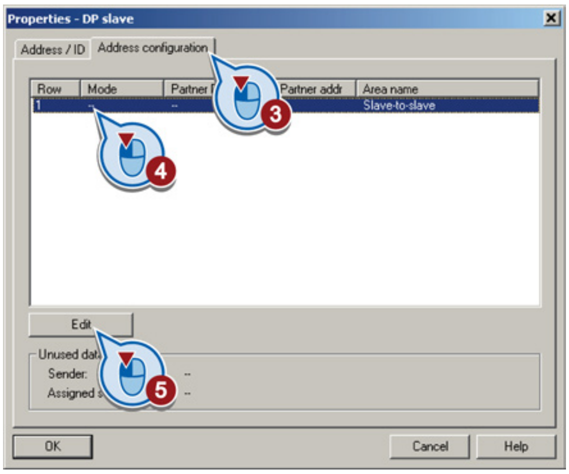
1. In HW Config in drive 2 (subscriber), insert a direct data exchange object, e.g. "Slave-to-slave, PZD2".



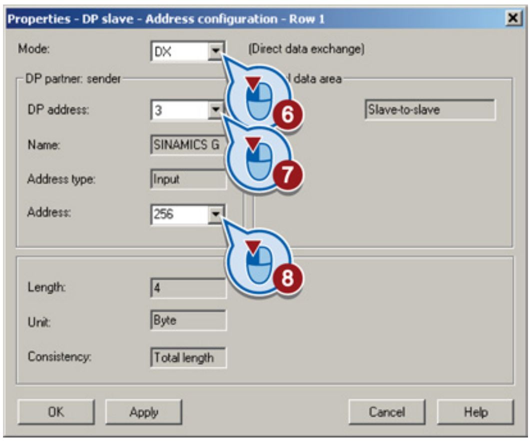
2. With a double-click, open the dialog box to make additional settings for the direct data exchange.



3. Activate the tab "Address configuration".
4. Select line 1.
5. Open the dialog box in which you define the Publisher and the address area to be transferred.



6. Select DX for direct data exchange
7. Select the address of drive 1 (publisher).
8. In the address field, select the start address specifying the data area to be received from drive 1. In the example, these are the status word 1 (PZD1) and the actual speed value with the start address 256.



9. Close both screen forms with OK.

You have now defined the value range for direct data exchange.

In the direct data exchange, drive 2 receives the sent data and writes this into the next available words, in this case, PZD3 and PZD4.

Settings in drive 2 (subscriber)

Drive 2 is preset in such a way that it receives its setpoint from the higher-level controller. In order that drive 2 accepts the actual value sent from drive 1 as setpoint, you must set the following:

- In drive 2, set the PROFIdrive telegram selection to "Free telegram configuration" (p0922 = 999).
- In drive 2, set the source of the main setpoint to p1070 = 2050.3.

The inverter indicates the inverter addresses that are configured for direct data exchange in parameter r2077.

A.8.5 Connecting fail-safe digital inputs

The following examples show the interconnection of a fail-safe digital input accordance with PL d to EN 13849-1 and SIL2 according to IEC61508. You can find further examples and information in the Safety Integrated Function Manual.

The examples comply with PL d according to EN 13849-1 and SIL2 according to IEC 61508 for the case that all components are installed within one control cabinet.

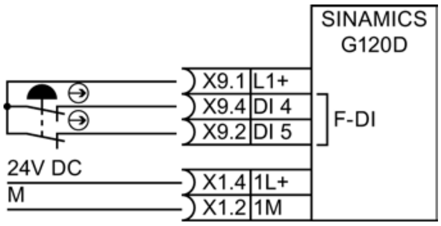


Figure A-13 Connecting a sensor, e.g. Emergency Stop mushroom push-button or limit switch

You may connect emergency stop control devices in series because it is not possible for these devices to fail and be actuated at the same time.

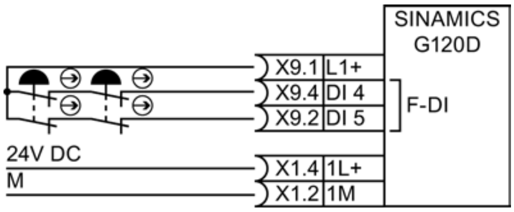


Figure A-14 Connecting electromechanical sensors in series

According to IEC 62061 (SIL) and ISO 13849-1 (PL), position switches of protective doors may also connected in series.

Exception: If several protective doors are regularly opened at the same time, it is not possible for faults to be detected, which means that the position switches must not be connected in series.

You can find additional connection options in the Safety Integrated Function Manual, see Section: Further information (Page 360).

A.9 Documentation for the acceptance test of fail-safe functions

A.9.1 Machine documentation

Machine or plant description

Designation	…
Type	…
Serial number	…
Manufacturer	…
End customer	…
Block diagram of the machine and/or plant: … … … … … … …	

Inverter data

Table A- 8 Hardware version of the safety-related inverter

Labeling the drive	Order number and hardware version of the inverter
…	…
…	…

Function table

Table A- 9 Active safety functions depending on the operating mode and safety equipment

Operating mode	Safety equipment	Drive	Selected safety function	Checked
…	…	…	…	
…	…	…	…	
Example:				
Automatic	*Protective door closed*	*Conveyor belt*	---	---
	Protective door open	*Conveyor belt*	*STO*	
	Emergency Stop button pressed	*Conveyor belt*	*STO*	

Acceptance test reports

File name of the acceptance reports	
…	…
…	…

Data backup

Data	Storage medium			Holding area
	Archiving type	Designation	Date	
Acceptance test reports	…	…	…	…
PLC program	…	…	…	…
Circuit diagrams	…	…	…	…

Countersignatures

Commissioning engineer

This confirms that the tests and checks have been carried out properly.

Date	Name	Company/dept.	Signature
…	…	…	…

Machine manufacturer

This confirms that the settings recorded above are correct.

Date	Name	Company/dept.	Signature
…	…	…	…

A.9.2 Log the settings for the basic functions, firmware V4.4 ... V4.6

Drive = <pDO-NAME_v>

Table A- 10 Firmware version

Name	Number	Value
Control Unit firmware version	r18	<r18_v>
SI version, safety functions integrated in the drive (processor 1)	r9770	<r9770_v>

Table A- 11 Monitoring cycle

Name	Number	Value
SI monitoring clock cycle (processor 1)	r9780	<r9780_v>

Table A- 12 Checksums

Name	Number	Value
SI reference checksum SI parameters (processor 1)	p9799	<p9799_v>
SI reference checksum SI parameters (processor 2)	p9899	<p9899_v>

Table A- 13 Settings of the safety functions

Name		Number	Value
SI enable, functions integrated in the drive		p9601	<p9601_v>
Only for the CU250S-2 Control Unit	SI enable safe brake control	p9602	<p9602_v>
SI PROFIsafe address		p9610	<p9610_v>
SI F-DI changeover, tolerance time		p9650	<p9650_v>
SI STO debounce time		p9651	<p9651_v>
Only for the CU250S-2 Control Unit	SI Safe Stop 1 delay time	p9652	<p9652_v>
SI forced dormant error detection timer		p9659	<p9659_v>

Table A- 14 Safety logbook

Name	Number	Value
SI checksum to check changes	r9781[0]	<r9781[0]_v>
SI checksum to check changes	r9781[1]	<r9781[1]_v>
SI change control time stamp	r9782[0]	<r9782[0]_v>
SI change control time stamp	r9782[1]	<r9782[1]_v>

A.10 Standards (PM250D)

	European Low Voltage Directive The SINAMICS G120D-2 product range complies with the requirements of the Low Voltage Directive 2006/95/EC. The units are certified for complaince with the following standards: EN 61800-5-1 — Semiconductor inverters –General requirements and line commutated inverters EN 60204-1 — Safety of machinery –Electrical equipment of machines
	European Machinery Directive The SINAMICS G120D-2 inverter series does not fall under the scope of the Machinery Directive. However, the products have been fully evaluated for compliance with the essential Health & Safety requirements of the directive when used in a typical machine application. A Declaration of Incorporation is available on request.
	European EMC Directive When installed according to the recommendations described in this manual, the SINAMICS G120D-2 fulfils all requirements of the EMC Directive as defined by the EMC Product Standard for Power Drive Systems EN 61800-3
	Underwriters Laboratories UL and CUL LISTED POWER CONVERSION EQUIPMENT for use in a pollution degree 2 environment.
SEMI F47	**Specification for Semiconductor Process Equipment Voltage Sag Immunity** SINAMICS G120D-2 Inverters fulfill the requirements of the SEMI F47-0706 standard.
	ISO 9001 Siemens plc operates a quality management system, which complies with the requirements of ISO 9001.

Certificates can be downloaded from the internet under the following link:

Standards (http://support.automation.siemens.com/WW/view/en/22339653/134200)

A.11 Electromagnetic Compatibility

The SINAMICS G120 drives have been tested in accordance with the EMC Product Standard EN 61800-3:2004.

Details see declaration of conformity

Note

Install all drives in accordance with the manufacturer's guidelines and in accordance with good EMC practices.

Use screened cable type CY. Maximal cable length is 15 m.

Table A- 15 Compliance Table

Category C2 - First Environment - Professional Use	
Order number	Remark
6SL3525-0PE17-***A***0 6SL3525-0PE21-***A***0 6SL3525-0PE23-***A***0 6SL3525-0PE24-***A***0 6SL3525-0PE25-***A***0 6SL3525-0PE27-***A***0	All inverters with integrated Class A filters. The inverter meets the requirements for category C2 for conducted emissions. In a domestic environment this product may cause radio interference in which case supplementary mitigation measures may be required.

EMC Emissions

Note

Install all drives in accordance with the manufacturer's guidelines and in accordance with good EMC practices.

Use screened cable type CY. The maximal cable length is 15 m.

Do not exceed the default switching frequency 4 kHz.

Table A- 16 Conducted disturbance voltage and radiated emissions

EMC Phenomenon	Converter type Remark	Level acc. to IEC 61800-3
Conducted emissions (disturbance voltage)	All converters with integrated class A filters. Order number: 6SL3525-0PE**-*A**	**Category C2** First Environment - Professional Use
Radiated emissions	Converter frame sizes A, B and C with integrated class A filter. Order number: 6SL3525-0PE17-*A** 6SL3525-0PE21-*A** 6SL3525-0PE23-*A** 6SL3525-0PE24-*A** 6SL3525-0PE25-*A** 6SL3525-0PE27-*A** In a domestic environment this product may cause radio interference in which case supplementary mitigation measures may be required.	**Category C2** First Environment - Professional Use

Harmonic Currents

Table A- 17 Harmonic Currents

Typical Harmonic Current (% of rated input current) at U_K 1 %							
5th	**7th**	**11th**	**13th**	**17th**	**19th**	**23rd**	**25th**
54	39	11	5	5	3	2	2

Note

Units installed within the category C2 (domestic) environment require supply authority acceptance for connection to the public low-voltage power supply network. Please contact your local supply network provider.

Units installed within the category C3 (industrial) environment do not require connection approval.

EMC Immunity

The SINAMICS G120D drives have been tested in accordance with the immunity requirements of category C3 (industrial) environment:

Table A- 18 EMC Immunity

EMC Phenomenon	Standard	Level	Performance Criterion
Electrostatic Discharge (ESD)	EN 61000-4-2	4 kV Contact discharge	A
		8 kV Air discharge	
Radio-frequency Electromagnetic Field	EN 61000-4-3	80 MHz … 1000 MHz 10 V/m	A
Amplitude modulated		80 % AM at 1 kHz	
Fast Transient Bursts	EN 61000-4-4	2 kV @ 5 kHz	A
Surge Voltage	EN 61000-4-5	1 kV differential (L-L)	A
1.2/50 µs		2 kV common (L-E)	
Conducted	EN 61000-4-6	0.15 MHz … 80 MHz 10 V/rms	A
Radio-frequency Common Mode		80 % AM at 1 kHz	
Mains Interruptions & Voltage Dips	EN 61000-4-11	95 % dip for 3 ms	A
		30 % dip for 10 ms	C
		60 % dip for 100 ms	C
		95 % dip for 5000 ms	D
Voltage Distortion	EN 61000-2-4	10 % THD	A
Voltage Unbalance	EN 61000-2-4	3 % Negative Phase Sequence	A
Frequency Variation	EN 61000-2-4	Nominal 50 Hz or 60 Hz (± 4 %)	A
Commutation Notches	EN 60146-1-1	Depth = 40 %	A
		Area = 250 % x degrees	

Note

The immunity requirements apply equally to both filtered and unfiltered units.

A.12 Further information on your inverter

A.12.1 Further information

Table A- 19 Technical Support

<table>
<tr><th>France</th><th>Germany</th><th>Italy</th><th>Spain</th><th>United Kingdom</th></tr>
<tr><td>+33 (0) 821 801 122</td><td>+49 (0)911 895 7222</td><td>+39 (02) 24362000</td><td>+34 902 237 238</td><td>+44 161 446 5545</td></tr>
<tr><td colspan="5">Further service contact information: Support contacts (http://support.automation.siemens.com/WW/view/en/16604999)</td></tr>
</table>

Table A- 20 Manuals with further information

<table>
<tr><th>Information level</th><th>Manual</th><th>Content</th><th>Available languages</th><th>Download or order number</th></tr>
<tr><td>+</td><td>Getting Started</td><td>(this manual)</td><td rowspan="2">English
German
Italian
French
Spanish</td><td rowspan="5">Manuals
Manuals can be download using the following link:
Document download (http://support.automation.siemens.com/WW/view/en/25021636/133300)

SINAMICS Manual Collection (DVD)
The manual collection can be order using the following order number:
• 6SL3298-0CA00-0MG0</td></tr>
<tr><td>++</td><td>Operating instructions - inverter</td><td>Installing, commissioning and operating the inverter.
Description of inverter functions.
Technical data.</td></tr>
<tr><td>+++</td><td>Function Manual Safety Integrated</td><td>Configuring PROFIsafe.
Installing, commissioning and operating the integrated fail-safe function.</td><td rowspan="3">English,
German</td></tr>
<tr><td>+++</td><td>List manual</td><td>Complete list of parameters, alarms and faults.
Graphic function block diagrams.</td></tr>
<tr><td>+++</td><td>Operating instructions - BOP-2, IOP</td><td>Description of operator panel</td></tr>
</table>

Table A- 21 Support when configuring and selecting the converter

Manual or tool	Contents	Available languages	Download or order number
Catalog D 31	Ordering data and technical information for the standard SINAMICS G converters	English, German, Italian, French, Spanish	Everything about SINAMICS G120 (www.siemens.en/sinamics-g120)
Online catalog (Industry Mall)	Ordering data and technical information for all SIEMENS products	English, German	
SIZER	The overall configuration tool for SINAMICS, MICROMASTER and DYNAVERT T drives, motor starters, as well as SINUMERIK, SIMOTION controls and SIMATIC Technology	English, German, Italian, French	You obtain SIZER on a DVD (Order number: 6SL3070-0AA00-0AG0) and in the Internet: Download SIZER (http://support.automation.siemens.com/WW/view/en/10804987/130000)
Configuration Manual	Selecting geared motors, motors, converters and braking resistor based on calculation examples	English, German	Configuration Manual (http://support.automation.siemens.com/WW/view/en/37728795)

A.12.2 Product Support

If you have further questions

You can find additional information on the product and more in the Internet under: Product support (http://support.automation.siemens.com/WW/view/en/4000024).

In addition to our documentation, under this address we offer our complete knowledge base online: You can find the following information:

- Actual product information (Update), FAQ (frequently asked questions), downloads.
- The Newsletter contains the latest information on the products you use.
- The Knowledge Manager (Intelligent Search) helps you find the documents you need.
- Users and specialists from around the world share their experience and knowledge in the Forum.
- You can find your local representative for Automation & Drives via our contact database under "Contact & Partner".
- Information about local service, repair, spare parts and much more can be found under "Services".

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