

ILA2D DeviceNet

Lexium Integrated Drive Product manual

V2.01, 11.2008



Important information

This manual is part of the product.

Carefully read this manual and observe all instructions.

Keep this manual for future reference.

Hand this manual and all other pertinent product documentation over to all users of the product.

Carefully read and observe all safety instructions and the chapter "Before you begin - safety information".

Some products are not available in all countries.

For information on the availability of products, please consult the catalog.

Subject to technical modifications without notice.

All details provided are technical data which do not constitute warranted qualities.

Most of the product designations are registered trademarks of their respective owners, even if this is not explicitly indicated.

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Writing conventions and symbols

Work steps If work steps must be performed consecutively, this sequence of steps is represented as follows:

- Special prerequisites for the following work steps
- ▶ Step 1
- ◁ Specific response to this work step
- ▶ Step 2

If a response to a work step is indicated, this allows you to verify that the work step has been performed correctly.

Unless otherwise stated, the individual steps must be performed in the specified sequence.

Bulleted lists The items in bulleted lists are sorted alphanumerically or by priority. Bulleted lists are structured as follows:

- Item 1 of bulleted list
- Item 2 of bulleted list
 - Subitem for 2
 - Subitem for 2
- Item 3 of bulleted list

Making work easier Information on making work easier is highlighted by this symbol:



Sections highlighted this way provide supplementary information on making work easier.

Parameters In text sections, parameters are shown with the parameter name, for example `POSdirOfRotat`. The way parameters are represented in tables is explained in the chapter Parameters. The parameter list is sorted alphabetically by parameter name.

SI units SI units are the original values. Converted units are shown in brackets behind the original value; they may be rounded.

Example:

Minimum conductor cross section: 1.5 mm² (AWG 14)

1 Introduction

1.1 About this manual

This manual is valid for all ILA2D standard products. This chapter lists the type code for this product. The type code can be used to identify whether your product is a standard product or a customized model.

1.2 Unit overview

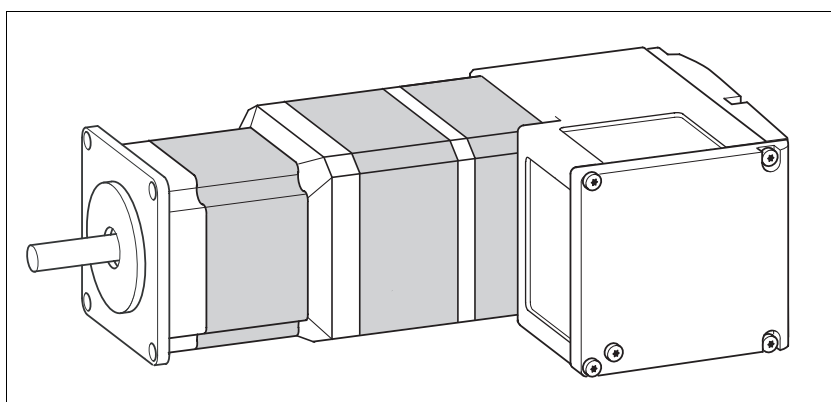


Figure 1.1 Device overview

The "Lexium Integrated Drive" consists of a servo motor and integrated electronics. The product integrates interfaces, control electronics, a holding brake (optional) and the power stage.

Reference value supply

The "Lexium Integrated Drive" moves the motor according to the commands received by a fieldbus master, for example a PLC or a PC.

Safety function

The integrated safety function STO (IEC 61800-5-2) complies with Safety Integrity Level SIL2. The safety function allows for a category 0 stop as per IEC 60204-1 without external power contactors. It is not necessary to interrupt the supply voltage. This reduces the system costs and the response times.

Drive profile

The product supports two different drive profiles:

- CIP "Position Controller Profile"
- Manufacturer-specific drive profile

1.3 Components and interfaces

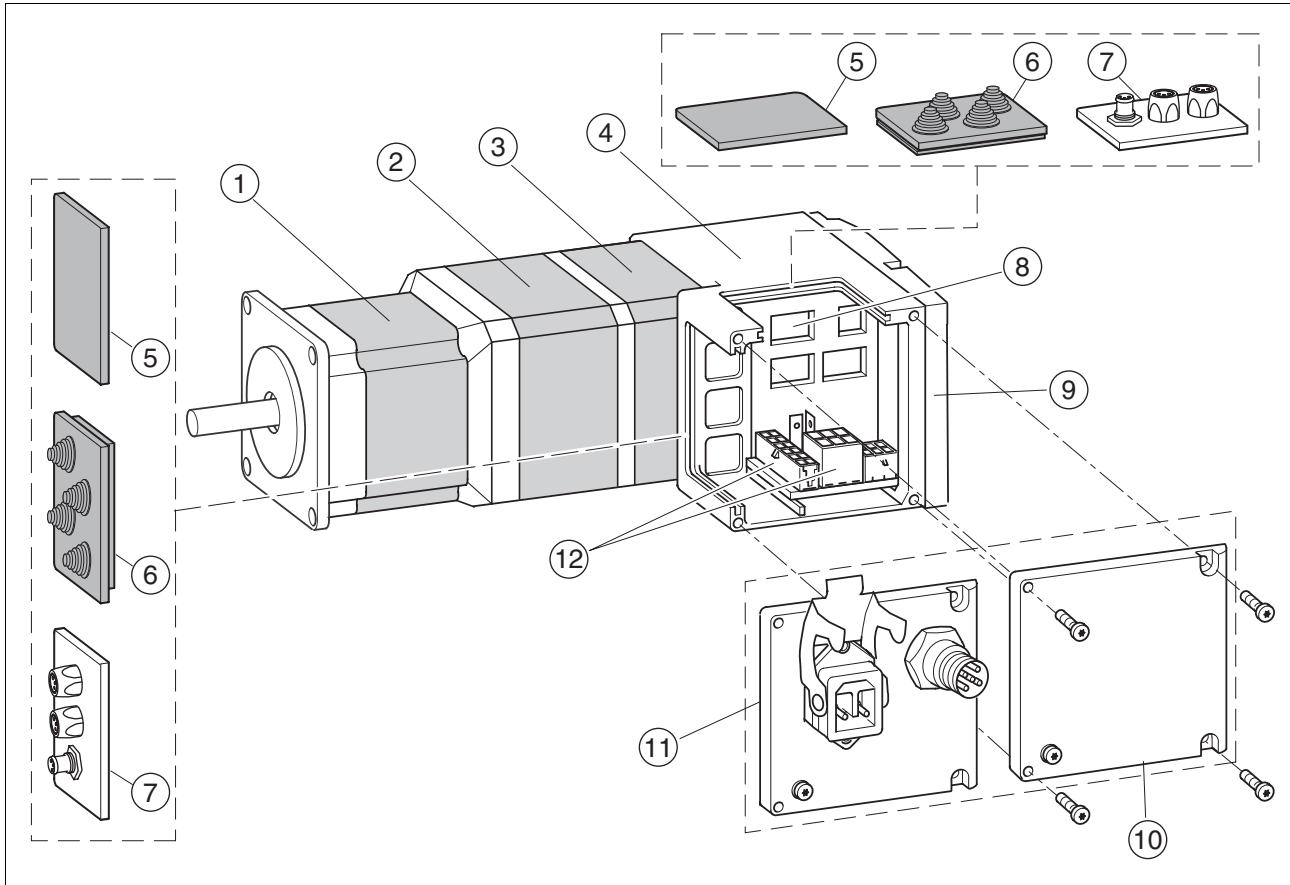


Figure 1.2 Components and interfaces

- (1) AC synchronous servo motor
- (2) Holding brake (optional)
- (3) Encoder
- (4) Electronics housing
- (5) Insert for sealing (accessory)
- (6) Insert with cable entry (accessory)
- (7) I/O insert with industrial connector (accessory)
- (8) Switches for settings
- (9) Cover of electronics housing, must not be removed
- (10) Cover of connector housing, to be removed for installation
- (11) Cover with industrial connector for Vdc supply voltage and IN/OUT fieldbus connection (optional)
- (12) Electrical interfaces

1.3.1 Components

<i>Motor</i>	The motor is a brushless AC synchronous servo motor with 3-phase technology. The motor has a high power density due to the use of the latest magnetic materials and an optimized design.
<i>Electronics</i>	<p>The electronic system comprises control electronics and power stage. Control electronics and power stage have a common power supply and are not galvanically isolated.</p> <p>The product can be parameterized and controlled via the fieldbus interface.</p> <p>4 digital 24V signals are also available. Each of these signals can be used as an input or output.</p>
<i>Encoder</i>	<p>The standard product operates with a singleturn encoder.</p> <p>The singleturn encoder has an internal resolution of 32768 increments per revolution.</p> <p>Scaling of the product is set to 16384 user-defined units per revolution.</p> <p>The product can optionally be equipped with a multiturn encoder. The multiturn encoder covers a range of 4096 motor revolutions.</p>
<i>Holding brake</i>	The product can optionally be equipped with an integrated holding brake. The holding brake is controlled automatically.

1.3.2 Interfaces

<i>Supply voltage VDC</i>	The supply voltage VDC supplies the control electronics and the power stage.
<i>Fieldbus interface</i>	The drive features a DeviceNet fieldbus interface. The DeviceNet fieldbus interface is used for controlling and commissioning the drive.
<i>RS485 interface</i>	<p>An RS485 interface is provided in addition to the fieldbus interface. The RS485 interface is also used to commission the drive.</p> <p>You can also use the RS485 interface and the commissioning software to monitor the drive during operation. It is not possible to establish a simultaneous connection with the fieldbus.</p>
<i>24 V signal interface</i>	<p>4 digital 24V signals are available. Each of these signals can be used as an input or output.</p> <p>The 24V signals are available to the master controller. However, it is also possible to parameterize special functions such as connection of limit switches.</p>

1.4 Nameplate

The nameplate contains the following data:

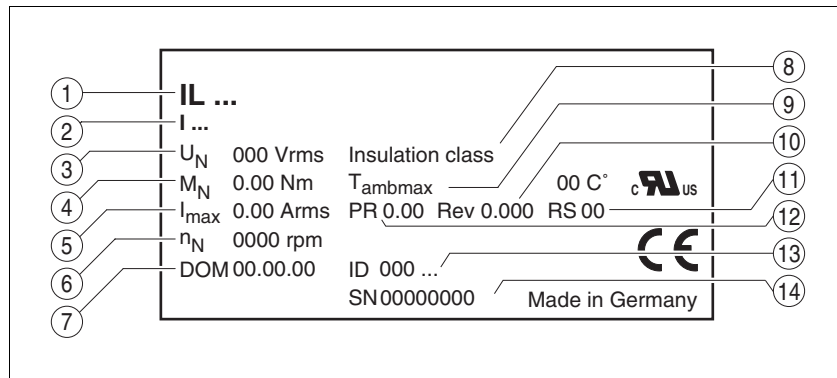


Figure 1.3 Nameplate

- (1) Type code
- (2) Type code (old designation)
- (3) Nominal voltage
- (4) Nominal torque
- (5) Maximum input current
- (6) Nominal speed
- (7) Date of manufacture
- (8) Thermal class
- (9) Maximum ambient air temperature
- (10) Software revision
- (11) Hardware revision
- (12) Firmware number
- (13) Material number
- (14) Serial number

1.5 Type code

	ILA	2	D	57	1	P	B	1	A	0	--
Motor ILA = Servo motor											
Supply voltage 2 = 24 ... 48 V _{dc}											
Communication interface D = DeviceNet											
Size 57 = 57 mm											
Length 1 = 1 stack 2 = 2 stacks											
Winding P = Medium speed of rotation/medium torque T = High speed of rotation/low torque											
Connection version B = Printed circuit board connector C = Industrial connector											
Position capture 1 = Servo Singleturn 2 = Servo Multiturn ¹⁾ .											
Holding brake A = Without holding brake F = With holding brake ²⁾											
Gearbox 0 = Without gearbox											
Reserved											

1) Not available in combination with the holding brake option
 2) Not available in combination with the servo multiturn option.

Customized product In the case of a customized product, position 9 is an "S".
 Positions 10 ... 13 are the number of the customized product.
 Example: IL●●●●●S1234--

1.6 Documentation and literature references

- Source product manuals* The current product manuals are available for download from the Internet.
<http://www.schneider-electric.com>
- Source EPLAN Macros* For easier engineering, macro files and product master data are available for download from the Internet at:
<http://www.schneider-electric.com>
- Reference documents*
- [1] The CIP Networks Library
Volume 1
Common Industrial Protocol
Edition 3.1
 - [2] The CIP Networks Library
Volume 3
DeviceNet Adaption of CIP
Edition 1.3
 - [3] DeviceNet terms of Usage Agreement
ODVA: <http://www.odva.org>
- User Association* **Open DeviceNet Vendor Association (ODVA)**
<http://www.odva.org>
- Additional literature* We recommend the following literature for more in-depth information:
- Ellis, George: Control System Design Guide. Academic Press
 - Kuo, Benjamin; Golnaraghi, Farid: Automatic Control Systems. John Wiley & Sons

1.7 Declaration of conformity



SCHNEIDER ELECTRIC MOTION DEUTSCHLAND GmbH & Co. KG
Breslauer Str. 7 D-77933 Lahr

EC DECLARATION OF CONFORMITY
YEAR 2008

- according to EC Directive Machinery 98/37/EC
 according to EC Directive EMC 2004/108/EC
 according to EC Directive Low Voltage 2006/95/EC

We declare that the products listed below meet the requirements of the mentioned EC Directives with respect to design, construction and version distributed by us. This declaration becomes invalid with any modification on the products not authorized by us.

Designation: Motors with integrated control electronics

Type: ILA, ILE, ILS

Product number: 0x6600xxxxxxx, 0x6610xxxxxxx, 0x66206xxxxxx, 0x66307xxxxxx
0x6640xxxxxxx, 0x66606xxxxxx, 0x66707xxxxxx

Applied harmonized standards, especially: EN ISO 13849-1:2006, Performance Level "d" (category 3)
EN 61800-3:2004, second environment
EN 62061:2005, SILcl 2
EN 61508:2001, SIL 2

Applied national standards and technical specifications, especially: UL 508C
Product documentation

Schneider Electric Motion Deutschland
GmbH & Co. KG

Company stamp: Postfach 11 80 • D-77901 Lahr
Breslauer Str. 7 • D-77933 Lahr

Date/ Signature: 10 July 2008

Name/ Department: Wolfgang Brandstätter/Development

1.8 TÜV certificate for functional safety



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2 Before you begin - safety information

2.1 Qualification of personnel

Only appropriately trained persons who are familiar with and understand the contents of this manual and all other pertinent product documentation are authorized to work on and with this product. In addition, these persons must have received safety training to recognize and avoid hazards involved. These persons must have sufficient technical training, knowledge and experience and be able to foresee and detect potential hazards that may be caused by using the product, by changing the settings and by the mechanical, electrical and electronic equipment of the entire system in which the product is used.

All persons working on and with the product must be fully familiar with all applicable standards, directives, and accident prevention regulations when performing such work.

2.2 Intended use

This product is a motor with an integrated drive and intended for industrial use according to this manual.

The product may only be used in compliance with all applicable safety regulations and directives, the specified requirements and the technical data.

Prior to using the product, you must perform a risk assessment in view of the planned application. Based on the results, the appropriate safety measures must be implemented.

Since the product is used as a component in an entire system, you must ensure the safety of persons by means of the design of this entire system (for example, machine design).

Operate the product only with the specified cables and accessories. Use only genuine accessories and spare parts.

The product must NEVER be operated in explosive atmospheres (hazardous locations, Ex areas).

Any use other than the use explicitly permitted is prohibited and can result in hazards.

Electrical equipment should be installed, operated, serviced, and maintained only by qualified personnel.

2.3 Hazard categories

Safety instructions to the user are highlighted by safety alert symbols in the manual. In addition, labels with symbols and/or instructions are attached to the product that alert you to potential hazards.

Depending on the seriousness of the hazard, the safety instructions are divided into 4 hazard categories.

DANGER

DANGER indicates an imminently hazardous situation, which, if not avoided, **will result** in death or serious injury.

WARNING

WARNING indicates a potentially hazardous situation, which, if not avoided, **can result** in death, serious injury, or equipment damage.

CAUTION

CAUTION indicates a potentially hazardous situation, which, if not avoided, **can result** in injury or equipment damage.

CAUTION

CAUTION used without the safety alert symbol, is used to address practices not related to personal injury (e.g. **can result** in equipment damage).

2.4 Basic information

⚠ DANGER

UNINTENDED CONSEQUENCES OF EQUIPMENT OPERATION

When the system is started, the drives are usually out of the operator's view and cannot be visually monitored.

- Only start the system if there are no persons in the hazardous area.

Failure to follow these instructions will result in death or serious injury.

⚠ WARNING

UNEXPECTED MOVEMENT

Drives may perform unexpected movements because of incorrect wiring, incorrect settings, incorrect data or other errors.

Interference (EMC) may cause unpredictable responses in the system.

- Carefully install the wiring in accordance with the EMC requirements.
- Switch off the voltage at the inputs $\overline{STO_A}$ ($\overline{PWRR_A}$) and $\overline{STO_B}$ ($\overline{PWRR_B}$) to avoid an unexpected restart of the motor before switching on and configuring the product.
- Do not operate the product with unknown settings or data.
- Perform a comprehensive commissioning test.

Failure to follow these instructions can result in death or serious injury.

▲ WARNING**LOSS OF CONTROL**

- The designer of any control scheme must consider the potential failure modes of control paths and, for certain critical functions, provide a means to achieve a safe state during and after a path failure. Examples of critical control functions are EMERGENCY STOP, overtravel stop, power outage and restart.
- Separate or redundant control paths must be provided for critical functions.
- System control paths may include communication links. Consideration must be given to the implication of unanticipated transmission delays or failures of the link.
- Observe the accident prevention regulations and local safety guidelines.¹⁾
- Each implementation of the product must be individually and thoroughly tested for proper operation before being placed into service.

Failure to follow these instructions can result in death or serious injury.

1) For USA: Additional information, refer to NEMA ICS 1.1 (latest edition), Safety Guidelines for the Application, Installation, and Maintenance of Solid State Control and to NEMA ICS 7.1 (latest edition), Safety Standards for Construction and Guide for Selection, Installation for Construction and Operation of Adjustable-Speed Drive Systems.

▲ WARNING**UNEXPECTED BEHAVIOR AND DESTRUCTION OF SYSTEM COMPONENTS**

When you work on the wiring and when you unplug or plug in connectors, this may cause unexpected behavior and destruction of system components.

- Switch the power supply off before working on the wiring.

Failure to follow these instructions can result in death, serious injury or equipment damage.

2.5 Functional safety

Using the safety functions integrated in this product requires careful planning. For more information see chapter 5.4 "Safety function STO ("Safe Torque Off")" on page 60.

2.6 Standards and terminology

Technical terms, terminology and the corresponding descriptions in this manual are intended to use the terms or definitions of the pertinent standards.

In the area of drive systems, this includes, but is not limited to, terms such as "safety function", "safe state", "fault", "fault reset", "failure", "error", "error message", "warning", "warning message", etc.

Among others, these standards include:

- IEC 61800 series: "Adjustable speed electrical power drive systems"
- IEC 61800-7 series: "Adjustable speed electrical power drive systems - Part 7-1: Generic interface and use of profiles for power drive systems - Interface definition"
- IEC 61158 series: "Industrial communication networks - Fieldbus specifications"
- IEC 61784 series: "Industrial communication networks - Profiles"
- IEC 61508 series: "Functional safety of electrical/electronic/programmable electronic safety-related systems"

Also see the glossary at the end of this manual.

3 Technical Data

This chapter contains information on the ambient conditions and on the mechanical and electrical properties of the product family and the accessories.

3.1 Certifications

Product certifications:

Certified by	Assigned number	Validity
TÜV Nord	SAS-1728/08	2013-01-09
ODVA File Number	10547	
UL	File E 153659	

Certified safety function This product has the following certified safety function:

- Safety function STO "Safe Torque Off" (IEC 61800-5-2)

3.2 Ambient conditions

Ambient temperature during operation

The maximum permissible ambient temperature during operation depends on the distance between the devices and the required power. Observe the pertinent instructions in the chapter Installation.

Operating temperature ^{1) 2)}	[°C]	0 ... 40
Operating temperature with current reduction of 2 % per Kelvin ¹⁾	[°C]	40 ... 55

1) Limit values with flanged motor (steel plate 300x300x10 mm)

2) If the product is to be used in compliance with UL 508C, note the information provided in chapter 3.5 "Conditions for UL 508C".

Ambient conditions transportation and storage

The environment during transport and storage must be dry and free from dust. The maximum vibration and shock load must be within the specified limits.

Temperature	[°C]	-25 ... +70
-------------	------	-------------

Temperature

Max. temperature of power stage ¹⁾	[°C]	105
Max. temperature of motor ²⁾	[°C]	110

1) Can be read via parameter

2) Measured on the surface

Relative humidity

The following relative humidity is permissible during operation:

Relative humidity	[%]	15 ... 85
-------------------	-----	-----------

Installation altitude The installation altitude is defined as height above sea level.

Installation altitude	[m]	≤1000
-----------------------	-----	-------

Vibration and shock

Vibration, sinusoidal	As per IEC/EN 60068-2-6 0.15 mm (from 10 Hz ... 60 Hz) 20 m/s ² (from 10 Hz ... 500 Hz)
-----------------------	--

Shock, semi-sinusoidal	As per IEC/EN 60068-2-27: 150 m/s ² (11 ms)
------------------------	---

EMC

Emission	IEC/EN 61800-3: Class C2 EN 61000-6-4 EN 55022: Class A
----------	---

Noise immunity	IEC/EN 61800-3: Second environment
----------------	------------------------------------

3.3 Mechanical data

3.3.1 Degree of protection

IP degree of protection The product has the following IP degree of protection as per EN 60529.

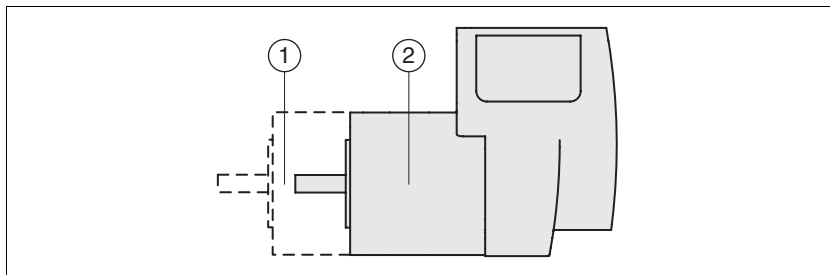


Figure 3.1 IP degree of protection

Item	Degree of protection
1 Shaft bushing	IP41
Shaft bushing with GBX gear (accessory)	IP54
2 Housing, except shaft bushing	IP54

The total degree of protection is determined by the component with the lowest degree of protection.

Overview of IP degrees of protection

First digit	Second digit
Protection against intrusion of objects	Protection against intrusion of water
0 No protection	0 No protection
1 External objects >50 mm	1 Vertically falling dripping water
2 External objects >12 mm	2 Dripping water falling at an angle (75 ° ... 90 °)
3 External objects >2.5 mm	3 Spraying water
4 External objects >1 mm	4 Splashing water
5 Dust-protected	5 Water jets
6 Dust-tight	6 Heavy sea
	7 Immersion
	8 Submersion

Degree of protection if STO is used

You must ensure that conductive substances cannot get into the product (pollution degree 2). If you use the safety function and conductive substances get into the product, the safety function may become inoperative.

3.3.2 Mounting position

Mounting position The following mounting positions are defined and approved as per EN 60034-7:

- IM B5 drive shaft horizontal
- IM V1 drive shaft vertical, shaft end down
- IM V3 drive shaft vertical, shaft end up

3.3.3 Dimensions

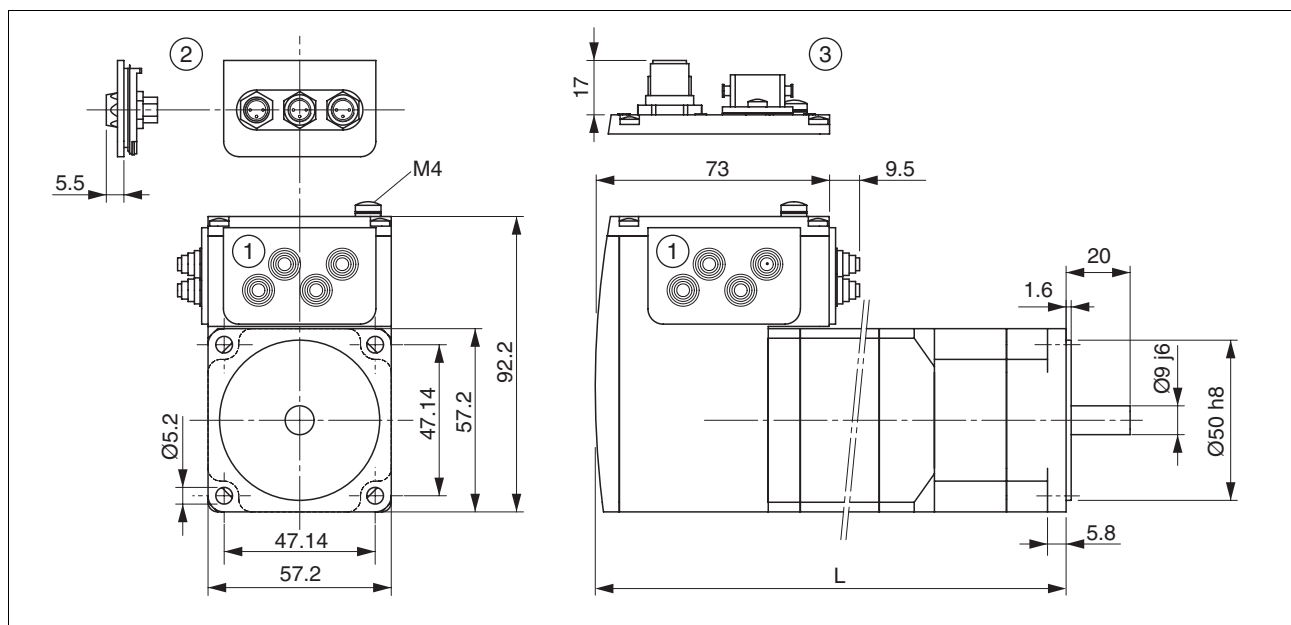


Figure 3.2 Dimensions

- (1) Insert with cable entry (accessory)
- (2) Insert kit (accessory)
- (3) Industrial connector (option)

Total length L

ILA••571...	••1A0	••2A0	••1F0
L [mm]	145.3	179.3	190.8

ILA••572...	••1A0	••2A0	••2F0
L [mm]	163.8	197.8	209.3

3.4 Electrical Data

Overview of printed circuit board connectors

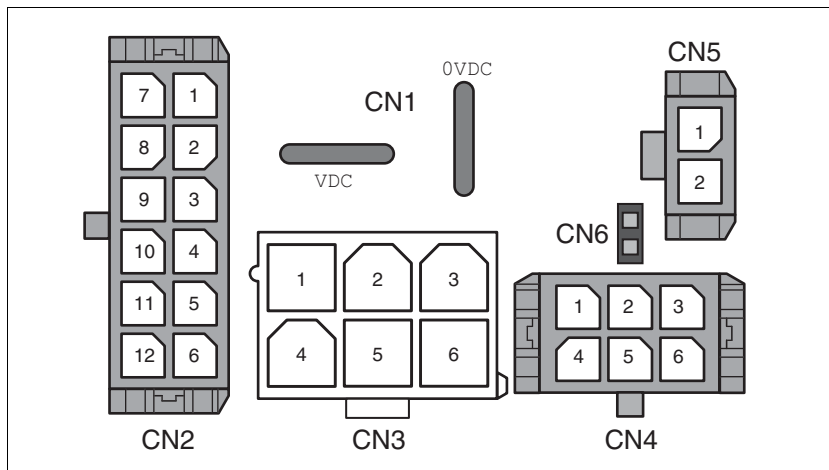


Figure 3.3 Overview of printed circuit board connectors

3.4.1 Supply voltage VDC at CN1

		ILA2•571	ILA2•572
Nominal voltage ¹⁾	[V _{dc}]	24 / 48	24 / 48
Limit values ¹⁾	[V _{dc}]	18 ... 55.2	18 ... 55.2
Ripple at nominal voltage	[V _{pp}]	≤3.6	≤3.6
Max. continuous current input ²⁾	[A]		
Winding type P		5	7
Winding type T		7.5	7.5
Peak input current	[A]		
Winding type P		7	8.5
Winding type T		11	9
Fuse to be connected upstream ³⁾	[A]	≤16	≤16

1) If the product is to be used in compliance with UL 508C, note the information provided in chapter 3.5 "Conditions for UL 508C".

2) The actual power requirement is often significantly lower, because the maximum possible motor torque is usually not required for operation of a system.

3) See chapter 5.2.1 "Supply voltage"

Inrush current Charging current for capacitor C=1500 µF

3.4.2 Fieldbus at CN2

DeviceNet signals The DeviceNet signals conform to the DeviceNet standard and are galvanically isolated.

Transmission rate	[kBaud 125 / 250 / 500]
Transmission protocol	DeviceNet

3.4.3 Reference value supply at CN2

Pulse/direction, A/B/I input signals The pulse/direction and A/B/I signals conform to the RS422 interface specifications

Symmetrical	Conforming to RS422	
Input resistance	[kΩ]	5
Input frequency pulse/direction	[kHz]	≤400
Input frequency A/B	[kHz]	≤400

3.4.4 Commissioning at CN3

RS485 signals The RS485 signals conform to the RS485 standard and are not galvanically isolated.

Transmission rate	[kBaud	9.6 / 19.2 / 38.4
]	
Transmission protocol	Modbus RTU	

3.4.5 24V signals at CN4

Signal inputs The signal inputs are not protected against reverse polarity and not galvanically isolated.

Logic 0 (U_{low})	[V]	-3 ... +4.5
Logic 1 (U_{high})	[V]	+15 ... +30
Input current (typical at 24 V)	[mA]	2
Debounce time LIO1 ... LIO4	[ms]	1.25 ... 1.5
Debounce time LIO1 and LIO2 ¹⁾	[ms]	0.01
Jitter LIO1 and LIO2 ¹⁾	[μs]	<2

1) When the function "Fast Position Capture is used"

Signal outputs The signal outputs are short-circuit protected and not galvanically isolated.

Nominal voltage	[V]	24
Voltage range	[V]	23 ... 25
Maximum current per output	[mA]	100
Maximum total current	[mA]	200
Suitable for inductive loads	[mH]	1000
Voltage drop at 50 mA load	[V]	≤1

3.4.6 STO safety function at CN5 and CN6

The signal inputs are not galvanically isolated.

Logic 0 (U_{low})	[V]	-3 ... +4.5
Logic 1 (U_{high})	[V]	+15 ... +30
Input current $\overline{STO_A}$ ($\overline{PWRR_A}$) (typical at 24 V)	[mA]	≤10
Input current $\overline{STO_B}$ ($\overline{PWRR_B}$) (typical at 24 V)	[mA]	≤3
Debounce time	[ms]	1 ... 5
Detection of signal difference between $\overline{STO_A}$ ($\overline{PWRR_A}$) and $\overline{STO_B}$ ($\overline{PWRR_B}$)	[s]	<1
Response time (until shutdown of power stage)	[ms]	<50
Permitted test pulse width of upstream devices	[ms]	<1

*Data for maintenance plan and
safety calculations*

Use the following data of the STO safety function for your maintenance plan and the safety calculations:

Lifetime (IEC 61508)		20 years
SFF (IEC 61508) Safe Failure Fraction	[%]	47
HFT (IEC 61508) Hardware Fault Tolerance Type A subsystem		1
Safety integrity level IEC 61508 IEC 62061		SIL2 SILCL2
PFH (IEC 61508) Probability of Dangerous Hard- ware Failure per Hour	[1/h]	$5.223 \cdot 10^{-9}$
PL (ISO 13849-1) Performance Level		d (Category 3)
MTTF _d (ISO 13849-1) Mean Time to Dangerous Failure		1995 years
DC (ISO 13849-1) Diagnostic Coverage	[%]	90

3.5 Conditions for UL 508C

If the product is used to comply with UL 508C, the following conditions must be met:

Ambient temperature during operation

Surrounding air temperature	[°C]	0 ... +40
-----------------------------	------	-----------

Surrounding air temperature with current reduction of 2% per Kelvin ¹⁾	[°C]	40 ... 55
---	------	-----------

Pollution degree Use in an environment with pollution degree 2.

Power supply Use only power supply units that are approved for overvoltage category III.

The supply voltage must not exceed 42 V_{dc}.

Wiring Use only 60/75 °C copper conductors.

4 Basics

4.1 Functional safety

Automation and safety engineering are two areas that were completely separated in the past but recently have become more and more integrated. Engineering and installation of complex automation solutions are greatly simplified by integrated safety functions.

Usually, the safety engineering requirements depend on the application. The level of the requirements results from the risk and the hazard potential arising from the specific application.

Working with IEC 61508

IEC 61508 standard

The standard IEC 61508 "Functional safety of electrical/electronic/programmable electronic safety-related systems" covers the safety-related function. Instead of a single component, an entire function chain (for example, from a sensor through the logical processing units to the actuator) is considered as a unit. This function chain must meet the requirements of the specific safety integrity level as a whole. Systems and components that can be used in various applications for safety tasks with comparable risk levels can be developed on this basis.

SIL, Safety Integrity Level

The standard IEC 61508 defines 4 safety integrity levels (SIL) for safety functions. SIL1 is the lowest level and SIL4 is the highest level. A hazard and risk analysis serves as a basis for determining the required safety integrity level. This is used to decide whether the relevant function chain is to be considered as a safety function and which hazard potential it must cover.

PFH, Probability of a dangerous hardware failure per hour

To maintain the safety function, the IEC 61508 standard requires various levels of measures for avoiding and controlling faults, depending on the required SIL. All components of a safety function must be subjected to a probability assessment to evaluate the effectiveness of the measures implemented for controlling faults. This assessment determines the PFH (probability of a dangerous failure per hour) for a safety system. This is the probability per hour that a safety system fails in a hazardous manner and the safety function cannot be correctly executed. Depending on the SIL, the PFH must not exceed certain values for the entire safety system. The individual PFH values of a function chain are added; the total PFH value must not exceed the maximum value specified in the standard.

SIL	PFH at high demand or continuous demand
4	$\geq 10^{-9} \dots < 10^{-8}$
3	$\geq 10^{-8} \dots < 10^{-7}$
2	$\geq 10^{-7} \dots < 10^{-6}$
1	$\geq 10^{-6} \dots < 10^{-5}$

HFT and SFF Depending on the SIL for the safety system, the IEC 61508 standard requires a specific hardware fault tolerance HFT in connection with a specific proportion of safe failures SFF (safe failure fraction). The hardware fault tolerance is the ability of a system to execute the required safety function in spite of the presence of one or more hardware faults. The SFF of a system is defined as the ratio of the rate of safe failures to the total failure rate of the system. According to IEC 61508, the maximum achievable SIL of a system is partly determined by the hardware fault tolerance HFT and the safe failure fraction SFF of the system.

IEC 61508 distinguishes two types of subsystems (type A subsystem, type B subsystem). These types are specified on the basis of criteria which the standard defines for the safety-relevant components.

SFF	HFT type A subsystem			HFT type B subsystem		
	0	1	2	0	1	2
< 60%	SIL1	SIL2	SIL3	---	SIL1	SIL2
60% ... <90%	SIL2	SIL3	SIL4	SIL1	SIL2	SIL3
90% ... < 99%	SIL3	SIL4	SIL4	SIL2	SIL3	SIL4
≥99%	SIL3	SIL4	SIL4	SIL3	SIL4	SIL4

Fault avoidance measures Systematic errors in the specifications, in the hardware and the software, usage faults and maintenance faults of the safety system must be avoided to the maximum degree possible. To meet these requirements, IEC 61508 specifies a number of measures for fault avoidance that must be implemented depending on the required SIL. These measures for fault avoidance must cover the entire life cycle of the safety system, i.e. from design to decommissioning of the system.

4.2 DeviceNet fieldbus

4.2.1 DeviceNet technology

The ODVA (**O**pen **D**evice**N**et **V**endor **A**ssociation) is in charge of the specifications for the DeviceNet network and DeviceNet devices. For more information on the ODVA see: <http://www.odva.org>

Number of nodes Up to 64 nodes can operate in a DeviceNet network (0 - 63).

Cable length The maximum cable length in the individual network segments depends on the baud rate and the conductor cross section.

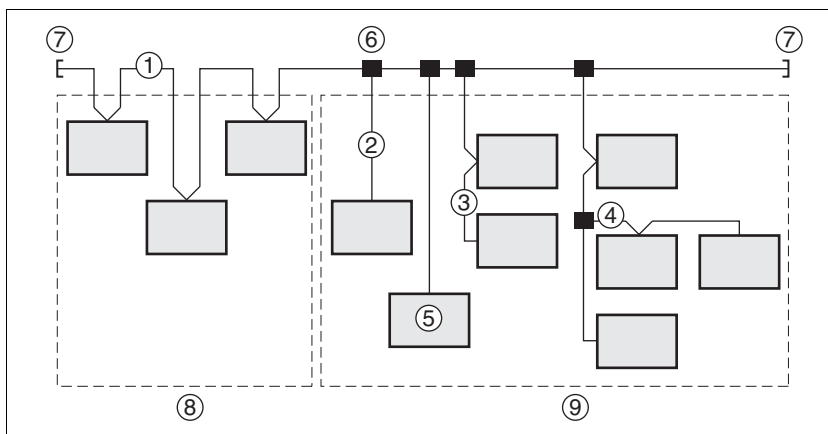


Figure 4.1 A possible DeviceNet structure

- (1) Trunk Line
- (2) Drop Line, 0 - 6 m
- (3) Daisy Chain Drop-Off
- (4) Branched Drop-Off
- (5) Network Node
- (6) Trunk Line Tap Junction
- (7) Terminating Resistor
- (8) Zero Drop
- (9) Short Drops

Cable type	125 kbit/s	250 kbit/s	500 kbit/s
Total length of thick trunk line	500m	250 m	100m
Total length of thin trunk line	100m	100m	100m
Total length of flat trunk line	420 m	200m	75 m
max. length of a drop line	6 m	6 m	6 m
max. length of all drop lines	156 m	78 m	39 m

The "thick trunk" cable consists of two shielded, twisted lines containing a wire in the center of the cable. The shield is on the outside. The cable is not branched.

The "thin trunk" cable has a more flexible design. Ts easier to install. The cable is used as a drop line and can also be used as a trunk line for short distances.

Drive profile The product supports two different drive profiles:

- CIP "Position Controller Profile"
- Manufacturer-specific drive profile

The chapter 8 "Operation" describes the manufacturer-specific drive profile. Information on the "Position Controller Profile" drive profile is provided exclusively in chapter 8.7 "Drive profile Position Controller Profile".

Properties The product supports the following communication equipment from the DeviceNet specification:

- CIP "Position Controller" Profil (Device Type = 10_h)
- Group 2 Server
- UCCM-capable device
- Predefined master/slave connections
 - Explicit Message
 - Polled I/O Connection
 - Full "fragmentation protocol" support
 - Dynamic creation of two explicit messages and an I/O message
- Heartbeat message
- Shutdown message

Data Link Layer The DeviceNet data link layer uses the transmission mechanisms of the CAN specification. This makes it possible to use a wide selection of available CAN controllers.

Physical Layer The DeviceNet physical layer uses twisted wire pairs. The data is transmitted via one wire pair. The second wire pair is connected to the supply voltage. This means that devices with their own power supply and devices that are powered by DeviceNet (e.g. I/O nodes) can be connected. The DeviceNet must be terminated at both ends with a 120Ω resistor.

Another feature of DeviceNet is that devices can be inserted or removed during operation. It is not necessary to shut down the bus.

Object model The following object classes from the CIP object model are available:

Object class	Class ID	Instance ID
Identity Object	1	1
Message Router Object	2	1
DeviceNet Object	3	1
Assembly Object	4	101 Standard Output Assembly 111 Standard Input Assembly 102 Extended Output Assembly 112 Extended Input Assembly
Connection Object	5	1 = Explicit Message 2 = Poll Connection 5+6 = Dyn. Explicit Connection 7 = Dyn. I/O connection
Position Controller Supervisor Object	36	1
Position Controller Object	37	1
Acknowledge Handler Object	43	1
Vendor-specific objects	101...199	1

The vendor-specific class IDs 101 to 199 correspond to the object dictionary (class ID = object group + 100). The attributes of a class correspond to the subindex entry within the object group.

Communication model DeviceNet uses the producer-consumer communication model. All nodes check the bus line as to whether a data packet with their identifiers is available. Data packets that are sent by producers can only be received by the consumers of these packets.

Master-slave, multi-master and peer-to-peer topologies can be implemented in the DeviceNet.

Groups of connections DeviceNet is a connection-oriented network. Connections must be established and managed between two nodes. The connection ID is contained in the 11 bit CAN identifier. There are 4 connection groups with different priorities:

Group 1	Top-priority process data (highest priority)
Group 2	For simple master-slave connections
Group 3	For explicit messages
Group 4	Reserved group (lowest priority)

Device profile Device profiles are definitions for various types of nodes. The device profile of a node is described in Electronic Data Sheets (EDS). There are predefined device profiles for:

- Digital I/O nodes
- Analog I/O nodes
- Generic profile, adaptable and suitable for all DeviceNet slaves
- Position profiles
- Motor controllers

Electronic Data Sheet An EDS file is a file in ASCII format. This file contains device-specific and vendor-specific descriptions of all parameters for a device. The EDS file also contains the fieldbus-specific communication parameters. The EDS file is required for commissioning.

4.2.2 Message types

DeviceNet defines multiple access methods for communication. The product described here uses the "Explicit Message" and "I/O Message" access methods.

Explicit Message An access is a write or read access to a single parameter. This chapter describes the use of the "Explicit Messages" on the basis of just a small number of messages since this type of communication can be used with all available parameters in the same way.

I/O Message The "I/O Message" is used for positioning mode since it allows information to be transmitted in a much more compact form. "I/O Messages" contain time-critical data that are specifically compiled for a use case. "I/O Messages" have a high-priority identifier so their transmission via the bus has top priority. The parameters for configuring DeviceNet communication are described in 7 "Commissioning". Chapter 9 "Examples" provides hands-on application examples.

Command processing: Transmit data and receive data The master sends a command to the drive system (slave) to execute a motion command, activate operating modes or request information from the slave. The slave executes the command and acknowledges it with a result message or an error message.

The master device can send new commands as soon as it has received acknowledgement concerning the current command. Acknowledgement information and error messages are included in the transmitted data in bit-coded form.

The master must then continuously monitor for completion of the processing command by evaluating the receive data of the slave.

4.2.3 Data structure

The data frame with transmit and receive data and all byte, word and double-word values are shown in hexadecimal notation. Hexadecimal values are indicated as such by means of an "h" behind the numerical value, e.g. "31_h", decimal values have no special identification. Note the different counting format of bits (0 ... 7, right to left) and bytes (0-xx, left to right)

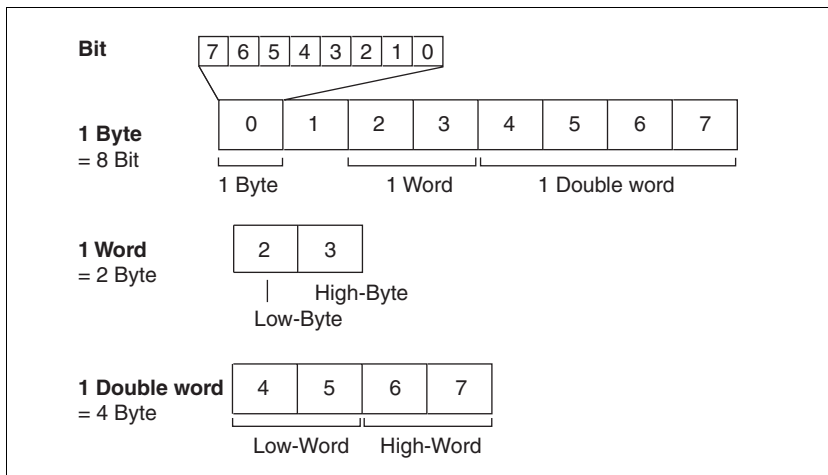


Figure 4.2 General data structure from the bit to the double word

The figure shows the bus view.

In the case of the Big Endian format, the bytes are transmitted one after the other from 0 to 7.

In the case of the Little Endian format, low-byte / high-byte and low-word / high-word are transmitted in a reversed way.

Byte sequence There are two type of byte sequence: Little Endian / Intel format and Big Endian / Motorola format.

Unless explicitly specified otherwise, this manual uses the Big Endian format from the perspective of the DeviceNet scanner.



The byte sequence is entered in "Big Endian" format (Motorola format) in the DeviceNet scanner, but is transmitted via the bus in "Little Endian" format (Intel format). The representation is therefore different on the DeviceNet scanner and on the fieldbus monitor!

The data is transmitted via the buis left-aligned in Little Endian format, i.e. numerical values greater than one byte are transmitted with the low-est-value byte first.

4.2.4 Communication via "Explicit Message"

A single parameter (DeviceNet-specific or vendor-specific) is read or written using an Explicit Message. For an overview of all parameters, see chapter For an overview of all parameters, see chapter 11 "Parameters"..

This chapter provides an example of communication via Explicit Messages in the form of a read request and a write request. This type of communication is identical for all parameters.

4.2.4.1 Reading a parameter

Task The master (MAC ID 2) is to read the parameter `n_act` of the slave (MAC ID 10).

- `Class.Instance.Attribute = 130.1.8 = 82h.01h.08h`

Transmit data

Data 0	Data 1	Data 2	Data 3	Data 4
0A _h	0E _h	82 _h	01 _h	08 _h

Data 0: 0A_h = Frag = 0, XID = 0, Destination MAC ID 0A

Data 1: 0E_h = Service Code = Get_Attribute_Single Request

Data 2: 82_h = Class 130

Data 3: 01_h = Instance 1

Data 4: 08_h = Attribute 8

Receive data

Data 0	Data 1	Data 2	Data 3
02 _h	8E _h	02 _h	58 _h

Data 0: 02_h = Frag = 0, XID = 0, Destination MAC ID 2

Data 1: 8E_h = Get_Attribute_Single successful Response

Data 2+3: 0258_h = 600

4.2.4.2 Writing parameters

Task The master (MAC ID 2) is to set the parameter `RAMPsym` of the slave (MAC ID 10) to the value 1000.

- `Class.Instance.Attribute = 106.1.1 = 6Ah.01h.01h`
- `Value = 1000 = 03E8h`

Transmit data

Data 0	Data 1	Data 2	Data 3	Data 4	Data 5	Data 6
0Ah	10h	6Ah	01h	01h	03h	E8h

Data 0: 0Ah = Frag = 0, XID = 0, Source MAC ID 10
 Data 1: 10h = Service Code = Set_Attribute_Single
 Data 2: 6Ah = Class 106
 Data 3: 01h = Instance 1
 Data 4: 01h = Attribute 1
 Data 5+6: 03E8h = Value 1000

Receive data

Data 0	Data 1
02h	90h

Data 0: 02h = Frag = 0, XID = 0, Destination MAC ID = 02
 Data 1: 90h = Set_Attribute_Single successful Response

4.2.4.3 Synchronous errors

If a write or read command is unsuccessful, the product responds with an error telegram (error response). The transmitted error number provides information on the exact cause.

Task The master (MAC ID 2) is to set the parameter `n_act` of the slave (MAC ID 10) to a random value.

- Class.Instance.Attribute = 130.1.8 = 82_h.01_h.08_h
- Value = any

Transmit data

Data 0	Data 1	Data 2	Data 3	Data 4	Data 5	Data 6
0A _h	10 _h	82 _h	01 _h	08 _h	xx _h	xx _h

Data 0: 0A_h = Frag = 0, XID = 0, Source MAC ID 10
 Data 1: 10_h = Service Code = Set_Attribute_Single
 Data 2: 82_h = Class 130
 Data 3: 01_h = Instance 1
 Data 4: 08_h = Attribute 8
 Data 5+6: any

Receive data

Data 0	Data 1	Data 2	Data 3
02 _h	94 _h	0E _h	FF _h

Data 0: 02_h = Frag = 0, XID = 0, Destination MAC D 2
 Data 1: 94_h = Set_Attribute_Single Error Response
 Data 2: 0E_h = Error Code
 Data 3: FF_h = Additional code (object-specific)
 Data 2+3: 0EFF_h = Attribute not settable

A list of synchronous error messages in data byte 2 can be found in chapter 10 "Diagnostics and troubleshooting".

4.2.5 Communication via "I/O Message"

An "I/O Message" is used for real-time exchange of process data. This type of connection is ideal for positioning mode. Transmission is very fast because the data is sent without administration data and an acknowledgement from the recipient is not required.

The master can control the operating state of the slave by means of "I/O Messages", e.g. enable and disable the power stage, trigger a "Quick Stop", reset faults and activate operating modes.

Changing operating states and activating operating modes must be executed separately. An operating mode can normally only be activated if the operating state is already "Operation Enable".

A new operating mode can only be activated when the motor is at a standstill.

Output - Input Output and input represent the data direction from the master's perspective.

- Output: Commands from the master to the slave
- Input: Status messages from the slave to the master

Assembly I/O messages contain a summary (assembly) of different parameters that are transmitted with a single message.

The following assemblies are permanently defined:

- Standard Assemblies
 - Output Assembly 101
 - Input Assembly 111
- Extended Assemblies
 - Output Assembly 102
 - Input Assembly 112

Polled I/O Connection The assemblies are used in a polled I/O connection. A polled I/O connection is initiated by the master with a poll command. The Slave responds with a poll response.

Hands-on examples for using the assemblies can be found in chapter 9 "Examples".

4.2.5.1 Output Assemblies

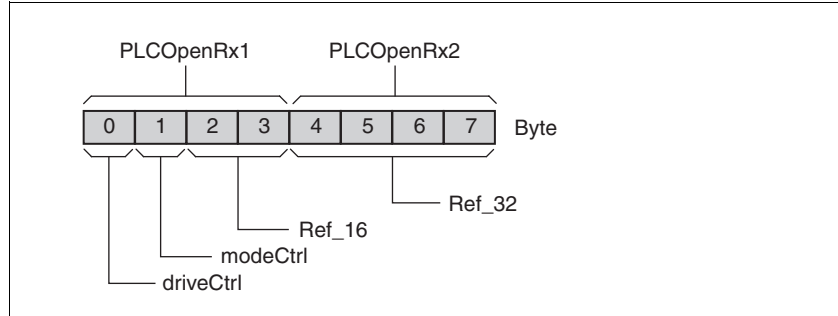
Standard Output Assembly

Figure 4.3 Output Assembly 101

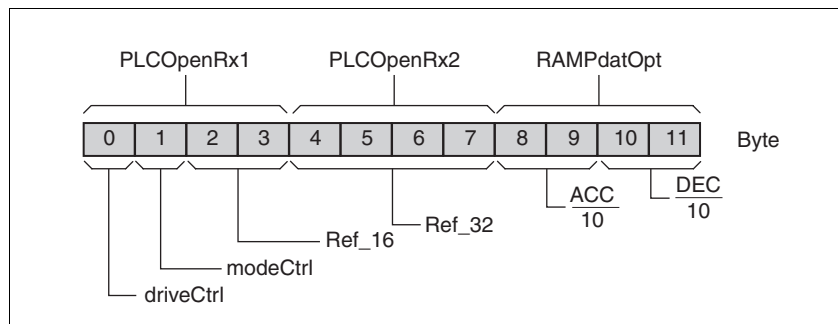
Extended Output Assembly

Figure 4.4 Output Assembly 102

- driveCtrl* The operating state is set with the "driveCtrl" byte.
For a detailed description of the bits, see chapter 8.3.3 "Changing operating states".
- modeCtrl* The operating mode is set with the "modeCtrl" byte.
For a detailed description of the bits, see chapter 8.4.2 "Starting and changing an operating mode".
- Ref_16* The reference value for the speed of rotation is set with the "Ref_16" word. The reference value depends on the operating mode. See the chapter on the operating mode for a description.
- Ref_32* The double word "Ref_32" is used to set the reference value for the target position. The reference value depends on the operating mode. See the chapter on the operating mode for a description.
- ACC/DEC* The double word "ACC/DEC" is used to set motor-optimized acceleration and deceleration. The value corresponds to the parameter RAMPaccdec.

4.2.5.2 Input Assemblies

Standard Input Assembly

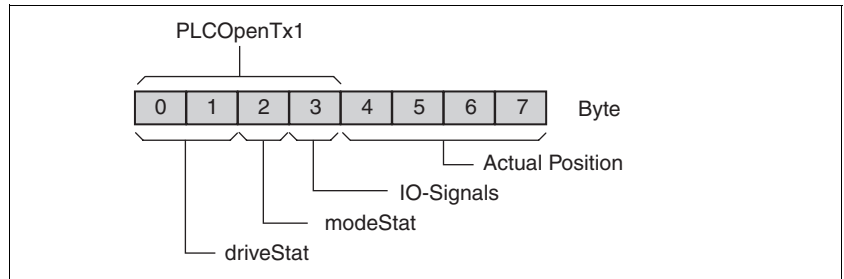


Figure 4.5 Input Assembly 111

Extended Input Assembly

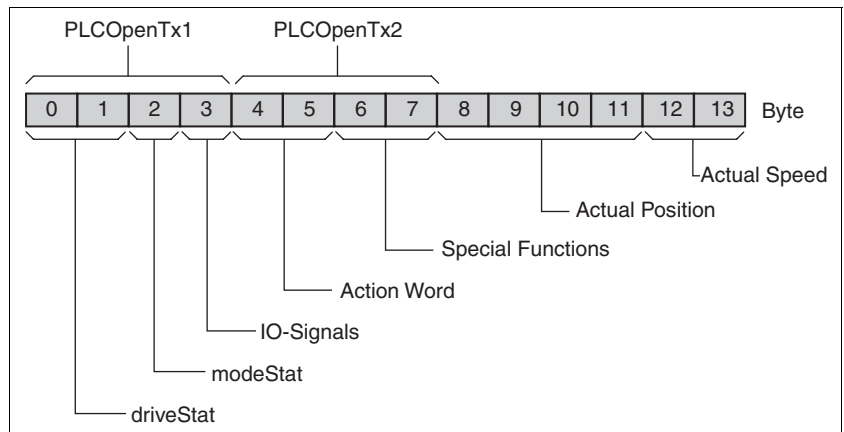


Figure 4.6 Input Assembly 112

driveStat The current operating state is indicated with the "driveStat" word.

For a detailed description of the bits, see chapter 8.3.2 "Indicating the operating states".

modeStat The current operating mode is indicated with the "modeStat" byte.

For a detailed description of the bits, see chapter 8.4.1 "Displaying and monitoring the operating mode".

I/O signals The "I/O signals" byte is used to indicate the status of the digital signal inputs / outputs.

Bit	Pin	Signal	Factory setting
0	CN4.3	LIO1	Positive limit switch (LIMP)
1	CN4.6	LIO2	Negative limit switch (LIMN)
2	CN4.2	LIO3	No function / free available
3	CN4.5	LIO4	Reference switch (REF)
4	CN5.1	$\overline{STO_A}$ ($\overline{PWRR_A}$)	Safety function STO ¹⁾
5	CN5.2	$\overline{STO_B}$ ($\overline{PWRR_B}$)	Safety function STO ¹⁾
6	-	-	Not assigned
7	-	-	Not assigned

1) Cannot be modified

Action Word The "Action Word" is used to provide information on the motor and profile generator.

Bit	Meaning
0 ... 4	Error class
5	Reserved
6	Motor at standstill, actual speed = 0
7	MOTP: Motor rotates clockwise (positive)
8	MOTN: Motor rotates counterclockwise (negative)
9 ... 10	Reserved
11	TAR0: Profile generator at standstill, reference speed of rotation = 0
12	DEC: Profile generator decelerates
13	ACC: Profile generator accelerates
14	CONST: Profile generator moves at constant speed
15	Reserved

Special Functions The "Special Functions" word is used to get the data of the event counter of the "Fast Position Capture" function.

For a description of the function, see chapter 8.6.6 "Fast position capture".

Bit	Meaning
0 ... 1	Bits 0 and 1 of the parameter <code>Cap1Count</code>
2 ... 3	Bits 0 and 1 of the parameter <code>Cap2Count</code>
4 ... 15	Reserved

Actual position The current motor position is indicated with the double word "Actual Position". The value corresponds to the parameter `_p_actusr`.

Actual speed The current speed is indicated with the word "Actual Speed". The value corresponds to the parameter `_n_act`.

4.2.6 Handshake with Mode Toggle Bit

Mode Toggle Synchronized processing can be carried out with the transmit data in byte "modeCtrl" bit "Mode Toggle" and the receive data in byte "modeStat" bit "Mode Error" and bit "Mode Toggle". Synchronized processing means that the master waits for feedback messages from the slave so it can respond appropriately.

Example 1: Positioning The master starts a positioning task. At points in time $t_1, t_2 \dots$, the master checks the responses from the slave. It waits for the end of positioning. The end is identified by bit "x_end" = 1.

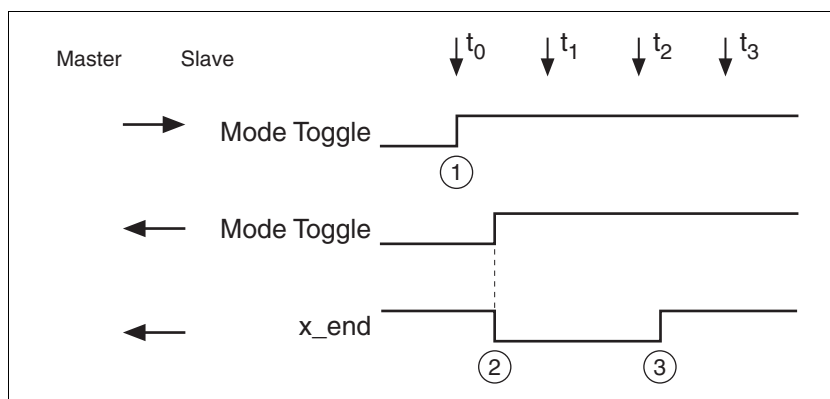


Figure 4.7 Mode Toggle Handshake

- (1) Master starts positioning with "Mode Toggle" = 1
- (2) Slave signals that positioning is running with "Mode Toggle" = 1; at the same time "x_end" = 0
- (3) Slave signals that positioning is ended with "x_end" = 1

Example 2: Short-time positioning The master starts a positioning movement that will only take a very short time. The duration is shorter than the polling cycle of the master. At point in time t_1 the movement is already complete. Using bit "x_end", the master does not know whether the movement is already complete or has not yet been started. However, it can identify this with the "Mode Toggle" bit.

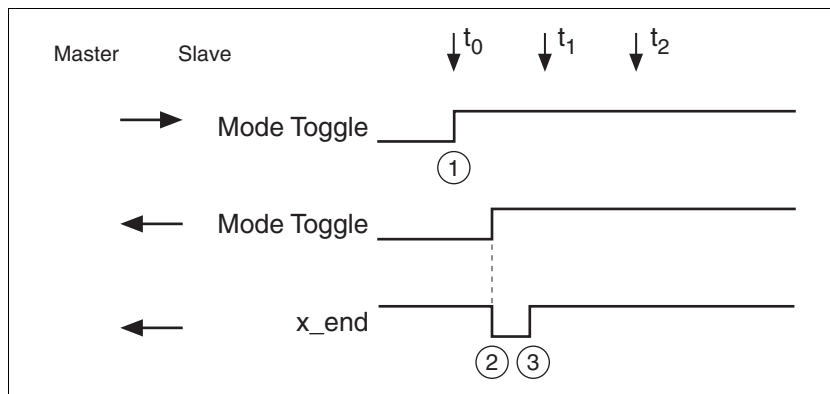


Figure 4.8 Mode Toggle Handshake, short movement

- (1) Master starts positioning with "Mode Toggle" = 1
- (2) Slave signals that positioning is running with "Mode Toggle" = 1; at the same time "x_end" = 0
- (3) Slave signals that positioning is ended with "x_end" = 1

4.2.7 Communication parameters

This chapter describes the communication parameters supported by the product.

The following DeviceNet classes are supported:

- Identity
- Message Router
- DeviceNet
- Assembly
- DeviceNet Connection
- Acknowledge Handler
- Position Controller Supervisor
- Position Controller
- Vendor-specific objects

Acronyms NV: Non-Volatile, persistent
 V: Volatile, not persistent
 RO: Read Only
 RW: Read Write

4.2.7.1 Identity object

Class ID 1 (01_h)

The Identity object contains the identification data of the product. The object defines an instance with ID 1.

Class attributes

ID	Access	Name	Data type	Description	Value
1	Get (NV-RO)	Revision	UINT	Revision	1
2	Get (NV-RO)	Max instance	UINT	Greatest currently existing instance number of an object derived from this class	1

Instance attributes

ID	Access	Name	Data type	Description	Value
1	Get (NV-RO)	Vendor ID ¹⁾	UINT	Unique vendor number	348 (15C _h)
2	Get (NV-RO)	Device families type ²⁾	UINT	Unit series	10 _h (Position Controller)
3	Get (NV-RO)	Product type	UINT	Unique device type	xxxx
4	Get (NV-RO)	Revision	STRUCT of	Revision of device	xx.xx
		MainRevision	USINT		
		SubRevision	USINT		
5	Get (V-RO)	Status ³⁾	WORD	Summarized device status	

ID	Access	Name	Data type	Description	Value
6	Get (NV-RO)	Serial number	UDINT	Serial number	
7	Get (NV-RO)	Product name ⁴⁾	SHORT_STRING	Device name in text form	
8	Get (V-RO)	Device status	USINT	Current device state in state machine	
10	Get/Set (NV-RW)	Heartbeat Interval	USINT	Interval between two heartbeat messages (in sec)	Default value is 0 (no Heartbeat messages)

- 1) Vendor number assigned by ODVA
- 2) Corresponds to the ODVA device profile
- 3) Current device status; bits 8...11 contain the error status
- 4) Max. 32 characters

4.2.7.2 DeviceNet object

Class ID 3 (03_h)

The DeviceNet object contains the communication parameters for the DeviceNet interface. There is one instance with ID 1.

Class attributes

ID	Access	Name	Data type	Description	Value
1	Get (NV-RO)	Revision	UINT	Revision	2
2	Get (NV-RO)	Max instance	UINT	Greatest currently existing instance number of an object derived from this class	1

Instance attributes

ID	Access	Name	Data type	Description	Value
1	Get/Set (NV-RW)	MAC ID ¹⁾	USINT	Device address	0...63
2	Get (V-RO)	Read value baud rate ²⁾	USINT	Specified baud rate	0 = 125 kBaud 1 = 250 kBaud 2 = 500 kBaud
3	Get/Set (V-RW)	BOI	BOOL	Reaktion auf Bus Off Interrupt	0: CAN Controller remains in Bus Off (Default) 1: Controller reset and then restart
4	Get/Set (V-RW)	Bus Off Counter	USINT	Counter indicating the number of times the CAN Controller was in Bus Off Status Write access clears the counter	0...255
5	Get (V-RO)	Allocation Information	STRUCT of		
5	Get (V-RO)	Allocation selection byte ³⁾	BYTE		
5	Get (V-RO)	MAC ID from master	BYTE	Detected master MAC ID	0...63

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ID	Access	Name	Data type	Description	Value
6	Get (V-RO)	MAC ID switch changed	BOOL	Switch with device address has changed since it was last switched on	0 = No change 1 = Change
8	Get (V-RO)	Status of MAC ID switch ¹⁾	USINT	Switch setting for device address	0...99
100	Get/Set (NV-RW)	Baud rate setting ²⁾	USINT	Baud rate setting	0 = 125 kBaud 1 = 250 kBaud 2 = 500 kBaud 3 = Autobaud (default)

1) MAC ID 0...63: The MAC address depends on the switch setting; MAC ID 64...99: Address is determined by attribute 1

2) The baud rate is automatically detected with Autobaud

3) See: The CIP Networks Library, Volume 3, DeviceNet Adaption of CIP, chapter 5-3

4.2.7.3 Assembly object

Class ID 4(04_h)

An Assembly object is a container that contains one or more attributes of other objects. This way, multiple attributes can be transmitted from or to a slave simultaneously with a single connection.

In this context, the terms input data and output data are important:

- Outputs are commands from the network to the device
- Inputs are status messages from the device to the network

The following instances of the Assembly Object are implemented in the device:

Instance ID	Type	Name	Number of bytes
101	Output Assembly	Vendor-specific standard profile	8
111	Input Assembly	Vendor-specific standard profile	8
102	Output Assembly	Vendor-dependent extended profile	12
112	Input Assembly	Vendor-dependent extended profile	14

Class attributes

ID	Access	Name	Data type	Description	Values
1	Get (NV-RO)	Revision	UINT	Revision	2
2	Get (NV-RO)	Max instance	UINT	Greatest currently existing instance number of an object derived from this class	5

Common instance attributes

The Assembly Objects are all static. The mapping of the objects can be read with attributes 1 and 2 (read only).

Attribute 3 is the standard data attribute.

The instance attributes supported in the class Assembly are described in the following table:

ID	Access	Name	Data type	Description	Value
1	Get (NV-RO)	Number of members in the list	UINT		See below
2	Get (NV-RO)	List of members ¹⁾ :	ARRAY of STRUCT	List of DeviceNet paths	See below
		Data type	UINT	Size in bits	See below
		Path size	UINT	Path size in bytes	See below
		Path	EPATH		See below
3	Get/Set (V-RW)	Contents of assembly ²⁾	ARRAY of BYTE	Data from/to device	
4	Get (NV-RO)	Size	UINT	Number of bytes in attribute 3	See below

1) List of all members with data type and DeviceNet path to the attributes contained

2) Attribute 3 contains the Input Assemblies or the Output Assemblies. "Set" access is only possible with the output assemblies

4.2.7.4 Connection object

Class ID 5(05_h)

The Connection object with class ID 5 manages access channels to or from the devices.

As a group 2 server on the DeviceNet, the drive supports the "Predefined Master/Slave Connection Set".

Class attributes

ID	Access	Name	Data type	Description	Value
1	Get (NV-RO)	Revision	UINT	Revision	1
2	Get (NV-RO)	Max instance	UINT	Number of instances	5

Explicit message connection object

Instance ID 1 = predefined Explicit Connection

Instance ID 5 and 6 = dynamic Explicit Connection

This instance represents a point-to-point connection between two devices. In an explicit message one **single** attribute of an object is transmitted to a device or read by the terminal device.

ID	Access	Name	Data type	Description	Value
1	Get (NV-RO)	Status	USINT	Status of object	0 = Non-existent 3 = Assembled 5 = Deleted
2	Get (NV-RO)	Instance type	USINT	I/O or Explicit Message	0 = Explicit Message
3	Get (NV-RO)	Transport Class Trigger	BYTE	Behavior of the connection	83 _h = Class 3 Server
4	Get (NV-RO)	Produced Connection ID	UINT		1100xxxxxx xxxxxx = Node address
5	Get (NV-RO)	Consumed Connection ID	UINT		11100xxxxxx xxxxxx = Node address

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ID	Access	Name	Data type	Description	Value
6	Get (NV-RO)	Initial Comm Characteristics	BYTE		33 _h Producer: Group 3 msg. Consumer: Group 3 msg.
7	Get (NV-RO)	Produced Connection Size	UINT	Maximum number of bytes that are transmitted via this connection	44
8	Get (NV-RO)	Consumed Connection Size	UINT	Maximum number of bytes that are transmitted via this connection	44
9	Get/Set (NV-RW)	Expected Packet Rate	UINT	Time response of connection (ms)	2500
12	Get/Set (NV-RW)	Watchdog Timeout Action	USINT	Response after timeout	1 = Auto Delete 3 = Deferred Delete (Default = 1)
13	Get (NV-RO)	Produced Connection Path length	UINT	Length of attribute 14	0
14	Get/Set (NV-RW)	Produced Connection Path	EPATH		Zero
15	Get (NV-RO)	Consumed Connection Path length	UINT	Length of attribute 16	0
16	Get/Set (NV-RW)	Consumed Connection Path	EPATH		Zero
18	Get/Set (NV-RW)	Connection Timeout Multiplier	USINT	For Watchdog Timer to monitor the Expected Packet Rate ¹⁾	0

1) See: The CIP Networks Library, Volume 1, Common Industrial Protocol, chapter 3-4.4.18

Explicit messages must be confirmed. An error is confirmed with an error message.

Polled I/O Message Object

Instance ID 2 = Predefined Poll Connection
Instance ID 7 = Dynamic I/O Connection

A poll command message and a poll response message transmit multiple I/O data between a master and one or more slaves.

In a poll I/O connection a DeviceNet master acts as a client and a DeviceNet slave as a server. The client sends commands to the server in a Poll Command message, the server returns status data to the client in a Poll Response message.¹

ID	Access	Name	Data type	Description	Value
1	Get (NV-RO)	Status	USINT	Status of object	0 = Non-existent 3 = Assembled 5 = Deleted
2	Get (NV-RO)	Instance type	USINT	I/O or Explicit Message	1 = I/O Message
3	Get (NV-RO)	Transport Class Trigger	BYTE	Behavior of the connection ¹⁾	83 _h = Class 3 Server
4	Get (NV-RO)	Produced Connection ID	UINT		01111xxxxx xxxxxx = Node address

1. See: The CIP Networks Library, Volume 3, DeviceNet Adaption of CIP, chapter 3-11

ID	Access	Name	Data type	Description	Value
5	Get (NV-RO)	Consumed Connection ID	UINT		10xxxxxx101 xxxxxx = Node address
6	Get (NV-RO)	Initial Comm Characteristics	BYTE		01 _h Producer: Group 1 msg. Consumer: Group 2 msg.
7	Get (NV-RO)	Produced Connection Size	UINT	Maximum number of bytes that can be transmitted via this connection without fragmentation	8
8	Get (NV-RO)	Consumed Connection Size	UINT	Maximum number of bytes that can be transmitted via this connection without fragmentation	8
9	Get/Set (NV-RW)	Expected Paket Rate	UINT	Time response of the connection (ms) ²⁾	1000
12	Get/Set (NV-RW)	Watchdog Timeout Action	USINT		0 = Transition to Timeout 1 = Auto Delete 2 = Auto Reset (Default = 0) ³⁾
13	Get (NV-RO)	Produced Connection Path length	UINT	Length of attribute 14	6
14	Get/Set (NV-RW)	Produced Connection Path	EPATH	Application objects whose data is produced via this connection. Factory settings: Position Controller	20 24 24 00 30 21 _h
15	Get (NV-RO)	Consumed Connection Path length	UINT	Length of attribute 16	6
16	Get/Set (NV-RW)	Consumed Connection Path	EPATH	Application objects whose data is consumed via this connection Factory settings: Position Controller	20 24 24 00 30 20 _h
18	Get/Set (NV-RW)	Connection Timeout Multiplier	USINT	For Watchdog Timer to monitor the Expected Paket Rate ⁴⁾	0
100	Get/Set (NV-RW)	Polled I/O Input	USINT	Input Position Controller Profil Input Assembly Instanz	110 111, 112
101	Get/Set (NV-RW)	Polled I/O Output	USINT	Output Position Controller Profil Output Assembly Instanz	100 101, 102

1) See: The CIP Networks Library, Volume 1, Common Industrial Protocol, chapter 3-4.4.3

2) See: The CIP Networks Library, Volume 1, Common Industrial Protocol, chapter 3-4.5

3) See: The CIP Networks Library, Volume 1, Common Industrial Protocol, chapter 3-4.4.12

4) See: The CIP Networks Library, Volume 1, Common Industrial Protocol, chapter 3-4.4.18

4.2.7.5 Acknowledge Handler object

Class ID 43(2B_h)

The Acknowledge Handler object manages the incoming messages via DeviceNet. It provides information on received confirmations, timeouts, repetitions, etc.

The Acknowledge Handler object defines exactly one instance.

Class attributes

ID	Access	Name	Data type	Description	Value
1	Get (NV-RO)	Revision	UINT	Revision	1
2	Get (NV-RO)	Max instance	UINT	Greatest currently existing instance number of an object derived from this class	1

Instance attributes

ID	Access	Name	Data type	Description	Value
1	Get/Set (V-RW)	Acknowledge Timer	UINT	Time to wait for confirmation before a transmission retry is required	1...65535 ms 0 = Invalid 16 = Default
2	Get/Set (V-RW)	Retry Limit	USINT	Number of Ack Timeouts before the application is informed of a "Retry_Limit_Reached" event	0...255 1=Default
3	Get/Set (V-RW)	COS Producing Connection Instance	UINT	Instance of connection that is informed via Ack handler events	Default: 4 (COS/Cyclic I/O Connection)
4	Get (V-RO)	Ack List Size	BYTE	Max. number of list entries in Ack List	Default: 1
5	Get (V-RO)	Ack List	BYTE, ARRAY of UINT	List of active connections that receive confirmations	Default: {01 04 00}h
6	Get (V-RO)	Data with Ack Path List Size	BYTE	Max. number in attribute 7	Default: 1
7	Get (V-RO)	Data with Ack Path List	BYTE, ARRAY of - UINT - USINT - EPATH		Default: { 01 04 00 06 20 01 24 6D 30 03 }h

All attributes are stored in volatile memory. The application can set the values for Acknowledge Timer, Retry Limit and Producing Connection Instance to values different from those specified.

4.2.7.6 Vendor-specific objects**Class ID 101 - 199 (65_h - C7_h)**

The device-specific parameters are defined in object class 101 and higher. For a detailed description of the individual parameters, see chapter 11 "Parameters".

4.2.7.7 Network management

Device Heartbeat Message

The device supports the heartbeat protocol as per "The CIP Networks Library", Volume 3, DeviceNet Adaption of CIP, chapter 2-12. The heartbeat message provides the device status at cyclic intervals with the Device Fault bit.

The cycle time is defined with Identity object, attribute 10 "Heartbeat Interval".

The following information is sent by the drive with the heartbeat message:

- Device Status (1 Byte): Attribute 8 of the Identity object
- SF - System Fault (1 bit): Bus communication error
- UF - User Fault (1 bit): Error caused by user commands
- DF - Device Fault (1 bit): Device fault

Device Shutdown Message

The device supports the shutdown protocol as per "The CIP Networks Library", Volume 3, DeviceNet Adaption of CIP, chapters 2-13. This message is generated if the device switches to offline status.

Two bytes in the shutdown message are reserved for the shutdown code. This code is vendor-specific; it is shown for the device in the following table:

Class ID	Instance ID	Shutdown Code	Description
1	1	4	Remote request: Reset Service for the Identity object (service code 5)
2	1	4	Remote request: Setting of the MAC ID via attribute 1 of the DeviceNet object
3	0	5	Internal Diagnostics Fault: The device switched to shutdown status as a result of one of the following causes: 1. CAN Transmit Queue Overrun 2. CAN Receive Queue Overrun 3. CAN Receive Buffer

5 Engineering

This chapter contains information on the application of the product that is vital in the design phase.

5.1 Configurable inputs and outputs

This product has digital inputs and outputs that can be configured. This standard assignment can be adapted to the requirements of the customer's installation. For more information, see chapter 8.6.9 "Configurable inputs and outputs".

5.2 External power supply units

⚠ DANGER

ELECTRIC SHOCK CAUSED BY INCORRECT POWER SUPPLY UNIT

The ∇ VDC and +24VDC supply voltages are connected with many exposed signal connections in the drive system.

- Use a power supply unit that meets the PELV (Protective Extra Low Voltage) requirements.
- For North America: Use a power supply unit with a maximum of 42 V_{dc} for compliance with UL 508C.
- Connect the negative output of the power supply unit to PE (ground).

Failure to follow these instructions will result in death or serious injury.

5.2.1 Supply voltage

General The power supply unit must be rated for the power requirements of the drive. The input current can be found in the technical data.

The actual power requirements are often significantly lower because the maximum possible motor torque is usually not required for normal operation of a system.

When designing the system, note that the input current of the drive is higher during the motor acceleration phase than during constant movement.

Protection against reverse polarity

In the case of reverse polarity, the supply voltage is short-circuited. The drive is continuous short circuit-proof up to a short-circuit current of a maximum of 15 A. If the power is supplied by a transformer power supply unit, several hundred amperes may flow for a short period of time in the event of reverse polarity; the drive is rated for this and will not be damaged.

Fuse: a circuit-breaker (16 A, trip characteristic B) or a blade fuse (FKS, max. 15 A) or a fuse (5 mm x 20 mm, 10 A slow-blow).

Regeneration condition Note the following for drives with large external mass moments of inertia or for highly dynamic applications:

Motors return regeneration energy during deceleration. The DC bus can store a limited amount of energy in the capacitors. Connecting additional capacitors to the DC bus increases the amount of energy that can be stored.

If the capacity of the capacitors is exceeded, the excess energy must be discharged via internal or external braking resistors. If the energy is not discharged, an overvoltage monitor will shut off the power stage.

Overvoltages can be limited by adding a braking resistor with a corresponding braking resistor controller. This converts the regenerated energy to heat energy during deceleration.

Braking resistor controllers can be found in chapter 12 "Accessories and spare parts". See the product manual for a description of the braking resistor controller.

▲ WARNING

LOSS OF CONTROL DUE TO REGENERATION CONDITION

Regeneration conditions resulting from braking or external driving forces may increase the VDC supply voltage to an unexpected level. Components not rated for this voltage may be destroyed or cause misoperation.

- Verify that all VDC consumers are rated for the voltage occurring during regeneration conditions (for example limit switches).
- Use only power supply units that will not be damaged by regeneration conditions.
- Use a braking resistor controller, if necessary.

Failure to follow these instructions can result in death, serious injury or equipment damage.

Internal 24V signal power supply An internal 24V power supply for the sensor system is integrated in the product.

The internal 24V signal power supply must not be connected to the internal 24V signal power supply of another product.

5.3 Ground design

The ground connections of all interfaces are galvanically connected, including the ground for the VDC supply voltage.

The following points must be considered when you wire the drives in a system:

- The voltage drop in the VDC power supply lines must be kept as low as possible (less than 1 V). At higher ground potential differences between different drives, the communication / control signals may be affected.
- If the distance between the system components is greater, it is recommended to use decentralized power supply units close to the individual drives to supply the VDC voltage. However, the ground connections of the individual power supply units must be connected with the largest possible conductor cross section.
- The internal 24V signal power supply must not be connected in parallel with the internal 24V signal power supply of a different drive.
- If the master controller (e.g. PLC, IPC etc.) does not have galvanically isolated outputs for the drives, you must verify that the current of the VDC supply voltage has no path back to the power supply unit via the master controller. Therefore, the master controller ground may be connected to the VDC supply voltage ground at a single point only. This is usually the case in the control cabinet. The ground contacts of the various signal connectors in the drive are therefore not connected; there is already a connection via the VDC supply voltage ground.
- If the controller has a galvanically isolated interface for communication with the drives, the ground of this interface must be connected to the signal ground of the first drive. This ground may be connected to a single drive only to avoid ground loops. This also applies to a galvanically isolated CAN connection.

Equipotential bonding conductors

Potential differences can result in excessive currents on the cable shields. Use equipotential bonding conductors to reduce currents on the cable shields.

The equipotential bonding conductor must be rated for the maximum current flowing. Practical experience has shown that the following conductor cross sections can be used:

- 16 mm² (AWG 4) for equipotential bonding conductors up to a length of 200 m
- 20 mm² (AWG 4) for equipotential bonding conductors with a length of more than 200 m

5.4 Safety function STO ("Safe Torque Off")

See page 33 for information on using the IEC 61508 standard.

5.4.1 Definitions

<i>Safety function STO (IEC 61800-5-2)</i>	The safety function STO ("Safe Torque Off", "Safe Torque Off") shuts off the motor torque safely. It is not necessary to interrupt the supply voltage. There is no monitoring for standstill.
<i>"Power Removal"</i>	The STO safety function ("Safe Torque Off") is also known as "Power Removal".
<i>Category 0 stop (IEC 60204-1)</i>	Stopping by immediate removal of power to the machine actuators (i.e. an uncontrolled stop).
<i>Category 1 stop (IEC 60204-1)</i>	Controlled stop with power available to the machine actuators to achieve the stop. Power is not interrupted until the stop is achieved.

5.4.2 Function

The STO safety function integrated into the product can be used to implement an "EMERGENCY STOP" (IEC 60204-1) for category 0 stops. With an additional, approved EMERGENCY STOP module, it is also possible to implement category 1 stops.

Function principle The STO safety function is triggered via 2 redundant inputs. The circuits of the two inputs must be separate so that there are always two channels.

The switching process must be simultaneous for both inputs (skew <1s). The power stage is disabled and an error message is generated. The motor can no longer generate torque and coasts down without braking. A restart is possible after resetting the error message with a "Fault Reset".

The power stage is disabled and an error message is generated if only one of the two inputs is switched off or if the skew is too great. This error message can only be reset by switching off the product.

5.4.3 Requirements for using the safety function

⚠ WARNING
<p>LOSS OF SAFETY FUNCTION</p> <p>Incorrect usage may cause a hazard due to the loss of the safety function.</p> <ul style="list-style-type: none"> • Observe the requirements for using the safety function. <p>Failure to follow these instructions can result in death or serious injury.</p>

<i>Category 0 stop</i>	During a category 0 stop, the motor coasts down in an uncontrolled way. If access to the machine coasting down involves a hazard (results of the hazard and risk analysis), you must take appropriate measures.
<i>Category 1 stop</i>	A controlled stop must be triggered with a category 1 stop. The controlled standstill is not monitored by the drive system. In the case of power outage or an error, a controlled stop is impossible. Final shutoff of the motor is achieved by switching off the two inputs of the STO safety function. The shutoff is usually controlled by a standard EMERGENCY STOP module with a safe time delay.
<i>Behavior of holding brake</i>	Triggering the STO safety function means that the delay time for motors with holding brake is not effective. The motor cannot generate holding torque to bridge the time to application of the holding brake. Especially in the case of vertical axes it is important to verify whether additional measures are required to avoid lowering of the load.
<i>Vertical axes, external forces</i>	If external forces act on the motor (vertical axis) and an unwanted movement, for example caused by gravity, could cause a hazard, the motor must not be operated without additional measures for fall protection.
<i>Unintended restart</i>	To avoid an unexpected restart after restoration of power (e.g. after a power outage), the parameter <code>IO_AutoEnable</code> must be set to "off". Note that a master controller must not trigger an unintended restart.
<i>Degree of protection if STO is used</i>	You must ensure that conductive substances cannot get into the product (pollution degree 2). If you use the safety function and conductive substances get into the product, the safety function may become inoperative.
<i>Protected cable installation</i>	<p>If short circuits or cross circuits can be expected in connection with the two signals of the STO safety function and if they are not detected by upstream devices, protected cable installation is required.</p> <p>In the case of an unprotected cable installation, the two signals of the STO safety function may be connected to external voltage if a cable is damaged. If the two signals are connected to external voltage, the STO safety function is no longer operative.</p>

Protected cable installation possibilities:

- Use separate cables for two signals. Any additional wires in these cables may only carry voltages according to PELV.
- Use a shielded cable. The grounded shield is designed to dissipate the external voltage in the case of damages and to trip the fuse in this way.
- Use a separately grounded shield. If there are other wires in the cable, the two signals must be isolated from these wires by a grounded, separate shield.

Data for maintenance plan and safety calculations

Use the following data of the STO safety function for your maintenance plan and the safety calculations:

Lifetime (IEC 61508)		20 years
SFF (IEC 61508) Safe Failure Fraction	[%]	47
HFT (IEC 61508) Hardware Fault Tolerance Type A subsystem		1
Safety integrity level IEC 61508 IEC 62061		SIL2 SILCL2
PFH (IEC 61508) Probability of Dangerous Hardware Failure per Hour	[1/h]	$5.223 \cdot 10^{-9}$
PL (ISO 13849-1) Performance Level		d (Category 3)
MTTF _d (ISO 13849-1) Mean Time to Dangerous Failure		1995 years
DC (ISO 13849-1) Diagnostic Coverage	[%]	90

Hazard and risk analysis

As a system manufacturer you must conduct a hazard and risk analysis of the entire system. The results must be taken into account in the application of the STO safety function.

The type of circuit resulting from the analysis may differ from the following application examples. Additional safety components may be required. The results of the hazard and risk analysis have priority.

5.4.4 Application examples STO

Example of category 0 stop Application without EMERGENCY STOP module, category 0 stop.

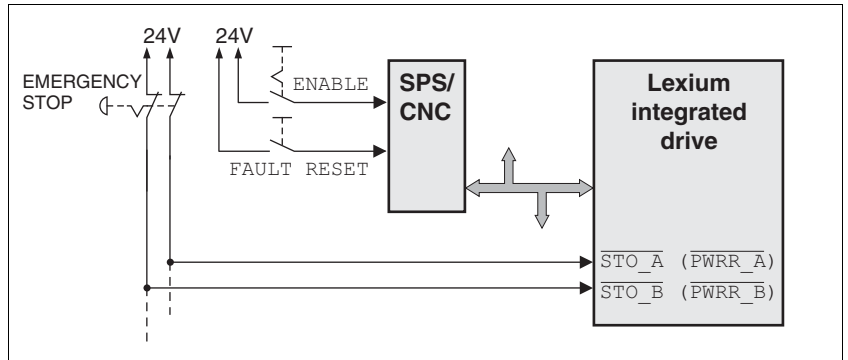


Figure 5.1 Example of category 0 stop

Please note:

- When the EMERGENCY STOP switch is tripped, this initiates a category 0 stop

Example of category 1 stop Application with EMERGENCY STOP module, category 1 stop.

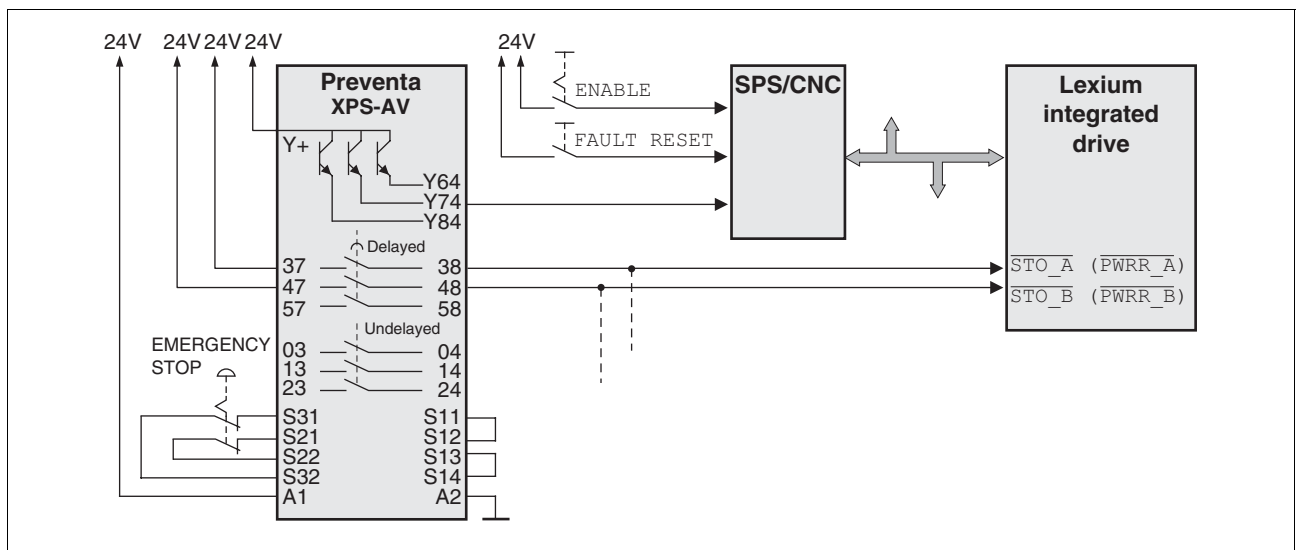


Figure 5.2 Example of category 1 stop

Please note:

- The master controller must immediately trigger a controlled stop, e.g. via the "Quick Stop" function.
- The inputs $\overline{\text{STO_A}}$ ($\overline{\text{PWRR_A}}$) and $\overline{\text{STO_B}}$ ($\overline{\text{PWRR_B}}$) must be switched off with a time delay. The delay is set at the EMERGENCY STOP safety module. If the motor has not yet stopped when the delay time has elapsed, it coasts down in an uncontrolled way (uncontrolled stop).
- The specified minimum current and the permissible maximum current of the relay must be observed if the relay outputs of the EMERGENCY STOP module are used.

5.5 Monitoring functions

The monitoring functions in the product can help to guard the system and reduce the risks involved in a system misoperation. These monitoring functions may not be used to protect persons.

The following monitoring functions are available:

Monitoring	Task
Data link	Error response if the link becomes inoperative
Limit switch signals	Monitors for permissible range of travel
I^2t limitation	Power limitation in event of overloading
Tracking error	Monitors for difference between actual motor position and reference position
Overvoltage and undervoltage	Monitors for overvoltage and undervoltage of the supply voltage
Motor overload	Monitors for excessively high current in the motor phases
Overtemperature	Monitors the device for overtemperature

For a description of the monitoring functions, see chapter 8.6.1 "Monitoring functions", page 160.

6 Installation

▲ WARNING

LOSS OF CONTROL

- The designer of any control scheme must consider the potential failure modes of control paths and, for certain critical functions, provide a means to achieve a safe state during and after a path failure. Examples of critical control functions are EMERGENCY STOP, overtravel stop, power outage and restart.
- Separate or redundant control paths must be provided for critical functions.
- System control paths may include communication links. Consideration must be given to the implication of unanticipated transmission delays or failures of the link.
- Observe the accident prevention regulations and local safety guidelines.¹⁾
- Each implementation of the product must be individually and thoroughly tested for proper operation before being placed into service.

Failure to follow these instructions can result in death or serious injury.

1) For USA: Additional information, refer to NEMA ICS 1.1 (latest edition), Safety Guidelines for the Application, Installation, and Maintenance of Solid State Control and to NEMA ICS 7.1 (latest edition), Safety Standards for Construction and Guide for Selection, Installation for Construction and Operation of Adjustable-Speed Drive Systems.

▲ CAUTION

RISK OF INJURY WHEN THE PRINTED CIRCUIT BOARD CONNECTORS ARE REMOVED

- Before removing the connectors, you must unlocked them.
 - Supply voltage ∇ DVC:
Unlock by pulling at the connector housing
 - Others:
Unlock by pressing the connector lock
- Only pull the connector housing (not the cable).

Failure to follow these instructions can result in injury or equipment damage.



The chapter Engineering contains basic information that you should know before starting the installation.

6.1 Electromagnetic compatibility, EMC

▲ WARNING
SIGNAL AND DEVICE INTERFERENCE
Signal interference can cause unexpected responses of device.
<ul style="list-style-type: none"> • Install the wiring in accordance with the EMC requirements. • Verify compliance with the EMC requirements.
Failure to follow these instructions can result in death, serious injury or equipment damage.

Limit values This product meets the EMC requirements according to the standard IEC 61800-3, if the measures described in this manual are implemented during installation.

If the selected composition is not designed for category C1, note the following:

▲ WARNING
HIGH-FREQUENCY INTERFERENCE
In a domestic environment this product may cause high-frequency interference that may require action to suppress interference.
Failure to follow these instructions can result in death or serious injury.

EMC measures	Effect
Keep cables as short as possible. Do not install unnecessary cable loops, use short cables from the star point in the control cabinet to the external ground connection.	Reduces capacitive and inductive interference.
Ground the product via the motor flange or with a ground strap to the ground connection at the cover of the connector housing.	Reduces emissions, increases immunity.
Ground shields of digital signal wires at both ends by connecting them to a large surface or via conductive connector housings.	Reduces interference affecting the signal wires, reduces emissions
Connect large surface areas of cable shields, use cable clamps and ground straps	Reduces emissions.

Shielding The following cables must be shielded:

- Fieldbus cable
- STO safety function, see the requirements in chapter 5.4.3 "Requirements for using the safety function"

The following cables do not need to be shielded:

- Supply voltage ∇ DC
- 24 V signal interface

Equipotential bonding conductors Potential differences can result in excessive currents on the cable shields. Use equipotential bonding conductors to reduce currents on the cable shields.

The equipotential bonding conductor must be rated for the maximum current flowing. Practical experience has shown that the following conductor cross sections can be used:

- 16 mm² (AWG 4) for equipotential bonding conductors up to a length of 200 m
- 20 mm² (AWG 4) for equipotential bonding conductors with a length of more than 200 m

6.2 Mechanical installation

▲ WARNING

MOTOR DAMAGE AND LOSS OF CONTROL

Shock or strong pressure applied to the motor shaft may destroy the motor.

- Protect the motor shaft during handling and transportation.
- Avoid shocks to the motor shaft during mounting.
- Do not press parts onto the shaft. Mount parts to the shaft by glueing, clamping, shrink-fitting or screwing.

Failure to follow these instructions can result in death, serious injury or equipment damage.

▲ WARNING

MOTOR WITHOUT BRAKING EFFECT

If power outage and faults cause the power stage to be switched off, the motor is no longer stopped by the brake and may increase its speed even more until it reaches a mechanical stop.

- Verify the mechanical situation.
- If necessary, use a cushioned mechanical stop or a suitable brake.

Failure to follow these instructions can result in death, serious injury or equipment damage.

▲ WARNING

LOSS OF BRAKING FORCE DUE TO WEAR OR HIGH TEMPERATURE

Applying the holding brake while the motor is running will cause excessive wear and loss of the braking force. Heat decreases the braking force.

- Do not use the brake as a service brake.
- Note that "EMERGENCY STOPS" may also cause wear
- At operating temperatures of more than 80°C (176°F), do not exceed a maximum of 50% of the specified holding torque when using the brake.

Failure to follow these instructions can result in death, serious injury or equipment damage.

▲ CAUTION**HOT SURFACES**

Depending on the operation, the surface may heat up to more than 100°C (212°F).

- Do not allow contact with the hot surfaces.
- Do not allow flammable or heat-sensitive parts in the immediate vicinity.
- Consider the measures for heat dissipation described.
- Check the temperature during test runs.

Failure to follow these instructions can result in injury or equipment damage.



To install a drive in locations difficult to access, it may be useful to carry out the electrical installation first and then install the fully wired drive.

Heat dissipation

The motor may become very hot, for example in the case of incorrect arrangement of multiple motors. The surface temperature of the motor must not exceed 110 °C during continuous operation.

- Verify that the maximum temperature is not exceeded.
- Verify that there is sufficient heat dissipation, for example by means of good ventilation or heat dissipation via the motor flange.

Mounting

The motor is designed to be mounted using four M5 screws. The motor flange must be mounted on a flat surface to avoid mechanical tension from being transmitted to the housing.

Painted surfaces have an insulating effect. During mounting verify that the motor flange is mounted in such a way as to allow for good conductivity (electrical and thermal).

Mounting distances

No minimum clearances are required for installation. However, note that the motor can become very hot.

Observe the bending radii of the cables used.

Ambient conditions

Observe the permissible ambient conditions.

6.3 Electrical installation

⚠ WARNING

UNEXPECTED BEHAVIOR CAUSED BY FOREIGN OBJECTS

Foreign objects, deposits or humidity can cause unexpected behavior.

- Keep foreign objects from getting into the product.
- Do not remove the cover of the electronics housing. Only remove the connector housing cover.
- Verify correct seat of seals and cable entries.

Failure to follow these instructions can result in death, serious injury or equipment damage.

⚠ WARNING

LOSS OF SAFETY FUNCTION CAUSED BY FOREIGN OBJECTS

Conductive foreign objects, dust or liquids may cause the STO safety function to become inoperative.

- Do not use the STO safety function unless you have protected the system against contamination by conductive substances.

Failure to follow these instructions can result in death or serious injury.

⚠ WARNING

DAMAGE TO SYSTEM COMPONENTS AND LOSS OF CONTROL

Interruptions of the negative connection of the controller supply voltage can cause excessively high voltages at the signal connections.

- Do not interrupt the negative connection between the power supply unit and load with a fuse or switch.
- Verify correct connection before switching on.
- Do not connect the controller supply voltage or change its wiring while the is supply voltage present.

Failure to follow these instructions can result in death, serious injury or equipment damage.



The chapter Engineering contains basic information that you should know before starting the installation.

6.3.1 Wiring examples

The following figure shows a typical wiring example. The limit switches and the reference switch are supplied via the internal 24V signal power supply.

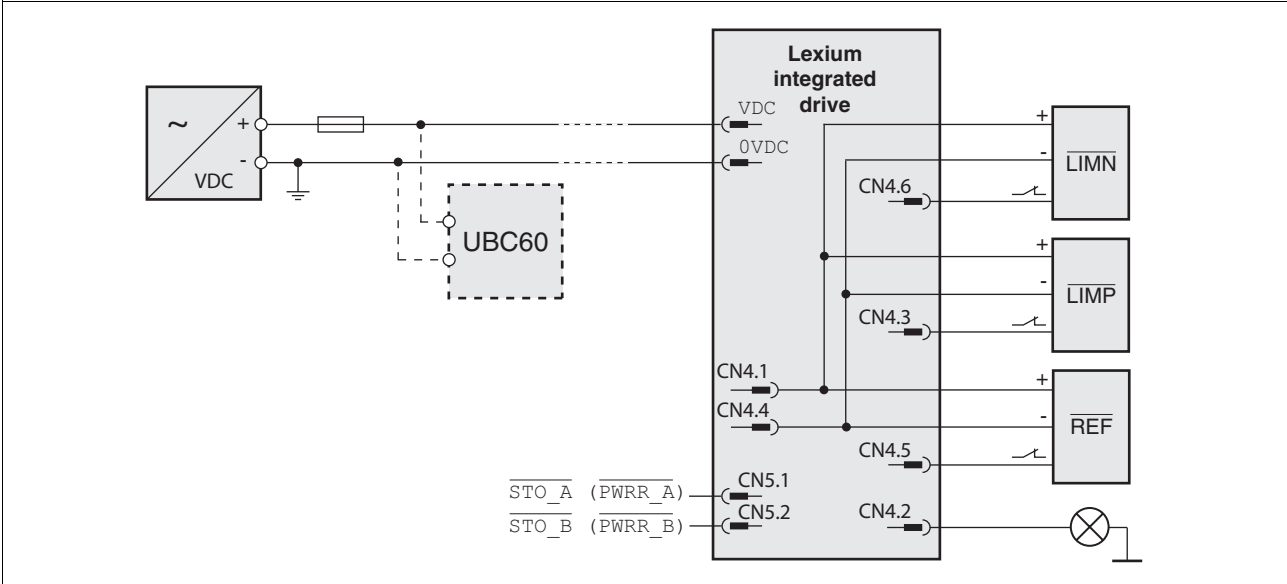


Figure 6.1 Wiring example

The UBC60 braking resistor controller is available as an accessory, see chapter 12 "Accessories and spare parts".

6.3.2 Overview of all connections

Overview of printed circuit board connectors

The following figure shows the pin assignment of the interfaces with the connector housing cover open.

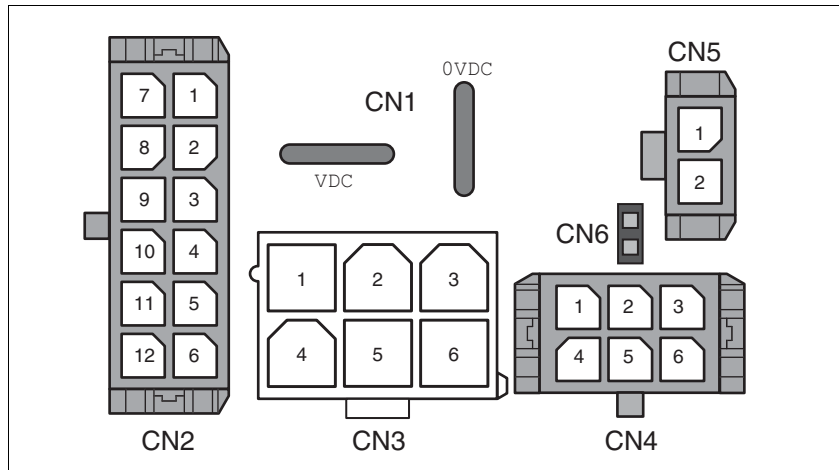


Figure 6.2 Overview of all connections

Connection	Assignment
CN1	Supply voltage \sqrt{VDC}
CN2	Fieldbus interface and reference value supply (for Electronic Gear operating mode)
CN3	Commissioning interface
CN4	24V signals
CN5	Safety function STO "Safe Torque Off" (IEC/EN 61800-5-2)
CN6	Jumper for disabling STO safety function

The drive can be connected via cable entries or industrial connectors.

For connection via cable entries see page 73.

For connection via industrial connectors see page 76.

6.3.3 Connection via cable entry

The cable specifications and pin assignments can be found in the chapters that describe the connections.

Preparing and fastening cables

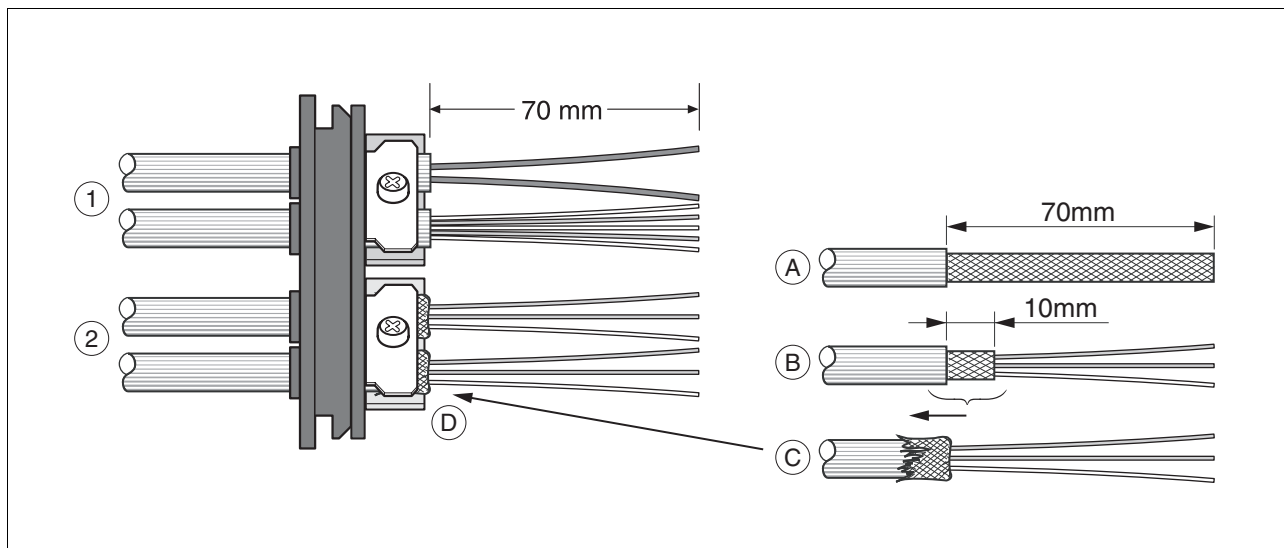


Figure 6.3 Fastening the cable in the cable entry

- (1) Unshielded cable
- (2) Shielded cable

- ▶ Trim the cable bushings to fit the cable.
- NOTE: The specified degree of protection IP54 can only be achieved with properly trimmed cable bushings.
- ▶ (A) Strip the jacket of all cables; length 70 mm.
- ▶ (B) Shorten the shield to a rest of 10 mm.
- ▶ (C) Slide the shield braiding back over the cable jacket.
- ▶ (D) Loosen the strain relief.
- ▶ Push the cables through the strain relief.
- ▶ Glue EMC shielding foil around the shield.
- ▶ Pull the cable back to the strain relief.
- ▶ Fasten the strain relief.

Mounting connectors

The table below lists the parts and data required for assembly. Connector housings and crimp contacts are included in the accessories kit. See also chapter 12 "Accessories and spare parts".



Only use the special tool listed in the Accessories chapter to release single crimp contacts from the connector housing.

Connection	Conductor cross section of the crimp contact [mm ²]	Stripping length [mm]	Manufacturer's crimp contact no.	Crimping tool	Connector manufacturer	Connector type
CN1	0.75 ... 1.5 (AWG 18 ... 16) 2.5 ... 4.0 (AWG 12)	5 ... 65 ... 6	160773-6 341001-6	654174-1	Tyco Electronics	Positive Lock 1-926 522-1
CN2	0.14 ... 0.6 (AWG 24 ... 20)	2.5 ... 3.0	43030-0007	69008-0982	Molex	Micro-Fit 3.0 43025-1200
CN3	0.25 ... 1.0 (AWG 24 ... 18)	3.0 ... 3.5	39-00-0060	69008-0724	Molex	Mini-Fit Jr. 39-01-2065
CN4	0.14 ... 0.6 (AWG 24 ... 20)	2.5 ... 3.0	43030-0007	69008-0982	Molex	Micro-Fit 3.0 43025-0600
CN5	0.14 ... 0.6 (AWG 24 ... 20)	2.5 ... 3.0	43030-0007	69008-0982	Molex	Micro-Fit 3.0 43645-0200

Prepare the cable for connection as follows:

- ▶ Strip the ends of the cable.
- ▶ Attach cable lugs and crimp contacts. Verify that you have the correct crimp contacts and the matching crimping tool.
- ▶ Slide the cable lugs and crimp contacts straight into the connector until they snap in place.

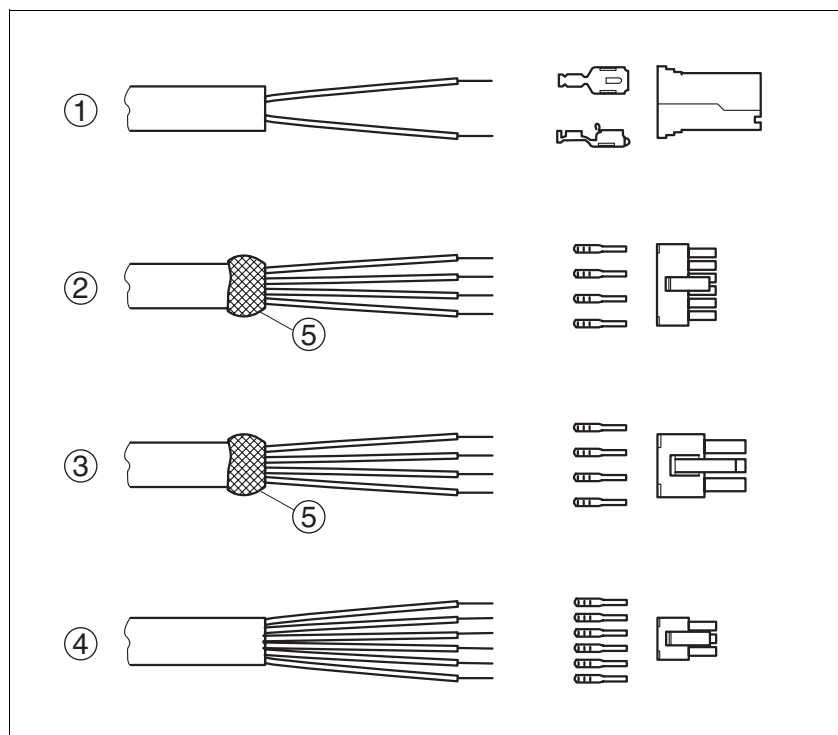


Figure 6.4 Connectors, cable lugs and crimp contacts

- (1) CN1 supply voltage VDC
- (2) CN2 fieldbus
- (3) CN3 commissioning
- (4) CN4 24V signals
- (5) Shield wire with EMC shield foil

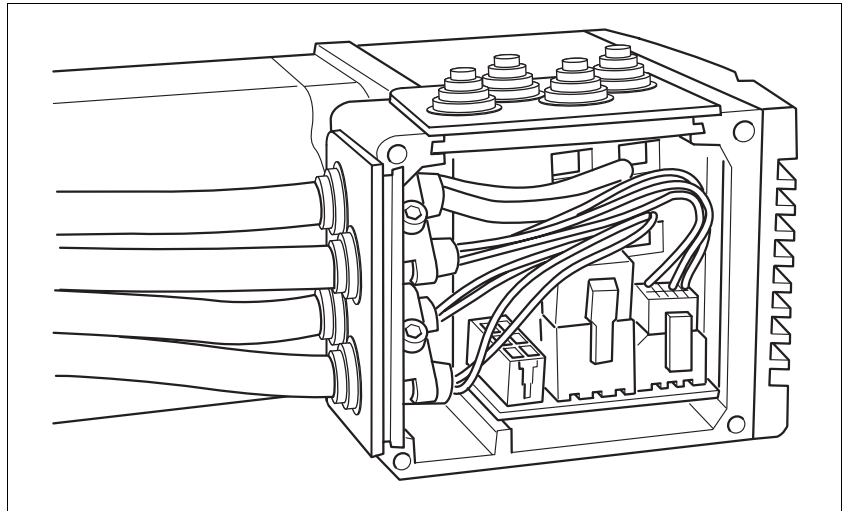
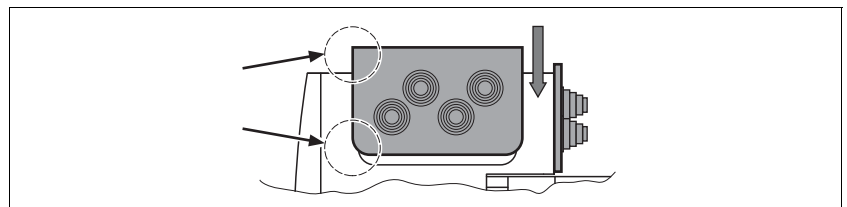
Mounting the cable entry

Figure 6.5 Inserting the cable entries

- ▶ Unscrew the connector housing cover.
NOTE: Shipping locks made of cardboard must not be used for operating the drive. Replace all shipping locks by cable entries or signal inserts.
- ▶ First adjust the parameter switches as these are difficult to access once the cables are connected.
For a description of the parameter switches, see the chapters describing the connections.
- ▶ Connect the plug of the assembled cable to the matching socket. The plugs cannot be turned out of position and must click into place when being plugged in.
Only pull the connector housing (not the cable).
- ▶ Plug the cable entry in one of the two cutouts provided. The side to be used for the cable entry depends on the space available in your system.
NOTE: The pointed corners of the cable entry must point in the direction of the connector housing cover. Degree of protection IP54 is not reached if the cable entry is mounted the other way around.



- ▶ Close the cutout that is not used with a sealing insert for cutouts.
- ▶ Finally, screw the connector housing cover back into place.
If screws are lost use M3x12 only.

6.3.4 Connection with industrial connectors

Interface	Connector used
Supply voltage VDC	Hirschmann STASEI 200
DeviceNet fieldbus	Circular connector M12 , 5 poles, A-coded
24V signal inputs and outputs	Circular connector M8, 3 poles
Safety function STO "Safe Torque Off" (IEC/EN 61800-5-2)	Circular connector M8, 4 poles

Because the requirements are different depending on the system configuration, pre-assembled cables specially designed for Ethernet fieldbus connections can be procured from various suppliers.

Information on pre-assembled cables, connector kits and recommended suppliers can be found in chapter 12 "Accessories and spare parts".

6.3.5 Connection of V_{DC} supply voltage

⚠ DANGER

ELECTRIC SHOCK CAUSED BY INCORRECT POWER SUPPLY UNIT

The V_{DC} and $+24V_{DC}$ supply voltages are connected with many exposed signal connections in the drive system.

- Use a power supply unit that meets the PELV (Protective Extra Low Voltage) requirements.
- For North America: Use a power supply unit with a maximum of $42 V_{dc}$ for compliance with UL 508C.
- Connect the negative output of the power supply unit to PE (ground).

Failure to follow these instructions will result in death or serious injury.

⚠ WARNING

LOSS OF CONTROL DUE TO REGENERATION CONDITION

Regeneration conditions resulting from braking or external driving forces may increase the V_{DC} supply voltage to an unexpected level. Components not rated for this voltage may be destroyed or cause misoperation.

- Verify that all V_{DC} consumers are rated for the voltage occurring during regeneration conditions (for example limit switches).
- Use only power supply units that will not be damaged by regeneration conditions.
- Use a braking resistor controller, if necessary.

Failure to follow these instructions can result in death, serious injury or equipment damage.

⚠ WARNING

DAMAGE TO SYSTEM COMPONENTS AND LOSS OF CONTROL

Interruptions of the negative connection of the controller supply voltage can cause excessively high voltages at the signal connections.

- Do not interrupt the negative connection between the power supply unit and load with a fuse or switch.
- Verify correct connection before switching on.
- Do not connect the controller supply voltage or change its wiring while the is supply voltage present.

Failure to follow these instructions can result in death, serious injury or equipment damage.

CAUTION**DAMAGE TO CONTACTS**

The connection for the controller supply voltage at the product does not have an inrush current limitation. If the voltage is switched on by means of switching of contacts, damage to the contacts or contact welding may result.

- Use a power supply unit that limits the peak value of the output current to a value permissible for the contact.
- Switch the power input of the power supply unit instead of the output voltage.

Failure to follow these instructions can result in equipment damage.

Cable specifications and terminal

Two different crimp contacts are available for different conductor cross sections, see chapter 6.3.3 "Connection via cable entry".

Minimum conductor cross section	[mm ²]	0.75 (AWG 18)
Maximum connection cross section	[mm ²]	4.0 (AWG 12)
Stripping length	[mm]	5 ... 65 ... 6
<hr/>		
Crimp contact 1607736-6	[mm ²]	
Minimum connection cross section		0.75 (AWG 18)
Maximum connection cross section		1.5 (AWG 16)
<hr/>		
Crimp contact 341001-6	[mm ²]	
Minimum connection cross section		2.5 (AWG 12)
Maximum connection cross section		4.0 (AWG 12)

Unshielded cables may be used for the V_{DC} supply voltage. Twisted pair is not required.

- ▶ Use pre-assembled cables to reduce the risk of wiring errors.
- ▶ Verify that wiring, cables and connected interfaces meet the PELV requirements.

Connecting the cables

- ▶ Note the specified technical data.
- ▶ Note the information provided in chapters 5.2 "External power supply units" and 5.3 "Ground design".
- ▶ Install fuses for the power supply cable accordance with the selected conductor cross section / wire gauge (note the inrush currents).

Pin assignment printed circuit board connector

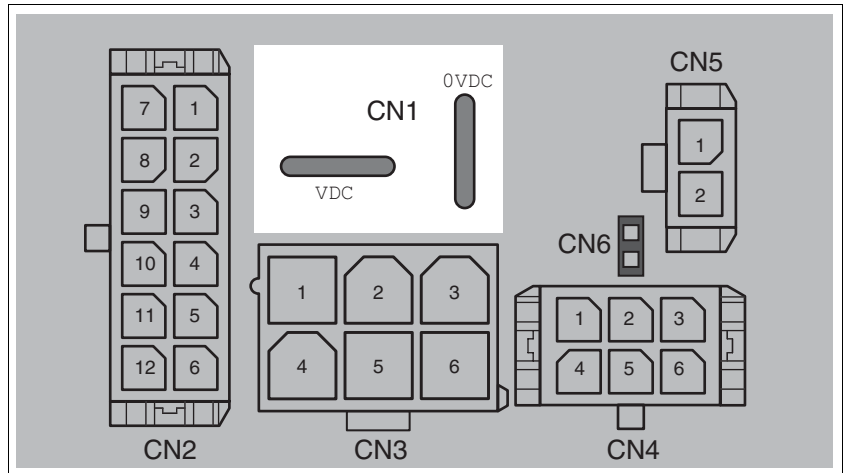


Figure 6.6 Pin assignment supply voltage

Signal	Meaning	Number ¹⁾
VDC	Supply voltage	1
0VDC	Reference potential to VDC	2

1) Information relates to pre-assembled cables

You can crimp together two wires to supply multiple drives via one DC bus. Two different crimp contacts are available for different conductor cross sections, see chapter 6.3.3 "Connection via cable entry".

Pin assignment industrial connector

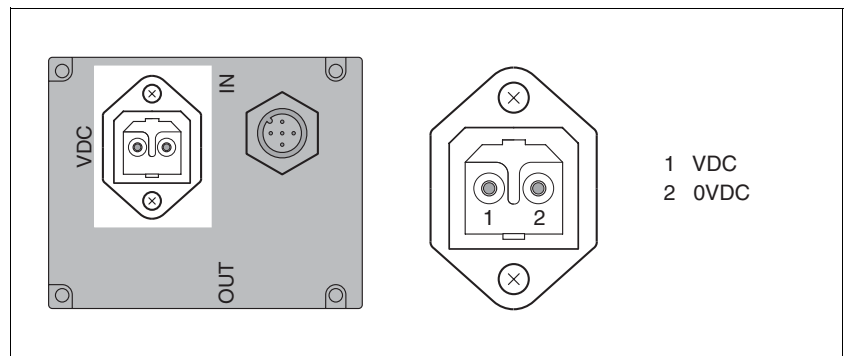


Figure 6.7 Pin assignment supply voltage

Pin	Signal	Meaning	Number ¹⁾
1	VDC	Supply voltage	1
2	0VDC	Reference potential to VDC	2

1) Information relates to pre-assembled cables

6.3.6 DeviceNet fieldbus interface connection

Function Using the DeviceNet interface, you can connect the drive system as a slave to a DeviceNet network.

The fieldbus interface is galvanically isolated from the power supply VDC.

The presence of the bus supply voltage is monitored internally. The monitoring function can be activated and deactivated using the commissioning software.

Cable specifications For details on the cable specification, see chapter 4.2 "DeviceNet fieldbus".

- ▶ Use equipotential bonding conductors, see page 67.
- ▶ Use pre-assembled cables to reduce the risk of wiring errors.
- ▶ Verify that wiring, cables and connected interfaces meet the PELV requirements.

Terminating resistor Both ends of the entire bus system must be terminated with a terminating resistor of 120 Ω between CAN_H and CAN_L each.

Setting the address Each device on the network is identified by a unique, adjustable node address.

The following illustration shows the factory setting of the device address.

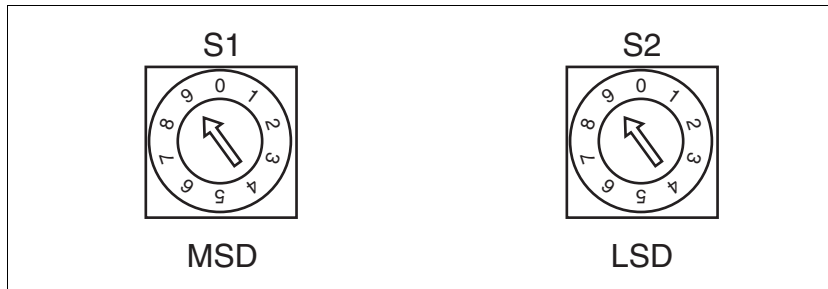


Figure 6.8 Factory settings of the rotary switches

- (S1) MSD (most significant digit)
Determines the tens digit of the node address
- (S2) LSD (least significant digit)
Determines the ones digit of the node address

With a switch setting of 01 ... 63, the selected switch setting corresponds to the MAC ID.

With a switch setting of 64 ... 99, the MAC ID is set with the RSNetWorx configuration software.

- ▶ Before changing the switch settings, switch off all supply voltages.
- ▶ Adjust the rotary switches according to your requirements.

Factory setting Rotary switch: MAC ID 99 (MSD = 9, LSD = 9)
Parameter: MAC ID 63

Baud rate setting The baud rate is identified automatically. However, it can be defined permanently using the parameter `DVNbaud`.

Pin assignment printed circuit board connector

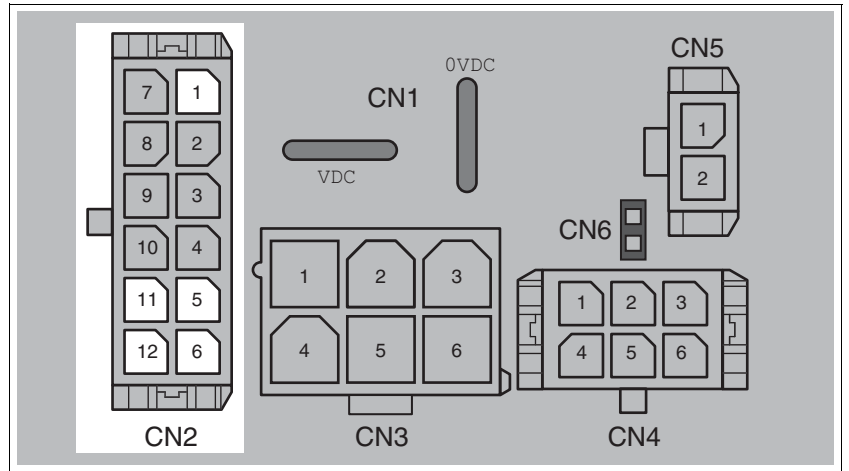


Figure 6.9 Pin assignment printed circuit board connector

Pin	Signal	Meaning
CN2.1	SHLD	Shield connection
CN2.5	V+	Bus supply voltage
CN2.11	V-	Reference potential to V+
CN2.6	CAN_H	Fieldbus
CN2.12	CAN_L	Fieldbus

Pin assignment industrial connector

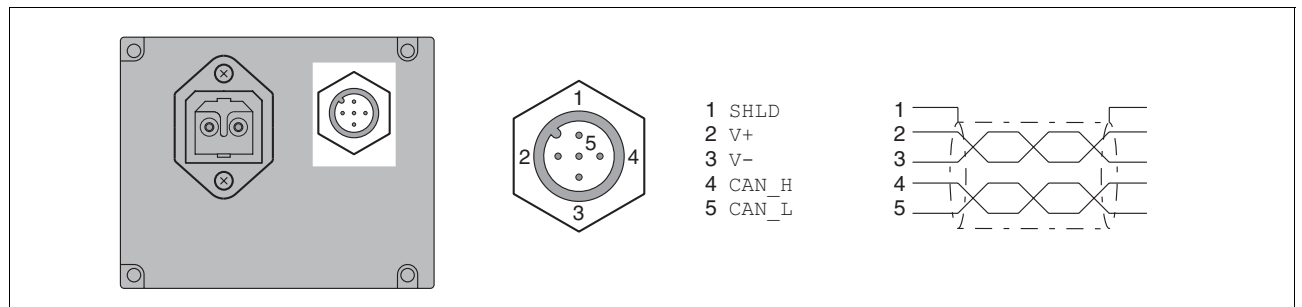


Figure 6.10 Pin assignment industrial connector

Pin	Signal	Meaning
1	SHLD	Shield connection (internally connected to CN2.1)
2	V+	Bus supply voltage (internally connected to CN2.5)
3	V-	Reference potential to V+ (internally connected to CN2.11)
4	CAN_H	Fieldbus (internally connected to CN2.6)
5	CAN_L	Fieldbus (internally connected to CN2.12)

6.3.7 RS485 interface connection

Function An RS485 interface is provided in addition to the fieldbus interface. The RS485 interface is also used to commission the drive.

You can also use the RS485 interface and the commissioning software to monitor the drive during operation. It is not possible to establish a simultaneous connection with the fieldbus.

Cable specifications and terminal

- Shielded cable
- Twisted-pair cables
- Grounding of the shield at both ends

Maximum cable length	[m]	400
Minimum conductor cross section	[mm ²]	0.25 (AWG 22)
Maximum connection cross section	[mm ²]	1.0 (AWG 18)
Stripping length	[mm]	3.0 ... 3.5

- ▶ Use equipotential bonding conductors, see page 67.
- ▶ Use pre-assembled cables to reduce the risk of wiring errors.
- ▶ Verify that wiring, cables and connected interfaces meet the PELV requirements.

Setting the address The node address, baud rate and data format are set using parameters.

Factory settings:

- Node address: 1
- Baud rate: 19200
- Data format: 8 bit, even parity, 1 stop

Pin assignment printed circuit board connector

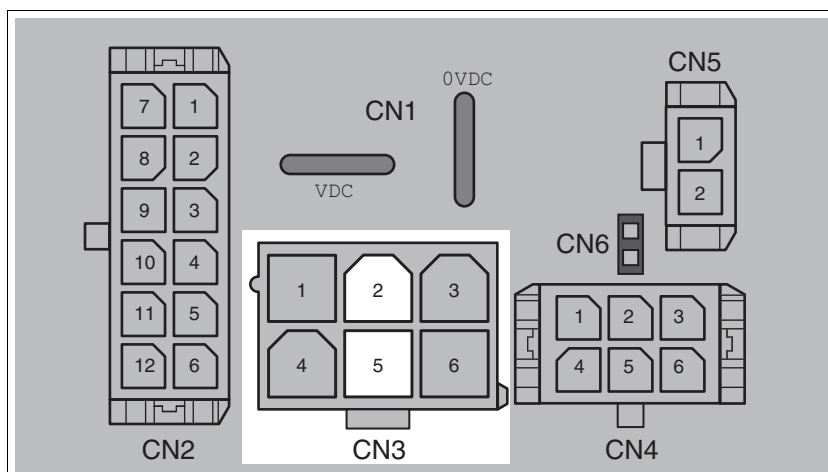


Figure 6.11 Pin assignment printed circuit board connector

Pin	Signal	Meaning
2	+RS485	RS485 interface
5	-RS485	RS485 interface

6.3.8 24V signal interface connection

Internal 24V signal power supply An internal 24V power supply for the sensor system is integrated in the product.

The internal 24V signal power supply must not be connected to the internal 24V signal power supply of another product.

Cable specifications and terminal

Minimum conductor cross section	[mm ²]	0.2 (AWG 24)
Maximum connection cross section	[mm ²]	0.6 (AWG 20)
Stripping length	[mm]	2.5 ... 3.0

- ▶ Use pre-assembled cables to reduce the risk of wiring errors.
- ▶ Verify that wiring, cables and connected interfaces meet the PELV requirements.

Configuration Different functions can be assigned to the digital signal inputs and outputs. For a detailed description, see chapter 8.6.9 "Configurable inputs and outputs".

Factory settings The following table provides an overview of the factory settings.

Pin	Signal	Factory setting	I/O
CN4.3	LIO1	Input Positive limit switch (LIMP)	I
CN4.6	LIO2	Input Negative limit switch (LIMN)	I
CN4.2	LIO3	Input Free available	I
CN4.5	LIO4	Input Reference switch (REF)	I

⚠ WARNING

LOSS OF CONTROL

The use of $\overline{\text{LIMP}}$ and $\overline{\text{LIMN}}$ can provide some protection against hazards (e.g. collision with mechanical stop caused by incorrect reference values).

- Use $\overline{\text{LIMP}}$ and $\overline{\text{LIMN}}$ where possible.
- Verify that the external sensors or switches are properly connected.
- Verify the correct of the limit switches. The limit switches must be mounted in a position far enough away from the mechanical stop to allow for an adequate stopping distance.
- Before you can use $\overline{\text{LIMP}}$ and $\overline{\text{LIMN}}$, you must enable them.

Failure to follow these instructions can result in death, serious injury or equipment damage.

During movements the two limit switches are monitored via the input signals $\overline{\text{LIMP}}$ and $\overline{\text{LIMN}}$. If the drive hits a limit switch, the motor stops. Triggering of the limit switch is signaled.

Pin assignment printed circuit board connector

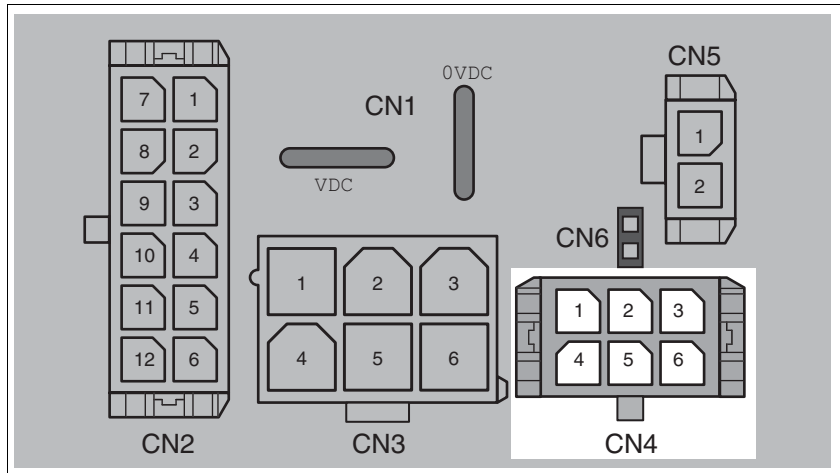


Figure 6.12 Pin assignment printed circuit board connector

Pin	Signal	Meaning	I/O
1	+24VDC_OUT	The internal 24V signal power supply may be used to supply the sensor system (e.g. limit switches)	O
2	LIO3	Freely usable input / output	I/O
3	LIO1	Freely usable input / output	I/O
4	0VDC	Internally connected to CN1 . 0VDC	
5	LIO4	Freely usable input / output	I/O
6	LIO2	Freely usable input / output	I/O

6.3.9 Connection of STO safety function

⚠ WARNING
<p>LOSS OF SAFETY FUNCTION</p> <p>Incorrect usage may cause a hazard due to the loss of the safety function.</p> <ul style="list-style-type: none"> Observe the requirements for using the safety function. <p>Failure to follow these instructions can result in death or serious injury.</p>

Requirements

For information and requirements relating to the STO safety function, see chapter 5.4 "Safety function STO ("Safe Torque Off")".

Cable specifications and terminal

- Shielded cable corresponding to the requirements for protected layout of wires

Minimum conductor cross section	[mm ²]	0.34 (AWG 20)
Maximum connection cross section	[mm ²]	0.6 (AWG 20)
Stripping length	[mm]	2.5 ... 3.0

- ▶ Use equipotential bonding conductors, see page 67.
- ▶ Use pre-assembled cables to reduce the risk of wiring errors.
- ▶ Verify that wiring, cables and connected interfaces meet the PELV requirements.

The cable available as an accessory is a special cable that is only available with a connector. The shield of the cable is connected to the grounded housing of the drive via the metal connector. It is sufficient to connect one end of the cable to the grounded housing.

Pin assignment printed circuit board connector

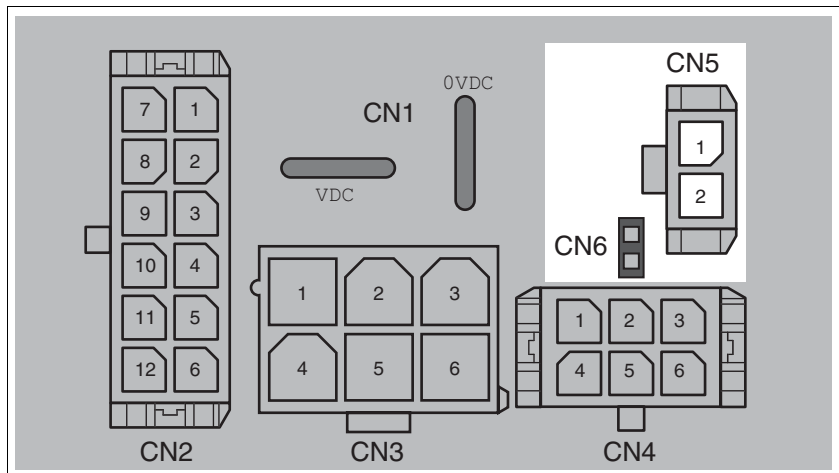
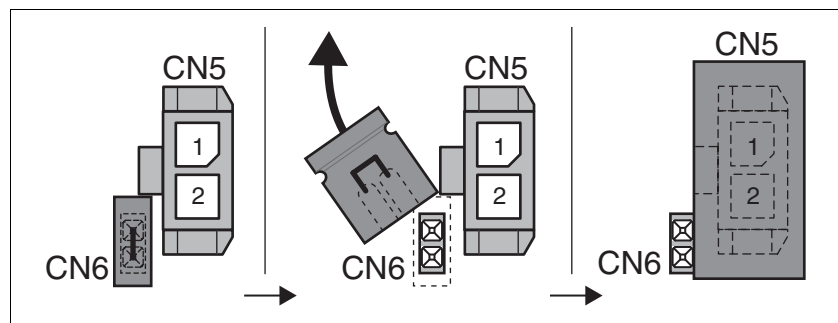


Figure 6.13 Pin assignment of safety function

Pin	Signal	Meaning
CN5.1	STO_A (PWRR_A)	Safety function STO "Safe Torque Off" (IEC/ EN 61800-5-2)
CN5.2	STO_B (PWRR_B)	Safety function STO "Safe Torque Off" (IEC/ EN 61800-5-2)
CN6		Jumper plugged in: STO disabled Jumper removed: STO enabled

NOTE: Jumper CN5 cannot be plugged in as long as jumper CN6 is still plugged in (mechanical lock).

Connecting the safety function



- ▶ Remove jumper CN6.
- ▶ Connect the connector to CN5.

6.3.10 Connection for reference value supply

Function External reference signals for the operating mode "Electronic Gear" can be supplied via CN2.

The signal inputs PULSE/DIR and A/B are used in combination:

- Interface mode "PULSE/DIR"
Pulse/direction signals
- Interface mode "A/B"
AB encoder signals

Cable specifications and terminal

- Shielded cable
- Twisted-pair cables
- Grounding of the shield at both ends

Maximum cable length ¹⁾	[m]	100
Minimum conductor cross section	[mm ²]	0.14 (AWG 24)
Maximum connection cross section	[mm ²]	0.6 (AWG 20)
Stripping length	[mm]	2.5 ... 3.0

1) The cable length depends on the conductor cross section and the driver circuit used

- ▶ Use equipotential bonding conductors, see page 67.
- ▶ Use pre-assembled cables to reduce the risk of wiring errors.
- ▶ Verify that wiring, cables and connected interfaces meet the PELV requirements.

Signal level The inputs operate with the RS422 level and are not galvanically isolated.

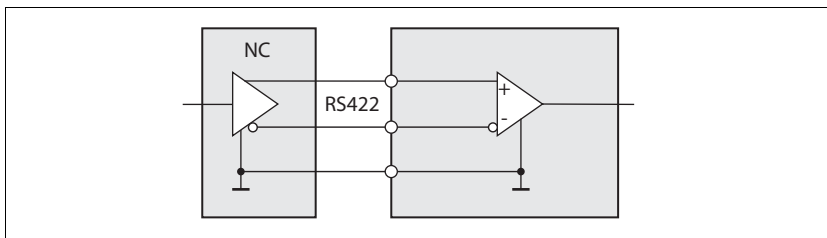


Figure 6.14 Circuit of the signal inputs

- Logic 0
 - 0 level at input "+"
 - 1 level at input "-"
- Logic 1
 - 1 level at input "+"
 - 0 level at input "-"

Open inputs are logic 0.

Interface mode "PULSE/DIR" The motor executes an angle step with the rising edge of the PULSE signal. The direction of rotation is controlled by the DIR signal.

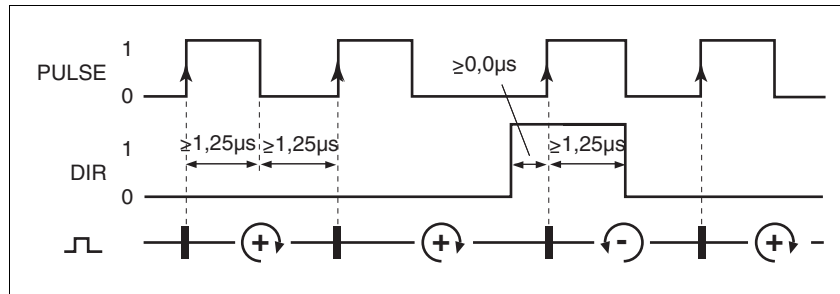


Figure 6.15 Pulse/direction signals

Signal	Signal value	Meaning
PULSE	0 -> 1	Angle step
DIR	0 / open	Clockwise direction of rotation
	1	Counterclockwise direction of rotation

Interface mode "A/B" In "A/B" interface mode, A/B encoder signals are supplied as reference values.

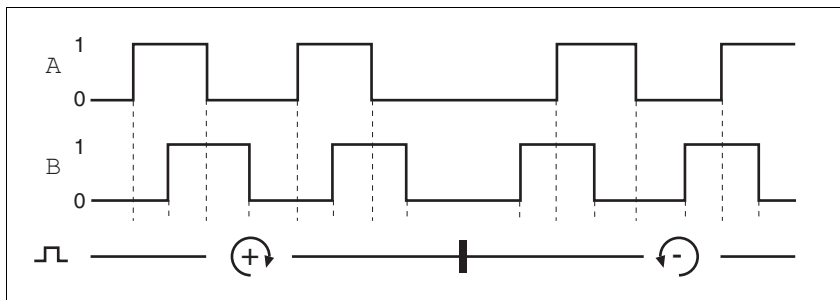


Figure 6.16 AB encoder signals

Pin assignment printed circuit board connector

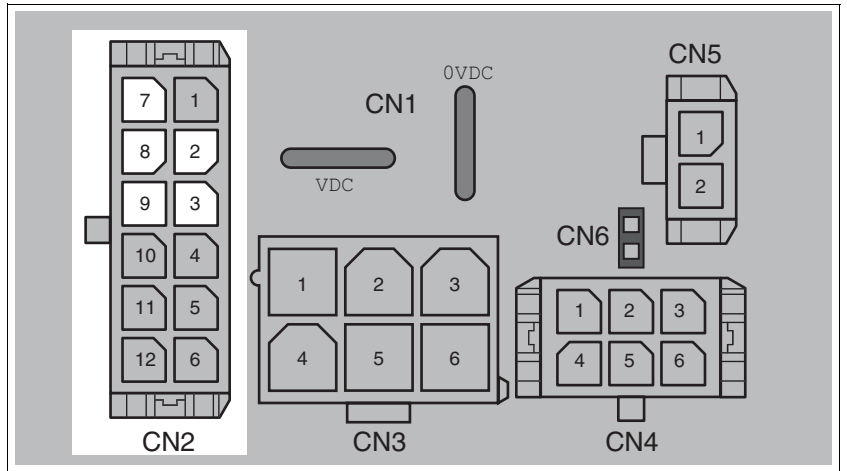


Figure 6.17 Pin assignment of the pulse/direction or A/B interface

Pin	Signal	Meaning
7	POS_0V	Internally connected to 0VDC
2	+DIR or +B	Direction of rotation "DIR" or "B" channel of AB encoder signals
8	-DIR or -B	Direction of rotation "DIR" or "B" channel of AB encoder signals
3	+PULSE or +A	Motor step "PULSE" or "A" channel of AB encoder signals
9	-PULSE or -A	Motor step "PULSE" or "A" channel of AB encoder signals

6.4 Connection accessories

6.4.1 Accessory "Insert kit, 3x I/O"

The accessory makes the signals LIO1, LIO2 and LIO4 available outside of the device via industrial connectors.

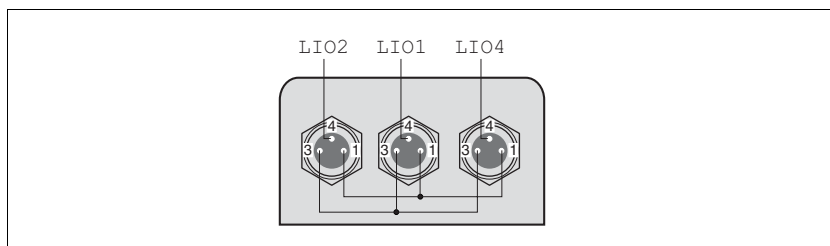


Figure 6.18 Pin assignment

Pin 1 is internally connected to CN4.1 (+24VDC_OUT).

Pin 3 is internally connected to CN4.4 (0VDC).

6.4.2 Accessory "Insert kit, 2x I/O, 1x STO in"

The accessory makes the signals LIO1, LIO2 and the signals of the STO safety function available outside of the device via industrial connectors.

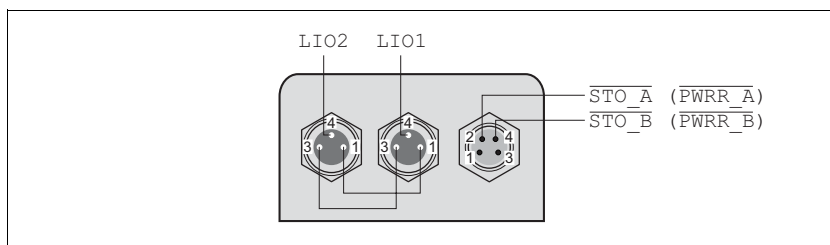


Figure 6.19 Pin assignment

Pin 1 is internally connected to CN4.1 (+24VDC_OUT).

Pin 3 is internally connected to CN4.4 (0VDC).

6.4.3 Accessory "Insert kit, 1x STO in, 1x STO out"

The accessory makes the signals of the STO safety function available outside of the device via industrial connectors.

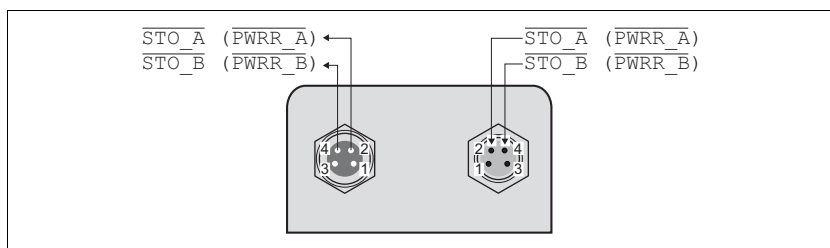


Figure 6.20 Pin assignment

6.4.4 Accessory "Insert kit, 4x I/O, 1x STO in, 1x STO out"

The accessory makes the signals LIO1, LIO2, LIO3 and LIO4 and the signals of the STO safety function available outside of the device via industrial connectors.

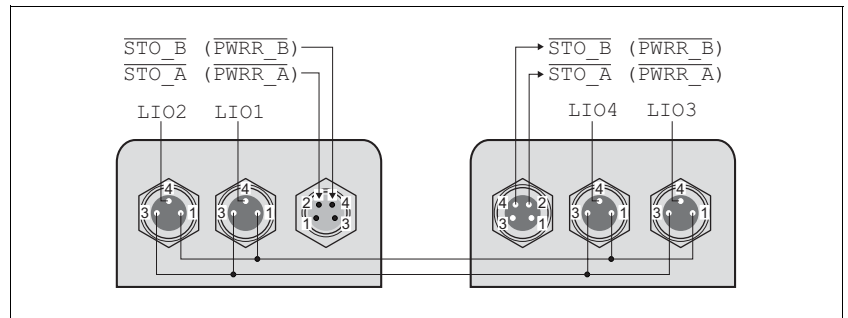


Figure 6.21 Pin assignment

Pin 1 is internally connected to CN4.1 (+24VDC_OUT).

Pin 3 is internally connected to CN4.4 (0VDC).

6.5 Checking wiring

Verify proper installation:

- ▶ Did you properly install and connect all cables and connectors?
- ▶ Are there any live, exposed cables?
- ▶ Did you properly connect the signal wires?
- ▶ Did you properly install all seals (degree of protection IP54)?

7 Commissioning



*An alphabetically sorted overview of **all** parameters can be found in the chapter "Parameters". The use and the function of some parameters are explained in more detail in this chapter.*

⚠ DANGER

UNINTENDED CONSEQUENCES OF EQUIPMENT OPERATION

When the system is started, the drives are usually out of the operator's view and cannot be visually monitored.

- Only start the system if there are no persons in the hazardous area.

Failure to follow these instructions will result in death or serious injury.

⚠ WARNING

UNEXPECTED MOVEMENT

When the drive is operated for the first time, there is a risk of unexpected movements caused by possible wiring errors or unsuitable parameters.

- Perform the first test run without coupled loads.
- Verify that a functioning button for EMERGENCY STOP is within reach.
- Anticipate movements in the incorrect direction or oscillation of the drive.
- Only start the system if there are no persons or obstructions in the hazardous area.

Failure to follow these instructions can result in death, serious injury or equipment damage.

⚠ WARNING**UNINTENDED BEHAVIOR**

The behavior of the drive system is governed by numerous stored data or settings. Unsuitable settings or data may trigger unexpected movements or responses to signals and disable monitoring functions.

- Do NOT operate the drive system with unknown settings or data.
- Verify that the stored data and settings are correct.
- When commissioning, carefully run tests for all operating states and potential fault situations.
- Verify the functions after replacing the product and also after making changes to the settings or data.
- Only start the system if there are no persons or obstructions in the hazardous area.

Failure to follow these instructions can result in death, serious injury or equipment damage.

⚠ WARNING**MOTOR WITHOUT BRAKING EFFECT**

If power outage and faults cause the power stage to be switched off, the motor is no longer stopped by the brake and may increase its speed even more until it reaches a mechanical stop.

- Verify the mechanical situation.
- If necessary, use a cushioned mechanical stop or a suitable brake.

Failure to follow these instructions can result in death, serious injury or equipment damage.

⚠ WARNING**ROTATING PARTS**

Rotating parts may cause injuries and may catch clothing or hair. Loose parts or parts that are unbalanced may be flung.

- Verify correct mounting and installation of all rotating parts.
- Use a cover to help protect against rotating parts.

Failure to follow these instructions can result in death, serious injury or equipment damage.

▲ WARNING**FALLING PARTS**

The motor may move, tip and crash down as a result of the reaction torque.

- Mount the motor securely so it will not break loose during strong acceleration.

Failure to follow these instructions can result in death, serious injury or equipment damage.

▲ CAUTION**HOT SURFACES**

Depending on the operation, the surface may heat up to more than 100°C (212°F).

- Do not allow contact with the hot surfaces.
- Do not allow flammable or heat-sensitive parts in the immediate vicinity.
- Consider the measures for heat dissipation described.
- Check the temperature during test runs.

Failure to follow these instructions can result in injury or equipment damage.

7.1 Overview

This chapter describes the commissioning procedure for the drive.

The following components are required for commissioning:

- EDS file (<http://www.schneider-electric.com>)
- RSNetWorx configuration software
- Basic knowledge of RSNetWorx configuration software
- Commissioning software Lexium CT (<http://www.schneider-electric.com>)
- Fieldbus converter for the commissioning software



The following commissioning steps are also required if you want to use a configured device under changed operating conditions.

To be done

- Carry out all of the steps below in the specified order.

To be done ...	Page
6.5 "Checking wiring"	91
7.2.1 "Setting the device address"	97
7.2.2 "Adding the product to the fieldbus"	98
7.2.3 "Lexium CT commissioning software"	100

- Carry out the following steps using the commissioning software.

To be done ...	Page
7.2.4 "Setting basic parameters and limit values"	102
7.2.5 "Digital inputs / outputs"	105
7.2.6 "Checking the signals of the limit switches"	106
7.2.7 "Testing safety function STO"	107
7.2.8 "Releasing the holding brake manually"	108
7.2.9 "Checking direction of rotation"	109
7.2.10 "Setting parameters for encoder"	110

7.2 Commissioning procedure

⚠ WARNING
<p>LOSS OF CONTROL DUE TO UNSUITABLE PARAMETER VALUES</p> <p>Unsuitable parameter values may disable monitoring functions and trigger unexpected movements or responses of signals.</p> <ul style="list-style-type: none"> • Prepare a list with the parameters required for the functions used. • Check the parameters before operation. • Only start the system if there are no persons or obstructions in the hazardous area. <p>Failure to follow these instructions can result in death, serious injury or equipment damage.</p>

7.2.1 Setting the device address

Setting the address Each device on the network is identified by a unique, adjustable node address.

The following illustration shows the factory setting of the device address.

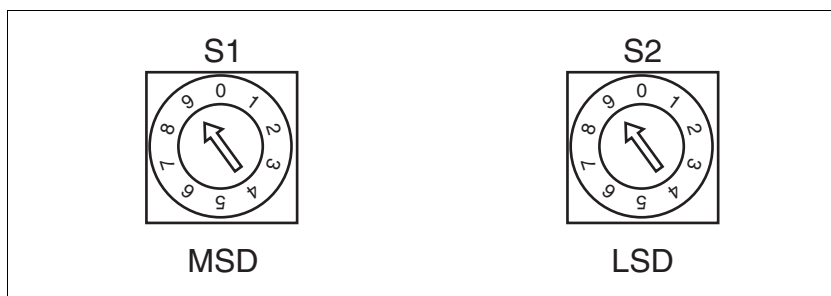


Figure 7.1 Factory settings of the rotary switches

- (S1) MSD (most significant digit)
Determines the tens digit of the node address
- (S2) LSD (least significant digit)
Determines the ones digit of the node address

With a switch setting of 01 ... 63, the selected switch setting corresponds to the MAC ID.

With a switch setting of 64 ... 99, the MAC ID is set with the RSNetWorx configuration software.

- ▶ Before changing the switch settings, switch off all supply voltages.
- ▶ Adjust the rotary switches according to your requirements.

Factory setting Rotary switch: MAC ID 99 (MSD = 9, LSD = 9)
Parameter: MAC ID 63

7.2.2 Adding the product to the fieldbus

The product is added to the fieldbus using the RSNNetWorx configuration software.

Configuring the product

- ▶ Add the product to the PLC by means of a network scan.
- ▶ On the "General" tab, change the MAC ID to a free address if you have not selected a fixed MAC ID with the rotary switch.
- ▶ Display the "Parameters" tab and load all parameters from the product.
- ▶ In the parameters Polled I/O Input and Polled I/O Output, select the required "Connection Object".

Descriptions can be found in chapters 4.2.5 "Communication via I/O Message" and 8.7 "Drive profile Position Controller Profile".

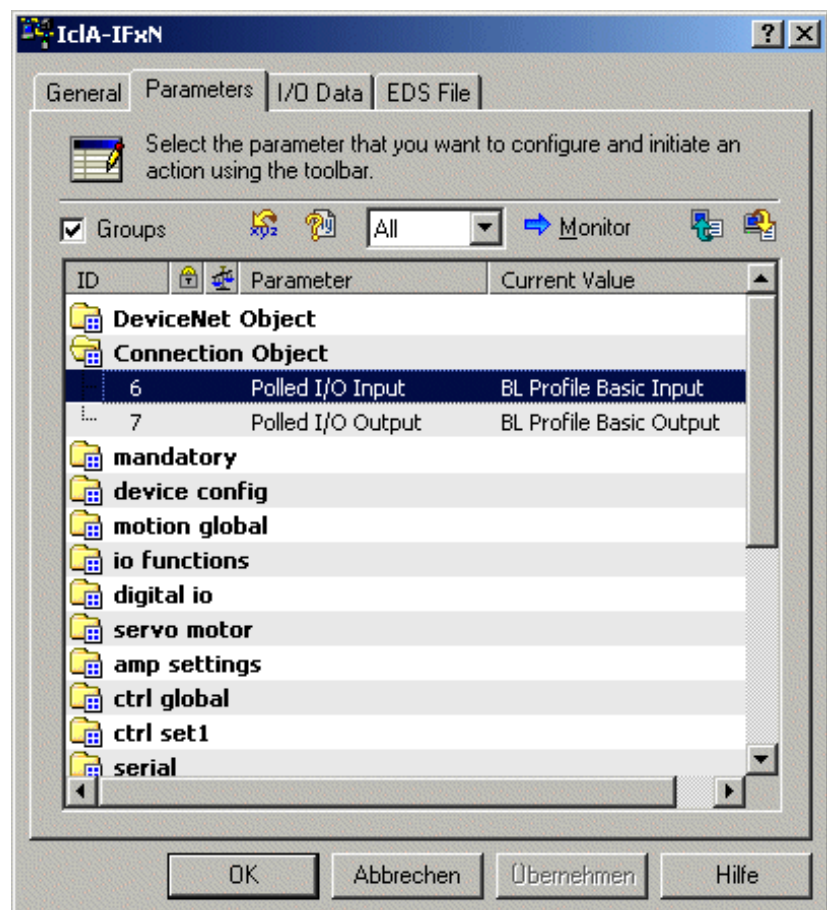


Figure 7.2 Configuring the Connection Object in the device

If you want to use extended input/output assemblies, you must adjust the reserved bytes in the DeviceNet-Scanner configuration.

- Configuring the DeviceNet scanner*
- ▶ In the DeviceNet Scanner configuration on the "Scanlist" tab, add the product to the "Scanlist".
 - ▶ On the "Scanlist" tab, use the "Edit I/O Parameters" button to adjust the bytes as described below.
- Position Controller Profile 100 -> 8 Bytes
Standard Output Assembly 101 -> 8 Bytes
Extended Output Assembly 102 -> 12 Bytes
 - Position Controller Profile 110 -> 8 Bytes
Standard Input Assembly 111 -> 8 Bytes
Extended Input Assembly 112 -> 14 Bytes

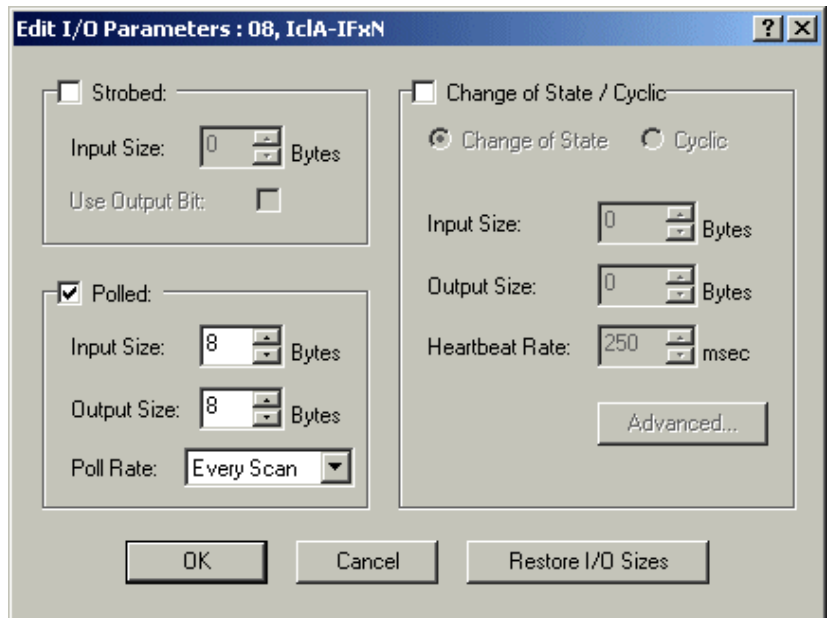


Figure 7.3 Reserving a data range

7.2.3 Lexium CT commissioning software

The commissioning software has a graphic user interface and is used for commissioning, diagnostics and testing settings.

Source commissioning software The latest version of the commissioning software is available for download from the internet:

<http://www.schneider-electric.com>

Functions of the commissioning software The functions of the commissioning software include:

- Scan various fieldbuses for devices
- Extensive information on connected devices
- Display and enter device parameters
- Archive and duplicate device parameters
- Manual positioning of the motor
- Test input and output signals
- Record, evaluate and archive motion and signals
- Error diagnostics
- Optimize control behavior (servo motors only)

System requirements The minimum hardware requirements for installation and operation of the software are:

- IBM-compatible PC
- Approx. 200 MB of hard disk space
- 512 MB RAM
- Graphics card and monitor with a resolution of at least 1024x768 pixels
- Free serial interface (RS232) or free USB interface
- Operating system Windows 2000, Windows XP Professional or Windows Vista
- Acrobat Reader 5.0 or newer
- Internet connection (for initial installation and updates)

Converter You require a converter to connect the product to a PC. The connection can be made via the commissioning interface or the fieldbus interface.

The commissioning interface differs from the fieldbus interface as follows:

- Commissioning interface:
 - Converter for RS485 is required.
 - Connection possible during operation.
 - Master does not have to be deactivated.
 - 24V fieldbus supply does not have to be activated.
- Fieldbus interface:
 - Converter for DeviceNet is required.
"USB-to-CAN compact", www.ixxat.com
 - Connection not possible during operation.
 - Master must be deactivated.
 - 24V fieldbus supply must be activated.

Online help The commissioning software offers comprehensive help functions, which can be accessed via "? - Help Topics" or by pressing the F1 key.

7.2.4 Setting basic parameters and limit values

⚠ WARNING**UNINTENDED BEHAVIOR**

The behavior of the drive system is governed by numerous stored data or settings. Unsuitable settings or data may trigger unexpected movements or responses to signals and disable monitoring functions.

- Do NOT operate the drive system with unknown settings or data.
- Verify that the stored data and settings are correct.
- When commissioning, carefully run tests for all operating states and potential fault situations.
- Verify the functions after replacing the product and also after making changes to the settings or data.
- Only start the system if there are no persons or obstructions in the hazardous area.

Failure to follow these instructions can result in death, serious injury or equipment damage.



Prepare a list with the parameters required for the functions used.

Setting thresholds

Suitable thresholds must be calculated from the system configuration and motor characteristics. So long as the motor is operated without external loads you will not need to change the default settings.

The maximum motor current must for example be reduced as a determining factor of the torque if the permissible torque of a system component will otherwise be exceeded.

Current limitation

The maximum motor current can be set with the parameter `CTRL_I_max`.

The maximum current for the "Quick Stop" function can be limited with the parameter `LIM_I_maxQSTP` and for the "Halt" function with the parameter `LIM_I_maxHalt`.

- ▶ Use the parameter `CTRL_I_max` to set the maximum motor current.
- ▶ Use the parameter `LIM_I_maxQSTP` to set the maximum motor current for the "Quick Stop" function.
- ▶ Use the parameter `LIM_I_maxHalt` to set the maximum motor current for the "Halt" function.

In operating modes with profile generator, acceleration and deceleration are limited through ramp functions. The motor can be decelerated via a deceleration ramp or the maximum current for the functions "Quick Stop" and "Halt".

Parameter Name	Description	Unit Minimum value Default value Maximum value	Data type R/W persistent Expert	Parameter address via fieldbus
CTRL_I_max	Current limitation The value must not exceed the maximum permissible current of the motor or the power stage. Default: M_I_max	A _{pk} 0.00 - 299.99	UINT16 UINT16 R/W per. -	Modbus 4610 CIP 118.1.1
LIM_I_maxQSTP	Current limitation for Quick Stop Max. current during braking via torque ramp due to an error of error classes 1 or 2 and when a software stop is triggered. Maximum and default settings depend on the motor and the power stage (settings M_I_max and PA_I_max) In increments of 0.01A _{pk}	A _{pk} - - -	UINT16 UINT16 R/W per. -	Modbus 4362 CIP 117.1.5
LIM_I_maxHalt	Current limitation for Halt Max. current during braking after Halt or when an operating mode is terminated. Maximum and default settings depend on the motor and the power stage (settings M_I_max and PA_I_max) In increments of 0.01A _{pk}	A _{pk} - - -	UINT16 UINT16 R/W per. -	Modbus 4364 CIP 117.1.6

Limitation of speed of rotation The parameter CTRL_n_max can be used to limit the maximum speed of rotation.

- ▶ Use the parameter CTRL_n_max to set the maximum speed of rotation of the motor.

Parameter Name	Description	Unit Minimum value Default value Maximum value	Data type R/W persistent Expert	Parameter address via fieldbus
CTRL_n_max	Speed limitation The set value must not exceed the maximum motor speed. Default: maximum motor speed (see M_n_max)	min ⁻¹ 0 - 13200	UINT16 UINT16 R/W per. -	Modbus 4612 CIP 118.1.2

Type of reference value supply ▶ Use the parameter IOposInterfac to define the type of reference value supply for the "Electronic Gear" operating mode.

Parameter Name HMI menu	Description	Unit Minimum value Default value Maximum value	Data type R/W persistent Expert	Parameter address via fieldbus
IOposInterfac	Signal selection position interface 0 / A Input: Input ENC_A, ENC_B quadruple evaluation 1 / P Dinput: Input PULSE, DIR RS422 I/O interface (Pos) NOTE: Changed settings do not become active until the unit is switched on the next time.	- 0 0 1	UINT16 UINT16 R/W per. -	Modbus 1284 CIP 105.1.2

7.2.5 Digital inputs / outputs

The device has 4 configurable 24V signals. These 24V signals can each be configured as either an input or an output.

The configuration of the 24V signals is described in chapter 8.6.9 "Configurable inputs and outputs".

Factory settings The following table provides an overview of the factory settings.

Pin	Signal	Factory setting	I/O
CN4.3	LIO1	Input Positive limit switch (LIMP)	I
CN4.6	LIO2	Input Negative limit switch (LIMN)	I
CN4.2	LIO3	Input Free available	I
CN4.5	LIO4	Input Reference switch (REF)	I

Signal level The `_IO_LIO_act` parameter provides information on the current signal level of the 24V signals.

Parameter Name	Description	Unit	Data type	Parameter address via fieldbus
		Minimum value	R/W	
		Default value	persistent	
		Maximum value	Expert	
<code>_IO_LIO_act</code>	Status of digital inputs/outputs	-	UINT16	Modbus 2090
	Coding of the individual signals:	-	UINT16	CIP 108.1.21
	Bit 0: LIO1	0	R/-	
	Bit 1: LIO2	-	-	
	...			

7.2.6 Checking the signals of the limit switches

⚠ WARNING**LOSS OF CONTROL**

The use of $\overline{\text{LIMP}}$ and $\overline{\text{LIMN}}$ can provide some protection against hazards (e.g. collision with mechanical stop caused by incorrect reference values).

- Use $\overline{\text{LIMP}}$ and $\overline{\text{LIMN}}$ where possible.
- Verify that the external sensors or switches are properly connected.
- Verify the correct of the limit switches. The limit switches must be mounted in a position far enough away from the mechanical stop to allow for an adequate stopping distance.
- Before you can use $\overline{\text{LIMP}}$ and $\overline{\text{LIMN}}$, you must enable them.

Failure to follow these instructions can result in death, serious injury or equipment damage.

- You must have configured functions "Negative limit switch (LIMN)" and "Positive limit switch (LIMP)", see chapter 8.6.9 "Configurable inputs and outputs".
- ▶ Set up the limit switches in such a way as to keep the motor from overtraveling the limit switches.
- ▶ Trigger the limit switches manually.
- ◁ The commissioning software displays an error condition caused by a limit switch.

The appropriate parameters can be used to release the limit switches and to set the evaluation to active 0 or active 1, see chapter 8.6.1 "Monitoring functions".



Use active 0 monitoring signals if possible, because they are failsafe.

7.2.7 Testing safety function STO

Operation with STO If you wish to use the STO safety function, carry out the following steps.

- Supply voltage switched off.
- ▶ Verify that the inputs $\overline{STO_A}$ ($\overline{PWRR_A}$) and $\overline{STO_B}$ ($\overline{PWRR_B}$) are electrically isolated from each other. The two signals must not be electrically connected.
- Supply voltage switched on.
- ▶ Enable the power stage (without motor movement).
- ▶ Trigger the safety function. $\overline{STO_A}$ ($\overline{PWRR_A}$) and $\overline{STO_B}$ ($\overline{PWRR_B}$) must be switched off simultaneously (time offset <1s).
- ◁ The power stage is disabled and error message 1300 is generated. (NOTE: Error message 1301 indicates a wiring error.)
- ▶ Verify that the `IO_AutoEnable` parameter is set to "off" to avoid unexpected restart.
- ▶ Check the behavior of the drive during fault conditions.
- ▶ Document all tests of the safety function in your acceptance certificate.

Operation without STO You must perform the following steps if you do not want to use the STO safety function.

- ▶ Check whether the jumper CN6 is connected.

7.2.8 Releasing the holding brake manually

The drive automatically controls the integrated holding brake. However, during commissioning it may be necessary to release the holding brake manually.

The power supply must be on to release the holding brake manually.

⚠ WARNING

UNEXPECTED MOVEMENT

Manual release of the holding brake or an error may cause an unexpected movement in the system.

- Switch off the voltage at the inputs $\overline{STO_A}$ ($\overline{PWRR_A}$) and $\overline{STO_B}$ ($\overline{PWRR_B}$) to avoid an unexpected restart of the motor.
- Take appropriate measures to avoid damage caused by the falling loads.
- Only run the test if there are no persons or obstacles in the hazardous area.

Failure to follow these instructions can result in death or serious injury.

<i>Power stage disabled</i>	The holding brake can be released with the parameter <code>BRK_release</code> and the commissioning software when the power stage is not enabled. The power stage cannot be enabled with a manually released holding brake.
<i>Power stage enabled</i>	When the power stage is enabled, the automatic holding brake controller is active. If the holding brake is manually released an error message is generated.

Parameter Name	Description	Unit Minimum value Default value Maximum value	Data type R/W persistent Expert	Parameter address via fieldbus
BRK_release	Processing of holding brake 0 / close: automatic processing (default) 1 / open: manual release of brake The brake output can only be activated in the states 'Switch on disabled' or 'Ready to switch on'. If the power stage is active, the value is automatically set to 0.	- 0 0 1	UINT16 UINT16 R/W - -	Modbus 2068 CIP 108.1.10

7.2.9 Checking direction of rotation

Direction of rotation Rotation of the motor shaft in a clockwise or counterclockwise direction of rotation. Clockwise rotation is when the motor shaft rotates clockwise as you look at the end of the protruding motor shaft.

- ▶ Start the operating mode Jog.
- ▶ Start a movement with clockwise direction of rotation.
- ◁ The motor rotates with clockwise direction of rotation.
- ▶ Start a movement with counterclockwise direction of rotation.
- ◁ The motor rotates with counterclockwise direction of rotation.
- ▶ If the arrow and direction of rotation do not match, correct this with the `POSdirOfRotat` parameter, see chapter 8.6.10 "Reversal of direction of rotation".

7.2.10 Setting parameters for encoder

Setting an absolute position When starting up, the device reads the absolute position of the motor from the encoder. The current absolute position can be read with the parameter `_p_absENCusr`.

When the motor is at a standstill, the current mechanical motor position can be defined as the new absolute position of the motor with the parameter `ENC_pabsusr`. The value can be set with the power stage enabled or disabled. Setting the absolute position also shifts the position of the index pulse of the encoder and the index pulse of the encoder simulation.

Parameter Name	Description	Unit Minimum value Default value Maximum value	Data type R/W persistent Expert	Parameter address via fieldbus
<code>_p_absENCusr</code>	<p>Motor position with reference to encoder range in user units</p> <p>The value range is determined by the encoder type. In the case of singleturn encoders, the value refers to one motor revolution, in the case of multiturn encoders to the entire encoder range (e.g. 4096 revolutions).</p> <p>NOTE: The position is not valid until the absolute motor position has been determined. In the case of invalid absolute motor position: _WarnLatched _WarnActive Bit 13=1: Absolute motor position not yet captured</p>	usr - 0 -	UINT32 UINT32 R/- -	Modbus 7710 CIP 130.1.15
<code>ENC_pabsusr</code>	<p>Directly set the motor encoder position</p> <p>The value range depends on the encoder type.</p> <p>Singleturn encoder: 0 ... $\text{max_pos_usr/rev.} - 1$ Multiturn encoder: 0 ... $(4096 * \text{max_pos_usr/rev.}) - 1$</p> <p><code>max_pos_usr/rev.</code>: maximum user position for one motor turn. This value is 16384 with the default scaling.</p> <p>NOTE: * If processing is to be performed with inversion of the direction of rotation, this must be set before the motor encoder position is adjusted. * The set value does not become active until the controller is switched on the next time. After the write access, a wait time of at least 1 second is required before the controller is switched off. * Changing this value also changes the position of the virtual index pulse and the index pulse for the ESIM function.</p>	usr -2147483648 - 2147483647	INT32 INT32 R/W - -	Modbus 1324 CIP 105.1.22

Singleturn encoder In the case of a singleturn encoder, you can shift the position of the index pulse of the encoder by setting a new absolute position. If the position value is 0, the index pulse is defined at the current mechanical motor position.

This also changes the position of the index pulse of the encoder simulation.

Multiturn encoder In the case of a multiturn encoder, the mechanical working range of the motor can be shifted to the continuous range of the encoder by setting a new absolute position.

If the motor is moved counterclockwise from the absolute position 0, there is an underrun of the absolute position of the multiturn encoder. However, the internal actual position keeps counting forward and delivers a negative position value. After switching off and on, the internal actual position would no longer be the negative position value, but the absolute position of the encoder.

Overruns or underruns are discontinuous positions in the working range. To avoid such jumps, the absolute position in the encoder must be set in such a way that the mechanical limits are within the continuous range of the encoder.

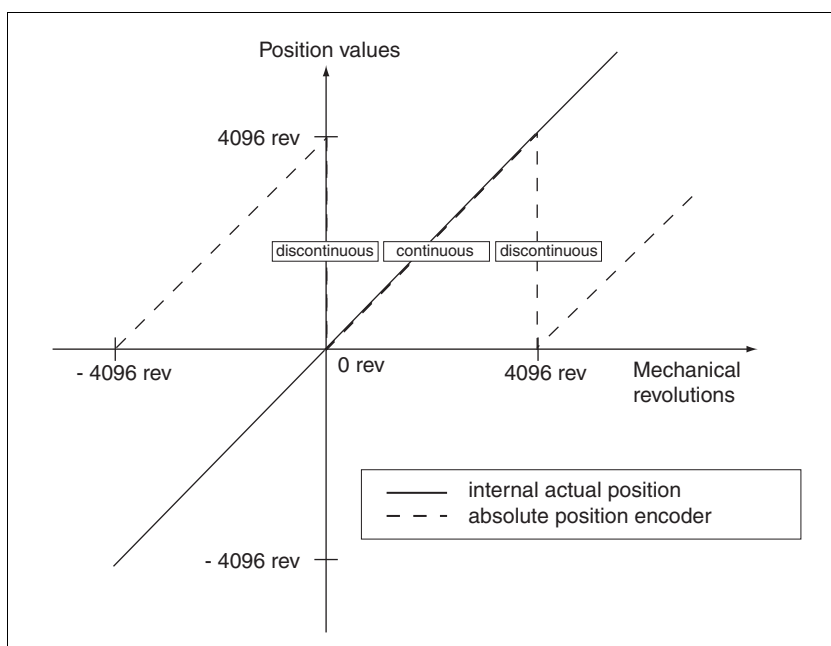


Figure 7.4 Position values of multiturn encoder

- Set the absolute position at the mechanical limit to a position value >0.

This achieves that the mechanical working range will be in the continuous range of the encoder.

7.3 Controller optimization with step response

7.3.1 Controller structure

The controller structure corresponds to the classical cascade control of a closed positioning loop with current controller, speed controller and position controller. The reference value of the speed controller can also be smoothed by an upstream filter.

The controllers are tuned from the "inside" to the "outside" in the following sequence: current controller, speed controller and position controller. The superimposed control loop remains off.

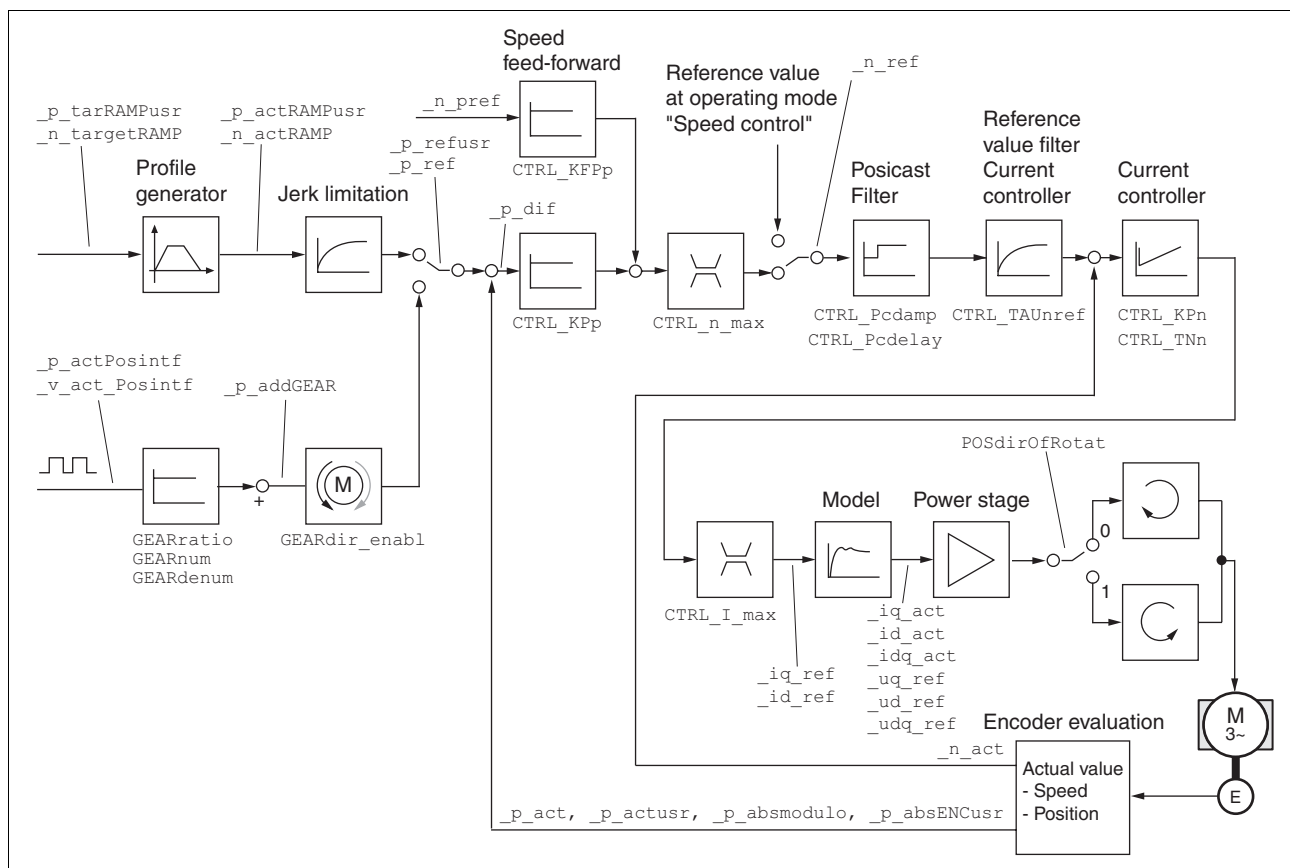


Figure 7.5 Controller structure

- Current controller** The current controller determines the torque of the motor. The current controller is automatically optimally tuned with the stored motor data.
- Speed controller** The speed controller maintains the required speed of rotation of the motor by varying the output motor torque depending on the load situation. The speed controller has a decisive influence on the speed with which the drive responds. The dynamics of the speed controller depend on:
- the moment of inertia of the drive and the controlled system
 - the torque of the motor
 - the stiffness and elasticity of the elements in the flow of forces
 - the play of the mechanical drive elements
 - the friction

Position controller The position controller reduces the difference between reference position and the actual position of the motor (position deviation) to a minimum. When the motor is at a standstill, the position deviation is virtually zero in the case of a well-tuned position controller. When the motor is running, a position deviation results that depends on the speed of rotation.

In the operating modes Profile Position, Profile Velocity, Homing and Jog, the reference position for the closed positioning loop is generated by the internal motion profile generator.

In the operating mode Electronic Gear, the reference position for the closed positioning loop is generated by external A/B or pulse/direction input signals.

An optimized speed control loop is a prerequisite for good amplification of the position controller.

7.3.2 Optimization

The drive optimization function matches the unit to the operating conditions. The following options are available:

- Selecting control loops. Higher level control loops are automatically disconnected.
- Defining reference signal: signal form, height, frequency and starting point
- Testing control response with the signal generator.
- Recording and assessing the control behavior on the monitor with the commissioning software.

Setting reference signals

- ▶ Start controller optimization with the commissioning software using the sequence of menus and commands "Functions - Recording/Tuning...".
- ▶ Display the "Tune" tab.
- ▶ Set the following values for the reference signal:
 - Amplitude: 100 min⁻¹
 - Period: 100 ms
 - Signal: Positive step
 - Number of repetitions: 1



Only the signal types "Step" and "Square" allow you to determine the entire dynamic behavior of a control loop. The manual shows all signal paths for the signal type "Step".

Entering controller values

The optimization steps described on the following pages require you to enter control loop parameters and test their effect by triggering a step function.

A step function is triggered as soon as you start recording in the commissioning software bar with the "Start" button (arrow icon).

You can enter controller values for optimization in the parameters window in the "Control" group.

7.3.3 Optimizing the speed controller

Optimum settings of complex mechanical control systems requires hands-on experience with controller tuning. This includes the ability to calculate control loop parameters and to apply identification procedures.

Less complex mechanical systems can often be successfully optimized by means of experimental adjustment using the aperiodic limit method. The following two parameters are used for this:

Parameter Name	Description	Unit Minimum value Default value Maximum value	Data type R/W persistent Expert	Parameter address via fieldbus
CTRL_KPn	Speed controller P-term The default value is calculated on the basis of the motor parameters.	A/min ⁻¹ 0.0001 - 1.2700	UINT16 UINT16 R/W per. -	Modbus 4614 CIP 118.1.3
CTRL_TNn	Speed controller setting time	ms 0.00 - 327.67	UINT16 UINT16 R/W per. -	Modbus 4616 CIP 118.1.4

Check and optimize the calculated values in a second step, as described on page 119.

Determining the mechanical system of the system

To assess and optimize the transient response behavior of your system, group its mechanical system into one of the following two categories.

- System with rigid mechanical system
- System with a less rigid mechanical system

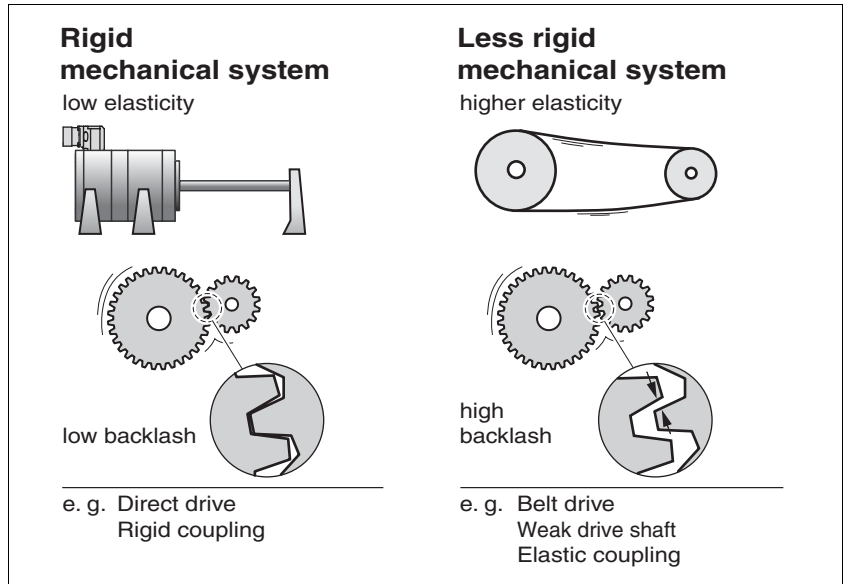


Figure 7.6 Rigid and less rigid mechanical systems

- ▶ Couple the motor and the mechanical system
- ▶ If you use limit switches, check their function after installation of the motor.

Switching off the reference value filter of the speed controller

The reference value filter allows you to improve the transient response with optimized speed control. The reference value filter must be switched off when you set the speed controller for the first time.

- ▶ Disable the reference value filter of the speed controller. Set the parameter CTRL_TAUnref to the minimum limit value "0".

Parameter Name	Description	Unit	Data type	Parameter address via fieldbus
		Minimum value	R/W	
		Default value	persistent	
		Maximum value	Expert	
CTRL_TAUnref	Filter time constant ref.value filter of the ref. speed value	ms	UINT16	Modbus 4626
		0.00	UINT16	CIP 118.1.9
		0.00	R/W	
		327.67	per.	
			-	



The procedure for optimization of the settings is only a suggestion. It is responsibility of the user to decide whether the method is suitable for the actual application.

Determining control parameter values for rigid mechanical systems

Prerequisites for tuning the control performance as per the table comprise:

- Known and constant inertia of load and motor
- Rigid mechanical system

The P-factor $CTRL_KPn$ and the correction time $CTRL_TNn$ depend on:

- J_L : Mass moment of inertia of the load
- J_M Mass moment of inertia of the motor

► Determine the controller values based on Table 7.1:

J_L [kgcm ²]	$J_L = J_M$		$J_L = 5 * J_M$		$J_L = 10 * J_M$	
	KPn	TNn	KPn	TNn	KPn	TNn
1	0.0125	8	0.008	12	0.007	16
2	0.0250	8	0.015	12	0.014	16
5	0.0625	8	0.038	12	0.034	16
10	0.125	8	0.075	12	0.069	16
20	0.25	8	0.15	12	0.138	16

Table 7.1 Determining controller values

Determining controller values with less rigid mechanics

For optimization purposes the P-factor of the speed controller at which the controller adjusts the speed $_n_act$ as quickly as possible without overshooting is determined.

- Set the correction time $CTRL_TNn$ to infinite.
 $CTRL_TNn = 327.67$ ms.

If a load torque is acting on the stationary motor, the correction time must be set just high enough to prevent an uncontrolled change of the motor position.



In the case of drive systems in which the motor is under load while at standstill, for example vertical axes, setting the integral action time to "Infinite" may result in unwanted position deviations so that the value needs to be reduced. However, this can adversely affect optimization results.

▲ WARNING

UNEXPECTED MOVEMENT

The jump function moves the motor in speed mode at constant speed until the specified time has expired.

- Check that the selected values for speed and time do not exceed the available distance.
- If possible, use limit switches or stop as well.
- Make sure that a functioning button for EMERGENCY STOP is within reach.
- Make sure that the system is free and ready for the motion before starting the function.

Failure to follow these instructions can result in death, serious injury or equipment damage.

- ▶ Initiate a jump function.
- ▶ After the first test check the maximum amplitude for the current set-point $_Iq_ref$.

Set the amplitude of the reference value just high enough so the reference value for the current $_Iq_ref$ remains below the maximum value $CTRL_I_max$. On the other hand, the value selected should not be too low, otherwise friction effects of the mechanical system will determine the performance of the control loop.

- ▶ Trigger another step function if you had to to modify $_n_ref$ and check the amplitude of $_Iq_ref$.
- ▶ Increase or decrease the P term in small increments until $_n_act$ is obtained as fast as possible. The following diagram shows the required transient response on the left. Overshooting - as shown on the right - is reduced by reducing $CTRL_KPn$.

Deviations from $_n_ref$ and $_n_act$ result from setting $CTRL_TNn$ to "Infinite".

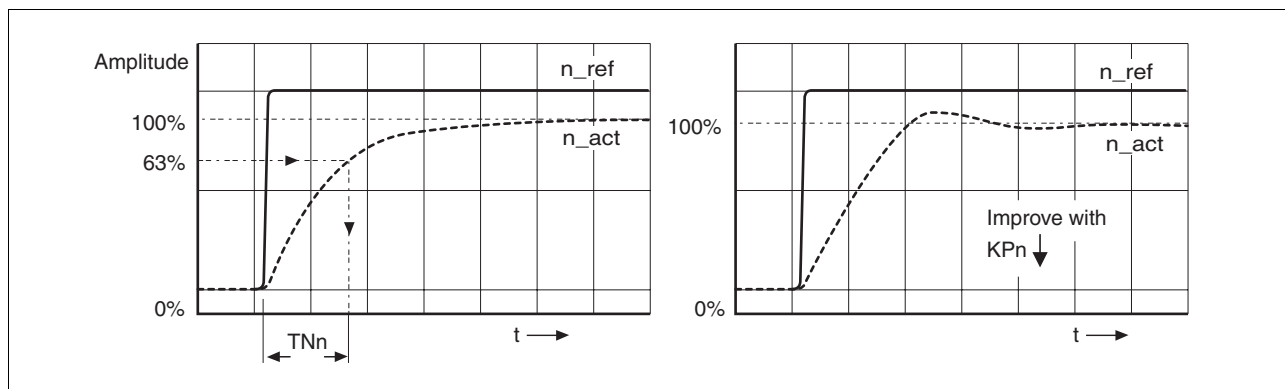


Figure 7.7 Determining "TNn" for the aperiodic limit



In the case of drive systems in which oscillations occur before the aperiodic limit is reached, the P-term "KPn" must be reduced to until oscillations can no longer be detected. This occurs frequently in the case of linear axes with a toothed belt drive.

Graphic determination of the 63% value

Graphically determine the point at which the actual speed `_n_act` reaches 63% of the final value. The integral action time `CTRL_TNn` then results as a value on the time axis. The commissioning software supports you with the evaluation:

Problems during optimization

High-frequency resonances in mechanical components may interfere with controller optimization. The values for `CTRL_KPn` and `CTRL_TNn` cannot be set satisfactorily if this occurs.

7.3.4 Checking and optimizing default settings

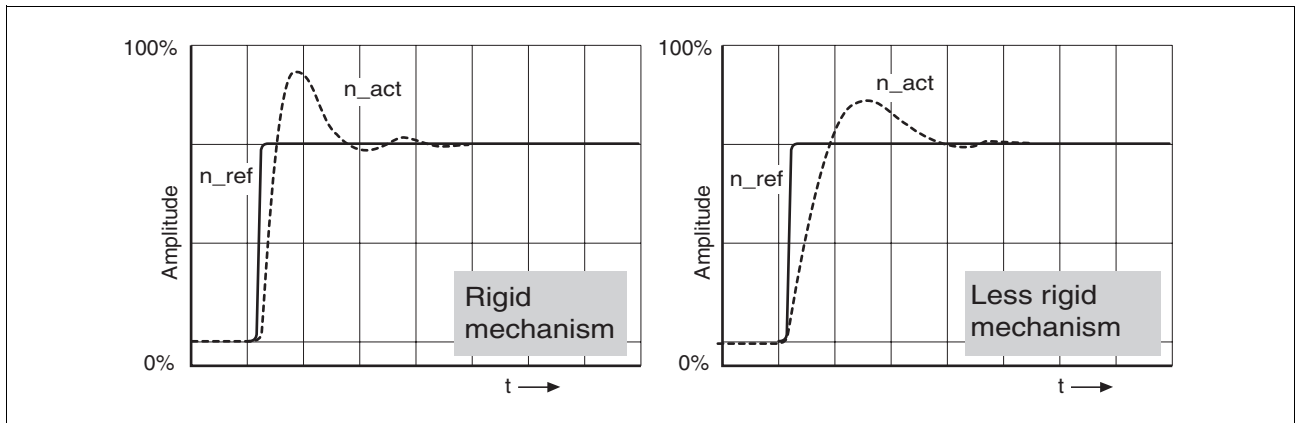


Figure 7.8 Step responses with good control performance

The controller is properly set when the jump response is approximately identical to the signal path shown. Good control response can be recognized by

- Fast adjustment
- Overshooting up to a maximum of 40% - 20% is recommended.

If the control response does not correspond to the curve shown, change CTRL_KPn' in steps of about 10% and then initiate a jump function once again:

- If the controller is too slow: select CTRL_KPn greater.
- If the controller tends to oscillate: select CTRL_KPn smaller.

Oscillation ringing is characterized by continuous acceleration and deceleration of the motor.

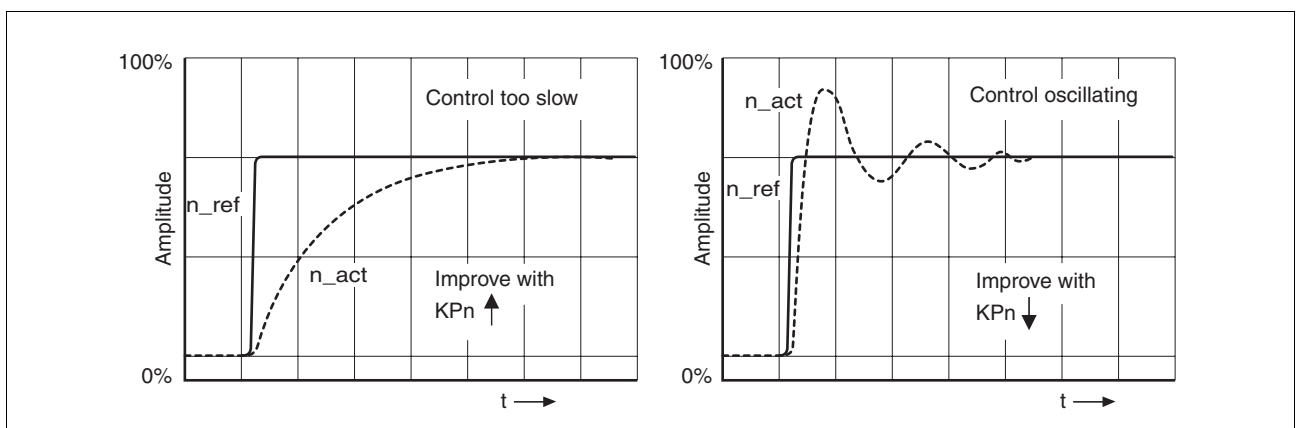


Figure 7.9 Optimizing inadequate speed controller settings



If the controller performance remains unsatisfactory in spite of optimization, contact your local sales representative.

7.3.5 Optimizing the position controller

Optimization requires good control dynamics in the subordinate speed control circuit.

When tuning the position controller, you must optimize the P term CTRL_KPp in two limits:

- CTRL_KPp too high: Overshooting of the mechanical system, instability of the closed-loop control
- CTRL_KPp too low: High position deviation

Parameter Name	Description	Unit Minimum value Default value Maximum value	Data type R/W persistent Expert	Parameter address via fieldbus
CTRL_KPp	Position controller P-term The default value is calculated.	1/s 2.0 - 495.0	UINT16 UINT16 R/W per. -	Modbus 4620 CIP 118.1.6

▲ WARNING

UNEXPECTED MOVEMENT

The jump function moves the motor in speed mode at constant speed until the specified time has expired.

- Check that the selected values for speed and time do not exceed the available distance.
- If possible, use limit switches or stop as well.
- Make sure that a functioning button for EMERGENCY STOP is within reach.
- Make sure that the system is free and ready for the motion before starting the function.

Failure to follow these instructions can result in death, serious injury or equipment damage.

Setting the reference signal

- ▶ Select Position Controller as the reference value generator in the commissioning software.
- ▶ Set the reference signal:
 - Signal type: "Step"
 - Set the amplitude to approx. 1/10 motor revolution.

The amplitude is entered in user-defined units. With the default scaling, the resolution is 16384 usr per motor revolution.

Selecting recording signals

- ▶ Select the values in General Recording Parameters:
 - Setpoint of the position controller `_p_refusr` (`_p_ref`)
 - Actual position of the position controller `_p_actusr` (`_p_act`)
 - actual speed `_n_act`
 - current motor current `_Iq_ref`

Controller values for the position controller can be changed in the same parameter group used for the speed controller.

Optimizing the position controller value

- ▶ Trigger a step function with the default controller values.
- ▶ After the first test, check the values achieved for `_n_act` and `_Iq_ref` for current and speed control. The values must reach the current and speed limitation range.

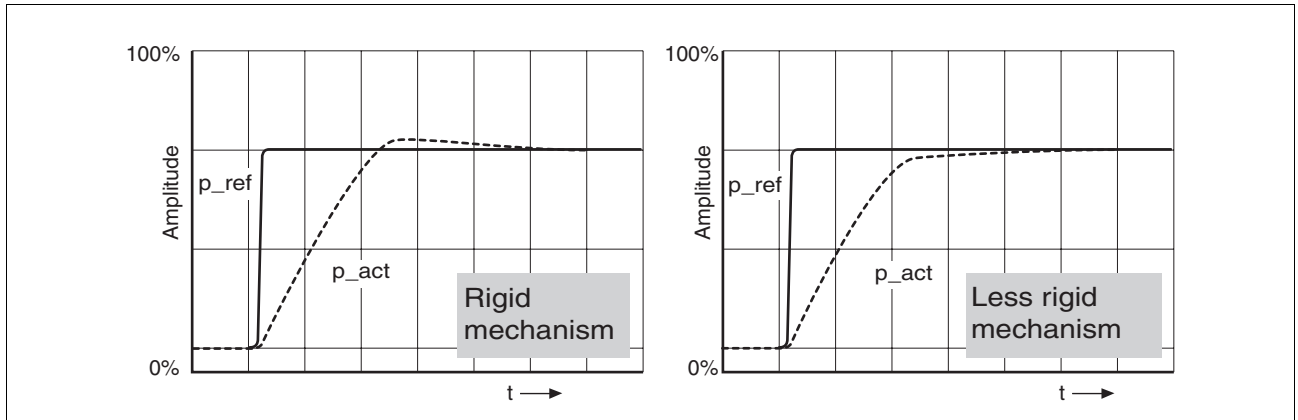


Figure 7.10 Step responses of a position controller with good control performance

The setting of the proportional term `CTRL_KPp` is optimal if the reference value is reached rapidly and with little or no overshooting.

If the control performance does not correspond to the curve shown, change the P term `CTRL_KPp` in increments of approx. 10% and trigger another step function.

- If the closed-loop control tends to oscillate: Use a lower `CTRL_KPp` value.
- If the actual value is too slow reaching the reference value: Use a higher `CTRL_KPp` value.

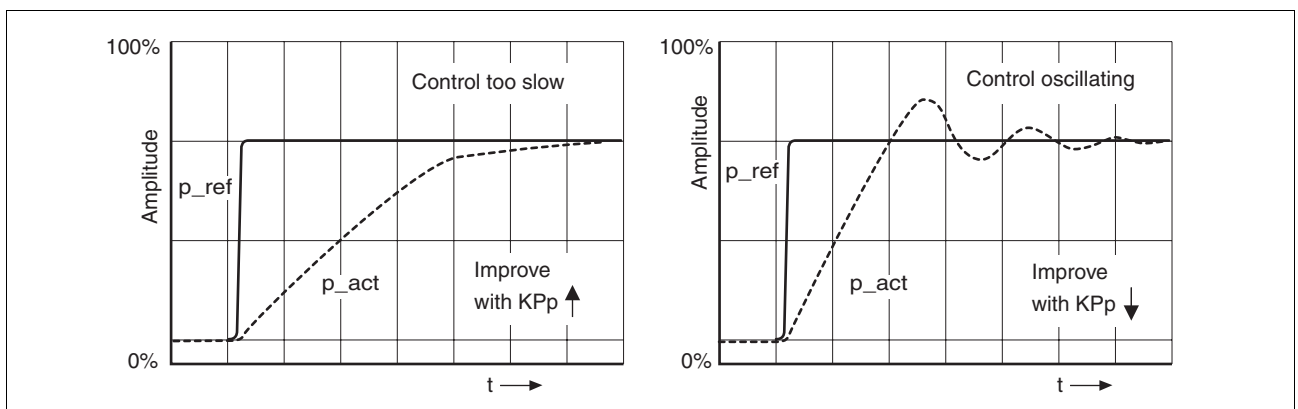


Figure 7.11 Optimizing insufficient position controller settings

8 Operation

The chapter "Operation" describes the basic operating states, operating modes and functions of the device.



*An alphabetically sorted overview of **all** parameters can be found in the chapter "Parameters". The use and the function of some parameters are explained in more detail in this chapter.*

8.1 Overview of operating modes

The following table shows an overview of the operating modes and the way reference values are supplied.

Operating mode	Reference value supply	Description
Jog	Fieldbus commands	Page 133
Speed control	Fieldbus commands	Page 136
Electronic gear	P/D or A/B	Page 137
Profile position	Fieldbus commands	Page 141
Profile Velocity	Fieldbus commands	Page 144
Homing	Fieldbus commands	Page 146

Reference value for control loop

The following table shows the relationship between operating mode, control loop and the use of the profile generator.

Operating mode	Control loop	Profile generator
Jog	Position controller	X
Speed control	Speed controller	-
Electronic gear	Position controller	-
Profile position	Position controller	X
Profile Velocity	Position controller	X
Homing	Position controller	X

8.2 Access control

The device has several access channels. Using an access channel, you can control the device (for example, state transitions or motor movements).

An access channel can be assigned exclusive access control. With exclusive access control, you can only control the device via this access channel.

The device has the following access channels:

- Fieldbus
- Commissioning software
- Signal inputs

8.2.1 Via fieldbus

You can use the `AccessLock` parameter to restrict access control to the fieldbus. In this case, the product can no longer be controlled via another access channel.

Parameter Name	Description	Unit Minimum value Default value Maximum value	Data type R/W persistent Expert	Parameter address via fieldbus
AccessLock	Locking other access channels 0: Release other access channels 1: Lock other access channels The fieldbus can lock active access to the device via the following access channels with this parameter: - Input signals - Commissioning software Processing of the input signal HALT cannot be locked.	- 0 - 1	UINT16 UINT16 R/W - -	Modbus 316 CIP 101.1.30

8.2.2 Via commissioning software

With the "Access" field, you can restrict access control to the commissioning software. In this case, the product can no longer be controlled via another access channel.

8.2.3 Via signal inputs

You can control the device using the functions of the signal inputs `LI01` ... `LI04`. Control is not possible while another access channel has exclusive access control.

The following signal inputs are effective even if another access channel has exclusive access control.

- The digital signal inputs of the STO safety function.
- The digital signal inputs with the functions "Halt", "Positive limit switch (LIMP)", "Negative limit switch (LIMN)" and "Reference switch (REF)".

8.3 Operating states

8.3.1 State diagram

After switching on and when an operating mode is started, the product goes through a number of operating states.

The state diagram (state machine) shows the relationships between the operating states and the state transitions.

The operating states are monitored and influenced by internal monitoring functions and system functions such as temperature monitoring or current monitoring.

Graphic representation The state diagram is shown graphically as a flow chart.

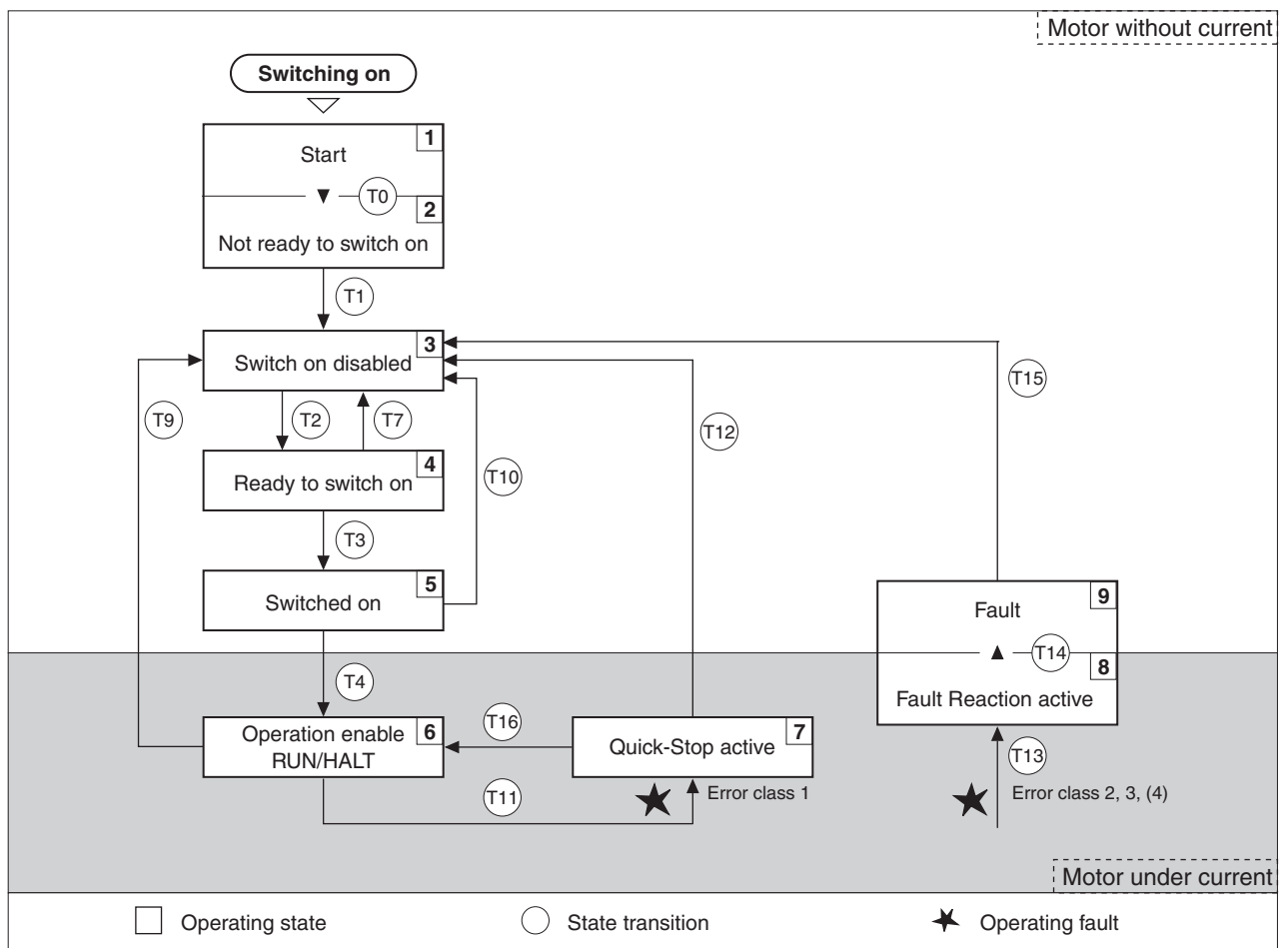


Figure 8.1 State diagram

Operating states You can display the operating states with the commissioning software.

Operating states	Description of operating states
1 Start	Controller supply voltage is switched on, initialization of electronics
2 Not ready to switch on	Power stage is not ready to switch on ¹⁾
3 Switch on disabled	Switching on the power stage is disabled
4 Ready to switch on	The power stage is ready to be switched on
5 Switched on	Motor without current Power stage ready No operating mode active
6 Operation enable	RUN: Device is running in the selected operating mode HALT: The motor is stopped with power stage enabled
7 Quick Stop active	"Quick Stop" function executed
8 Fault response active	Error detected, response is active
9 Fault	Device is in fault state

1) The device must be switched off and then switched on again

Error class The product triggers an error response in the event of a fault. Depending upon the severity of the fault, the device responds in accordance with one of the following error classes:

Error class	Reaction	Meaning
0	Warning	Message only, no interruption.
1	"Quick Stop"	Motor stops with "Quick Stop", power stage and controller remain switched on and enabled.
2	"Quick Stop" with switch-off	Motor stops with "Quick Stop", power stage and controller are disabled after standstill has been achieved.
3	Fatal error	Power stage and controller switch off immediately without stopping the motor first.
4	Uncontrolled operation	Power stage and controller switch off immediately without stopping the motor first. Error response can only be reset by switching off the device.

Error response The state transition T13 (error class 2, 3 or 4) initiates an error response as soon as an internal occurrence signals an error to which the device must react.

Error class	State from -> to	Response
2	x -> 8	Braking with "Quick Stop" Brake is applied Power stage is disabled
3,4 or Safety function STO	x -> 8 -> 9	Power stage is disabled immediately, even if "Quick Stop" is still active

An operating error can be triggered by a temperature sensor, for example. The device cancels the motion command and starts the error response, e.g. deceleration and stopping with "Quick Stop" or disabling the power stage. Subsequently, the operating state changes to "Fault".

To exit the "Fault" operating state, the cause of the error must be remedied and a "Fault Reset" must be executed.

In the event of a "Quick Stop" triggered by errors of class 1 (operating state 7), a "Fault Reset" returns you directly to operating state 6.

State transitions State transitions are triggered by an input signal, a fieldbus command or as a response to a monitoring signal.

Transition	Operating state	Condition / event ^{1) 2)}	Response
T0	1-> 2	• Device electronics successfully initialized	
T1	2-> 3	• Parameter successfully initialized	
T2	3 -> 4	• No undervoltage Encoder successfully checked Actual speed: <1000 min ⁻¹ $\overline{STO_A}$ ($\overline{PWRR_A}$) and $\overline{STO_B}$ ($\overline{PWRR_B}$) = +24V (or jumper CN6 plugged in)	
T3	4 -> 5	• Request for enabling the power stage	
T4	5 -> 6	• Automatic transition	Power stage is enabled User-defined parameters are checked Holding brake is released (if available)
T7	4 -> 3	• Undervoltage • $\overline{STO_A}$ ($\overline{PWRR_A}$) and $\overline{STO_B}$ ($\overline{PWRR_B}$) = 0V • Actual speed: >1000 min ⁻¹ (for example by external driving force)	-
T9	6 -> 3	• Request for disabling the power stage	Power stage is immediately disabled.
T10	5 -> 3	• Request for disabling the power stage	
T11	6 -> 7	• Class 1 error	Motion command is canceled with "Quick Stop".
T12	7 -> 3	• Request for disabling the power stage	Power stage is disabled immediately, even if "Quick Stop" is still active.
T13	x -> 8	• Errors Class 2, 3 or 4	Error response is carried out, see "Error response"
T14	8 -> 9	• Error response terminated (error from class 2) • Errors Class , 3 or 4	
T15	9-> 3	• Function: "Fault Reset"	Error is reset (cause of error must be corrected).
T16	7 -> 6	• Function: "Fault reset"	

1) In order to initiate a state transition it is sufficient if one condition is met

2) Fieldbus commands only with fieldbus control mode

8.3.2 Indicating the operating states

You can indicate the current operating state via the signal outputs, the commissioning software or the fieldbus.

Signal outputs Indication of the operating states via the signal outputs must be configured, see chapter 8.6.9 "Configurable inputs and outputs".

State	"No fault"	"Active"
2: Not ready to switch on	0	0
3: Switch on disabled	0	0
4: Ready to switch on	1	0
5: Switched on	1	0
6: Operation enable	1	1
7: Quick Stop activ	0	0
8: Fault Reaction active	0	0
9: Fault	0	0

Commissioning software For a detailed description, see the "Lexium CT commissioning software" product manual.

Fieldbus The current operating state is indicated with the "driveStat" word.

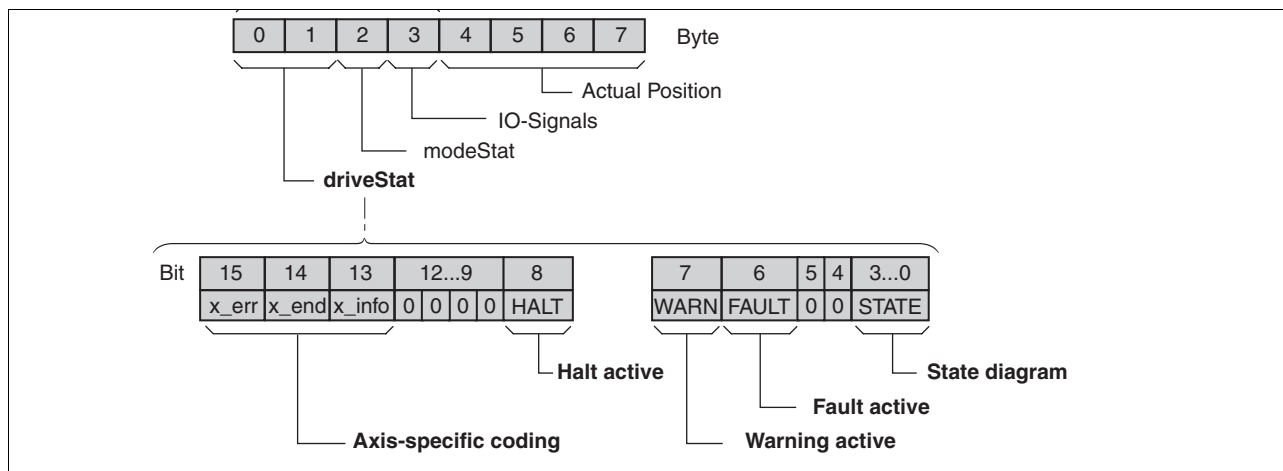


Figure 8.2 Structure of driveStat

Bit	Name	Value	Meaning
0 ... 3	STATE	000F _h	Current operating state
6	FAULT	0040 _h	An error has occurred
7	WARN	0080 _h	A warning was generated
8	HALT	0100 _h	"Halt" function is active
9 ... 12	-	-	Reserved
13	x_info	2000 _h	Additional information on operating mode
14	x_end	4000 _h	Operating mode termination
15	x_err	8000 _h	Operating mode error

8.3.3 Changing operating states

You can switch the operating state via the commissioning software or the fieldbus.

Commissioning software For a detailed description, see the "Lexium CT commissioning software" product manual.

Fieldbus The operating state is set with the "driveCtrl" byte.

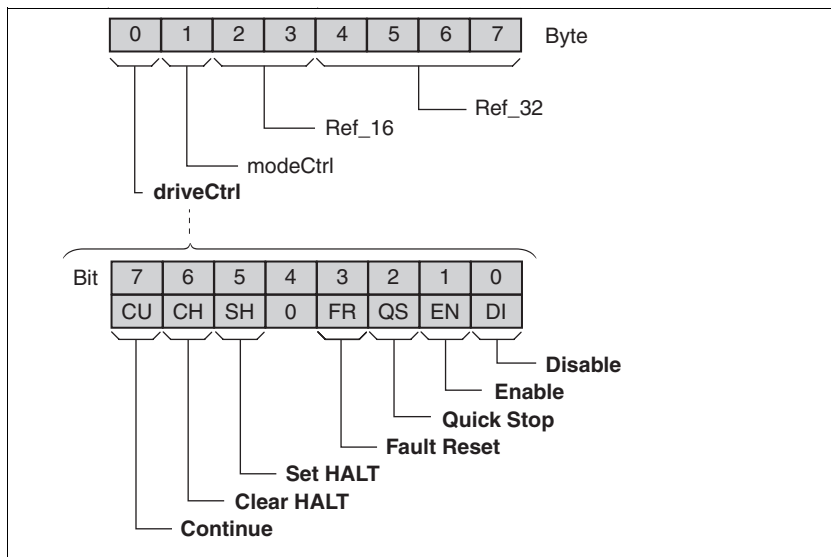


Figure 8.3 Structure of driveCtrl

Bit	Name	Value	Meaning
0	DI	01 _h	Disable power stage
1	EN	02 _h	Enable power stage
2	QS	04 _h	Execute "Quick Stop" function
3	FR	08 _h	Execute "Fault Reset" function
4	-	10 _h	Reserved
5	SH	20 _h	Execute "Halt" function
6	CH	40 _h	Clear "Halt" function
7	CU	80 _h	Resume operating mode interrupted by "Halt"

During access, these bits respond in an edge-selective way, i.e. the corresponding function is triggered with a 0->1 edge.

If a request for changing the operating state is not successful, this request is ignored. There is no error response.

Ambivalent bit combinations are treated in accordance with the following priority list:

- Bit 0 (Disable) prior to bit 1 (Enable)
- Bit 2 (Quick Stop) prior to bit 3 (Fault Reset)
- Bit 5 (Set HALT) prior to bit 6 (Clear HALT) and bit 7 (Continue)

8.4 Indicating, starting and changing operating modes

▲ WARNING

UNINTENDED OPERATION

- Note that any changes to the values of these parameters are executed by the drive controller immediately on receipt of the data set.
- Verify that the system is free and ready for movement before changing these parameters.

Failure to follow these instructions can result in death, serious injury or equipment damage.

Prerequisites The device must be ready for operation and properly initialized for an operating mode to be started.

The product cannot run in two operating modes at the same time. If an operating mode is active, you can only change to a different operating mode if the current operating mode is terminated or canceled.

An operating mode is terminated if the drive is at a standstill, for example, if the target position of a positioning process is reached or if the drive is stopped by a "Quick Stop" or "Halt". If an error occurs during processing which causes the current operating mode to be canceled, the movement can be resumed or you can change to a different operating mode after the cause of the error has been removed.

Changing operating states and activating operating modes must be executed separately. An operating mode can normally only be activated if the operating state is already "Operation Enable".

8.4.1 Displaying and monitoring the operating mode

You can display and monitor the current operating mode using the commissioning software or the fieldbus.

Commissioning software For a detailed description, see the "Lexium CT commissioning software" product manual.

Fieldbus The current operating mode is indicated with the "modeStat" byte.

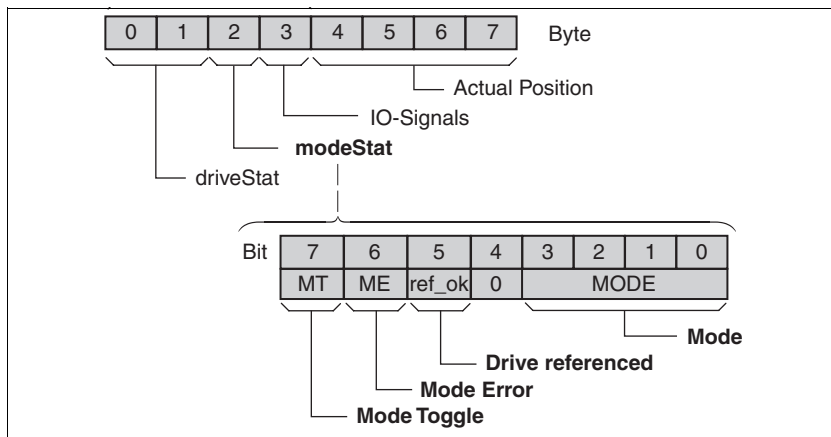


Figure 8.4 Structure of modeStat

Bit	Name	Description
0 ... 3	MODE	Indicates the currently selected operating mode 1: Jog 2: Homing 3: Profile position 4: Profile velocity 5: Electronic gear 7: Speed control
4	-	Reserved
5	ref_ok	Is set if operating mode Homing was successfully completed
6	ME	Is set if a request from a master was rejected
7	MT	Handshake via "Mode Toggle", see chapter 4.2.6 "Handshake with Mode Toggle Bit"

8.4.2 Starting and changing an operating mode

You can start and change an operating mode using the commissioning software or the fieldbus.

Commissioning software For a detailed description, see the "Lexium CT commissioning software" product manual.

Fieldbus The operating mode is set with the "modeCtrl" byte.

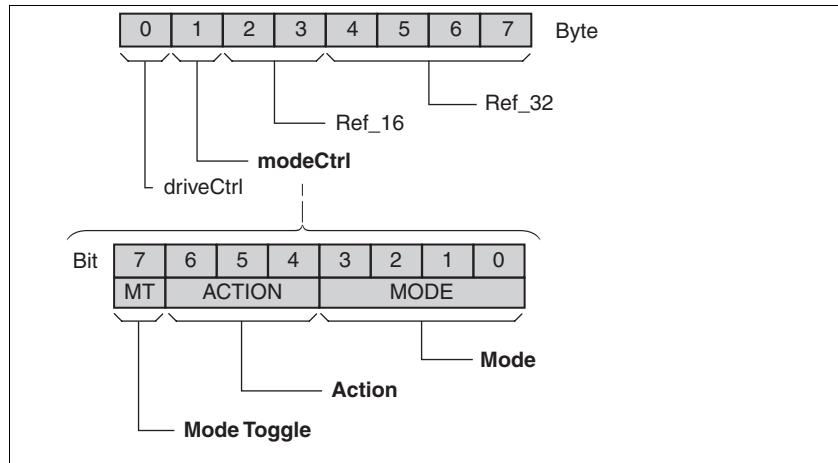


Figure 8.5 Structure of modeCtrl

Bit	Name	Description
0 ... 3	MODE	Indicates the currently selected operating mode 1: Jog 2: Homing 3: Profile position 4: Profile velocity 5: Electronic gear 7: Speed control
4 ... 6	ACTION	Operating-mode-dependent action
7	MT	Handshake via Mode Toggle, see chapter 4.2.6 "Handshake with Mode Toggle Bit"

The operating modes can be changed during operation. For this purpose, the current process must be completed or explicitly canceled. The drive must be at a standstill.

Handling of errors If the state of the "Mode Toggle" bit is changed, this is considered as a request to start an operating mode or to change data of the current operating mode.

If the request cannot be processed, the "Mode Error" bit is set in the "modeStat" byte. This has no effect on the selected operating mode. The corresponding error number can be read from the parameter ModeError.

The "Mode Error" bit remains set until a new command is triggered.

8.5 Operating modes

8.5.1 Operating mode Jog

⚠ DANGER

UNEXPECTED MOVEMENT

With suitable parameterization the product can start movements automatically after application of the VDC power supply. An unexpected restart may occur after a power failure.

- Check the behavior of the system during application of the power supply.
- Make sure that no persons can be endangered by a restart of the system after a power failure.
- Make sure that there are no persons in the range of action of the moving system components.

Failure to follow these instructions will result in death or serious injury.

⚠ WARNING

UNINTENDED OPERATION

- Note that any changes to the values of these parameters are executed by the drive controller immediately on receipt of the data set.
- Verify that the system is free and ready for movement before changing these parameters.

Failure to follow these instructions can result in death, serious injury or equipment damage.

Overview of jog

The motor moves by one jog unit or at constant speed of rotation in continuous operation. The length of the jog unit, the values for the speed of rotation and the waiting time prior to continuous operation can be set.

The current motor position is the start position for the Jog operating mode. The jog distance and the values for the speed of rotation are entered in user-defined units.

Starting the operating mode

The operating mode is started by means of an output assembly. In the byte "modeCtrl", bit "Mode Toggle" is not set.

modeCtrl	Reference value ref_16	Reference value ref_32
01 _h	As JOGactivate	-

Status information The word "driveStat" provides information on the operating mode.

Bit	Name	Meaning
13	x_info	Reserved
14	x_end	0: Operating mode active 1: Operating mode terminated
15	x_err	0: No error 1: Error

Description With the start signal for the jog movement, the motor first moves by a defined jog distance $JOG_{stepusr}$. If the start signal is still available after a specified waiting time JOG_{time} , the device switches to continuous operation until the start signal is canceled.

The illustration below shows an overview.

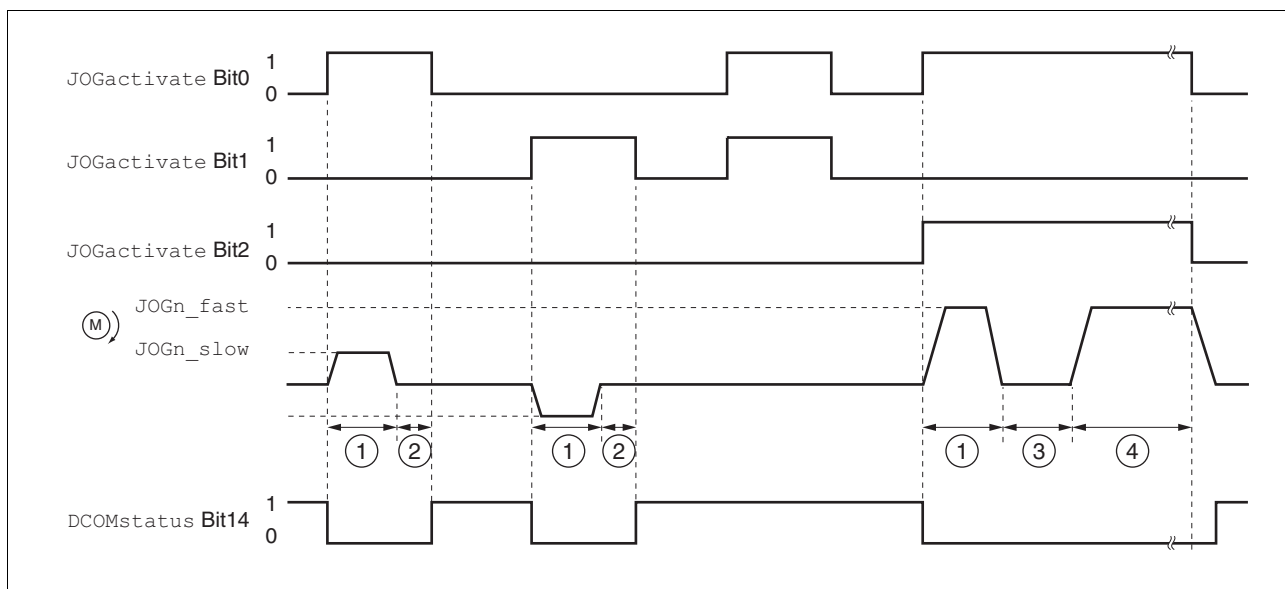


Figure 8.6 Jog, slow and fast

- (1) Distance unit
- (2) $t < \text{waiting time}$
- (3) $t > \text{waiting time}$
- (4) Continuous operation

The jog distance, waiting time and speed levels can be set. If the jog distance is zero, the jog movement starts directly with continuous operation irrespective of the wait time.

Parameter Name	Description	Unit Minimum value Default value Maximum value	Data type R/W persistent Expert	Parameter address via fieldbus
JOGactivate	<p>Activation of jog</p> <p>Bit0 : Positive direction of rotation Bit1 : Negative direction of rotation Bit2 : 0=slow 1=fast</p> <p>If both bits for the direction of rotation are activated at the same time, no movement is started. If a jog movement is running, the simultaneous activation of the bits for the direction of rotation has no effect.</p>	- 0 0 7	R/W - -	
JOGn_slow	<p>Speed for slow jog</p> <p>The adjustable value is internally limited to the current parameter setting in RAMPn_max.</p>	min ⁻¹ 1 60 13200	UINT16 UINT16 R/W per. -	Modbus 10504 CIP 141.1.4
JOGn_fast	<p>Speed for fast jog</p> <p>The adjustable value is internally limited to the current parameter setting in RAMPn_max.</p>	min ⁻¹ 1 180 13200	UINT16 UINT16 R/W per. -	Modbus 10506 CIP 141.1.5
JOGstepusr	<p>Jog distance prior to continuous run</p> <p>0: Direct activation of continuous run >0: Positioning distance per jog cycle</p>	usr 0 20 2147483647	INT32 INT32 R/W per. -	Modbus 10510 CIP 141.1.7
JOGtime	<p>Wait time prior to continuous run</p> <p>This time is only effective if you have set a jog distance not equal to 0, otherwise the drive immediately starts a continuous run.</p>	ms 1 500 32767	UINT16 UINT16 R/W per. -	Modbus 10512 CIP 141.1.8

Terminating the operating mode Jog is finished when the motor has stopped and

- the direction signal is inactive
- the operating mode has been interrupted by "Halt" or an error

Further options For further settings and functions for the operating mode, see page 160.

8.5.2 Operating mode Speed control

⚠ WARNING**UNINTENDED OPERATION**

- Note that any changes to the values of these parameters are executed by the drive controller immediately on receipt of the data set.
- Verify that the system is free and ready for movement before changing these parameters.

Failure to follow these instructions can result in death, serious injury or equipment damage.

Overview of Speed Control

In the Speed Control operating mode, a reference value for the speed of rotation of the motor is preset.

Transitions between two speeds follow the adjusted control loop parameters.

The following overview shows the function principle of the parameters which can be set for the operating mode.

Starting the operating mode

The operating mode is started by means of an output assembly. In the byte "modeCtrl", bit "Mode Toggle" is not set.

modeCtrl	Reference value ref_16	Reference value ref_32
17 _h	As SPEEDn_target	-

Status information

The word "driveStat" provides information on the operating mode.

Bit	Name	Meaning
13	x_info	0: Motor rotating 1: Motor standstill
14	x_end	0: Operating mode active 1: Operating mode terminated
15	x_err	0: No error 1: Error

Setting limit values

See chapter 7.2.4 "Setting basic parameters and limit values" for setting the limitation of the current and the speed of rotation.

Parameter Name	Description	Unit Minimum value Default value Maximum value	Data type R/W persistent Expert	Parameter address via fieldbus
SPEEDn_target	Reference speed in operating mode speed control The internal maximum speed is limited to the current setting in CTRL_n_max.	min ⁻¹ -30000 0 30000	INT16 INT16 R/W -	Modbus 8456 CIP 133.1.4

Terminating the operating mode

Processing is terminated by:

- Deactivation of the operating mode and standstill of motor
- Standstill of motor caused by "Halt" or by an error

8.5.3 Operating mode Electronic gear

⚠ WARNING

UNINTENDED OPERATION

- Note that any changes to the values of these parameters are executed by the drive controller immediately on receipt of the data set.
- Verify that the system is free and ready for movement before changing these parameters.

Failure to follow these instructions can result in death, serious injury or equipment damage.

Description In Electronic Gear operating mode, the reference signals are supplied in the form of A/B signals or pulse/direction signals. A new position reference value is calculated on the basis of these signals plus an adjustable gear ratio.

The parameter `IOposInterfac` defines the type of reference value supply.

Example An NC control provides reference signals to two units. The motors execute different, proportional positioning movements in accordance with the gear ratios.

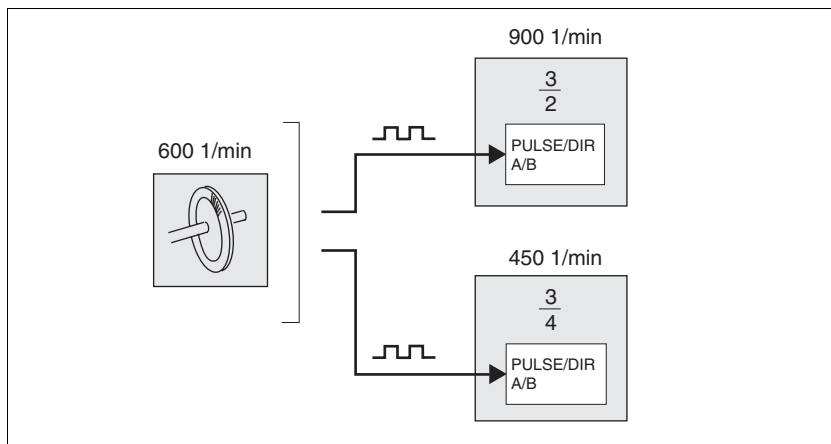


Figure 8.7 Reference value via NC controller

Starting the operating mode The operating mode is started by means of an output assembly. In the byte "modeCtrl", bit "Mode Toggle" is not set.

Description	modeCtrl	Reference value ref_16	Reference value ref_32
Immediate synchronization	05 _h	As GEARdenom	As GEARnum
Synchronization with compensation movement	15 _h	As GEARdenom	As GEARnum

Status information The word "driveStat" provides information on the operating mode.

Bit	Name	Meaning
13	x_info	Reserved
14	x_end	0: Operating mode active 1: Operating mode terminated
15	x_err	0: No error 1: Error

Terminating the operating mode Processing is terminated by:

- Deactivation of the operating mode and standstill of motor
- Standstill of motor caused by "Halt" or by an error

8.5.3.1 Parameterization

Overview The following overview shows the function principle of the parameters which can be set for the operating mode Electronic Gear.

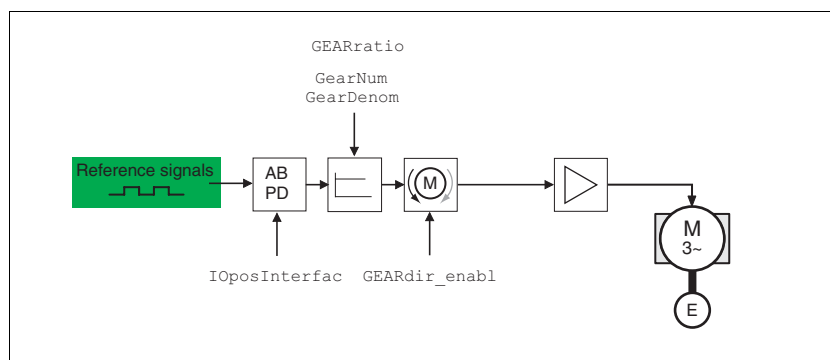


Figure 8.8 Operating mode Electronic Gear, effect of adjustable parameters

The resulting positioning distance depends on the current motor resolution. It amounts to 32768 motor increments per revolution.

Settings which are independent of the type of synchronization include:

- Gear ratio (predefined value or user-defined gear ratio)
- Maximum permissible position deviation (SPV_p_maxDiff)
- Release of direction of rotation

Setting limit values See chapter 7.2.4 "Setting basic parameters and limit values" for setting the limitation of the current and the speed of rotation.

Synchronization The device operates synchronously with other devices, for example, other drives. If the operating mode is terminated, synchronicity with the other drives is lost. Position changes of the reference signals that occur during the interruption continue to be counted internally.

When the operating mode Electronic Gear is resumed, these position changes can be compensated for or ignored. This depends on the way the operating mode is started.

Gear ratio The gear ratio is the ratio of the motor increments and the externally supplied reference increments for the movement of the motor.

$$\text{Gear factor} = \frac{\text{Motor increments}}{\text{Reference increments}} = \frac{\text{Gear factor numerator}}{\text{Gear factor denominator}}$$

The parameter `GEARratio` allows you to set a predefined gear ratio. It is also possible to set your own gear ratio.

The user-defined gear ratio is defined with the parameters for numerator and denominator. A negative numerator value reverses the motor's direction of rotation. The gear ratio is preset to 1:1.

- Use the `GEARratio` to specify whether you want to use a particular gear ratio or a user-defined ratio with numerator/denominator.

If you use the numerator/denominator, the required ratio is defined via the output assembly.

Parameter Name HMI menu	Description	Unit Minimum value Default value Maximum value	Data type R/W persistent Expert	Parameter address via fieldbus
GEARratio	Selection of special gear ratios 0 / GearFactor: Usage of gear ratio adjusted with <code>GEARnum/GEARdenom</code> 1 / 200: 200 2 / 400: 400 3 / 500: 500 4 / 1000: 1000 5 / 2000: 2000 6 / 4000: 4000 7 / 5000: 5000 8 / 10000: 10000 9 / 4096: 4096 10 / 8192: 8192 11 / 16384: 16384 A change of the reference value by the specified value causes one motor revolution.	- 0 0 11	UINT16 UINT16 R/W per. -	Modbus 9740 CIP 138.1.6
GEARnum	Numerator of gear ratio <code>GEARnum</code> ----- = Gear ratio <code>GEARdenom</code> The new gear ratio is applied when the numerator value is supplied.	- -2147483648 1 2147483647	INT32 INT32 R/W per. -	Modbus 9736 CIP 138.1.4
GEARdenom	Denominator of gear ratio See description <code>GEARnum</code>	- 1 2147483647	INT32 INT32 R/W per. -	Modbus 9734 CIP 138.1.3

Example With a setting of 1000 reference increments, the motor is to rotate by 2000 motor increments. This results in a gear factor of 2.

Position change with power stage disabled

If "Synchronization with compensation movement" is selected, the parameter `GEARposChgMode` determines the way changes to the motor position and reference value (RS422 interface) are handled with disabled power stage. These position changes can be ignored or taken into account for transitions to the "OperationEnable" state:

- Off: All position changes with disabled power stage are not taken into account
- On: Position changes with disabled power stage are taken into account. Please note that all position changes between starting the operating mode and the subsequent enabling of the power stage are not taken into account.

Parameter Name HMI menu	Description	Unit Minimum value Default value Maximum value	Data type R/W persistent Expert	Parameter address via fieldbus
GEARposChgMode	<p>Consideration of position changes with inactive power stage</p> <p>0 / off: Position changes in states with inactive power stage are discarded. 1 / on: Position changes in states with inactive power stage are considered.</p> <p>This setting has an effect only if gear processing is started in the mode 'Synchronization with compensation movement'.</p>	- 0 0 1	UINT16 UINT16 R/W per. -	Modbus 9750 CIP 138.1.11

Release of direction

Release of direction allows you to limit movements to clockwise or counterclockwise rotation. Release of direction is set with the parameter `GEARdir_enabl`.

Parameter Name HMI menu	Description	Unit Minimum value Default value Maximum value	Data type R/W persistent Expert	Parameter address via fieldbus
GEARdir_enabl	<p>Enabled movement direction of gear processing</p> <p>1 / positive: Pos. direction 2 / negative: Neg. direction 3 / both: Both directions</p> <p>This allows you to activate a return movement lock function.</p>	- 1 3 3	UINT16 UINT16 R/W per. -	Modbus 9738 CIP 138.1.5

8.5.4 Operating mode Profile position

⚠ WARNING

UNINTENDED OPERATION

- Note that any changes to the values of these parameters are executed by the drive controller immediately on receipt of the data set.
- Verify that the system is free and ready for movement before changing these parameters.

Failure to follow these instructions can result in death, serious injury or equipment damage.

In Profile Position operating mode, a movement with an adjustable motion profile is performed from a start position to a target position. The value of the target position can be specified as either a relative or an absolute position.

You can set a motion profile with values for acceleration ramp, deceleration ramp and target speed.

Relative and absolute positioning

In the case of absolute positioning, the positioning distance is specified absolutely with reference to the zero point of the axis. A zero point must be defined with the Homing operating mode before absolute positioning can be used for the first time.

In the case of a relative positioning, the positioning distance is specified relatively with reference to the current axis position or the target position.

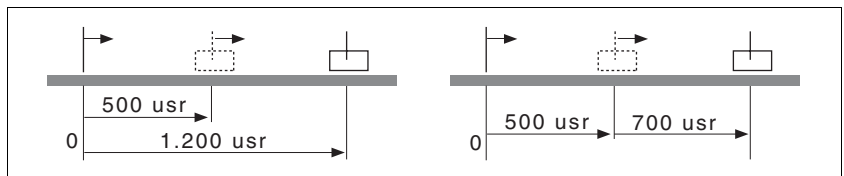


Figure 8.9 Absolute positioning (left) and relative positioning (right)

Starting the operating mode

The operating mode is started by means of an output assembly. In the byte "modeCtrl", bit "Mode Toggle" is not set.

Description	modeCtrl	Reference value ref_16	Reference value ref_32
absolute	03 _h	As PPn_target	As Ppp_absusr
Relative with reference to the currently set target position	13 _h	As PPn_target	As Ppp_relprefusr
Relative with reference to the current motor position	23 _h	As PPn_target	As Ppp_relpactusr

Status information The word "driveStat" provides information on the operating mode.

Bit	Name	Meaning
13	x_info	0: Target position not reached 1: Target position reached
14	x_end	0: Operating mode active 1: Operating mode terminated
15	x_err	0: No error 1: Error

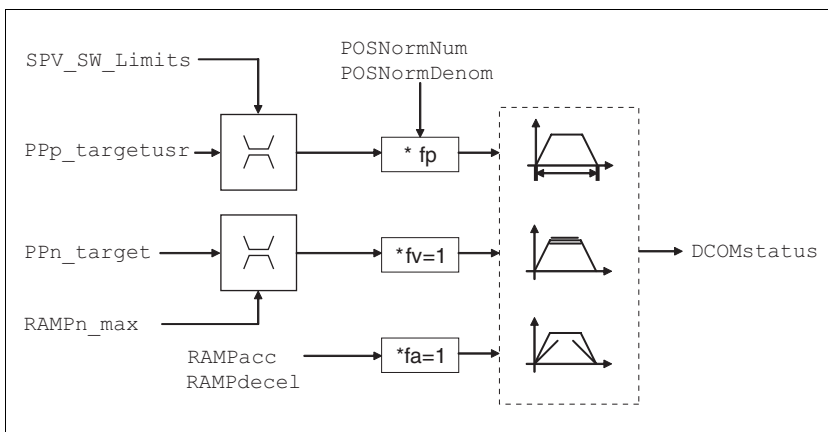


Figure 8.10 Operating mode Profile Position, effect of adjustable parameters

Current position The current position can be determined with the 2 parameters p_actusr and p_actRAMPusr.

Parameter Name	Description	Unit Minimum value Default value Maximum value	Data type R/W persistent Expert	Parameter address via fieldbus
<u>p_actusr</u>	Actual motor position in user units	usr - 0 -	INT32 INT32 R/- -	Modbus 7706 CIP 130.1.13
<u>p_actRAMPusr</u>	Actual position of motion profile generator In user units	usr - 0 -	INT32 INT32 R/- -	Modbus 7940 CIP 131.1.2

Target position A new position value is assigned with the parameter PpP_targetusr.

In the case of absolute positioning, the positioning distance is specified absolutely with reference to the zero point of the axis.

In the case of a relative positioning, the positioning distance is specified relatively with reference to the current axis position or the target position.

Parameter Name	Description	Unit Minimum value Default value Maximum value	Data type R/W persistent Expert	Parameter address via fieldbus
PPn_target	Reference speed in operating mode profile position The maximum value is limited to the current setting in CTRL_n_max. The adjustable value is internally limited to the current parameter setting in RAMPn_max.	min ⁻¹ 1 60 13200	R/W - -	
AbsHomeRequest	Absolute positioning only after homing 0 / no: No 1 / yes: Yes	- 0 0 1	UINT16 UINT16 R/W per. -	Modbus 1580 CIP 106.1.22
PPp_absusr	Target position absolute of operating mode profile position Min./max values depend on: - Scaling factor - Software limit switches (if they are activated)	usr - 0 -	R/W - -	
PPp_relpactusr	Target position relative to current motor position Min./max values depend on: - Position normalization factor - Software limit switches (if they are activated) In the case of active positioning in Profile Position mode, relative positioning refers to the current motor position. The absolute user position limits can only be overrun if the drive is at standstill when the movement starts (x_end=1). In this case, implicit position setting to position 0 is performed.	usr - 0 -	R/W - -	
PPp_relprefusr	Target position relative to the current target position Min./max values depend on: - Position normalization factor - Software limit switches (if they are activated) In the case of active positioning in operating mode Profile Position, relative positioning refers to the target position of the current movement. The absolute user position limits can only be overrun if the drive is at standstill when the movement starts (x_end=1). In this case, implicit position setting to position 0 is performed.	usr - 0 -	R/W - -	

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8.5.5 Operating mode Profile velocity

⚠ WARNING

UNINTENDED OPERATION

- Note that any changes to the values of these parameters are executed by the drive controller immediately on receipt of the data set.
- Verify that the system is free and ready for movement before changing these parameters.

Failure to follow these instructions can result in death, serious injury or equipment damage.

In the operating mode Profile Velocity, the drive accelerates to an adjustable target speed of rotation. You can set a motion profile with values for acceleration and deceleration ramps.

Starting the operating mode

The operating mode is started by means of an output assembly. In the byte "modeCtrl", bit "Mode Toggle" is not set.

modeCtrl	Reference value ref_16	Reference value ref_32
04h	As PVn_target	-

Status information

The word "driveStat" provides information on the operating mode.

Bit	Name	Meaning
13	x_info	0: Reference speed not reached 1: Reference speed reached
14	x_end	0: Operating mode active 1: Operating mode terminated
15	x_err	0: No error 1: Error

Overview

The following overview shows the effect of the parameters which can be set for the Profile Velocity operating mode.

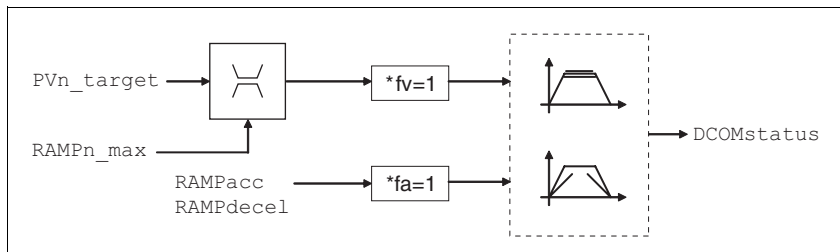


Figure 8.11 Operating mode Profile Velocity, effects of adjustable parameters

Reference speed

The reference speed is assigned via the parameter PVn_target in min⁻¹ and can be changed during the movement. The operating mode is not limited by the positioning range limits. New speed values are accepted immediately during the execution of a running motion command.

Parameter Name	Description	Unit Minimum value Default value Maximum value	Data type R/W persistent Expert	Parameter address via fieldbus
PVn_target	Reference speed of operating mode profile velocity The maximum value is limited to the current setting in CTRL_n_max. The adjustable value is internally limited to the current parameter setting in RAMPn_max.	min ⁻¹ -13200 - 13200	R/W - -	

Current speed The current speed is determined by using the 2 parameters `_n_act` and `_n_actRAMP`.

Parameter Name	Description	Unit Minimum value Default value Maximum value	Data type R/W persistent Expert	Parameter address via fieldbus
<code>_n_act</code>	Actual motor speed	min ⁻¹ - 0 -	INT16 INT16 R/- -	Modbus 7696 CIP 130.1.8
<code>_n_actRAMP</code>	Actual speed of motion profile generator	min ⁻¹ - 0 -	INT32 INT32 R/- -	Modbus 7948 CIP 131.1.6

8.5.6 Operating mode Homing

⚠ WARNING**UNINTENDED OPERATION**

- Note that any changes to the values of these parameters are executed by the drive controller immediately on receipt of the data set.
- Verify that the system is free and ready for movement before changing these parameters.

Failure to follow these instructions can result in death, serious injury or equipment damage.

Overview of Homing

The operating mode Homing establishes an absolute position reference between the motor position and a defined axis position. Homing can be carried out by a means of a reference movement or by position setting.

- A reference movement is a movement to a defined point, the reference point, on the axis; the objective is to establish the absolute position reference between the motor position and the axis position. The reference point also defines the zero point that is used for all subsequent absolute positioning movements as a reference point. It is possible to parameterize a shift of the zero point.

A reference movement must be completed for the new zero point to be valid. If the reference movement is interrupted, it must be started again. As opposed to the other operating modes, a reference movement must be completed before a new operating mode can be activated.

The signals required for the reference movement must be wired. Monitoring signals that are not used must be deactivated.

- Position setting lets you set the current motor position to a desired position value to which the subsequent position values will relate.



Homing is not required for a motor with a multiturn encoder because it provides a valid absolute position immediately after being switched on.

- Types of reference movements* There are 4 standard types of reference movements:
- Movement to negative limit switch $\overline{\text{LIMN}}$
 - Movement to positive limit switch $\overline{\text{LIMP}}$
 - Movement to reference switch $\overline{\text{REF}}$ with counterclockwise direction of rotation
 - Movement to reference switch $\overline{\text{REF}}$ with clockwise direction of rotation

Reference movements are possible with or without index pulse.

- Reference movement without index pulse
Movement from the switching edge to a distance distance from switching edge
- Reference movement with index pulse
Movement from the switching edge to the closest index pulse of the motor. The current motor position can be read via the parameter `_p_absENCusr`. The index pulse is at position value 0.

Starting the operating mode The operating mode is started by means of an output assembly. In the byte "modeCtrl", bit "Mode Toggle" is not set.

Description	modeCtrl	Reference value ref_16	Reference value ref_32
Position setting	02h	-	As <code>HMp_setpusr</code>
Reference movement	12h	As <code>HMmethod</code>	-

Status information The word "driveStat" provides information on the operating mode.

Bit	Name	Meaning
13	x_info	Reserved
14	x_end	0: Operating mode active 1: Operating mode terminated
15	x_err	0: No error 1: Error

Operating mode terminated The operating mode is terminated after successful homing, a motor standstill by "Halt" or an error.

When the power stage is disabled, the valid reference point is retained.

Description There are various methods of homing which can be selected via the parameters `HMmethod`.

Parameter Name	Description	Unit Minimum value Default value Maximum value	Data type R/W persistent Expert	Parameter address via fieldbus
HMmethod	<p>Homing method</p> <p>0 / deactivate: Deactivated 1 / LIMN indexpuls: LIMN with index pulse 2 / LIMP indexpuls: LIMP with index pulse 7 / REFpos indexpuls: REF+ with index pulse, inv., outside 8 / REFneg indexpuls: REF+ with index pulse, inv., inside 9: REF+ with index pulse, not inv., inside 10: REF+ with index pulse, not inv., outside 11: REF- with index pulse, inv., outside 12: REF- with index pulse, inv., inside 13: REF- with index pulse, not inv., inside 14: REF- with index pulse, not inv., outside 17 / LIMN: LIMN 18 / LIMP: LIMP 23 / REFpos: REF+, inv., outside 24: REF+, inv., inside 25: REF+, not inv., inside 26: REF+, not inv., outside 27 / REFneg: REF-, inv., outside 28: REF-, inv., inside 29: REF-, not inv., inside 30: REF-, not inv., outside 33: Index pulse neg. direction 34: Index pulse pos. Direction</p> <p>Abbreviations: REF+: Search movement in pos. direction REF-: Search movement in pos. direction inv.: Invert direction in switch not inv.: Direction not inverted in switch outside: Index pulse / distance outside switch inside: Index pulse / distance inside switch</p>	- 0 - 35	R/W - -	

Use the parameter $IOsigREF$ to set the evaluation to active 0 or active 1 of the reference switch \overline{REF} . A release of the switch is not required.

The parameters $IOsigLimp$ and $IOsigLimN$ are used to release the input signals \overline{LIMP} and \overline{LIMN} and the evaluation is set to active 0 or active 1.



Use active 0 monitoring signals if possible, because they are failsafe.

Parameter Name	Description	Unit Minimum value Default value Maximum value	Data type R/W persistent Expert	Parameter address via fieldbus
IOsigRef	Signal evaluation REF	-	UINT16	Modbus 1564
	1 / normally closed: Normally closed NC 2 / normally open: Normally open NO	1 1 2	UINT16 R/W per. -	CIP 106.1.14
	The reference switch is only activated (to REF) while homing is processed.			
IOsigLimN	Signal evaluation LIMN	-	UINT16	Modbus 1566
	0 / inactive: Inactive 1 / normally closed: Normally closed NC 2 / normally open: Normally open NO	0 1 2	UINT16 R/W per. -	CIP 106.1.15
IOsigLimP	Signal evaluation LIMP	-	UINT16	Modbus 1568
	0 / inactive: Inactive 1 / normally closed: Normally closed NC 2 / normally open: Normally open NO	0 1 2	UINT16 R/W per. -	CIP 106.1.16

The parameters HMn and HMn_out are used for setting the speeds for the reference movement.

Parameter Name	Description	Unit Minimum value Default value Maximum value	Data type R/W persistent Expert	Parameter address via fieldbus
HMn	Speed of rotation for search of switch	min ⁻¹	UINT16	Modbus 10248
	The adjustable value is internally limited to the current parameter setting in RAMPn_max.	1 60 13200	UINT16 R/W per. -	CIP 140.1.4
HMn_out	Speed of rotation for moving away from switch	min ⁻¹	UINT16	Modbus 10250
	The adjustable value is internally limited to the current parameter setting in RAMPn_max.	1 6 3000	UINT16 R/W per. -	CIP 140.1.5

The parameter HMp_homeusr can be used to specify a desired position value, which is set at the reference point after a successful reference movement. This position value defines the current motor position at the reference point. This also defines the zero point.

Parameter Name	Description	Unit Minimum value Default value Maximum value	Data type R/W persistent Expert	Parameter address via fieldbus
HMp_homeusr	Position at reference point	usr	INT32	Modbus 10262
	After a successful reference movement, this position is automatically set at the reference point.	-2147483648 0 2147483647	INT32 R/W per. -	CIP 140.1.11

The parameters HMoutdisusr and HMsrchdisusr can be used for activation of the monitoring of the switch function.

Parameter Name	Description	Unit Minimum value Default value Maximum value	Data type R/W persistent Expert	Parameter address via fieldbus
HMoutdisusr	<p>Maximum distance for search for switching edge</p> <p>0: Monitoring of distance inactive >0: Maximum distance in user-defined units</p> <p>After detection of the switch, the drive starts to search for the defined switching edge. If it is not found within the distance defined here, the reference movement is canceled with an error.</p>	usr 0 0 2147483647	INT32 INT32 R/W per. -	Modbus 10252 CIP 140.1.6
HMrchdisusr	<p>Max. search distance after overrun of switch</p> <p>0: Search distance processing disabled >0: Search distance in user units</p> <p>The switch must be activated again within this search distance, otherwise the reference movement is canceled.</p>	usr 0 0 2147483647	INT32 INT32 R/W per. -	Modbus 10266 CIP 140.1.13

8.5.6.1 Reference movement without index pulse

Description First, the product moves to the defined limit switch or reference switch. Then the product moves to a defined distance from the switching edge. The distance from the switching edge can be specified with the parameter HMdisusr.

Parameter Name	Description	Unit Minimum value Default value Maximum value	Data type R/W persistent Expert	Parameter address via fieldbus
HMdisusr	Distance from switching edge to reference point After the drive 'leaves' the switch, it is positioned into the working area by a defined distance. This target point is defined as the reference point. The parameter is only effective during reference movements without index pulse search.	usr 1 200 2147483647	INT32 INT32 R/W per. -	Modbus 10254 CIP 140.1.7

Reference movement to limit switch The following illustration shows a reference movement to the negative limit switch with distance from the switching edge (HMmethod = 17).

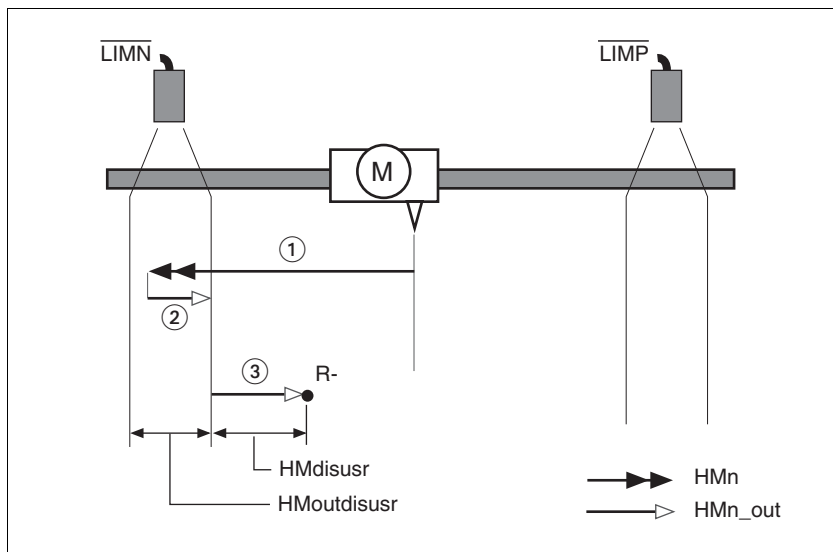


Figure 8.12 Reference movement to the negative limit switch

- (1) Movement to limit switch at search speed
- (2) Movement to switching edge at speed for moving away from switch
- (3) Movement to distance from switching edge at speed for moving away from switch

Reference movement to reference switch The following illustration shows reference movements to the reference switch with distance from the switching edge (HMmethod =27 to 30).

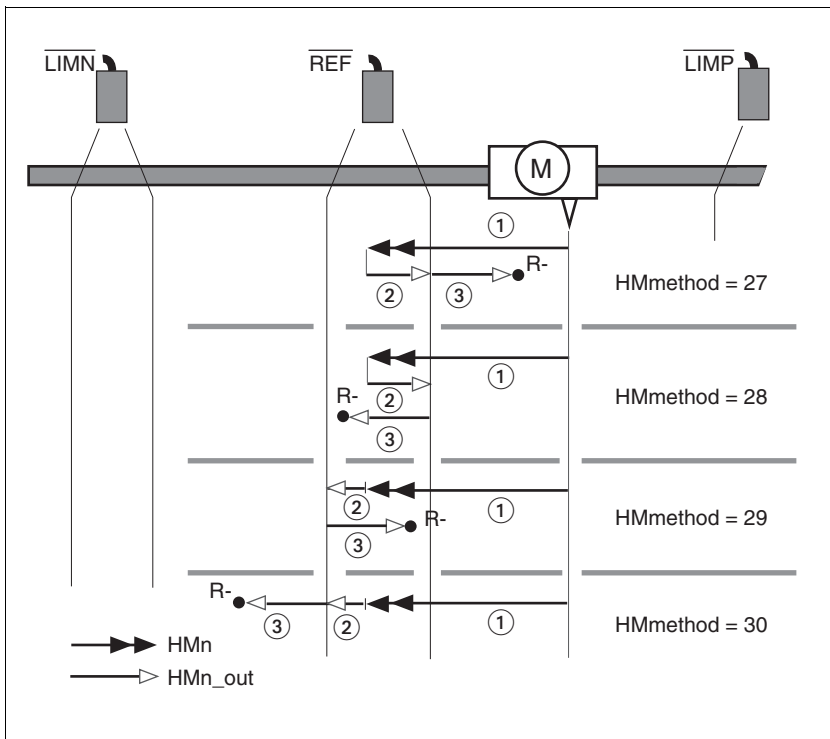


Figure 8.13 Reference movements to the reference switch

- (1) Movement to reference switch at search speed
- (2) Movement to switching edge at speed for moving away from switch
- (3) Movement to distance from switching edge at speed for moving away from switch

Examples The following illustration shows reference movements to the reference switch with distance from the switching edge ($HM_{method}=27$). You can see different responses at different search speeds and start positions.

- Movement to the reference switch with first movement in negative direction; the reference switch is once in front of the starting point (A1, A2), once behind it (B1, B2).
- Additional movement when the unit moves through the switch range (A2, B2).

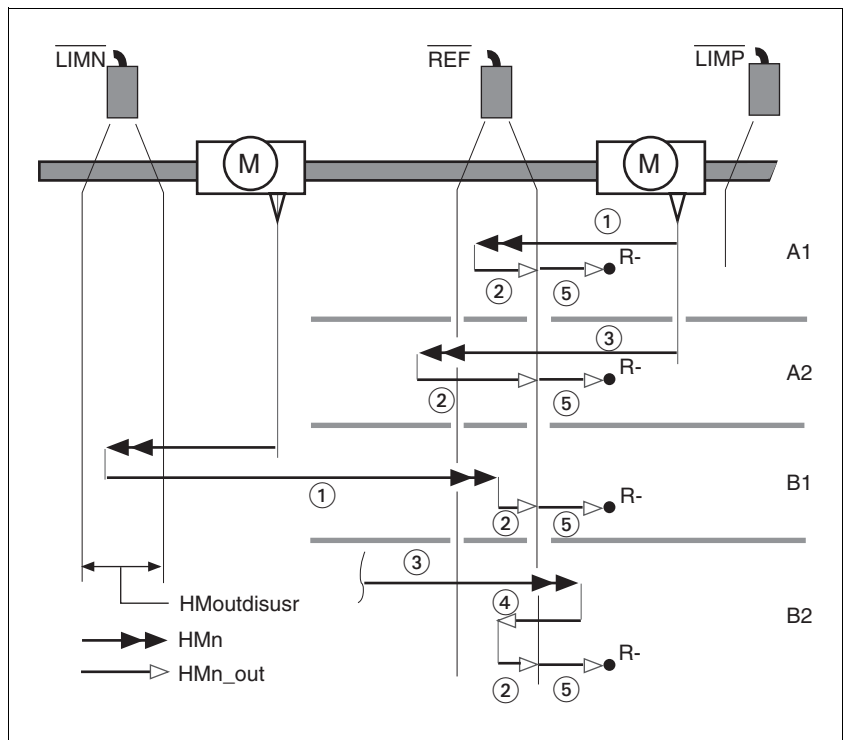


Figure 8.14 Reference movements to the reference switch

- (1) Movement to reference switch at search speed
- (2) Movement to switching edge at speed for moving away from switch
- (3) Excessively fast movement to reference switch at search speed
- (4) Return movement to switch range at speed for moving away from switch
- (5) Movement to distance from switching edge at speed for moving away from switch

8.5.6.2 Reference movement with index pulse

Description First, the product moves to the defined limit switch or reference switch. Then the product moves to the nearest index pulse.

Parameterization The position distance between the switching edge and index pulse can be determined with the parameter HMdisREFtoIDX.

The value should be >0.05.

This way, the reference movement with index pulse is reproducible.

If the index pulse is too close to the switching edge, the limit switch or reference switch can be moved mechanically.

Otherwise the position of the index pulse can be moved with the parameter ENC_pabsusr, see Chapter 7.2.10 "Setting parameters for encoder".

Parameter Name	Description	Unit Minimum value Default value Maximum value	Data type R/W persistent Expert	Parameter address via fieldbus
HMdisREFtoIDX	Distance from switching edge to index pulse This read value delivers the difference between the index pulse position and the position at the switching edge of the limit or reference switch. It allows to check the distance between the index pulse and the switching edge and serves as a criterion for determining whether the reference movement with index pulse processing can be reproduced. In increments of 1/10000 revolutions	revolution - 0.0000 -	INT32 INT32 R/- -	Modbus 10264 CIP 140.1.12

Reference movement to limit switch The following illustration shows a reference movement to the positive limit switch with movement to the first index pulse (`HMmethod = 2`).

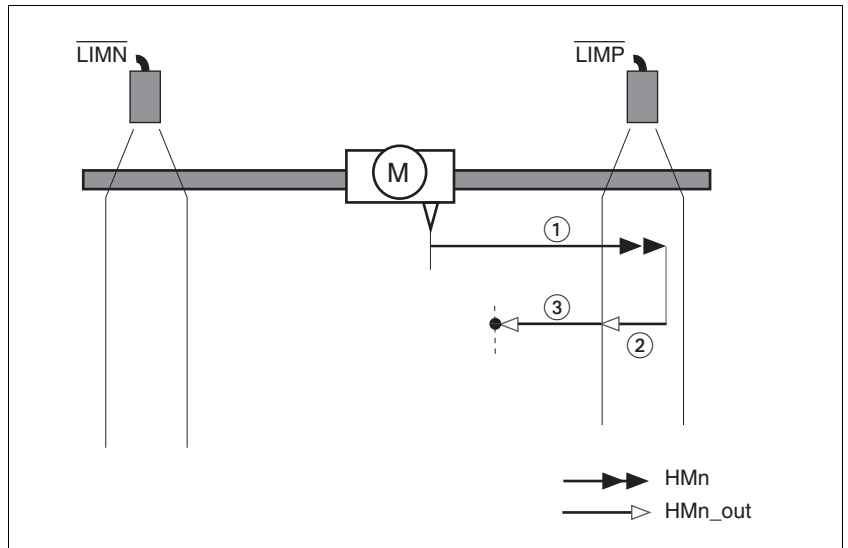


Figure 8.15 Reference movement to the positive limit switch

- (1) Movement to limit switch at search speed
- (2) Movement to switching edge at speed for moving away from switch
- (3) Movement to index pulse at speed for moving away from switch

Reference movement to reference switch

The following illustration shows reference movements to the reference switch with movement to the first index pulse (HMmethod = 11 to 14).

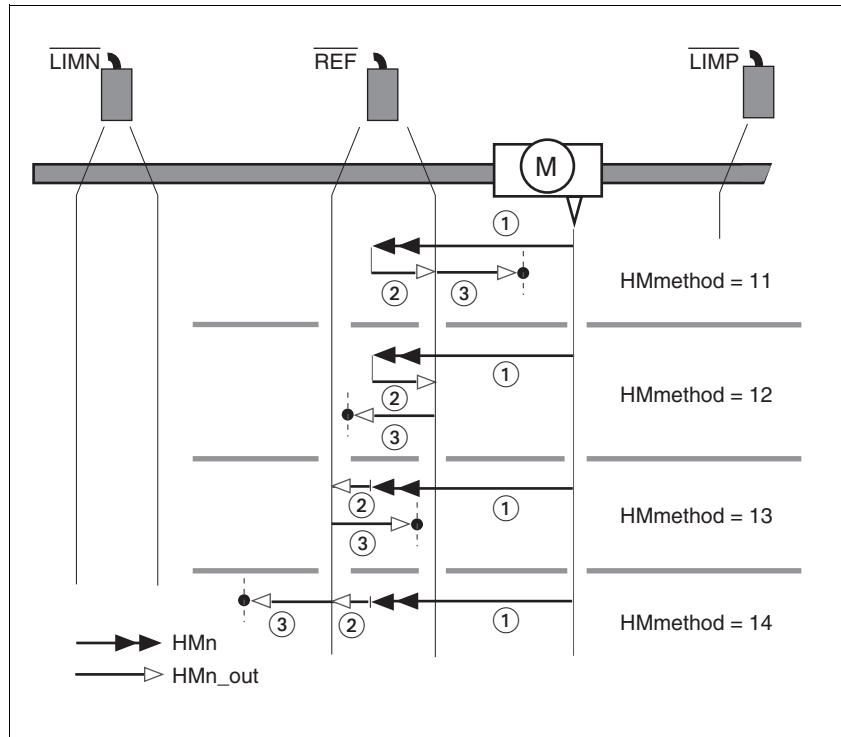


Figure 8.16 Reference movements to the reference switch

- (1) Movement to reference switch at search speed
- (2) Movement to switching edge at speed for moving away from switch
- (3) Movement to index pulse at speed for moving away from switch

Examples The following illustration shows reference movements to the reference switch with movement to the first index pulse ($HMmethod = 11$). Various responses at different search speeds and start positions are shown.

- Movement to the reference switch with first movement in negative direction; the reference switch is once in front of the starting point (A1, A2), once behind it (B1, B2).
- Additional movement when the unit moves through the switch range (A2, B2).

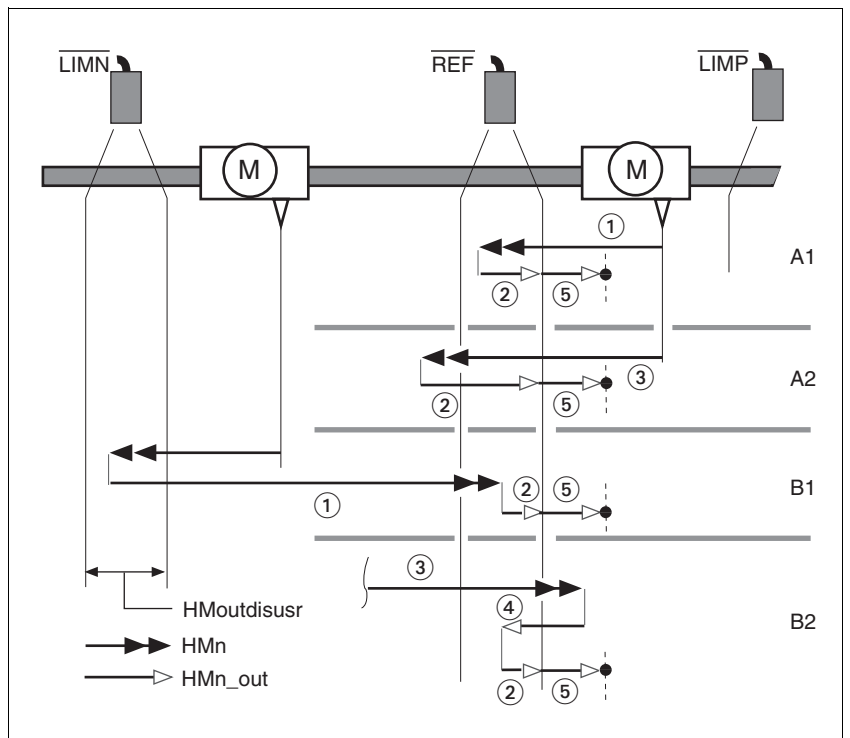


Figure 8.17 Reference movements to the reference switch

- (1) Movement to reference switch at search speed
- (2) Movement to switching edge at speed for moving away from switch
- (3) Excessively fast movement to reference switch at search speed
- (4) Return movement to switch range at speed for moving away from switch
- (5) Movement to index pulse at speed for moving away from switch

8.5.6.3 Reference movement to the index pulse

Description The motor moves from the current motor position to the index pulse.

Reference movement to index pulse The following illustration shows reference movements to the index pulse (HMmethod = 33 and 34).

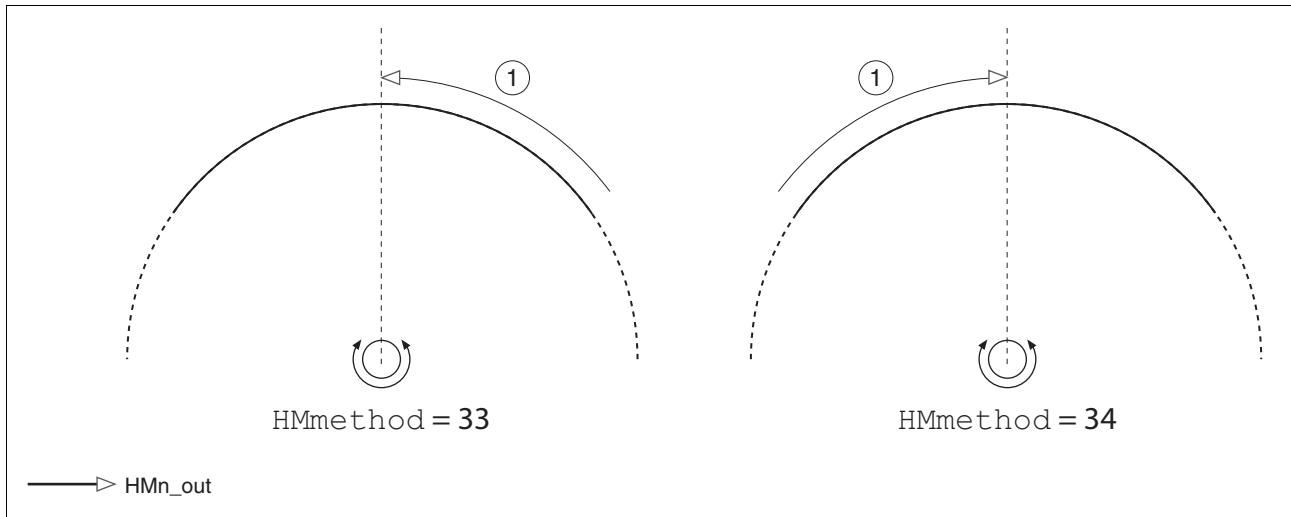


Figure 8.18 Reference movements to the index pulse

- (1) Movement to index pulse at speed for moving away from switch

8.5.6.4 Homing by position setting

Description By means of position setting, the current motor position is set to the position value in parameter HMP_setpusr. This also defines the zero point.

Homing by position setting can only be carried out when the motor is at a standstill. Any active position deviation is retained and can still be compensated by the position controller after position setting.

Parameter Name	Description	Unit Minimum value Default value Maximum value	Data type R/W persistent Expert	Parameter address via fieldbus
HMP_setpusr	Position setting to position setting position Action object: write access triggers position setting. Only possible if the motor is at standstill. Position scaling is not considered.	usr -2147483648 - 2147483647	R/W - -	

Example Position setting can be used to carry out a continuous motor movement without exceeding the positioning limits.

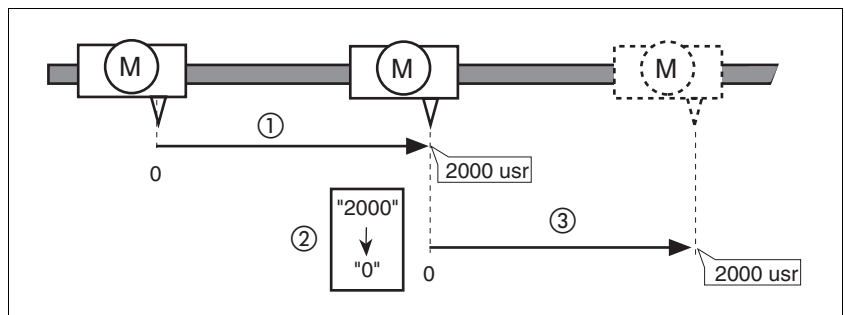


Figure 8.19 Positioning by 4000 usr units with position setting

- (1) The motor is positioned by 2000 usr.
- (2) By means of position setting to 0, the current motor position is set to position value 0 which, at the same time, defines a new zero point.
- (3) When a new motion command by 2000 usr is triggered, the new target position is 2000 usr.

This method avoids overtravel of the absolute position limits during a positioning operation because the zero point is continuously adjusted.

The reference position is read by means of parameter _p_refusr.

Parameter Name	Description	Unit Minimum value Default value Maximum value	Data type R/W persistent Expert	Parameter address via fieldbus
_p_refusr	Reference position in user units Value corresponds to the reference position of the position controller.	usr - 0 -	INT32 INT32 R/- -	Modbus 7704 CIP 130.1.12

8.6 Functions

8.6.1 Monitoring functions

8.6.1.1 Status monitoring of the control loops

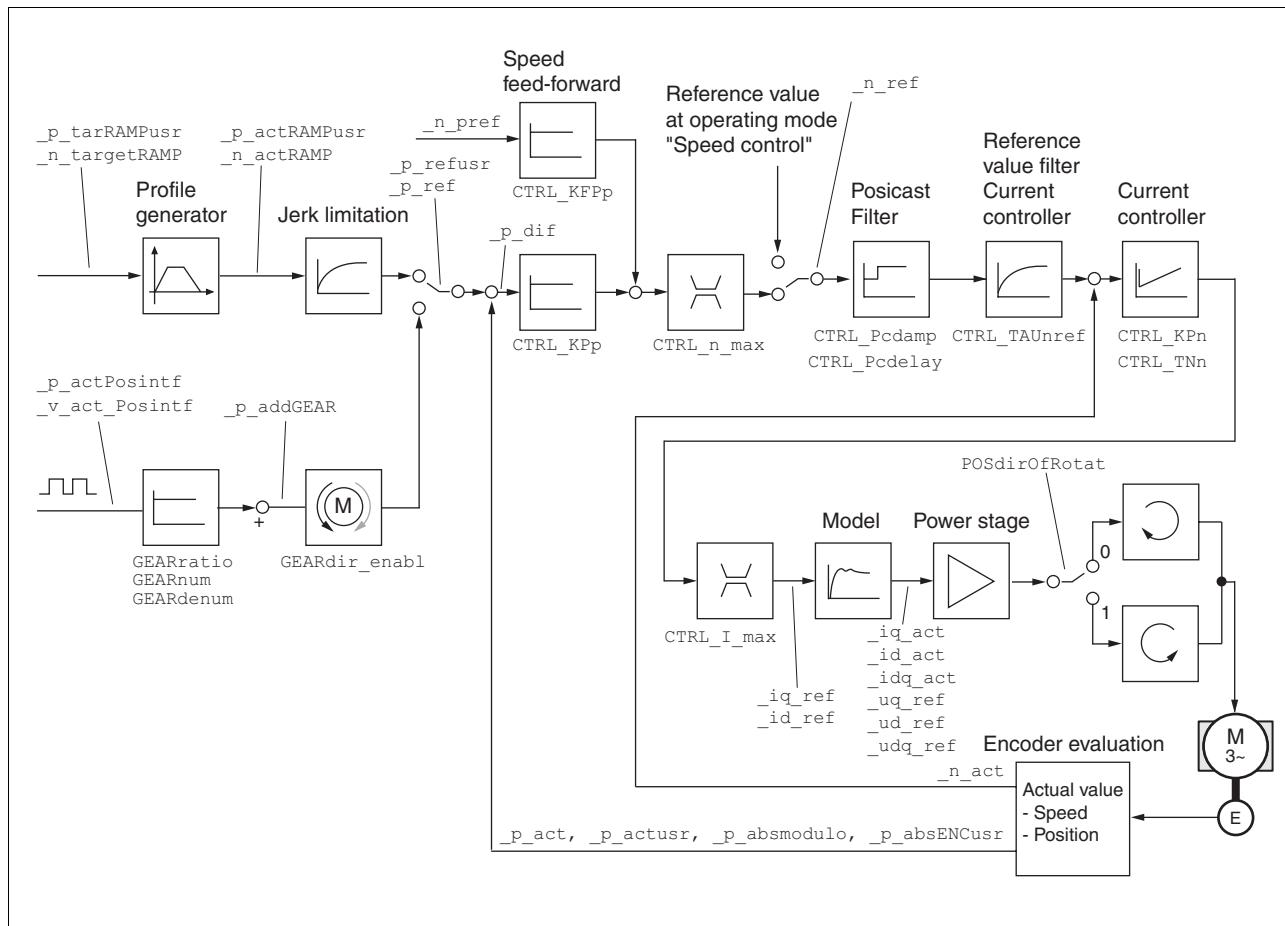


Figure 8.20 Status monitoring of the control loops

8.6.1.2 Positioning range

Positioning range The motor can be moved to any point on the axis within the positioning range by means of absolute positioning.

The current position of the motor can be read with the parameter `_p_actusr`.

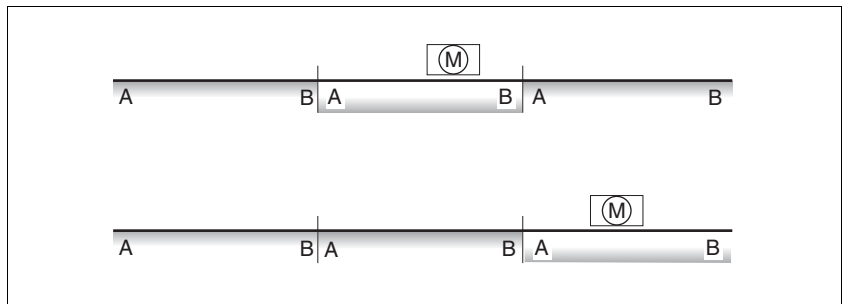


Figure 8.21 Positioning range

With the default scaling, the positioning limits are:

- (A) -1073741824 usr
- (B) 1073741823 usr

Overtraveling of the positioning limits is possible in all operating modes, except during absolute positioning in Profile Position operating mode.

If the motor overtravels the positioning limit, the reference point is lost.

In the case of relative positioning in the operating mode Profile Position, the unit checks whether the position limits will be overtraveled before the movement is started. If so, internal position setting to 0 is triggered when the movement is started. The reference point is lost (`ref_ok = 1 -> 0`).

Software limit switches The positioning range can be limited by software limit switches. This is possible as soon as the drive has a valid zero point (`ref_ok = 1`). The position values are specified with reference to the zero point. The software limit switches are set via the parameters `SPVswLimPusr` and `SPVswLimNusr` are activated via `SPV_SW_Limits`. Bit 2 of parameter `_SigLatched` signals the triggering of a software limit switch.

The determining factor for position monitoring of the software limit switch range is the reference position of the position controller. Therefore, depending on the controller settings, the motor may stop before it reaches the limit switch position.

Parameter Name	Description	Unit Minimum value Default value Maximum value	Data type R/W persistent Expert	Parameter address via fieldbus
SPVswLimPusr	Positive position limit for software limit switch If a user value entered is outside of the permissible user range, the limit switch limits are automatically set to the max. user value.	usr - 2147483647 -	INT32 INT32 R/W per. -	Modbus 1544 CIP 106.1.4
SPVswLimNusr	Negative position limit for software limit switch Refer to description 'SPVswLimPusr'	usr - -2147483648 -	INT32 INT32 R/W per. -	Modbus 1546 CIP 106.1.5

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Parameter Name	Description	Unit Minimum value Default value Maximum value	Data type R/W persistent Expert	Parameter address via fieldbus
SPV_SW_Limits	<p>Monitoring of software limit switches</p> <p>0 / none: None (default) 1 / SWLIMP: Activation of software limit switches positive direction 2 / SWLIMN: Activation of software limit switches negative direction 3 / SWLIMP+SWLIMN: Activation of software limit switches both directions</p> <p>Monitoring of software limit switches only works in case of successful homing (ref_ok = 1).</p>	- 0 0 3	UINT16 UINT16 R/W per. -	Modbus 1542 CIP 106.1.3

Limit switches

⚠ WARNING

LOSS OF CONTROL

The use of $\overline{\text{LIMP}}$ and $\overline{\text{LIMN}}$ can provide some protection against hazards (e.g. collision with mechanical stop caused by incorrect reference values).

- Use $\overline{\text{LIMP}}$ and $\overline{\text{LIMN}}$ where possible.
- Verify that the external sensors or switches are properly connected.
- Verify the correct of the limit switches. The limit switches must be mounted in a position far enough away from the mechanical stop to allow for an adequate stopping distance.
- Before you can use $\overline{\text{LIMP}}$ and $\overline{\text{LIMN}}$, you must enable them.

Failure to follow these instructions can result in death, serious injury or equipment damage.

During movements the two limit switches are monitored via the input signals $\overline{\text{LIMP}}$ and $\overline{\text{LIMN}}$. If the drive hits a limit switch, the motor stops. Triggering of the limit switch is signaled.

The parameters IOsigLimP and IOsigLimN are used to release the input signals $\overline{\text{LIMP}}$ and $\overline{\text{LIMN}}$ and the evaluation is set to active 0 or active 1.



Use active 0 monitoring signals if possible, because they are failsafe.

Parameter Name	Description	Unit Minimum value Default value Maximum value	Data type R/W persistent Expert	Parameter address via fieldbus
IOsigLimN	Signal evaluation LIMN	-	UINT16	Modbus 1566
	0 / inactive: Inactive	0	UINT16	CIP 106.1.15
	1 / normally closed: Normally closed NC	1	R/W	
	2 / normally open: Normally open NO	2	per. -	
IOsigLimP	Signal evaluation LIMP	-	UINT16	Modbus 1568
	0 / inactive: Inactive	0	UINT16	CIP 106.1.16
	1 / normally closed: Normally closed NC	1	R/W	
	2 / normally open: Normally open NO	2	per. -	
IOsigRef	Signal evaluation REF	-	UINT16	Modbus 1564
	1 / normally closed: Normally closed NC	1	UINT16	CIP 106.1.14
	2 / normally open: Normally open NO	1	R/W	
		2	per. -	

The reference switch is only activated (to REF) while homing is processed.

Moving drive out The drive can be moved away from the limit switch range to the movement range in the Jog operating mode.

8.6.1.3 Monitoring internal signals

Temperature monitoring Sensors monitor the temperature of motor and power stage. All temperature limit values are permanently set. If the temperature of a component approaches its permissible temperature limit, the device generates a warning message. If the temperature exceeds the limit value for more than 5 seconds, the power stage is disabled and the controller switches off. The device signals a temperature error.

Parameter Name	Description	Unit Minimum value Default value Maximum value	Data type R/W persistent Expert	Parameter address via fieldbus
_Temp_act_PA	Power stage temperature	°C	INT16	Modbus 7200
		-	INT16	CIP 128.1.16
		0	R/-	
		-	per. -	
PA_T_max	Maximum permissible power stage temperature	°C	INT16	Modbus 4110
		-	INT16	CIP 116.1.7
		0	R/-	
		-	per. -	
PA_T_warn	Temperature warning threshold of power stage	°C	INT16	Modbus 4108
		-	INT16	CIP 116.1.6
		0	R/-	
		-	per. -	

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I²t monitoring If the device operates with high peak currents, temperature monitoring with sensors can be too sluggish. I²t monitoring allows the controller to anticipate a rise in temperature and to reduce the current to the nominal value when the I²t limit value is exceeded.

When the value falls below the limit value, the device can be operated with maximum performance again.

Parameter Name	Description	Unit	Data type	Parameter address via fieldbus
		Minimum value Default value Maximum value	R/W persistent Expert	
_I2t_act_M	Current motor overload	%	INT16	Modbus 7218 CIP 128.1.25
		-	INT16	
		0	R/-	
		-	-	
_I2t_mean_M	Motor load	%	INT16	Modbus 7220 CIP 128.1.26
		-	INT16	
		0	R/-	
		-	-	

Tracking error monitoring The drive monitors the so-called position deviation at 1ms intervals. The position deviation is the difference between the current reference position and the actual position. If the value of this position difference exceeds the limit value set in parameter *SPV_P_maxDiff*, this will cause an immediate stop (tracking error) with an error class that can be parameterized.

Select the limit value in parameter *SPV_P_maxDiff* considerably greater than the maximum position deviation that may occur during normal operation. This way, a tracking error will only occur in case of errors, for example, in the case of excessively high external load torques or inoperative encoder.

The maximum control deviation that occurred during operation can be determined with the parameter *_p_DifPeak*; it can be compared to the maximum permissible position deviation. This allows you to determine how far away the product was from the shut-off limit.

In addition, you can change the error class for a tracking error, see also chapter 8.6.1 "Monitoring functions".

Parameter Name	Description	Unit	Data type	Parameter address via fieldbus
		Minimum value Default value Maximum value	R/W persistent Expert	
_p_DifPeak	Value of the maximum tracking error of the position controller The tracking error is the current position control deviation. See <i>SPV_p_maxDiff</i> for more information. A write access resets this value.	revolution	UINT32	Modbus 4382 CIP 117.1.15
		0.0000	UINT32	
		-	R/W	
		429496.7295	-	
_p_dif	Current deviation between reference and actual position Corresponds to the current control deviation of the position controller.	revolution	INT32	Modbus 7716 CIP 130.1.18
		-214748.3648	INT32	
		-	R/-	
		214748.3647	-	

Parameter Name	Description	Unit Minimum value Default value Maximum value	Data type R/W persistent Expert	Parameter address via fieldbus
SPV_p_maxDiff	Max. permissible tracking error of the position controller The tracking error is the current position control deviation.	revolution 0.0001 1.0000 200.0000	UINT32 UINT32 R/W per. -	Modbus 4636 CIP 118.1.14

Monitoring parameters The device status and operating state can be monitored by means of various objects.

Parameter Name	Description	Unit Minimum value Default value Maximum value	Data type R/W persistent Expert	Parameter address via fieldbus
_SigActive	Current status of monitoring signals See _SigLatched for more details on the bit codes.	- - 0 -	UINT32 UINT32 R/- - -	Modbus 7182 CIP 128.1.7

Parameter Name	Description	Unit Minimum value Default value Maximum value	Data type R/W persistent Expert	Parameter address via fieldbus
_SigLatched	Saved status of monitoring signals	-	UINT32	Modbus 7184
	Signal status: 0: Not activated 1: Activated	- 0 -	UINT32 R/- -	CIP 128.1.8
	Bit assignments: Bit 0: General fault Bit 1: Limit switches (LIMP/LIMN/REF) Bit 2: Out of range (SW limit switches, tuning) Bit 3: Quickstop via fieldbus Bit 4: Inputs STO are 0 Bit 5: Reserved Bit 6: RS485 fault Bit 7: CAN fault Bit 8: Ethernet fault Bit 9: Frequency of reference signal too high Bit 10: Fault current operating mode Bit 11: Reserved Bit 12: Profibus fault Bit 13: Reserved Bit 14: Undervoltage DC bus Bit 15: Overvoltage DC bus Bit 16: Mains phase missing Bit 17: Motor connection fault Bit 18: Motor overcurrent/short circuit Bit 19: Motor encoder fault Bit 20: Undervoltage 24VDC Bit 21: Overtemperature (power stage, motor) Bit 22: Tracking error Bit 23: Max. speed exceeded Bit 24: Inputs STO different Bit 25: Reserved Bit 26: Reserved Bit 27: Reserved Bit 28: Reserved Bit 29: EEPROM fault Bit 30: System booting (Hardware fault or parameter error) Bit 31: System error (e.g. watchdog)			
	Monitoring functions are product-dependent.			
_WarnActive	Active warnings, bit-coded	-	UINT16	Modbus 7190
	See _WarnLatched for more details on the bit codes.	- 0 -	UINT16 R/- -	CIP 128.1.11

Parameter Name	Description	Unit Minimum value Default value Maximum value	Data type R/W persistent Expert	Parameter address via fieldbus
_WarnLatched	Saved warnings, bit-coded	-	UINT16	Modbus 7192
	<p>Saved warning bits are deleted in the case of a FaultReset. Bits 10, 11, 13 are deleted automatically.</p> <p>Signal status: 0: Not activated 1: Activated</p> <p>Bit assignments: Bit 0: General warning (see _LastWarning) Bit 1: Temperature of power stage high Bit 2: Temperature of motor high Bit 3: Reserved Bit 4: Power stage overload (I²t) Bit 5: Motor overload (I²t) Bit 6: Braking resistor overload (I²t) Bit 7: CAN warning Bit 8: Motor encoder warning Bit 9: RS485 protocol warning Bit 10: STO_A (PWRR_A) and/or STO_B (PWRR_B) Bit 11: DC bus undervoltage/missing mains phase Bit 12: Profibus warning Bit 13: Position not yet valid (position capture still running) Bit 14: Ethernet warning Bit 15: Reserved</p> <p>Monitoring functions are product-dependent.</p>	- - 0 -	UINT16 UINT16 R/- -	CIP 128.1.12
_actionStatus	Action word	-	UINT16	Modbus 7176
	<p>Signal status: 0: not activated 1: activated</p> <p>Bit 0: Warning Bit 1: Error class 1 Bit 2: Error class 2 Bit 3: Error class 3 Bit 4: Error class 4 Bit 5: Reserved Bit 6: Drive is at standstill (<9 [1/min]) Bit 7: Drive rotates clockwise Bit 8: Drive rotates counter-clockwise Bit 9: Reserved Bit 10: Reserved Bit 11: Profile generator idle (reference speed is 0) Bit 12: Profile generator decelerates Bit 13: Profile generator accelerates Bit 14: Profile generator moves at constant speed Bit 15: Reserved</p>	- 0 -	UINT16 UINT16 R/- -	CIP 128.1.4
_StopFault	Error number of last stop fault	-	UINT16	Modbus 7178
		- 0 -	UINT16 R/- -	CIP 128.1.5

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Setting error responses The responses of the device to errors are subdivided into error classes; the error class can be set for a number of monitoring functions. This allows you to tune the error response of the device to operation requirements.

Parameter Name	Description	Unit Minimum value Default value Maximum value	Data type R/W persistent Expert	Parameter address via fieldbus
SPV_Flt_pDiff	Error response to tracking error 1 / ErrorClass1: Error class 1 2 / ErrorClass2: Error class 2 3 / ErrorClass3: Error class 3	- 1 3 3	UINT16 UINT16 R/W per. -	Modbus 1302 CIP 105.1.11

8.6.2 Scaling

⚠ WARNING

UNEXPECTED MOVEMENT CAUSED BY CHANGED SCALING

Changing the scaling changes the effect of the values in user-defined units. The same motion commands can therefore cause different movements.

- Note that the scaling affects all relationships between the set values and the movements of the drive.
- Check the corresponding usr parameters and values of the system in user-defined units.

Failure to follow these instructions can result in death, serious injury or equipment damage.

Description Scaling translates user units to internal units of the device, and vice versa. The device saves position values in user-defined units.

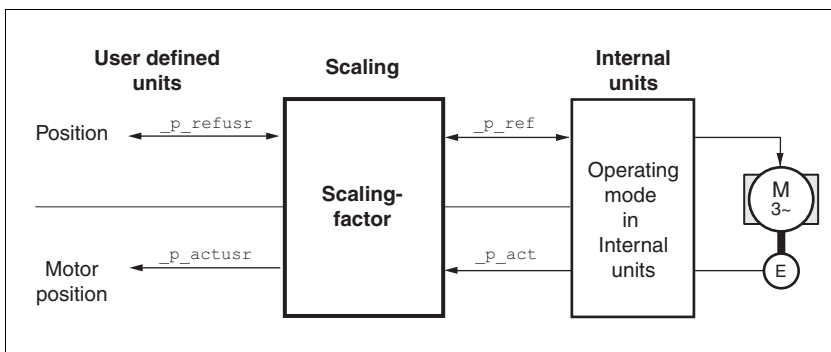


Figure 8.22 Scaling

Scaling factor The scaling factor is the relationship between the number of motor revolutions and the required user-defined units [usr].

$$\text{Scaling factor} = \frac{\text{Motor revolutions}}{\text{Change of the user position [usr]}}$$

Figure 8.23 Representation of the scaling factor

The scaling factor is set using the parameters POSscaleNum and POSscaleDenom. A new scaling factor is activated when you specify the numerator value.

When specifying the scaling factor, note that numerator and denominator can only be integer values. A scaling factor less than 1/131072 will limit the working range. An error is signaled when the working range is exceeded.

The scaling factor can only be changed when the power stage is disabled. Values in user-defined units are converted to internal units when the power stage is enabled.

Parameter Name	Description	Unit Minimum value Default value Maximum value	Data type R/W persistent Expert	Parameter address via fieldbus
POSscaleNum	Numerator of position scaling Specification of the scaling factor: Motor revolutions [U] ----- Change of user position [usr] A new scaling is activated when the numerator value is supplied. User limit values may be reduced due to the calculation of an internal factor.	revolution 1 1 2147483647	INT32 INT32 R/W per. -	Modbus 1552 CIP 106.1.8
POSscaleDenom	Denominator of position scaling Refer to numerator (POSscaleNum) for a description. A new scaling is activated when the numerator value is supplied.	usr 1 16384 2147483647	INT32 INT32 R/W per. -	Modbus 1550 CIP 106.1.7



If an existing device is replaced by this device, and if the same positioning commands are to be used, the scaling must be set in accordance with the settings used previously.

Default scaling

A value of 16384 user-defined units per motor revolution is set as the default scaling.

Examples

Various situations can be distinguished as far as setting user-defined units is concerned.

- Scaling corresponds to default scaling
1 motor revolution = 16384 user-defined units
=> Every second motor position can be approached.
- Scaling corresponds to motor resolution (minimum scaling)
1 motor revolution = 32768 user-defined units
=> Every motor position can be approached.
- Scaling is less than the default scaling
1 motor revolution = 4096 user-defined units
=> Every fourth motor position can be approached.

The following parameters need to be adjusted to obtain the same motor position after a change of the scaling factor: HMoutdisusr, HMdisusr, HMp_homeusr, HMsrchdisusr, JOGstepusr, SPVswLimPusr and SPVswLimNusr.

Example 1 Positioning by 1111 user-defined units is to correspond to 3 motor revolutions. This results in

$$\text{Scaling factor} = \frac{3 \text{ rev}}{1111 \text{ usr}}$$

Figure 8.24 Calculation of the scaling factor, example 1

If you now start relative positioning by 900 user-defined units, the motor moves by $900 \text{ usr} * 3/1111 \text{ rev/usr} = 2.4302 \text{ revolutions}$.

Example 2 Calculation of a scaling factor in length units: 1 motor revolution corresponds to a distance of 100 mm. Each user-defined unit [usr] is to correspond to one step of 0.01 mm.

This means: $1 \text{ usr} = 0.01 \text{ mm} * 1 \text{ rev} / 100 \text{ mm} = 1/10000 \text{ revolutions}$.

$$\text{Scaling factor} = \frac{1 \text{ rev}}{10000 \text{ usr}}$$

Figure 8.25 Calculation of the scaling factor, example 2

Example 3 Setting positioning in 1/1000 rad

$$1 \text{ rad} = 1 \text{ rev} / (2 * \pi)$$

$$\pi = 3.1416 \text{ (rounded)}$$

$$\text{User value} = 1 \text{ usr}$$

$$\text{Device value} = 1 / (2 * \pi * 1000) \text{ U}$$

$$\text{Scaling factor} = \frac{1 \text{ rev}}{2 * 3,1416 * 1000 \text{ usr}} = \frac{1 \text{ rev}}{6283,2 \text{ usr}} = \frac{10 \text{ rev}}{62832 \text{ usr}}$$

Figure 8.26 Calculation of the scaling factor, example 3

8.6.3 Motion profile

Profile generator Target position and target speed of rotation are input values to be specified by the user. The profile generator uses these values to calculate a motion profile depending on the selected operating mode.

The values of the profile generator plus the values of a jerk limitation are transformed into a motor movement.

The acceleration and deceleration behavior of the motor can be described as a ramp function of the profile generator. The characteristic values of the ramp function are the ramp shape and the ramp steepness.

Ramp steepness The steepness of the ramp determines the speed changes of the motor per time unit. The ramp steepness can be set for the acceleration ramp via the parameter `RAMPacc` and for the deceleration ramp via `RAMPdecel`.

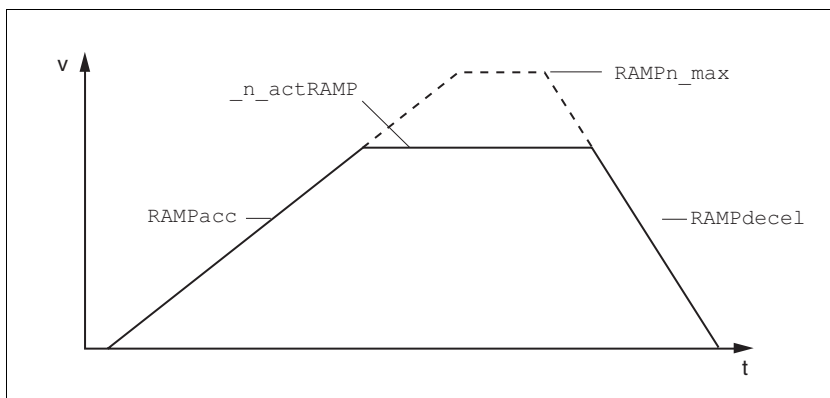


Figure 8.27 Acceleration and deceleration ramps

Parameter Name	Description	Unit Minimum value Default value Maximum value	Data type R/W persistent Expert	Parameter address via fieldbus
RAMPacc	Acceleration of profile generator	min ⁻¹ /s 1 600 3000000	UINT32 UINT32 R/W per. -	Modbus 1556 CIP 106.1.10
RAMPdecel	Deceleration of profile generator	min ⁻¹ /s 750 750 3000000	UINT32 UINT32 R/W per. -	Modbus 1558 CIP 106.1.11

Parameter Name	Description	Unit Minimum value Default value Maximum value	Data type R/W persistent Expert	Parameter address via fieldbus
RAMPn_max	<p>Limitation of ref. speed for op. modes with profile generation</p> <p>The parameter is active in the following operating modes:</p> <ul style="list-style-type: none"> - Profile position - Profile velocity - Homing - Jog <p>If a greater reference speed is set in one of these operating modes, it is automatically limited to RAMPn_max. This way, commissioning at limited speed is easy to perform.</p>	<p>min⁻¹</p> <p>60</p> <p>13200</p> <p>13200</p>	<p>UINT16</p> <p>UINT16</p> <p>R/W</p> <p>per.</p> <p>-</p>	<p>Modbus 1554</p> <p>CIP 106.1.9</p>

Jerk limitation Jerk limitation removes sudden changes in the acceleration to obtain smooth, virtually jerk-free changes of the speed of rotation.

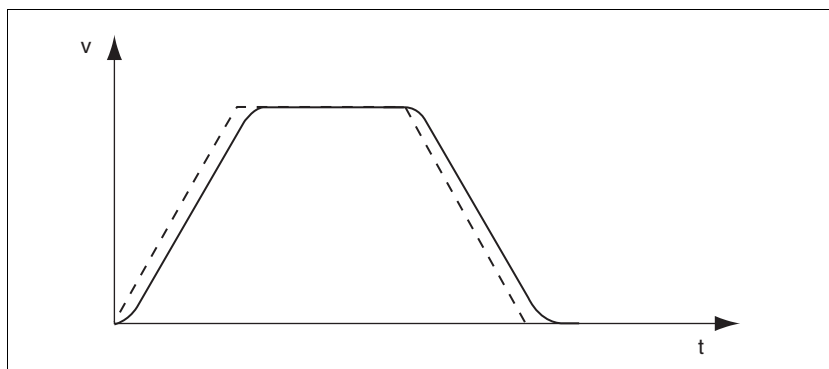


Figure 8.28 Speed curve with and without (dotted) jerk limitation

The jerk limitation is activated and adjusted via the parameter RAMP_TAUjerk.

The end of the movement (x_end = 1) is not signaled until the target position at the end of the jerk limitation has been reached.

Parameter Name	Description	Unit Minimum value Default value Maximum value	Data type R/W persistent Expert	Parameter address via fieldbus
RAMP_TAUjerk	<p>Jerk limitation</p> <p>0 / off: Off 1 / 1: 1 ms 2 / 2: 2 ms 4 / 4: 4 ms 8 / 8: 8 ms 16 / 16: 16 ms 32 / 32: 32 ms 64 / 64: 64 ms 128 / 128: 128 ms</p> <p>Limits the acceleration change (jerk) of the reference position generation during the positioning transitions: Standstill - acceleration Acceleration - constant speed Constant speed - deceleration Deceleration - standstill</p> <p>Processing in the following operating modes: - Profile velocity - Profile position - Jog - Homing</p> <p>Adjustments can only be made if the operating mode is inactive (x_end=1).</p>	ms 0 0 128	UINT16 UINT16 R/W per. -	Modbus 1562 CIP 106.1.13

8.6.4 Quick Stop

Function principle "Quick Stop" is a quick brake function which stops the motor as a result of an error of error classes 1 and 2 or as a result of a software stop.

In the event of an error response to an error of error class 1, the power stage remains enabled. In the case of error class 2, the power stage is disabled after the drive has come to a standstill.

The motor can be decelerated via a deceleration ramp or a maximum current. Use the parameter LIM_QStopReact to set the type of deceleration.

- ▶ Set the type of deceleration with the LIM_QStopReact parameter.
- ▶ Use parameter RAMPquickstop to define a required deceleration ramp or parameter LIM_I_maxQSTP to set a required maximum current.

Maximum current The drive absorbs excess braking energy during. If the DC bus voltage exceeds the permissible limit the power stage is disabled and the device signals "DC bus overvoltage". The motor coasts down without any braking force.

The current for the moment ramp should be set in such a way that the drive comes to a standstill with the required deceleration.

"Quick Stop" ramp The "Quick Stop" ramp must be set in such a way that the drive comes to a standstill with the desired deceleration when the function is triggered.

The drive absorbs excess braking energy during deceleration. If the DC bus voltage exceeds the permissible limit the power stage is disabled and the device signals "DC bus overvoltage". The motor coasts down without any braking force.

"Quick Stop reset" A "Quick Stop" must be reset by a "Fault Reset".

If a "Quick Stop" has been triggered by the positive or negative limit switch the drive can be moved back into the movement range via the jog operating mode.

Parameter Name	Description	Unit Minimum value Default value Maximum value	Data type R/W persistent Expert	Parameter address via fieldbus
LIM_QStopReact	Type of deceleration for Quick Stop 6 / Deceleration ramp: Deceleration ramp 7 / Torque ramp: Torque ramp Setting of deceleration ramp with parameter RAMPquickstop. Setting of torque ramp with parameter LIM_I_maxQSTP. The deceleration ramp is only available for operating modes with profile generator. The torque ramp is used in the operating modes without profile generator.	- 6 7 7	INT16 INT16 R/W per. -	Modbus 1584 CIP 106.1.24

Parameter Name	Description	Unit Minimum value Default value Maximum value	Data type R/W persistent Expert	Parameter address via fieldbus
RAMPquickstop	Deceleration ramp for Quick Stop Deceleration of the drive when a software stop is triggered or if an error of error class 1 has occurred.	min ⁻¹ /s 200 6000 3000000	UINT32 UINT32 R/W per. -	Modbus 1572 CIP 106.1.18
LIM_I_maxQSTP	Current limitation for Quick Stop Max. current during braking via torque ramp due to an error of error classes 1 or 2 and when a software stop is triggered. Maximum and default settings depend on the motor and the power stage (settings M_I_max and PA_I_max) In increments of 0.01A _{pk}	A _{pk} - - -	UINT16 UINT16 R/W per. -	Modbus 4362 CIP 117.1.5

8.6.5 Halt

Function principle The "Halt" function is an interruption function used to stop the motor and temporarily interrupt operation.

Internal position adjustment is performed once the drive comes to a standstill. Position control is activated and the motor is stopped with the power stage remaining enabled.

When all "Halt" requests are cleared, the interrupted movement is resumed. If the "Halt" request is already cleared during deceleration, the drive continues to decelerate until it comes to a standstill and then accelerates again.

The "Halt" function can be activated by any source (such as commissioning software or signal input).

The motor can be decelerated via a deceleration ramp or a maximum current. Use the parameter LIM_HaltReaction to set the type of deceleration.

- ▶ Set the type of deceleration with the LIM_HaltReaction parameter.
- ▶ Use parameter RAMPdecel to define a required deceleration ramp or parameter LIM_I_maxHalt to set a required maximum current.

Maximum current The drive absorbs excess braking energy during. If the DC bus voltage exceeds the permissible limit the power stage is disabled and the device signals "DC bus overvoltage". The motor coasts down without any braking force.

The current for the moment ramp should be set in such a way that the drive comes to a standstill with the required deceleration.

"Halt" ramp The "Halt" ramp must be set in such a way that the drive comes to a standstill with the desired deceleration after a "Halt" request.

The drive absorbs excess braking energy during deceleration. If the DC bus voltage exceeds the permissible limit the power stage is disabled and the device signals "DC bus overvoltage". The motor coasts down without any braking force.

Parameter Name	Description	Unit Minimum value Default value Maximum value	Data type R/W persistent Expert	Parameter address via fieldbus
LIM_HaltReaction	Type of deceleration for halt 1 / Deceleration ramp: Deceleration ramp 3 / Torque ramp: Torque ramp Setting of deceleration ramp with parameter RAMPdecel. Setting of torque ramp with parameter LIM_I_maxHalt. The deceleration ramp is only available for operating modes with profile generator. The torque ramp is used in the operating modes without profile generator.	- 1 3 3	INT16 INT16 R/W per. -	Modbus 1582 CIP 106.1.23

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Parameter Name	Description	Unit Minimum value Default value Maximum value	Data type R/W persistent Expert	Parameter address via fieldbus
RAMPdecel	Deceleration of profile generator	min ⁻¹ /s 750 750 3000000	UINT32 UINT32 R/W per. -	Modbus 1558 CIP 106.1.11
LIM_I_maxHalt	Current limitation for Halt Max. current during braking after Halt or when an operating mode is terminated. Maximum and default settings depend on the motor and the power stage (settings M_I_max and PA_I_max) In increments of 0.01A _{pk}	A _{pk} - - -	UINT16 UINT16 R/W per. -	Modbus 4364 CIP 117.1.6

8.6.6 Fast position capture

The "Fast position capture" function captures the current motor position at the point in time a digital 24V signal is available at one of the two capture inputs. For example, this function can be used for detection of registration marks.

Settings 2 independent capture inputs are available for the "Fast Position Capture" function.

- LIO1 (CAP1)
- LIO2 (CAP2)

One of 2 possible functions for capture can be selected for each capture input:

- Position capture with rising or falling edge at the capture input, adjustable with parameters CAP1CONFIG and CAP2CONFIG.
- One-time or continuous capture in the case of multiple edges at the capture input with parameters CAP1ACTIVATE and CAP2ACTIVATE.

Continuous capture means that the motor position is captured anew at every defined edge; the previous captured value is lost.

The captured motor position is less accurate during the acceleration phase and the deceleration phase.

Activating fast position capture Activating one-time position capture

- For CAP1: Write value 1 to parameter Cap1Activate
- For CAP2: Write value 1 to parameter Cap2Activate

Activating continuous position capture

- For CAP1: Write value 2 to parameter Cap1Activate
- For CAP2: Write value 2 to parameter Cap2Activate

Terminating position capture In the case of one-time single position capture, the "fast position capture" function is terminated when the first signal edge is detected.

In the case continuous position capture or if no signal edge is detected, the capture can be stopped by writing the parameter Cap1Activate, value 0 or Cap2Activate, value 0.

Parameter Name HMI menu	Description	Unit Minimum value Default value Maximum value	Data type R/W persistent Expert	Parameter address via fieldbus
Cap1Activate	Capture unit 1 start/stop 0 / Capture stop: Cancel capture function 1 / Capture once: Start one-time capture 2 / Capture continuous: Start continuous capture In the case of one-time capture, the function is terminated when the first value is captured. In the case of continuous capture, the function continues to run.	- 0 - 2	UINT16 UINT16 R/W -	Modbus 2568 CIP 110.1.4

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Parameter Name HMI menu	Description	Unit Minimum value Default value Maximum value	Data type R/W persistent Expert	Parameter address via fieldbus
Cap1Config	Capture unit 1 configuration 0 / 1->0 : Position capture at 1->0 change 1 / 0->1 : Position capture at 0->1 change	- 0 0 1	UINT16 UINT16 R/W - -	Modbus 2564 CIP 110.1.2
Cap1Count	Capture unit 1 event counter Counts the capture events. The counter is reset when capture unit 1 is activated.	- - 0 -	UINT16 UINT16 R/- - -	Modbus 2576 CIP 110.1.8
Cap1Pos	Capture unit 1 captured position Captured position at the time of the "capture signal". The captured position is calculated again after "Position Setting" or "Homing".	usr - 0 -	INT32 INT32 R/- - -	Modbus 2572 CIP 110.1.6
Cap2Activate	Capture unit 2 start/stop 0 / Capture stop : Cancel capture function 1 / Capture once : Start one-time capture 2 / Capture continuous : Start continuous capture In the case of one-time capture, the function is terminated when the first value is captured. In the case of continuous capture, the function continues to run.	- 0 - 2	UINT16 UINT16 R/W - -	Modbus 2570 CIP 110.1.5
Cap2Config	Capture unit 2 configuration 0 / 1->0 : Position capture at 1->0 change 1 / 0->1 : Position capture at 0->1 change	- 0 0 1	UINT16 UINT16 R/W - -	Modbus 2566 CIP 110.1.3
Cap2Count	Capture unit 2 event counter Counts the capture events. The counter is reset when capture unit 2 is activated.	- - 0 -	UINT16 UINT16 R/- - -	Modbus 2578 CIP 110.1.9
Cap2Pos	Capture unit 2 captured position Captured position at the time of the "capture signal". The captured position is calculated again after "Position Setting" or "Homing".	usr - 0 -	INT32 INT32 R/- - -	Modbus 2574 CIP 110.1.7
CapStatus	Status of the capture units Read access: Bit 0: position capture via input CAP1 carried out Bit 1: position capture via input CAP2 carried out	- - 0 -	UINT16 UINT16 R/- - -	Modbus 2562 CIP 110.1.1

8.6.7 Standstill window

The standstill window can be used to check whether the drive has reached the reference position.

If the control deviation $_p_dif$ of the position controller remains in the standstill window after the end of the positioning for the period $STANDpwinTime$, the device signals the end of processing ($x_end = 0 > 1$).

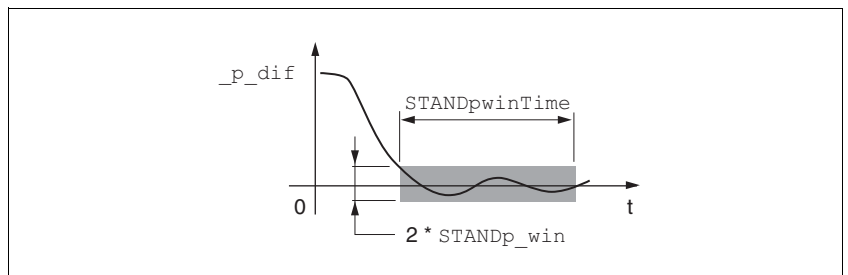


Figure 8.29 Standstill window

The parameters $STANDp_win$ and $STANDpwinTime$ define the size of the window.

The parameter $STANDpwinTout$ can be used to set the period of time after which an error is signaled if the standstill window was not reached.

Parameter Name	Description	Unit Minimum value Default value Maximum value	Data type R/W persistent Expert	Parameter address via fieldbus
$STANDp_win$	Standstill window, permissible control deviation The control deviation for the standstill window time must be within this range for a standstill of the drive to be detected. Processing of the standstill window must be activated via the parameter ' $STANDpwinTime$ '.	revolution 0.0000 0.0010 3.2767	UINT16 UINT16 R/W per. -	Modbus 4370 CIP 117.1.9
$STANDpwinTime$	Standstill window, time 0: Monitoring of standstill window deactivated >0: Time in ms during which the control deviation must be in the standstill window	ms 0 0 32767	UINT16 UINT16 R/W per. -	Modbus 4372 CIP 117.1.10
$STANDpwinTout$	Timeout time for standstill window monitoring 0 : Timeout monitoring deactivated >0 : Timeout time in ms Standstill window processing values are set via $STANDp_win$ und $STANDpwinTime$. Time monitoring starts when the target position (reference position of position controller) is reached or when the profile generator has finished processing.	ms 0 0 16000	UINT16 UINT16 R/W per. -	Modbus 4374 CIP 117.1.11

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8.6.8 Brake function

Use motors with a holding brake to avoid unintended movement of the motor when no current is applied.

The holding brake is not available with all product versions.

⚠ WARNING

LOSS OF BRAKING FORCE DUE TO WEAR OR HIGH TEMPERATURE

Applying the holding brake while the motor is running will cause excessive wear and loss of the braking force. Heat decreases the braking force.

- Do not use the brake as a service brake.
- Note that "EMERGENCY STOPS" may also cause wear
- At operating temperatures of more than 80°C (176°F), do not exceed a maximum of 50% of the specified holding torque when using the brake.

Failure to follow these instructions can result in death, serious injury or equipment damage.

Control The integrated holding brake is controlled automatically.

Releasing the holding brake

The holding brake is automatically released when the power stage is enabled. After a delay time the drive switches to operating state 6 "Operation Enable".

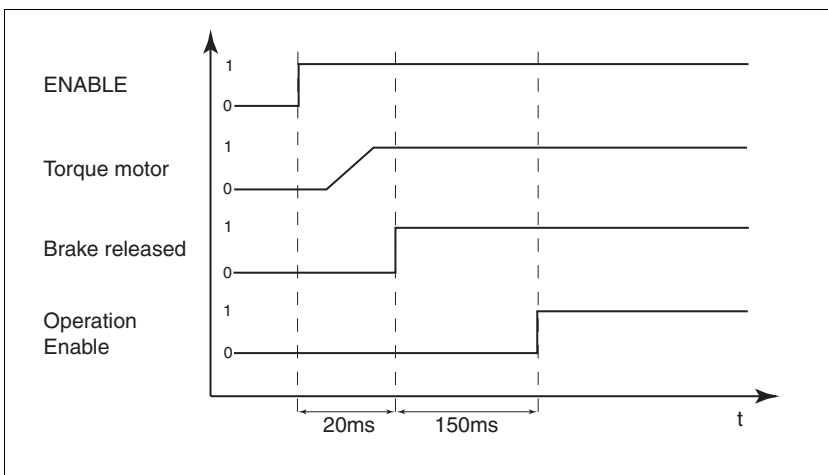


Figure 8.30 Releasing the holding brake

Applying the holding brake When the power stage is disabled and in the event of an error of error class 2, the holding brake is automatically applied. However, the motor current is not disconnected until after a delay time. This allows the holding brake to be applied before the motor loses its torque.

In the event of an error of error classes 3 or 4, the holding brake is automatically applied and the motor current is immediately disconnected.

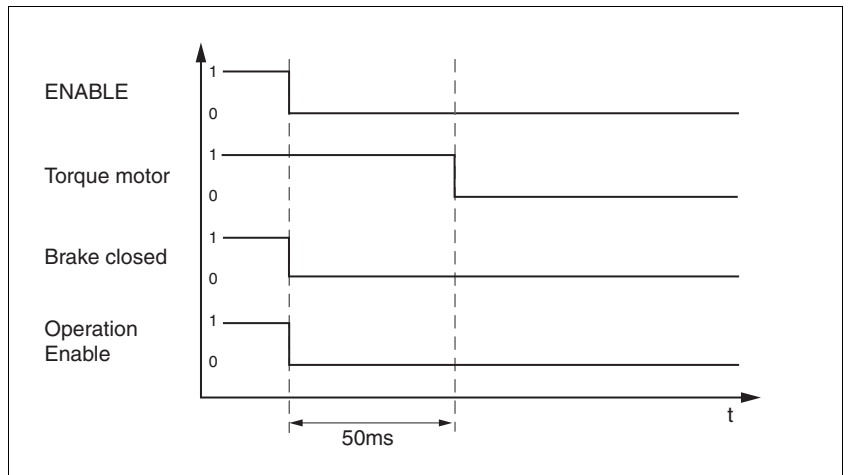


Figure 8.31 Applying the holding brake

The delay time is not effective if the power stage is disabled via the STO safety function. Especially in the case of vertical axes it is important to verify whether additional measures are required to avoid lowering of the load.

8.6.9 Configurable inputs and outputs

⚠ WARNING**UNINTENDED BEHAVIOR OF INPUTS AND OUTPUTS**

The functions of the inputs and outputs depend on the selected start-up operating mode and the settings of the corresponding parameters.

- Verify that the wiring is appropriate for the settings.
- Only start the system if there are no persons or obstructions in the hazardous area.
- When commissioning, carefully run tests for all operating states and potential fault situations.

Failure to follow these instructions can result in death, serious injury or equipment damage.

Description Different functions can be assigned to the digital signal inputs and outputs.

The parameters IOfunct_LIO1 ... IOfunct_LIO4 are available to configure the function

Factory settings The following table provides an overview of the factory settings.

Pin	Signal	Factory setting	I/O
CN4.3	LIO1	Input Positive limit switch (LIMP)	I
CN4.6	LIO2	Input Negative limit switch (LIMN)	I
CN4.2	LIO3	Input Free available	I
CN4.5	LIO4	Input Reference switch (REF)	I

Current status The _IO_LIO_act parameter indicates the current status of the digital signal inputs or outputs.

Parameter Name	Description	Unit Minimum value Default value Maximum value	Data type R/W persistent Expert	Parameter address via fieldbus
_IO_LIO_act	Status of digital inputs/outputs	-	UINT16	Modbus 2090
	Coding of the individual signals:	-	UINT16	CIP 108.1.21
	Bit 0: LIO1	0	R/-	
	Bit 1: LIO2	-	-	
	...			

8.6.9.1 Description of functions for signal inputs

<i>Input Free available</i>	The function has no device-internal functionality. Via parameter <code>_IO_LIO_act</code> , the signal input can be read as required.
<i>Input Fault reset</i>	An error message is reset with the function, see chapter 8.3 "Operating states".
<i>Input Enable</i>	The power stage is enabled with the function, see chapter 8.3 "Operating states".
<i>Input Halt</i>	The function triggers a "Halt", see chapter 8.6.5 "Halt".
<i>Input Jog positive</i>	The function performs a jog movement with clockwise direction of rotation, see chapter 8.5.1 "Operating mode Jog".
<i>Input Jog negative</i>	The function performs a jog movement with counterclockwise direction of rotation, see chapter 8.5.1 "Operating mode Jog".
<i>Input Jog fast/slow</i>	The function switches between slow and fast jog, see chapter 8.5.1 "Operating mode Jog".
<i>Input Reference switch (REF)</i>	The function defines the way the reference switch operates. See chapter 8.5.6 "Operating mode Homing".
<i>Input Positiv limit switch (LIMP)</i>	The function defines the way the positive limit switch operates. See chapter 8.5.6 "Operating mode Homing" and chapter 8.6.1.2 "Positioning range".
<i>Input Negative limit switch (LIMN)</i>	The function defines the way the negative limit switch operates. See chapter 8.5.6 "Operating mode Homing" and chapter 8.6.1.2 "Positioning range".

8.6.9.2 Description of functions for signal outputs

<i>Output Free available</i>	The function lets you directly set and output via parameter <code>IO_LO_set</code> .
<i>Output No fault</i>	The function provides information on the error state, see chapter 8.3.2 "Indicating the operating states".
<i>Output Active</i>	The function provides the "Operation enable" operating state signal, see chapter 8.3.2 "Indicating the operating states".

Parameter Name	Description	Unit Minimum value Default value Maximum value	Data type R/W persistent Expert	Parameter address via fieldbus
IO_LO_set	Setting the digital outputs directly	-	UINT16	Modbus 2082
	Write access to output bits is only active if the signal pin is available as an output and if the function of the output was set to 'Available as required'.	0	UINT16 R/W	CIP 108.1.17
	Coding of the individual signals: Bit 0: LO1_OUT Bit 1: LO2_OUT ...	-	-	-

8.6.9.3 Configuration of the signal inputs and outputs

The table below provides an overview of the signal inputs and outputs to which a function can be assigned.

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Functions for signal inputs

Function	Signal
No function / free available	LIO1, LIO2, LIO3, LIO4
Fault reset	LIO1, LIO2, LIO3, LIO4
Enable	LIO1, LIO2, LIO3, LIO4
Halt	LIO1, LIO2, LIO3, LIO4
Jog positive	LIO1, LIO2, LIO3, LIO4
Jog negative	LIO1, LIO2, LIO3, LIO4
Jog fast/slow	LIO1, LIO2, LIO3, LIO4
Reference switch (REF)	LIO1, LIO2, LIO3, LIO4
Positiv limit switch (LIMP)	LIO1
Negative limit switch (LIMN)	LIO2

Functions for signal outputs

Function	Jog
No function / free available	LIO1, LIO2, LIO3, LIO4
No fault	LIO1, LIO2, LIO3, LIO4
Active	LIO1, LIO2, LIO3, LIO4

Parameter Name	Description	Unit Minimum value Default value Maximum value	Data type R/W persistent Expert	Parameter address via fieldbus
IOfunct_LIO1	Function Input/Output LIO1 1 / Input Free available: Available as required 2 / Input Fault reset: Reset fault (local control mode only) 3 / Input Enable: Enable (local control mode only) 4 / Input Halt: Halt 9 / Input Jog positive: Jog positive 10 / Input Jog negative: Jog negative 11 / Input Jog fast/slow: Jog fast/slow 20 / Input Reference switch (REF): Reference switch (REF) 21 / Input Positive limit switch (LIMP): Positive limit switch (LIMP) 101 / Output Free available: Available as required 102 / Output No fault: No fault 103 / Output Active: Ready	- - 0 -	UINT16 UINT16 R/W per. -	Modbus 1826 CIP 107.1.17

Parameter Name	Description	Unit Minimum value Default value Maximum value	Data type R/W persistent Expert	Parameter address via fieldbus
IOfunct_LIO2	Function Input/Output LIO2	-	UINT16	Modbus 1828
		-	UINT16	CIP 107.1.18
	1 / Input Free available: Available as required	0	R/W	
	2 / Input Fault reset: Reset fault (local control mode only)	-	per.	
	3 / Input Enable: Enable (local control mode only)		-	
	4 / Input Halt: Halt			
	9 / Input Jog positive: Jog positive			
	10 / Input Jog negative: Jog negative			
	11 / Input Jog fast/slow: Jog fast/slow			
	20 / Input Reference switch (REF): Reference switch (REF)			
	22 / Input Negative limit switch (LIMN): Negative limit switch (LIMN)			
	101 / Output Free available: Available as required			
	102 / Output No fault: No fault			
103 / Output Active: Ready				
IOfunct_LIO3	Function Input/Output LIO3	-	UINT16	Modbus 1830
		-	UINT16	CIP 107.1.19
	1 / Input Free available: Available as required	0	R/W	
	2 / Input Fault reset: Reset fault (local control mode only)	-	per.	
	3 / Input Enable: Enable (local control mode only)		-	
	4 / Input Halt: Halt			
	9 / Input Jog positive: Jog positive			
	10 / Input Jog negative: Jog negative			
	11 / Input Jog fast/slow: Jog fast/slow			
	20 / Input Reference switch (REF): Reference switch (REF)			
	101 / Output Free available: Available as required			
	102 / Output No fault: No fault			
	103 / Output Active: Ready			
IOfunct_LIO4	Function Input/Output LIO4	-	UINT16	Modbus 1832
		-	UINT16	CIP 107.1.20
	1 / Input Free available: Available as required	0	R/W	
	2 / Input Fault reset: Reset fault (local control mode only)	-	per.	
	3 / Input Enable: Enable (local control mode only)		-	
	4 / Input Halt: Halt			
	9 / Input Jog positive: Jog positive			
	10 / Input Jog negative: Jog negative			
	11 / Input Jog fast/slow: Jog fast/slow			
	20 / Input Reference switch (REF): Reference switch (REF)			
	101 / Output Free available: Available as required			
	102 / Output No fault: No fault			
	103 / Output Active: Ready			

8.6.10 Reversal of direction of rotation

The parameter `POSdirOfRotat` can be used to reverse the direction of rotation of the motor. Note that changed settings do not become active until after the device is switched off and on again.

Connect the limit switch that limits the working range for clockwise rotation to $\overline{\text{LIMP}}$. Connect the limit switch that limits the working range for counterclockwise rotation to $\overline{\text{LIMN}}$.

Parameter Name	Description	Unit Minimum value Default value Maximum value	Data type R/W persistent Expert	Parameter address via fieldbus
POSdirOfRotat	Definition of direction of rotation 0 / clockwise: Clockwise 1 / counter clockwise: Counter-clockwise Meaning: At positive speeds, the drive rotates clockwise (looking at the motor shaft at the flange). NOTE: If you use limit switches, you must interchange the limit switch connections after changing the settings. The limit switch which is reached with a jog movement in positive direction must be connected to the LIMP input and vice versa. NOTE: Changed settings do not become active until the unit is switched on the next time.	- 0 0 1	UINT16 UINT16 R/W per. -	Modbus 1560 CIP 106.1.12

8.6.11 Restoring default values



All parameter values set by the user are lost in this process. It is possible at any time to save all parameter values set for a device as a configuration using the commissioning software.

8.6.11.1 Resetting user parameters

Parameter `PARuserReset` is used to reset all parameter values to the default values, except for the communication parameters.

Parameter Name	Description	Unit Minimum value Default value Maximum value	Data type R/W persistent Expert	Parameter address via fieldbus
PARuserReset	Reset user parameters Bit 0 = 1: Set persistent parameters to default values. All parameters are reset with the exception of: - Communication parameters - Definition of the direction of rotation - Signal selection position interface - I/O functions NOTE: The new settings are not saved to the EEPROM!	- 0 - 7	UINT16 UINT16 R/W - -	Modbus 1040 CIP 104.1.8

8.6.11.2 Restoring the factory settings

Factory settings via commissioning software

The factory settings are set via the menu items Configuration => Factory Settings. All parameter values are reset to the default values. The new settings only become active until after the device is switched off and on again.

- ▶ Disconnect the product from the the fieldbus in order to avoid conflicts by simultaneous access.

8.7 Drive profile Position Controller Profile

The drive supports the "Position Controller Profile" drive profile.

Device type: 10_h.

- Reference documents*
- [1] The CIP Networks Library
Volume 1
Common Industrial Protocol
Edition 3.1
 - [2] The CIP Networks Library
Volume 3
DeviceNet Adaption of CIP
Edition 1.3
 - [3] DeviceNet terms of Usage Agreement
ODVA: <http://www.odva.org>

For detailed information on the "Position Controller Profile" drive profile, see "The CIP Networks Library, Volume 1", chapter "Position Controller Profile".

Object model The following object classes from the CIP object model are available for the "Position Controller Profile" drive profile:

Object class	Class ID	Instance ID
Position Controller Supervisor Object	36	1
Position Controller Object	37	1
Vendor-specific objects	101...199	1

8.7.1 Communication via an "IO Message"

The "Position Controller Profile" supports the following formats:

Command Message

	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Byte 0	Enable	-	Hard Stop	Smooth Stop	Direction	Incremental	-	LoadData/StartProfile
Byte 1	Command Data 1							
Byte 2	Command Axis Number			Command Message Type				
Byte 3	Command Data 2							
Byte 4	Command Data 3							
Byte 5	Command Data 4							
Byte 6	Command Data 5							
Byte 7	Command Data 6							

Figure 8.32 Command Message

The following table shows the structure of byte 0:

Bit	Name	Function
0	LoadData / Start-Profile	Handshake for a "Command Message" To trigger a "Command Message", you require a rising edge at the "LoadData / StartProfile" bit. To obtain data via a "Response message", you do not require a rising edge at the "LoadData / StartProfile" bit.
1	Start Block	No function
2	Incremental	0: : Absolute positioning 1: Relative positioning
3	DIR	0: Counterclockwise rotation 1: Clockwise rotation
4	Smooth Stop	0: Clear "Halt" 1: Set "Halt"
5	Hard Stop	0->1: Set "Quick Stop" 1->0: Reset "Quick Stop" 1)
6	RegArm	No function
7	Enable	Enable and disable the power stage

1) Only possible when the drive is at a standstill and if the "Quick Stop was triggered by a 0->1 edge."

The following table shows the available types of "Command Messages":

Type	Command Message
01 _h	Target position
02 _h	Target velocity
03 _h	Acceleration
04 _h	Deceleration
1A _h	Position Controller Supervisor Attribute
1B _h	Position Controller Attribute

Response Message

	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Byte 0	Enable	-	-	Current Direction	General Fault	On Target Position	-	Profile in Progress
Byte 1	Response Data 1							
Byte 2	Load Complete	-	FE Fault	Negative Limit	Positive Limit	-	-	-
Byte 3	Response Axis Number			Response Message Type				
Byte 4	Response Data 2							
Byte 5	Response Data 3							
Byte 6	Response Data 4							
Byte 7	Response Data 5							

Figure 8.33 Response Message

The following table shows the structure of byte 0:

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Bit	Bit	Function
0	ProfileInProgress	1: Operating mode active (x_end=0)
1	BlockInExecution	No function
2	OnTargetPosition	1: Target position reached
3	General Fault	Is set in operating states 2, 3, 7 ¹⁾ , 8 and 9 ²⁾ .
4	Current Direction	0: Counterclockwise rotation 1: Clockwise rotation
5	HomeLevel	No function
6	RegLevel	No function
7	Enable	1: Power stage enabled

1) Not for "Quick Stop via the fieldbus."

2) The operating states are described in chapter 8.3 "Operating states".

The following table shows the structure of byte 1:

Bit	Name	Function
0	LoadData / Start-Profile	No function
1	FwdLimit	No function
2	RevLimit	No function
3	PositiveLimit	1: Error positive limit switch (LIMP)
4	NegativeLimit	1: Error negative limit switch (LIMN)
5	FE Fault	1: Tracking error
6	BlockFault	No function
7	LoadComplete	Handshake

The following table shows the available types of "Response Messages":

Type	Response Message
01 _h	Actual position
03 _h	Actual Velocity
14 _h	Command/Response Error
1A _h	Position Controller Supervisor Attribute
1B _h	Position Controller Attribute

8.7.2 Operating states

For an overview of the operating states, see chapter 8.3.1 "State diagram".

The following section describes how you can change and display the operating states in the "Position Controller Profile" drive profile.

Indicating the operating states

The operating states are indicated using the "Response Message" byte 0 bit 3 and bit 7.

Operating state	Bit 7 Enable	Bit 3 General Fault
2: Not ready to switch on	0	0
3: Switch on disabled	0	0
4: Ready to switch on	0	0
5: Switched on	0	0
6: Operation enable	1	0
7: Quick Stop activ	1	1
8: Fault Reaction active	0	1
9: Fault	0	1

Changing operating states

You can change the operating state with the "Command Message" byte 0 bit 5 and bit 7.

byte0	Operating states
Bit 7 Enable	0->1: Enable the power stage ¹⁾ Drive switches to operating state 6 Operation enable. 1 -> 0: Disable power stage and reset errors Drive switches to operating state 4 Ready to switch on.
Bit 5 Hard Stop	0->1: Trigger "Quick Stop" Drive switches to operating state 7 Quick Stop activ 1->0: Reset "Quick Stop" Drive switches to operating state 6 Operation enable

1) The drive must be in operating state 4 Ready to switch on.

An error is reset using the vendor-specific attribute 103 of the object "Position Controller 25_n" value =1.

Operating state during fault condition	Transition to operating state
7: Quick Stop active	6: Operation enable
9: Fault	4: Ready to switch on

8.7.3 Operating modes

The following operating modes are supported:

- Profile Position (CIP: Position mode)
- Profile Velocity (CIP: Velocity mode)
- Homing (vendor-specific)

Indicating operating modes

You can indicate the current operating mode using attribute 3 and attribute 100 of the object "Position Controller 25_h".

Changing the operating modes

The operating mode Profile Position (CIP: Position mode) or the operating mode Profile Velocity (CIP: Velocity mode) can be set via attribute 3 of the object "Position Controller 25_h".

In addition, you can use attribute 100 of the object "Position Controller 25_h" to set the vendor-specific operating mode Homing.

Two separate values are saved internally for the speed for the operating modes Profile Position and Profile Velocity. This way, the speed value is not lost when the operating mode is changed.

You can switch between operating modes as soon as one operating mode has been terminated.

Profile position

A movement is triggered when you set a target position.

New values entered for speed, acceleration and deceleration do not take effect while a movement is in process. These values only apply when a target position is set again.

Profile Velocity

The operating mode is started when you set the target speed.

Homing

The vendor-specific operating mode is described in chapter 8.5.6 "Operating mode Homing".

Use the vendor-specific attribute 100 to set the operating mode.

Use the vendor-specific attribute 101 to select the type of reference movement and start the operating mode.

Homing by position setting

Use attribute 13 of the object "Position Controller 25_h" for homing by means of position setting, see chapter 8.5.6.4 "Homing by position setting". The Homing operating mode does not have to be set when you do this.

8.7.4 Object "Position Controller Supervisor 24_h"

Attribute	ro/rw	CIP name	Data type	Description	Remarks
1	ro	Number of Attributes	USINT	Number of supported attributes	
3	ro	Axis Number	USINT	Axis Number	Value is 1
5	ro	General Fault	BOOL	General fault that can be reset with a "Fault Reset".	Is set in operating states 2, 3, 7 ¹⁾ , 8 and 9 ²⁾ .
6	rw	Command Message Type	USINT	Configuration "Command Message Type".	
7	rw	Response Message Type	USINT	Configuration "Response Message Type".	
100	rw	Vendor-specific error information	UINT	Vendor-specific error number of last incorrect "I/O Message"	High Word: Incorrect Message Type ³⁾ Low Word: Vendor-specific error number.

1) Not for "Quick Stop via the fieldbus."

2) The operating states are described in chapter 8.3 "Operating states".

3) Value 0 if byte 0 contains an error

8.7.5 Object "Position Controller 25_h"

Attribute	ro/rw	CIP name	Data type	Description	Remarks
1	ro	Number of Attributes	USINT	Number of supported attributes	
2	ro	Attribute List	Array of USINT	List of supported attributes	
3	rw	Mode	USINT	Operating mode 0: Profile position 1: Profile velocity	You can set other operating modes using attribute 100.
6	rw	Target position	DINT	Target position in operating mode Profile Position Unit: [usr]	
7	rw	Target velocity	DINT	Reference speed Unit: [min ⁻¹]	Negative figures not permitted. See also attribute 23.
8	rw	Acceleration	DINT	Acceleration Unit: [min ⁻¹ /s]	A new value only becomes effective with the next movement.
9	rw	Deceleration	DINT	Deceleration Unit: [min ⁻¹ /s]	A new value only becomes effective with the next movement.
10	rw	Incremental Position Flag	BOOL	Positioning 0: Absolute positioning 1: Relative positioning	Relative positioning with reference to the last end position.
11	rw	Load Data/Profile Handshake	BOOL	Used to accept data of an "IO Message" in the drive and to start a movement.	The bits "Load Data/Profile Handshake" and "Load Data Complete" are used as a handshake for the "IO Message".
12	ro	On Target Position	BOOL	Target position reached	In Profile Position operating mode

Attribute	ro/rw	CIP name	Data type	Description	Remarks
13	rw	Actual position	DINT	Current position Unit: [usr]	Reading the value gets the current position of the motor. Writing executes the function Position Setting of the Homing operating mode.
14	ro	Actual Velocity	DINT	Current speed Unit: [min ⁻¹]	Value is positive. See also attribute 23.
17	rw	Enable	BOOL	0: Disable power stage 1: Enable power stage	0 -> 1: Fault reset
20	rw	Smooth Stop	BOOL	Function "Halt"	
21	rw	Hard Stop	BOOL	Function "Quick Stop"	
23	rw	Direction	BOOL	Direction of rotation 0: Counterclockwise rotation 1: Clockwise rotation	Reading the value gets the current direction of rotation of the motor. Writing sets the direction of rotation for the "Profile Velocity" operating mode.
29	ro	Wrap Around	BOOL	Position overrun 1: Position overrun exists	
45	rw	Max Dynamic Following Error	DINT	Maximum permissible position deviation	Corresponds to parameter SPV_p_maxDiff
47	rw	Following Error	BOOL	Tracking error 1: Maximum permissible position deviation exceeded	
48	ro	Actual Following Error	DINT	Current position deviation	Corresponds to parameter _p_dif
56	ro	Positive Limit Triggered	BOOL	Positive limit switch triggered	
57	ro	Negative Limit Triggered	BOOL	Negative limit switch triggered	
58	ro	Load Data Complete	BOOL	Indicates that the data of the "IO Message" have been loaded by the drive	The bits "Load Data/Profile Handshake" and "Load Data Complete" are used as a handshake for the "IO Message".
100	rw	ModeExt	USINT	Enhanced operating mode 0: Profile position 1: Profile velocity 100: Homing	
101	rw	Homing method	USINT	Type of reference movement	Corresponds to parameter HMmethod
102	ro	Drive State	UDINT	Vendor-specific status word	Corresponds to parameter _xStatus
103	rw	Fault Reset	BOOL	1: Reset fault	

9 Examples

9.1 Wiring examples

The following figure shows a typical wiring example. The limit switches and the reference switch are supplied via the internal 24V signal power supply.

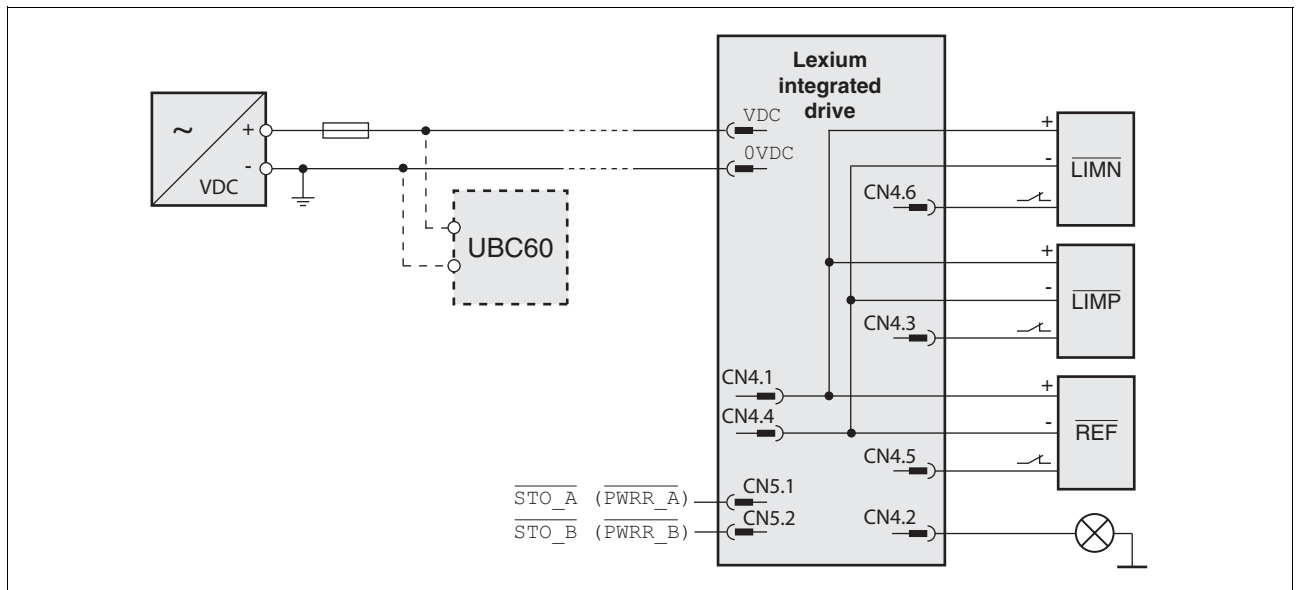


Figure 9.1 Wiring example

The UBC60 braking resistor controller is available as an accessory, see chapter 12 "Accessories and spare parts".

9.2 Wiring of the STO safety function

Using the safety functions integrated in this product requires careful planning. For more information see chapter 5.4 "Safety function STO ("Safe Torque Off")" on page 60.

9.3 Settings as examples



The byte sequence is entered in "Big Endian" format (Motorola format) in the DeviceNet scanner, but is transmitted via the bus in "Little Endian" format (Intel format). The representation is therefore different on the DeviceNet scanner and on the fieldbus monitor!

The examples are shown in Big Endian format. They can be entered directly in the DeviceNet scanner. The bus monitor displays the data in Little Endian format.

9.3.1 Overview of examples

The programming examples show hands-on applications for network operation. All examples are shown based on an I/O message with output assembly 101 and input assembly 111.

All examples show only the data field of the message without the CAN identifier field.

Structure of the examples

The examples cover the following topics:

- Task
- Initial conditions
- Required entries in the Output Assembly 101
- Response in Input Assembly 111
- Possible restrictions for command execution
- Representation in Big Endian format (DeviceNet scanner view)

Output Assembly 101 Operating modes can be set and movements started with Output Assembly 101. Target values can be changed during processing.

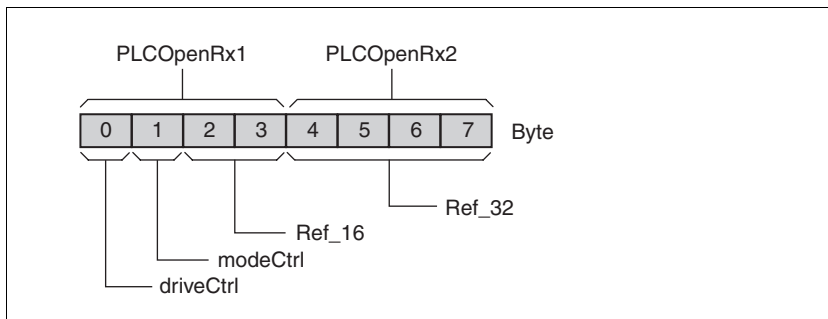


Figure 9.2 Output Assembly 101

The following fields are available in the Assembly:

- Byte "driveCtrl": Managing the operating state
- Byte "modeCtrl": Starting and changing the operating modes
- Word "Ref_16": Depends on operating mode, e.g. reference speed
- Double word "Ref_32": Depends on operating mode, e.g. reference position

The values for these fields are not used by the drive until the state in byte "modeCtrl" bit "ModeToggle" changed.

Input Assembly 111 You can use Input Assembly 111 to monitor the operating state and motion commands.

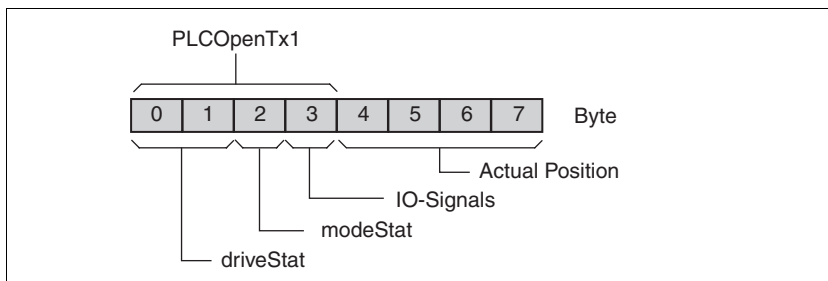


Figure 9.3 Input Assembly 111

The following fields are available:

- Word "driveStat": Indicates the current operating state, warning and error bits and the status of the current operating mode.
- Byte "modeStat": Indicates the currently selected operating mode
- Byte "IO Signals": Status of the input signals
- Double word "Actual Position": Actual motor position

9.3.2 Operating states via an I/O message

⚠ WARNING
<p>UNINTENDED OPERATION</p> <ul style="list-style-type: none"> • Note that any changes to the values of these parameters are executed by the drive controller immediately on receipt of the data set. • Verify that the system is free and ready for movement before changing these parameters. <p>Failure to follow these instructions can result in death, serious injury or equipment damage.</p>

9.3.2.1 Enabling and disabling the power stage

- Enable power stage*
- Operating state "Ready to Switch On"
 - ▶ "driveCtrl" bit "Disable": 0
 - ▶ "driveCtrl" bit "Enable": 0 -> 1

	Master <---> Slave	
Disable is requested	---> Output	driveCtrl 01 _h
Product signals operating state 4	<--- Input	driveStat xxx4 _h
Request Enable	---> Output	driveCtrl 02 _h
Product signals operating state 5	<--- Input	driveStat xxx5 _h
Product signals operating state 6	<--- Input	driveStat xxx6 _h

- Disable power stage*
- Operating state "Operation enable" or "Quick Stop active"
 - ▶ "driveCtrl" bit "Enable": 0
 - ▶ "driveCtrl" bit "Disable": 0 -> 1

	Master <---> Slave	
Enable is requested	---> Output	driveCtrl 02 _h
Product signals operating state 6	<--- Input	driveStat xxx6 _h
Request disable	---> Output	driveCtrl 01 _h
Product signals operating state 4	<--- Input	driveStat xxx4 _h

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9.3.2.2 Execute "Quick Stop" function

A running motion command can be interrupted at any time using the function "Quick Stop".

Executing a "Quick Stop"

- Operating state "Operation Enable"
 - ▶ "driveCtrl" bit "Enable": 0 -> 1
 - ▶ "driveCtrl" bit "Quick Stop": 0 -> 1

Master <---> Slave		
Request Enable	---> Output	driveCtrl 02 _h
Drive system signals operating state 6	<--- Input	driveStat xxx6 _h
Request Quick Stop (+ Enable)	---> Output	driveCtrl 06 _h
Drive system signals operating state 7	<--- Input	driveStat xxx7 _h
Waiting until drive system comes to a standstill		
Drive system remains in operating state 7	<--- Input	driveStat xxx7 _h

Resetting a "Quick Stop"

- Operating state "Quick Stop active"
 - ▶ "driveCtrl" bit "Quick Stop": 0
 - "driveCtrl" bit "Fault Reset": 1
 - ▶ "driveCtrl" bit "Fault Reset": 0

Master <---> Slave		
Drive system is to restart: Clearing a Quick Stop request, performing a Fault Reset	---> Output	driveCtrl 0A _h
Drive system signals operating state 6	<--- Input	driveStat xxx6 _h
Clearing Fault Reset	---> Output	driveCtrl 02 _h
Drive system signals operating state 6	<--- Input	driveStat xxx6 _h

10 Diagnostics and troubleshooting

10.1 Service

If you cannot resolve an error yourself please contact your sales office. Have the following details available:

- Nameplate (type, identification number, serial number, DOM, ...)
- Type of error (such as LED flash code or error number)
- Previous and concomitant circumstances
- Your own assumptions concerning the cause of the error

Also include this information if you return the product for inspection or repair.

10.2 Error indication

The last cause of interruption and the last 10 error messages are stored. You can display the last 10 error messages using the commissioning software and the fieldbus.

For a description of all error numbers, see chapter 10.4 "Table of error numbers".

Asynchronous errors Asynchronous errors are triggered by internal monitoring (e.g. temperature) or by external monitoring (e.g. limit switch). An error response is initiated if an asynchronous error occurs.

Asynchronous errors are indicated in the following way:

- Transition to operating state "Quick Stop" or to operating state "Fault".
- Information in the "driveStat" byte
- Error number is written to parameter `StopFault`

Synchronous errors Synchronous errors occur as direct errors in response to a fieldbus command. These include, for example:

- Error during execution of an action command or control command
- Parameter value outside the permissible value range
- Invalid action command or control command during processing
- Access to unknown parameter

For a detailed description of the synchronous errors, see chapter 10.2.5 "Synchronous errors".

10.2.1 State diagram

After switching on and when an operating mode is started, the product goes through a number of operating states.

The state diagram (state machine) shows the relationships between the operating states and the state transitions.

The operating states are monitored and influenced by internal monitoring functions and system functions such as temperature monitoring or current monitoring.

Graphic representation The state diagram is shown graphically as a flow chart.

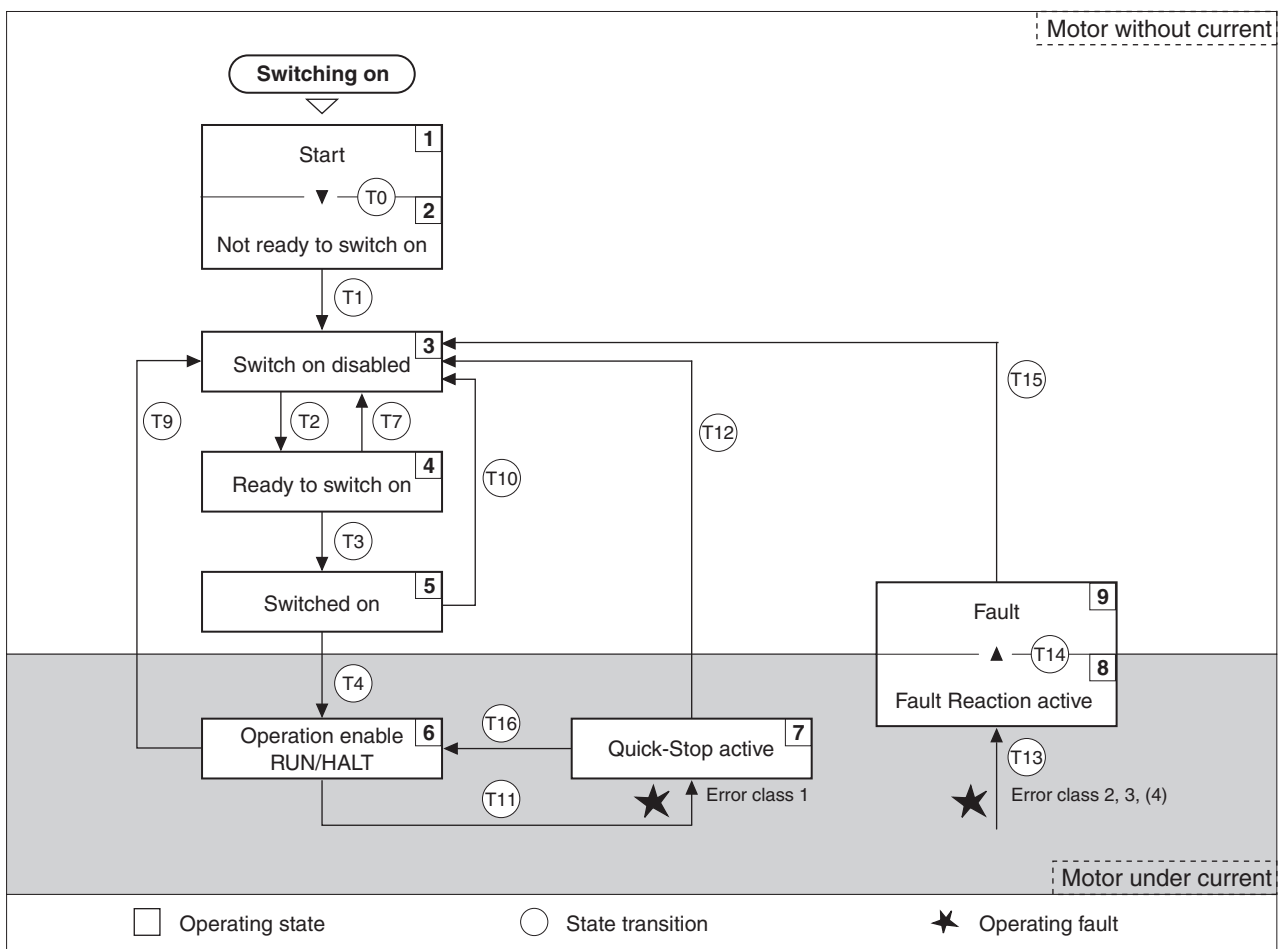


Figure 10.1 State diagram

Operating states You can display the operating states with the commissioning software.

Operating states	Description of operating states
1 Start	Controller supply voltage is switched on, initialization of electronics
2 Not ready to switch on	Power stage is not ready to switch on ¹⁾
3 Switch on disabled	Switching on the power stage is disabled
4 Ready to switch on	The power stage is ready to be switched on
5 Switched on	Motor without current Power stage ready No operating mode active
6 Operation enable	RUN: Device is running in the selected operating mode HALT: The motor is stopped with power stage enabled
7 Quick Stop active	"Quick Stop" function executed
8 Fault response active	Error detected, response is active
9 Fault	Device is in fault state

1) The device must be switched off and then switched on again

State transitions State transitions are triggered by an input signal, a fieldbus command or as a response to a monitoring signal.

Transition	Operating state	Condition / event ^{1) 2)}	Response
T0	1-> 2	• Device electronics successfully initialized	
T1	2-> 3	• Parameter successfully initialized	
T2	3 -> 4	• No undervoltage Encoder successfully checked Actual speed: <1000 min ⁻¹ $\overline{STO_A} (\overline{PWRR_A})$ and $\overline{STO_B} (\overline{PWRR_B}) = +24V$ (or jumper CN6 plugged in)	
T3	4 -> 5	• Request for enabling the power stage	
T4	5 -> 6	• Automatic transition	Power stage is enabled User-defined parameters are checked Holding brake is released (if available)
T7	4 -> 3	• Undervoltage • $\overline{STO_A} (\overline{PWRR_A})$ and $\overline{STO_B} (\overline{PWRR_B}) = 0V$ • Actual speed: >1000 min ⁻¹ (for example by external driving force)	-
T9	6 -> 3	• Request for disabling the power stage	Power stage is immediately disabled.
T10	5 -> 3	• Request for disabling the power stage	
T11	6 -> 7	• Class 1 error	Motion command is canceled with "Quick Stop".
T12	7 -> 3	• Request for disabling the power stage	Power stage is disabled immediately, even if "Quick Stop" is still active.
T13	x -> 8	• Errors Class 2, 3 or 4	Error response is carried out, see "Error response"
T14	8 -> 9	• Error response terminated (error from class 2) • Errors Class , 3 or 4	
T15	9-> 3	• Function: "Fault Reset"	Error is reset (cause of error must be corrected).
T16	7 -> 6	• Function: "Fault reset"	

1) In order to initiate a state transition it is sufficient if one condition is met

2) Fieldbus commands only with fieldbus control mode

10.2.2 Error indication with LEDs

State indication The LEDs indicate error messages and warnings. They show the operating states in coded form.

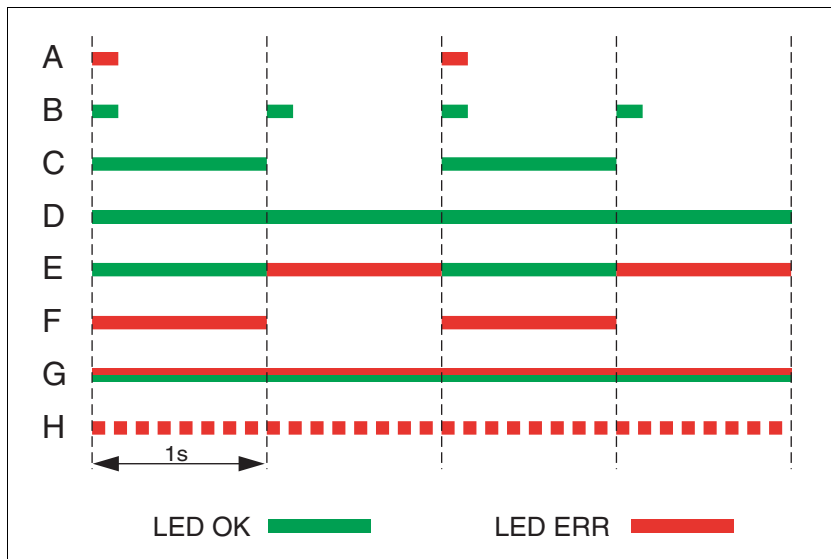


Figure 10.2 Error indication with LEDs

Operating states

- (A) 1 Start
- 2 Not ready to switch on
- (B) 3 Switch on disabled
- (C) 4 Ready to switch on
- 5 Switched on
- (D) 6 Operation enable
- (E) 7 Quick Stop active
- 8 Fault Reaction active
- (F) 9 Fault
- (G) Firmware not available
- (H) Internal error

10.2.3 Error indication using the commissioning software

- You need a PC with the commissioning software and a working connection to the product.
- ▶ Select "Diagnostics - Error memory". A dialog box which shows the error messages is displayed.

The commissioning software shows a 4 digit error number in the list of the error memory with a prefixed "E" in front.

Error messages are displayed showing status, error class, time when an error occurred and a short description. Under "Additional information " you can verify the exact conditions when the error occurred.

- ▶ Correct the error and reset the error message.
In the case of class 4 errors, you must switch off the controller supply voltage and switch it on again.

10.2.4 Error indication via the fieldbus

Cause of last stop The parameter `_StopFault` allows you to read out of the error number and the last cause of interruption. If there is no error, the value of the parameter is 0. If an error occurs, the error is written to the error memory along with other status information. In the case of subsequent errors, only the triggering cause of error is stored.

Error memory The error memory is an error history of the last 10 errors; it is not cleared even if the device is switched off. The following parameters allow you to manage the error memory:

Parameter Name	Description	Unit Minimum value Default value Maximum value	Data type R/W persistent Expert	Parameter address via fieldbus
FLT_del_err	Clear error memory	-	UINT16	Modbus 15112
	1: Delete all entries in the error memory	0	UINT16	CIP 159.1.4
	The clearing process is completed if a 0 is returned after a read access.	- 1	R/W -	-
FLT_MemReset	Reset error memory read pointer	-	UINT16	Modbus 15114
	1: Set error memory read pointer to oldest error entry.	0	UINT16	CIP 159.1.5
		- 1	R/W -	-

The error memory can only be read sequentially. The parameter `FLT_MemReset` must be used to reset the read pointer. Then the first error entry can be read. The read pointer is automatically set to the next entry; a read access delivers the next error entry. If the error number 0 is returned there is no error entry.

Position of the entry	Meaning
1	1. Error entry, oldest message
2	2. Error entry, later message, if present
...	...
10	10. error entry. In the case of 10 error entries the most current error value is contained here

An individual error entry consists of several pieces of information which are read out using various parameters. When you read out an error entry, the error number must be read out first with the parameter `FLT_err_num`.

Parameter Name	Description	Unit Minimum value Default value Maximum value	Data type R/W persistent Expert	Parameter address via fieldbus
FLT_err_num	<p>Error number</p> <p>Reading this parameter copies the entire error entry (error class, time of occurrence of error, ...) to an intermediate memory from which all elements of the error can then be read.</p> <p>In addition, the read pointer of the error memory is automatically set to the next error entry.</p>	- 0 - 65535	UINT16 UINT16 R/- -	Modbus 15362 CIP 160.1.1
FLT_class	<p>Error class</p> <p>0: Warning (no response) 1: Error (Quick Stop -> state 7) 2: Error (Quick Stop -> state 8, 9) 3: Fatal error (state 9, can be acknowledged) 4: Fatal error (state 9, cannot be acknowledged)</p>	- 0 - 4	UINT16 UINT16 R/- -	Modbus 15364 CIP 160.1.2
FLT_Time	<p>Error time</p> <p>With reference to operating hours counter</p>	s 0 - 536870911	UINT32 UINT32 R/- -	Modbus 15366 CIP 160.1.3
FLT_Qual	<p>Error additional information</p> <p>This entry contains additional information on the error, depending on the error number. Example: a parameter address</p>	- 0 - 65535	UINT16 UINT16 R/- -	Modbus 15368 CIP 160.1.4

10.2.5 Synchronous errors

Explicit Error Response If an Explicit Request message cannot be processed by the slave, the master receives an error message in the associated Explicit Response. This response message contains 2 bytes:

- General Error Code
- Additional Error Code

All errors can be read out with object 100.1.1. If the general error code has the value =1F_h, the field "additional error code" contains vendor-specific error numbers in coded form.

Response during I/O connection The slave responds to an incorrect I/O command in the next I/O response by setting bit 6 (ME, ModeError) in byte modeStat. This does not interrupt the current process. To determine the cause of the error, the master can read the error number with the object 100.1.1 by means of an explicit access.

The error indication is reset when the next valid data telegram is transmitted.

Table of general error codes The error codes that can be contained in the "General Error Code" field are listed in the following table:

Error code	Name	Meaning
00 _h	Success	The service was successfully executed by the specified object.
01 _h	Connection failure	A connection-specific service has failed along the connection path.
02 _h	Resource unavailable	Resources that the object required to execute the requested service were not available.
03 _h	Invalid parameter value	See status code 0x20, which is the preferred value for this condition.
04 _h	Path segment error	The path segment identifier or segment syntax could not be interpreted by the processing node. Path processing is terminated when a path segment error is detected.
05 _h	Path destination unknown	The path refers to an object class, an instance or a structure element that is unknown or not contained in the processing node. Path processing is terminated if an error is detected that is due to an unknown path destination.
06 _h	Partial transfer	Only part of the expected data was transmitted.
07 _h	Connection lost	The connection for message transmission was interrupted.
08 _h	Service not supported	The requested service was not implemented or was not defined for this object class or this instance.
09 _h	Invalid attribute value	Invalid attribute data was detected
0A _h	Attribute list error	An attribute in the response "Get_Attribute_List" or "Set_Attribute_List" has a status that is not zero.
0B _h	Already in requested mode/state	The object is already in the mode/state that was requested by the service
0C _h	Object state conflict	The object cannot execute the requested service in its current mode/state
0D _h	Object already exists	The requested instance of the object to be created already exists.
0E _h	Attribute not settable	A request to change an attribute that cannot be set was received.
0F _h	Privilege violation	Checking of an authorization/privilege has failed
10 _h	Device state conflict	The requested service cannot be executed in the current mode/state of the device.

Error code	Name	Meaning
11 _h	Reply data too large	The data volume for transmission in the response buffer is larger than the allocated response buffer
12 _h	Fragmentation of a primitive value	The service has specified an operation that results in fragmentation of the original data value, i.e. half a REAL data type.
13 _h	Not enough data	The service does not return enough data to execute the specified operation.
14 _h	Attribute not supported	The attribute specified in the request is not supported
15 _h	Too much data	The service returned more data than expected
16 _h	Object does not exist	The specified object does not exist in the device.
17 _h	Service fragmentation sequence not in progress	The fragmentation sequence for this service is not currently activated for this data.
18 _h	No stored attribute data	The attribute data of this object were not saved before the requested service.
19 _h	Store operation failure	The attribute data of this object was not saved, because an error occurred during the attempt.
1A _h	Routing failure, request packet too large	The request packet of the service was too large to be transmitted to the destination on a network along the path. The routing device had to cancel the service.
1B _h	Routing failure, response packet too large	The response packet of the service was too large to be transmitted from the destination on a network along the path. The routing device had to cancel the service.
1C _h	Missing attribute list entry data	The service did not provide an attribute in an attribute list that was required to allow the service to carry out the requested behavior.
1D _h	Invalid attribute value list	The service returns the list of the attributes provided with the status information for the invalid attributes.
1E _h	Embedded service error	An embedded service resulted in an error.
1F _h	Vendor specific error	A vendor-specific error was detected. The "Additional Code" field (additional error code) of the response message defines the detected error. If "Additional Code" contains the value "FE", the synchronous error code must be read with the object 100.1.1. If "Additional Code" contains a value not equal to "FE", the error number can also be directly determined (instead of being read with object 100.1.1) by adding the prefix "A3", for example: error code = 1Fh, additional code = 08h -> error code = A308h: drive in Fault state.
20 _h	Invalid parameter	A parameter assigned to the request was invalid. This code is used if a parameter does not meet the requirements of this specification and/or the requirements defined in an application object specification.
21 _h	Write-once value or medium already written	An attempt was made either to write data again to a write-once medium (e. g. WORM drive, PROM) that already contained data, or to change a specified value that cannot be changed.
22 _h	Invalid Reply Received	An invalid reply was received (e. g. the service reply code is not the same as the request code or the reply is shorter than the expected minimum length of the reply). This status code may also be used for other causes of invalid responses.
23 _h - 24 _h		Reserved by CIP for future extensions
25 _h	Key Failure in path	The key segment that was inserted in the path as the first segment does not match the destination module. The object-specific status indicates the part of the key test that has failed.
26 _h	Path Size Invalid	The size of the path that was sent with the service request is either not large enough to allow routing of the request, or it contained too much routing data.
27 _h	Unexpected attribute in list	An attempt was made to set an attribute that cannot be set at this time.
28 _h	Invalid Member ID	The member ID specified in the request does not exist in the specified class/instance/attribute
29 _h	Member not settable	A request to change a member that cannot be changed was received.

Error code	Name	Meaning
2A _h	Group 2 only server general failure	Service or attribute is not supported (attribute cannot be set)
2B _h - CF _h	-	Reserved by CIP for future extensions
D0 _h -FF _h	Reserved for Object Class and service errors	This error code range is used to indicate errors related to object classes. Use this range only if none of the error codes listed in this table exactly represents the detected error.

10.3 Troubleshooting

10.3.1 Fieldbus communication

A properly functioning fieldbus operation is essential for evaluating operational and error messages.

Checking connections

If the product cannot be addressed via the fieldbus, first check the connections.

Check the following connections:

- ▶ System power supply
- ▶ Supply connections
- ▶ Fieldbus cables and wiring
- ▶ Fieldbus connection

Also verify correct wiring of the limit switches and terminating resistors.

In the case of DeviceNet, the two ends of the network (at the devices farthest away from each other) must be terminated with a 120 Ohm resistor each.

Fieldbus function test

If the connections are correct, check the settings for the fieldbus addresses. After correct configuration of the transmission data, test fieldbus mode.

- ▶ In addition to the master that knows the product via the EDS file and addressing, activate a bus monitor that, as a passive device, displays messages.
- ▶ Switch the supply voltage off and on.
- ▶ Observe the network messages that are generated briefly after the supply voltage is switched on. A bus monitor can be used to record the elapsed time between telegrams and the relevant information in the telegram.

Possible errors: Polling, parameter setting, configuration

If the connection to a device cannot be established, check the following:

- Address: Every network device must have a unique address.
- Parameterization: The vendor ID and the product code of the device must conform to the values stored in the EDS file.

10.3.2 Troubleshooting of error sorted by error bit

To facilitate troubleshooting, all error numbers are categorized by so-called error bits. The error bits can be read using the parameter `_SigLatched`. Signal status "1" indicates an error or warning message.

Error bit	Meaning	Error class	Cause	Troubleshooting
0	General error	0		
1	Limit switch (LIMP/LIMN/REF)	1	Limit switch is or was activated, line interrupted	Move drive into movement range, match positioning data to axis range, special message in error memory
2	Range of travel exceeded (software limit switch, tuning range)	1	Motor not in area of travel	Check range of travel, home the drive again
3	"Quick Stop" via fieldbus	1	Fieldbus command	
4	Inputs $\overline{STO_A}$ ($\overline{PWRR_A}$) and $\overline{STO_B}$ ($\overline{PWRR_B}$) are "0"	3	STO safety function was triggered	Check guard door, cabling
6	Error in fieldbus RS485, Modbus		Interruption of the fieldbus communication, only with RS485, e.g. Modbus	Check the communication cables, check the fieldbus, check the communication parameters.
9	Reference signal error (frequency too high)		Frequency too high, interference	EMC measures, do not exceed maximum frequency (technical data)
10	Error in processing of the current operating mode	2	Processing error	For detailed information see additional information in the error memory
14	DC bus undervoltage	2	DC bus voltage below threshold value for "Quick Stop"	Check DC bus voltage
		3	DC bus voltage below threshold value for switch-off of the drive	
15	DC bus overvoltage	3	DC bus overvoltage, deceleration too fast	Extend braking process, use external braking resistor
18	Motor overload	3	Phase current too high	Reduce load
20	Undervoltage controller supply voltage		Controller supply voltage has fallen below the minimum value	Check controller supply voltage. Check for short-term voltage dips during load changes
21	Temperature of power stage too high	3	The power stage overheated	Reduce load
22	Tracking error	par.	Tracking error	Reduce external load or acceleration, error response is adjustable via "Fit_pDiff"
24	Inputs $\overline{STO_A}$ ($\overline{PWRR_A}$) and $\overline{STO_B}$ ($\overline{PWRR_B}$) are different	4	Interruption of the signal wires	Check signal cable, check signal connection, replace
29	EEPROM error	3-4	Checksum in EEPROM incorrect	Run a "First Setup", save the user-defined parameters to the EEPROM, contact your local sales office
30	System start-up error (hardware or parameter error)	3-4	Cause of error as indicated	Resolution depends on indicated cause of error

Error bit	Meaning	Error class	Cause	Troubleshooting
31	Internal system error (e. g. Watchdog)	4	Internal system error System error, e.g. division by 0 or timeout checks	Switch device off and on, replace device Comply with EMC measures, switch device off and on, contact your local sales office

10.4 Table of error numbers

The cause of error for each error message is coded as an error number and stored in the parameter `FLT_err_num`. The following table shows all the error numbers and their meaning. If "par." is shown with the error class, the error class is parameterizable.

Error number categories:

Error number	range
E 1xxx	General
E 2xxx	Overcurrent
E 3xxx	Voltage
E 4xxx	Temperature
E 5xxx	Hardware
E 6xxx	Software
E 7xxx	Interface, wiring
E Axxx	Motor movement
E Bxxx	Communication

Information on error bits and troubleshooting can be found on page 214.

Error class

The product triggers an error response in the event of a fault. Depending upon the severity of the fault, the device responds in accordance with one of the following error classes:

Error class	Reaction	Meaning
0	Warning	Message only, no interruption.
1	"Quick Stop"	Motor stops with "Quick Stop", power stage and controller remain switched on and enabled.
2	"Quick Stop" with switch-off	Motor stops with "Quick Stop", power stage and controller are disabled after standstill has been achieved.
3	Fatal error	Power stage and controller switch off immediately without stopping the motor first.
4	Uncontrolled operation	Power stage and controller switch off immediately without stopping the motor first. Error response can only be reset by switching off the device.

Error number	Class	Bit	Description, cause and correctives
E 1100	-	-	Parameter out of permissible range
E 1101	-	-	Parameter does not exist Fault signaled by parameter management: parameter (index) does not exist.
E 1102	-	-	Parameter does not exist Fault signaled by parameter management: parameter (subindex) does not exist.
E 1103	-	-	Parameter write not permissible (READ only) Write access to read only parameter.

Error number	Class	Bit	Description, cause and correctives
E 1104	-	-	Write access denied (no access authorization) Parameter only accessible at expert level. The write access level expert is required.
E 1106	-	-	Command not allowed while power stage is active Command not allowed while the power stage is enabled (state "OperationEnable" or "QuickStopActive"). Disable the power stage and repeat the command.
E 1107	-	-	Access via other interface blocked Access occupied by another channel (e.g.: commissioning software is active and fieldbus access was tried at the same time). Check the channel that blocks the access.
E 110B	3	30	Initialization error (additional info=Modbus register address) Error detected at power enable parameter check e.g. reference speed value for profile position is greater than max. allowed speed of drive. Value in additional error info shows the Modbus register address of the parameter where the initialization error was detected.
E 110E	-	-	Parameter changed that requires a restart of the drive Only displayed by the commissioning software. A parameter modification requires the drive to be switched off and on. Restart the drive to activate the parameter functionality. Check the parameter chapter for the parameter that required a restart of the drive.
E 110F	-	-	Function not available in this type of device The specific type of device does not support this function or this parameter value. Check if you have the correct device type, in particular type of motor, type of encoder, holding brake.
E 1300	3	4	Safety function STO activated The safety function STO was activated in "Operation enable" state. Reset the fault; check the wiring of the STO inputs.
E 1301	4	24	STO_A (PWRR_A) and STO_B (PWRR_B) different level The levels of the inputs STO_A (PWRR_A) and STO_B (PWRR_B) were different for more than 1 second. The drive has to be switched off and the reason fixed (e.g.: check emergency stop active) before it is switched on.
E 1310	3	9	Reference signal frequency too high The frequency of the pulse signal (A/B, Pulse/Direction, CW/CCW) is higher than the allowed value. Adapt the output pulse frequency of the controller to fit the input specification of the drive. Take care to also adapt the electronic gear ratio for the application requirements (position accuracy and speed).
E 1312	-	-	Limit or reference switch signal in I/O functions not defined Reference movements require limit switches. These limit switches are not assigned to inputs. Assign the LIMP, LIMN and REF functions to the inputs.

Error number	Class	Bit	Description, cause and correctives
E 2300	3	18	Power stage overcurrent Motor short circuit and deactivation of the power stage. Check the motor power connection.
E 3200	3	15	DC bus overvoltage Excessive regeneration during braking. Check deceleration ramp, check dimensioning of drive and braking resistor.
E 3201	3	14	DC bus undervoltage (switch-off threshold) Power supply loss, poor power supply.
E 3202	2	14	DC bus undervoltage (Quick Stop threshold) Power supply loss, poor power supply.
E 4100	3	21	Power stage overtemperature Transistors overtemperature: ambient temperature is too high, fan is inoperative, dust. Remove the protective foil, improve the heat dissipation in the cabinet.
E 4101	0	1	Warning power stage overtemperature Transistors overtemperature: ambient temperature is too high, fan is inoperative, dust. Remove the protective foil, improve the heat dissipation in the cabinet.
E 4302	0	5	Motor overload (I2t) warning The current has exceeded the nominal value for an extended period of time.
E 610D	-	-	Error in selection parameter Wrong parameter value selected. Check the value to be written.
E 7328	4	19	Motor encoder sends: position capture errors Encoder signals internal position capturing fault. Contact technical support or replace the motor.
E 7329	0	8	Motor encoder sends: Warning EMC, encoder signals internal warning. Contact technical support or replace the motor.
E 7338	0	13	No valid motor absolute position Warning to inform you that absolute position has not yet been determined. Depending on application, fix the absolute position. Device still usable and all functions are OKAY.
E 7500	0	9	RS485/Modbus: overrun error EMC; cabling problem. Check cables.
E 7501	0	9	RS485/Modbus: framing error EMC; cabling problem. Check cables.
E 7502	0	9	RS485/Modbus: parity error EMC; cabling problem. Check cables.

Error number	Class	Bit	Description, cause and correctives
E 7503	0	9	RS485/Modbus: receive error EMC; cabling problem. Check cables.
E A060	2	10	Calculated speed in electronic gear/pulse control too high Gear ratio or speed reference value too high Reduce the gear ratio or speed reference value.
E A061	2	10	Position change in reference value with electronic gear/pulse control too high Position reference change is too high. Reference value input signal disturbance. Reduce the resolution of the master. Check reference value input signal.
E A300	-	-	Braking procedure after HALT request still active HALT was removed too soon. New command was sent before motor standstill was reached after a HALT request. Wait for complete stop before removing HALT signal. Wait until motor has come to a complete standstill.
E A301	-	-	Drive in state 'Quick Stop active' Error with error class 1 occurred. Drive stopped with Quick Stop command.
E A302	1	1	Interruption by LIMP LIMP was activated because working range was exceeded, misoperation of limit switch or signal disturbance. Check application. Check limit switch function and connection.
E A303	1	1	Interruption by LIMN LIMN was activated because working range was exceeded, misoperation of limit switch or signal disturbance. Check application. Check limit switch function and connection.
E A305	-	-	Power stage cannot be activated in the current operating state (state diagram) Fieldbus: trying to enable the power stage in operating state "Not ready to switch on". Refer to the state diagram in the operation chapter of the manual.
E A306	1	3	Interruption by user-initiated software stop Drive is in state "Quick Stop active" due to a software stop request. The activation of a new operating mode is not possible, the error code is sent as the response to the activation command. Clear break condition with command Fault Reset.
E A307	-	-	Interruption by internal software stop In homing and jog modes, the movement is internally interrupted using an internal software stop. The activation of a new operating mode is not possible, the error code is sent as the response to the activation command. Clear break condition with command Fault Reset.
E A308	-	-	Drive in state 'Fault' Error with error class 2 or higher occurred. Check error code (HMI or commissioning tool), remove error condition and clear error state with command Fault Reset.

Error number	Class	Bit	Description, cause and correctives
E A309	-	-	Drive not in state 'Operation Enable' A command which requires the state "Operation enable" was sent (e.g.: omode change). Set drive to state "OperationEnable" and repeat the command.
E A310	-	-	Power stage not active Command is not possible because the power stage is not enabled (state "Operation Enabled" or "Quick Stop"). Set drive to a state with the power stage enabled, refer to the state diagram in the operation chapter of the manual.
E A313	-	-	Position overrun, reference point is therefore no longer defined (ref_ok=0) The position range limits were exceeded which resulted in a loss of the reference point. An absolute movement cannot be made until the definition of a new reference point. Define a new reference point by means of homing mode.
E A314	-	-	No reference position Command needs a defined reference point (ref_ok=1). Define a new reference point by means of homing mode.
E A315	-	-	Homing active Command not possible if homing is active. Wait until homing movement is finished.
E A317	-	-	Drive is not at standstill Command sent which is not allowed when the motor is not at a standstill e.g. - change of software limit switches - change of handling of monitoring signals - setting of reference point - teach in of data set Wait until motor has come to a standstill (x_end = 1).
E A318	-	-	Operating mode active (x_end=0) Activation of a new operating mode is not possible while the current operating mode is still active. Wait until the command in the operating mode has finished (x_end=1) or terminate current operating mode with HALT command.
E A319	1	2	Manual tuning/Autotuning: drive moved out of permissible range The motor exceeds the parameterized maximum allowed position range. Check allowed position range value and time interval.
E A31A	-	-	Manual tuning/Autotuning: amplitude/offset too high Amplitude plus offset for tuning exceed internal speed or current limitation. Choose lower amplitude and offset values.
E A31B	-	-	HALT requested Command not allowed while a HALT is requested. Clear HALT request and repeat command.

Error number	Class	Bit	Description, cause and correctives
E A31C	-	-	Invalid position setting with software limit switch Value for negative (positive) software limit switch is greater (less) than value for positive (negative) software limit switch. Homing position value is set outside the range of the software limits. Set correct position values.
E A31D	-	-	Speed range overflow ('CTRL_n_max') The reference speed value was set to a value greater than the max. speed defined in 'CTRL_n_max'. Increase the value of 'CTRL_n_max' or reduce the reference speed value.
E A31E	1	2	Interruption by positive software limit switch Command not possible because of overtravel of positive software limit switch. Jog back to software limit range.
E A31F	1	2	Interruption by negative software limit switch Command not possible because of overrun of negative software limit switch. Jog back to software limit range.
E A320	par.	22	Tracking error too high External load or acceleration are too high. Reduce external load or acceleration, error response is adjustable via 'Fit_pDiff'.
E A324	1	10	Error during homing (additional info = detailed error number) Homing movement was stopped by an error, the detailed reason is indicated by the additional info in the error buffer. Possible sub error codes: EA325 EA326 EA327 EA328 EA329
E A325	1	10	Limit switch to be approached not enabled Homing to LIMP or LIMN and limit switches are disabled. Enable limit switch via 'IOsigLimP' or 'IOsigLimN'.
E A326	1	10	REF switch not found between LIMP and LIMN REF input switch defective or not correctly connected. Check the function and wiring of the REF switch.
E A327	1	10	Reference movement to REF without direction reversal, improper enabling of limit switch LIM Search of REF without direction reversal in positive (negative) direction with LIMP (LIMN) activated. Check the function and wiring of the LIMP (LIMN) switch.
E A328	1	10	Reference movement to REF without direction reversal, overrun of LIM or REF not permissible Search of REF without direction reversal and REF or LIM overtravel. Reduce homing speed ('HMn') or increase deceleration ('RAMPdecel'). Check the function and wiring of LIMP, LIMN and REF switch.

Error number	Class	Bit	Description, cause and correctives
E A329	1	10	More than one signal LIMP/LIMN/REF active REF or LIM not connected correctly or supply voltage for switches too low. Check the wiring and 24VDC supply voltage.
E A32A	1	10	Ext. monitoring signal LIMP with neg. direction of rotation Start reference movement with neg. direction of rotation (e.g. reference movement to LIMN) and activate the LIMP switch (switch in opposite direction of movement). Check correct connection and function of limit switch. Activate a jog movement with negative direction of rotation (target limit switch must be connected to the inputs LIMN).
E A32B	1	10	Ext. monitoring signal LIMN with pos. direction of rotation Start reference movement with pos. direction of rotation (e.g. reference movement to LIMP) and activate the LIMN switch (switch in opposite direction of movement). Check correct connection and function of limit switch. Activate a jog movement with positive direction of rotation (target limit switch must be connected to the inputs LIMP).
E A32C	1	10	REF error (switch signal briefly enabled or switch overtraveled) Switch signal disturbance. Motor subjected to vibration or shock when stopped after activation of the switch signal. Check supply voltage, cabling and function of switch. Check motor reaction after stopping and optimize controller settings.
E A32D	1	10	LIMP error (switch signal briefly enabled or switch overtraveled) Switch signal disturbance. Motor subjected to vibration or shock when stopped after activation of the switch signal. Check supply voltage, cabling and function of switch. Check motor reaction after stopping and optimize controller settings.
E A32E	1	10	LIMN error (switch signal briefly enabled or switch overtraveled) Switch signal disturbance. Motor subjected to vibration or shock when stopped after activation of the switch signal. Check supply voltage, cabling and function of switch. Check motor reaction after stopping and optimize controller settings.
E A330	-	-	Reference movement to index pulse cannot be reproduced. Index pulse is too close to the switch The position difference between the change of the switch signal and the occurrence of the index pulse is too low. Change mounting point of limit switch (the optimum is a position one half of a motor revolution away from the current mechanical position, direction towards the outside of the working range).
E A332	1	10	Jog error (additional info = detailed error number) Jog movement was stopped by error. For additional info, check the detailed error number in the error buffer.

Error number	Class	Bit	Description, cause and correctives
E A334	2	0	<p>Timeout at Standstill window monitor</p> <p>Position deviation after movement finished greater than standstill window, e.g. caused by an external load.</p> <p>Check load. Check settings for standstill window ('STANDp_win', 'STANDpwinTime' and 'STANDpwinTout'). Optimize controller settings.</p>
E A337	0	10	<p>Operating mode cannot be continued</p> <p>Continuation of interrupted movement in profile position mode is not possible because another mode had been active in the meantime. In Motion Sequence mode, continuation is impossible if a motion blend was interrupted.</p>
E A33A	-	-	<p>Reference point is not defined (ref_ok=0)</p> <p>No homing done and no motor with absolute encoder connected. Homing position lost because the working position range was left.</p> <p>Start homing. Use motor with multiturn encoder if no homing is to be done.</p>
E B100	0	9	<p>RS485/Modbus: unknown service</p> <p>Unsupported Modbus service was received. Check application on the Modbus master.</p>
E B200	0	9	<p>RS485/Modbus: Protocol error</p> <p>Logical protocol error: wrong length or unsupported subfunction. Check application on the Modbus master.</p>
E B201	2	6	<p>RS485/Modbus: Nodeguard error</p> <p>Modbus is defined as command interface ('DEVcmdinterf'=Modbus): connection monitoring parameter ('MBnode_guard') is <>0ms and a nodeguard event was detected.</p> <p>Check application on the Modbus master or change value (set to 0ms or increase the parameter 'MBnode_guard' monitoring time).</p>
E B202	0	9	<p>RS485/Modbus: Nodeguard warning</p> <p>Modbus is not defined as command interface ('DEVcmdinterf '<>Modbus): connection monitoring parameter ('MBnode_guard') is <>0ms and a nodeguard event was detected.</p> <p>Check application on the Modbus master or change (set to 0ms or increase the parameter 'MBnode_guard' monitoring time).</p>
E B500	0	7	<p>DeviceNet: io data could not be processed</p> <p>Error while processing I/O data: output data contains invalid value. Check output data content (application).</p>
E B501	2	7	<p>DeviceNet: Duplicate MAC ID</p> <p>A device with the same MAC ID is found at the DeviceNet bus. Use another MAC ID for this device or for the other device.</p>
E B502	2	0	DeviceNet: Receive queue overrun
E B503	2	0	DeviceNet: Transmit queue overrun
E B504	2	0	DeviceNet: Error when sending an io message

Error number	Class	Bit	Description, cause and correctives
E B505	2	7	DeviceNet: CAN-Controller in Busoff Too many error frames have been detected, CAN devices with different baudrates. Check CAN bus installation.
E B506	2	0	DeviceNet: CAN overflow (message lost) Two short DeviceNet messages have been sent too fast.
E B507	2	7	DeviceNet: Reset request, change of baud rate or MAC-ID Master sent DeviceNet reset request while power stage was enabled. Reset the device only while the power stage is disabled.
E B508	2	7	DeviceNet: Power supply disabled DeviceNet bus power supply was switched off while the power stage was enabled. Disable the power stage before switching off the DeviceNet master.
E B509	2	7	DeviceNet: Timeout explicit connection
E B50A	2	7	DeviceNet: Timeout I/O connection
E B50B	2	7	DeviceNet: Explicit connection terminated while state is 'Operation enable' An explicit connection was closed while no I/O channel was open and the power stage was enabled. If you use explicit connections only, disable the power stage before closing the connection.
E B50C	2	7	DeviceNet: I/O connection terminated while state is 'Operation enable' An I/O connection was terminated while the power stage was enabled. Disable the power stage before closing the I/O connection.
E B50D	-	-	DeviceNet: Data length not correct, too many bytes
E B50E	-	-	DeviceNet: Data length not correct, insufficient number of bytes

11 Parameters

This chapter provides an overview of the parameters which can be used for operating the product.

▲ WARNING

UNINTENDED BEHAVIOR CAUSED BY PARAMETERS

The behavior of the drive system is governed by numerous parameters. Unsuitable parameter values can trigger unintended movements or signals or deactivate monitoring functions.

- Never change a parameters unless you understand its meaning.
- Only start the system if there are no persons or obstructions in the hazardous area.
- When commissioning, carefully run tests for all operating states and potential fault situations.

Failure to follow these instructions can result in death, serious injury or equipment damage.

11.1 Representation of the parameters

When parameters are explained, this contains, on the one hand, information which is needed for unique identification of a parameter. On the other hand, the parameter explanations can also provide information on settings, defaults and parameter properties.

Entering values

Note that the parameters are input in the fieldbus without decimal point. All decimal places must be entered.

Input examples:

Maximum value	Commissioning software	Fieldbus
2.0	2.0	20
23.57	23.57	2357
1,000	1,000	1000

11.1.1 Explanation of the parameter representation

A parameter explanation has the following features:

Parameter Name	Description	Unit Minimum value Default value Maximum value	Data type R/W persistent Expert	Parameter address via fieldbus
Example_Name	Brief description (cross-reference) Selection values 1 / Selection value1 : Explanation 1 2 / Selection value2 : Explanation 2 Further description and details	A _{pk} 0.00 3.00 300.00	UINT32 R/W per. -	Fieldbus 1234

The most important terms in the heading line of a parameter table are explained in the following.

- Parameter Name* The parameter name clearly identifies a parameter.
- Description* Brief description (cross-reference)
The brief description contains some information on the parameter and a cross-reference to the page that describes the function of the parameter.
Selection values
In the case of parameters which offer a selection of settings, the value to be entered via the fieldbus and the designation of the value for input via the commissioning software and the HMI are specified.
1 = Value via fieldbus
Selection value1 = Selection value via commissioning software
Further description and details
Provides further information on the parameter.
- Unit* The unit of the value.
- Minimum value* The minimum value which can be entered.
- Default value* Factory setting.
- Maximum value* The maximum value which can be entered.
- Data type* The data type determines the valid range of values, especially if minimum and maximum values are not explicitly indicated for a parameter.

Data type	Byte	Min value	Max value
INT8	1 Byte / 8 Bit	-128	127
UINT8	1 Byte / 8 Bit	0	255
INT16	2 Byte / 16 Bit	-32768	32767
UINT16	2 Byte / 16 Bit	0	65535
INT32	4 Byte / 32 Bit	-2147483648	2147483647
UINT32	4 Byte / 32 Bit	0	4294967295

- R/W* Indicates read and/or write values
"R/" values can only be read
"R/W" values can be read and written.

- Persistent* "per." indicates whether the value of the parameter is persistent, i.e. whether it remains in the memory after the device is switched off . When changing a value via commissioning software or fieldbus, the user must explicitly store the changed value in the persistent memory.
- Parameter address* Each parameter has a unique parameter address. The parameter address is used to access the parameter via the fieldbus.
- The address consists of:
- Class.Instance.Attribute

11.2 List of all parameters

Parameter Name	Description	Unit Minimum value Default value Maximum value	Data type R/W persistent Expert	Parameter address via fieldbus
_acc_pref	Acceleration of reference value generation	min ⁻¹ /s	INT32	Modbus 7954
	Sign according to the changed speed value:	-	INT32	CIP 131.1.9
	Increased speed: pos. sign	0	R/-	
	Reduced speed: neg. sign	-	-	
_AccessInfo	Current access channel for action objects	-	UINT16	Modbus 280
	Low byte :	-	UINT16	CIP 101.1.12
	0 : Used by channel in high byte	0	R/-	
	1 : Exclusively used by channel in high byte	-	-	
	High byte: Current assignment of access channel			
	0: reserved			
	1: IO			
	2: HMI			
	3: Modbus RS485			
	4: CANopen			
	5: CANopen via seconds SDO channel			
	6: Profibus			
	7: DeviceNet			
8: reserved				
9: Ethernet				
10..15: Modbus TCP				
_actionStatus	Action word (167)	-	UINT16	Modbus 7176
	Signal status:	-	UINT16	CIP 128.1.4
	0: not activated	0	R/-	
	1: activated	-	-	
	Bit 0: Warning			
	Bit 1: Error class 1			
	Bit 2: Error class 2			
	Bit 3: Error class 3			
	Bit 4: Error class 4			
	Bit 5: Reserved			
	Bit 6: Drive is at standstill (<9 [1/min])			
	Bit 7: Drive rotates clockwise			
	Bit 8: Drive rotates counter-clockwise			
	Bit 9: Reserved			
	Bit 10: Reserved			
	Bit 11: Profile generator idle (reference speed is 0)			
	Bit 12: Profile generator decelerates			
Bit 13: Profile generator accelerates				
Bit 14: Profile generator moves at constant speed				
Bit 15: Reserved				
_l2t_act_M	Current motor overload (164)	%	INT16	Modbus 7218
		-	INT16	CIP 128.1.25
		0	R/-	
		-	-	

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Parameter Name	Description	Unit Minimum value Default value Maximum value	Data type R/W persistent Expert	Parameter address via fieldbus
_I2t_mean_M	Motor load (164)	% - 0 -	INT16 INT16 R/- -	Modbus 7220 CIP 128.1.26
_Id_act	Actual motor current d-component In increments of 0.01A _{pk}	A _{pk} - 0.00 -	INT16 INT16 R/- -	Modbus 7684 CIP 130.1.2
_Id_ref	Reference motor current d-component (weakening the field) In increments of 0.01A _{pk}	A _{pk} - 0.00 -	INT16 INT16 R/- -	Modbus 7714 CIP 130.1.17
_Idq_act	Total motor current (vector sum d-components and q-components) In increments of 0.01A _{pk}	A _{pk} - 0.00 -	INT16 INT16 R/- -	Modbus 7686 CIP 130.1.3
_IO_LIO_act	Status of digital inputs/outputs (105) Coding of the individual signals: Bit 0: LIO1 Bit 1: LIO2 ...	- - 0 -	UINT16 UINT16 R/- -	Modbus 2090 CIP 108.1.21
_IO_STO_con	Connection of STO inputs 0 / not available: Inputs not available 1 / not connected: Inputs available, but not connected (jumpered) 3 / connected: Inputs available and connected (safety function STO active) Inputs STO_A (PWRR_A) and STO_B (PWRR_B)	- 0 - 3	UINT16 UINT16 R/- -	Modbus 2088 CIP 108.1.20
_Iq_act	Actual motor current q-component In increments of 0.01A _{pk}	A _{pk} - 0.00 -	INT16 INT16 R/- -	Modbus 7682 CIP 130.1.1
_Iq_ref	Reference motor current q-component (generating torque) In increments of 0.01A _{pk}	A _{pk} - 0.00 -	INT16 INT16 R/- -	Modbus 7712 CIP 130.1.16
_LastWarning	Last warning as number Number of the most recent warning. If the warning becomes inactive again, the number is memorized until the next fault reset. Value 0: No warning occurred	- - 0 -	UINT16 UINT16 R/- -	Modbus 7186 CIP 128.1.9
_n_act	Actual motor speed (145)	min ⁻¹ - 0 -	INT16 INT16 R/- -	Modbus 7696 CIP 130.1.8

Parameter Name	Description	Unit Minimum value Default value Maximum value	Data type R/W persistent Expert	Parameter address via fieldbus
_n_actRAMP	Actual speed of motion profile generator (145)	min ⁻¹ - 0 -	INT32 INT32 R/- -	Modbus 7948 CIP 131.1.6
_n_pref	Speed of reference value generation	min ⁻¹ - 0 -	INT32 INT32 R/- -	Modbus 7950 CIP 131.1.7
_n_ref	Reference speed of speed controller	min ⁻¹ - 0 -	INT16 INT16 R/- -	Modbus 7694 CIP 130.1.7
_n_targetRAMP	Reference speed of motion profile generator	min ⁻¹ - 0 -	INT32 INT32 R/- -	Modbus 7946 CIP 131.1.5
_OpHours	Operating hours counter	s - 0 -	UINT32 UINT32 R/- -	Modbus 7188 CIP 128.1.10
_p_absENCusr	Motor position with reference to encoder range in user units (110) The value range is determined by the encoder type. In the case of singleturn encoders, the value refers to one motor revolution, in the case of multiturn encoders to the entire encoder range (e.g. 4096 revolutions). NOTE: The position is not valid until the absolute motor position has been determined. In the case of invalid absolute motor position: _WarnLatched _WarnActive Bit 13=1: Absolute motor position not yet captured	usr - 0 -	UINT32 UINT32 R/- -	Modbus 7710 CIP 130.1.15
_p_absmodulo	Absolute pos. with ref. to 1 motor revolution in internal units NOTE: The position is not valid until the absolute motor position has been determined. In the case of invalid absolute motor position: _WarnLatched _WarnActive Bit 13=1: Absolute motor position not yet captured	Inc - 0 -	UINT32 UINT32 R/- -	Modbus 7708 CIP 130.1.14

Parameter Name	Description	Unit Minimum value Default value Maximum value	Data type R/W persistent Expert	Parameter address via fieldbus
_p_act	Actual position of motor in internal units	Inc - 0 -	INT32 INT32 R/- -	Modbus 7700 CIP 130.1.10
_p_actPosintf	Actual position at position interface Counted position increments at RS 422 signal interface	Inc -2147483648 - 2147483647	INT32 INT32 R/- -	Modbus 2058 CIP 108.1.5
_p_actRAMPusr	Actual position of motion profile generator (142) In user units	usr - 0 -	INT32 INT32 R/- -	Modbus 7940 CIP 131.1.2
_p_actusr	Actual motor position in user units (142)	usr - 0 -	INT32 INT32 R/- -	Modbus 7706 CIP 130.1.13
_p_addGEAR	Initial position electronic gear When electronic gear is inactive, the reference position for the position controller can be determined here. This position is set when electronic gear is activated with the selection of 'Synchronization with compensation movement'.	Inc - 0 -	INT32 INT32 R/- -	Modbus 7942 CIP 131.1.3
_p_dif	Current deviation between reference and actual position (164) Corresponds to the current control deviation of the position controller.	revolution -214748.3648 - 214748.3647	INT32 INT32 R/- -	Modbus 7716 CIP 130.1.18
_p_DifPeak	Value of the maximum tracking error of the position controller (164) The tracking error is the current position control deviation. See SPV_p_maxDiff for more information. A write access resets this value.	revolution 0.0000 - 429496.7295	UINT32 UINT32 R/W -	Modbus 4382 CIP 117.1.15
_p_ref	Reference position in internal units Value corresponds to the reference position of the position controller.	Inc - 0 -	INT32 INT32 R/- -	Modbus 7698 CIP 130.1.9
_p_refusr	Reference position in user units (159) Value corresponds to the reference position of the position controller.	usr - 0 -	INT32 INT32 R/- -	Modbus 7704 CIP 130.1.12
_p_tarRAMPusr	Target position of motion profile generator Absolute position value of the profile generator, calculated on the basis of the relative and absolute position values received. In user units	usr - 0 -	INT32 INT32 R/- -	Modbus 7938 CIP 131.1.1

Parameter Name	Description	Unit Minimum value Default value Maximum value	Data type R/W persistent Expert	Parameter address via fieldbus
_prgNoDEV	Firmware program number	-	UINT16	Modbus 258
	Example: PR840.1	-	UINT16	CIP 101.1.1
	The value is entered as a decimal value: 8401	0.0 -	R/- -	
_prgVerDEV	Firmware version number	-	UINT16	Modbus 260
	Example: V4.201	-	UINT16	CIP 101.1.2
	The value is entered as a decimal value: 4201	0.000 -	R/- -	
_serialNoDEV	Device serial number	-	UINT32	Modbus 302
	Serial number: unique number for identifica- tion of the product	0 -	UINT32	CIP 101.1.23
		4294967295 -	R/- per. -	
_SigActive	Current status of monitoring signals (165)	-	UINT32	Modbus 7182
	See _SigLatched for more details on the bit codes.	-	UINT32	CIP 128.1.7
		0 -	R/- -	

Parameter Name	Description	Unit Minimum value Default value Maximum value	Data type R/W persistent Expert	Parameter address via fieldbus
_SigLatched	Saved status of monitoring signals (166)	-	UINT32	Modbus 7184
	Signal status: 0: Not activated 1: Activated	- 0 -	UINT32 R/- -	CIP 128.1.8
	Bit assignments: Bit 0: General fault Bit 1: Limit switches (LIMP/LIMN/REF) Bit 2: Out of range (SW limit switches, tuning) Bit 3: Quickstop via fieldbus Bit 4: Inputs STO are 0 Bit 5: Reserved Bit 6: RS485 fault Bit 7: CAN fault Bit 8: Ethernet fault Bit 9: Frequency of reference signal too high Bit 10: Fault current operating mode Bit 11: Reserved Bit 12: Profibus fault Bit 13: Reserved Bit 14: Undervoltage DC bus Bit 15: Overvoltage DC bus Bit 16: Mains phase missing Bit 17: Motor connection fault Bit 18: Motor overcurrent/short circuit Bit 19: Motor encoder fault Bit 20: Undervoltage 24VDC Bit 21: Overtemperature (power stage, motor) Bit 22: Tracking error Bit 23: Max. speed exceeded Bit 24: Inputs STO different Bit 25: Reserved Bit 26: Reserved Bit 27: Reserved Bit 28: Reserved Bit 29: EEPROM fault Bit 30: System booting (Hardware fault or parameter error) Bit 31: System error (e.g. watchdog)			
	Monitoring functions are product-dependent.			
_StopFault	Error number of last stop fault (167)	-	UINT16	Modbus 7178
		- 0 -	UINT16 R/- -	CIP 128.1.5
_Temp_act_PA	Power stage temperature (163)	°C	INT16	Modbus 7200
		- 0 -	INT16 R/- -	CIP 128.1.16
_Ud_ref	Reference motor voltage d-component	V	INT16	Modbus 7690
	In increments of 0.1V	- 0.0 -	INT16 R/- -	CIP 130.1.5

Parameter Name	Description	Unit Minimum value Default value Maximum value	Data type R/W persistent Expert	Parameter address via fieldbus
_UDC_act	Voltage at DC bus	V	UINT16	Modbus 7198
	Supply voltage VDC in 0.1 V increments	- 0.0 -	UINT16 R/- -	CIP 128.1.15
_Udq_ref	Total motor voltage (vector sum d-components and q-components)	V	INT16	Modbus 7692
	Square root of ($_{Uq_ref}^2 + _{Ud_ref}^2$)	- 0.0 -	INT16 R/- -	CIP 130.1.6
	In increments of 0.1V			
_Uq_ref	Reference motor voltage q-component	V	INT16	Modbus 7688
	In increments of 0.1V	- 0.0 -	INT16 R/- -	CIP 130.1.4
_v_act_Posintf	Actual speed at position interface	Inc/s	INT32	Modbus 2060
	Determined pulse frequency at RS 422 signal interface	-2147483648 - 2147483647	INT32 R/- -	CIP 108.1.6
_VoltUtil	Degree of utilization of DC bus voltage	%	INT16	Modbus 7718
	With a value of 100%, the drive operates at the voltage limit.	- 0 -	INT16 R/- -	CIP 130.1.19
	$_{VoltUtil} = (_{Udq_ref} / _{Udq_ref}) * 100\%$			
_WarnActive	Active warnings, bit-coded (166)	-	UINT16	Modbus 7190
	See _WarnLatched for more details on the bit codes.	- 0 -	UINT16 R/- -	CIP 128.1.11

Parameter Name	Description	Unit Minimum value Default value Maximum value	Data type R/W persistent Expert	Parameter address via fieldbus
_WarnLatched	Saved warnings, bit-coded (167)	-	UINT16	Modbus 7192
	Saved warning bits are deleted in the case of a FaultReset. Bits 10, 11, 13 are deleted automatically.	- 0 -	UINT16 R/- -	CIP 128.1.12
	Signal status: 0: Not activated 1: Activated			
	Bit assignments: Bit 0: General warning (see _LastWarning) Bit 1: Temperature of power stage high Bit 2: Temperature of motor high Bit 3: Reserved Bit 4: Power stage overload (I ² t) Bit 5: Motor overload (I ² t) Bit 6: Braking resistor overload (I ² t) Bit 7: CAN warning Bit 8: Motor encoder warning Bit 9: RS485 protocol warning Bit 10: STO_A (PWRR_A) and/or STO_B (PWRR_B) Bit 11: DC bus undervoltage/missing mains phase Bit 12: Profibus warning Bit 13: Position not yet valid (position capture still running) Bit 14: Ethernet warning Bit 15: Reserved			
	Monitoring functions are product-dependent.			
AbsHomeRequest	Absolute positioning only after homing (143)	-	UINT16	Modbus 1580
	0 / no: No 1 / yes: Yes	0 0 1	UINT16 R/W per. -	CIP 106.1.22
AccessLock	Locking other access channels (124)	-	UINT16	Modbus 316
	0: Release other access channels 1: Lock other access channels	0 -	UINT16 R/W -	CIP 101.1.30
	The fieldbus can lock active access to the device via the following access channels with this parameter: - Input signals - Commissioning software	1	-	
	Processing of the input signal HALT cannot be locked.			
BRK_release	Processing of holding brake (108)	-	UINT16	Modbus 2068
	0 / close: automatic processing (default) 1 / open: manual release of brake	0 0 1	UINT16 R/W -	CIP 108.1.10
	The brake output can only be activated in the states 'Switch on disabled' or 'Ready to switch on'.		-	
	If the power stage is active, the value is automatically set to 0.			

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Parameter Name	Description	Unit Minimum value Default value Maximum value	Data type R/W persistent Expert	Parameter address via fieldbus
BRK_status	Status of holding brake 0: closed 1: open 2: not available	- 0 0 2	UINT16 UINT16 R/- -	Modbus 2070 CIP 108.1.11
Cap1Activate	Capture unit 1 start/stop (179) 0 / Capture stop: Cancel capture function 1 / Capture once: Start one-time capture 2 / Capture continuous: Start continuous capture In the case of one-time capture, the function is terminated when the first value is captured. In the case of continuous capture, the function continues to run.	- 0 - 2	UINT16 UINT16 R/W -	Modbus 2568 CIP 110.1.4
Cap1Config	Capture unit 1 configuration (180) 0 / 1->0: Position capture at 1->0 change 1 / 0->1: Position capture at 0->1 change	- 0 0 1	UINT16 UINT16 R/W -	Modbus 2564 CIP 110.1.2
Cap1Count	Capture unit 1 event counter (180) Counts the capture events. The counter is reset when capture unit 1 is activated.	- - 0 -	UINT16 UINT16 R/- -	Modbus 2576 CIP 110.1.8
Cap1Pos	Capture unit 1 captured position (180) Captured position at the time of the "capture signal". The captured position is calculated again after "Position Setting" or "Homing".	usr - 0 -	INT32 INT32 R/- -	Modbus 2572 CIP 110.1.6
Cap2Activate	Capture unit 2 start/stop (180) 0 / Capture stop: Cancel capture function 1 / Capture once: Start one-time capture 2 / Capture continuous: Start continuous capture In the case of one-time capture, the function is terminated when the first value is captured. In the case of continuous capture, the function continues to run.	- 0 - 2	UINT16 UINT16 R/W -	Modbus 2570 CIP 110.1.5
Cap2Config	Capture unit 2 configuration (180) 0 / 1->0: Position capture at 1->0 change 1 / 0->1: Position capture at 0->1 change	- 0 0 1	UINT16 UINT16 R/W -	Modbus 2566 CIP 110.1.3
Cap2Count	Capture unit 2 event counter (180) Counts the capture events. The counter is reset when capture unit 2 is activated.	- - 0 -	UINT16 UINT16 R/- -	Modbus 2578 CIP 110.1.9

Parameter Name	Description	Unit Minimum value Default value Maximum value	Data type R/W persistent Expert	Parameter address via fieldbus
Cap2Pos	Capture unit 2 captured position (180) Captured position at the time of the "capture signal". The captured position is calculated again after "Position Setting" or "Homing".	usr - 0 -	INT32 INT32 R/- -	Modbus 2574 CIP 110.1.7
CapStatus	Status of the capture units (180) Read access: Bit 0: position capture via input CAP1 carried out Bit 1: position capture via input CAP2 carried out	- - 0 -	UINT16 UINT16 R/- -	Modbus 2562 CIP 110.1.1
CTRL_I_max	Current limitation (103) The value must not exceed the maximum permissible current of the motor or the power stage. Default: M_I_max	A _{pk} 0.00 - 299.99	UINT16 UINT16 R/W per. -	Modbus 4610 CIP 118.1.1
CTRL_KFPp	Speed feed-forward control position controller Overshoot of up to 110% is possible.	% 0.0 100.0 110.0	UINT16 UINT16 R/W per. -	Modbus 4624 CIP 118.1.8
CTRL_KPn	Speed controller P-term (114) The default value is calculated on the basis of the motor parameters.	A/min ⁻¹ 0.0001 - 1.2700	UINT16 UINT16 R/W per. -	Modbus 4614 CIP 118.1.3
CTRL_KPp	Position controller P-term (120) The default value is calculated.	1/s 2.0 - 495.0	UINT16 UINT16 R/W per. -	Modbus 4620 CIP 118.1.6
CTRL_n_max	Speed limitation (103) The set value must not exceed the maximum motor speed. Default: maximum motor speed (see M_n_max)	min ⁻¹ 0 - 13200	UINT16 UINT16 R/W per. -	Modbus 4612 CIP 118.1.2
CTRL_Pcdamp	Damping Posicast filter speed The filter is switched off at a value of 1000.	% 50.0 100.0 100.0	UINT16 UINT16 R/W per. expert	Modbus 4648 CIP 118.1.20
CTRL_Pcdelay	Time delay Posicast filter speed The filter is switched off at a value of 0.	ms 0.00 0.00 25.00	UINT16 UINT16 R/W per. expert	Modbus 4650 CIP 118.1.21
CTRL_TAUnref	Filter time constant ref.value filter of the ref. speed value (115)	ms 0.00 0.00 327.67	UINT16 UINT16 R/W per. -	Modbus 4626 CIP 118.1.9

Parameter Name	Description	Unit Minimum value Default value Maximum value	Data type R/W persistent Expert	Parameter address via fieldbus
CTRL_TNn	Speed controller setting time (114)	ms 0.00 - 327.67	UINT16 R/W per. -	Modbus 4616 CIP 118.1.4
DVNadr	DeviceNet address (node number) Address changes are only accepted if the rotary switch is set to an address > 63 or if the unit does not have a rotary switch. NOTE: A changed address does not become active until the unit is switched on the next time.	- 1 63 63	UINT16 R/W per. -	Modbus 5908 CIP 123.1.10
DVNbaud	DeviceNet Baud rate 0 / 125KBaud: 125 kBaud 1 / 250KBaud: 250 kBaud 2 / 500KBaud: 500 kBaud 3 / Autobaud: Autobaud	- 0 3 3	UINT16 R/W per. -	Modbus 5910 CIP 123.1.11
DVNbuspowerSpv	Monitoring of DeviceNet bus supply 0 / on: Monitoring active 1 / off: Monitoring inactive	- 0 0 1	UINT16 R/W per. -	Modbus 5914 CIP 123.1.13
DVNdiag	DeviceNet diagnosis Bit 0 : expl. connection ID1: 0=closed, 1=open Bit 1 : expl. connection ID5: 0=closed, 1=open Bit 2 : expl. connection ID6: 0=closed, 1=open Bit 3 : io connection ID2: 0=closed, 1=open Bit 4 : io connection ID7: 0=closed, 1=open Bit 5 : error state: 0=ok, 1=BUSOFF Bit 6 : expl. connection EPR: 0=ok, 1=time-out Bit 7 : io. connection EPR: 0=ok, 1=timeout Bit 8 : error state: 0=ok, 1=passive Bit 9 : receive error: 0=ok, 1=message error Bit 10 : bus state: 0=offline, 1=online Read access deletes bits 7, 8, 9	- 0 - - - - - - - - - - - - - - - - - -	UINT32 R/W - - -	Modbus 5912 CIP 123.1.12
DVNioDataIn	DeviceNet IO data input 110 / position controller: Position controller 111 / standard assembly: Standard assembly 112 / extended assembly: Extended assembly	- 110 110 112	UINT16 R/W per. -	Modbus 5916 CIP 123.1.14
DVNioDataOut	DeviceNet IO data output 100 / position controller: Position controller 101 / standard assembly: Standard assembly 102 / extended assembly: Extended assembly	- 100 100 102	UINT16 R/W per. -	Modbus 5918 CIP 123.1.15

Parameter Name	Description	Unit Minimum value Default value Maximum value	Data type R/W persistent Expert	Parameter address via fieldbus
ENC_pabsusr	<p>Directly set the motor encoder position (110)</p> <p>The value range depends on the encoder type.</p> <p>Singleturn encoder: 0 ... max_pos_usr/rev. - 1</p> <p>Multiturn encoder: 0 ... (4096 * max_pos_usr/rev.) -1</p> <p>max_pos_usr/rev.: maximum user position for one motor turn. This value is 16384 with the default scaling.</p> <p>NOTE: * If processing is to be performed with inversion of the direction of rotation, this must be set before the motor encoder position is adjusted. * The set value does not become active until the controller is switched on the next time. After the write access, a wait time of at least 1 second is required before the controller is switched off. * Changing this value also changes the position of the virtual index pulse and the index pulse for the ESIM function.</p>	usr -2147483648 - 2147483647	INT32 INT32 R/W - -	Modbus 1324 CIP 105.1.22
FLT_class	<p>Error class (209)</p> <p>0: Warning (no response) 1: Error (Quick Stop -> state 7) 2: Error (Quick Stop -> state 8, 9) 3: Fatal error (state 9, can be acknowledged) 4: Fatal error (state 9, cannot be acknowledged)</p>	- 0 - 4	UINT16 UINT16 R/- - -	Modbus 15364 CIP 160.1.2
FLT_del_err	<p>Clear error memory (208)</p> <p>1: Delete all entries in the error memory</p> <p>The clearing process is completed if a 0 is returned after a read access.</p>	- 0 - 1	UINT16 UINT16 R/W - -	Modbus 15112 CIP 159.1.4
FLT_err_num	<p>Error number (209)</p> <p>Reading this parameter copies the entire error entry (error class, time of occurrence of error, ...) to an intermediate memory from which all elements of the error can then be read.</p> <p>In addition, the read pointer of the error memory is automatically set to the next error entry.</p>	- 0 - 65535	UINT16 UINT16 R/- - -	Modbus 15362 CIP 160.1.1
FLT_Idq	<p>Motor current at error time</p> <p>In increments of 10mA</p>	A - 0.00 -	UINT16 UINT16 R/- - -	Modbus 15378 CIP 160.1.9

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Parameter Name	Description	Unit Minimum value Default value Maximum value	Data type R/W persistent Expert	Parameter address via fieldbus
FLT_MemReset	Reset error memory read pointer (208) 1: Set error memory read pointer to oldest error entry.	- 0 - 1	UINT16 UINT16 R/W -	Modbus 15114 CIP 159.1.5
FLT_n	Speed at error time	min ⁻¹ - 0 -	INT16 INT16 R/- -	Modbus 15376 CIP 160.1.8
FLT_powerOn	Number of power on cycles	- 0 - 4294967295	UINT32 UINT32 R/- -	Modbus 15108 CIP 159.1.2
FLT_Qual	Error additional information (209) This entry contains additional information on the error, depending on the error number. Example: a parameter address	- 0 - 65535	UINT16 UINT16 R/- -	Modbus 15368 CIP 160.1.4
FLT_Temp_DEV	Temperature of device at error time	°C - 0 -	INT16 INT16 R/- -	Modbus 15382 CIP 160.1.11
FLT_Temp_PA	Temperature of power stage at error time	°C - 0 -	INT16 INT16 R/- -	Modbus 15380 CIP 160.1.10
FLT_Time	Error time (209) With reference to operating hours counter	s 0 - 536870911	UINT32 UINT32 R/- -	Modbus 15366 CIP 160.1.3
FLT_UDC	DC bus voltage at error time In increments of 100mV	V - 0.0 -	UINT16 UINT16 R/- -	Modbus 15374 CIP 160.1.7
FLTAmpOnCyc	ENABLE cycles up to the time of error Number of power on cycles from the time the power supply (control voltage) was switched on to the time the error occurred.	- - 0 -	UINT16 UINT16 R/- -	Modbus 15370 CIP 160.1.5
FLTAmpOnTime	Time of error after ENABLE	s - 0 -	UINT16 UINT16 R/- -	Modbus 15372 CIP 160.1.6
GEARdenom	Denominator of gear ratio (139) See description GEARnum	- 1 1 2147483647	INT32 INT32 R/W per. -	Modbus 9734 CIP 138.1.3

Parameter Name	Description	Unit Minimum value Default value Maximum value	Data type R/W persistent Expert	Parameter address via fieldbus
GEARdir_enabl	<p>Enabled movement direction of gear processing (140)</p> <p>1 / positive: Pos. direction 2 / negative: Neg. direction 3 / both: Both directions</p> <p>This allows you to activate a return movement lock function.</p>	- 1 3 3	UINT16 UINT16 R/W per. -	Modbus 9738 CIP 138.1.5
GEARnum	<p>Numerator of gear ratio (139)</p> <p>GEARnum ----- = Gear ratio GEARdenom</p> <p>The new gear ratio is applied when the numerator value is supplied.</p>	- -2147483648 1 2147483647	INT32 INT32 R/W per. -	Modbus 9736 CIP 138.1.4
GEARposChgMode	<p>Consideration of position changes with inactive power stage (140)</p> <p>0 / off: Position changes in states with inactive power stage are discarded. 1 / on: Position changes in states with inactive power stage are considered.</p> <p>This setting has an effect only if gear processing is started in the mode 'Synchronization with compensation movement'.</p>	- 0 0 1	UINT16 UINT16 R/W per. -	Modbus 9750 CIP 138.1.11
GEARratio	<p>Selection of special gear ratios (139)</p> <p>0 / GearFactor: Usage of gear ratio adjusted with GEARnum/GEARdenom 1 / 200: 200 2 / 400: 400 3 / 500: 500 4 / 1000: 1000 5 / 2000: 2000 6 / 4000: 4000 7 / 5000: 5000 8 / 10000: 10000 9 / 4096: 4096 10 / 8192: 8192 11 / 16384: 16384</p> <p>A change of the reference value by the specified value causes one motor revolution.</p>	- 0 0 11	UINT16 UINT16 R/W per. -	Modbus 9740 CIP 138.1.6
HMdisREFtoIDX	<p>Distance from switching edge to index pulse (154)</p> <p>This read value delivers the difference between the index pulse position and the position at the switching edge of the limit or reference switch.</p> <p>It allows to check the distance between the index pulse and the switching edge and serves as a criterion for determining whether the reference movement with index pulse processing can be reproduced.</p> <p>In increments of 1/10000 revolutions</p>	revolution - 0.0000 -	INT32 INT32 R/- - -	Modbus 10264 CIP 140.1.12

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Parameter Name	Description	Unit Minimum value Default value Maximum value	Data type R/W persistent Expert	Parameter address via fieldbus
HMdisusr	Distance from switching edge to reference point (151) After the drive 'leaves' the switch, it is positioned into the working area by a defined distance. This target point is defined as the reference point. The parameter is only effective during reference movements without index pulse search.	usr 1 200 2147483647	INT32 INT32 R/W per. -	Modbus 10254 CIP 140.1.7
HMmethod	Homing method (148) 0 / deactivate: Deactivated 1 / LIMN indexpuls: LIMN with index pulse 2 / LIMP indexpuls: LIMP with index pulse 7 / REFpos indexpuls: REF+ with index pulse, inv., outside 8 / REFneg indexpuls: REF+ with index pulse, inv., inside 9: REF+ with index pulse, not inv., inside 10: REF+ with index pulse, not inv., outside 11: REF- with index pulse, inv., outside 12: REF- with index pulse, inv., inside 13: REF- with index pulse, not inv., inside 14: REF- with index pulse, not inv., outside 17 / LIMN: LIMN 18 / LIMP: LIMP 23 / REFpos: REF+, inv., outside 24: REF+, inv., inside 25: REF+, not inv., inside 26: REF+, not inv., outside 27 / REFneg: REF-, inv., outside 28: REF-, inv., inside 29: REF-, not inv., inside 30: REF-, not inv., outside 33: Index pulse neg. direction 34: Index pulse pos. Direction Abbreviations: REF+: Search movement in pos. direction REF-: Search movement in pos. direction inv.: Invert direction in switch not inv.: Direction not inverted in switch outside: Index pulse / distance outside switch inside: Index pulse / distance inside switch	- 0 - 35	R/W -	
HMn_out	Speed of rotation for moving away from switch (149) The adjustable value is internally limited to the current parameter setting in RAMPn_max.	min ⁻¹ 1 6 3000	UINT16 UINT16 R/W per. -	Modbus 10250 CIP 140.1.5
HMn	Speed of rotation for search of switch (149) The adjustable value is internally limited to the current parameter setting in RAMPn_max.	min ⁻¹ 1 60 13200	UINT16 UINT16 R/W per. -	Modbus 10248 CIP 140.1.4

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Parameter Name	Description	Unit Minimum value Default value Maximum value	Data type R/W persistent Expert	Parameter address via fieldbus
HMoutdisusr	Maximum distance for search for switching edge (150) 0: Monitoring of distance inactive >0: Maximum distance in user-defined units After detection of the switch, the drive starts to search for the defined switching edge. If it is not found within the distance defined here, the reference movement is canceled with an error.	usr 0 0 2147483647	INT32 INT32 R/W per. -	Modbus 10252 CIP 140.1.6
HMp_homeusr	Position at reference point (149) After a successful reference movement, this position is automatically set at the reference point.	usr -2147483648 0 2147483647	INT32 INT32 R/W per. -	Modbus 10262 CIP 140.1.11
HMp_setpusr	Position setting to position setting position (159) Action object: write access triggers position setting. Only possible if the motor is at standstill. Position scaling is not considered.	usr -2147483648 - 2147483647	R/W - -	
HMSrchdisusr	Max. search distance after overrun of switch (150) 0: Search distance processing disabled >0: Search distance in user units The switch must be activated again within this search distance, otherwise the reference movement is canceled.	usr 0 0 2147483647	INT32 INT32 R/W per. -	Modbus 10266 CIP 140.1.13
IO_AutoEnable	Processing of power stage activation at PowerOn 0 / off: Active Enable during power on does not activate the power stage. 1 / on: Active Enable during power on activates the power stage. 2 / AutoOn: Power stage is automatically activated at power on.	- 0 0 2	UINT16 UINT16 R/W per. -	Modbus 1292 CIP 105.1.6
IO_LO_set	Setting the digital outputs directly (185) Write access to output bits is only active if the signal pin is available as an output and if the function of the output was set to 'Available as required'. Coding of the individual signals: Bit 0: LO1_OUT Bit 1: LO2_OUT ...	- - 0 -	UINT16 UINT16 R/W - -	Modbus 2082 CIP 108.1.17
IODirPosintf	Direction of counting at position interface 0 / clockwise: Clockwise 1 / counter clockwise: Counter-clockwise	- 0 0 1	UINT16 UINT16 R/W per. -	Modbus 2062 CIP 108.1.7

Parameter Name	Description	Unit Minimum value Default value Maximum value	Data type R/W persistent Expert	Parameter address via fieldbus
IOfunct_LIO1	Function Input/Output LIO1 (186)	-	UINT16	Modbus 1826
	1 / Input Free available: Available as required	-	UINT16	CIP 107.1.17
	2 / Input Fault reset: Reset fault (local control mode only)	0	R/W	
	3 / Input Enable: Enable (local control mode only)	-	per.	
	4 / Input Halt: Halt		-	
	9 / Input Jog positive: Jog positive			
	10 / Input Jog negative: Jog negative			
	11 / Input Jog fast/slow: Jog fast/slow			
	20 / Input Reference switch (REF): Reference switch (REF)			
	21 / Input Positive limit switch (LIMP): Positive limit switch (LIMP)			
	101 / Output Free available: Available as required			
	102 / Output No fault: No fault			
	103 / Output Active: Ready			
IOfunct_LIO2	Function Input/Output LIO2 (187)	-	UINT16	Modbus 1828
	1 / Input Free available: Available as required	-	UINT16	CIP 107.1.18
	2 / Input Fault reset: Reset fault (local control mode only)	0	R/W	
	3 / Input Enable: Enable (local control mode only)	-	per.	
	4 / Input Halt: Halt		-	
	9 / Input Jog positive: Jog positive			
	10 / Input Jog negative: Jog negative			
	11 / Input Jog fast/slow: Jog fast/slow			
	20 / Input Reference switch (REF): Reference switch (REF)			
	22 / Input Negative limit switch (LIMN): Negative limit switch (LIMN)			
	101 / Output Free available: Available as required			
	102 / Output No fault: No fault			
	103 / Output Active: Ready			
IOfunct_LIO3	Function Input/Output LIO3 (187)	-	UINT16	Modbus 1830
	1 / Input Free available: Available as required	-	UINT16	CIP 107.1.19
	2 / Input Fault reset: Reset fault (local control mode only)	0	R/W	
	3 / Input Enable: Enable (local control mode only)	-	per.	
	4 / Input Halt: Halt		-	
	9 / Input Jog positive: Jog positive			
	10 / Input Jog negative: Jog negative			
	11 / Input Jog fast/slow: Jog fast/slow			
	20 / Input Reference switch (REF): Reference switch (REF)			
	101 / Output Free available: Available as required			
	102 / Output No fault: No fault			
	103 / Output Active: Ready			

Parameter Name	Description	Unit Minimum value Default value Maximum value	Data type R/W persistent Expert	Parameter address via fieldbus
IOfunct_LIO4	Function Input/Output LIO4 (187)	-	UINT16	Modbus 1832
		-	UINT16	CIP 107.1.20
	1 / Input Free available: Available as required	0	R/W	
	2 / Input Fault reset: Reset fault (local control mode only)	-	per.	
	3 / Input Enable: Enable (local control mode only)		-	
	4 / Input Halt: Halt			
	9 / Input Jog positive: Jog positive			
	10 / Input Jog negative: Jog negative			
	11 / Input Jog fast/slow: Jog fast/slow			
	20 / Input Reference switch (REF): Reference switch (REF)			
	101 / Output Free available: Available as required			
	102 / Output No fault: No fault			
	103 / Output Active: Ready			
IOposInterfac	Signal selection position interface (104)	-	UINT16	Modbus 1284
		0	UINT16	CIP 105.1.2
	0 / AInput: Input ENC_A, ENC_B quadruple evaluation	0	R/W	
	1 / PInput: Input PULSE, DIR	1	per.	
	RS422 I/O interface (Pos)		-	
	NOTE: Changed settings do not become active until the unit is switched on the next time.			
IOsigLimN	Signal evaluation LIMN (149)	-	UINT16	Modbus 1566
		0	UINT16	CIP 106.1.15
	0 / inactive: Inactive	1	R/W	
	1 / normally closed: Normally closed NC	2	per.	
	2 / normally open: Normally open NO		-	
IOsigLimP	Signal evaluation LIMP (149)	-	UINT16	Modbus 1568
		0	UINT16	CIP 106.1.16
	0 / inactive: Inactive	1	R/W	
	1 / normally closed: Normally closed NC	2	per.	
	2 / normally open: Normally open NO		-	
IOsigRef	Signal evaluation REF (149)	-	UINT16	Modbus 1564
		1	UINT16	CIP 106.1.14
	1 / normally closed: Normally closed NC	1	R/W	
	2 / normally open: Normally open NO	2	per.	
			-	
	The reference switch is only activated (to REF) while homing is processed.			
JOGactivate	Activation of jog (135)	-		
		0	R/W	
	Bit0 : Positive direction of rotation	0	-	
	Bit1 : Negative direction of rotation	7	-	
	Bit2 : 0=slow 1=fast			
	If both bits for the direction of rotation are activated at the same time, no movement is started. If a jog movement is running, the simultaneous activation of the bits for the direction of rotation has no effect.			

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Parameter Name	Description	Unit Minimum value Default value Maximum value	Data type R/W persistent Expert	Parameter address via fieldbus
JOGn_fast	Speed for fast jog (135) The adjustable value is internally limited to the current parameter setting in RAMPn_max.	min ⁻¹ 1 180 13200	UINT16 UINT16 R/W per. -	Modbus 10506 CIP 141.1.5
JOGn_slow	Speed for slow jog (135) The adjustable value is internally limited to the current parameter setting in RAMPn_max.	min ⁻¹ 1 60 13200	UINT16 UINT16 R/W per. -	Modbus 10504 CIP 141.1.4
JOGstepusr	Jog distance prior to continuous run (135) 0: Direct activation of continuous run >0: Positioning distance per jog cycle	usr 0 20 2147483647	INT32 INT32 R/W per. -	Modbus 10510 CIP 141.1.7
JOGtime	Wait time prior to continuous run (135) This time is only effective if you have set a jog distance not equal to 0, otherwise the drive immediately starts a continuous run.	ms 1 500 32767	UINT16 UINT16 R/W per. -	Modbus 10512 CIP 141.1.8
LIM_HaltReaction	Type of deceleration for halt (177) 1 / Deceleration ramp: Deceleration ramp 3 / Torque ramp: Torque ramp Setting of deceleration ramp with parameter RAMPdecel. Setting of torque ramp with parameter LIM_I_maxHalt. The deceleration ramp is only available for operating modes with profile generator. The torque ramp is used in the operating modes without profile generator.	- 1 3 3	INT16 INT16 R/W per. -	Modbus 1582 CIP 106.1.23
LIM_I_maxHalt	Current limitation for Halt (103) Max. current during braking after Halt or when an operating mode is terminated. Maximum and default settings depend on the motor and the power stage (settings M_I_max and PA_I_max) In increments of 0.01A _{pk}	A _{pk} - - -	UINT16 UINT16 R/W per. -	Modbus 4364 CIP 117.1.6
LIM_I_maxQSTP	Current limitation for Quick Stop (103) Max. current during braking via torque ramp due to an error of error classes 1 or 2 and when a software stop is triggered. Maximum and default settings depend on the motor and the power stage (settings M_I_max and PA_I_max) In increments of 0.01A _{pk}	A _{pk} - - -	UINT16 UINT16 R/W per. -	Modbus 4362 CIP 117.1.5

Parameter Name	Description	Unit Minimum value Default value Maximum value	Data type R/W persistent Expert	Parameter address via fieldbus
LIM_QStopReact	Type of deceleration for Quick Stop (175) 6 / Deceleration ramp: Deceleration ramp 7 / Torque ramp: Torque ramp Setting of deceleration ramp with parameter RAMPquickstop. Setting of torque ramp with parameter LIM_I_maxQSTP. The deceleration ramp is only available for operating modes with profile generator. The torque ramp is used in the operating modes without profile generator.	- 6 7 7	INT16 INT16 R/W per. -	Modbus 1584 CIP 106.1.24
M_I_0	Continuous motor current at standstill In increments of 0.01A _{pk}	A _{pk} - - -	UINT16 UINT16 R/- -	Modbus 3366 CIP 113.1.19
M_I_max	Maximum motor current In increments of 0.01A _{pk}	A _{pk} - - -	UINT16 UINT16 R/- -	Modbus 3340 CIP 113.1.6
M_I_nom	Nominal motor current In increments of 0.01A _{pk}	A _{pk} - - -	UINT16 UINT16 R/- -	Modbus 3342 CIP 113.1.7
M_I2t	Maximum permissible time for M_I_max	ms - - -	UINT16 UINT16 R/- -	Modbus 3362 CIP 113.1.17
M_Jrot	Mass moment of inertia of motor In increments of 0.1kgcm ²	kg cm ² - - -	UINT16 UINT16 R/- -	Modbus 3352 CIP 113.1.12
M_kE	Motor EMF constant kE Voltage constant in V _{pk} at 1000 1/min	- - - -	UINT16 UINT16 R/- -	Modbus 3350 CIP 113.1.11
M_L_d	Motor inductance d-direction In increments of 0.01 mH	mH - - -	UINT16 UINT16 R/- -	Modbus 3358 CIP 113.1.15
M_L_q	Motor inductance q-direction In increments of 0.01 mH	mH - - -	UINT16 UINT16 R/- -	Modbus 3356 CIP 113.1.14

Parameter Name	Description	Unit Minimum value Default value Maximum value	Data type R/W persistent Expert	Parameter address via fieldbus
M_M_max	Maximum motor torque	N cm - - -	UINT16 UINT16 R/- -	Modbus 3346 CIP 113.1.9
M_M_nom	Nominal motor torque	N cm - - -	UINT16 UINT16 R/- -	Modbus 3344 CIP 113.1.8
M_n_max	Maximum permissible motor speed	min ⁻¹ - - -	UINT16 UINT16 R/- -	Modbus 3336 CIP 113.1.4
M_n_nom	Nominal motor speed	min ⁻¹ - - -	UINT16 UINT16 R/- -	Modbus 3338 CIP 113.1.5
M_Polepair	Number of pole pairs of motor	- - - -	UINT16 UINT16 R/- -	Modbus 3368 CIP 113.1.20
M_R_UV	Motor connection resistance In increments of 10mOhm	Ω - - -	UINT16 UINT16 R/- -	Modbus 3354 CIP 113.1.13
M_U_nom	Nominal motor voltage Voltage in increments of 100mV	V - - -	UINT16 UINT16 R/- -	Modbus 3348 CIP 113.1.10
MBadr	Modbus address Valid addresses: 1 to 247	- 1 1 247	UINT16 UINT16 R/W per. -	Modbus 5640 CIP 122.1.4
MBbaud	Modbus Baud rate 9600 / 9.6KB : 9600 Baud 19200 / 19.2KB : 19200 Baud 38400 / 38.4KB : 38400 Baud NOTE: Changed settings do not become active until the unit is switched on the next time	- 9600 19200 38400	UINT16 UINT16 R/W per. -	Modbus 5638 CIP 122.1.3

Parameter Name	Description	Unit Minimum value Default value Maximum value	Data type R/W persistent Expert	Parameter address via fieldbus
MBformat	Modbus data format 1 / 8Bit NoParity 1Stop: 8 bits, no parity bit, 1 stop bit 2 / 8Bit EvenParity 1Stop: 8 bits, even parity bit, 1 stop bit 3 / 8Bit OddParity 1Stop: 8 bits, odd parity bit, 1 stop bit 4 / 8Bit NoParity 2Stop: 8 bits, no parity bit, 2 stop bits NOTE: Changed settings do not become active until the unit is switched on the next time	- 1 2 4	UINT16 UINT16 R/W per. -	Modbus 5642 CIP 122.1.5
ModeError	Error code for synchronous errors (ME flag) Manufacturer-specific error code that caused the ModeError flag to be set. Usually, this is an error that was caused by the activation of an operating mode.	- - 0 -	UINT16 UINT16 R/- - -	Modbus 6962 CIP 127.1.25
MT_dismax	Max. permissible distance If the reference value is active and the maximum permissible distance is exceeded, an error of class 1 is generated. The value 0 switches off monitoring.	revolution 0.0 1.0 999.9	UINT16 UINT16 R/W - -	Modbus 11782 CIP 146.1.3
PA_T_max	Maximum permissible power stage temperature (163)	°C - 0 -	INT16 INT16 R/- per. -	Modbus 4110 CIP 116.1.7
PA_T_warn	Temperature warning threshold of power stage (163)	°C - 0 -	INT16 INT16 R/- per. -	Modbus 4108 CIP 116.1.6
PA_U_maxDC	Maximum permissible DC bus voltage Voltage in increments of 100mV	V - - -	UINT16 UINT16 R/- per. -	Modbus 4102 CIP 116.1.3
PA_U_minDC	DC bus voltage low threshold for switching off the drive Voltage in increments of 100mV	V - - -	UINT16 UINT16 R/- per. -	Modbus 4104 CIP 116.1.4
PA_U_minStopDC	DC bus voltage low threshold for Quick Stop If this threshold is reached, the drive performs a Quick Stop. Voltage in increments of 100mV	V - - -	UINT16 UINT16 R/- per. -	Modbus 4116 CIP 116.1.10

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Parameter Name	Description	Unit Minimum value Default value Maximum value	Data type R/W persistent Expert	Parameter address via fieldbus
PAR_CTRLreset	Reset controller parameters 0 / no: No 1 / yes: Yes The controller parameters of the speed controller and the position controller are reset. The current controller is automatically adjusted under consideration of the connected motor.	- 0 - 1	UINT16 UINT16 R/W -	Modbus 1038 CIP 104.1.7
PAReprSave	Save parameter values to EEPROM Bit 0 = 1: Save all persistent parameters The currently set parameters are saved to the non-volatile memory (EEPROM). The saving process is complete when the parameter is read and 0 is returned.	- - - -	UINT16 UINT16 R/W -	Modbus 1026 CIP 104.1.1
PAReprSaveDVN	Save parameter to EEPROM with DeviceNet When the configuration is downloaded with RSNetWorx, this parameter is transferred last. It saves the current parameter settings to the non-volatile memory (EEPROM). The parameter can be changed between two values and causes a download in case of a manual change in RSNetWorkx. Both values are saved.	- 0 0 1	UINT16 UINT16 R/W -	Modbus 16218 CIP 163.1.45
PARfactorySet	Restore factory settings (default values) 0 / No: No 1 / Yes: Yes All parameters are set to their default values, these are saved to the EEPROM. Restoring the factory settings is only possible via the commissioning software. The saving process is complete when the parameter is read and 0 is returned. NOTE: The default becomes active only when the unit is switched on the next time.	- 0 - 3	R/W - -	
PARuserReset	Reset user parameters (189) Bit 0 = 1: Set persistent parameters to default values. All parameters are reset with the exception of: - Communication parameters - Definition of the direction of rotation - Signal selection position interface - I/O functions NOTE: The new settings are not saved to the EEPROM!	- 0 - 7	UINT16 UINT16 R/W -	Modbus 1040 CIP 104.1.8

Parameter Name	Description	Unit Minimum value Default value Maximum value	Data type R/W persistent Expert	Parameter address via fieldbus
POSdirOfRotat	<p>Definition of direction of rotation (188)</p> <p>0 / clockwise: Clockwise 1 / counter clockwise: Counter-clockwise</p> <p>Meaning: At positive speeds, the drive rotates clockwise (looking at the motor shaft at the flange).</p> <p>NOTE: If you use limit switches, you must interchange the limit switch connections after changing the settings. The limit switch which is reached with a jog movement in positive direction must be connected to the LIMP input and vice versa.</p> <p>NOTE: Changed settings do not become active until the unit is switched on the next time.</p>	- 0 0 1	UINT16 UINT16 R/W per. -	Modbus 1560 CIP 106.1.12
POSScaleDenom	<p>Denominator of position scaling (170)</p> <p>Refer to numerator (POSScaleNum) for a description.</p> <p>A new scaling is activated when the numerator value is supplied.</p>	usr 1 16384 2147483647	INT32 INT32 R/W per. -	Modbus 1550 CIP 106.1.7
POSScaleNum	<p>Numerator of position scaling (170)</p> <p>Specification of the scaling factor:</p> <p>Motor revolutions [U] ----- Change of user position [usr]</p> <p>A new scaling is activated when the numerator value is supplied.</p> <p>User limit values may be reduced due to the calculation of an internal factor.</p>	revolution 1 1 2147483647	INT32 INT32 R/W per. -	Modbus 1552 CIP 106.1.8
PPn_target	<p>Reference speed in operating mode profile position (143)</p> <p>The maximum value is limited to the current setting in CTRL_n_max. The adjustable value is internally limited to the current parameter setting in RAMPn_max.</p>	min ⁻¹ 1 60 13200	R/W - -	
PPp_absusr	<p>Target position absolute of operating mode profile position (143)</p> <p>Min./max values depend on: - Scaling factor - Software limit switches (if they are activated)</p>	usr - 0 -	R/W - -	

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Parameter Name	Description	Unit Minimum value Default value Maximum value	Data type R/W persistent Expert	Parameter address via fieldbus
PPp_relpactusr	<p>Target position relative to current motor position (143)</p> <p>Min./max values depend on: - Position normalization factor - Software limit switches (if they are activated)</p> <p>In the case of active positioning in Profile Position mode, relative positioning refers to the current motor position. The absolute user position limits can only be overrun if the drive is at standstill when the movement starts ($x_{end}=1$). In this case, implicit position setting to position 0 is performed.</p>	usr - 0 -	R/W - -	
PPp_relprefusr	<p>Target position relative to the current target position (143)</p> <p>Min./max values depend on: - Position normalization factor - Software limit switches (if they are activated)</p> <p>In the case of active positioning in operating mode Profile Position, relative positioning refers to the target position of the current movement. The absolute user position limits can only be overrun if the drive is at standstill when the movement starts ($x_{end}=1$). In this case, implicit position setting to position 0 is performed.</p>	usr - 0 -	R/W - -	
PVn_target	<p>Reference speed of operating mode profile velocity (145)</p> <p>The maximum value is limited to the current setting in CTRL_n_max. The adjustable value is internally limited to the current parameter setting in RAMPn_max.</p>	min ⁻¹ -13200 - 13200	R/W - -	

Parameter Name	Description	Unit Minimum value Default value Maximum value	Data type R/W persistent Expert	Parameter address via fieldbus
RAMP_TAUjerk	<p>Jerk limitation (174)</p> <p>0 / off: Off 1 / 1: 1 ms 2 / 2: 2 ms 4 / 4: 4 ms 8 / 8: 8 ms 16 / 16: 16 ms 32 / 32: 32 ms 64 / 64: 64 ms 128 / 128: 128 ms</p> <p>Limits the acceleration change (jerk) of the reference position generation during the positioning transitions: Standstill - acceleration Acceleration - constant speed Constant speed - deceleration Deceleration - standstill</p> <p>Processing in the following operating modes: - Profile velocity - Profile position - Jog - Homing</p> <p>Adjustments can only be made if the operating mode is inactive (x_end=1).</p>	ms 0 0 128	UINT16 UINT16 R/W per. -	Modbus 1562 CIP 106.1.13
RAMPacc	Acceleration of profile generator (172)	min ⁻¹ /s 1 600 3000000	UINT32 UINT32 R/W per. -	Modbus 1556 CIP 106.1.10
RAMPacdec	<p>Optimized ramp setting with one access</p> <p>Adjustment of acceleration and deceleration values with a single access</p> <p>High word: acceleration Low word: deceleration</p> <p>Values are entered in 10rpm/s</p> <p>Write access changes the values under RAMPacc and RAMPdec. The limit values are checked on the basis of the values indicated for these parameters. If the currently set value cannot be represented as 16 bit value, the max, UINT16 value is written.</p>	usr - 0 -	R/W - -	
RAMPdec	Deceleration of profile generator (172)	min ⁻¹ /s 750 750 3000000	UINT32 UINT32 R/W per. -	Modbus 1558 CIP 106.1.11

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Parameter Name	Description	Unit Minimum value Default value Maximum value	Data type R/W persistent Expert	Parameter address via fieldbus
RAMPn_max	<p>Limitation of ref. speed for op. modes with profile generation (173)</p> <p>The parameter is active in the following operating modes:</p> <ul style="list-style-type: none"> - Profile position - Profile velocity - Homing - Jog <p>If a greater reference speed is set in one of these operating modes, it is automatically limited to RAMPn_max. This way, commissioning at limited speed is easy to perform.</p>	min ⁻¹ 60 13200 13200	UINT16 UINT16 R/W per. -	Modbus 1554 CIP 106.1.9
RAMPquickstop	<p>Deceleration ramp for Quick Stop (176)</p> <p>Deceleration of the drive when a software stop is triggered or if an error of error class 1 has occurred.</p>	min ⁻¹ /s 200 6000 3000000	UINT32 UINT32 R/W per. -	Modbus 1572 CIP 106.1.18
RAMPsym	<p>Symmetrical ramp</p> <p>Acceleration and deceleration of the profile generator (16 bit value) in 10 (1/min)/s</p> <p>Write access changes the values under RAMPacc and RAMPdecel. The limit values are checked on the basis of the values indicated for these parameters.</p> <p>Read access returns the greater value from RAMPacc/RAMPdecel. If the currently set value cannot be represented as 16 bit value, the max, UINT16 value is written.</p>	usr - 0 -	UINT16 UINT16 R/W - -	Modbus 1538 CIP 106.1.1
SPEEDn_target	<p>Reference speed in operating mode speed control (136)</p> <p>The internal maximum speed is limited to the current setting in CTRL_n_max.</p>	min ⁻¹ -30000 0 30000	INT16 INT16 R/W - -	Modbus 8456 CIP 133.1.4
SPEEDreference	<p>Selection of ref. value source for operating mode speed control</p> <p>0 / none: None 1 / Analog Input: Reference value via +/- 10V interface ANA1 2 / Parameter 'speedTarg': Reference value via parameter SPEEDn_target</p>	- 0 0 2	UINT16 UINT16 R/W - -	Modbus 8450 CIP 133.1.1
SPV_Flt_pDiff	<p>Error response to tracking error (168)</p> <p>1 / ErrorClass1: Error class 1 2 / ErrorClass2: Error class 2 3 / ErrorClass3: Error class 3</p>	- 1 3 3	UINT16 UINT16 R/W per. -	Modbus 1302 CIP 105.1.11
SPV_p_maxDiff	<p>Max. permissible tracking error of the position controller (165)</p> <p>The tracking error is the current position control deviation.</p>	revolution 0.0001 1.0000 200.0000	UINT32 UINT32 R/W per. -	Modbus 4636 CIP 118.1.14

Parameter Name	Description	Unit Minimum value Default value Maximum value	Data type R/W persistent Expert	Parameter address via fieldbus
SPV_SW_Limits	Monitoring of software limit switches (162) 0 / none: None (default) 1 / SWLIMP: Activation of software limit switches positive direction 2 / SWLIMN: Activation of software limit switches negative direction 3 / SWLIMP+SWLIMN: Activation of software limit switches both directions Monitoring of software limit switches only works in case of successful homing (ref_ok = 1).	- 0 0 3	UINT16 UINT16 R/W per. -	Modbus 1542 CIP 106.1.3
SPVswLimNusr	Negative position limit for software limit switch (161) Refer to description 'SPVswLimPusr'	usr - -2147483648 -	INT32 INT32 R/W per. -	Modbus 1546 CIP 106.1.5
SPVswLimPusr	Positive position limit for software limit switch (161) If a user value entered is outside of the permissible user range, the limit switch limits are automatically set to the max. user value.	usr - 2147483647 -	INT32 INT32 R/W per. -	Modbus 1544 CIP 106.1.4
STANDp_win	Standstill window, permissible control deviation (181) The control deviation for the standstill window time must be within this range for a standstill of the drive to be detected. Processing of the standstill window must be activated via the parameter 'STANDpwin-Time.	revolution 0.0000 0.0010 3.2767	UINT16 UINT16 R/W per. -	Modbus 4370 CIP 117.1.9
STANDpwinTime	Standstill window, time (181) 0: Monitoring of standstill window deactivated >0: Time in ms during which the control deviation must be in the standstill window	ms 0 0 32767	UINT16 UINT16 R/W per. -	Modbus 4372 CIP 117.1.10
STANDpwinTout	Timeout time for standstill window monitoring (181) 0 : Timeout monitoring deactivated >0 : Timeout time in ms Standstill window processing values are set via STANDp_win und STANDpwinTime. Time monitoring starts when the target position (reference position of position controller) is reached or when the profile generator has finished processing.	ms 0 0 16000	UINT16 UINT16 R/W per. -	Modbus 4374 CIP 117.1.11

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12 Accessories and spare parts

12.1 Accessories

Source commissioning software The latest version of the commissioning software is available for download from the internet:

<http://www.schneider-electric.com>

Source EPLAN Macros For easier engineering, macro files and product master data are available for download from the Internet at:

<http://www.schneider-electric.com>

Designation	Order no.
Braking Resistor Controller UBC60	ACC3EA001
Installation kit	VW3L10111
Insert with cable entry (2 pcs)	VW3L10100N2
Insert with cable entry (10 pcs)	VW3L10100N10
Cable entry for commissioning	VW3L10222
Insert for sealing (10 pcs)	VW3L10000N10
Insert for sealing (20 pcs)	VW3L10000N20
Insert for sealing (50 pcs)	VW3L10000N50
Cable for commissioning interface, 3m	VW3L1R000R30
Insert kit for commissioning	VW3L1R000
Cable kit, power supply, DeviceNet, 3m	VW3L2D001R30
Cable kit, STO, 3m	VW3L20010R30
Cable kit, STO, 5m	VW3L20010R50
Cable kit, STO, 10m	VW3L20010R100
Cable kit, STO, 15m	VW3L20010R150
Cable kit, STO, 20m	VW3L20010R200
Cable, power supply, 3m	VW3L30001R30
Cable, power supply, 5m	VW3L30001R50
Cable, power supply, 10m	VW3L30001R100
Cable, power supply, 15m	VW3L30001R150
Cable, power supply, 20m	VW3L30001R200
Cable, STO, 3m	VW3L30010R30
Cable, STO, 5m	VW3L30010R50
Cable, STO, 10m	VW3L30010R100
Cable, STO, 15m	VW3L30010R150
Cable, STO, 20m	VW3L30010R200
Connector, DeviceNet	VW3L5D000
Connector kit, 2 x I/O	VW3L50200
Connector kit, 3 x I/O	VW3L50300
Connector, STO output	VW3L50010

Designation	Order no.
Insert kit, 3 x I/O	VW3L40300
Insert kit, 2 x I/O, 1 x STO input	VW3L40210
Insert kit, 1 x STO input, 1 x STO output	VW3L40020
Insert kit, 4 x I/O, 1 x STO input, 1 x STO output	VW3L40420

Cable Supplier recommendations:

- Hans Turck GmbH & Co. KG
www.turck.com
- Franz Binder GmbH & Co. elektrische Bauelemente KG
www.binder-connector.de
- PHOENIX CONTACT GmbH & Co. KG
www.phoenixcontact.com
- Lumberg Automation
www.lumberg-automation.com

Tool The tools required for cable assembly must be ordered directly from the manufacturer.

- Crimping tool for CN1: AMP 654174-1
- Crimping tool for CN2, CN4 and CN5: Molex 69008-0982
- Crimping tool for CN3: Molex 69008-0724
- Extraction tool for CN2, CN4 and CN5: Molex 11-03-0043
- Extraction tool for CN3: Molex 11-03-0044

Converter A converter is required for commissioning and for service purposes.

- Converter: USB-to-CAN compact, www.ixxat.com

12.2 Gearboxes

Designation	Order no.
Planetary gear for Lexium Integrated Drive ILAxx571, ratio 3/1	GBX060003A571L
Planetary gear for Lexium Integrated Drive ILAxx571, ratio 5/1	GBX060005A571L
Planetary gear for Lexium Integrated Drive ILAxx571, ratio 8/1	GBX060008A571L
Planetary gear for Lexium Integrated Drive ILAxx571, ratio 16/1	GBX060016A571L
Planetary gear for Lexium Integrated Drive ILAxx571, ratio 40/1	GBX060040A571L
Planetary gear for Lexium Integrated Drive ILAxx572, ratio 3/1	GBX060003A572L
Planetary gear for Lexium Integrated Drive ILAxx572, ratio 5/1	GBX060005A572L
Planetary gear for Lexium Integrated Drive ILAxx572, ratio 8/1	GBX060008A572L
Planetary gear for Lexium Integrated Drive ILAxx572, ratio 16/1	GBX060016A572L
Planetary gear for Lexium Integrated Drive ILAxx572, ratio 40/1	GBX060040A572L

13 Service, maintenance and disposal

▲ WARNING

DAMAGE TO SYSTEM COMPONENTS AND LOSS OF CONTROL

Interruptions of the negative connection of the controller supply voltage can cause excessively high voltages at the signal connections.

- Do not interrupt the negative connection between the power supply unit and load with a fuse or switch.
- Verify correct connection before switching on.
- Do not connect the controller supply voltage or change its wiring while the is supply voltage present.

Failure to follow these instructions can result in death, serious injury or equipment damage.

▲ CAUTION

RISK OF INJURY WHEN THE PRINTED CIRCUIT BOARD CONNECTORS ARE REMOVED

- Before removing the connectors, you must unlocked them.
 - Supply voltage ∇ DC:
Unlock by pulling at the connector housing
 - Others:
Unlock by pressing the connector lock
- Only pull the connector housing (not the cable).

Failure to follow these instructions can result in injury or equipment damage.



The product may only be repaired by a certified customer service center. No warranty or liability is accepted for repairs made by unauthorized persons.

13.1 Service address

If you cannot resolve an error yourself please contact your sales office. Have the following details available:

- Nameplate (type, identification number, serial number, DOM, ...)
- Type of error (such as LED flash code or error number)
- Previous and concomitant circumstances
- Your own assumptions concerning the cause of the error

Also include this information if you return the product for inspection or repair.



If you have any questions please contact your sales office. Your sales office staff will be happy to give you the name of a customer service office in your area.

<http://www.schneider-electric.com>

13.2 Maintenance

Check the product for pollution or damage at regular intervals.

13.2.1 Lifetime STO safety function

The STO safety function is designed for a lifetime of 20 years. After this period, the data of the safety function are no longer valid. The expiry date is determined by adding 20 years to the DOM shown on the nameplate of the product.

- ▶ This date must be included in the maintenance plan of the system.

Do not use the safety function after this date.

Example The DOM on the nameplate of the product is shown in the format DD.MM.YY, for example 31.12.07 . (December 31, 2007). This means: Do not use the safety function after December 31, 2027.

13.3 Replacing units

⚠ WARNING

UNINTENDED BEHAVIOR

The behavior of the drive system is governed by numerous stored data or settings. Unsuitable settings or data may trigger unexpected movements or responses to signals and disable monitoring functions.

- Do NOT operate the drive system with unknown settings or data.
- Verify that the stored data and settings are correct.
- When commissioning, carefully run tests for all operating states and potential fault situations.
- Verify the functions after replacing the product and also after making changes to the settings or data.
- Only start the system if there are no persons or obstructions in the hazardous area.

Failure to follow these instructions can result in death, serious injury or equipment damage.



Prepare a list with the parameters required for the functions used.

Observe the following procedure when replacing devices.

- ▶ Save all parameter settings to your PC using the commissioning software, see chapter 7.2.3 "Lexium CT commissioning software".
- ▶ Switch off all supply voltages. Verify that no voltages are present (safety instructions).
- ▶ Label all connections and uninstall the product.
- ▶ Note the identification number and the serial number shown on the product nameplate for later identification.
- ▶ Install the new product as per chapter 6 "Installation".
- ▶ Commission the product as per chapter 7 "Commissioning".

13.4 Shipping, storage, disposal

Note the ambient conditions in chapter 3.2 "Ambient conditions".

- Shipping* The product must be protected against shocks during transportation. If possible, use the original packaging for shipping.
- Storage* The product may only be stored in spaces where the specified permissible ambient conditions for room temperature and humidity are met. Protect the product from dust and dirt.
- Disposal* The product consists of various materials that can be recycled and must be disposed of separately. Dispose of the product in accordance with local regulations.

14 Glossary

14.1 Units and conversion tables

The value in the specified unit (left column) is calculated for the desired unit (top row) with the formula (in the field).

Example: conversion of 5 meters [m] to yards [yd]
 $5 \text{ m} / 0.9144 = 5.468 \text{ yd}$

14.1.1 Length

	in	ft	yd	m	cm	mm
in	-	/ 12	/ 36	* 0.0254	* 2.54	* 25.4
ft	* 12	-	/ 3	* 0.30479	* 30.479	* 304.79
yd	* 36	* 3	-	* 0.9144	* 91.44	* 914.4
m	/ 0.0254	/ 0.30479	/ 0.9144	-	* 100	* 1000
cm	/ 2.54	/ 30.479	/ 91.44	/ 100	-	* 10
mm	/ 25.4	/ 304.79	/ 914.4	/ 1000	/ 10	-

14.1.2 Mass

	lb	oz	slug	kg	g
lb	-	* 16	* 0.03108095	* 0.4535924	* 453.5924
oz	/ 16	-	* 1.942559×10^{-3}	* 0.02834952	* 28.34952
slug	/ 0.03108095	/ 1.942559×10^{-3}	-	* 14.5939	* 14593.9
kg	/ 0.45359237	/ 0.02834952	/ 14.5939	-	* 1000
g	/ 453.59237	/ 28.34952	/ 14593.9	/ 1000	-

14.1.3 Force

	lb	oz	p	dyne	N
lb	-	* 16	* 453.55358	* 444822.2	* 4.448222
oz	/ 16	-	* 28.349524	* 27801	* 0.27801
p	/ 453.55358	/ 28.349524	-	* 980.7	* 9.807×10^{-3}
dyne	/ 444822.2	/ 27801	/ 980.7	-	/ 100×10^3
N	/ 4.448222	/ 0.27801	/ 9.807×10^{-3}	* 100×10^3	-

14.1.4 Power

	HP	W
HP	-	* 746
W	/ 746	-

14.1.5 Rotation

	min ⁻¹ (RPM)	rad/s	deg./s
min ⁻¹ (RPM) -		* $\pi / 30$	* 6
rad/s	* $30 / \pi$	-	* 57.295
deg./s	/ 6	/ 57.295	-

14.1.6 Torque

	lb-in	lb-ft	oz-in	Nm	kp-m	kp-cm	dyne-cm
lb-in	-	/ 12	* 16	* 0.112985	* 0.011521	* 1.1521	* 1.129×10^6
lb-ft	* 12	-	* 192	* 1.355822	* 0.138255	* 13.8255	* 13.558×10^6
oz-in	/ 16	/ 192	-	* 7.0616×10^{-3}	* 720.07×10^{-6}	* 72.007×10^{-3}	* 70615.5
Nm	/ 0.112985	/ 1.355822	/ 7.0616×10^{-3}	-	* 0.101972	* 10.1972	* 10×10^6
kp-m	/ 0.011521	/ 0.138255	/ 720.07×10^{-6}	/ 0.101972	-	* 100	* 98.066×10^6
kp-cm	/ 1.1521	/ 13.8255	/ 72.007×10^{-3}	/ 10.1972	/ 100	-	* 0.9806×10^6
dyne-cm	/ 1.129×10^6	/ 13.558×10^6	/ 70615.5	/ 10×10^6	/ 98.066×10^6	/ 0.9806×10^6	-

14.1.7 Moment of inertia

	lb-in ²	lb-ft ²	kg-m ²	kg-cm ²	kp-cm-s ²	oz-in ²
lb-in ²	-	/ 144	/ 3417.16	/ 0.341716	/ 335.109	* 16
lb-ft ²	* 144	-	* 0.04214	* 421.4	* 0.429711	* 2304
kg-m ²	* 3417.16	/ 0.04214	-	* 10×10^3	* 10.1972	* 54674
kg-cm ²	* 0.341716	/ 421.4	/ 10×10^3	-	/ 980.665	* 5.46
kp-cm-s ²	* 335.109	/ 0.429711	/ 10.1972	* 980.665	-	* 5361.74
oz-in ²	/ 16	/ 2304	/ 54674	/ 5.46	/ 5361.74	-

14.1.8 Temperature

	°F	°C	K
°F	-	(°F - 32) * 5/9	(°F - 32) * 5/9 + 273.15
°C	°C * 9/5 + 32	-	°C + 273.15
K	(K - 273.15) * 9/5 + 32	K - 273.15	-

14.1.9 Conductor cross section

AWG	1	2	3	4	5	6	7	8	9	10	11	12	13
mm ²	42.4	33.6	26.7	21.2	16.8	13.3	10.5	8.4	6.6	5.3	4.2	3.3	2.6

AWG	14	15	16	17	18	19	20	21	22	23	24	25	26
mm ²	2.1	1.7	1.3	1.0	0.82	0.65	0.52	0.41	0.33	0.26	0.20	0.16	0.13

14.2 Terms and Abbreviations

<i>Actual position</i>	Current position of moving components in the drive system.
<i>Assembly</i>	Various attributes are combined in one single data packet. Client and server know the structure of the packets. See also Explicit Message.
<i>Attribute</i>	A single value of an object (in a network device) that can be read or written over the network. (see Class - Instance - Object - Attribute)
<i>Big Endian format</i>	Method of storing data; the highest-value byte of a data word is at the first position (big end first).
<i>CIP</i>	C ommon I ndustrial P rotocol, general specification for communication between fieldbus devices.
<i>Class</i>	DeviceNet describes the behavior of a network node in so-called object classes. A class defines the behavior of (related) objects and consists of attributes and so-called services to work with these attributes (read/write) for example: class vehicles, object car, attribute fuel level, service fill (see Class - Instance - Object - Attribute)
<i>Client</i>	First transmitter, then recipient of fieldbus messages in the client-server relationship. Starts transmission with a transmission to the server; the reference point is the server object dictionary.
<i>Consumer</i>	Network device that receives data packets, see also Producer
<i>COS</i>	C hange O f S tate: special I/O connection in which data is only transmitted when changes occur.
<i>Default value</i>	Factory setting.
<i>Degree of protection</i>	The degree of protection is a standardized specification for electrical equipment that describes the protection against the ingress of foreign objects and water (for example: IP 20).
<i>Direction of rotation</i>	Rotation of the motor shaft in a clockwise or counterclockwise direction of rotation. Clockwise rotation is when the motor shaft rotates clockwise as you look at the end of the protruding motor shaft.
<i>DOM</i>	The D ate o f m anufacturing on the nameplate of the device is shown in the format DD.MM.YY, for example 31.12.06 (December 31, 2006).
<i>Drive system</i>	System consisting of controller, power stage and motor.
<i>EDS</i>	(E lectronic D ata S heet); contains the specific properties of a product.
<i>EMC</i>	Electromagnetic compatibility
<i>Encoder</i>	Sensor for detection of the angular position of a rotating component. Installed in a motor, the encoder shows the angular position of the rotor.
<i>Error</i>	Discrepancy between a computed, observed or measured value or condition and the specified or theoretically correct value or condition.
<i>Error class</i>	Classification of errors into groups. The different error classes allow for specific responses to faults, for example by severity.
<i>ESD</i>	(e lectro s tatic d ischarge) is the electrostatic discharge and describes processes and effects occurring during the discharge of electric charges.

<i>Fatal error</i>	In the case of fatal error, the product is not longer able to control the motor, so that an immediate deactivation of the power stage is necessary.
<i>Fault</i>	Operating state of the drive caused as a result of a discrepancy between a detected (computed, measured or signaled) value or condition and the specified or theoretically correct value or condition.
<i>Fault reset</i>	A function used to restore the drive to an operational state after a detected error is cleared by removing the cause of the error so that the error is no longer active (transition from operating state "Fault" to state "Operation Enable").
<i>I²t monitoring</i>	Anticipatory temperature monitoring. The expected temperature rise of components is calculated in advance on the basis of the motor current. If a limit value is exceeded, the drive reduces the motor current.
<i>I/O</i>	Inputs/outputs
<i>Inc</i>	Increments
<i>Index pulse</i>	Signal of an encoder to reference the rotor position in the motor. The encoder returns one index pulse per revolution.
<i>Input</i>	Direction of data flow from the network perspective: data packet/status message from device, see also Output
<i>Instance</i>	An actual object that is derived from a specific class. (see Class - Instance - Object - Attribute)
<i>Internal units</i>	Resolution of the power stage at which the motor can be positioned. Internal units are specified in increments.
<i>LED</i>	Light Emitting Diode
<i>Limit switch</i>	Switches that signal overtravel of the permissible range of travel.
<i>Little Endian format</i>	Method of storing data; the lowest-value byte of a data word is at the first position (little end first).
<i>MAC ID</i>	Node address (MAC=Media Access Control); a unique address in the entire network.
<i>Master</i>	Active bus device that controls the data traffic on the network.
<i>MT</i>	ModeToggle , toggling a bit from 0 -> 1 or 1 -> 0
<i>NTC</i>	Resistor with negative temperature coefficient. Resistance value is reduced as the temperature rises.
<i>Object</i>	An object is a member of a specific class. The object 'bicycle' is a member of the class 'vehicles'. The object 'car' is a member of the class 'vehicles'. (see Class - Instance - Object - Attribute)
<i>ODVA</i>	Open DeviceNet Vendor Association . Nutzer Organisation für DeviceNet Standards. User organization for DeviceNet standards
<i>Output</i>	Direction of data flow from the network perspective: data packet/command to a device, see also Input
<i>Parameter</i>	Device data and values that can be set by the user.
<i>PELV</i>	Protective Extra Low Voltage, low voltage with isolation. For more information: IEC 60364-4-41
<i>Persistent</i>	Indicates whether the value of the parameter remains in the memory after the device is switched off.

<i>PLC</i>	Programmable logic controller
<i>RO , RW</i>	Read Only = Parameter can only be read Read/Write = Parameter can be read and written
<i>Power stage</i>	The power stage controls the motor. The power stage generates current for controlling the motor on the basis of the positioning signals from the controller.
<i>Producer</i>	Network device that generates data packets, see also Consumer
<i>PTC</i>	Resistor with positive temperature coefficient. Resistance value increases as the temperature rises.
<i>Pulse/direction signals</i>	Digital signals with variable pulse frequencies which signal changes in position and direction of rotation via separate signal wires.
<i>Quick Stop</i>	Function used to enable fast deceleration of the motor via a command or in the event of an error.
<i>rms</i>	Root Mean Square value of a voltage (V_{rms}) or a current (A_{rms})
<i>RS485</i>	Fieldbus interface as per EIA-485 which enables serial data transmission with multiple devices.
<i>RCD</i>	Residual Current Device
<i>Scaling factor</i>	This factor is the ratio between an internal unit and a user-defined unit.
<i>Scanner</i>	Bus device that, as a master unit, controls all data transmission via the bus. Corresponds to the master.
<i>Server</i>	First the transmitter, then the recipient of fieldbus messages in the client-server relationship; responds to the request of a client; the reference point is the server object dictionary
<i>Slave</i>	Passive bus device that receives control commands and provides data to the master.
<i>Slave address</i>	Communication between master and slave is only possible after the assignment of unique addresses.
<i>Toggle</i>	The value of a bit changes from 0 to 1 or vice versa, see MT, ModeToggle
<i>UCMM</i>	U nconnected M essage M anager: unconfirmed message channel
<i>User-defined unit</i>	Unit whose reference to motor rotation can be determined by the user via parameters.
<i>Warning</i>	If the term is used outside the context of safety instructions, a warning alerts to a potential problem that was detected by a monitoring function. A warning is not an error and does not cause a transition of the operating state.
<i>Watchdog</i>	Unit that monitors cyclic basic functions in the product. The power stage is disabled and the outputs are switched off in the event of errors.

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