LXM05C

AC servo drive
Product manual

V1.00, 12.2006

Telemecanique

Schneider Electric

Important information

The drive systems described here are products for general use that conform to the state of the art in technology and are designed to prevent any dangers. However, drives and drive controllers that are not specifically designed for safety functions are not approved for applications where the functioning of the drive could endanger persons. The possibility of unexpected or unbraked movements can never be totally excluded without additional safety equipment. For this reason personnel must never be in the danger zone of the drives unless additional suitable safety equipment prevents any personal danger. This applies to operation of the machine during production and also to all service and maintenance work on drives and the machine. The machine design must ensure personal safety. Suitable measures for prevention of property damage are also required.

See safety section for additional critical instructions.

Not all product variants are available in all countries.
Please consult the current catalogue for information on the availability of product variants.

We reserve the right to make changes during the course of technical developments.

All details provided are technical data and not promised characteristics.

In general, product names must be considered to be trademarks of the respective owners, even if not specifically identified as such.

Table of Contents

Writing conventions and symbols

Work steps   If work steps must be carried out in sequence, they are shown as follows:

■ Special prerequisites for the following work steps

▶ Step 1

◁ Important response to this work step

▶ Step 2

If a response to a work step is specified, this will inform you that the step has been carried out correctly.

Unless otherwise stated, the individual instruction steps must be carried in the given sequence.

Lists   Lists can be sorted alphanumerically or by priority. Lists are structured as follows:

• Point 1

• Point 2

– Subpoint to 2

– Subpoint to 2

• Point 3

Making work easier   Information on making work easier can be found at this symbol:

This offers supplementary information on making work easier.
See the chapter on safety for an explanation of the safety instructions.

Parameter display   The parameters are shown in the text with parameter name and HMI code, e.g. POSdirOfRotat (*Prot*). The tabular view is explained in the chapter on Parameters on page 11-1. The parameter list is alphabetically arranged by parameter name.

1 Introduction

1.1 Unit overview
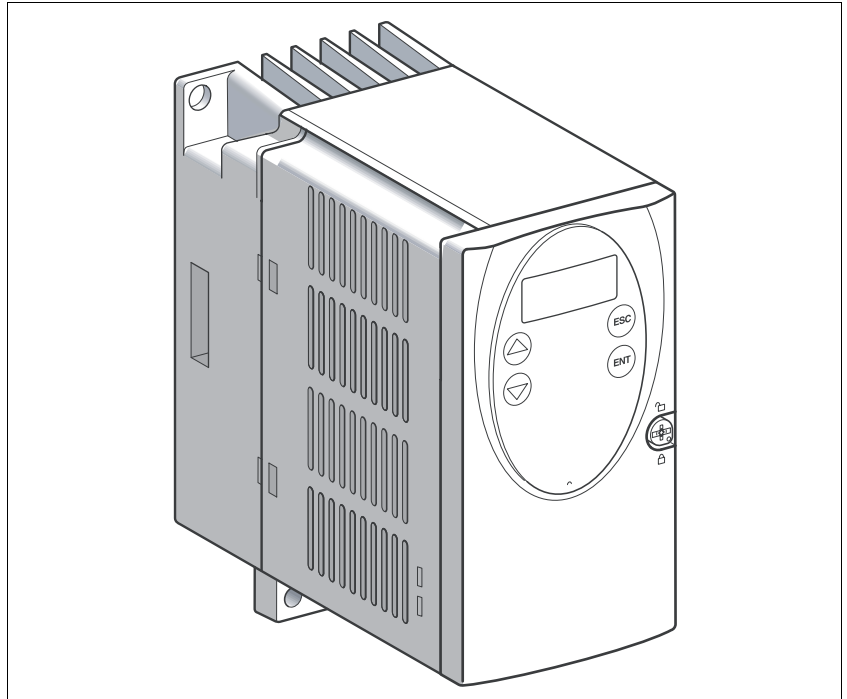
Drive system The LXM05C is an AC servo drive that can be used anywhere.

Reference values are normally specified and monitored by a higher-level PLC, e.g. Premium.

It offers a very compact and powerful drive system in combination with selected servomotorsSchneider Electric.

The front panel includes an input panel (HMI, **H**uman**M**achine**I**nterface) with display and keypad for setting parameters.

Reference value default The setpoint value can be specified via:

- Inputs: CW/CCW, pulse/direction signals or A/B encoder signals

- ±10 V analogue signals for torque control or speed control. Position feedback of the actual motor position is accomplished by A/B encoder signals

1.2   Components and interfaces
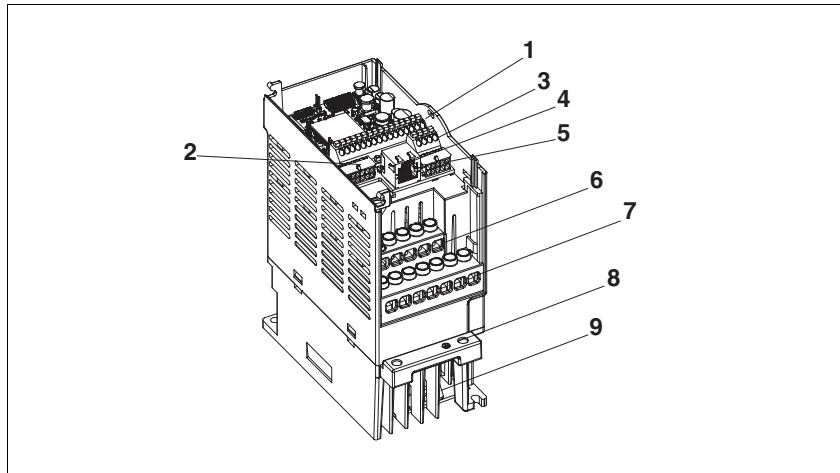
(1)   CN1, I/O signal connection (spring loaded terminals)

- One analogue reference input ±10V in speed control and current control modes (torque control)
- Nine digital inputs/outputs. The assignment depends on the selected operating mode
- Five RS422 inputs for CW/CCW, pulse/direction signals or A/B encoder signals

(2)   12-pin CN2 female connector for motor encoder (SinCos Hi-perface® sensor)

(3)   CN3, connection for 24 V power supply

(4)   CN4, RJ45 female connector for connection

- PC with PowerSuite commissioning software
- Remote terminal

(5)   10-pin CN5 female connector for

- Output of actual motor position via A/B encoder signals for position feedback for a higher level position controller (e.g. PLC with motion-control card).

(6)   Screw terminals for connecting the mains power

(7)   Screw terminals for connecting the motor and external brake resistors

(8)   Bracket for EMC mounting plate

(9)   Heat sink

1.3 Type code

LXM	**05**	**C**	**D10**	**M2**	**(•••)**

Product designation
LXM - Lexium

Product type
05 - AC servo drive for one axis

Interfaces
C - pulse direction

Peak current (crest value Î) [A_{pk}]
U70 - 7A_{pk}
D10 - 10A_{pk}
D14 - 14A_{pk}
D17 - 17A_{pk}
D22 - 22A_{pk}
D28 - 28A_{pk}
D34 - 34A_{pk}
D57 - 57A_{pk}

Power amplifier supply voltage [V_{AC}]
M2 - 1~, 230V_{AC}
N4 - 3~, 400V_{AC}

Other options

1.4 Documentation and literature references

The following User's manuals are supplied with this drive system:

- **Product manual**, describes the technical data, installation, commissioning and all operating modes and operating functions.

- **Motor manual**, describes the technical properties of the motors, including correct installation and commissioning.

The user's manuals can also be found in the Internet at
http://www.telemecanique.com.

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

1.5 Directives and standards

CE mark With the declaration of conformity and the CE mark on the product the manufacturer certifies that the product complies with the requirements of all relevant EC directives.

EC Machine Directive   The drive systems described here are not machines as defined by the EC Machine Directive (98/37/EEC) but components for installation in machines. They do not have moving parts designed for specific purposes. However, they can be components of a machine or system.

The manufacturer must certify that the complete system conforms to the machine directive with the CE mark.

EC EMC Directive   The EC Electromagnetic Compatibility Directives (89/336/EEC) applies to products that cause electromagnetic interference or whose operation may be be adversely affected by electromagnetic interference.

Conformity with the EMC Directive can only be expected of drive systems after correct installation in the machine. The information on ensuring electromagnetic compatibility given in the chapter on "Installation" must be followed to ensure that the drive system in the machine or system is EMC-compatible and that the product can legally be operated.

EC Low-Voltage Directive   The EC Low-Voltage Directive (73/23/EEC) lays down safety requirements for "electrical apparatus" as protection against the risks that can originate in such devices and can be created in response to external influences.

The drive systems described here comply with the EN 50178 Standard as per the Low-Voltage Directive.

Declaration of conformity   The declaration of conformity certifies that the drive system complies with the specific EC directive.

Standards for safe operation   IEC 60204-1: Electrical equipment of machines, General requirements

IEC 60529: IP degrees of protection

Standards for compliance with EMC limit values   IEC 61800-3: Variable-speed electrical drives

1.6 Declaration of conformity

The following declaration of conformity is applicable when the product is used under the specified general conditions and with the cables listed in the accessories.

EC Declaration of Conformity
Year 2006

⊠ according to EC Directive Low Voltage 73/23/EEC; changed by CE Marking Directive 93/68/EEC
⊠ according to EC Directive on Machinery 98/37/EEC
⊠ according to EC Directive EMC 2004/108/EEC

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:	AC Servo Drive
Type:	LXM05Cxxxxxx
Product number:	01637x1741xxx
Applied harmonized standards, especially:	EN 50178:1998 EN 61800-3:2001, second environment according to Berger Lahr EMC test conditions
Applied national standards and technical specifications, especially:	UL 508C Berger Lahr EMC test conditions 200.47-01 EN Product documentation
Company stamp:	**Berger Lahr GmbH & Co. KG** Postfach 11 80 · D-77901 Lahr Breslauer Str. 7 · D-77933 Lahr
Date/ Signature:	29 October 2006
Name/ Department:	Wolfgang Brandstätter/R & D

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2 Safety

2.1 Qualification of personnel

Only technicians who are familiar with and understand the contents of this manual and the other relevant manuals are authorised to work on and with this drive system. The technicians must be able to detect potential dangers that may be caused by setting parameters, changing parameter values and generally by the mechanical, electrical and electronic equipment.

The technicians must have sufficient technical training, knowledge and experience to recognise and avoid dangers.

The technicians must be familiar with the relevant standards, regulations and safety regulations that must be observed when working on the drive system.

2.2 Intended use

The drive systems described here are products for general use that conform to the state of the art in technology and are designed to prevent any dangers. However, drives and drive controllers that are not specifically designed for safety functions are not approved for applications where the functioning of the drive could endanger persons. The possibility of unexpected or unbraked movements can never be totally excluded without additional safety equipment. For this reason personnel must never be in the danger zone of the drives unless additional suitable safety equipment prevents any personal danger. This applies to operation of the machine during production and also to all service and maintenance work on drives and the machine. The machine design must ensure personal safety. Suitable measures for prevention of property damage are also required.

In the system configuration described the drive systems must be used in industrial applications only and must have a fixed connection only.

In all cases the applicable safety regulations and the specified operating conditions, such as environmental conditions and specified technical data, must be observed.

The drive system must not be commissioned and operated until completion of installation in accordance with the EMC regulations and the specifications in this manual.

To prevent personal injury and damage to property damaged drive systems must not be installed or operated.

Changes and modifications of the drive systems are not permitted and if made all no warranty and liability will be accepted.

The drive system must be operated only with the specified wiring and approved accessories. In general, use only original accessories and spare parts.

The drive systems must not be operated in an environment subject to explosion hazard (ex area).

2.3   Hazard categories

Safety notes and general information are indicated by hazard messages in the manual. In addition there are symbols and instructions affixed to the product that warn of possible hazards and help to operate the product safely.

Depending on the seriousness of the hazard, the messages are divided into three hazard categories.

⚠ **DANGER**

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

⚠ **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.

2.4 General safety instructions

┌───┐
│ ⚠ **DANGER** │
├───┤

Electric shock, fire or explosion

- Only qualified personnel who are familiar with and understand the contents of this manual are authorised to work on and with this drive system.

- The system manufacturer is responsible for compliance with all applicable regulations relevant to earthing the drive system.

- Many components, including printed wiring boards, operate at mains voltage. **Do not touch**. Do **not** touch unshielded components or screws of the terminals with voltage present.

- Install all covers and close the housing doors before applying power.

- The motor generates voltage when the shaft is rotated. Lock the shaft of the motor to prevent rotation before starting work on the drive system.

- Before working on the drive system:

  – Switch off power to all terminals.

  – Place a sign "DO NOT SWITCH ON" on the switch and lock to prevent switching on.

  – **Wait 6 minutes** (for discharge of DC bus capacitors). Do **not** short-circuit DC bus

  – Measure voltage at DC bus and check for <45V. (The DC bus LED is not a safe indication for absence of the DC bus voltage).

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

┌───┐
│ ⚠ **WARNING** │
├───┤

Unexpected movement

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

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

- Install the wiring carefully in accordance with the EMC requirements.

- Do not operate a drive system with unknown settings or data.

- Carry out a comprehensive commissioning test.

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

⚠ **WARNING**

Loss of control over controller

- Observe the accident prevention regulations. (For USA see also NEMA ICS1.1 and NEMA ICS7.1)

- The system manufacturer must take the potential error possibilities of the signals and the critical functions into account to ensure a safe status during and after errors. Some examples are: emergency stop, final position limitation, power failure and restart.

- The assessment of error possibilities must also include unexpected delays and the failure of signals or functions.

- Suitable redundant control paths must be in place for dangerous functions.

- Check that measures taken are effective.

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

2.5 Monitoring functions

The monitoring functions in the product protect the system and reduce the risks involved in a system malfunction. These monitoring functions are not sufficient for personal protection.
The following errors and limit values can be monitored:

Monitoring	Task	Protective function
Motor overload	Monitoring for excessively high current in the motor phases	Functional safety and device protection
Overvoltage and undervoltage	Monitoring for overvoltage and undervoltage of the power supply	Functional safety and device protection
Overtemperature	Monitoring device for overtemperature	Device protection

Table 2.1 Monitoring functions

For the description of the monitoring function see 7.6.1 "Monitoring functions" from page 7-14.

3   Technical Data

This chapter contains information on the required environmental conditions and on the mechanical and electrical properties of the unit family and the accessories.

3.1   Environmental conditions

When considering the ambient temperature a distinction is made between the permissible temperatures during operation and the permissible storage and transport temperature.

ambient operating temperature

The maximum permissible ambient air temperature during operation depends on the clearance between the units and the required output. The relevant requirements in the chapter on installation are also very important.

Temperature [1)	[°C]	0 ... +50

1) no icing

Ambient climate for transport and storage

The environment during transport and storage must be dry and dust-free. The maximum oscillation and shock stress must be within the specified limits. The bearing and transport temperature must remain within the specified range.

Temperature	[°C]	-25 ... +70

Pollution degree

Pollution degree		2

Relative humidity

The relative humidity is allowed as follows:

rel. air humidity	conforming to IEC60721-3-3, Class 3K3, 5% ... 85%, no condensation permitted

Installation height

Installation height above mean sea level for 100% power	[m]	<1000
Max. ambient temperature 40°C, no protective foil and side distance >50 mm	[m]	<2000m

Vibration and shock loading

The strength during oscillation stress on the units corresponds to EN 50178 Section 9.4.3.2 and IEC 61131-2 Section 6.3.5.1.

Oscillation and vibration	Conforming to IEC/EN 60068-2-6: 1.5 mm peak to peak from 3 ... 13 Hz, 1 gn from 13 ... 150 Hz
Shock loading	15 gn for 11 ms conforming to IEC/EN 60068-2-27

Wiring   Use copper wiring resistant to at least 60°C or 75°C.

3.1.1 Degree of protection

The devices have the degree of protection IP20. The degree of protection IP40 is met for the top of the housing if the protective cover on top of the device has not been removed. The safety cover may need to be removed because of the ambient temperature or the device clearances, see chapter 5.2.1 "Installing the device" page 5-7.

3.2 Mechanical data

3.2.1 Dimensional drawings
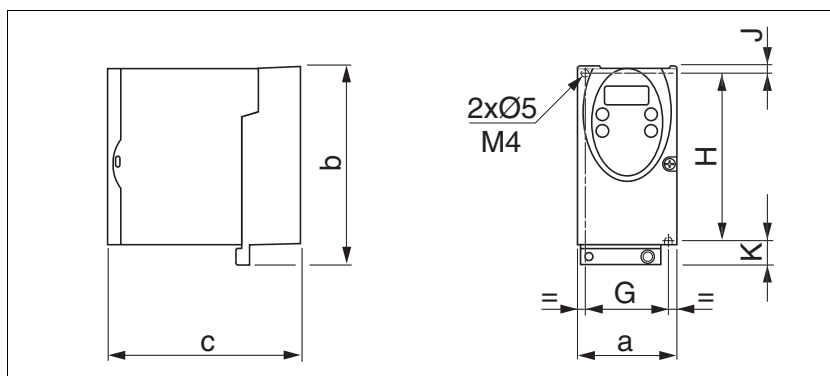
Figure 3.1   Dimensional drawing
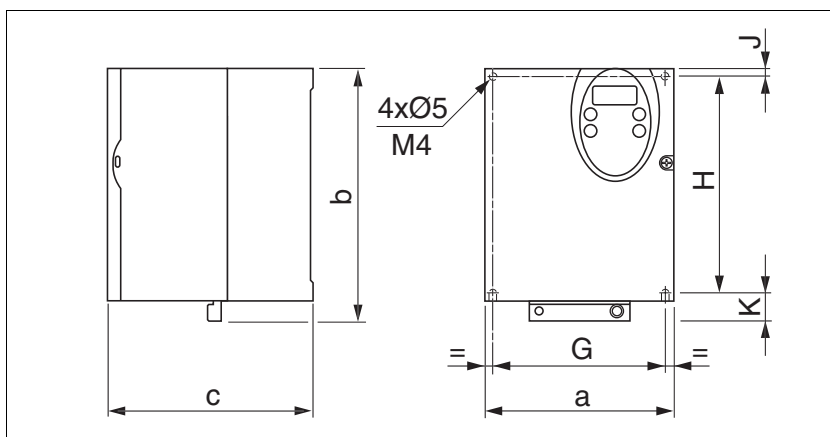
Figure 3.2   Dimensional drawing

LXM05•...		U70••• D10•••	D14•• D17•••	D2••• D3•••	D5•••
Figure		Figure 3.1	Figure 3.1	Figure 3.2	Figure 3.2
a	mm	72	107	142	180
b	mm	145	143	184	232
c	mm	140	150	150	170
G	mm	60	93	126	160
H	mm	121.5	121.5	157	210
J	mm	5	5	6.5	5
K	mm	18.5	16.5	20.5	17
Weight	kg	1.1	1.4	2	4.8
Type of cooling		Convec-tion [1]	Fan	Fan	Fan
Top-hat rail installation		77.5 [2]	105 [2]	-	-

1) >1 m/s
2) Width of adapter plate

3.3 Electrical Data

3.3.1 Performance data for power amplifier

Mains voltage: range and tolerance

115V$_{AC}$	[V$_{AC}$]	100 -15% ... 120 +10%
230V$_{AC}$	[V$_{AC}$]	200 -15% ... 240 +10%
400V$_{AC}$	[V$_{AC}$]	380 -15% ... 480 +10%
Frequency	[Hz]	50 -5% ... 60 +5%

transient overvoltages	overvoltage category III

Inrush current and leakage current

Inrush current	[A]	<60
Leakage current (as per IEC 60990, Figure 3)	[mA]	<30 [1]

1) measured on mains with earthed neutral point, with no external mains filter. When using residual-current devices make sure that a 30 mA residual-current device can trigger at 15 mA. A high-frequency leakage current also flows, which is not considered in the measurement. Residual current devices respond differently to this.

Power consumption and impedance of mains supply

The specified power consumption refers to a mains with the specified reference voltage and the assumed short-circuit impedance at nominal power output. The power consumption depends strongly on the impedance of the supply mains. This is specified by a possible short-circuit current. If the actual mains deviates from this, mains reactors must be installed upstream.

Monitoring the continuous output current

The continuous output current at 4kHz and 8kHz is monitored by the device. If the value is continuously exceeded, the output current is reduced by the device. The internal overtemperature monitoring does not respond at the specified values so long as the ambient temperature re-

mains below 40°C and no heat is generated at the internal braking resistor.

Peak output current for 3 seconds The peak output current at 4kHz and 8kHz can be output by the device for 3 seconds. If the peak current flows at motor standstill, the higher heat build-up enables the current limiting of the device earlier that when the motor is rotating.

Continuous and peak currents are lower at 8kHz because of higher losses. This is particularly clear in devices with higher DC bus voltage.

Voltage against PE The insulation of the devices is designed for a nominal voltage corresponding to the value of the reference voltage. The voltage against earth must not exceed these values.

Approved motors For an overview of the approved motor series (BRH, BSH) that can be attached to this device series see the product catalogue. When making the selection consider the type and amount of the mains voltage.

LXM05•...		U70M2	D10M2	D17M2	D28M2	D14N4	D22N4	D34N4	D57N4
Nominal voltage	[V]	230 (1~)	230 (1~)	230 (1~)	230 (1~)	400 (3~)	400 (3~)	400 (3~)	400 (3~)
Current consumption at nominal voltage	[A$_{rms}$]	4.2	7	11	20	4	6	9.2	16.8
nominal power (device power output)	[kW]	0.4	0.75	1.2	2.5	1.4	2.0	3.0	6.0
max. permissible short circuit current of mains	[kA]	1	1	1	1	5	5	5	22
power loss [1]	[W]	38	48	74	142	65	90	147	240
continuous output current at 4kHz	[A$_{rms}$]	3	4	8	15	6	9	15	25
	[A$_{pk}$]	4.24	5.66	11.31	21.21	8.49	12.73	21.21	35.36
peak output current at 4kHz	[A$_{rms}$]	5	7	12	20	10	16	24	40
	[A$_{pk}$]	7.07	9.90	16.97	28.28	14.14	22.63	33.94	56.57
continuous output current at 8kHz	[A$_{rms}$]	2.4	3.2	7	13	5	7	11	20
	[A$_{pk}$]	3.39	4.53	9.90	18.38	7.07	9.90	15.56	28.28
peak output current at 8kHz	[A$_{rms}$]	4.3	6	11	20	7.5	14	18	30
	[A$_{pk}$]	6.08	8.49	15.56	28.28	10.61	19.80	25.46	42.43
Primary fuse [2]	[A]	10	10	15/16	25	10	15/16	15/16	25

1) condition: internal braking resistor not active; value at nominal current, nominal voltage and nominal power
2) Fuses: fusible links of class CC or J as per UL 248-4, alternatively miniature circuit-breakers with B or C characteristic. 15/16A specification: circuit breakers are available with 16A nominal current, UL fuses with 15A.

3.3.2   24VDC controller power supply

Spring loaded terminals   The spring loaded terminals have a maximum cross-section of 0.75mm^2 and a maximum current loading capacity of 2A.

24V power supply   The 24V supply voltage must meet the requirements of IEC 61131-2 (PELV standard power supply):

Input voltage	[V]	24V -15% / +20%
Power consumption (without load)	[A]	≤1
Ripple voltage		<5%

3.3.3   Signals

Signal inputs are reverse polarity protected, outputs are resistant to short-circuit. There is an electrical connection to `0VDC`.

24V input signals   The levels of the inputs correspond when configured as "source" in EN 61131-2, Type 1

Logical 1 (V_{high})	[V]	+15 ... +30
Logical 0 (V_{low})	[V]	-3 ... +5
Input current (typical)	[mA]	10
Debouncing time	[ms]	1 ... 1.5

24V output signals   The 24V output signals correspond to IEC 61131-2.

Output voltage	[V]	≤30
max. switching current	[mA]	≤50
voltage drop at 50 mA load	[V]	≤1

Analogue input signals

Differential input voltage range	[V]	-10 - +10
Input resistance	[kΩ]	≥10
Resolution `ANA1`	[Bit]	14
Sampling time `ANA1`	[ms]	0.25

Position input signals   The CW/CCW, pulse/direction and A/B signals conform to the RS422 interface specifications

Symmetrical		conforming to RS422
Input resistance	[kΩ]	5
CW/CCW input frequency	[kHz]	≤400
Input frequency, pulse/direction	[kHz]	≤400
Input frequency, A/B	[kHz]	≤400

Encoder simulation output signal   The encoder simulation output signal complies with the RS422 interface specifications

Logic level		conforming to RS422
Output frequency per signal	[kHz]	≤400
Motor increments per seconds	[Inc/s]	≤1,6

Sensor signals

Output voltage for encoder		+10V / 100mA
SIN/COS input signalVoltage range		$1V_{pp}$ with 2.5V offset, $0.5V_{pp}$ at 100kHz
Input resistance	[Ω]	120

The output voltage is short-circuit protected and overload resistant. The transmission protocol is asynchronous half-duplex in compliance with RS485.

3.3.4 Braking resistor

The device has an internal braking resistor. If this is insufficient, it will be necessary to use one or more external braking resistors, see chapter 5.3.5 "Connection of braking resistor" page 5-19. For an overview of the available external braking resistors see the chapter on accessories on page 11-1.

The following minimum resistance values are required for the use of one or more external braking resistors. The internal resistance must be disabled, see also Commissioning, page 5-20.

The continuous output of the connected external braking resistors must not exceed the nominal power of the device.

LXM05•...		U70M2	D10M2	D17M2	D28M2	D14N4	D22N4	D34N4	D57N4
Energy consumption of internal capacitors E_{var}	[Ws]	17.7	17.7	26.6	43.0	26.0 [1]	52.0 [2]	52.0	104.0 [3]
resistance internal	[Ω]	40	40	40	20	40	30	30	20
Continuous output P_{PR}	[W]	20	20	40	60	40	60	60	100
Peak energy E_{CR}	[Ws]	900	900	900	1600	1000	1600	1600	2000
Making voltage	[V]	430	430	430	430	770	770	770	760
External braking resistor min	[Ω]	50	50	27	16	60	25	25	10
External braking resistor max	[Ω]	75	75	45	27	80	36	36	21

1) at 480V: 6.0Ws
2) at 480V: 12.0Ws
3) at 480V: 10.0Ws

3.3.5   Internal mains filter

The EMC standards differentiate between various application cases:

EN 61800-3:2001-02; IEC 61800-3, Ed.2	Description
first environment, general availability; category C1	operation in living areas, e.g. sale by hardware supplier
first environment, restricted availability; category C2	operation in living areas, sale through dealers only
second environment; category C3	operation in industrial mains

This drive system meets the EMC requirements for the second environment under the IEC 61800-3 standard if the measures described for the installation are taken into account. When operating outside this application area 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.

Better values can be achieved depending on the unit and the application and also the structure, e.g. on installation in an enclosed switch cabinet. If the limit values for the first environment (public networks, category C2) are required, external line filters must be connected in series.

The following limit values for wiring-related interference quantities are met by EMC-compliant construction and by using the cables offered in the accessories:

Devices with internal mains filter	second environment (industrial environment, category C3), device installed in an enclosed control cabinet with 15 dB attenuation: up to 10m motor cable length

An external line filter is required when using a unit without an integrated line filter or with long motor lines. The operator must ensure that the EMC directives are observed in this case. For order data for external line filters see the chapter on accessories on page 11-4.

3.4 Technical Data accessories

3.4.1 External braking resistors

VW3A760...		1Rxx	2Rxx	3Rxx	4Rxx	5Rxx	6Rxx	7Rxx
Resistance value	[Ω]	10	27	27	27	72	72	72
Continuous output	[W]	400	100	200	400	100	200	400
max. make time at 115V	[s]	3	1.8	4.2	10.8	6.36	16.8	42
max. make time at 230V	[s]	0.72	0.552	1.08	2.64	1.44	3.72	9.6
max. make time at 400V	[s]	0.12	0.084	0.216	0.504	0.3	0.78	1.92
Peak output at 115V	[kW]	6.3	2.3	2.3	2.3	0.9	0.9	0.9
Peak output at 230V	[kW]	18.5	6.8	6.8	6.8	2.6	2.6	2.6
Peak output at 400V	[kW]	60.8	22.5	22.5	22.5	8.5	8.5	8.5
max. peak energy at 115V	[Ws]	18800	4200	9700	25000	5500	14600	36500
max. peak energy at 230V	[Ws]	13300	3800	7400	18100	3700	9600	24700
max. peak energy at 400V	[Ws]	7300	1900	4900	11400	2500	6600	16200

3.4.2 Line reactor

Line reactor If the mains power does not correspond to the requirements described for impedance, line reactors may need to be installed, see also the chapter on installation. For order data see the chapter on accessories on page 11-4.

3.4.3 External mains filter

The EMC standards differentiate between various application cases; see Chapter 3.3.5 "Internal mains filter", page 3-7.

Better values can be achieved depending on the unit and the application and also the structure, e.g. on installation in an enclosed switch cabinet. If the limit values for the first environment (public networks, category C2) are required, external line filters must be connected in series.

The following limit values for wiring-related interference quantities are met by EMC-compliant construction and by using the cables offered in the accessories:

All devices with an external mains filter | first environment, restricted availability (public mains, category C2), device installed in an enclosed control cabinet with 15 dB attenuation. up to 20m motor cable length

second environment (industrial environment, category C3), device installed in an enclosed control cabinet with 15 dB attenuation: up to 40m motor cable length (100m at 8kHz switching frequency)

An external line filter is required when using a unit without an integrated line filter or with long motor lines. The operator must ensure that the EMC directives are observed in this case. For order data for external line filters see the chapter on accessories on page 11-4.

3.4.4   Holding brake controller HBC

For motors with holding brake we recommend appropriate control logic (HBC) that releases the brake when the motor is powered and locks the motor axis at the correct moment before the power amplifier supply voltage is switched off and optionally reduces the braking voltage.

Dimensions HBC

Dimensions (H * B * D)	[mm]	99 * 22.5 * 114.5
Installation on top-hat rail		

Power supply

Nominal voltage	[V]	24
Voltage range	[V]	19.2 ... 30
Current consumption	[A]	0.5 + braking current

Signal input

Voltage range	[V]	19.2 ... 30
Input current at 24V	[mA]	<10

Holding brake output

Voltage before voltage reduction	[V]	23 ... 25
Voltage with voltage reduction	[V]	17 ... 19
Maximum output current	[A]	1.6
Time to voltage reduction	[ms]	1000

The holding brake controller has a safe electrical isolation of the holding brake output.

3.4.5   Reference value adapter RVA

Dimensions

Dimensions (H * B * D)	[mm]	77 * 135 * 37
Installation on top-hat rail		

Electrical data

Input		
Supply voltage	[V]	19,2 ... 30
Current consumption (5VSE unloaded)	[mA]	50
Current consumption (5VSE 300mA)	[mA]	150
Output, Encoder		
5VSE	[V]	4,75 ... 5,25
Maximum output current	[mA]	300
sense-controlled, short-circuit and overload-proof		

3.4.6 Cable

Overview of cables required

	max. length [m]	min. cross section [mm^2]	corr. PELV	shielded, earthed both ends	twisted pair
Controller supply voltage	–	0.75	X		
Power amplifier supply voltage	–	– [1]			
Motor phases	– [2]	– [3]		X	
Cable for HBC ⇒ motor [4] see motor phases	– [2], max. 0.12 unshielded	– [3] [5]		X	
Cable for HBC ⇒ device	max. 0.12 unshielded	0.75 [5]		X	
ext. braking resistor	3	as in power amplifier supply voltage		X	
Motor encoder	100	10*0.25 mm² and 2*0.5 mm²	X	X	X
Encoder signals A/B/I	100	0.25	X	X	X
PULSE/DIR	100	0.14	X	X	X
CW/CCW	100	0.14	X	X	X
ESIM	100	0.14	X	X	X
Analogue inputs	10	0.14 - 1.5	X	X [6]	X
Digital inputs/outputs	15	0.14	X		
PC, decentralised control terminal	400	0.14	X	X	X

1) see 5.3.6 "Connection of power amplifier supply voltage"
2) Length depends on required limit values for line interference, see 3.3.5 "Internal mains filter" and 3.4.3 "External mains filter".
3) see 5.3.4 "Motor phase connections"
4) For BRS motors see motor manual
5) Temperature range: up to 105°C
6) Earth shield of analogue signal lines directly on device (signal input). At the other end of the cable insulate the shield or if interference occurs earth via a capacitor (e.g. 10nF).

Table 3.1   Cable specifications

Motor and encoder cable   Motor cable[1] and encoder cable [1.] are usable as trailing cable and available in different lengths. For the corresponding types see the accessories section on page 11-4.

Permissible voltage	[VAC]	600 (UL and CSA)
Shield		Shield braiding
Sheath		Oil-resistant PUR
Temperature range	[°C]	-40 ... +90 (fixed) -20 ... +80 (movable)
Minimum bending radius		4 x diameter (fixed) 7.5 x diameter (moving)

1. All details refer to BSH motor; for BRH motor see motor manual

4   Engineering

This chapter contains basic information on options for use of the product, which are essential for the engineering.

4.1   Logic type

This product can switch the 24V inputs and outputs as follows (*drC-
ıoLt*).

Logic type	active status
"Source"	Output supplies current current flows to the input
"Sink"	Output draws current current flows from the input

⚠ WARNING

Unmonitored operation

When using the "Sink" setting logic type the earth fault of a signal is detected as an On status.

- Use great care with wiring to prevent the possibility of an earth fault.

Failure to follow these instructions can result in death, serious injury or equipment damage.
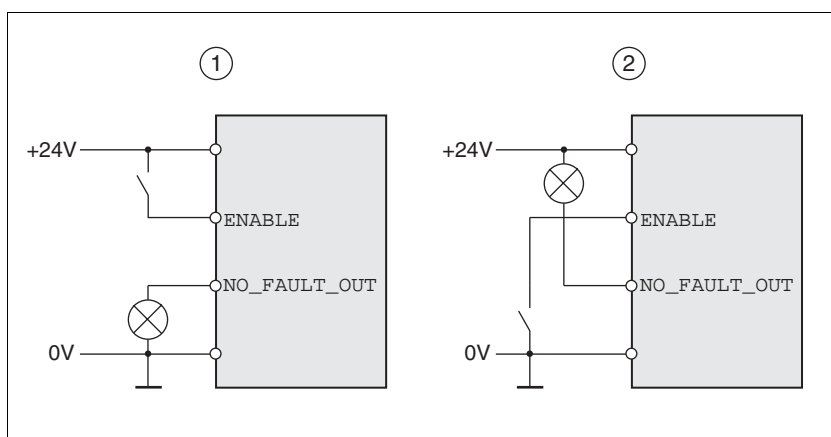
Figure 4.1   Logic type

(1)   "Source"
(2)   "Sink"

It is specified at "First setup" with the parameter `IOLogicType`. This setting affects the wiring and the control of sensors and must be thoroughly clarified during engineering with regard to the application.

4.2   Configurable inputs and outputs

This product has digital inputs and outputs that can be configured. The inputs and outputs have a defined standard assignment depending on the start-up operating mode. This assignment can be adapted to the requirements of the customer's installation. For more information see chapter 7.6.7 "Configurable inputs and outputs".

5   Installation

> ⚠ **WARNING**
>
> **Loss of control over controller**
>
> • Observe the accident prevention regulations. (For USA see also NEMA ICS1.1 and NEMA ICS7.1)
>
> • The system manufacturer must take the potential error possibilities of the signals and the critical functions into account to ensure a safe status during and after errors. Some examples are: emergency stop, final position limitation, power failure and restart.
>
> • The assessment of error possibilities must also include unexpected delays and the failure of signals or functions.
>
> • Suitable redundant control paths must be in place for dangerous functions.
>
> • Check that measures taken are effective.
>
> **Failure to follow these instructions can result in death or serious injury.**

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

5.1   Electromagnetic compatibility, EMC

> ⚠ **WARNING**
>
> **Interference with signals and devices**
>
> Distorted signals can cause unpredictable device responses.
>
> • Install the wiring in accordance with the EMC requirements.
>
> • Check compliance with the EMC requirements, particularly in an environment subject to strong interference.
>
> **Failure to follow these instructions can result in death, serious injury or equipment damage.**

This drive system meets the EMC requirements for the second environment under the IEC 61800-3 standard if the measures described for the installation are taken into account. When operating outside this application area 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.

An EMC-compliant design is required to maintain the specified limit va-
lues. Depending in the case better results can be achieved with the fol-
lowing measures:

- Upstream mains reactors. Information on current distortions can be
  obtained on request.

- Upstream external mains filters, particularly to maintain limit values
  for the first environment (living area, category C2)

- Particularly EMC-compliant design, e.g. in an enclosed switch cabi-
  net with 15dB damping of radiated interference

EMC and accessories   Information on the EMC kit (comprising EMC plate and earth clamps)
and the pre-assembled cables can be found from page 11-2.

Switching cabinet setup

EMC measures	Effect
Use EMC plate or galvanised or chrome-plated mounting plates, make large contact surface connections for metal parts, remove paint from contact surfaces	Good conductivity due to two-dimensional contacts
Earth the control cabinet, door and EMC plate with metal tapes or cables with a cross section area greater than 10 mm^2.	Reduction of emissions.
Fit switching devices such as contactors, relays or solenoids with interference suppressors or spark suppressors (e.g.diodes, varistors, RC elements)	Reduction of mutual interference
Install power and control components separately.	Reduction of mutual interference

Cabling

EMC measures	Effect
Keep wiring as short as possible. Do not install "safety loops", short cables from the star point in the switch cabinet to outlying earth connection.	Avoidance of capacitive and inductive interference injection
Use cable clamps to connect a large surface area of the shield of all shielded cables to the mounting plate at the control cabinet entry.	Reduction of emissions.
Fieldbus lines and signal lines must not be laid in the same conduit with lines for DC and AC voltage over 60 V. (Fieldbus lines can be laid in the same conduit with signal and analogue lines) Recommendation: lay in separate conduits at least 20 cm apart.	Prevention of mutual interference
Connect large surface areas of cable shields, use cable clamps and tapes	Reduction of emissions.
Earth shields on digital signal lines over a wide area at both ends or via conductive plug housing.	Preventing interference on control cables, reduction of emissions
Use bonding conductors in system with – wide-area installation – different voltage infeed – networking between different buildings	Protection of wiring, reduction of emissions.
Use fine-core bonding conductors	Deflect even high-frequency interference currents

EMC measures	Effect
Earth shield on analogue signal lines directly at the device (signal input), and insulate the shield at the other end of the cable or earth via a capacitor if interference occurs, e.g. 10 NF.	Preventing ripple loops due to low-frequency interference
Use only shielded motor cables with copper braiding and at least 85% covering, ground a large surface area of the shield at each end.	Controlled discharge of interference currents, reduction of emissions
If motor and machine are not conductively connected, e.g. by an insulated flange or a non-flat connection, earth the motor with an earth wire >10 mm^2 (>6 AWG) or ground strap.	Reduction of emissions, increase in resistance to interference
Lay connections of the 24 V_{DC} supply voltage as "twisted pair".	Preventing interference on control cables, reduction of emissions

Power supply

EMC measures	Effect
Operate drive system on mains with earthed neutral point (not IT mains).	Mains filter is only effective on systems with an earthed star point.
Connect the negative output of the PELV power supply unit to PE.	Reduction of EMC emissions, safety
Circuit breaker if there is danger of overvoltage or lightning strike	Protection against damage by overvoltage

EMC requirement: motor and motor encoder cables

Motor leads and motor sensor cables are especially critical signal lines. Use the cables recommended by your local representative. They must be tested for EMC safety and must be suitable for trailing cables.

The motor cable and the motor encoder cable on the drive solution must be laid out over a wide area with low resistance on the device, the switch cabinet output and on the motor.

▶ Lay out motor and motor encoder cables without interruption (do not install switch components) from the motor and encoder to the device.
If a line has to be interrupted, shielded connections and metal casing must be used to prevent interference.

▶ Lay the motor cable at least 20 cm from the signal cable.
If the distance is less than this, the motor cable and signal cables must be separated by grounded screening plates.

▶ For long lines bonding conductors with a suitable cross section must be used

Equipotential bonding conductors

The shields are connected at both ends for fault protection. Potential differences can result in excessive currents on the shield and must be prevented by equipotential bonding conductor cables.

If lines over 100 m are approved, the following applies: up to 200 m length a cable cross section of 16 mm^2 is sufficient, for greater lengths a cable cross section of 20 mm^2 is required.

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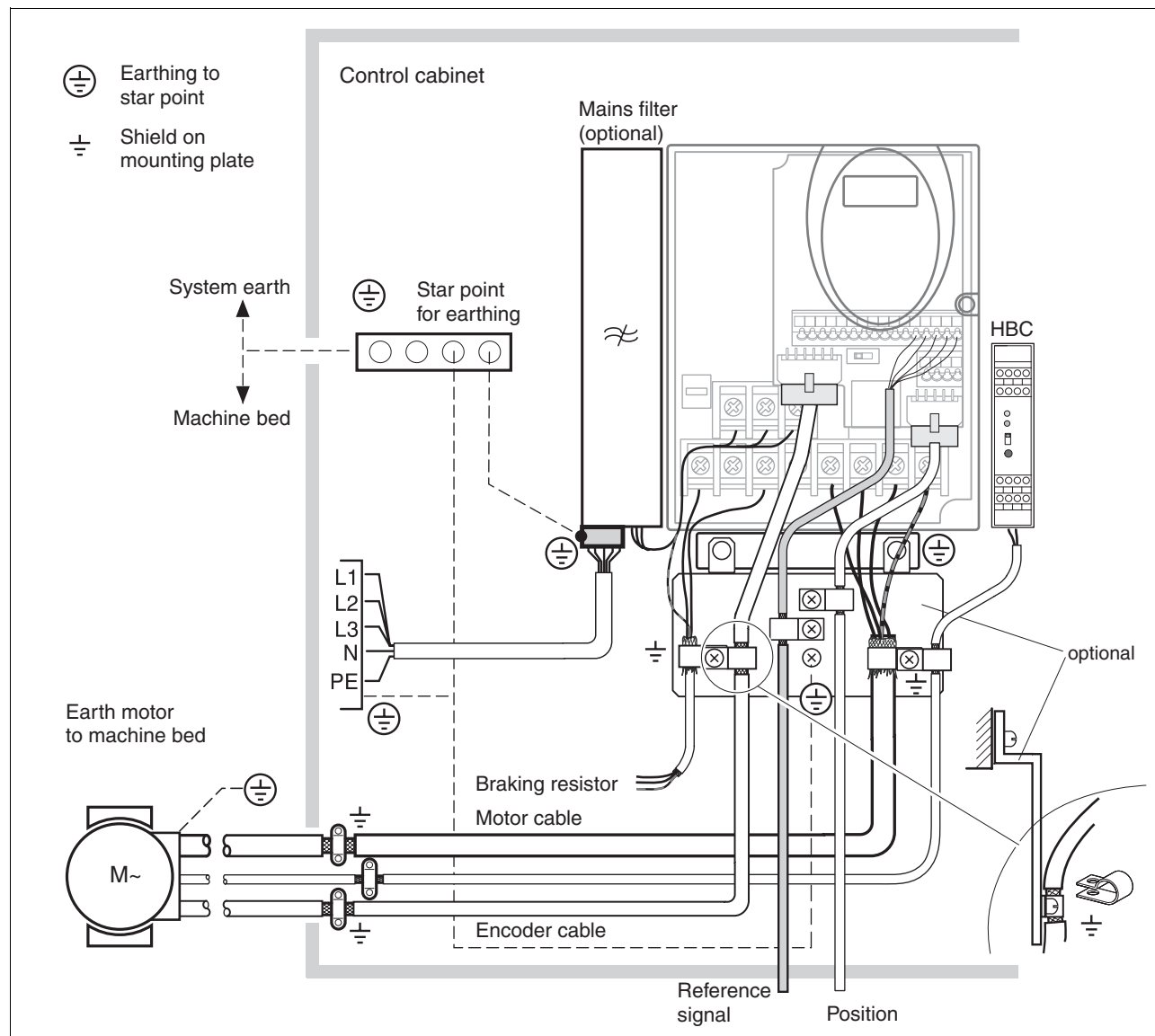
Figure 5.1   EMC measures

5.1.1   Operation in an IT mains

An IT mains is characterised by a neutral conductor that is insulated or earthed through a high impedance . If you use a permanent insulation monitor, it must be suited for non-linear loads (e.g. Type XM200 from Merlin Gerin). If, despite perfect wiring, a fault is indicated, you can, in the case of products with integrated mains filters, disconnect the earth connection to the Y- capacitors (deactivate the Y- capacitors).

With all other networks except for IT mains the earth connection via the Y- capacitors must be maintained.

If the earth connection to the Y- capacitors is removed, the specifications for the transmission of electromagnetic interference will no longer be maintained (specific categories see chapter 3.3.5 "Internal mains filter" page 3-7)! Separate measures are required to comply with national regulations and standards.

CAUTION: the motor must be designed for operation in the IT mains.
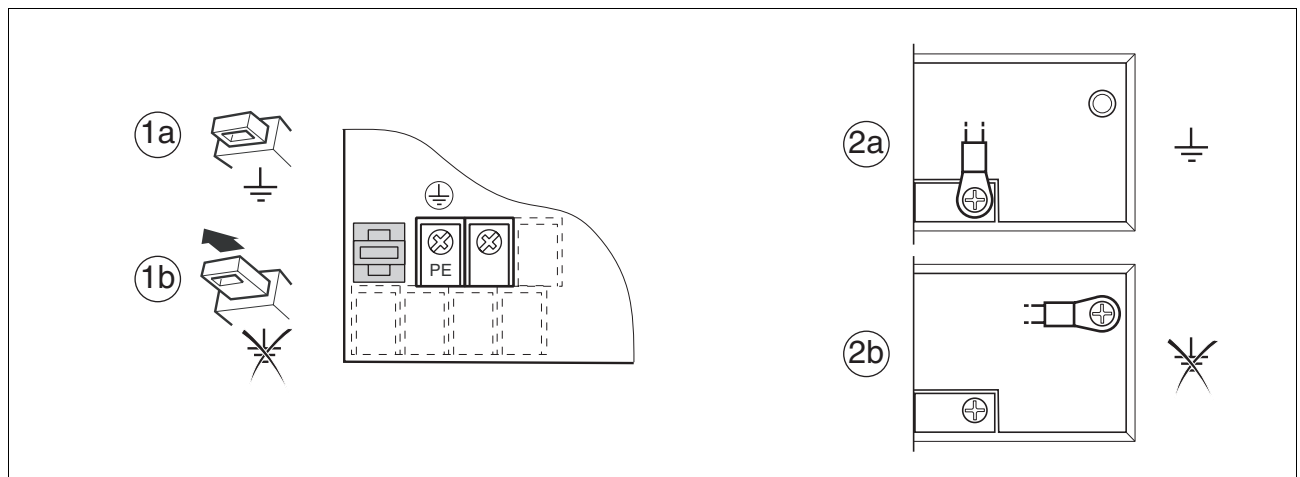
Devices with switch beside power terminals (1)	Devices with jumpers (2)
LXM05•... U7••• D1••• D2••• D3••• D4•••	LXM05•... D5•••
(1a): Y-capacitors of the internal filter effective (standard)	(2a): Y-capacitors of the internal filter effective (standard)
(1b): Y-capacitors of the internal filter disabled (IT mains)	(2b): Y-capacitors of the internal filter disabled (IT mains)

5.2   Mechanical installation

⚠ **DANGER**

Electric shock from foreign bodies or damage.

Conductive foreign bodies in the product or serious damage can cause voltage spread.

•   Do not use damaged products.

•   Prevent foreign bodies such as chips, screws or wire clippings from entering the product.

•   Do not use products that contain foreign bodies.

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

⚠ **CAUTION**

Hot surfaces

The heat sink on the product may heat up to over 100°C (212°F) depending on the operating mode.

•   Prevent contact with the hot heat sink.

•   Do not install flammable or heat-sensitive components in the immediate vicinity.

•   Follow the actions described for heat dissipation.

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

5.2.1 Installing the device

Switching cabinet   The switching cabinet must be dimensioned so all devices and accessories can be fixed in place and wired to meet EMC standards. The components include a holding brake controller or braking resistors.

The switching cabinet ventilation must be capable of extracting the heat generated by all devices and components installed in the switch cabinet.

Installation spacing;ventilation   When selecting the position of the device in the switching cabinet, note the following instructions:

- Adequate cooling of the device must be ensured by complying with the minimum installation distances. Prevent heat accumulation.

- The device must not be installed close to heat sources or mounted on flammable materials.

- The warm airflow from other devices and components must not heat the air used for cooling the device.

- The drive will switch off as a result of overtemperature when operated above the thermal limits.
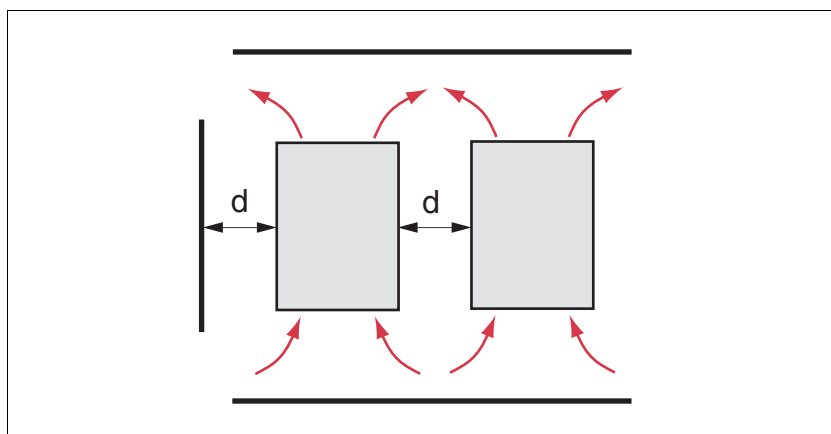
Figure 5.2   Installation spacing and air circulation

Temperature	Distance [1]	Measures without protective foil [2]	Measures with protective foil in place
0 °C ... +40 °C (32 °F ... 104 °F)	d > 50 mm (d > 1.97 in.)	None	None
	d < 50 mm (d < 1.97 in.)	None	d > 10 mm (d > 0.39 in.)
+40 °C ... +50 °C (104 °F ... 122 °F)	d > 50 mm (d > 1.97 in.)	None	Reduce nominal current and continuous current [3]
	d < 50 mm (d < 1.97 in.)	Reduce nominal current and continuous current [3]	Operation not possible

1) Distance in front of the device: 10 mm (0.39 in.), above: 50 mm (1.97 in.), below: 200 mm (7.87 in.)
2) Recommendation: remove protective foil on completion of the installation
3) by 2.2 % per °C above 40 °C (by 1.22 % per °F above 104 °F)

At least 10 mm of free space is required in front of the device. Make sure that the operator elements are accessible.
At least 50 mm of free space is required above the device.
The connector cables come out of the bottom of the housing. At least

200 mm free space under the device is required to ensure that wiring can be installed without excessive bending.

Installing the device

For the dimensions of the fastening holes see 3.2.1 "Dimensional drawings" from page 3-2.

▶ Install the device in a vertical position (±10°). This is particularly important for cooling the device.

▶ Attach the EMC plate at the bottom of the device, see also Figure 5.1, or use alternative attaching elements (comb bars, shield clamps, busbars).

Attach plate with safety instructions

▶ Attach the plate with safety instructions included with the device in a visible position on the front panel as specified by the national regulations.

An alternative to fastening the unit directly to the control cabinet mounting plate is adapter plates for mounting to top-hat rails, see chapter 3.2.1 "Dimensional drawings"

In this case mains filters cannot be attached directly beside or behind the device.

Painted surfaces have an insulating effect. Remove the paint from the attachment points over a wide area (bright metal) before attaching the unit to a painted mounting plate.

Remove the protective foil
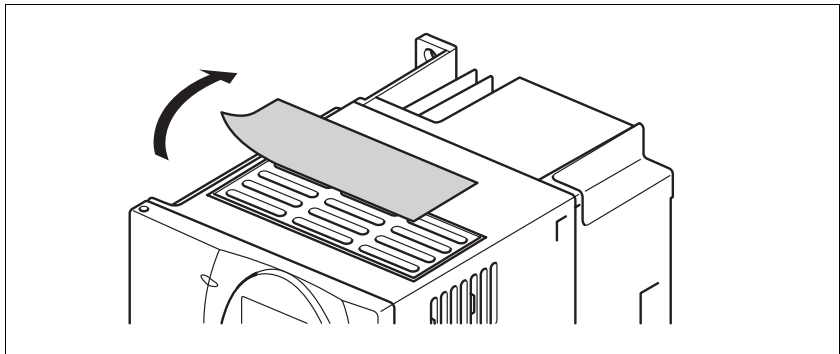
Figure 5.3   Removing protective foil

Remove the protective foil only after completion of all installation work. The protective foil must be removed if required by the thermal conditions.

5.2.2   Installing mains filter, mains reactor and braking resistor

External line filter   You can check whether the your unit has an integrated line filter by the type code and the specifications (see page 3-1).

An external line filter is required when using a unit without an integrated line filter or with long motor lines. The operator must ensure that the EMC directives are observed in this case.

For specifications of external mains filters see page 3-7.
For directions on electrical installation see mains supply from page 5-24.
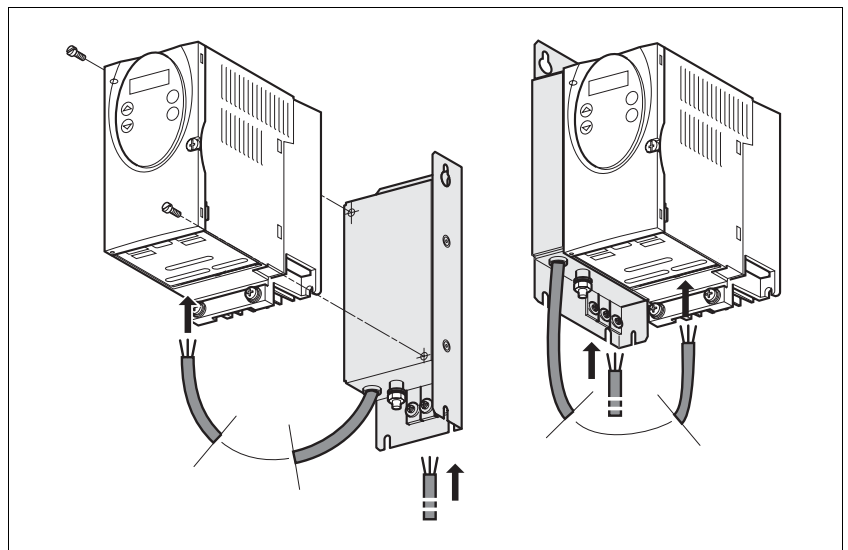
Figure 5.4   Installing mains filters

▶ Install the mains filter at the rear or the left side of the device.

If the line filter is mounted behind the unit, the line filter terminals will not be accessible after installation of the EMC plate.

If you are using the top-hat rail mounting plates, the line filter cannot be mounted directly beside or behind the unit.

Mains reactor   A mains reactor must be used under the following conditions:

• operation on power supply mains with low impedance (maximum possible short circuit current of the mains greater than specified in the Technical Data), see Technical Data from page 3-3

• at high average output power that is greater than half the nominal power

• where there are special requirements for the service life of the device (24 h operation)

• operation on mains with reactive-current compensation systems

• for improvement of the power factor at the mains input and to reduce the mains feedback

• if overvoltages greater than overvoltage category III could occur

Multiple devices can be operated with one mains reactor. The rated current of the reactor must be considered.

In the case of a mains impedance that allows a short-circuit current greater than 1 kA the inductance of the reactor must be greater than 0.8 mH.

Current harmonic waves place a heavy load on the internal DC bus capacitors. This has a significant influence on the service life of the device. For suitable mains reactors see accessories from page 11-4.

The information sheet included with the mains reactor contains additional information on mounting. For directions on electrical installation see power supply from page 5-24.

External braking resistor

⚠ **WARNING**

Hot Surfaces

The braking resistor may heat up to over 250°C depending on the operating mode.

- Prevent contact with the hot braking resistor.
- Do not place flammable or heat-sensitive components in the immediate vicinity of the braking resistor.
- Ensure good heat dissipation.
- Check the temperature of the braking resistor by conducting a test run under the most critical conditions.

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

The braking resistors recommended in accessories from page 11-1 comply with degree of protection IP65. They can be installed outside a switching cabinet in an environment with this degree of protection.

The information sheet included with the external braking resistor contains additional information for the mounting.

For information on the function and the electrical installation see page 5-19.

5.3 Electrical installation

⚠ **DANGER**

Electric shock, fire or explosion

• Only qualified personnel who are familiar with and understand the contents of this manual are authorised to work on and with this drive system.

• The system manufacturer is responsible for compliance with all applicable regulations relevant to earthing the drive system.

• Many components, including printed wiring boards, operate at mains voltage. **Do not touch**. Do **not** touch unshielded components or screws of the terminals with voltage present.

• Install all covers and close the housing doors before applying power.

• The motor generates voltage when the shaft is rotated. Lock the shaft of the motor to prevent rotation before starting work on the drive system.

• Before working on the drive system:

  – Switch off power to all terminals.

  – Place a sign "DO NOT SWITCH ON" on the switch and lock to prevent switching on.

  – **Wait 6 minutes** (for discharge of DC bus capacitors). Do **not** short-circuit DC bus

  – Measure voltage at DC bus and check for <45V. (The DC bus LED is not a safe indication for absence of the DC bus voltage).

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

⚠ **DANGER**

Electric shock from foreign bodies or damage.

Conductive foreign bodies in the product or serious damage can cause voltage spread.

• Do not use damaged products.

• Prevent foreign bodies such as chips, screws or wire clippings from entering the product.

• Do not use products that contain foreign bodies.

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

⚠ **DANGER**

Electric shock because of insufficient earthing

With insufficent earthing these is hazard of electric shock.

• Earth the drive system before applying power.

• Do not use metallic conduits as a earth conductor. Use a conductor housed within the conduit as the earth conductor.

• Use cross-sections of the protective earth conductor that comply with the applicable codes.

• Earth the cable shields on both ends, but do not regard the shields as protective earth.

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

⚠ **WARNING**

This product may cause direct current in the protective conductor

If a residual current device (RCD) is installed, general conditions must be observed.

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

Peripheral conditions for the use of a residual-current-operated protective device

If the installation regulations foresee upstream protection in the form of a residual-current-operated protective device (FI protection switch, RCD) then a residual-current-operated protective device "Type A" can be used for a single-phase drive booster with a connection between N and L. A "Type B" device must be used in all other cases.

The following properties should be taken into account:

• Filtering high frequency currents.

• Delay which prevents triggering due to possible charged fault capacities when switching on. This delay is not possible for 30 mA devices. In this case you should select devices which are not prone to unintentional triggering, for example a residual-current-operated protective device with increased interference resistance of the type s.i (super-immunised) (trademark Merlin Gerin).

If the plant consists of a number of drive boosters then a residual-current-operated protective device must be used for each drive booster.

Suitability of wiring

Cables must not be twisted, stretched, crushed or kinked. Use only cables that comply with the cable specification. For example, make sure that it is suitable for:

• Use as a trailing cable

• Temperature range

• Chemical resistance

• Layout outdoors

• Layout underground

5.3.1 Overview of procedure

▶ Observe the basic settings described in chapter 4 "Engineering". The selected settings influence the complete installation:

▶ Unlock the front panel of the device and open it.

▶ Connect the earth terminal of the device or the EMC plate to the earthing star point of the system.

▶ Connect the required terminal corresponding to the sequence of Table 5.1. If a different connection sequence is followed, terminals may be covered by other lines.

Follow the EMC requirements, see page 5-1.

▶ Then lock the front panel.

Connection from	Connection to	from page
Motor phases		5-16
External braking resistor		5-19
Mains supply		5-24
Motor rotary encoder	CN2	5-27
Holding brake controller (HBC)	CN1 and CN3	5-30
24 V controller supply voltage	CN3	5-32
Encoder simulation ESIM	CN5	5-34
Analogue inputs	CN1	5-35
Digital inputs/outputs	CN1	5-36
Pulse CW/CCW	CN1	5-37
Pulse/direction PD	CN1	5-39
Encoder signals A, B	CN1	5-42
PC or remote terminal	CN4	5-44

Table 5.1 Installation overview

5.3.2   Overview of all connections

Power connections

Power connections	device	
	LXM05●...	
T1	U70M2	(T1)
	D10F1	(T1)
	D10M2	(T1)
T2	D10M3X	(T2)
	D14N4	(T4)
	D17F1	(T3)
T3	D17M2	(T3)
	D17M3X	(T4)
	D22N4	(T4)
T4	D28F1	(T3)
	D28M2	(T3)
	D34N4	(T4)
T5	D42M3X	(T4)
	D57N4	(T5)

Table 5.2   Designations of the power connections

Power connections	Description
PE	Earth connection (protective earth)
R/L1, S/L2/N	Mains connection, single phase devices
R/L1, S/L2, T/L3	Mains connection, 3-phase devices
PA/+	DC bus
PBi	Braking resistor internal
PBe	Braking resistor external
PC/-	DC bus
U/T1,V/T2, W/T3	Motor connections

Table 5.3   Designations of the power connections

Signal connections
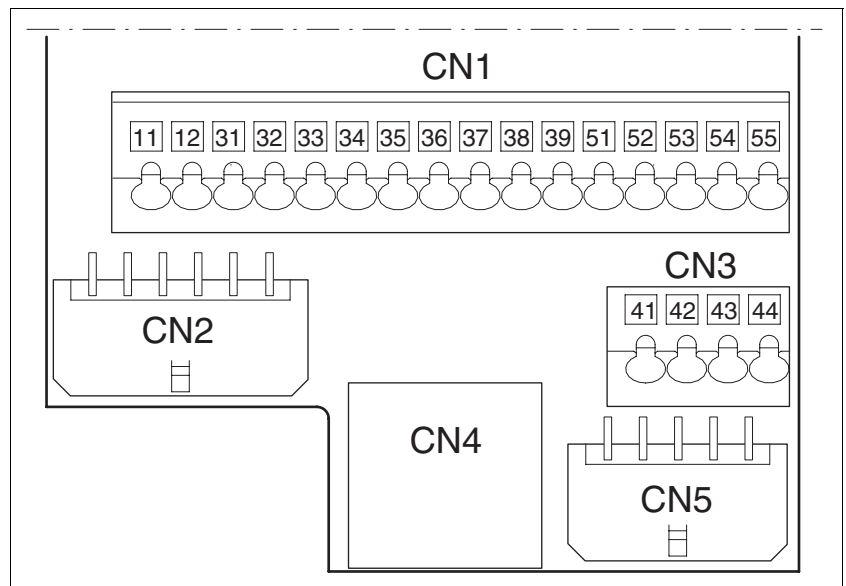
Figure 5.5   Overview of the signal connections

Connection/ switch	Assignments
CN1	Analogue inputs ±10V, pin 11 and 12
	Digital inputs/outputs, pin 31-39
	CW/CCW, pulse/direction PD, A/B encoder signals, pin 51 ... 55
CN2	Motor encoder (Hiperface Sensor)
CN3	24V PELV controller supply voltage
CN4	PC, remote terminal; (RJ45)
CN5	ESIM (A/B/I out)

Table 5.4 Assignment of the signal connections

5.3.3 Reference value signals

Operation is controlled by reference value signals. shows the assignment options depending on the operating modes.

Operating mode	Reference value	Connection
Current control	ANA_IN1 (current)	CN1, Pin 11, 12
Speed control	ANA_IN1 (speed of rotation)	CN1, Pin 11, 12
Pulse control	CW/CCW signals	CN1, Pin 51-55
	Pulse/direction PD signals	CN1, Pin 51-55
	A/B signals	CN1, Pin 51-55
Jog	generated	

Table 5.5   Reference value signals

5.3.4 Motor phase connections

> ## ⚠ DANGER
>
> **Electric shock**
>
> High voltages at the motor connection may occur unexpectedly.
>
> • The motor generates voltage when the shaft is rotated. Lock the motor shaft to prevent rotation before starting work on the drive system.
>
> • AC voltages may jump over unused wires in the motor cable. Isolate unused wires at both ends of the motor cable.
>
> • The system manufacturer is responsible for compliance with all applicable regulations relevant to earthing the drive system. Extend the earth through the motor cable with an additional earth at the motor housing.
>
> **Failure to follow these instructions will result in death or serious injury.**

Cable specifications
• Shielded cable

• Minimum cross section of wires: see table.

• Earthing of the shield at both ends

• Maximum cable length: depends on required limit values for line-related interference, see chapter 3.3.5 "Internal mains filter" page 3-7 and chapter 3.4.3 "External mains filter" page 3-8.

• for more information, see 3.4.6 "Cable" on page 3-10.[1]

1. For BRH motors see motor manual

LXM05•...		U70••• D10•••	D14•• D17••• D2••• D3••• D4••••	D5•••
Connection cross section	mm²	0.75 ... 1.5	1.5 ... 4	3.3 ... 16 [1]
AWG		14 ... 20	10 ... 16	6 ... 12 [1]
Tightening torque	Nm	0.5 ... 0.6	1.2 ... 1.5	2.2 ... 2.8

1) Wire end ferrules or fork-type cable lugs are required with a cross section of 2.5 mm² (AWG 14).

The wiring must have a sufficiently large cross section to ensure that the fuse at the mains connection can be tripped in the event of a fault.

▶ Use prefabricated cables to minimise the risk of a wiring error (from page 11-2).

Preparing cables   Note the dimensions specified when fabricating cables.
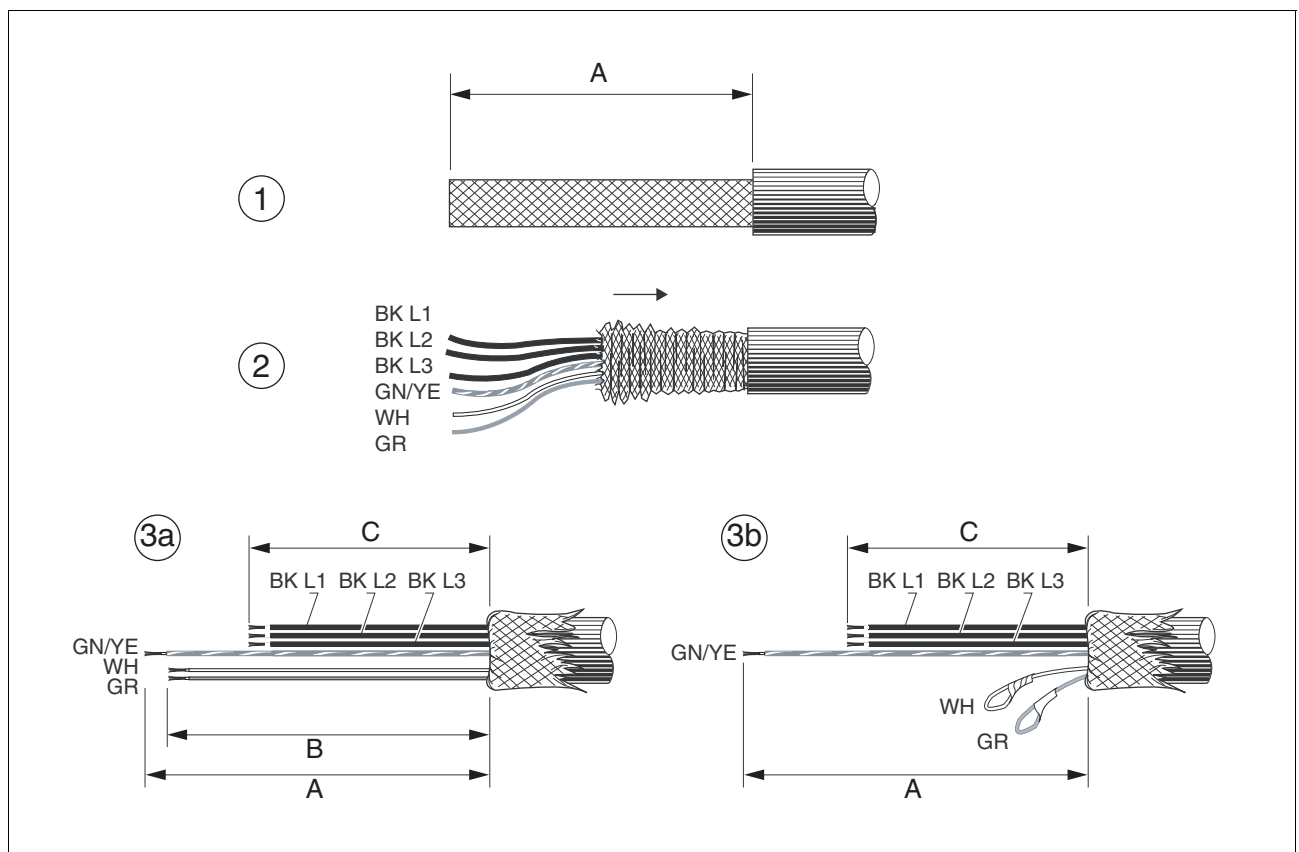
Figure 5.6   Steps (1-3) for fabrication of the motor cable

LXM05•...		U70••• D10••	D14•• D17•••	D2••• D3••• D4•••• D5•••
A	mm	130	130	130
B	mm	120	120	120
C	mm	75	85	90

▶ (1) Remove the cable sheath, length A depends on the device, see table.

▶ (2) Slide the shield braiding back over the cable sheath and store the shield braiding. Note that during installation the shield braiding must be positioned flat on the EMC plate.

▶ (3)Shorten the wires for the holding brake to length B for BRH motors (see motor manual) and the three motor lines to length C. The protective conductor has length A.[1]
(3a) The two brake connection lines must have length B for motors with holding brake.
(3b) The two brake connection lines must be separately insulated for motors without a holding brake.

Use fork-type cable lugs or wire end ferrules. The lead must fill the sleeve for its entire length to ensure maximum current carrying capacity and vibration resistance.

Monitoring The motor lines are monitored for:

• short circuit between the motor phases

• short circuit between the motor phases and PE

A short circuit between the motor phases and the DC bus, the braking resistor or the holding brake wiring is not monitored.

Connecting the motor cable ▶ Follow the EMC requirements for motor cables, see page 5-3.

▶ Insulate unused wires at both ends and individually, see Figure 5.7, Pos 1.

▶ Connect the motor leads and protective conductor to terminals U/T1, V/T2, W/T3 and PE. The cable assignment at the motor and device sides must match.

▶ Fix the cable shielding flat on the EMC plate.

Wiring diagram
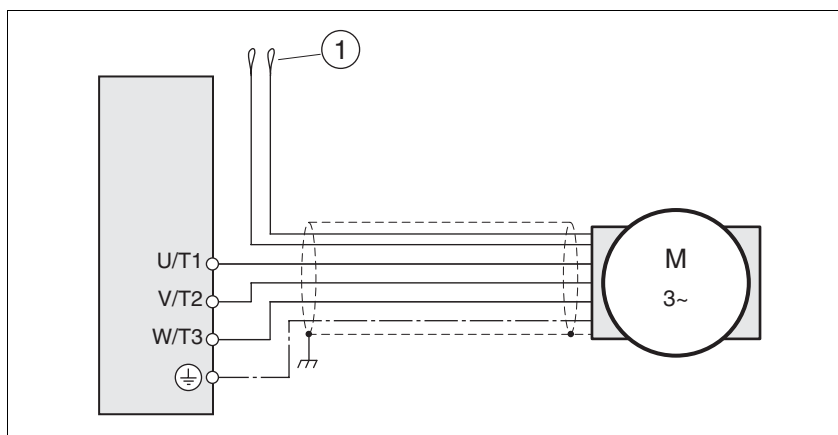
Figure 5.7 Motor wiring diagram, here without holding brake

1. For BRH motors see motor manual

Connection	Description	Colour
U/T1	Motor line	black L1 (BK)
V/T2	Motor line	black L2 (BK)
W/T3	Motor line	black L3 (BK)
PE	Protective conductor	green/yellow (GN/YE)
(1)	Holding brake connector cable [1] For motors with holding brake see page 5-30	white (WH), grey (GR)

1) For BRH motors see motor manual

5.3.5 Connection of braking resistor

> ⚠ **WARNING**
>
> **Unbraked motor**
>
> An insufficient braking resistor causes overvoltage on the DC bus and switches off the power amplifier. The motor is no longer actively braked.
>
> • Make sure that the braking resistor is sufficiently dimensioned.
> • Check the setting of the parameter for the braking resistor.
> • Check the temperature of the braking resistor by conducting a test run under the most critical conditions.
> • During the test make sure that at higher mains voltage there is less reserve in the capacitors on the DC bus.
>
> **Failure to follow these instructions can result in death, serious injury or equipment damage.**

5.3.5.1 Internal braking resistor

A braking resistor is integrated in the device to absorb braking energy. If the DC bus voltage exceeds a specified value, this braking resistor is switched on. The returned energy is converted to heat by the resistance. See also dimensioning aid, page 5-21.

The internal braking resistor is connected on delivery.

The internal braking resistor is at the back of the device.

5.3.5.2 External braking resistor

An external braking resistor is required for applications in which the motor must be heavily braked and the internal braking resistor cannot dissipate the excess braking energy.

Monitoring   The device monitors the power of the braking resistor. The load on the resistance can be read out.
The connection of the external resistance is protected against short circuit.

Selection of the external braking resistor

The size of an external braking resistor is specified by the required peaks and the continuous output at which the braking resistor can be operated.

The resistance value R [Ω] is derived from the required peak power and the DC bus voltage.

$$R = U^2 \ / \ P_{max}$$

U : Switching threshold [V]

P_{max} : Peek power [W]

R: Resistance [Ohm]

Figure 5.8   Calculating the resistance R of an external braking resistor

It two or more resistances are connected, not the following criteria:

- The resistors must be wired in parallel or in series so the required resistance is reached.

- The resistance value of the external resistance must not fall below a bottom limit, see chapter 3.3.4 "Braking resistor".

- The total continuous output of the individual resistors must yield the required continuous output.

For suitable braking resistors, see accessories on page 11-1.

Cable specifications

- Shielded wires

- minimum cross-section: as with mains power, see page 5-24. The wiring must have a sufficiently large cross section to ensure that the fuse at the mains connection can be triggered in the event of a fault.

- Earthing of the shield at both ends

- Maximum cable length: 3m

The braking resistors recommended in accessories have a 3-wire, temperature-resistant cable with a length of 0.75 m to 3 m.

Use fork-type cable lugs or wire end ferrules. The lead must fill the sleeve for its entire length to ensure maximum current carrying capacity and vibration resistance.

Connecting external braking resistor

▶ Observe the safety instructions for the electrical installation.

▶ Before opening the device disconnect it from the supply voltage.

▶ Remove the jumper, see Figure 5.9.

If the jumper is not removed, the internal braking resistor may be destroyed during operation.

▶ Earth the PE connection of the braking resistor.

▶ Connect the braking resistor to the device, see Figure 5.9.

▶ Spread the shielding of the cables out flat on the EMC plate.

Test the function of the braking resistor under realistic conditions during commissioning (page 6-15).

Wiring diagram
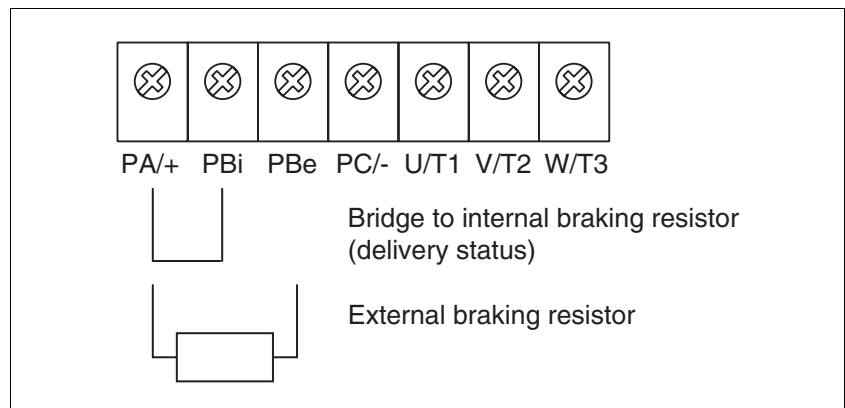
Figure 5.9   Wiring diagram, braking resistor

5.3.5.3   Dimensioning aid

The elements contributing towards the absorption of braking energy are calculated to assist in specification. This is used to calculate the size of the braking resistor.

An external braking resistor is required if the kinetic energy that must be absorbed exceeds the total of internal components, including the internal braking resistor.

Internal energy absorption   Braking energy is absorbed internally by the following mechanisms:

- DC bus capacitor W_{ZW}
- Internal braking resistor W_{IN}
- Electrical losses in the drive W_E
- Mechanical losses in the drive W_M

The energy W_{ZW} depends in a square-law function on the difference between the voltage before the braking operation and the response threshold.

The voltage before the braking operation depends on the line voltage. The energy absorption by the DC bus capacitors is lowest when the line voltage is highest. Use the values for the highest line voltage.

Energy absorption of the internal braking resistor   Two characteristic values relating to the internal braking resistor determine its energy absorption.

- The continuous output P_{AV} shows how much energy can be continuously dissipated without overloading the braking resistor.
- The maximum energy W_{peak} limits the higher heat loss which can be dissipated in the short term.

If the continuous output is exceeded for a specified time, the braking resistors remain unloaded for a correspondingly period. This ensures that the braking resistor is not destroyed.

The characteristic values P_{AV} and W_{peak} of the internal braking resistor can be found from page 3-6.

Electrical losses WE   The electrical losses W_E in the drive can be estimated from the peak power of the drive. The maximum power loss is around 10% of peak power for a typical efficiency factor of 90%. If the current on braking is lower, the power loss will be reduced accordingly.

Mechanical losses W_M   The mechanical losses result from absorption by friction, which occurs when the system is running. Mechanical losses can be ignored if the system requires a much longer time to coast to a stop than the time required to stop the system under braking. The mechanical losses can be calculated from the load torque and the speed from which the motor is to stop.

Example   Braking of a motor with the following data (AC IN equal to $400V_{AC}$):

- Starting speed: n = 4000 min^{-1}

- Rotor inertia: J_R= 4 $kgcm^2$

- Load inertia: J_L= 6 $kgcm^2$

The energy to be absorbed is given by:

$W_B = 1/2 * J * (2*\pi*n)^2$

to 88 Ws

Electrical and mechanical losses are ignored.

23 Ws are absorbed in the DC bus capacitors at a power supply of 400 V.

The internal braking resistor must absorb the residual 65 Ws. It can absorb a pulse of 80 Ws. The internal braking resistor is sufficient if the load is stopped once under braking.

If the braking process is repeated cyclically, the continuous output must be considered. If the cycle time is longer than the ratio of the energy to be absorbed W_B and the continuous power P_{AV}, the internal braking resistor is sufficient. If braking takes place more frequently, the internal braking resistor will not be sufficient.

In the example the ratio W_B/P_{AV} is 1.3 s. An external braking resistor is required with a shorter cycle time.

Ratings the external braking resistor
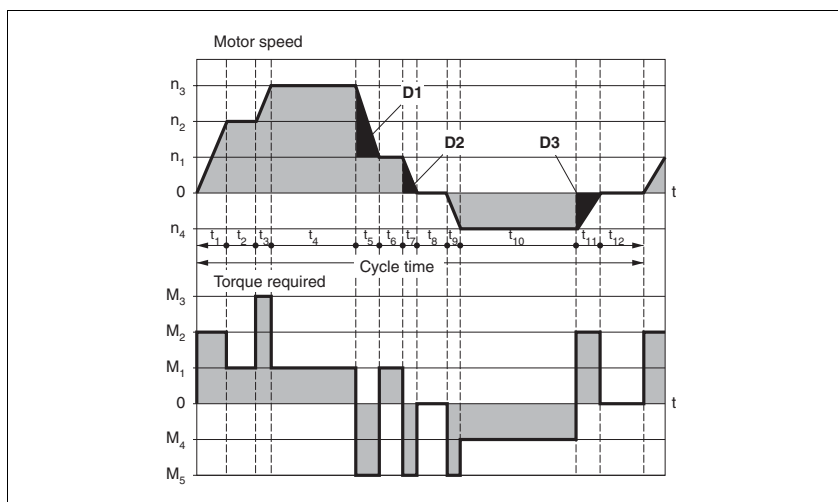
Figure 5.10   Characteristics for rating the braking resistor

These two characteristics are also used for the rating the motor. The segments of the characteristic under consideration in which the motor brakes are identified by (D_i)

Calculation of the energy at constant runout:

The total inertia (J_t) must be known.

J_t is given by:

$J_t = J_m + J_c$

J_m: Motor inertia with and without brake

J_c: Load inertia

The energy for each runout segment is calculated as follows:

$$E_i = \frac{1}{2} J_t \cdot \omega_i^2 = \frac{1}{2} J_t \cdot \left[\frac{2\pi n_i}{60}\right]^2$$

The following is derived for the segments (D_1) … (D_3):

$$E_1 = \frac{1}{2} J_t \cdot \left[\frac{2\pi(n_3 - n_1)}{60}\right]^2$$

$$E_2 = \frac{1}{2} J_t \cdot \left[\frac{2\pi n_1}{60}\right]^2$$

Units: E_i in joules, J_t in kg/m², w in rad and n_i in rpm.

The table shown below gives the energy uptake capacity, Evar, for the individual drive regulators (without regard to an internal or external braking resistor).

When continuing with the calculation, take into account only those segments Di whose energy Ei exceeds the uptake capacity shown in the table. These excess energies E_{Di} should be removed via the braking resistors (internal or external).

The calculation of E_{Di} is accomplished using the formula:

$E_{Di} = E_i - E_{var}$ (in Joules)

The continuous power P_c is calculated for each machine cycle

$$P_c = \frac{\sum E_{Di}}{\text{Cycletime}}$$

Units: P_c in [W], E_{Di} in [J] and cycle time T in [s]

Selection takes place in two steps:

• The maximum energy during the braking process must be less than the peak energy that the braking resistor can accommodate: $(E_{Di}) < (E_{Cr})$. In addition the continuous output of the internal braking resistor must not be exceeded: $(P_C) < (P_{Pr})$. If these conditions are met, then the internal braking resistor is adequate.

• If any one of the conditions is not met, it is necessary to use an external braking resistor. The resistance should be chosen such that the conditions are met. The value of the resistance must be between the specified minimum and maximum values, since other-

wise the load can no longer be safely braked or the product could be destroyed.

For the order data for the external braking resistors see the accessories section from page 11-4.

LXM05•...		U70M2	D10M2	D17M2	D28M2	D14N4	D22N4	D34N4	D57N4
Energy consumption of internal capacitors E_{var}	[Ws]	17.7	17.7	26.6	43.0	26.0 [1]	52.0 [2]	52.0	104.0 [3]
resistance internal	[Ω]	40	40	40	20	40	30	30	20
Continuous output P_{PR}	[W]	20	20	40	60	40	60	60	100
Peak energy E_{CR}	[Ws]	900	900	900	1600	1000	1600	1600	2000
Making voltage	[V]	430	430	430	430	770	770	770	760
External braking resistor min	[Ω]	50	50	27	16	60	25	25	10
External braking resistor max	[Ω]	75	75	45	27	80	36	36	21

1) at 480V: 6.0Ws
2) at 480V: 12.0Ws
3) at 480V: 10.0Ws

5.3.6 Connection of power amplifier supply voltage

⚠ **DANGER**

Electric shock because of insufficient earthing

This drive system has an increased leakage current > 3.5mA.

- Use a protective conductor at least 10 mm² (AWG 6) or two protective conductors with the cross section of the conductor for the power supply of the power terminals. Observe the local regulations for earthing.

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

⚠ **WARNING**

Insufficient protection against overcurrents

- Use the external fuses specified in "Technical Data".

- Do not connect the product to a power supply in which the short-circuit capacity exceeds the maximum short-circuit current approved in "Technical Data".

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

<table>
<tr><td colspan="2" align="center">**CAUTION**</td></tr>
<tr><td colspan="2">**Destruction by incorrect mains voltage**</td></tr>
<tr><td colspan="2">The incorrect mains voltage may destroy the product.</td></tr>
<tr><td colspan="2">• Before switching on and configuring the product, make sure that the type is approved for the mains voltage.</td></tr>
<tr><td colspan="2">**Failure to follow these instructions can result in equipment damage.**</td></tr>
</table>

Cable specifications   The wiring must have a sufficiently large cross section to ensure that the fuse at the mains connection can be tripped in the event of a fault.

When connecting the device in an IT mains follow the directions in 5.1.1 "Operation in an IT mains".

In addition, note the suitability of the wiring, see page 5-12 and the EMC-compliant connection, see page 5-2.

LXM05•...		U70••• D10•••	D14•• D17••• D2••• D3••• D4••••	D5•••
Connection cross section	mm^2	0.75 ... 1.5	1.5 ... 4	3.3 ... 16 [1]
AWG		14 ... 20	10 ... 16	6 ... 12 [1]
Tightening torque	Nm	0.5 ... 0.6	1.2 ... 1.5	2.2 ... 2.8

1) Wire end ferrules or fork-type cable lugs are required with a cross section of 2.5 mm² (AWG 14).

Preparing cables   Use fork-type cable lugs or wire end ferrules. The lead must fill the sleeve for its entire length to ensure maximum current carrying capacity and vibration resistance.

Connecting mains power   Observe the following instructions at all times:

• 3-phase devices must only be connected and operated on 3-phase.

• For devices with external mains filter the power cable must be shielded from 200 mm length between the external mains filter and the device and earthed at both ends.

• Observe the EMC requirements. If necessary, use overvoltage arrestors, mains filters and mains reactors, see page 5-9.

• Follow the requirements for design of corresponding UL, see page 3-1.

• The PE connection on the case must be connected to the mounting plate because of the high leakage currents.

Wiring diagram of 1-phase device   Figure 5.11 shows the connection of the mains power supply for a single phase device. The diagram also shows the wiring of the optional external mains filter and mains reactor .

CAUTION: in three-phase systems the neutral conductor N must generally be used instead of L2.
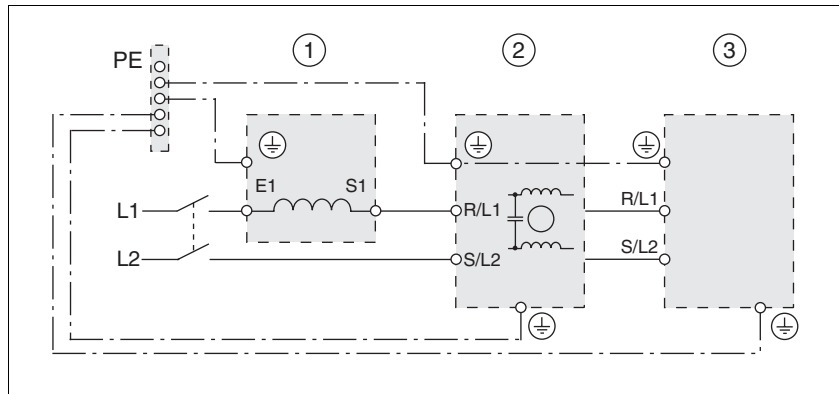
Figure 5.11   Wiring diagram:mains power for a single phase device

(1)   Mains reactor (optional)
(2)   Mains filter (optional)
(3)   Product

If neutral conductor N is used instead of L2, a fuse is only required with L1.

▶ Connect the power cables. Note the exact terminal assignment of your device, see chapter 5.3.2 "Overview of all connections".

Wiring diagram of 3-phase device   Figure 5.12 shows the connection of the mains power supply for a 3-phase device. The diagram also shows the wiring of the optional external mains filter and mains reactor .
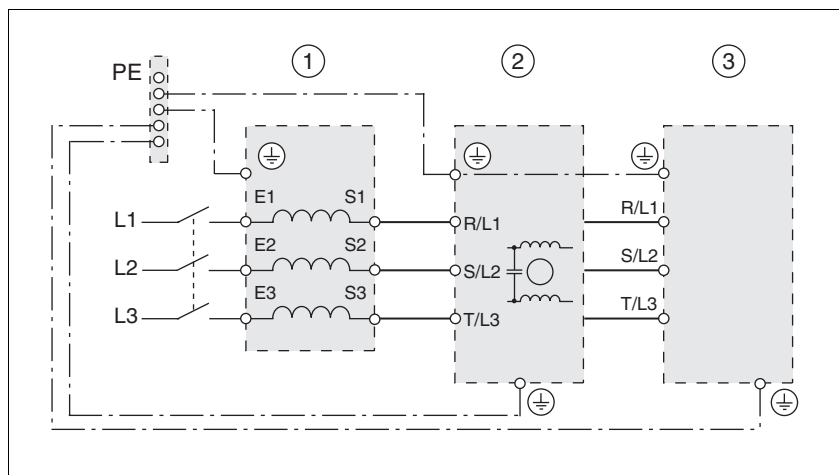
Figure 5.12   Wiring diagram:mains power for 3-phase device

(1)   Mains reactor (optional)
(2)   Mains filter (optional)
(3)   Product

▶ Connect the power cables. Note the exact terminal assignment of your device, see chapter 5.3.2 "Overview of all connections".

5.3.7   Connection for parallel operation

> # CAUTION
>
> **Incorrect parallel connection**
>
> Operation with a non-approved parallel connection on the DC bus may destroy the drive systems immediately or after a delay.
>
> - Find out the general conditions and requirements for parallel connections on the DC bus from your local representative.
>
> **Failure to follow these instructions can result in equipment damage.**

5.3.8   Connection of motor encoder (CN2)

Function and sensor type   The motor sensor is a Hiperface sensor (SinCos sensor) integrated into the motor. It captures the rotor position of the motor and sends the motor position to the unit both analogue and digitally.

Cable specifications
- Shielded cable
- Twisted pair lines
- Minimum cross section of signal wires: $10*0.25$ mm^2 + $2*0.5$ mm^2
- Earthing of the shield at both ends
- maximum cable length 100m
- for further information see 3.4.6 "Cable" on page 3-10[1]

Preparing cables
▶ Use prefabricated cables to minimise the risk of a wiring error (from page 11-2). Step 5 in Figure 5.13 must be carried out even with pre-fabricated cable. The dimensions for positioning the shield on the housing are applicable when the included EMC plate is used.

▶ If you are not using prefabricated wiring, follow the procedure and the dimensions in Figure 5.13.

1. For BRH motors see motor manual
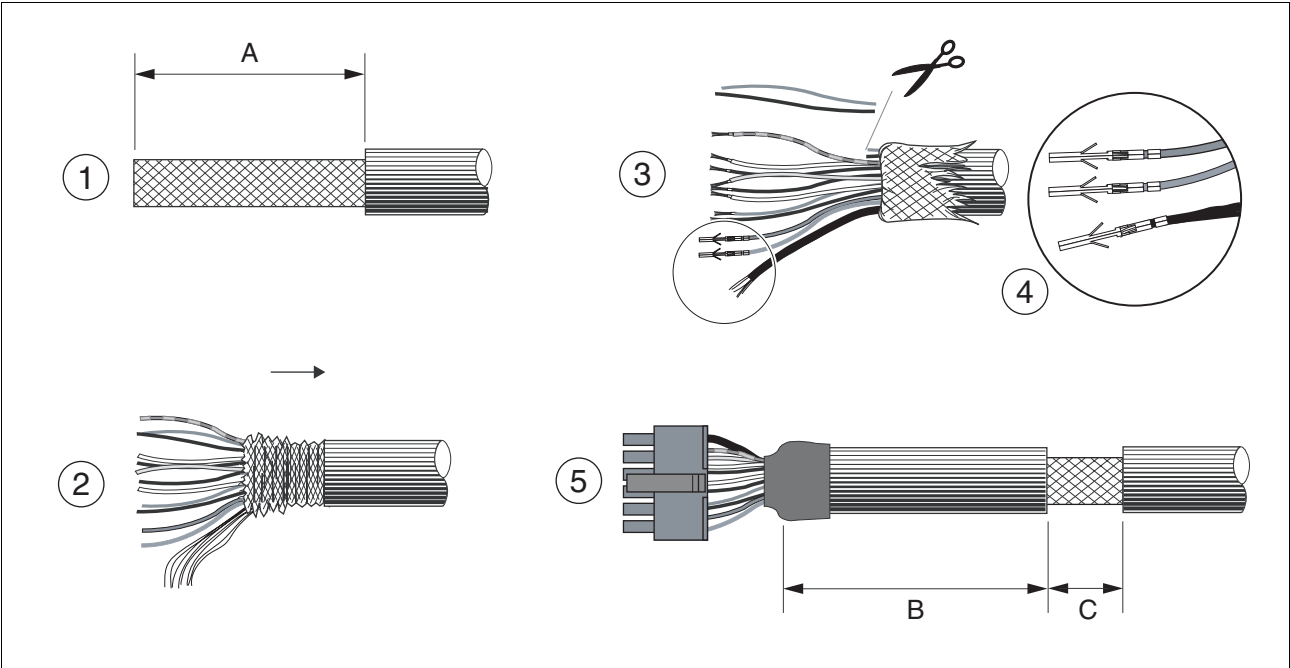
Figure 5.13   Steps (1-5) for fabrication of the sensor cable

LXM05•...		U70••• D10•	D14•• D17•••	D2••• D3••• D4•••	D5•••
A	mm	25	25	25	25
B	mm	90	100	130	120
C	mm	15	15	15	15

▶ (1) Remove the cable sheath, length A depends on the device, see table.

▶ (2) Shorten the shield braiding. The shield braided filler wire is required as the connection.

▶ (3) The red and the violet braided wire is not required and can be cut off. Isolate the shield lead with shrink wrap.

▶ (4) Crimp the plug contacts on the remaining braided wires and on the isolated shield wire. Isolate the shield braiding with shrink wrap. Plug the crimp contacts into the connector shell; for the pin assignment see .

   For the order number of the crimping pliers and the extraction tool see

▶ (5) Sheath the cable to length C on the position shown, the cable is fastened there at the EMC plate with a clamp (shield-earth connection).

Wiring diagram
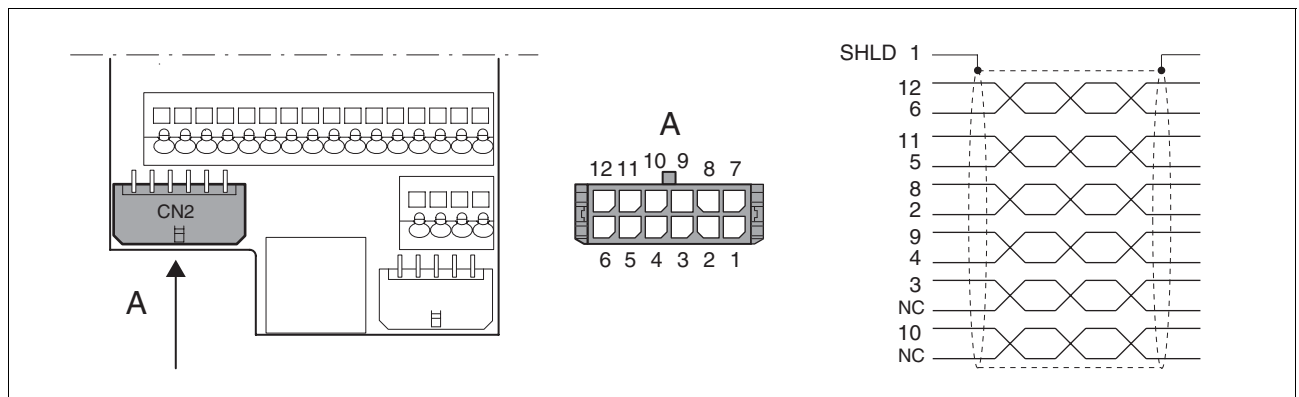
Figure 5.14   Wiring diagram of motor encoder

Pin	Signal	Motor, pin	Colour [1]	Pair	Description	I/O
1	SHLD				Shielding braid	
12	SIN	8	white	1	Sine signal	I
6	REFSIN	4	brown	1	Reference for sine signal, 2.5 V	O
11	COS	9	green	2	Cosine signal	I
5	REFCOS	5	yellow	2	Reference for cosine signal, 2.5V	O
8	Data	6	grey	3	Receive and transmit data	I/O
2	$\overline{\text{Data}}$	7	pink	3	Receive and transmit data, inverted	I/O
10	ENC_0V	11	blue	4	Encoder reference potential (encoder) ($0.5\,\text{mm}^2$)	O
			red	4	not connected ($0.5\,\text{mm}^2$)	
3	T_MOT_0V	1	black	5	Reference potential to T_MOT	
			purple	5	not connected	
9	T_MOT	2	grey/pink	6	temperature sensor PTC	I
4	ENC+10V_OUT	10	red/blue	6	$10\,\text{V}_{DC}$ power supply for encoder, max. 150 mA	O
7	n.c.				not connected	

1) Colour data is based on the prefabricated cables

Connecting motor sensor

▶ Make sure that the wiring, the cables and the connected interfaces meet the requirements for PELV.

▶ Note the EMC specification for motor sensor wiring from page 5-3, and ensure the equipotential bonding over equipotential bonding conductors.

▶ Connect the plug to CN2.

▶ Fasten the cable to the EMC plate and make sure that the cable shielding is spread over a wide area.

5.3.9 Connection of holding brake controller (HBC)

⚠ **DANGER**

Electric shock because of voltage spread

The wiring to the brake in the motor cable generally does not correspond to the PELV requirements.

•   Use a holding brake controller.

•   Do **not** connect the brake to the controller voltage.

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

⚠ **DANGER**

Electric shock

High voltages at the motor connection may occur unexpectedly.

•   The motor generates voltage when the shaft is rotated. Lock the motor shaft to prevent rotation before starting work on the drive system.

•   AC voltages may jump over unused wires in the motor cable. Isolate unused wires at both ends of the motor cable.

•   The system manufacturer is responsible for compliance with all applicable regulations relevant to earthing the drive system. Extend the earth through the motor cable with an additional earth at the motor housing.

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

Selection and dimensioning   For a motor with holding brake, we recommend an appropriate start-up logic (HBC) which releases the brake when current is supplied to the motor and which fixes the motor axle quickly when the motor is stopped.

Delay times for the release and the application of the brake can be set by parameters on the device, see page 7-29. For order data for the HBC see accessories from page .

Note the power requirement of the HBC. It depends on the switching current for the holding brake and is calculated from:
Input current HBC [A] = 0.5 A + switching current [A]

Under certain conditions you can omit a holding brake controller. However, it is imperative that the following points are taken into account:

•   A separate power supply is required. This must correspond to the specified brake tolerances.

•   The controller supply voltage and the power supply for the brake must be safely electrically isolated.

•   The drive power of many motors is reduced if the current reduction to the brake is omitted.

•   The unshielded section of the brake wire must not exceed 12 cm because of possible EMC interference.

Wiring diagram HBC
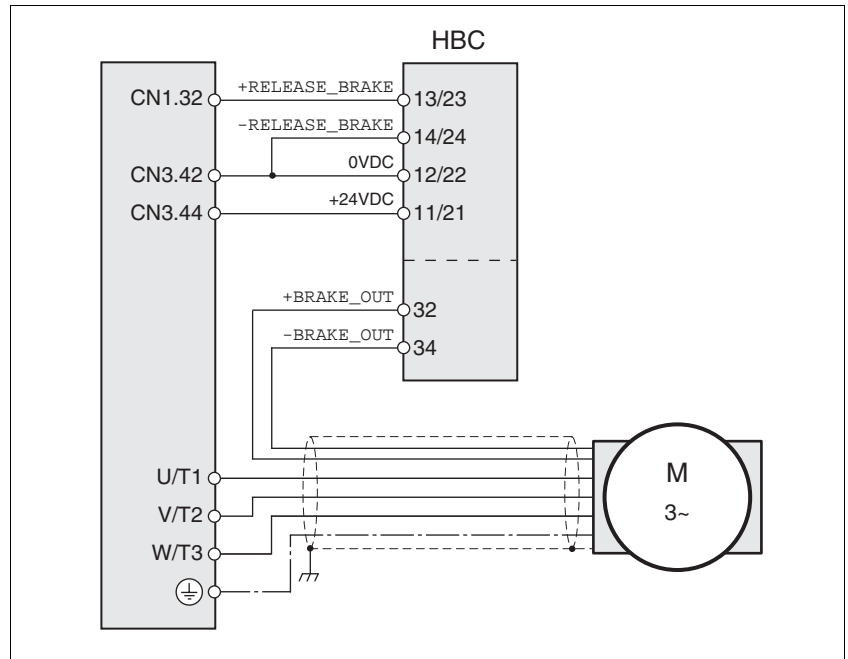
Figure 5.15   Wiring diagram, motor with holding brake and HBC. A separate brake line is required for BRH motors.

HBC terminal	HBC connection	Description	Colour
32	+BRAKE_OUT	Brake wire	white (WH)
34	–BRAKE_OUT	Brake wire	grey (GR)
13/23	+RELEASE_BRAKE	Brake output from servo amplifier	
14/24	–RELEASE_BRAKE	Reference potential for servo amplifier brake output	
11/21	+24VDC	Supply voltage	
12/22	0VDC	Reference potential for supply voltage	

A maximum motor cable length of 50m is permitted for the BSH motors when using the holding brake controller.

If a greater length is required, a cable with a larger cross section of the brake wires ($>1mm^2$) is permitted.

Connecting HBC   ▶ Attach the holding brake controller to the right of the device, see Figure 5.1.

▶ Insulate unused leads individually.

The power supply to the holding brake must be insulated from that of the PELV circuit of the device. The insulation is internal in the HBC described in the accessories chapter.

For further information on HBC see page 3-9, 6-20, 11-1.

5.3.10 Connection of controller supply voltage (24V at CN3)

The controller power supply (+24VDC) must be connected for all operating modes.

⚠ DANGER

Electric shock from incorrect power supply unit

The +24VDC supply voltage is connected with many accessible signals in the drive system.

- Use a power supply unit that meets the requirements for PELV (Protective Extra Low Voltage)
- Connect the negative output of the power supply unit to PE.

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

CAUTION

Destruction of contacts

The connection for the controller power supply at the drive system does not have a make current limit. If the voltage is switched on by switching contacts, the contacts may be destroyed or welded shut.

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

Failure to follow these instructions can result in equipment damage.

⚠ CAUTION

Destruction of system components and loss of control monitoring

Excessive currents can be created at the signal connections if the negative connection to the controller supply voltage is interrupted.

- Do not interrupt the negative connection between power supply unit and load with a fuse or switch
- Check for correct connection before switching on.
- Never connect the controller supply voltage or change its wiring while there is supply voltage present.

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

Wiring diagram
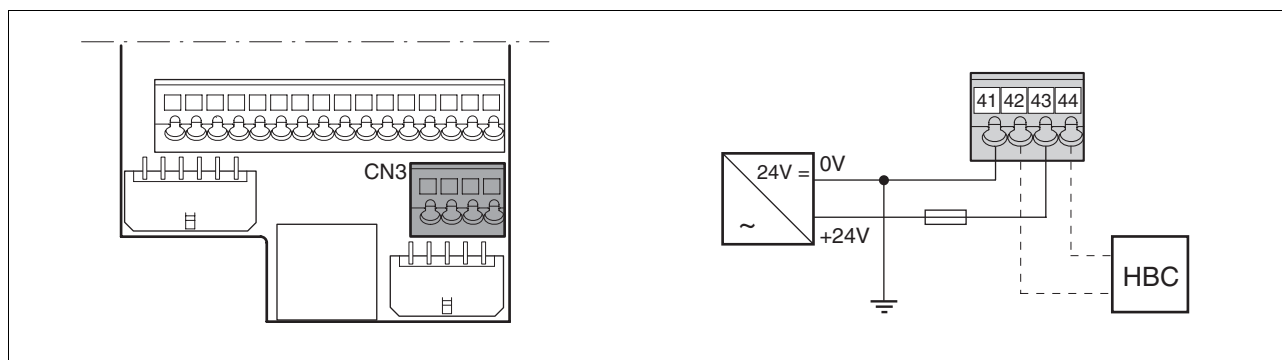
Figure 5.16   Controller supply voltage wiring diagram

Pin	Signal	Description
41	`0VDC`	Reference potential for 24 V voltage
42	`0VDC`	Reference potential for 24 V voltage
43	`+24VDC`	24 V controller supply voltage
44	`+24VDC`	24 V controller supply voltage

Connecting the controller supply voltage

▶ Make sure that the cables, the wiring and the connected interfaces meet the requirements for PELV.

▶ Feed the controller supply voltage from a power supply unit (PELV) to the device.

▶ Earth the negative output at the power supply

Rating

• Terminal CN3, pin 42 and 44 (see) can be used as a 0V/24V terminal for additional consumers. Note the maximum terminal current, see Technical Data, from page 3-1.

• As long as the controller supply voltage is switched on, the position of the motor will remain the same, even if the power amplifier supply voltage is switched off.

5.3.11 Connection of encoder simulation (CN5)

Function   The device is suitable for encoder simulation (ESIM). Signals for output of the actual position can be led out at CN5. They are two phase-shifted signals A and B. The A/B signals are generated by the motor encoder signal.

Resolution   The basic resolution of the encoder simulation at 4x resolution is 4096 increments per revolution.
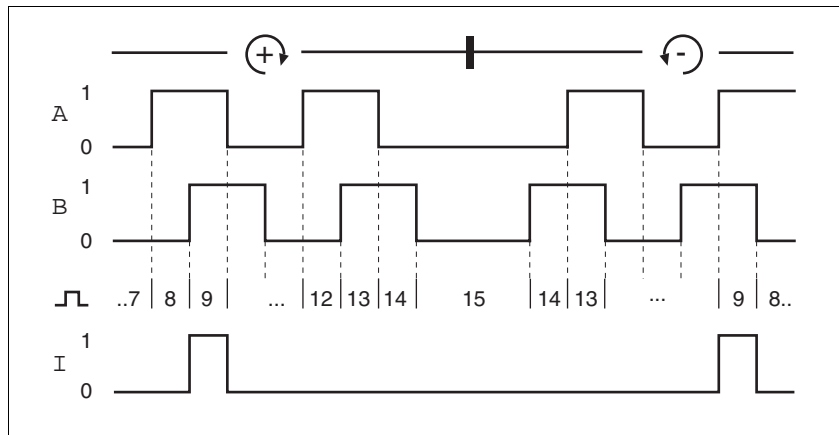
Figure 5.17   Timing diagram with A, B and index pulse signal, counting forwards and backwards

Cable specification   • Shielded cable

• Twisted-pair conductors

• Minimum cross section of the signal wires 0.14 mm^2

• Earthing of the screen at both ends

• Maximum length 100 m

▶ Use equipotential bonding conductors, see page 5-3.

▶ Use prefabricated cables to minimise the risk of a wiring error (from page).

Connecting ESIM   ▶ Connect the plug to CN5. If you are not using prefabricated wiring, make sure the pin assignment is correct.

▶ Make the appropriate settings during commissioning. See "First Setup", page 6-11

For the order number of the crimping pliers and the extraction tool see

Wiring diagram
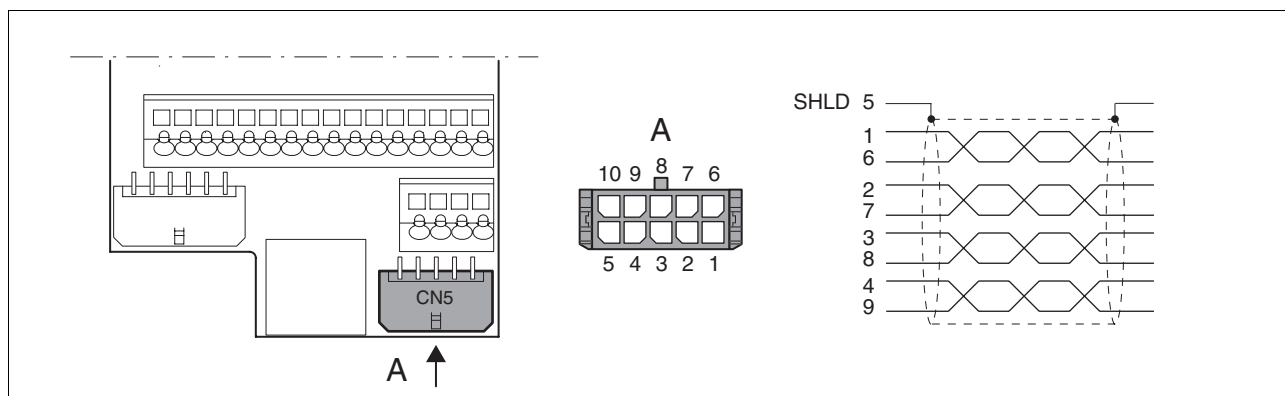
Figure 5.18   ESIM wiring diagram

Pin	Signal	Colour [1]	Description	I/O
1	ESIM_A	white	Channel A	RS422 output signal
6	$\overline{\text{ESIM\_A}}$	brown	Channel A, inverted	RS422 output signal
2	ESIM_B	green	Channel B	RS422 output signal
7	$\overline{\text{ESIM\_B}}$	yellow	Channel B, inverted	RS422 output signal
3	ESIM_I	grey	Index pulse	RS422 output signal
8	$\overline{\text{ESIM\_I}}$	pink	index pulse, inverted	RS422 output signal
4	LO4_OUT	red	Digital output 4	Open collector
9	ESIM_0V	blue	Reference potential	-
5	SHLD		Shield	
10	nc		not connected	

1) Information on colour refers to the cables available as accessories.

5.3.12   Connection of analogue inputs (CN1)

Cable specifications
- Shielded cable

- Twisted pair lines

- Minimum cross section of signal wires 0.14 mm^2, max. cross section 1.5 mm^2

- maximum length 10 m

Connecting analogue inputs   ▶ Attach the cable to the EMC plate, the shield must be attached to the earth potential over a wide area.
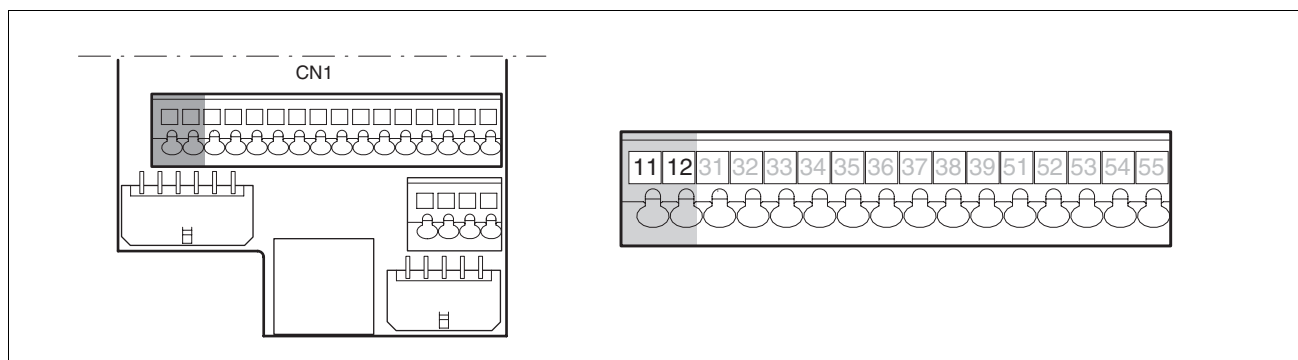
Figure 5.19   Wiring diagram, analogue inputs

Pin	Signal	Description	I/O
11	`ANA1+`	±10V, e.g. for current reference value or speed reference value	I
12	`ANA1-`	Reference potential for `ANA1+`, pin 11	I

Reference values and limits   The ±10V scaling of the analogue reference value can be specified for operation, see page .

5.3.13 Connection of digital inputs/outputs (CN1)

Cable specifications
- minimum cross-section 0.14 mm^2, max. cross-section 1.5 mm^2
- Maximum length at minimum cross section 15 m..

Connecting digital inputs/outputs
▶ Wire the digital connections to CN1.
▶ Earth the shield with low resistance and over a wide area at both ends of the cable.

Wiring diagram   The signal assignment depends on the start-up operating mode. The configuration and the standard assignment of the inputs and outputs are described in 7.6.7 "Configurable inputs and outputs".
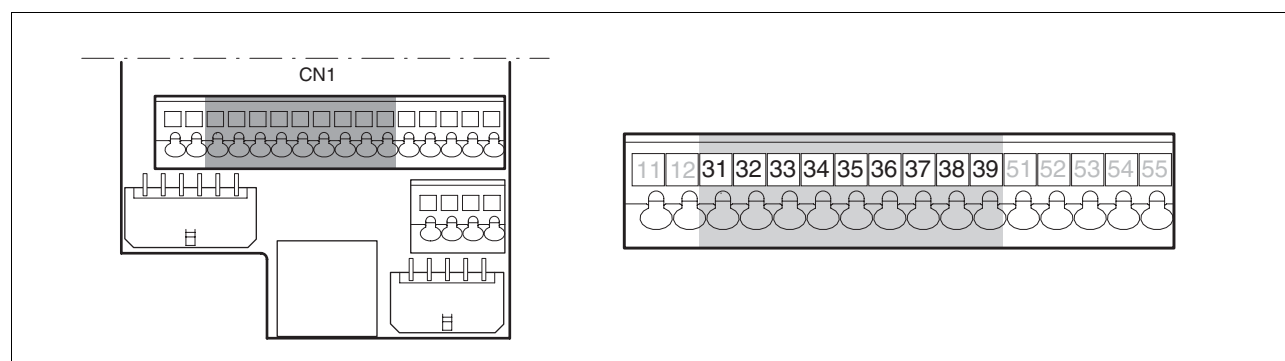
Figure 5.20   Wiring diagram, digital inputs/outputs

Pin	Signal assignment	Description	I/O
31	NO_FAULT_OUT/LO1_OUT	Digital output 1 / error output	24 V, O
32	BRAKE_OUT/LO2_OUT	Digital output 2 / control signal for holding brake controller HBC: 0 motor has no current 1 motor has current	24 V, O
33	LO3_OUT	Digital output 3	24 V, I
34	JOG_N/LI1	Digital input 1 / standard assignment depends on start-up operating mode	24 V, I
35	FAULT_RESET / JOG_P / LI2	Digital input 2 / standard assignment depends on start-up operating mode	24 V, I
36	ENABLE	Enable power amplifier	24 V, I
37	$\overline{\text{HALT}}$ / JOG_FS / LI4	Digital input 4 / standard assignment depends on start-up operating mode	24 V, I
38	LI5	Digital input 5	24 V, I
39	LI6	Digital input 6	24 V, I

5.3.14 CW/CCW connection (CN1)

⚠ WARNING

Unexpected movement

Incorrect or faulty signals as reference position can trigger unexpected movements.

- Use shielded cables with twisted-pair.
- Operate the interface with push-pull signals.
- Do not use signals without push-pull in critical applications or in an environment subject to interference.
- Do not use signals without push-pull with cable lengths over 3 m and limit the frequency to 50 kHz

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

⚠ CAUTION

Destruction of the product and loss of control

The PULSE, DIR, CW/CCW and A/B inputs at this connection are only designed for 5V. Excessive voltage can cause destruction of the product either immediately or at a later time.

- Check the correct connection before switching on.

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

Function The device is suitable for reference value default via externally fed CW/CCW signals. For example, this is required for the Pulse control operating mode.

"CW/CCW" interface mode The motor executes a clockwise motor step with the rising edge of the CW signal. The motor executes an counterclockwise motor step with the rising edge of the CCW signal.
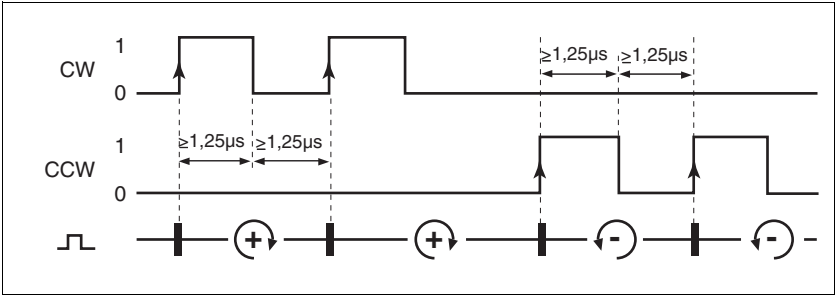
Figure 5.21   "CW/CCW" interface mode

Pin	Signal	Value	Function
52/53	CW	0 -> 1	clockwise motor step
54/55	CCW	0 -> 1	counterclockwise motor step

The maximum frequency is 400 kHz.

Circuit of the signal inputs
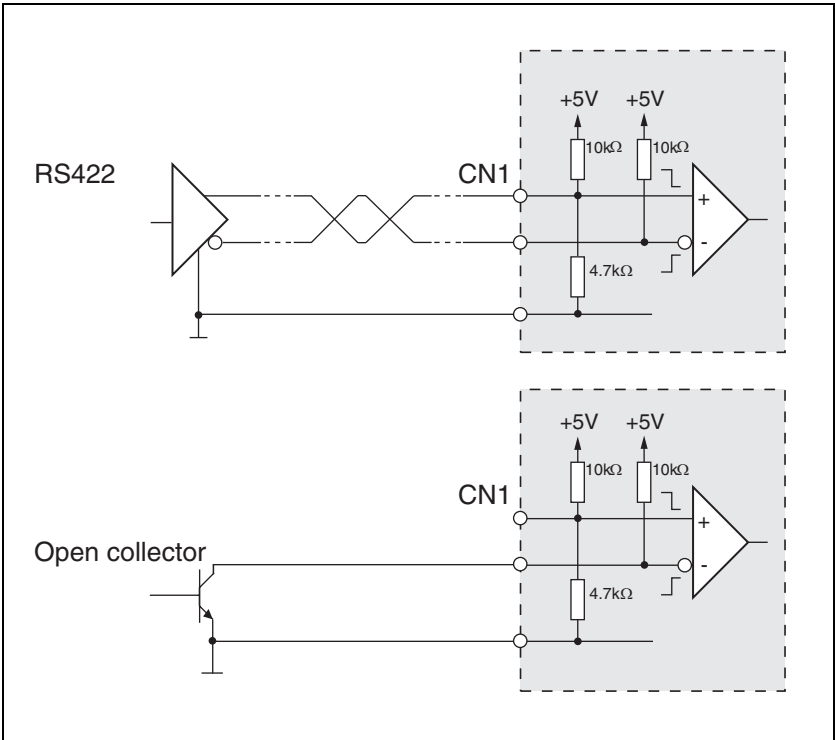
Figure 5.22   Circuit of the signal inputs

Cable specifications
- Shielded cable
- Twisted pair lines
- Minimum cross section of the signal wires 0.14 mm^2
- Earthing of the shield at both ends
- Maximum length 100 m

▶ Use equipotential bonding conductors, see page 5-3.

▶ Use prefabricated cables to minimise the risk of a wiring error (from page 11-2).

Connecting CW/CCW   ▶ Connect the signals to CN1. Observe the correct pin assignment.

▶ Make the appropriate settings during commissioning. See "First Setup", page 6-11
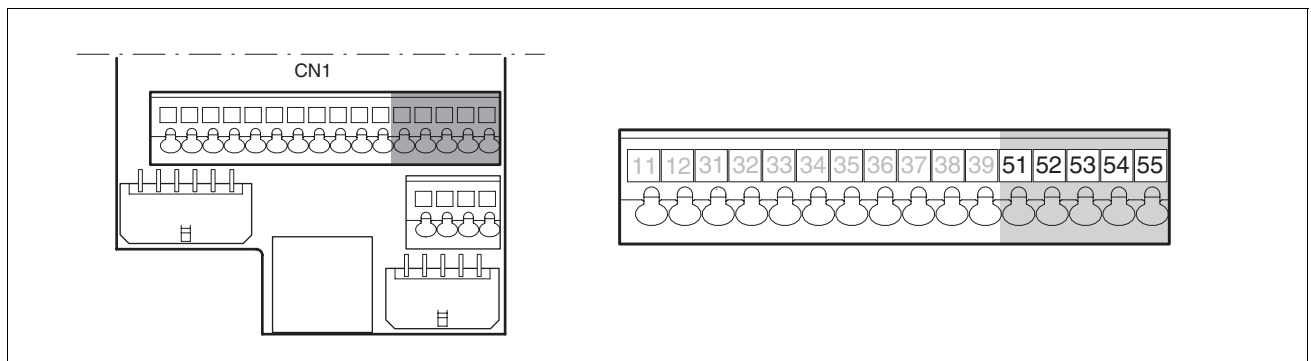
Wiring diagram

Figure 5.23   Wiring diagram PULSE

Pin	Signal	Colour [1]	Description	I/O
51	POS_0V	blue	Reference potential	-
52	CW	white	Motor step in clockwise rotation (+)	RS422 input signal
53	$\overline{CW}$	brown	Motor step in clockwise rotation, inverted (-)	RS422 input signal
54	CCW	green	Motor step in counterclockwise rotation (+)	RS422 input signal
55	$\overline{CCW}$	yellow	Motor step in counterclockwise rotation, inverted (-)	RS422 input signal

1) Information on colour refers to the cables available as accessories.

5.3.15 Connection of pulse/direction PD (CN1)

⚠ WARNING

Unexpected movement

Incorrect or faulty signals as reference position can trigger unexpected movements.

• Use shielded cables with twisted-pair.

• Operate the interface with push-pull signals.

• Do not use signals without push-pull in critical applications or in an environment subject to interference.

• Do not use signals without push-pull with cable lengths over 3 m and limit the frequency to 50 kHz

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

> ⚠ **CAUTION**
>
> **Destruction of the product and loss of control**
>
> The PULSE, DIR, CW/CCW and A/B inputs at this connection are only designed for 5V. Excessive voltage can cause destruction of the product either immediately or at a later time.
>
> • Check the correct connection before switching on.
>
> **Failure to follow these instructions can result in injury or equipment damage.**

Function The device is suitable for reference value default via externally fed pulse/direction signals PD. For example, this is required for the Pulse control-operating mode.

The signal interface is used for positioning the motor. Operation readiness of the drive and a possible breakdown are reported.

Pulse/direction PD The motor executes an angular step on the rising edge of the PULSE signal. The direction of rotation is controlled by the DIR signal.
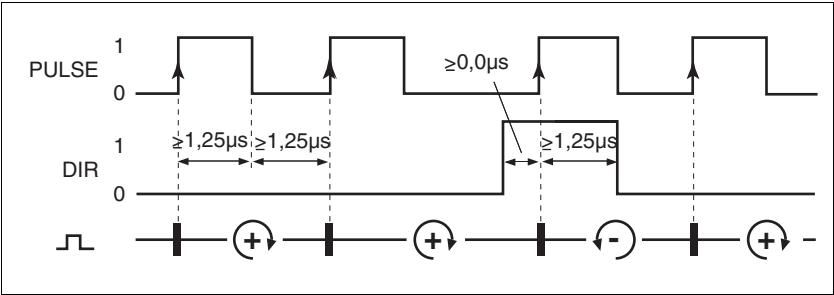
Figure 5.24   Pulse direction signal

Pin	Signal	Value	Function
52/53	PULSE	0 -> 1	Motor step
54/55	DIR	0 / open	Clockwise rotation

Circuit of the signal inputs
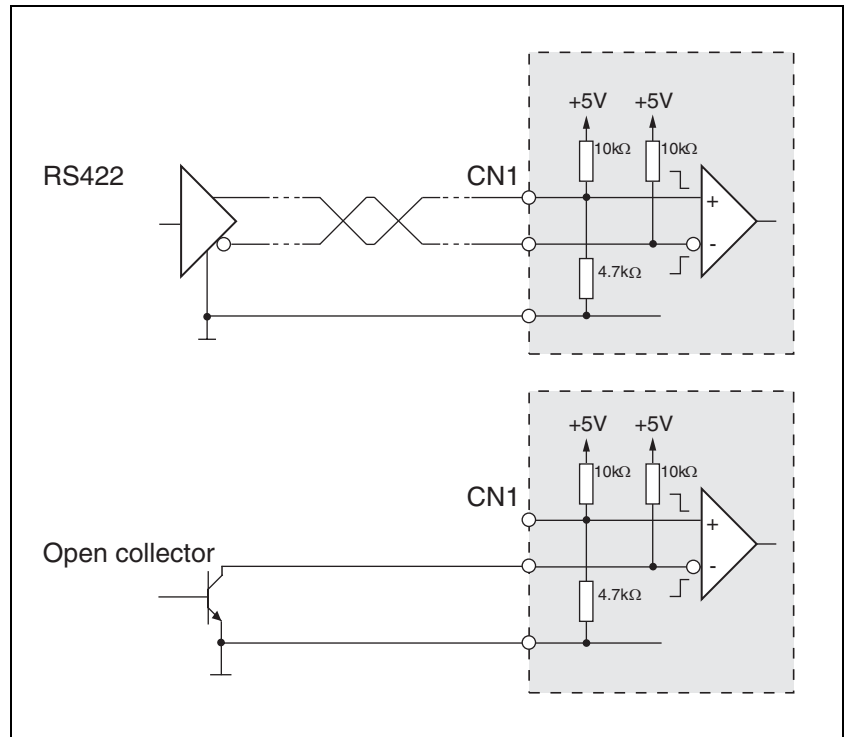
Figure 5.25   Circuit of the PULSE, DIR and ENABLE signal inputs

Cable specifications
- Shielded cable
- Twisted pair lines
- Minimum cross section of the signal wires 0.14 mm^2
- Earthing of the shield at both ends
- Maximum length 100 m
- ▶ Use equipotential bonding conductors, see page 5-3.
- ▶ Use prefabricated cables to minimise the risk of a wiring error (from page 11-2).

Connecting pulse/direction PD
- ▶ Connect the signals to CN1. Observe the correct pin assignment.
- ▶ Make the appropriate settings during commissioning. See "First Setup", page 6-11
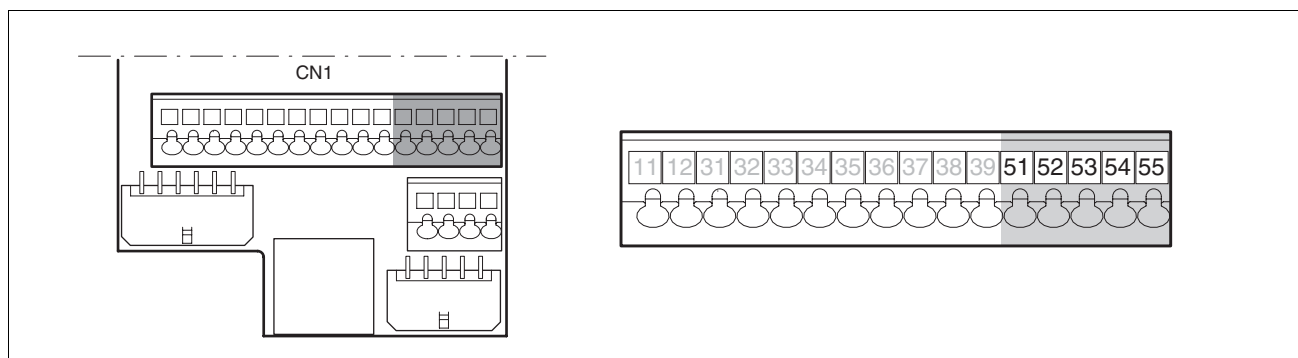
Wiring diagram

Figure 5.26   Wiring diagram PULSE

Pin	Signal	Colour [1]	Description	I/O
51	POS_0V	blue	Reference potential	-
52	PULSE	white	Motor step "Pulse"	RS422 input signal
53	$\overline{\text{PULSE}}$	brown	Motor step "Pulse", inverted	RS422 input signal
54	DIR	green	direction of rotation "DIR"	RS422 input signal
55	$\overline{\text{DIR}}$	yellow	direction of rotation "Dir", inverted	RS422 input signal

1) Information on colour refers to the cables available as accessories.

5.3.16 Connecting encoder signals A, B (CN1)

> ⚠ **CAUTION**
>
> **Destruction of the product and loss of control**
>
> The PULSE, DIR, CW/CCW and A/B inputs at this connection are only designed for 5V. Excessive voltage can cause destruction of the product either immediately or at a later time.
>
> • Check the correct connection before switching on.
>
> **Failure to follow these instructions can result in injury or equipment damage.**

Function   At CN1 the reference value preset can be made via externally fed A/B signals in Pulse control operating mode.

The maximum frequency for A/B signals is 400 kHz.
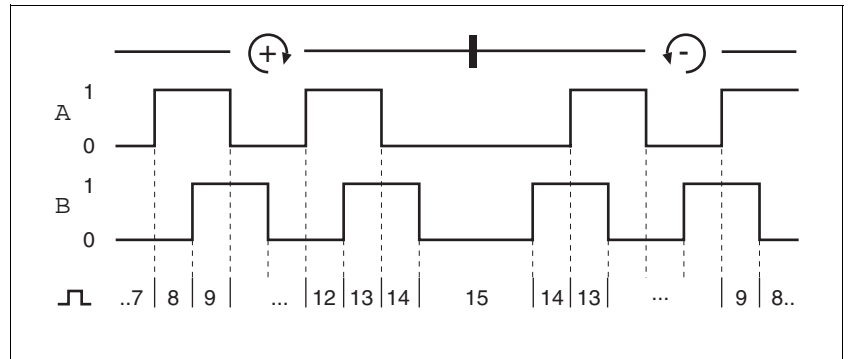
Figure 5.27   Timing diagram with A/B signal, counting forwards and backwards

Cable specifications
- Shielded cable
- Twisted pair lines
- Minimum cross section of the signal wires 0.25 mm^2
- Earthing of the shield at both ends
- Maximum cable length 100m
- ▶ Use equipotential bonding conductors, see page 5-3.
- ▶ Use prefabricated cables to minimise the risk of a wiring error (from page 11-1).

Connect the encoder
- ▶ Connect the signals to CN1. Observe the correct pin assignment.
- ▶ Make the appropriate settings during commissioning. See "First Setup", page 6-11
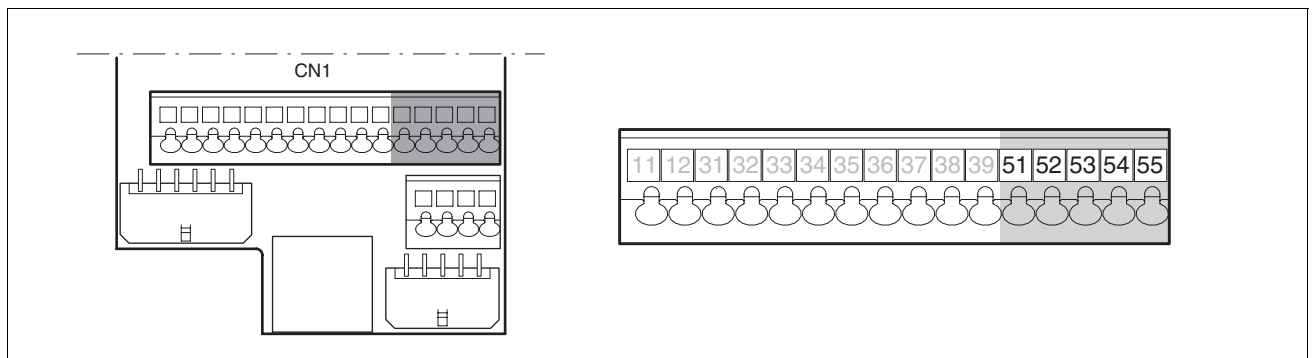
Wiring diagram

Figure 5.28   Wiring diagram, Encoder to CN5

Pin	Signal	Colour [1]	Description	I/O
51	POS_0V	blue	Reference potential	
52	ENC_A	white	Encoder signal channel A	RS422 input signal
53	$\overline{ENC\_A}$	brown	Channel A, inverted	RS422 input signal
54	ENC_B	green	Encoder signal channel B	RS422 input signal
55	$\overline{ENC\_B}$	yellow	Channel B, inverted	RS422 input signal

1) Information on colour refers to the cables available as accessories.

5.3.17 Connection to PC or remote terminal (CN4)

<table>
<tr><td colspan="2">

CAUTION

Damage to PC

If the interface connector on the product is directly connected to a Gigabit Ethernet plug on the PC, the interface on the PC may be destroyed.

• Never connect an Ethernet interface directly to this product.

Failure to follow these instructions can result in equipment damage.

</td></tr>
</table>

Function of the control terminal   The remote terminal with LCD display and keypad can be connected directly to CN4 with the supplied RJ-45 cable, see accessories from page 11-1. This allows the device to be operated at a distance from the system. The functions and display of the control terminal are identical to those of the HMI.

Cable specifications
• Shielded cable

• Twisted pair lines

• Minimum cross section of the signal wires 0.14 mm^2

• Earthing of the shield at both ends

• maximum length 400 m

PC connection   An RS485 to RS232 converter is required for the PC, see accessories from page 11-1. The converter is powered by the device.

Wiring diagram
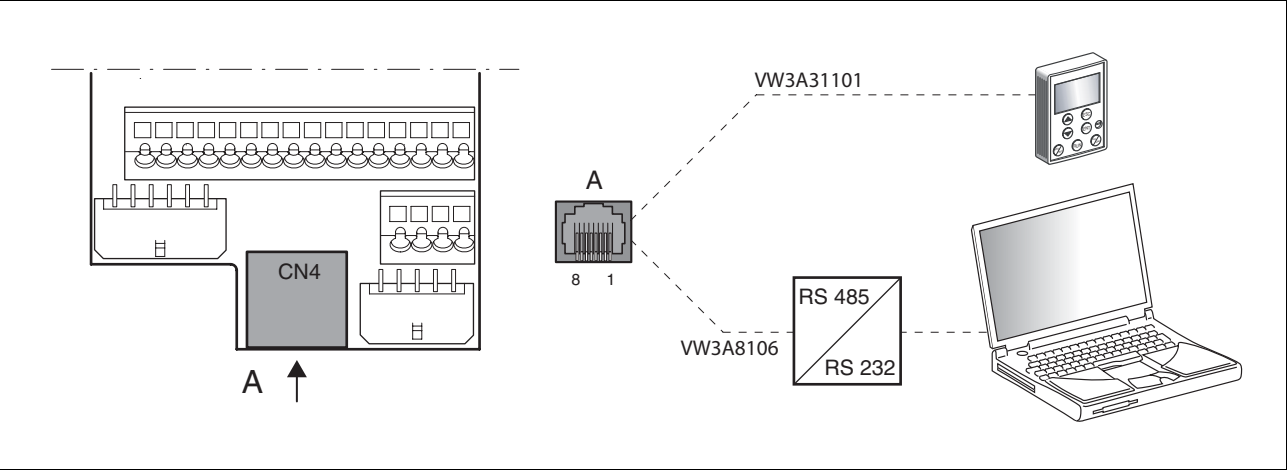
Figure 5.29   Wiring diagram of PC or remote terminal

Pin	Signal	Description	I/O
4	MOD_D1	Bidirectional send/receive signal	RS485 level
5	MOD_D0	Bidirectional send/receive signal, inverted	RS485 level
7	MOD+10V_OUT	10 V power supply, max. 150 mA)	O
8	MOD_0V	Reference potential to MOD+10V_OUT	O

5.3.18 Reference value adapter

Reference value adapter RVA   Reference signals of a master device can be sent simultaneously to up
to five devices using the RVA (Reference Value Adapter). This adapter
also supplies the supply voltage (5V, monitored with sense wires) for the
encoder. The correct power supply is shown by a "5VSE" LED.

An external rotary encoder (A/B signals) or an encoder simulation
(ESIM) can be used as a master device. Pulse/direction signals can also
be sent from a master controller.

Connecting RVA reference value   ▶ Make sure that the wiring, the cables and the connected interfaces
adapter   meet the requirements for PELV.

The RVA reference value adapter is powered by 24 V at the CN9 termi-
nals. A master controller (pulse/direction) can be connected to CN6. An
external rotary encoder or an ESIM signal can be applied to CN7.

Up to five devices that evaluate the specified reference signals can be
connected to CN1 to CN5.
The evaluation of the $\overline{\text{ACTIVE2\_OUT}}$ signal is set with switch S1. The
$\overline{\text{ACTIVE2\_OUT}}$ ready signal is evaluated by the device if the correspon-
dingly assigned switch is set to off. If the readiness comes from all de-
vices, the LED ACTIVE CN1-CN5 lights.

Connection CN1..5	Switch setting S1
connected devices on CN1-CN5	corresponding switch 1-5 at "off", $\overline{\text{ACTIVE2\_OUT}}$ signal of the corresponding device is evaluated
unconnected devices CN1-CN5	corresponding switches 1-5 at "on", $\overline{\text{ACTIVE2\_OUT}}$ signal is simulated
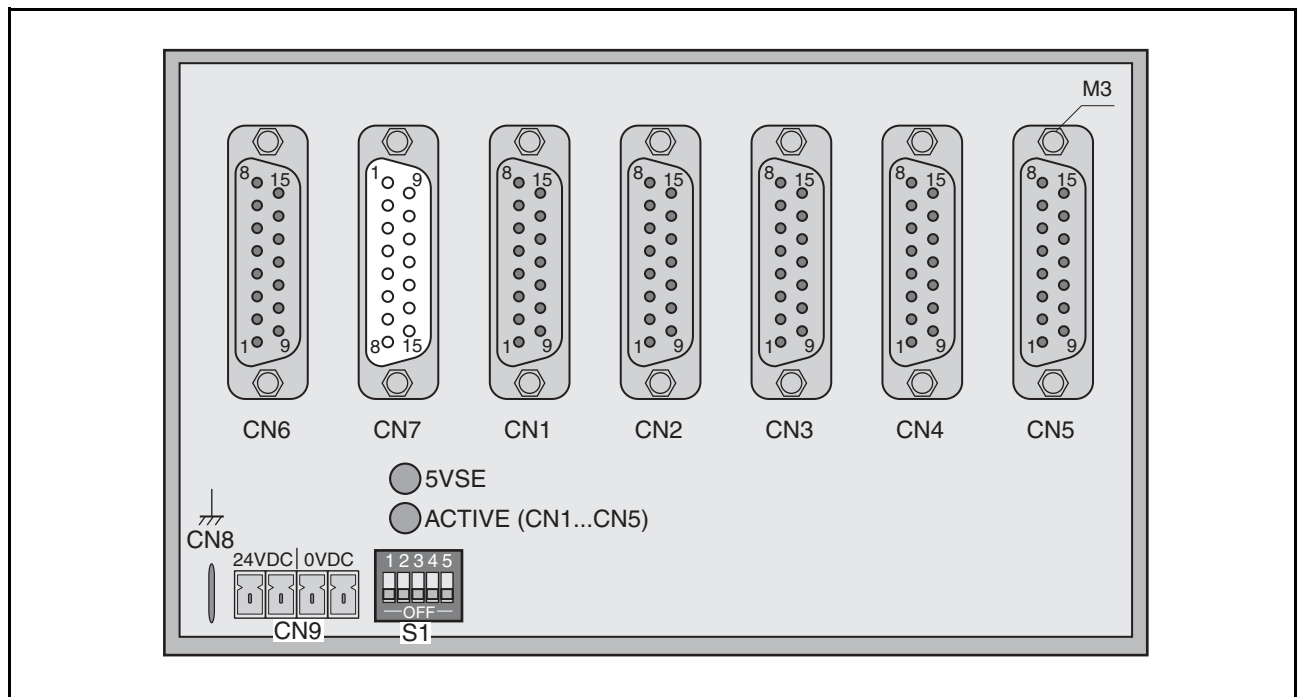
The following table shows the terminal assignment of CN1 - CN5:

Pin	Signal	Description	I/O
1	PULSE_OUT / A_OUT / ESIM_A_OUT	Pulse+, channel A, ESIM_A	O
9	$\overline{\text{PULSE\_OUT}}$ / $\overline{\text{A\_OUT}}$ / $\overline{\text{ESIM\_A\_OUT}}$	Pulse-, channel A inverted, ESIM_A inverted	O
2	DIR_OUT / B_OUT / ESIM_B_OUT	Direction+, channel B, ESIM_B	O
10	$\overline{\text{DIR\_OUT}}$ / $\overline{\text{B\_OUT}}$ / $\overline{\text{ESIM\_B\_OUT}}$	Direction, channel B inverted, ESIM_B inverted	O
3	ENABLE_OUT / I_OUT / ESIM_I_OUT	ENABLE+, index pulse, ESIM_I	O
11	$\overline{\text{ENABLE\_OUT}}$ / $\overline{\text{I\_OUT}}$ / $\overline{\text{ESIM\_I\_OUT}}$	ENABLE-, index pulse inverted, ESIM_I inverted	O
8	$\overline{\text{ACTIVE\_2/READY}}$	Drive ready	I
15	POS_0V	Reference potential	
4 - 7, 12 - 14	nc	not connected	

The following table shows the terminal assignment of CN6:

Pin	Signal	Description	I/O
1	PULSE / A / ESIM_A	Pulse+, channel A, ESIM_A	I
9	$\overline{\text{PULSE}}$ / $\overline{\text{A}}$ / $\overline{\text{ESIM\_A}}$	Pulse-, channel A inverted, ESIM_A inverted	I
2	DIR / B / ESIM_B	Direction+, channel B, ESIM_B	I
10	$\overline{\text{DIR}}$ / $\overline{\text{B}}$ / $\overline{\text{ESIM\_B}}$	Direction, channel B inverted, ESIM_B inverted	I
3	ENABLE / I / ESIM_I	ENABLE+, index pulse, ESIM_I	I
11	$\overline{\text{ENABLE}}$ / $\overline{\text{I}}$ / $\overline{\text{ESIM\_I}}$	ENABLE-, index pulse inverted, ESIM_I inverted	I
8	$\overline{\text{ACTIVE2\_OUT/READY\_OUT}}$	Drive ready	O
15	POS_0V	Reference potential	
4...7, 12...14	nc	not connected	

The following table shows the terminal assignment of CN7:

Pin	Signal	Description	I/O
1	A	Channel A	I
9	$\overline{\text{A}}$	Channel A inverted	I
12	B	Channel B	I
5	$\overline{\text{B}}$	Channel B inverted	I
13	I	Index pulse	I
6	$\overline{\text{I}}$	index pulse inverted	I
10	SENSE+	Monitoring motor encoder power supply	I
11	SENSE-	Reference potential to motor encoder monitor	I
2	5VDC_OUT	5V motor encoder power supply	O
3	POS_0V	Reference potential to 5VDC_OUT	
4, 7, 8, 14, 15	nc	not connected	

There are prefabricated cables for the Reference Value Adapter, see chapter 11 "Accessories and spare parts".
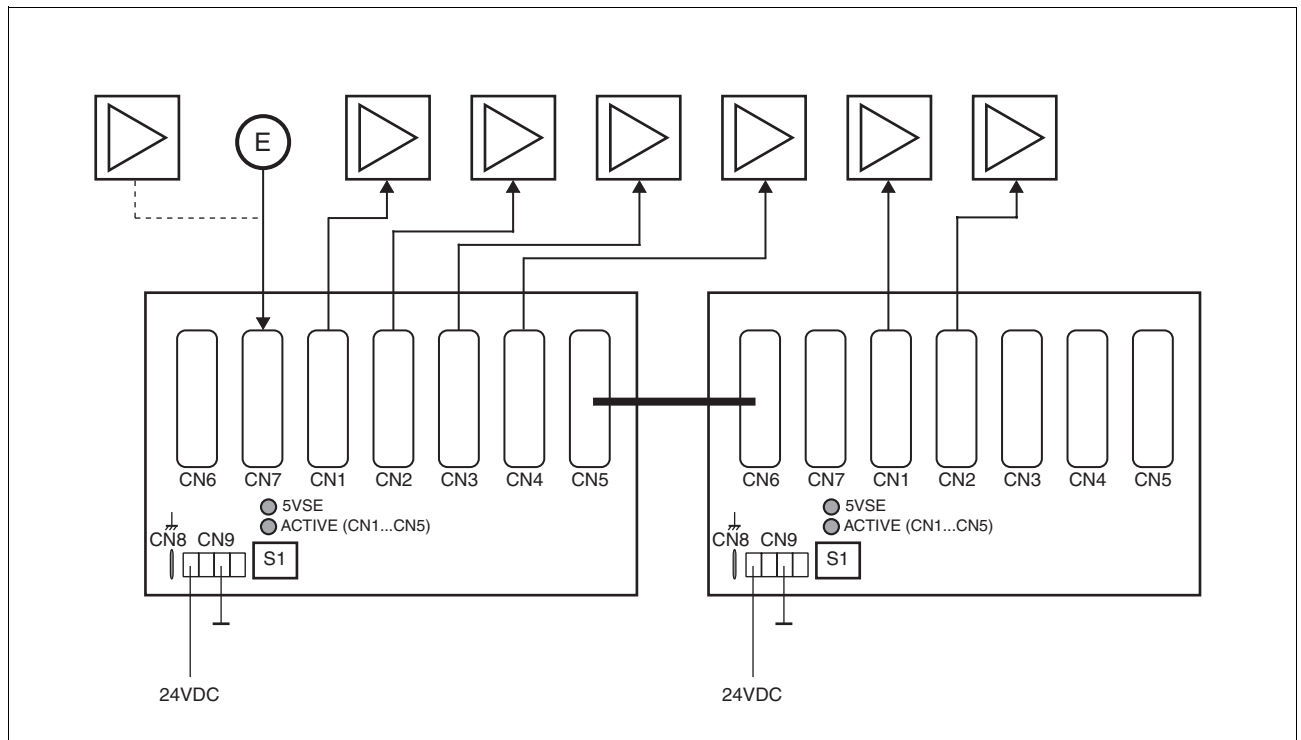
Figure 5.30   Wiring example: encoder signals A/B/I (at CN7) are forwarded to six devices through two cascaded Reference Value Adapters
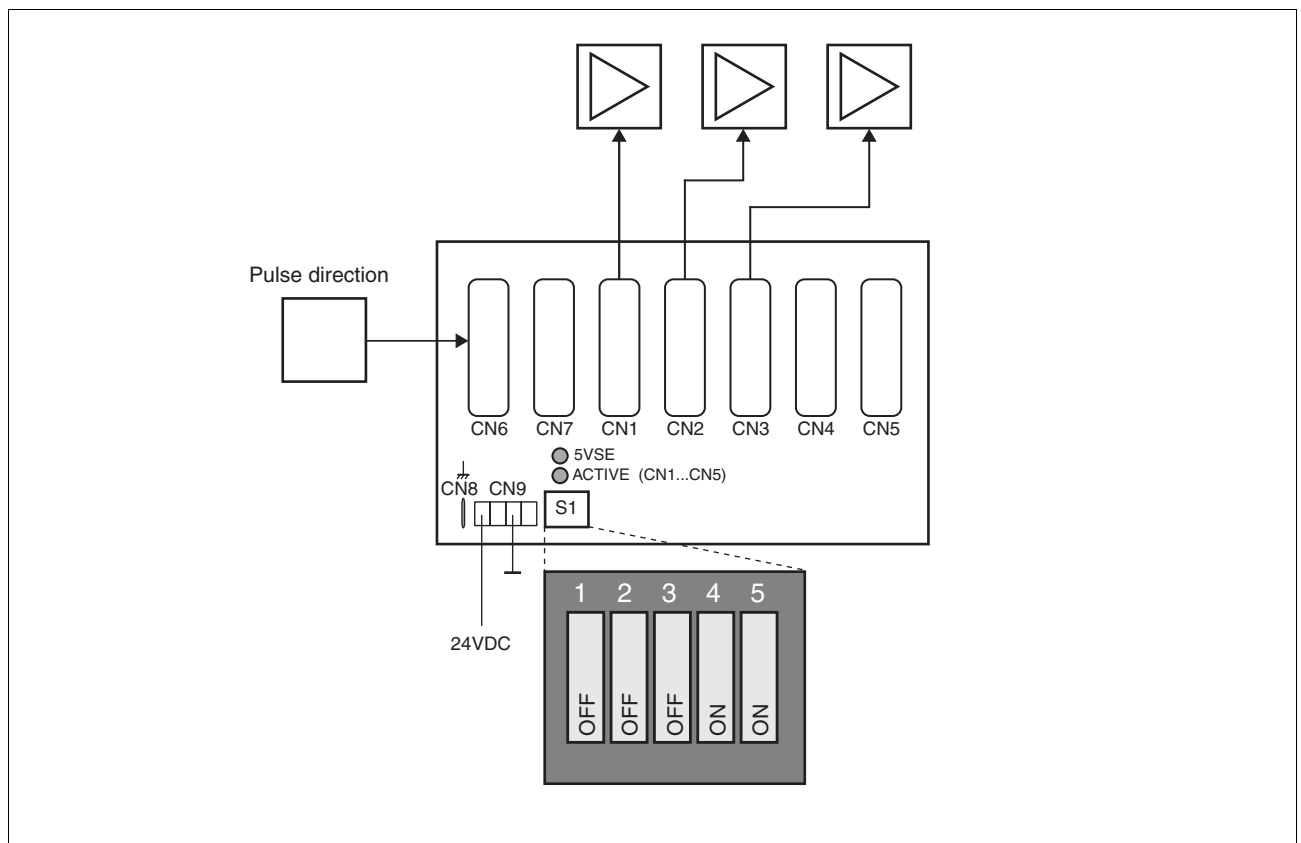
Figure 5.31   Wiring example: pulse direction signals (to CN6) are forwarded to three devices.

5.4 Checking installation

After completion of all steps we recommend checking the installation to prevent any errors before operation of the system.

▶ Make sure the drive system is correctly installed and wired up. Check in particular basic connections such as mains power and 24V power supply.

▶ Check in detail:

• Are all protective conductors connected?

• Are all fuses correct?

• Are any live cable ends exposed?

• Are all cables and connectors safely installed and connected?

• Are the control lines connected correctly?

• Have all EMC measures been taken?

▶ Remove the protective foil as required in accordance with the specifications on page 5-7.

6   Commissioning

*For an overview of **all** parameters can be found alphabetically sorted in the "parameters" section. The application and the function of some parameters are explained in more detail in this section.*

6.1   General safety instructions

> ⚠ **DANGER**
>
> **Electric shock, fire or explosion**
>
> - Only qualified personnel who are familiar with and understand the contents of this manual are authorised to work on and with this drive system.
>
> - The system manufacturer is responsible for compliance with all applicable regulations relevant to earthing the drive system.
>
> - Many components, including printed wiring boards, operate at mains voltage. **Do not touch**. Do **not** touch unshielded components or screws of the terminals with voltage present.
>
> - Install all covers and close the housing doors before applying power.
>
> - The motor generates voltage when the shaft is rotated. Lock the shaft of the motor to prevent rotation before starting work on the drive system.
>
> - Before working on the drive system:
>
>   – Switch off power to all terminals.
>
>   – Place a sign "DO NOT SWITCH ON" on the switch and lock to prevent switching on.
>
>   – **Wait 6 minutes** (for discharge of DC bus capacitors). Do **not** short-circuit DC bus
>
>   – Measure voltage at DC bus and check for <45V. (The DC bus LED is not a safe indication for absence of the DC bus voltage).
>
> **Failure to follow these instructions will result in death or serious injury.**

⚠ DANGER

Motor out of view

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

• Only start the system if there are no persons in the operating zone of the moving components and the system can be operated safely.

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

⚠ WARNING

Unexpected behaviour

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

• Do not operate a drive system with unknown settings or data.

• Check the stored data or settings.

• When commissioning carefully run tests for all operating statuses and fault cases.

• Check 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 materials in the danger zone and the system can be operated safely.

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

⚠ WARNING

Unbraked motor

In the case of power failure and faults which cause the power amplifier to be switched off, the motor is no longer controlled by the brake and increases its speed even more until it comes to a mechanical stop.

• Check 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
>
> **Unexpected movement**
>
> When the drive is operated for the first time there is a high risk of unexpected movement because of possible wiring errors or unsuitable parameters.
>
> - If possible, run the first test movement without coupled loads.
> - Make sure that a functioning button for EMERGENCY STOP is within reach.
> - Also anticipate a movement in the incorrect direction or oscillation of the drive.
> - Make sure that the system is free and ready for the movement before starting the function.
>
> **Failure to follow these instructions can result in death, serious injury or equipment damage.**

> ## ⚠ CAUTION
>
> **Hot surfaces**
>
> The heat sink on the product may heat up to over 100°C (212°F) depending on the operating mode.
>
> - Prevent contact with the hot heat sink.
> - Do not install flammable or heat-sensitive components in the immediate vicinity.
> - Follow the actions described for heat dissipation.
>
> **Failure to follow these instructions can result in injury or equipment damage.**

6.2 Overview

ⓘ *The following commissioning steps are also required if you are using a configured unit under changed operating conditions.*

What must be done

What you need to do...	Info
Checking installation	Page 5-48
Making "First Setup"	Page 6-11
Check and set critical device parameters	Page 6-15
Define ESIM resolution, if used	Page 6-23
Setting, scaling, testing analogue signals	Page 6-17
Set, test digital signals	Page 6-19
Configurable inputs/outputs	Page 6-19
Check the functioning of the holding brake controller if it is wired for that	Page 6-20
Checking motor direction of rotation	Page 6-21
Run autotuning	Page 6-28
Optimise controller settings manually - speed controller - position controller	Page 6-33 Page 6-34 Page 6-39

6.3 Tools for commissioning

6.3.1 Overview

Commissioning and setting parameters and also diagnostic tasks can be carried out with the following tools:

• Integrated HMI

• Remote terminal

• Commissioning software

ⓘ *Access to the complete list of parameters is only possible with the commissioning software.*

Integrated HMI   PC with commissioning software   Peripherical Control terminal
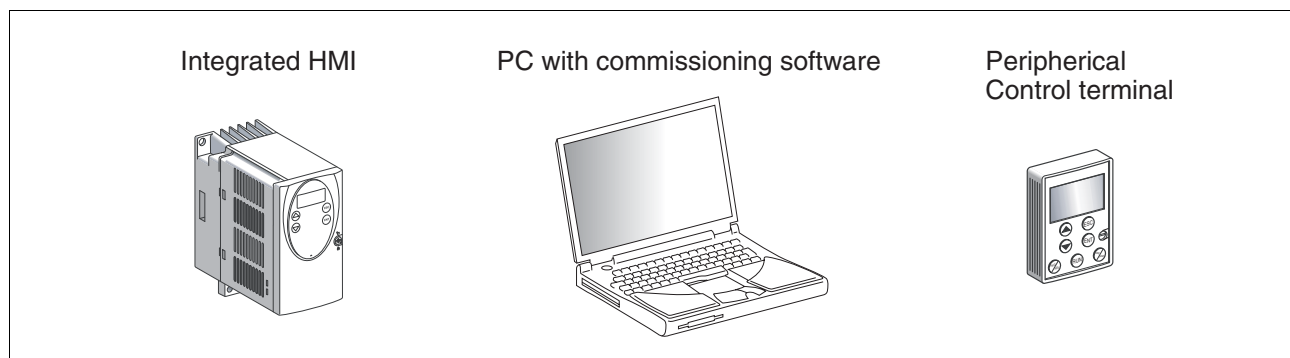
Figure 6.1   Commissioning tools

6.3.2   HMI: Human-Machine Interface

Function   The unit has the option of editing parameters with the integrated control panel (HMI). Displays for diagnosis are also possible. The sections on commissioning and operation include information on whether a function can be carried out with the HMI or whether the commissioning software must be used.

A brief introduction to the HMI structure and the operation is given below.

Control panel   The following figure shows the HMI (left) and the remote terminal (right).
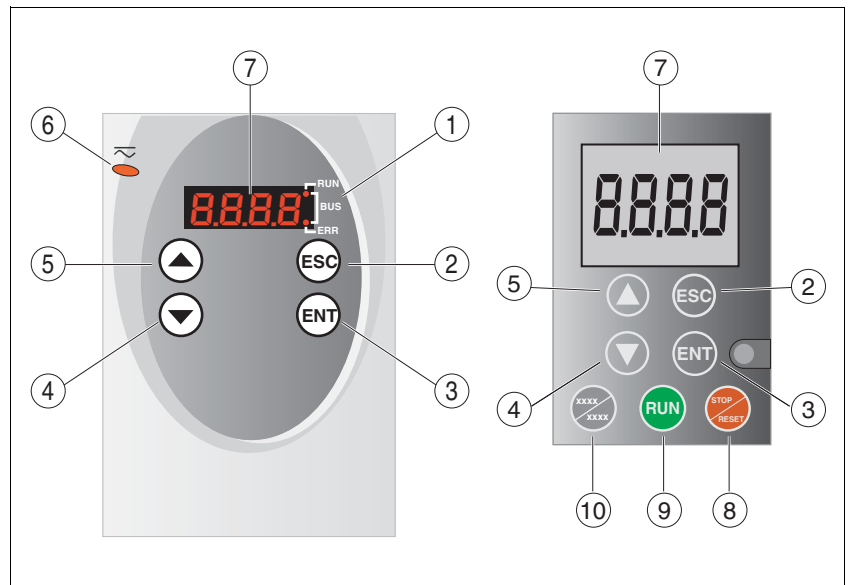
Figure 6.2   HMI and remote terminal

(1)   LEDs
(2)   ESC:
         - exit a menu or parameter
         - return from the displayed to the last saved value
(3)   ENT:
         - call a menu or parameter
         - save the displayed value to EEPROM
(4)   Down arrow:
         - switch to next menu or parameter
         - reduce the displayed value
(5)   Up arrow:
         - switch to previous menu or parameter
         - increase the displayed value
(6)   Red LED on: DC bus under power
(7)   Status display
(8)   Quick Stop (Software Stop)
(9)   No function
(10)   No function

Font on HMI display   Table 6.1 shows the assignment of the letters and numbers on the HMI display for the parameter display. Upper and lower case are only distinguished for the letter "C".

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
R	*b*	*cC*	*d*	*E*	*F*	*G*	*h*	*,*	*J*	*H*	*L*	*N*	*n*	*o*	*P*	*9*	*r*

S	T	U	V	W	X	Y	Z	1	2	3	4	5	6	7	8	9	0
5	*t*	*u*	*U*	*L*	*H*	*y*	*2*	*¡*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*0*

Table 6.1   HMI, available letters and numbers

Calling parameters via HMI   The parameters belonging to a specific menu item are in the first level below the top menu level for that item. In order to give a better orientation, the table of parameters also shows the overall menu path, e.g. 5Et-/ nꟼRH.

The following figure shows an example of calling a parameter (second level) and input or selection of a parameter value (third level).
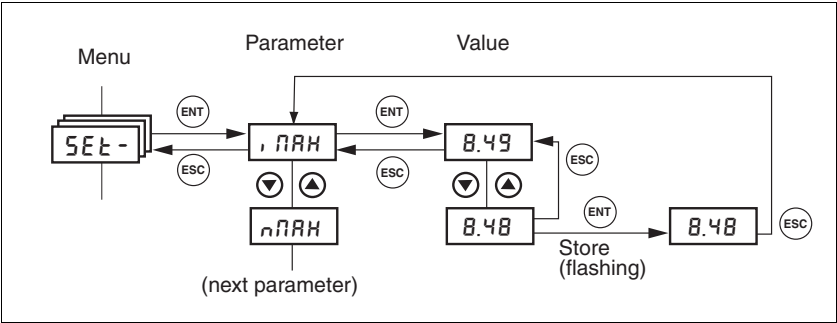
Figure 6.3   HMI, example of parameter setting

The two arrow keys allow setting of the numerical values within the permitted range of values, alphanumeric values are selected from lists.

When you press ENT, the selected value is accepted. Confirmation is indicated by the display flashing once. The modified value is saved in the EEPROM immediately.

If you press ESC, the display jumps back to the original value.

Menu structure   The HMI is menu-driven. Figure 6.4 shows the highest level of the menu structure.
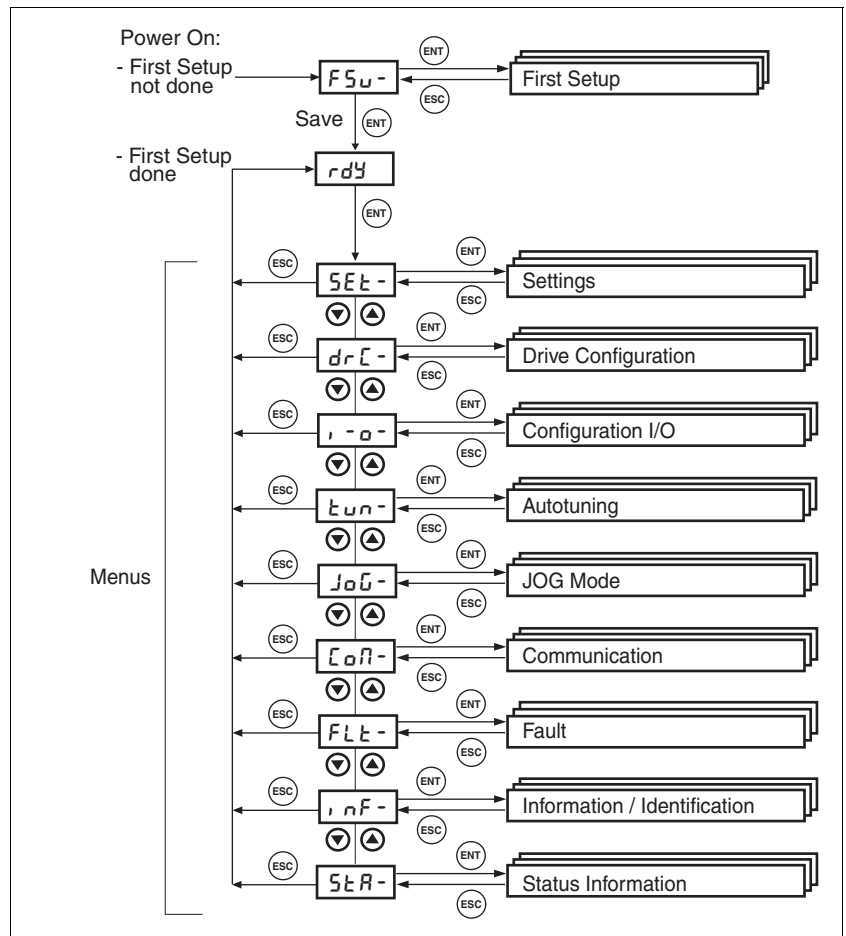
Figure 6.4   HMI menu structure

Status displays such as *rdY-* (Ready) can be found from page 6-14.

HMI menu		Description
FSU-	*FSu-*	First setup (**F**irst **S**et**U**p),
	ioPi	Signal selection position interface ("fieldbus" control mode only)
	io-M	Start-up operating mode for "local control mode"
	ioLt	Logic type of the digital inputs/outputs
SET-	*SEt-*	device settings (**SET**tings)
	AioF	Offset at analogue input ANA1
	AiiS	Setpoint current in speed control operating mode at 10V on analogue input ANA1
	AiUn	Zero-voltage window on analogue input ANA1
	ninS	Setpoint speed in speed control operating mode at 10V on ANA1
	in-P	Monitoring of position deviation
	in-n	Monitoring of speed of rotation deviation
	GFAC	Selection of special gear ratios
	nthr	Monitoring of speed of rotation value
	ithr	Monitoring of current value
	Uint	Monitoring of time window

HMI menu		Description
	⌐ПAH	Current limiting
	nLⁱП	Speed limitation via input
	nПAH	Speed limiter
	Lⁱ95	Current limiting for "Quick Stop"
	LⁱhA	Current limiting for "Halt"
DRC-	drC-	device configuration (**DR**ive **C**onfiguration)
	ⁱoLt	Logic type of the digital inputs/outputs
	ⁱo-П	Start-up operating mode
	ⁱoPⁱ	Signal selection position interface
	ⁱoGП	Pulse control processing mode
	ⁱoAE	Auto. enable at PowerOn if ENABLE input active
	ESSC	Encoder simulation - setting the resolution
	Prot	Definition of direction of rotation
	FCS	Restore factory settings (default values)
	btCL	Time delay when closing the brake
I-O-	ⁱ-o-	Configurable inputs/outputs(**I**n **O**ut)
	Lⁱ1	Function digital input LI1
	Lⁱ2	Function digital input LI2
	Lⁱ4	Function digital input LI4
	Lⁱ5	Function digital input LI5
	Lⁱ6	Function digital input LI6
	Lo1	Function digital output LO_OUT1
	Lo2	Function digital output LO_OUT2
	Lo3	Function digital output LO_OUT3
	Lo4	Function digital output LO_OUT4
TUN-	tun-	Autotuning (Auto**TUN**ing)
	Strt	Start Autotuning
	GAⁱn	Adapting controller parameters (tighter/looser)
	dⁱSt	Movement range autotuning
	dⁱr	Direction of rotation autotuning
	ПECh	System coupling type
	nrEF	Speed when autotuning
	WAⁱt	Waiting time between autotuning steps
	rES	Reset controller parameter
JOG-	JoG-	Jog (**JOG** Mode)
	Strt	Start jog
	nSLW	Speed for slow jog
	nFSt	Speed for fast jog
COM-	CoП-	Communication(**COM**munication)
	ПbAd	Modbus address (commissioning software)

HMI menu		Description
	Nbbd	Modbus baud rate (commissioning software)
	NbFo	Modbus data format (commissioning software)
	Nbuo	Modbus word sequence for double words (32 bit values) (commissioning software)
FLT-	*FLt-*	Error display(**Fau**L**T**)
	StPF	Error number of the last interruption cause
INF-	*inF-*	Information/identification (**INF**ormation / Identification)
	dEUC	Current selection of control mode
	-nAN	product name
	-Pnr	Firmware program number
	-PUr	Firmware version
	Pouo	Number of turn-on processes
	Pino	Nominal current of power amplifier
	PiNA	Maximum current of power amplifier
	Nino	Motor nominal current
	NiNA	Motor maximum current
STA-	*StA-*	Observation/monitoring of device, motor and travel data (**STA**tus Information)
	ioAC	Status of digital inputs and outputs
	AiAC	Voltage value analogue input ANA1
	nACt	Actual speed of the motor
	PACu	Actual position of the motor in user-defined units
	PdiF	Current control deviation of the position controller
	iACt	Total motor current (vector sum of d and q components
	iqrF	Set motor current q component (torque-creating)
	udCA	DC bus voltage of the power amplifier supply voltage
	tdEU	device temperature
	tPA	Temperature of the power amplifier
	urnS	Stored warnings bit-coded
	SiGS	Stored state of the monitoring signals
	oPh	Operating hours counter
	i2tr	Load factor braking resistor
	i2tP	Loading factor power amplifier
	i2tN	Loading factor motor

Status display The status display in its default setting shows the current operating status, see page 7-2. You can specify the following with the menu item *drc-* / *SuPU*:

- *StAt* shows the current operating status by default

- *nAct* shows the current motor speed by default

- *iAct* shows the current motor current by default

A change is only imported with the power amplifier disabled.

6.3.3 Commissioning software (PowerSuite)

Features The Windows-based commissioning software simplifies commissioning, setting parameters, simulation and diagnosis.

Compared to the HMI the commissioning software offers further options such as:

- Setting the controller parameters in a graphic interface
- Extensive diagnostic tools for optimisation and maintenance
- Long-term recording as an aid to assessing operating behaviour
- Testing input and output signals
- Tracking signal sequences on the monitor
- Interactive optimisation of controller behaviour
- Archiving all device settings and recordings with export functions for data processing

System requirements You will need a PC or laptop with a free serial port and an operating system with Windows 2000 or newer.

To connect the PC to the device see page 5-44.

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

6.4 Commissioning procedure

> ⚠ **WARNING**
>
> **Unsuitable parameter values**
>
> If unsuitable parameter values are used, safety functions may fail, unexpected movements or responses to signals may occur.
>
> • Prepare a list with the parameters required for the functions in use.
>
> • Check the parameters before operation.
>
> • Only start the system if there are no persons or materials in the danger zone and the system can be operated safely.
>
> **Failure to follow these instructions can result in death, serious injury or equipment damage.**

6.4.1 "First Setup"

"First Setup" must be made when the controller supply voltage is switched on for the first time or when the factory settings have been loaded.

Preparation ■ A PC with the commissioning software must be connected to the device unless the commissioning is conducted exclusively through the HMI.

▶ Switch on the controller power supply.

If no changes to the factory settings are made, they must still be backed up in the commissioning software by saving to the EEPROM.

Automatic read-in of the motor data set When the unit is switched on for the first time with the motor connected, the unit reads the motor data set automatically from the Hiperface sensor (motor sensor). The data set is checked for completeness and saved in the EEPROM.

The motor data set contains technical information about the motor such as the nominal and peak torque, the nominal current and speed and the pole-pair number. It cannot be modified by the user. The unit cannot be switched ready for operation without this information

"First Setup" via HMI The following diagram shows the sequence using HMI.
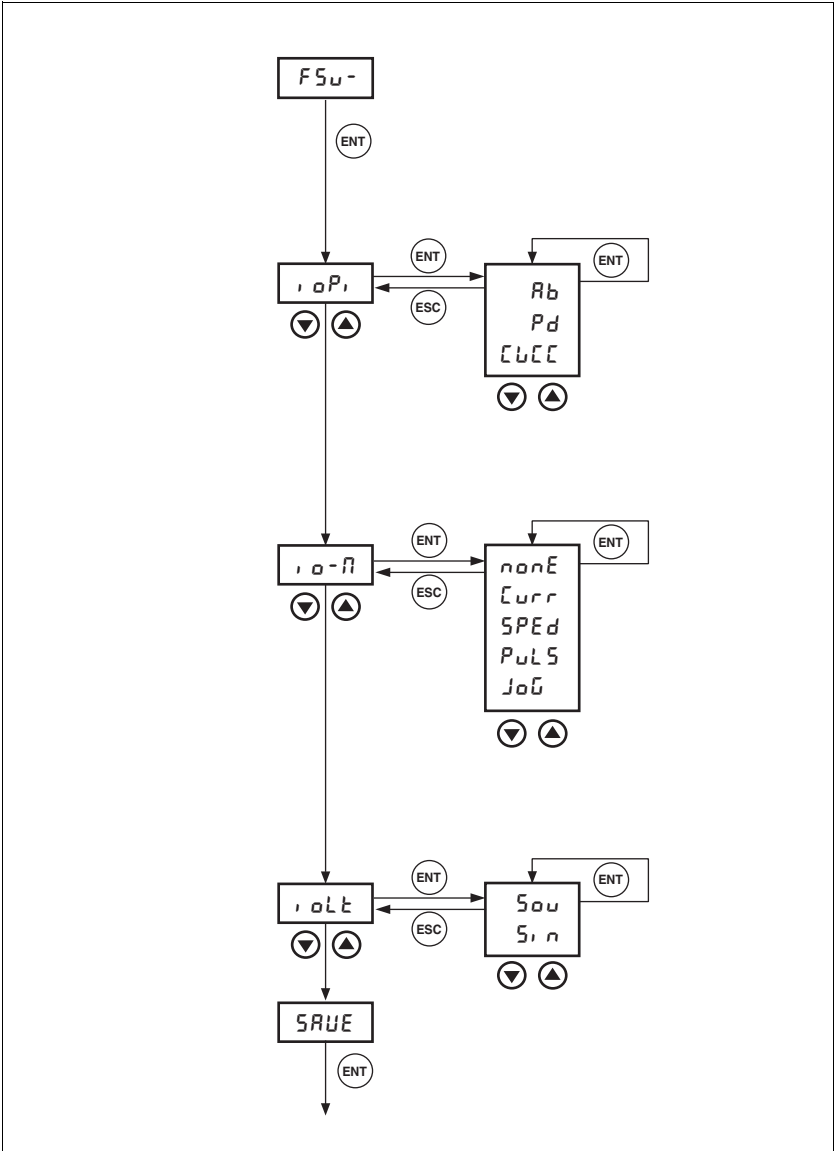
Figure 6.5   "First Setup" via HMI

Function of the RS422 interface   ▶ Set the assignment for the RS422 interface with the
                                           IOposInterfac (*ioPi*) parameter.

Parameter Name Code HMI menu, Code	Description	Unit Minimum value Default value Maximum value	Data type R/W persistent Expert	Parameter address via fieldbus
IOposInterfac IOPI DRC-*ioPi*	Signal selection at position interface(6-11) RS422 IO interface (Pos) as: **0 / ABinput / AB**: input ENC_A, ENC_B, ENC_I (index pulse) 4x evaluation **1 / PDinput /PD**: input PULSE, DIR, ENABLE2 **3 / CW-CCW / CWCC**: CW-CCW IMPORTANT: A change of the setting is not activated until the unit is switched on again.	- 0 3 3	UINT16 R/W per. - 	Modbus 1284

Start-up operating mode

■ DEVcmdinerf= IODevice
  (*dEUC = ı o*)

▶ Set the parameter IOdefaultMode (*ı o-ʮ*) to set the operating mode that is to enable the device every time it is started.

The operating modes are described from section 7-5.

Parameter Name Code HMI menu, Code	Description	Unit Minimum value Default value Maximum value	Data type R/W persistent Expert	Parameter address via fieldbus
IOdefaultMode IO-M DRC-ı o-ʮ	Start-up of operating mode (6-11) **0 / none / none** : none **1 / CurrentControl / Curr**: Current control (reference value from ANA1) **2 / SpeedControl / Sped**: Speed control (reference value of ANA1) **3 / PulseControl / Puls**: Pulse control **5 / JOG mode / JoG**: Jog IMPORTANT: The operating mode is automatically enabled when the drive switches to the 'OperationEnable' status and "IODevice / IO" is set in DEVcmdinterf.	- 0 3 5	UINT16 R/W per. -	Modbus 1286

Select logic type

▶ Specify the logic type with the parameter IOLogicType (*ı oLt*). For more information see chapter 4.1 "Logic type".

Parameter Name Code HMI menu, Code	Description	Unit Minimum value Default value Maximum value	Data type R/W persistent Expert	Parameter address via fieldbus
IOLogicType IOLT DRC-ı oLt	Logic type of the digital inputs/outputs() **0 / source / sou**: for current supply outputs (default) **1 / sink / sin**: for outputs drawing current IMPORTANT: A change of the setting is not activated until the device is switched on again.	- 0 0 1	UINT16 R/W per. -	Modbus 1288

Data back-up

▶ Back up all inputs on completion.
HMI: Save your settings with *SAUE*
Commissioning software: Save your settings with the menu path "Configuration - Save in EEPROM"

◁ The device saves all set values in the EEPROM and displays the status *nrdY*, *rdY* or *dı S* on the HMI.

A restart of the device is required to allow the changes to be accepted.

Further steps

▶ Stick a label on the unit with all important information required in case of service, e.g. fieldbus type, address and baud rate.

▶ Make the settings described below for commissioning.

Note that you can only return to the "Initial Setup" by restoring the factory settings, see 7.6.9.2 "Restore factory settings" page 7-41.

6.4.2 Operating status (status diagram)

After switching on and at the start of an operating mode, a sequence of operating states is progressed through.

The relationship between the operating states and the state transitions is shown in the state diagram (state machine).

The operating states are internally monitored and influenced by monitoring and system functions, such as temperature and current monitoring

Graphic representation The status diagram is shown graphically as a flow chart.
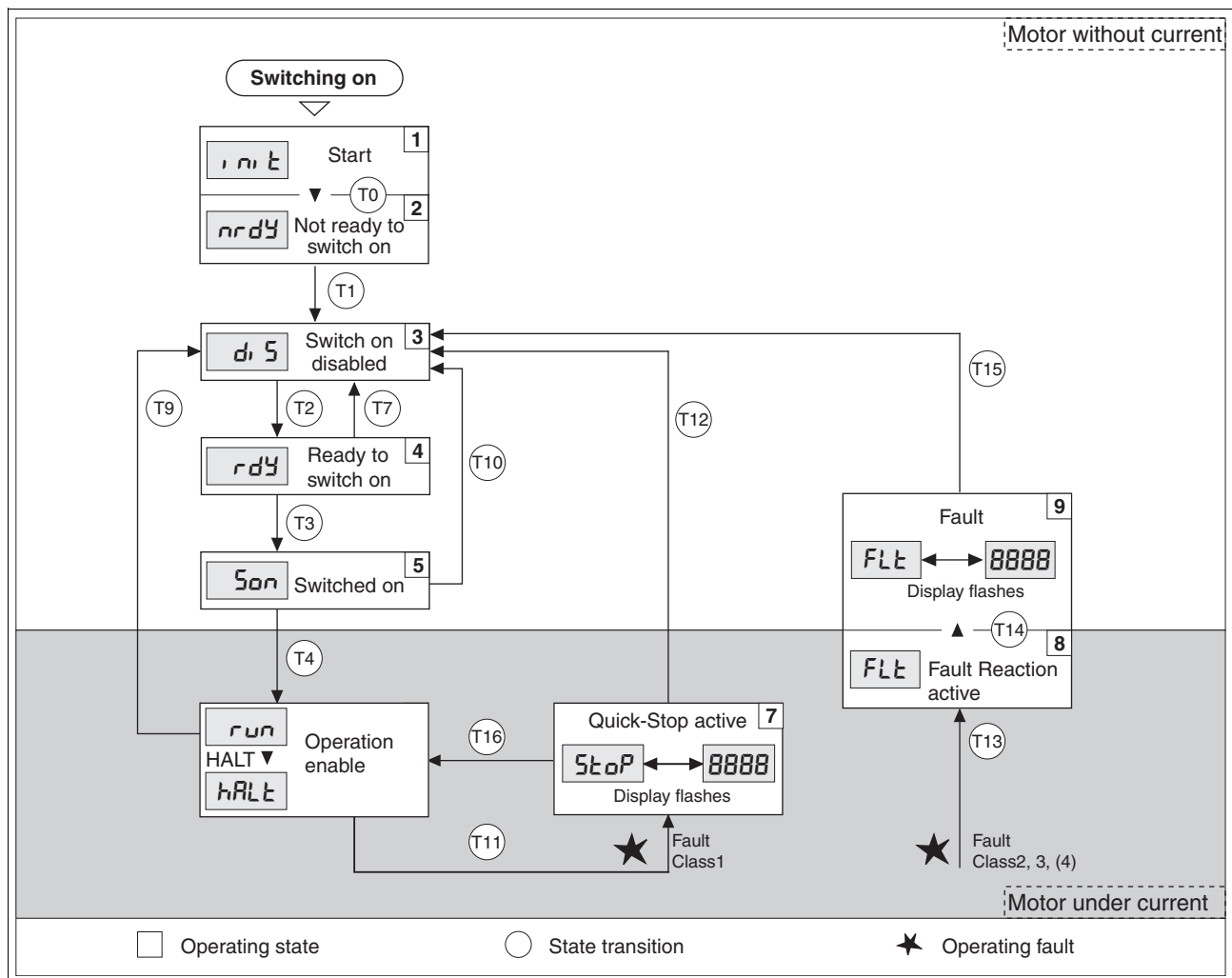
Figure 6.6   Status diagram

Operating states and mode transitions For detailed information on operating states and mode transitions see page 7-2.

6.4.3   Setting basic parameters and limit values

> ## ⚠ WARNING
>
> **Unexpected behaviour**
>
> The behaviour of the drive system is governed by numerous stored data or settings. Unsuitable settings or data may trigger unexpected movements or reactions to signals and disable monitoring functions.
>
> - Do not operate a drive system with unknown settings or data.
> - Check the stored data or settings.
> - When commissioning carefully run tests for all operating statuses and fault cases.
> - Check 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 materials in the danger zone and the system can be operated safely.
>
> **Failure to follow these instructions can result in death, serious injury or equipment damage.**

Prepare a list with the parameters required for the functions in use.

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 limiting   To protect the drive system, the maximum current flowing can be modified with the parameter CTRL_I_max. The maximum current for the "Quick Stop" operating function can be limited with the parameter LIM_I_maxQSTP and for the "Halt" operating function with the parameter LIM_I_maxHalt.

▶ Set the parameter CTRL_I_max to set the maximum motor current.

▶ Set the parameter LIM_I_maxQSTP to set the maximum current for "Quick Stop".

▶ Set the parameter LIM_I_maxHalt to set the maximum current for "Halt".

Parameter Name Code HMI menu, Code	Description	Unit Minimum value Default value Maximum value	Data type R/W persistent Expert	Parameter address via fieldbus
CTRL_I_max IMAX SET-ı, ΠRΗ	Current limiting(6-15) Value must not exceed max. permissible current of motor or power amplifier. Default is the smallest value of M_I_max and PA_I_max	A$_{pk}$ 0.00 - 299.99 **Fieldbus** 0 29999	UINT16 R/W per. -	Modbus 4610
LIM_I_maxQSTP LIQS SET-L, 95	Current limiting for Quick Stop(7-27) Max. current during braking via torque ramp resulting from an error with error class 1 or 2, and when a software stop is triggered Maximum and default value setting depend on motor and power amplifier in 0.01Apk steps	A$_{pk}$ - - -	UINT16 R/W per. -	Modbus 4362
LIM_I_maxHalt LIHA SET-L, hR	Current limiting for Halt(7-28) Max. current during braking after Halt or termination of an operating mode. Maximum and default value settings depend on motor and power amplifier in 0.01Apk steps	A$_{pk}$ - - -	UINT16 R/W per. -	Modbus 4364

Speed limitation The maximum speed can be limited with the parameter CTRL_n_max to protect the drive system.

▶ Specify the maximum motor speed with the parameter CTRL_n_max.

Parameter Name Code HMI menu, Code	Description	Unit Minimum value Default value Maximum value	Data type R/W persistent Expert	Parameter address via fieldbus
CTRL_n_max NMAX SET-nΠRΗ	Speed limiter(6-15) Setting value must not exceed max. speed of rotation of motor Default is max. speed of motor (see M_n_max)	1/min 0 - 13200	UINT16 R/W per. -	Modbus 4612

6.4.4 Analogue inputs

Analog inputs The analogue inputs allow analogue input voltages between -10V and +10V to be read in. The current voltage value on ANA1+ can be read using the parameter ANA1_act

■ Power amplifier supply voltage is switched off. Controller supply voltage is switched on.

▶ Apply a voltage to the analogue input ANA1 in the range of $\pm 10V_{DC}$.

▶ Check the applied voltage with the parameter ANA1_act.

Parameter Name Code HMI menu, Code	Description	Unit Minimum value Default value Maximum value	Data type R/W persistent Expert	Parameter address via fieldbus
ANA1_act A1AC STA-*A 1AC*	Voltage value analogue input ANA1()	mV -10000 - 10000	INT16 R/- - -	Modbus 2306

Reference value An input voltage at ANA1 can be used as a reference value for the operating mode current control or speed control. The reference value for a voltage of +10V can be set over the parameter ANA1_I_scale or ANA1_n_scale.

Parameter Name Code HMI menu, Code	Description	Unit Minimum value Default value Maximum value	Data type R/W persistent Expert	Parameter address via fieldbus
ANA1_I_scale A1IS SET-*A i S*	Setpoint current in current control operating mode at 10V on ANA1() An inversion of the evaluation of the analogue signal can be run with a neg. advance sign	A_{pk} -300.00 3.00 300.00 **Fieldbus** -30000 300 30000	INT16 R/W per. -	Modbus 8198
ANA1_n_scale A1NS SET-*A in5*	Setpoint speed in speed control operating mode at 10V on ANA1() The internal maximum speed is limited to the current setting in CTRL_n_max A negative advance sign can be used to effect an inversion of the evaluation of the analogue signal	1/min -30000 3000 30000	INT16 R/W per. -	Modbus 8454

Offset and the zero voltage window An offset can be parameterized for the input voltage at ANA1 over the parameter ANA1_offset and a zero voltage window can be parameterized over the parameter ANA1_win.

This corrected input voltage gives the voltage for the operating modes current control and speed control as well as the reading value for parameters ANA1_act.

Parameter Name Code HMI menu, Code	Description	Unit Minimum value Default value Maximum value	Data type R/W persistent Expert	Parameter address via fieldbus
ANA1_offset A1OF SET-*A 1oF*	Offset at analogue input ANA1() The ANA1 analogue input is corrected/relocated by the offset. A defined zero-voltage window acts in the range of the zero crossing of the corrected ANA1 analogue input.	mV -5000 0 5000	INT16 R/W per. -	Modbus 2326
ANA1_win A1WN SET-*A 1Wn*	Zero voltage window on analogue input ANA1() Value up to which an input voltage is interpreted as 0V Example: Setting 20mV ->range from -20 .. +20mV is interpreted as 0mV	mV 0 0 1000	UINT16 R/W per. -	Modbus 2322
ANA1_Tau -	Analog1: filter time constant() Low-pass filter first order (PT1) filter time constant. Filter affects analogue input ANA1. (sampling time PT1 filter: 250µsec)	ms 0.00 0.00 327.67 **Fieldbus** 0 0 32767	UINT16 R/W per. -	Modbus 2308
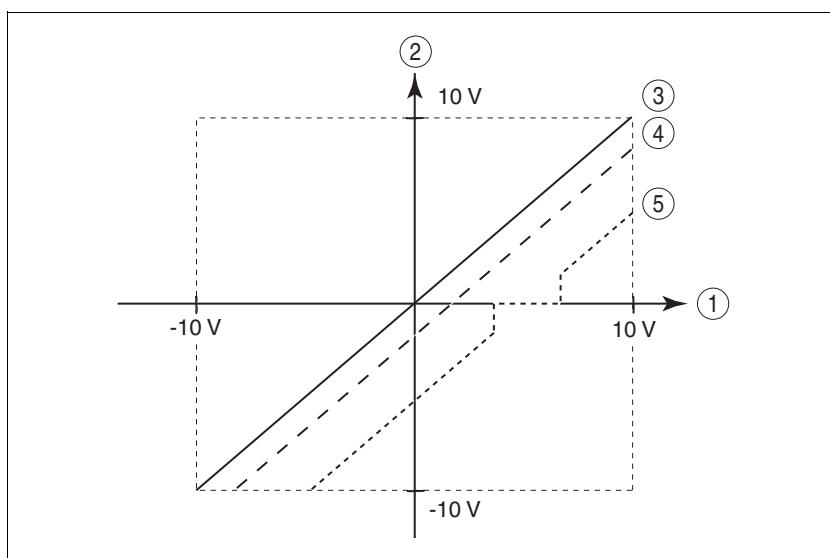
Figure 6.7   Offset and zero-voltage window

(1)   Input voltage at ANA1
(2)   Voltage value for current control and speed control operating modes sand the read value of the parameter ANA1_act
(3)   Input voltage without processing
(4)   Input voltage with offset
(5)   Input voltage with offset and zero-voltage window

AC servo drive

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6.4.5   Digital inputs/outputs

The switching states of the digital inputs and outputs can be displayed on the HMI and displayed and modified using the commissioning software or the fieldbus.

HMI   The signal states can be displayed with the HMI, but they cannot be modified.

▶ Call up the menu point 5ŁR / ı oRc.

◁ You will see the digital inputs (Bit 0-7) bit-coded.

▶ Press the "up arrow".

◁ You will see the digital inputs (Bit 8, 9) bit-coded.
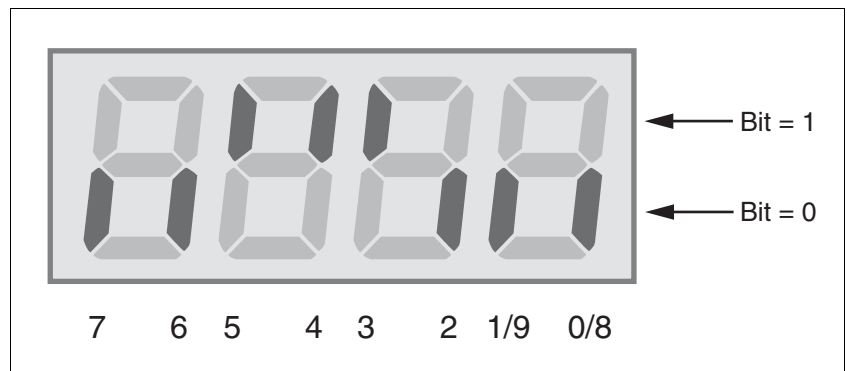
Figure 6.8   HMI, status display of the digital inputs/outputs

Bit	Local control mode	I/O
0	LI1	I
1	FAULT_RES/LI2	I
2	ENABLE	I
3	HALT/LI4	I
4	LI5	I
5	LI6	I
6	–	I
7	–	I
8	NO_FAULT_OUT/LO1_OUT	O
9	BRAKE_OUT/LO2_OUT	O
10	LO3_OUT	O
11	LO4_OUT	O

6.4.6   Setting configurable digital inputs/outputs

The device has configurable inputs (LI1...) and configurable outputs (LO1_OUT...). The standard assignment and the configurable assignment depends on the specified start-up operating mode. For more information see chapter 7.6.7 "Configurable inputs and outputs".

6.4.7 Checking holding brake

> ⚠ **WARNING**
>
> **Unexpected movement**
>
> For example, if the brake is released with vertical axes an unexpected movement may be triggered in the system.
>
> • Make sure that no damage will be caused by the load dropping.
>
> • Run the test only if there are no persons or materials in the danger zone of the moving system components.
>
> **Failure to follow these instructions can result in death, serious injury or equipment damage.**

Testing from HBC to holding brake

■ Supply voltage at HBC on, LED "24V on" on.

▶ Switch the power amplifier supply voltage off to prevent the motor from starting accidentally.

◁ The drive switches to operating status "Switch on disabled"

▶ Press the "Release brake" button on the HBC several times to release and close the holding brake alternately.

◁ The LED "Brake released" on the HBC flashes if there is voltage present at the holding brake output and the brake is released by the button.

▶ Test that the axis can be moved manually with the brake released. (note gearbox if applicable).

Testing from device to HBC

■ The device is in operating status "Ready to switch on" and the parameters for the holding brake must be set, see chapter 7.6.6 "Braking function with HBC" page 7-29.

▶ Start jog operating mode
(HMI: JoG- / Strt)

◁ The HMI displays JG. The brake is released. The LED "Brake released" on the HBC is lit up if there is brake voltage present and the brake is released.

For more information on the HBC see page 3-9, 5-30 and 11-1.

6.4.8   Check direction of rotation

Direction of rotation   Rotation of the motor shaft in a positive or negative direction of rotation. A positive direction of rotation is defined as the motor shaft rotating clockwise as the observer faces the end of the protruding shaft.

The initial setting of the controller parameters may result in an unstable closed-loop control at inertia ratios of "J ext" to "J motor" >10.

▶ Start jog operating mode
(HMI: JoG- / Strt)

◁ The HMI displays JG.

▶ Start a movement in clockwise rotation
(HMI: "up arrow")

◁ The motor rotates in clockwise rotation.
The HMI shows JG-

▶ Start a movement in the counterclockwise rotation
(HMI: "down arrow")

◁ The motor rotates in counterclockwise rotation.
The HMI shows -JG

⚠ WARNING

Unexpected movement if motor phases are reversed

Reversal of the motor phases can cause unexpected movements at high acceleration.

- Use the parameter POSdirOfRotat to reverse the direction of rotation, if required.

- Do not reverse the motor phases.

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

▶ If arrow and direction of rotation do not match, correct it with the parameter POSdirOfRotat, see 7.6.8 "Reversal of direction of rotation" page 7-40.

6.4.9 Check signals of position switch

Description   Position switches (NC contacts) are required for the functions "Enable positive motor move" und "Enable negative motor move", see Chapter 7.6.7 "Configurable inputs and outputs".

> ## ⚠ CAUTION
>
> **Loss of control over controller**
>
> The position switches can only trigger a stop when used correctly.
>
> • Note that this function is only available with "Enable positive motor move" and "Enable negative motor move".
>
> • Note that this function must be enabled via the corresponding parameter.
>
> • Check the installation and correct operation (direction-dependent).
>
> • Start the system only if there are no persons or material in the danger zone of the moving system components and the system can be operated safely.
>
> **Failure to follow these instructions can result in injury or equipment damage.**

■ The direction of rotation must be checked and corrected if necessary, see Chapter 6.4.8 "Check direction of rotation".

▶ Set the position switches so the drive cannot accidentally travel past a position switch.

▶ Start jog mode
(HMI: ꞁₒᏒ- / ᏕᏒᏒᏒ)

◁ The HMI displays ꞁᏒ.

Check the function "Enable positive motor move"   ▶ Start a positive movement (HMI: "arrow up") until the positive position switch is tripped to test the function "Enable positive motor move".

◁ The motor executes a positive movement until it reaches the positive position switch. The motor must stop. It can only leave the positive position switch by moving in the negative direction.

Check the function "Enable negative motor move"   ▶ Start a negative movement (HMI: "arrow down") until the negative position switch is tripped to test the function "Enable negative motor move".

◁ The motor executes a negative movement until is reaches the negative position switch. The motor must stop. It can only leave the negative position switch by moving in the positive direction.

If a reference value is pending and the motor is at a position switch, the function "Motor move disable" is active.

6.4.10 Setting parameters for encoder simulation

Defining resolution for encoder simulation   The resolution for the encoder simulation can be scaled with the parameter ESIMscale.

▶ Set the parameter ESIMscale to set the resolution.

Parameter Name Code HMI menu, Code	Description	Unit Minimum value Default value Maximum value	Data type R/W persistent Expert	Parameter address via fieldbus
ESIMscale ESSC DRC-*E55C*	Encoder simulation - setting the resolution() the complete value range is available for the resolution. For resolutions that can be divided by 4 the index pulse must be at A=high and B=high. IMPORTANT: A change of the setting is not activated until the device is switched on again. After the write access a wait of at least 1 second is required until the controller is switched off.	Inc 8 4096 65535	UINT16 R/W per. -	Modbus 1322

The index pulse can be defined by setting the absolute position encoder, see chapter 6.4.11 "Setting parameters for encoder".

6.4.11 Setting parameters for encoder

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

At motor standstill the new absolute position of the motor can be defined at the current mechanical motor position with the parameter ENC_pabsusr. The value can be transferred with the power amplifier active and inactive. Setting the absolute position also shifts the position of the index pulse of the encoder and the index pulse of the encoder simulation.

In the commissioning software you will find the parameter via the menu "Display - Specific panels".

Parameter Name Code HMI menu, Code	Description	Unit Minimum value Default value Maximum value	Data type R/W persistent Expert	Parameter address via fieldbus
_p_absENCusr -	Absolute position based on motor encoder work stroke in user-defined units(6-24) Value range is set by encoder type With Singleturn motor encoders the value is set with reference to one motor revolution, with Multiturn motor encoders with reference to the total work stroke of the encoder (e.g. 4096 revs) IMPORTANT: Position is only valid after determination of the motor absolute position. With invalid motor absolute position: _WarnLatched _WarnActive Bit 13=1: absolute position of motor not yet detected	usr - 	UINT32 R/- - -	Modbus 7710
ENC_pabsusr -	Setting position of the motor encoder directly(6-24) Value range depends on the encoder type. SEK52 (Singleturn): 0..max_pos_usr/rev. - 1 max_pos_usr/rev.: maximum user position for one motor revolution, with default position scaling this value is 16384. IMPORTANT: * If the process is to be conducted with direction inversion function, it must be set before setting the motor encoder position * The setting value will only be active when the controller is switched on the next time. After the write access a wait of at least 1 second is required until the controller is switched off. * Changing the value also changes the position of the virtual index pulse and the index pulse displaced at ESIM function.	usr 0 - 2147483647	UINT32 R/W - -	Modbus 1324

i *If the device or the motor is replaced, a new alignment will be required.*

Singleturn encoder With the Singleturn encoder the position of the index pulse of the encoder can be moved by setting a new absolute position. At position value 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 With the Multiturn encoder the mechanical work stroke of the motor can be shifted to the continuous range of the sensor by setting a new absolute position.

If the motor is moved counterclockwise from the absolute position 0, the SinCos multiturn receives an underrun of its absolute position. In contrast, the internal actual position counts mathematically forward and sends a negative position value. After switching off and on the internal actual position would no longer show the counterclockwise position value but the absolute position of the encoder.

An overflow or underrun are discontinuous positions in the area of travel. To prevent these jumps the absolute position in the sensor must be set so the mechanical limits are within the continuous range of the encoder.
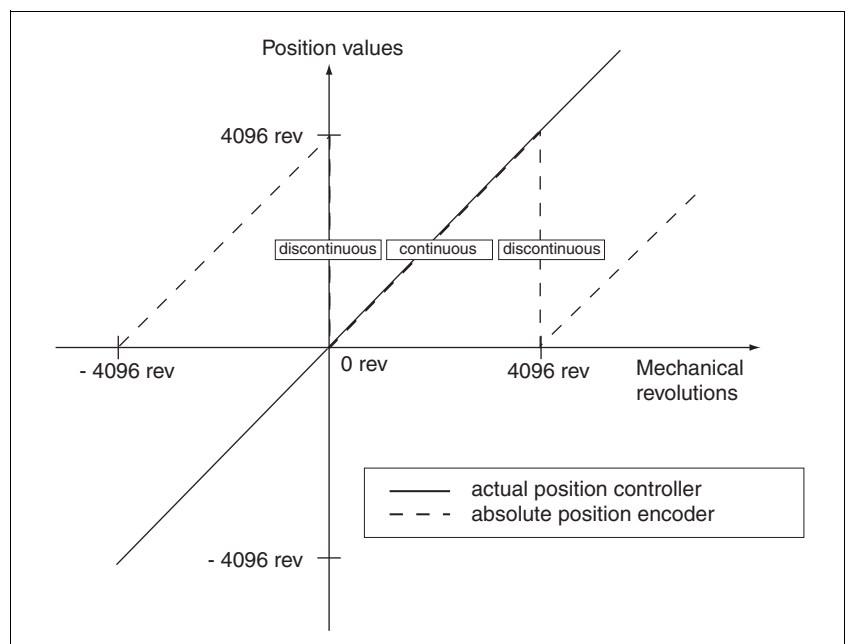
Figure 6.9   Position values of multiturn encoder

▶ When setting the absolute position at the mechanical limit set a position value >0. This ensures that when the drive is moved within the mechanical limits of the system the resulting encoder position is always within the continuous range of the encoder.

6.4.12 Setting parameters for braking resistor

<table>
<tr><td>

⚠ WARNING

Unbraked motor

An insufficient braking resistor causes overvoltage on the DC bus and switches off the power amplifier. The motor is no longer actively braked.

- Make sure that the braking resistor is sufficiently dimensioned.

- Check the setting of the parameter for the braking resistor.

- Check the temperature of the braking resistor by conducting a test run under the most critical conditions.

- During the test make sure that at higher mains voltage there is less reserve in the capacitors on the DC bus.

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

</td></tr>
</table>

If an external braking resistor is connected, the parameter `RESint_ext` must be set to "external".

The values of the external braking resistor must be set in the parameters `RESext_P`, `RESext_R` and `RESext_ton`, see chapter 3.4.1 "External braking resistors" page 3-8.

If the actual brake output exceeds the maximum allowable brake output, the device will output an error message and the power amplifier will be switched off.

<table>
<tr><td>

⚠ WARNING

Hot Surfaces

The braking resistor may heat up to over 250°C depending on the operating mode.

- Prevent contact with the hot braking resistor.

- Do not place flammable or heat-sensitive components in the immediate vicinity of the braking resistor.

- Ensure good heat dissipation.

- Check the temperature of the braking resistor by conducting a test run under the most critical conditions.

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

</td></tr>
</table>

▶ Test the function of the braking resistor under realistic conditions.

Parameter Name Code HMI menu, Code	Description	Unit Minimum value Default value Maximum value	Data type R/W persistent Expert	Parameter address via fieldbus
RESint_ext -	Control of braking resistor(6-15) **0 / internal**: internal braking resistor **1 / external**: external braking resistor	- 0 0 1	UINT16 R/W per. -	Modbus 1298
RESext_P -	Nominal power of external braking resis-tor(6-15)	W 1 10 32767	UINT16 R/W per. -	Modbus 1316
RESext_R -	Resistance value of external braking resis-tor(6-15)	Ω 0.01 100.00 327.67 **Fieldbus** 1 10000 32767	UINT16 R/W per. -	Modbus 1318
RESext_ton -	max. permissible switch-in time for external braking resistor(6-15)	ms 1 1 30000	UINT16 R/W per. -	Modbus 1314

6.4.13 Run autotuning

Autotuning determines the friction torque, an ever present load torque, and considers it in the calculation of the mass moment of inertia of the total system.

External factors, such as a load on the motor, are taken into account. Autotuning optimises the parameters for the controller settings see chapter 6.5 "Controller optimisation with step response".

Autotuning also supports typical vertical axes.

Autotuning is not suitable for inertia ratios of "J ext" to "J motor" >10.

```
┌─────────────────────────────────────────────────────┐
│                  ⚠ WARNING                            │
├─────────────────────────────────────────────────────┤
```

Unexpected movement

Autotuning moves the motor to set the drive controller. If incorrect parameters are input unexpected movements may occur or monitoring functions may be disabled.

- Check the parameters AT_dir and AT_dismax. The travel for the braking ramp in cases of error must also be taken into account.

- Check that the parameter LIM_I_maxQSTP is correctly set for Quick Stop.

- Make sure that a functioning button for EMERGENCY STOP is within reach.

- Make sure that the system is free and ready for the movement before starting the function.

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

▶ Select the setting for the parameter AT_mechanics depending on your mechanical components. If in doubt, select a softer coupling (less rigid mechanism, see Figure 6.11).

▶ Start the Autotuning with the commissioning software with the menu path "Operating Mode - Automatic optimisation". Also note additional settings in the "Display - Specific Displays" menu.

Autotuning can also be started from the HMI (ㄷʊn⁻ / 5ㄴrㄴ).

The calculated values are accepted immediately without an additional save.

If the Autotuning is interrupted with an error message, the default values are imported. Change the mechanical position and start the Autotuning again. If you want to check the plausibility of the calculated values, they can be displayed, see also 6.4.14 "Extended settings for autotuning" from page 6-30.

Parameter Name Code HMI menu, Code	Description	Unit Minimum value Default value Maximum value	Data type R/W persistent Expert	Parameter address via fieldbus
AT_dir DIR TUN-*dir*	Direction of rotation autotuning(6-28) **1 / pos-neg-home / pnh**: first positive direction, then negative direction with return to initial position **2 / neg-pos-home / nph**: first negative direction, then positive direction with return to initial position **3 / pos-home / p-h**: only positive direction with return to initial position **4 / pos / p--**: only positive direction without return to initial position **5 / neg-home / n-h**: only negative direction with return to initial position **6 / neg / n--**: only negative direction without return to initial position	- 1 1 6	UINT16 R/W - -	Modbus 12040
AT_dis DIST TUN-*diSt*	Movement range autotuning(6-28) Range in which the automatic optimisation processes of the controller parameters are run. The range is input relative to the current position. IMPORTANT: with "movement in only one direction" (parameter AT_dir) the specified range is used for every optimisation step. The actual movement typically corresponds to 20 times the value, but is not limited.	revolution 1.0 1.0 999.9 **Fieldbus** 10 10 9999	UINT32 R/W - -	Modbus 12038
AT_mechanics MECH TUN-*MECh*	System coupling type(6-28) 1: direct coupling (J ext. to J motor <3:1) 2: medium coupling () 3: medium coupling (short toothed belt) 4: medium coupling () 5: soft coupling (J ext. to J motor between 5:1 and 10:1, linear axis)	- 1 1 5	UINT16 R/W - -	Modbus 12060
AT_start -	Start Autotuning(6-28) 0: End 1: Activate	- 0 - 1	UINT16 R/W - -	Modbus 12034

6.4.14 Extended settings for autotuning

For most applications the procedure described is sufficient for autotuning. The following parameters can be used to monitor or even influence the autotuning.

The parameters `AT_state` and `AT_progress` can be used to monitor the percentage progress and the status of the autotuning.

Parameter Name Code HMI menu, Code	Description	Unit Minimum value Default value Maximum value	Data type R/W persistent Expert	Parameter address via fieldbus
AT_state -	Autotuning status(6-30) Bit15: auto_tune_err Bit14: auto_tune_end Bit13: auto_tune_process Bit 10..0: last processing step	- -	UINT16 R/- - -	Modbus 12036
AT_progress -	Autotuning progress(6-30)	% 0 0 100	UINT16 R/- - -	Modbus 12054

If you are conducting a test operation and want to check how a harder or softer setting affects the control parameters on your system, you can write to the parameter `AT_gain`, which changes the settings found during the autotuning. A value of 100% is generally not possible, because this value is at the stability limit. The available value is typically 70%-80%.

The parameter `AT_J` can be used to read out the moment of inertia of the entire system calculated during the autotuning.

Parameter Name Code HMI menu, Code	Description	Unit Minimum value Default value Maximum value	Data type R/W persistent Expert	Parameter address via fieldbus
AT_gain GAIN TUN-$GR_I n$	Adapting controller parameters (tighter/looser)(6-30) Measure of the degree of tightness of the regulation. The value 100 represents the theoretical optimum. Values larger than 100 mean that the regulation is tighter and smaller values mean that the regulation is looser.	% -	UINT16 R/W - -	Modbus 12052
AT_J -	Inertia of the entire system(6-30) is automatically calculated during the autotuning process in 0.1 kgcm^2 steps	kg cm^2 0.1 0.1 6553.5 **Fieldbus** 1 1 65535	UINT16 R/W per. -	Modbus 12056

The parameter `AT_wait` can be modified to set a wait time between the individual steps during the autotuning process. It only makes sense to set a wait time if a very flexible coupling is used, and particularly if the

next automatic autotuning step (change of hardness) is carried out while the system is still oscillating.

Parameter Name Code HMI menu, Code	Description	Unit Minimum value Default value Maximum value	Data type R/W persistent Expert	Parameter address via fieldbus
AT_wait WAIT TUN-ⱯႩ᷄᠎Ⴑ	Waiting time between autotuning steps(6-30)	ms 300 1200 10000	UINT16 R/W - -	Modbus 12050

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

The reference value filter of the current controller suppresses high-frequency resonance (>500Hz). However, if high-frequency resonance does interfere with controller optimisation, it may be necessary to increase the time constant with the parameter CTRL_TAUiref.

In most cases the default setting suppresses the high-frequency resonance.

Parameter Name Code HMI menu, Code	Description	Unit Minimum value Default value Maximum value	Data type R/W persistent Expert	Parameter address via fieldbus
CTRL_TAUiref -	Filter time constant reference value filter of the reference current value()	ms 0.00 1.20 4.00 **Fieldbus** 0 120 400	UINT16 R/W per. -	Modbus 4640

6.5 Controller optimisation with step response

6.5.1 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 set from "inside" to "outside" in the sequence current, speed and position controller. The higher-level control loop in each case stays switched out.
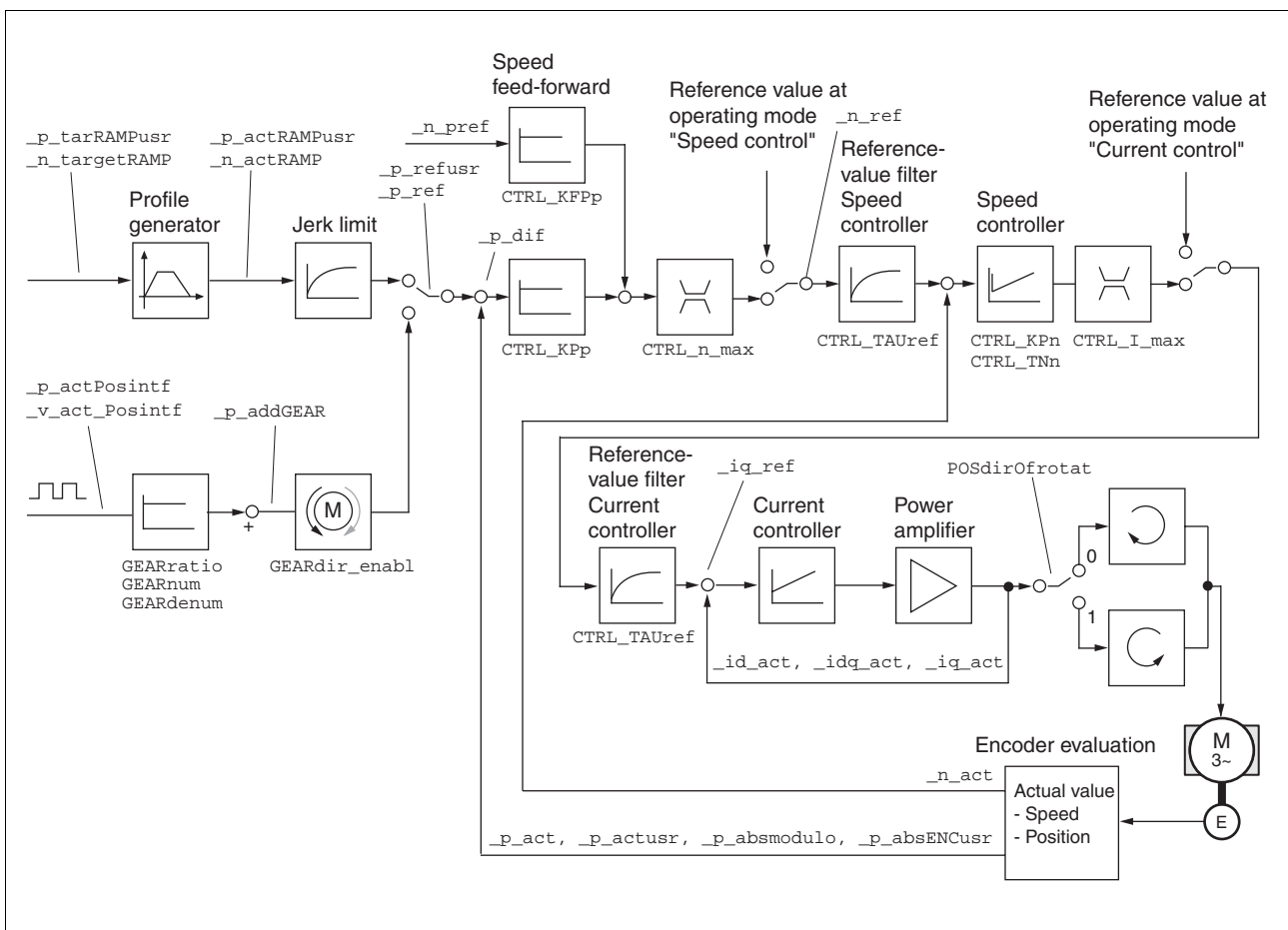
Figure 6.10   Controller structure for encoder evaluation via CN2

Current controller   The motor's drive torque is determined by the current controller. The current controller has been optimised automatically using the stored motor data.

Speed controller   The speed controller maintains the required motor speed by varying the output motor torque depending on the load situation. It exerts a decisive influence on the speed with which the drive reacts. The dynamics of the speed controller depend on

- the moments of inertia of the drive and the control distance

- the torque of the motor

- the stiffness and elasticity of the components in the power flow

- the backlash of the mechanical drive components
- the friction

Position controller The position controller reduces the difference between setpoint and actual motor position (tracking error) to a minimum. At motor standstill the tracking error is virtually zero with a well-adjusted position controller. In movement mode a speed-dependent tracking error occurs. The setpoint position for the closed positioning loop is generated by the internal travel profile generator during the profile position, profile velocity, homing and jog operating modes. In the Pulse control operating mode the setpoint position for the closed positioning loop is generated by external A/B or pulse/direction input signals.

A requirement for good amplification of the position controller is an optimised speed control loop.

6.5.2   Optimisation

The drive optimisation 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 behaviour on the monitor with the commissioning software.

Setting reference signals ▶ Start the controller optimisation with the commissioning software with the menu path "Command - Manual tuning".

▶ Set the following values for the reference signal:

- Signal form: 'Positive jump'
- Amplitude: 100 1/min
- Period duration: 100 ms
- Number of repetitions: 1
▶ Highlight the field "Autoscope".
▶ Also note additional settings in the menu "Display - Specific panels".

> *The total dynamic behaviour of a control loop can be only understood with the signal forms 'Jump' and 'Square wave'. Refer to the manual for all signal paths for the signal form 'Jump'.*

Inputting controller values Control parameters must also be input for the individual optimisation steps described over the following pages. These parameters must be tested by initiating a jump function.

A jump function is triggered as soon as a recording is started in the commissioning software tool bar with the "Start" button (arrow icon).

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

6.5.3 Optimising the speed controller

The optimum setting for complex mechanical control systems requires practical experience with setting and adjustment procedures for control equipment. This includes the ability to calculate control parameters and to apply identification procedures.

Less complex mechanical systems can generally be successfully optimised with the experimental adjustment procedure using the aperiodic limiting case method. Here the following two parameters are set:

Parameter Name Code HMI menu, Code	Description	Unit Minimum value Default value Maximum value	Data type R/W persistent Expert	Parameter address via fieldbus
CTRL_KPn -	Speed controller P-factor(6-34) Default value is calculated from motor parameters	A/(1/min) 0.0001 - 1.2700 **Fieldbus** 1 12700	UINT16 R/W per. -	Modbus 4614
CTRL_TNn -	Speed controller correction time(6-34)	ms 0.00 9.00 327.67 **Fieldbus** 0 900 32767	UINT16 R/W per. -	Modbus 4616

Check and optimise the calculated values in a second step, as described from page 6-38.

Determining the mechanics of the system

Decide which one of the following two systems fits the mechanics of your set-up to assess and optimise its transient response behaviour.

• System with rigid mechanism

• System with less rigid mechanism
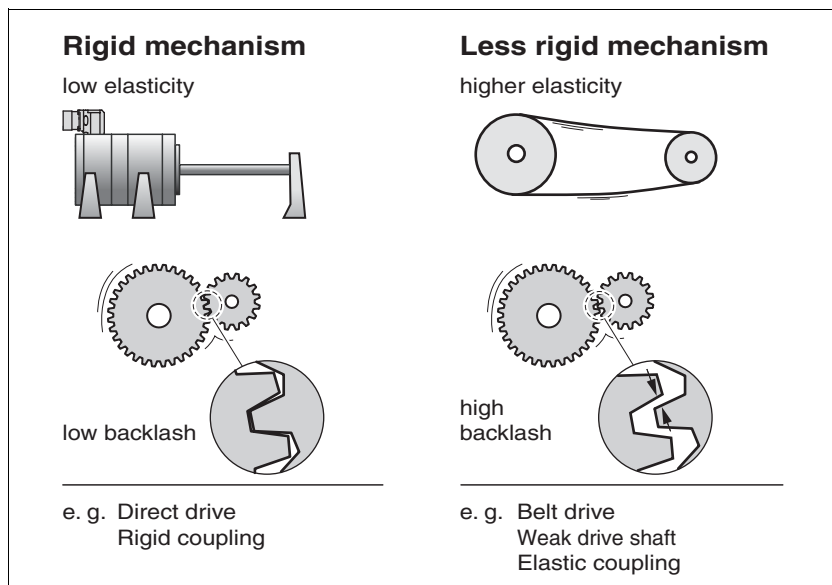
Figure 6.11   Mechanical systems with rigid and less rigid mechanisms

▶ Connect the motor to your system's mechanism.

▶ Test the limit switch function after installing the motor if limit switches are used.

Switch off reference value filter of speed controller

With the reference variable filter you can improve the response behaviour under optimised speed control. The reference value filter must be switched off when setting the speed controller for the first time.

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

Parameter Name Code HMI menu, Code	Description	Unit Minimum value Default value Maximum value	Data type R/W persistent Expert	Parameter address via fieldbus
CTRL_TAUnref -	Filter time constant reference value filter of the reference speed value(6-34)	ms 0.00 9.00 327.67 **Fieldbus** 0 900 32767	UINT16 R/W per. -	Modbus 4626

ℹ *The procedure for optimisation of the settings described is only a suggested setting. It is responsibility of the user to decide whether the method is suitable for the actual application.*

Determining controller values with rigid mechanics

Requirements for setting the control behaviour as per the table are:

• a known and constant inertia of load and motor

• a rigid mechanism

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 6.2:

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	0.250	8	0.150	12	0.138	16

Table 6.2   Determining controller values

Determining controller values with less rigid mechanics

For optimisation 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 drive systems in which the motor is loaded while stationary, e.g. with vertical axis operation, the correction time "infinite" may result in unwanted position deviations, thereby requiring the value to be reduced. However, this can adversely affect optimisation results.

⚠ WARNING

Unexpected movement

The step 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 travel.
- 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 movement 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 setpoint `_Iq_ref`.

Set the amplitude of the reference value – default was 100 rpm – just high enough so the current setpoint _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 mechanism will determine control loop response.

▶ Trigger a jump function again if you need to modify _n_ref and check the amplitude of _Iq_ref.

▶ Increase or decrease the P-factor in small steps until _n_act adjusts as fast as possible. The following diagram shows the adjustment response required 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".
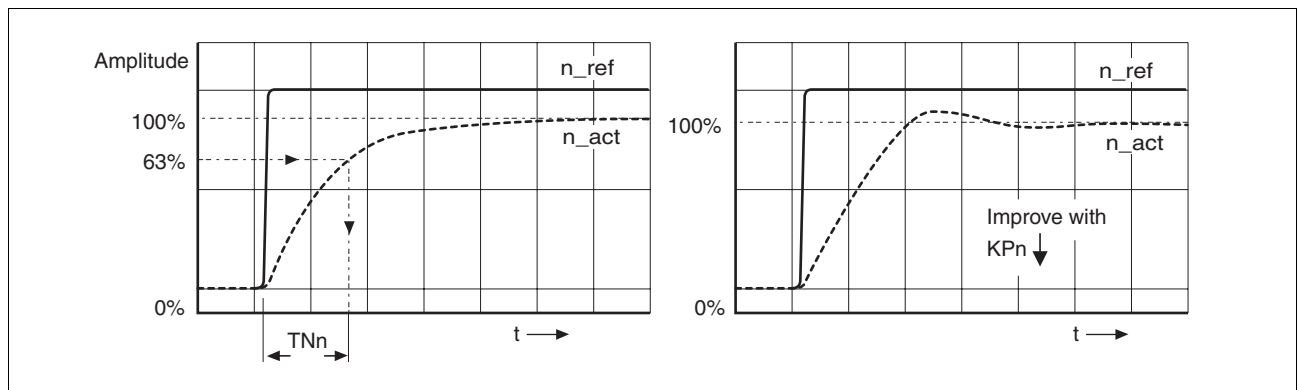
Figure 6.12   Determining 'TNn' in the aperiodic limiting case

For drive systems in which oscillations occur before the aperiodic limiting case is reached, the P-factor "KPn" must be reduced to the exact point where oscillations can no longer be detected. This occurs frequently with linear axes with a toothed belt drive.

Graphic determination of the 63% value

Determine graphically the point at which the actual speed _n_act will reach 63% of the end value. The correction time   CTRL_TNn is then shown as a value on the time axis. The commissioning software will help you with the evaluation:

Malfunctions during optimisation

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

The reference value filter of the current controller suppresses high-frequency resonance (>500Hz). However, if high-frequency resonance does interfere with controller optimisation, it may be necessary to increase the time constant with the parameter CTRL_TAUiref.

In most cases the default setting suppresses the high-frequency resonance.

Parameter Name Code HMI menu, Code	Description	Unit Minimum value Default value Maximum value	Data type R/W persistent Expert	Parameter address via fieldbus
CTRL_TAUiref -	Filter time constant reference value filter of the reference current value()	ms 0.00 1.20 4.00 **Fieldbus** 0 120 400	UINT16 R/W per. -	Modbus 4640

6.5.4 Checking and optimising default settings
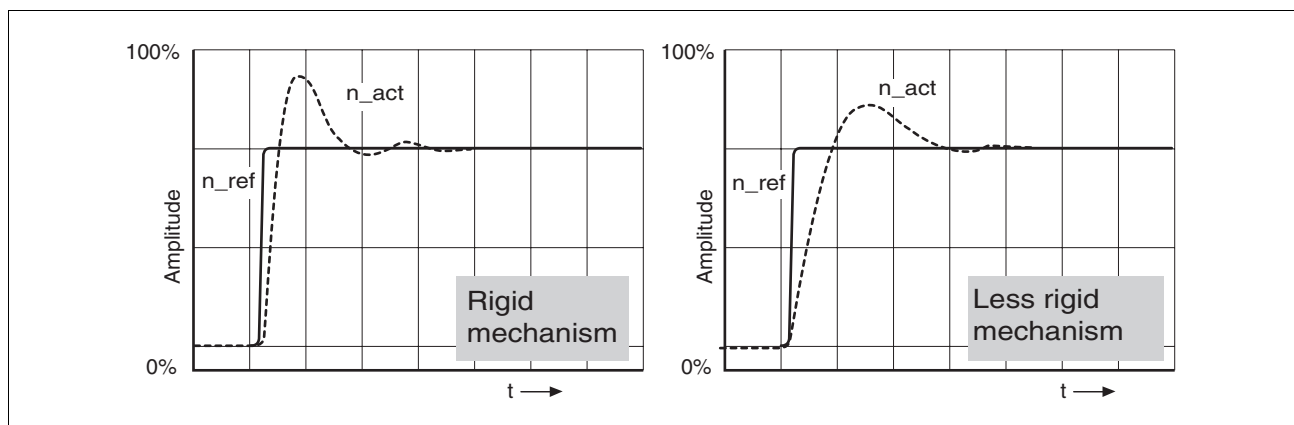
Figure 6.13   Step responses with good control behaviour

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

You can recognise an oscillation by the motor continuously accelerating and decelerating.
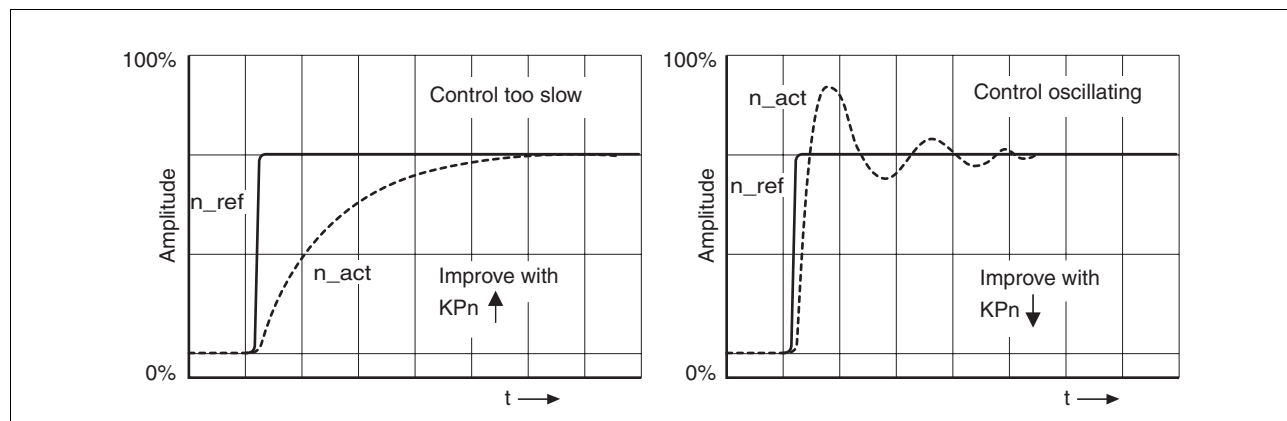
Figure 6.14   Optimise inadequate settings of the speed controller

If you cannot achieve sufficiently satisfactory controller properties in spite of optimisation, contact your local dealer.

6.5.5   Optimising the position controller

Optimisation requires a good control response in the lower-ranking speed control circuit.

When setting the position control the P-factor of the position controller CTRL_KPp must be optimised in two limits:

- CTRL_KPp too great: overshooting of the mechanism, instability of the controller

- CTRL_KPp too small: Large following error

Parameter Name Code HMI menu, Code	Description	Unit Minimum value Default value Maximum value	Data type R/W persistent Expert	Parameter address via fieldbus
CTRL_KPp -	Position controller P-factor(6-39) Default value is calculated	1/s 2.0 - 495.0 **Fieldbus** 20 4950	UINT16 R/W per. -	Modbus 4620

┌───┐
│   ⚠ **WARNING**   │
├───┤
│ **Unexpected movement**   │
│   │
│ The step 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 travel.   │
│   │
│ • 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 movement before starting the function.   │
│   │
│ **Failure to follow these instructions can result**│
│ **in death, serious injury or equipment damage.** │
└───┘

Setting the reference signal   ▶ Select the position controller reference value in the commissioning software.

▶ Set the reference signal:

• Signal form: 'Jump'

• Set amplitude for about 1/10 motor revolution.

The amplitude is input in user-defined units. At 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.

Optimising the position control value   ▶ Start a jump function with the default controller values.

▶ After the first test check the achieved values `_n_act` and `_Iq_ref` for current and speed control. The values must not cross into the range of current and speed limiting.
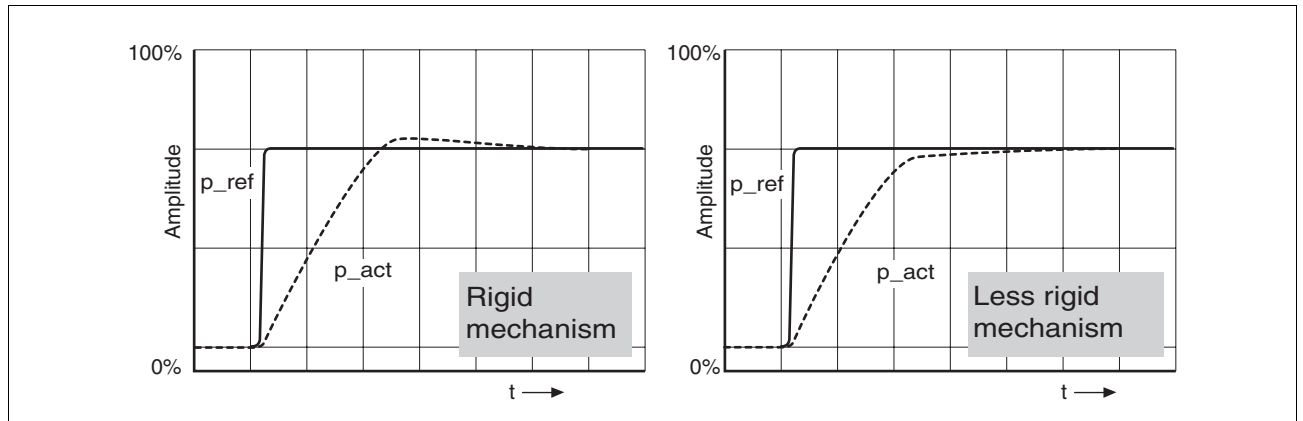
Figure 6.15   Step responses of a position controller with a good control behaviour

The proportional factor CTRL_KPp is at its optimum setting when the motor reaches its target position rapidly and with little or no overshooting.

If the control behaviour does not correspond to the curve shown, change the P-factor CTRL_KPp in steps of about 10% and then initiate a jump function once again.

- If the closed-loop control tends to oscillate: select CTRL_KPp smaller.

- If the actual value is too slow following the reference value: select CTRL_KPp larger.
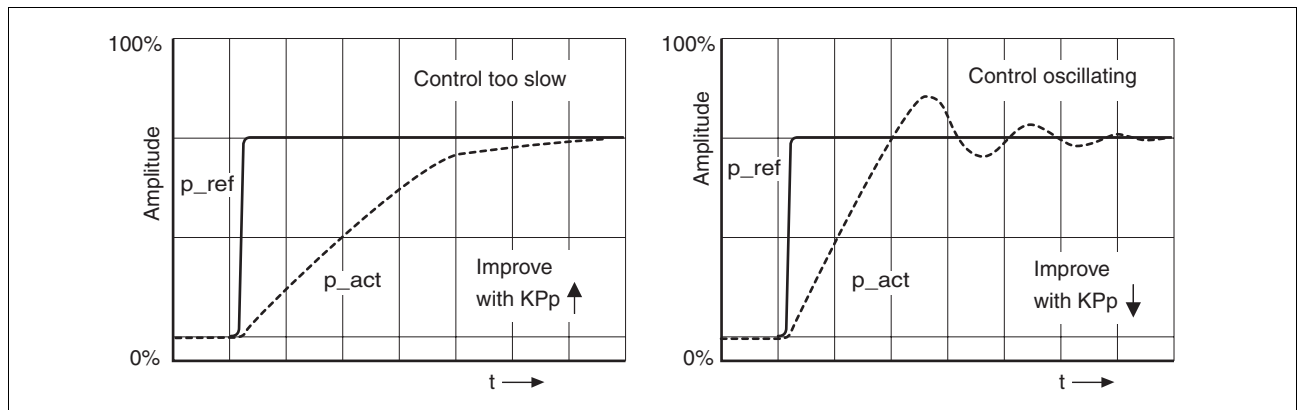
Figure 6.16   Optimising improper settings of the position controller

7 Operation

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

*For an overview of **all** parameters can be found alphabetically sorted in the "parameters" section. The application and the function of some parameters are explained in more detail in this section.*

7.1 Overview of operating modes

The following table is an overview of the operating modes and the type of reference value preselection.

Operating mode	Reference value default	Control loop	Description
Jog	HMI or digital input	Position controller	Page 7-6
Current control	analogue input	Current controller	Page 7-8
Speed control	analogue input	Speed controller	Page 7-9
Pulse control	P/D, A/B or CW/CCW	Position controller	Page 7-10

7.2 Access monitor

7.2.1 via HMI

The HMI receives the access monitoring when starting the jog operating mode or when starting Autotuning. Control by a different access channel, such as the commissioning software, is not possible in this case.

In addition, the HMI can be locked using the parameter `HMIlocked`. This means that control via the HMI is no longer possible.

Parameter Name Code HMI menu, Code	Description	Unit Minimum value Default value Maximum value	Data type R/W persistent Expert	Parameter address via fieldbus
HMIlocked -	Block HMI(7-1) 0: HMI not blocked 1: HMI blocked When the HMI is blocked the following actions are no longer possible: - Change parameters - Manual mode (Jog) - Autotuning - FaultReset	- 0 0 1	UINT16 R/W per. -	Modbus 14850

7.2.2 via commissioning software

The commissioning software must have exclusive access control. Control by a different access channel, such as the HMI, is not possible in this case.

7.2.3 via hardware input signals

The functions "Halt", "Fault reset" and "Enable" are always effective, even if the HMI or the commissioning software control the access.

7.3 Operating states

7.3.1 Status diagram

After switching on and at the start of an operating mode, a sequence of operating states is progressed through.

The relationship between the operating states and the state transitions is shown in the state diagram (state machine).

The operating states are internally monitored and influenced by monitoring and system functions, such as temperature and current monitoring

Graphic representation   The status diagram is shown graphically as a flow chart.
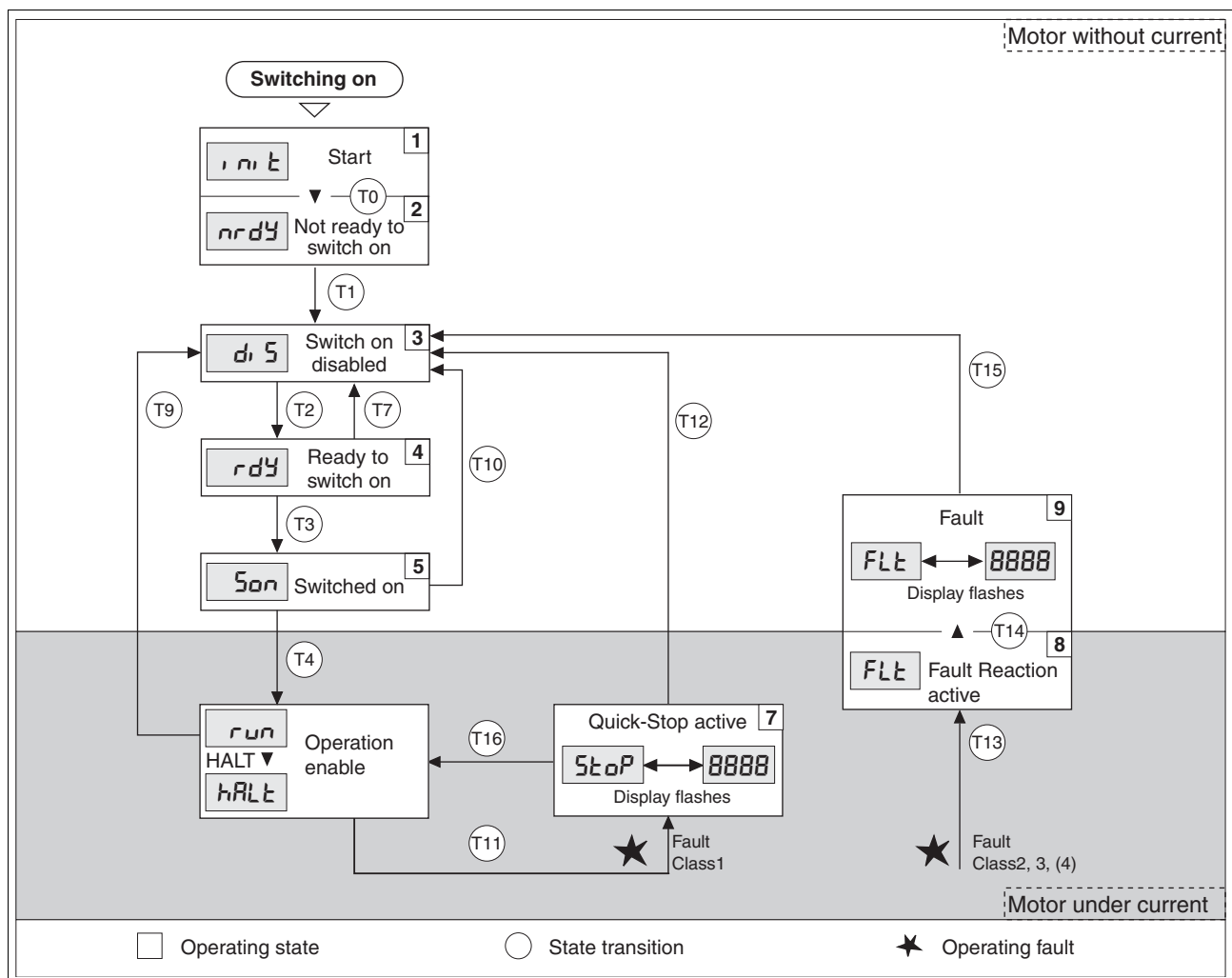
Figure 7.1   Status diagram

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Operating states   The operating states are displayed as standard by the HMI and the commissioning software.

Display	Status	State description
ın ıt	**1** Start	Controller supply voltage, electronics is initialised
nrdY	**2** Not ready to switch on	The power amplifier is not ready to switch on [1]
dı S	**3** Switch on disabled	Switching on the power amplifier is disabled
rdY	**4** Ready to switch on	The power amplifier is ready to switch on
Son	**5** Switched on	Motor not under current Power amplifier ready No operating mode active
run hALt	**6** Operation enable	RUN: device running in the selected operating mode HALT: The motor is stopped with active power amplifier
StoP	**7** Quick Stop active	"Quick Stop" is executed
FLt	**8** Fault Reaction active	Error detected, error response is enabled
FLt	**9** Fault	device is in fault condition

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

Error response   The status transition T13 initiates an error response as soon as an internal occurrence indicates a breakdown to which the device must react. The description of the error class can be seen in the diagnostics chapter.

Error class	Statusfrom - > to	Response
2	**x** -> **8**	Braking with "Quick Stop" Brake is closed Power amplifier is switched off
3.4 or "Power Removal"	**x** -> **8** -> **9**	Power amplifier is switched off immediately, even if "Quick Stop" is still active

A breakdown can be indicated by, for example, a temperature sensor. The device interrupts the travel command and carries out an error response e.g. braking and stopping with "Quick Stop" or switching off the power amplifier. Subsequently the operating status changes to "Fault".

To leave the "Fault" operating status the cause of the error must be corrected and a "Fault Reset" must be executed.

Reset error message   The FAULT_RESET input signal is used to run a "Fault Reset". An error message is reset by running a "Fault Reset".

*In the case of a "Quick Stop" triggered by errors of class 1 (operating status **7**), a "Fault Reset" triggers a direct return to the operating status **6**.*

Status transitions   Status transitions are triggered by an input signal or as a response to a monitoring signal.

Transi-tion	Operating status	Condition / result [1]	Response
T0	**1** -> **2**	• Motor speed below switch-on limit • device electronics successfully initialised	Check motor encoder
T1	**2** -> **3**	• First commissioning is completed	-
T2	**3** -> **4**	• Motor encoder check successful, DC bus voltage active, actual speed: <1000 1/min	-
T3	**4** -> **5**	• Input signal ENABLE0 -> 1	
T4	**5** -> **6**	• Automatic transition if input signal ENABLE still set	Activate power amplifier motor phases, earth, user parameters are che-cked release brake
T7	**4** -> **3**	• DC bus undervoltage • Actual speed: >1000 1/min (e.g. by auxiliary drive)	-
T9	**6** -> **3**	• Input signal ENABLE1 -> 0	Deactivate power amplifier immediately
T10	**5** -> **3**	• Input signal ENABLE1 -> 0	
T11	**6** -> **7**	• Class 1 error	Interrupt travel command with "Quick Stop"
T12	**7** -> **3**	• Input signal ENABLE1 -> 0	Deactivate power amplifier immediately, even if "Quick Stop" still active
T13	**x** -> **8**	• Errors Class 2, 3 or 4	Error response is carried out, see "error response"
T14	**8** -> **9**	• Error response completed • 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"	Specified operating mode is automatically conti-nued (cause of error must be corrected).

1) It is sufficient to fulfil one point to trigger the status transition

7.3.2   Changing operating status

A change of operating status takes place either via the commissioning software, the signal inputs or automatically.

Input signal	Status transi-tions	Change of status to
ENABLE 0 -> 1	T3, T4	**6**: Operation enable
ENABLE 1 -> 0	T5, T6	**4**: Ready to switch on
FAULT_RESET 0 -> 1	T15 T16	**4**: Ready to switch on **6**: Operation enable

7.3.3 Displaying the operating states

The display of operating status takes place via the signal outputs, the HMI or the commissioning software.

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

7.4 Starting and changing operating modes

⚠ WARNING

Unintended operation

- Note that inputs to these parameters are executed by the drive controller immediately on receipt of the data set.

- Make sure 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.

Requirements   To start an operating mode the unit must be ready to start and correctly initialised.

An operating mode cannot be carried out in parallel with another operating mode. If an operating mode is active, then you can only change to a different operating mode if the current operating mode is completed or is discontinued.

An operating mode is completed if the drive is at a standstill, e.g. if the target position of a positioning process is reached or if the drive is stopped by a "Quick Stop" or "Halt". If a fault occurs during the process which leads to the discontinuation of a current operating mode, then, after the cause of the fault has been removed, the traverse operation can be resumed, or you can change to a different operating mode.

Changing the operating states and enabling the operating modes must be executed separately. An operating mode can generally only be enabled if the operating status is already "operation enable".

7.4.1 Start operating mode

After start-up the device switches to the operating mode specified in the parameter `IOdefaultMode`.

The motor is placed under current by setting the input signal `ENABLE` and the set operating mode is started.

In addition, a "jog" or "Autotuning" can be started with the HMI.

7.4.2 Change operating mode

At drive standstill the default operating mode can be changed in the parameter `IOdefaultMode`. The operating modes cannot be changed while the operating mode is running. The new settings only become effective after switching off and switching on the device again.

7.5 Operating modes

7.5.1 Operating mode Jog

┌───┐
│ ⚠ **WARNING** │
│ │
│ **Unintended operation** │
│ │
│ • Note that inputs to these parameters are executed by the drive │
│   controller immediately on receipt of the data set. │
│ │
│ • Make sure that the system is free and ready for movement │
│   before changing these parameters │
│ │
│ **Failure to follow these instructions can result in death, se-** │
│ **rious injury or equipment damage.** │
└───┘

Overview of jog The motor traverses by one traverse unit or at constant speed in continuous operation. The length of the traverse unit, the speed levels and the wait time before continuous operation can be adjusted.

The current axis position is the start position for the jog operating mode. Position and speed values are input in user-defined units.

Start operating mode The operating mode can be started via the HMI. The power amplifier becomes active and the motor is under current by calling up the ᴊₒG- / Sᴛᴦᴛ. The motor runs by pushing the "up arrow" or "down arrow" buttons. You can change between slow and fast movement by simultaneously pushing the ENT-button.

Otherwise the operating mode can also be started as a start-up operating mode, see 6.4.1 ""First Setup"". Here the corresponding functions are preassigned to the signal inputs, see 7.6.7 "Configurable inputs and outputs".

At the start signal for jog the motor first moves over a defined path `JOGstepusr`. If the start signal is still pending after a specific wait time `JOGtime`, the device switches to continuous operation until the start signal is reset.

The graph below shows an overview.

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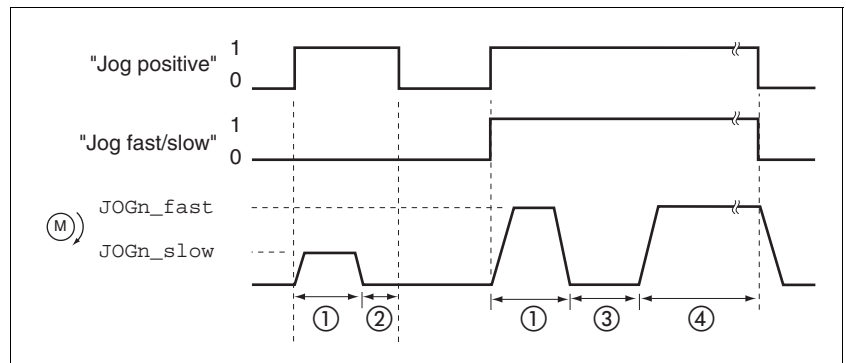
Figure 7.2   Jog, slow and fast

(1)   Traverse unit
(2)   t < wait time
(3)   t > wait time
(4)   Continuous operation

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

The following parameters can be set via the commissioning software.

Parameter Name Code HMI menu, Code	Description	Unit Minimum value Default value Maximum value	Data type R/W persistent Expert	Parameter address via fieldbus
JOGn_slow NSLW JOG-n5Lu	Speed for slow jog(7-6) The setting value is internally limited to the current parameter setting in RAMPn_max.	1/min 1 60 13200	UINT16 R/W per. -	Modbus 10504
JOGn_fast NFST JOG-nF5t	Speed for fast jog(7-6) The setting value is internally limited to the current parameter setting in RAMPn_max.	1/min 1 180 13200	UINT16 R/W per. -	Modbus 10506
JOGstepusr -	Inching movement before continuous operation(7-6) 0: direct activation of continuous operation >0: positioning section per inching cycle	usr 0 20	INT32 R/W per. -	Modbus 10510
JOGtime -	Waiting time before continuous operation(7-6) Time is only effective if an inching distance not equal to 0 has been set, otherwise direct transition to continuous operation.	ms 1 500 32767	UINT16 R/W per. -	Modbus 10512

End 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 possibilities   For further setting possibilities and functions for the operating mode see from page 7-14.

7.5.2 Operating mode Current control

Overview of current control   In the current control operating mode the reference value for the motor current is preset.

The following overview shows the effectivity of the parameters which can be set for the operating mode.
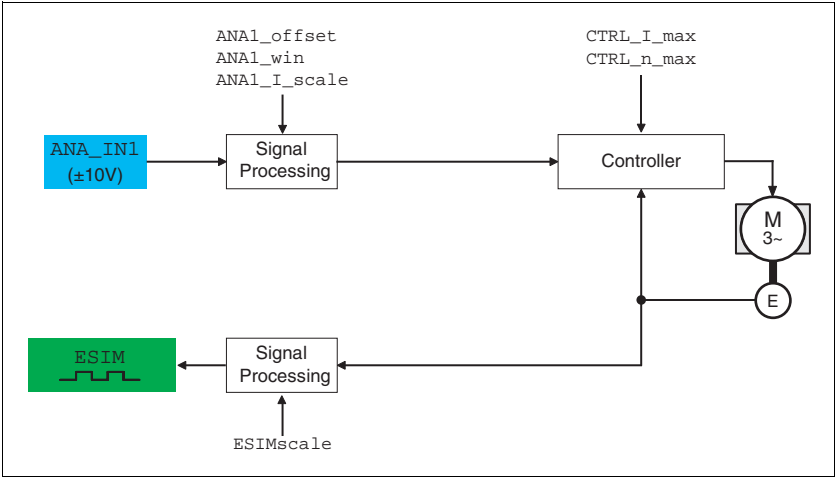
Figure 7.3   Current control mode.

Start operating mode   The operating mode must be set in the parameter `IOdefaultMode`. The power amplifier becomes active, the motor receives current and the analogue input is evaluated in accordance with the setting by setting the input signal `ENABLE`.

⚠ WARNING

Unexpectedly high speed of rotation

The motor in current control mode can reach extreme speeds when operated without limits or load.

• Check the configured speed limiter.

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

Parameter Name Code HMI menu, Code	Description	Unit Minimum value Default value Maximum value	Data type R/W persistent Expert	Parameter address via fieldbus
CUR_I_target -	Setpoint current in current control operating mode(7-8)	A_{pk} -300.00 0.00 300.00 **Fieldbus** -30000 0 30000	INT16 R/W - -	Modbus 8200

Reference value at +10 V input signal	The progress of the reference value in relation to the ±10V input value can be altered:

- Setting the reference value at +10V

- Setting parameters for a zero voltage window

- Setting parameters for a voltage offset

For setting options for the analogue inputs see .

The device calculates a current value, with which the motor accelerates to a speed which is limited by the load torque, from the ±10 V analogue value preset. Without a load the motor therefore accelerates to the variable speed limit.

End operating mode	The processing in the operating mode is completed if the operating mode has been "deactivated" and the drive is at a standstill, or if the motor speed has taken the value = 0 as a result of a fault.

7.5.3   Operating mode Speed control

Overview of speed control	In the speed control operating mode the reference value for the motor speed is preset.

Transitions between two speeds take place in relation to the set control parameters.

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

Figure 7.4   Speed control operating mode

Parameter Name Code HMI menu, Code	Description	Unit Minimum value Default value Maximum value	Data type R/W persistent Expert	Parameter address via fieldbus
SPEEDn_target -	Setpoint speed in speed control mode(7-9) The internal maximum speed is limited by the current setting in CTRL_n_max	1/min -30000 0 30000	INT16 R/W - -	Modbus 8456

Reference value at +10V input signal
The progress of the reference value in relation to the ±10V input value can be altered:

• Setting the reference value at +10V

• Setting parameters for a zero voltage window

• Setting parameters for a voltage offset

For setting options for the analogue inputs see .

End operating mode
The processing in the operating mode is completed if the operating mode has been "deactivated" and the drive is at a standstill, or if the motor speed has taken the value = 0 as a result of a fault.

7.5.4 Operating mode Pulse control

┌───┐
│   **⚠ WARNING**   │
├───┤
│ **Unintended operation**   │
│   │
│ • Note that inputs to these parameters are executed by the drive controller immediately on receipt of the data set. │
│   │
│ • Make sure 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 the operating mode Pulse control reference signals are fed in as A/B signals, pulse/direction signals or CW/CCW signals. They are offset to a new position preset with an adjustable gear ratio.

The parameter `IOposInterfac` specifies the type of reference signals.

Example
An NC control provides reference signals to two units. The motors execute different, proportional positioning movements in accordance with the gear ratios.
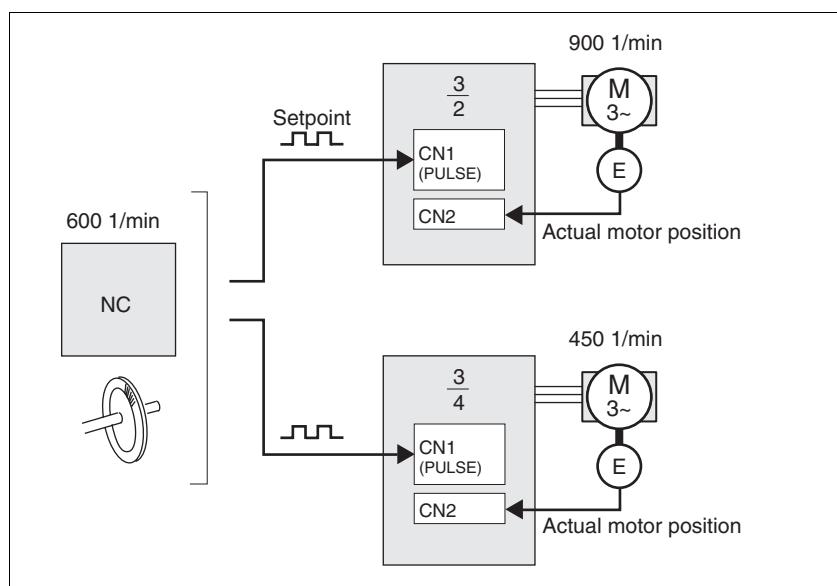
Figure 7.5   Preset default via NC controller

Start operating mode   The operating mode must be set in the parameter `IOdefaultMode`. The power amplifier becomes active, the motor receives current and the inputs are evaluated in accordance with the setting by setting the input signal `ENABLE`.

The type of synchronisation is set by the parameter `IO_GearMode`. If positioning changes are fed to the reference signals, then the device computes these with the gear ratio and positions the motor to the new setpoint position.

Position values are given in internal units. The device performs the changes immediately.

End operating mode   The process is ended by:

- disabling the operating mode and motor at standstill

- motor standstill by "Halt" or by an error

7.5.4.1 Parameterisation

Overview   The following overview shows the mode of action of the parameters which can be set for the operating mode Pulse control.
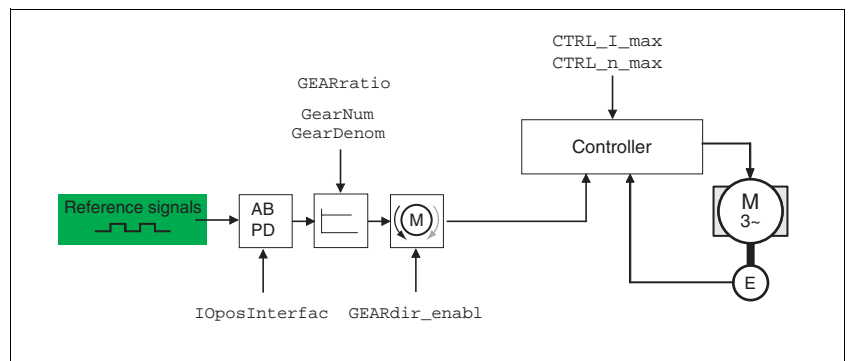
Figure 7.6   Effect of settable parameters

The resulting positioning movement is dependent upon the current motor resolution. It amounts to 131072 motor increments per revolution.

The setting values, independent of the type of synchronisation, are:

- Gear factor (predefined value or intrinsic gear factor)

- size of following error

- Release of the direction of rotation

Setting thresholds   For setting current limiting and speed limiting see 6-15.

Synchronisation   The device operates synchronously interconnected, e.g. with other drives. If the device leaves the processing for a short period of time, then the synchronous run with other drives is lost. However, position changes that occur at the reference signals are internally counted during the interruption.

The parameter `IO_GearMode` can be used to set whether these positioning changes are to be processed or ignored when the processing is resumed.

Parameter Name Code HMI menu, Code	Description	Unit Minimum value Default value Maximum value	Data type R/W persistent Expert	Parameter address via fieldbus
IO_GearMode IOGM DRC-ı oſΠ	Processing mode electr. gearing () 1: Real-time synchronisation 2: synchronisation with compensation movement	- 1 1 2	UINT16 R/W per. -	Modbus 1326

Gear ratio The gear ratio is the relationship between the motor increments and the externally inputted guide 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` serves to set the predefined gear ratio. Alternatively, an intrinsic gear ratio can be selected.

The intrinsic gear ratio is determined with the parameters count and name. A negative numerator value reverses the motor's direction of rotation. The gear ratio is preset to 1:1.

Example At a setting of 1000 reference increments the motor should rotate 2000 motor increments. This yields a gear ratio of 2.

Parameter Name Code HMI menu, Code	Description	Unit Minimum value Default value Maximum value	Data type R/W persistent Expert	Parameter address via fieldbus
GEARratio GFAC SET-ſFAſ	Selection of special gear ratios() 0: Use of the specified gear ratio from GEARnum/GEARdenom 1: 200 2: 400 3: 500 4: 1000 5: 2000 6: 4000 7: 5000 8: 10000 9: 4096 10: 8192 11: 16384 Changing the reference variable by the stated value results in one motor rotation.	- 0 0 11	UINT16 R/W per. -	Modbus 9740
GEARnum - 	Gear ratio numerator() Gear ratio= $\dfrac{\text{GEARnum}}{\text{GEARdenom}}$ The new gear ratio is enabled when the numerator value is transferred.	- -2147483648 1 2147483647 -	INT32 R/W per. -	Modbus 9736

Parameter Name Code HMI menu, Code	Description	Unit Minimum value Default value Maximum value	Data type R/W persistent Expert	Parameter address via fieldbus
GEARdenom -	Gear ratio denominator() see description GEARnum	- 1 1 2147483647	INT32 R/W per. -	Modbus 9734

Direction enabling   The direction enabling allows restriction of the movement to positive or negative direction of rotation. Direction enabling is set with the parameter GEARdir_enabl.

Parameter Name Code HMI menu, Code	Description	Unit Minimum value Default value Maximum value	Data type R/W persistent Expert	Parameter address via fieldbus
GEARdir_enabl -	Enabled direction of motion of the gear processing() **1 / positive** : pos. direction **2 / negative**: neg. direction **3 / both**: both directions (default) This can be used to enable a return motion lock.	- 1 3 3	UINT16 R/W per. -	Modbus 9738

Further possibilities   For further setting possibilities and functions for the operating mode see from page 7-14.

7.6 Functions

7.6.1 Monitoring functions

7.6.1.1 Status monitoring in movement mode
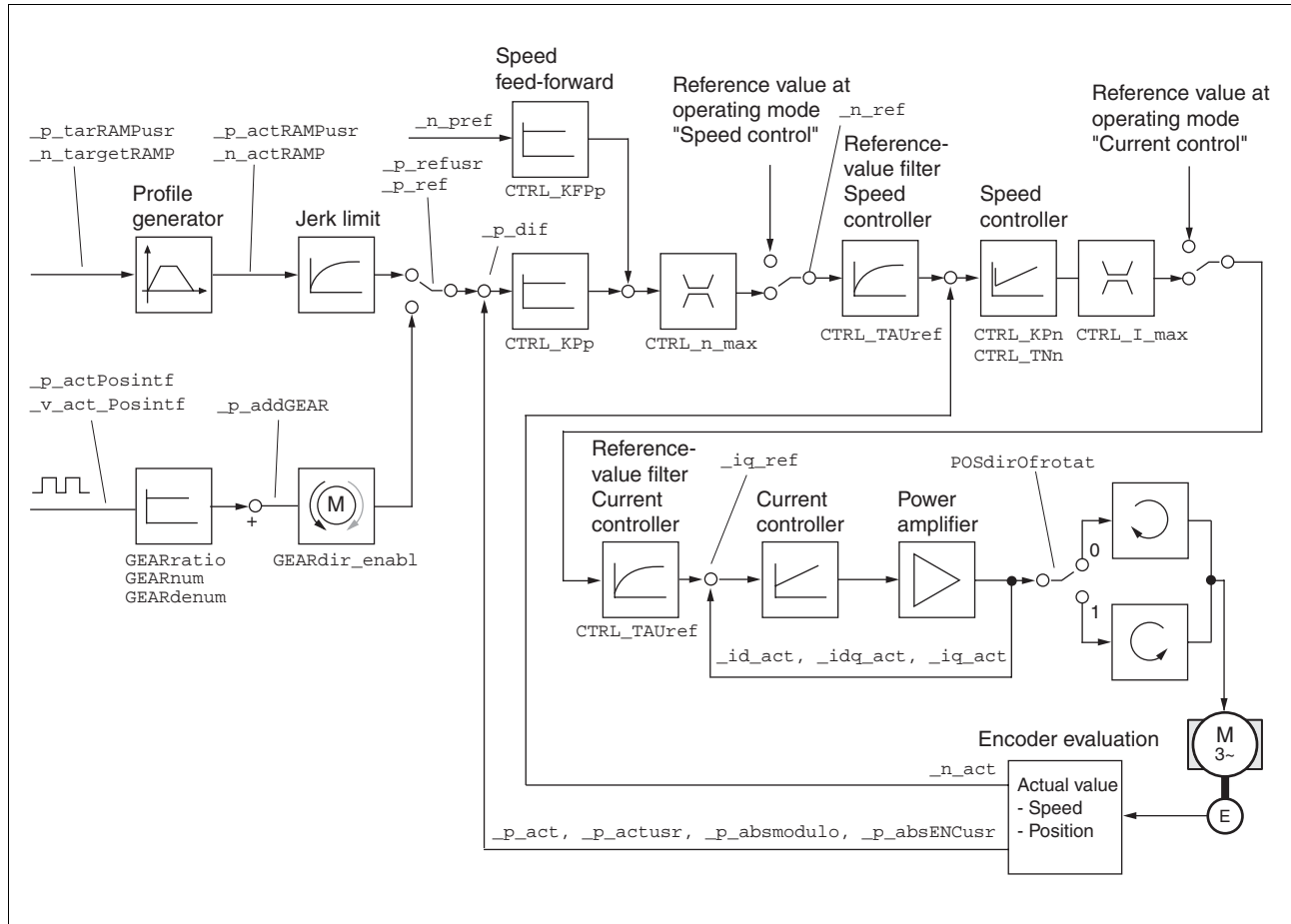
Figure 7.7   Status monitoring of the control loops

7.6.1.2 Monitoring internal signals

Monitoring systems protect the motor, the power amplifier and the braking resistor from overheating and contribute to the functional and operational safety. A list of all the safety equipment can be seen from page 2-4.

Temperature monitoring   Sensors monitor the temperature of motor, power amplifier and braking resistor. All temperature limits are permanently set. If the temperature of a component approaches its permissible temperature limit, the device creates a warning signal. If the temperature exceeds the limit value for more than 5 seconds, then the power amplifier and the regulation switches off. The device signals a temperature error.
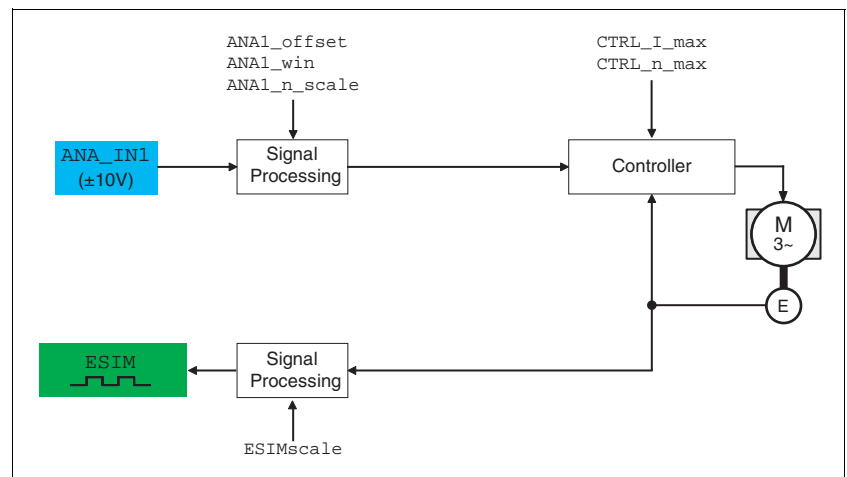
Parameter Name Code HMI menu, Code	Description	Unit Minimum value Default value Maximum value	Data type R/W persistent Expert	Parameter address via fieldbus
_Temp_act_DEV TDEV STA-*tdEU*	device temperature(7-14)	°C - 	INT16 R/- - -	Modbus 7204
_Temp_act_M -	Temperature motor(7-14) reasonable display is not possible for switching temperature sensors (for type of temperature sensor see parameter M_TempType)	°C - 	INT16 R/- - -	Modbus 7202
_Temp_act_PA TPA STA-*tPA*	Temperature of the power amplifier(7-14)	°C - 	INT16 R/- - -	Modbus 7200
M_T_max -	max. motor temperature(7-14)	°C - 	INT16 R/- - -	Modbus 3360
PA_T_max -	maximum permissible temperature of the power amplifier(7-14)	°C - 	INT16 R/- per. -	Modbus 4110
PA_T_warn -	Temperature limit of the power amplifier(7-14)	°C - 	INT16 R/- per. -	Modbus 4108

I^2t monitoring   If the device operates with high peak currents, then temperature monitoring with sensors can be too sluggish. With I^2t monitoring the closed-loop control anticipates a rise in temperature in time and if the I^2t threshold is exceeded, it reduces the motor, power amplifier or braking resistor current to their nominal value.

If the limit value is not reached, the individual components can be taken to the output limit again.

Parameter Name Code HMI menu, Code	Description	Unit Minimum value Default value Maximum value	Data type R/W persistent Expert	Parameter address via fieldbus
_I2tl_act_RES -	Actual overload braking resistor(7-14)	% - 	INT16 R/- - -	Modbus 7206
_I2tl_mean_RES I2TR STA-*i2tr*	Braking resistor load(7-14)	% - 	INT16 R/- - -	Modbus 7208
_I2t_peak_RES -	Overload braking resistor maximum value(7-14) Maximum overload braking resistor that has occurred in the last 10 sec.	% - 	INT16 R/- - -	Modbus 7210

Parameter Name Code HMI menu, Code	Description	Unit Minimum value Default value Maximum value	Data type R/W persistent Expert	Parameter address via fieldbus
_l2t_act_PA -	Overload power amplifier current(7-14)	% - 	INT16 R/- - -	Modbus 7212
_l2t_mean_PA I2TP STA-ı ΣℓP	Power amplifier load(7-14)	% - 	INT16 R/- - -	Modbus 7214
_l2t_peak_PA -	Overload power amplifier maximum value(7-14) Maximum overload power amplifier that has occurred in the last 10 sec.	% - 	INT16 R/- - -	Modbus 7216
_l2t_act_M -	Overload motor current(7-14)	% - 	INT16 R/- - -	Modbus 7218
_l2t_mean_M I2TM STA-ı ΣℓΠ	Motor load(7-14)	% - 	INT16 R/- - -	Modbus 7220
_l2t_peak_M -	Overload motor maximum value(7-14) Maximum overload motor that has occurred in the last 10 sec.	% - 	INT16 R/- - -	Modbus 7222

Tracking error monitoring The drive monitors the following error at 1ms intervals. The tracking error is the difference between the current setpoint and the actual position. If the difference exceeds the limit value set by the parameter SPV_P_maxDiff, it will immediately cause an interruption of movement (tracking error) with configurable error class.

Select the limit value in parameter SPV_P_maxDiff significantly higher than the maximum possible following error in error-free operation. This will ensure that a shutdown as a result of tracking error will only occur in case of error, e.g. with illegally increased external load torque, faulty position encoder etc.

The maximum control deviation occurring during operation can be determined with the parameter _p_DifPeak and compared with the maximum permissible following error. This allows the actual distance to the shut-off limit to be detected.

The error class for a tracking error can also be changed, see also 7.6.1 "Monitoring functions".

Calculating the tracking error The tracking error monitoring considers the dynamic tracking error and tracking error reduced by the speed pilot control (KFPp). Only the tracking error actually required for generating torque is compared with the specified tracking error limit. The lower limit value at which the tracking error must be set as a minimum is derived with the following formula. The change of P-intervals is calculated without considering the dynamic I-intervals and D-intervals from the tracking error to the current refe-

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rence value input. The current limit I_{max} is used as the current reference value.

Because the units of KPn[A/(rpm)] and p_dif[10000usr/rev] are not SI units, a conversion factor of 10000(usr/rev)/(60(s/min)) must be used.

$$\_p\_dif = \frac{CTRL\_I\_max}{CTRL\_KPp \cdot CTRL\_KPn} \cdot \frac{10000 \frac{usr}{U}}{60s/min}$$

Example of a tracking error calculation

The following values are used in the example:
I_{max}=10A, KPp=100/s, KPn=0.04A (rpm)

This yields the following:

$$\_p\_dif = \frac{10A}{100 \frac{1}{s} \cdot 0{,}04A \frac{min}{U}} \cdot \frac{10000 \frac{usr}{U}}{60s/min} = 416usr$$

The calculated value is the actual tracking error that immediately results in a tracking error with shutdown. Enter five times the calculated value in the parameter `SPV_P_maxDiff` to give an appropriate safety distance; for the example it would be 2080 usr.

Parameter Name Code HMI menu, Code	Description	Unit Minimum value Default value Maximum value	Data type R/W persistent Expert	Parameter address via fieldbus
_p_DifPeak -	Value of max. reached tracking errors of the position controller(7-14) The tracking error is the current position regulation offset minus the speed-dependent position regulation offset. Further information see SPV_p_maxDiff. A write operation resets the value again.	revolution 0.0000 - 429496.7295 **Fieldbus** 0 4294967295	UINT32 R/W - -	Modbus 4382
_p_dif PDIF STA-*Pd, F*	Current variation between reference and actual position(7-14) Corresponds to the current control deviation of the position controller without consideration of any dynamic components. Note: difference from SPV_p_maxDiff	revolution -214748.3648 - 214748.3647 **Fieldbus** -2147483648 2147483647	INT32 R/- - -	Modbus 7716
SPV_p_maxDiff -	Max. permissible tracking error of position controller(7-14) The tracking error is the current position regulation offset minus the speed-dependent position regulation offset. Actually, only the position offset caused by the moment requirements is still referred to for tracking error monitoring.	revolution 0.0001 1.0000 200.0000 **Fieldbus** 1 10000 2000000	UINT32 R/W per. -	Modbus 4636

Monitoring parameters   The unit and operating status can be monitored with various objects.

Parameter Name Code HMI menu, Code	Description	Unit Minimum value Default value Maximum value	Data type R/W persistent Expert	Parameter address via fieldbus
_SigActive -	Current state of the monitoring signals(7-14) Meaning see _SigLatched	- - -	UINT32 R/- - -	Modbus 7182
_SigLatched SIGS STA-5, ᴳ5	Stored state of the monitoring signals(7-14) Signal state: 0: not activated 1: activated Bit assignment Bit0: general error Bit1: limit switch (LIMP/LIMN/REF) Bit2: range exceeded (software limit switch, tuning) Bit3: Quick Stop via fieldbus Bit4: inputs PWRR are 0 Bit6: error RS485 Bit7: error CAN Bit9: frequency of reference signal too high Bit10: error current operating mode Bit12: Profibus error Bit14: undervoltage DC bus Bit15: overvoltage DC bus Bit16: no mains phase Bit17: connection to motor faulty Bit18. motor overcurrent/short circuit Bit19. error in motor encoder Bit20: undervoltage 24VDC Bit21: overtemperature (power amplifier, motor) Bit22: tracking error Bit23: max. speed exceeded Bit24: PWRR inputs different Bit29: error in EEPROM Bit30: system run-up (hardware or parameter fault) Bit31: System error (e.g. Watchdog) monitoring depends on the product.	- -	UINT32 R/- - -	Modbus 7184
_WarnActive -	Active warnings bit-coded(7-14) Meaning of Bits see _WarnLatched	- - -	UINT16 R/- - -	Modbus 7190

Parameter Name Code HMI menu, Code	Description	Unit Minimum value Default value Maximum value	Data type R/W persistent Expert	Parameter address via fieldbus
_WarnLatched WRNS STA-ᒋⲅⲛ5	Stored warnings bit-coded(7-14) Stored warning bits are erased in the event of a FaultReset. Bits 10,11,13 are automatically deleted. Signal state: 0: not activated 1: activated Bit assignment Bit 0: general warning (see _LastWarning) Bit 1: power amplifier temperature high Bit 2: motor temperature high Bit 3: reserved Bit 4: overload (I²t) power amplifier Bit 5: overload (I²t) motor Bit 6: overload (I²t) braking resistor Bit 7: CAN warning Bit 8: Motor Encoder warning Bit 9: RS485 protocol warning Bit 10: PWRR_A and/or PWRR_B Bit 11: DC bus undervoltage, faulty mains phase Bit 12: Profibus warning Bit 13: Position not yet valid (position detection continuing) Bit 14: reserved Bit 15: reserved monitoring is product-dependent	- - -	UINT16 R/- - -	Modbus 7192
_actionStatus - -	Action word(7-14) Signal state: 0: not activated 1: activated Bit0: Class 0 error Bit1 Class 1 error Bit2: Class 2 error Bit3 Class 3 error Bit4 Class 4 error Bit5 reserved Bit6: drive stopped (actual speed _n_act [1/min] < 9) Bit7: drive rotates in positive direction Bit8: drive rotates in negative direction Bit9: drive within position window (pwin) Bit10: reserved Bit11: Profile generator stopped (setpoint speed is 0) Bit12: Profile generator decelerating Bit13: Profile generator accelerating Bit14: Profile generator moves in constant mode Bit15: reserved	- - -	UINT16 R/- - -	Modbus 7176
_StopFault STPF FLT-5ᒋ𝘗𝘍	Fault number of the last interruption cause(7-14)	- -	UINT16 R/- - -	Modbus 7178

Set fault response The response of the unit to a fault is classified into error classes, and can be set for certain monitoring functions. This allows the error response of the unit to be matched to the operational requirements.

Parameter Name Code HMI menu, Code	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(7-14) **1 / ErrorClass1**error class 1 **2 / ErrorClass2**: error class 2 **3 / ErrorClass3**: error class 3	- 1 3 3	UINT16 R/W per. -	Modbus 1302
SPV_Flt_AC —	Error response to failure of a mains phase with 3-phase devices(7-14) **1 / ErrorClass1**error class 1 **2 / ErrorClass2**: error class 2 **3 / ErrorClass3**: error class 3	- 1 2 3	UINT16 R/W per. -	Modbus 1300

7.6.1.3 Commutation monitoring

Functional principle The unit continuously checks the plausibility of motor acceleration and effective motor moment, in order to recognise uncontrolled motor movements and to stop them if required. The monitoring function is referred to as commutation monitoring.

If the motor accelerates for a time period of more than 5 to 10ms, the commutation monitoring signals an uncontrolled motor movement, even though the drive regulation delays the motor with the set current value.

The unit shows flashing on HMI 5603 (error class 4)

Causes of error Uncontrolled motor movements can be traced back to the following causes:

• The motor phases U, V, W are connected to the unit incorrectly, i.e. each offset by 120° , e.g. U with V, V with W, W with U.

• Faulty or interfered evaluation of the rotor position by a faulty position encoder on the motor, interfered sensor signals or defective position acquisition in the unit.

In addition, the unit can recognise a commutation error in the following cases, since the above-mentioned plausibility conditions could equally apply:

• The motor receives an external torque that is greater than the specified maximum torque. The external force causes it to accelerate.

• The motor is manually moved either in the direction of the motor moment or in the opposite direction, while the drive regulation is active.

• The motor is moved to a mechanical stop.

• Speed and position control loop are set to be extremely unstable.

Parameterisation

> ⚠ **WARNING**
>
> **Unexpected movement**
>
> The risk of unexpected movement is increased when the monitoring functions are disabled.
>
> • Use the monitoring functions.
>
> **Failure to follow these instructions can result in death, serious injury or equipment damage.**

Parameter Name Code HMI menu, Code	Description	Unit Minimum value Default value Maximum value	Data type R/W persistent Expert	Parameter address via fieldbus
SPVcommutat -	Monitoring commutation(7-20) **0 / off**: off **1 / on**: on (default)	- 0 1 1	UINT16 R/W per. -	Modbus 1290

7.6.1.4 Earth fault monitoring

Functional principle   The device continuously checks the motor phases for earth fault with the power amplifier enabled. An earth fault of one or more motor phases is detected. An earth fault of the DC bus or the braking resistor is not detected.

Parameterisation

> ⚠ **WARNING**
>
> **Unexpected movement**
>
> The risk of unexpected movement is increased when the monitoring functions are disabled.
>
> • Use the monitoring functions.
>
> **Failure to follow these instructions can result in death, serious injury or equipment damage.**

Parameter Name Code HMI menu, Code	Description	Unit Minimum value Default value Maximum value	Data type R/W persistent Expert	Parameter address via fieldbus
SPV_EarthFlt -	Earth fault monitoring(7-21) **0 / off**: Off **1 / on**: On (default) In exceptional cases deactivation may be required, e.g.: - parallel connection of multiple devices - operation on an IT mains - long motor lines Disable the monitoring only if it responds when not wanted	- 0 1 1	UINT16 R/W per. expert	Modbus 1312

7.6.1.5 Mains phase monitoring

Functional principle

With three-phase devices the mains phases are monitored for failure of a mains phase. An error response can be set in the parameter SPV_Flt_AC. The parameter SPV_MainsVolt.

The parameters SPV_Flt_AC and SPV_MainsVolt have no function with single-phase devices.

Parameterisation

┌───┐
│ **⚠ WARNING**   │
│   │
│ **Unexpected movement**   │
│   │
│ The risk of unexpected movement is increased when the monito- │
│ ring functions are disabled.   │
│   │
│ • Use the monitoring functions.   │
│   │
│ **Failure to follow these instructions can result in death, se-** │
│ **rious injury or equipment damage.**   │
└───┘

Parameter Name Code HMI menu, Code	Description	Unit Minimum value Default value Maximum value	Data type R/W persistent Expert	Parameter address via fieldbus
SPV_Flt_AC -	Error response to failure of a mains phase with 3-phase devices(7-14) **1 / ErrorClass1**error class 1 **2 / ErrorClass2**: error class 2 **3 / ErrorClass3**: error class 3	- 1 2 3	UINT16 R/W per. -	Modbus 1300
SPV_MainsVolt -	Monitoring mains phases with 3-phase devices(7-22) **0 / off**: Off **1 / on**: On (default) 3-phase devices must only be connected and operated on 3-phase mains. In exceptio-nal cases it may be necessary to disable it, e.g.: - supply via the DC bus	- 0 1 1	UINT16 R/W per. expert	Modbus 1310

7.6.2   Scaling

Availability   This function is only active on jog operating mode.

Description   Scaling translates user units to internal units of the device, and vice versa. The device saves position values in user-defined units.
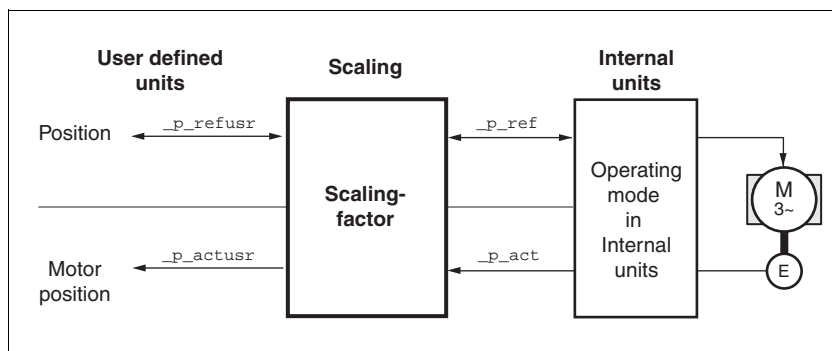
Figure 7.8   Scaling

Scaling factor   The scaling factor creates the relationship between the number of motor rotations and the required user units [usr] needed for this. It is specified in [rev/usr].

$$\text{Scaling factor} \quad = \quad \frac{\text{Motor revolution [rev]}}{\text{Change of the user position [usr]}}$$

Figure 7.9   Calculation of the scaling factor

Default scaling A value of 16384 user-defined units per motor revolution is set as the default scaling.

> ⚠ **WARNING**
>
> **Unexpected movement by changing the scaling**
>
> Changing the scaling changes the effect of the values in user-defined units. The same travel commands can therefore cause different movements.
>
> • Note that the scaling affects all relationships between the defaults and the drive movement.
>
> • Check the corresponding usr parameters and defaults of the system in user-defined units.
>
> **Failure to follow these instructions can result in death, serious injury or equipment damage.**

The scaling factor is set using the parameters `POSscaleNum` and `POSscaleDenom`. A new scaling factor is activated by transfer of the numerator value.

When quoting the scaling factor, take care that the relationship can be completely represented by a fraction.

Parameter Name Code HMI menu, Code	Description	Unit Minimum value Default value Maximum value	Data type R/W persistent Expert	Parameter address via fieldbus
POSscaleNum -	Numerator of the position scaling factor(7-23) :Definition of scaling factor Motor revolutions[U] -- Change in user position [usr] Acceptance of a new scaling factor takes place on the entry of the numerator User limits can be reduced when internal system factors are taken into account	revolution 1 1 2147483647	INT32 R/W per. -	Modbus 1552
POSscaleDenom -	Denominator of the position scaling factor(7-23) Description see numerator (POSscaleNum) Acceptance of a new scaling factor is by transfer of the numerator	usr 1 16384 2147483647	INT32 R/W per. -	Modbus 1550

If the existing unit is replaced by this unit, and if the same positioning orders are to be used, then the scaling is to be set in accordance with the settings used previously.

Value change of the scaling factor is only possible with inactive power amplifier. Values in user-defined units are converted to internal units with the power amplifier active.

Examples There are 3 cases for the setting of the user-defined units.

- Scaling corresponds to the default scaling
  1 motor revolution = 16384 user-defined units

  => every 8th motor position can be approached.

- Scaling corresponds to the motor resolution (minimum scaling)
  1 motor revolution = 131072 user-defined units

  => every motor position can be approached.

- Scaling is less than the default scaling
  1 motor resolution = 4096 user-defined units

  => every 32nd motor position can be approached.

Example 1 Positioning of 1111 user-defined units is to correspond to 3 motor revolutions. This gives:

$$\text{Scaling factor} = \frac{3 \text{ rev}}{1111 \text{ usr}}$$

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If you carry out a relative positioning operation of 900 user-defined units now, the motor will move 900 usr * 3/1111 rev/usr = 2.4302 motor revolutions.

Example 2   Calculation of the scaling factor in length units: 1 motor revolution corresponds to a path of 100 mm. Every user-defined unit [usr] should correspond to one 0.01 mm step.

This gives: 1 usr = 0.01 mm * 1 rev/100 mm = 1/10000 rev.

$$\text{Scaling factor} \;=\; \frac{1 \text{ rev}}{10000 \text{ usr}}$$

Example 3   Setting the positioning in 1/1000 rad
1rad = 1 U/(2*π)
π = 3.1416 (rounded)

User value = 1 usr

device value = 1/(2*π*1000) U

$$\text{Scaling factor} \;=\; \frac{1 \text{ rev}}{2*3,1416*1000 \text{ usr}} = \frac{1 \text{ rev}}{6283,2 \text{ usr}} = \frac{10 \text{ rev}}{62832 \text{ usr}}$$

7.6.3   Movement profile

Availability   This function is only active on jog operating mode.

Profile generator   Target position and final speed are input values to be entered by the user. The profile generator uses these values to calculate a motion profile dependent on the selected operating mode.

The initial values of the profile generator and the addable jolt limiting are transformed into a motor movement by the drive regulator.

The acceleration and deceleration behaviour 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 shape   A linear ramp for the acceleration and deceleration phases is available as the ramp shape. The profile settings are valid for both directions of movement of the drive.

Ramp steepness   The steepness of the ramp determines the speed changes of the motor per unit time. It can be specified for the acceleration ramp via parameter `RAMPacc` for the deceleration ramp via `RAMPdecel`.

Figure 7.10   Acceleration and deceleration ramps

Parameter Name Code HMI menu, Code	Description	Unit Minimum value Default value Maximum value	Data type R/W persistent Expert	Parameter address via fieldbus
RAMPacc -	Profile generator acceleration(7-26)	(1/min)/s 30 600 3000000	UINT32 R/W per. -	Modbus 1556
RAMPdecel -	Profile generator deceleration(7-26)	(1/min)/s 750 750 3000000	UINT32 R/W per. -	Modbus 1558

7.6.4 Quick Stop

> ⚠ **WARNING**
>
> **Unbraked motor**
>
> An insufficient braking resistor causes overvoltage on the DC bus and switches off the power amplifier. The motor is no longer actively braked.
>
> • Make sure that the braking resistor is sufficiently dimensioned.
>
> • Check the setting of the parameter for the braking resistor.
>
> • Check the temperature of the braking resistor by conducting a test run under the most critical conditions.
>
> • During the test make sure that at higher mains voltage there is less reserve in the capacitors on the DC bus.
>
> **Failure to follow these instructions can result in death, serious injury or equipment damage.**

"Quick Stop" is a fast braking function which stops the motor as a result of a fault of error class 1 and 2 or by a software stop.

In the event of a fault category 1 fault response, the power amplifier remains on. In the case of error class 2, the output stage switches off after the drive is at a standstill.

Maximum current The unit absorbs the excess braking energy. If the DC bus voltage exceeds the permissible limit the output stage switches off and the unit signals "DC bus overvoltage". The motor runs down without braking.

The current for the moment ramp should be set so that the drive comes to a standstill with the required delay.

Parameter Name Code HMI menu, Code	Description	Unit Minimum value Default value Maximum value	Data type R/W persistent Expert	Parameter address via fieldbus
LIM_I_maxQSTP LIQS SET-L, 95	Current limiting for Quick Stop(7-27) Max. current during braking via torque ramp resulting from an error with error class 1 or 2, and when a software stop is triggered Maximum and default value setting depend on motor and power amplifier in 0.01Apk steps	A$_{pk}$ - - -	UINT16 R/W per. -	Modbus 4362

If the device switches off frequently with "Quick Stop" with "DC bus overvoltage", then the maximum braking current should be reduced, the drive load should be reduced or an external braking resistor should be installed.

7.6.5   Halt

The "Halt" function brakes the motor with a moment ramp The parameter `LIM_I_maxHalt` specifies the current for the moment ramp.

After drive standstill an internal position compensation is run, the position control is enabled and the motor is stopped with the power amplifier active.

After cancellation of all "Halt" requests the interrupted movement is continued. If the $\overline{\text{HALT}}$ signal is cancelled during the braking procedure, the drive still runs down to standstill and only then accelerates again.

The "Halt" function can be set from any desired source (such as commissioning software or input signal $\overline{\text{HALT}}$).

Maximum current   The unit absorbs the excess braking energy. If the DC bus voltage exceeds the permissible limit the output stage switches off and the unit signals "DC bus overvoltage". The motor runs down without braking.

The current for the moment ramp should be set so that the drive comes to a standstill with the required delay.

Parameter Name Code HMI menu, Code	Description	Unit Minimum value Default value Maximum value	Data type R/W persistent Expert	Parameter address via fieldbus
LIM_I_maxHalt LIHA SET-*Li hA*	Current limiting for Halt(7-28) Max. current during braking after Halt or termination of an operating mode. Maximum and default value settings depend on motor and power amplifier in 0.01Apk steps	A_{pk} - - -	UINT16 R/W per. -	Modbus 4364

7.6.6   Braking function with HBC

Inadvertent movement of the motor without current is prevented by the use of motors with a holding brake. The holding brake requires a holding brake control system HBC, see chapter "Accessories"

Holding brake controller   The holding brake controller HBC controls the brake in such a way to allow fast switching with a minimum of heat generation. In addition, the brake connection, which is located in one cable with the wiring connections to the motor, safely disconnects the signal connections on the device in the event of a breakdown of the insulation of the motor cable.

The function "Brake release" is used to actuate the holding brake controller. The function must be configured to a signal output, see 7.6.7 "Configurable inputs and outputs".

The function of the HBC and the holding brake can be tested, see 6.4.7 "Checking holding brake" page 6-20.

Settable parameters   A time delay for release of the holding brake (BRK_trelease) and setting the holding brake (BRK_tclose) can be configured.

Delayed release   When the power amplifier is activated the parameter BRK_trelease implements a delayed response of the drive against the release (opening) of the holding brake.

The setting of the parameter BRK_trelease depends on the motor type and can be found in the motor data sheet.
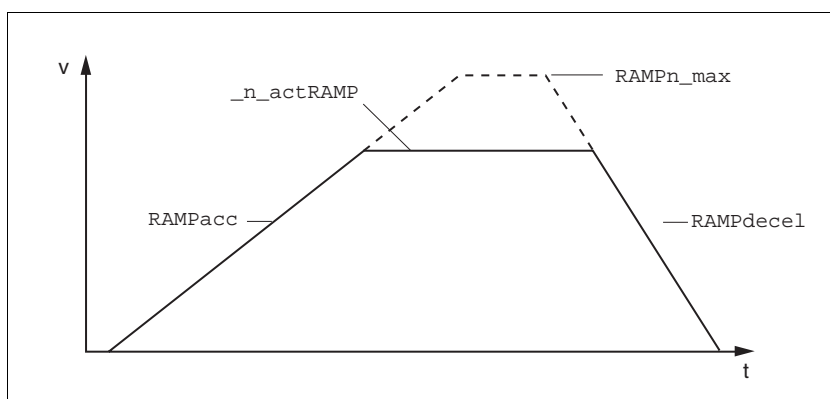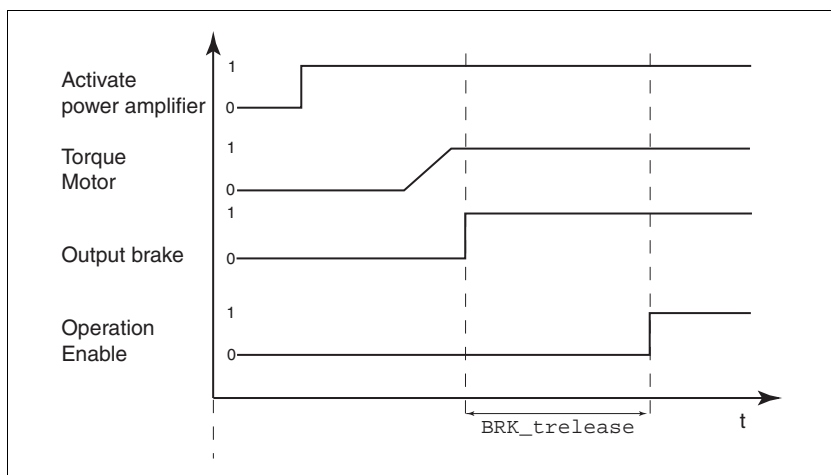

Figure 7.11   Releasing the holding brake

Parameter Name Code HMI menu, Code	Description	Unit Minimum value Default value Maximum value	Data type R/W persistent Expert	Parameter address via fieldbus
BRK_trelease BTRE DRC-ｂｔｒＥ	Time delay when opening/release of brake(7-29)	ms 0 0 1000	UINT16 R/W per. -	Modbus 1294

Delayed application   The holding brake is set when the power amplifier is disabled. The motor remains under current, however, for the time set on the parameter BRK_tclose.

The setting of the parameter `BRK_tclose` depends on the motor type and can be found in the motor data sheet.
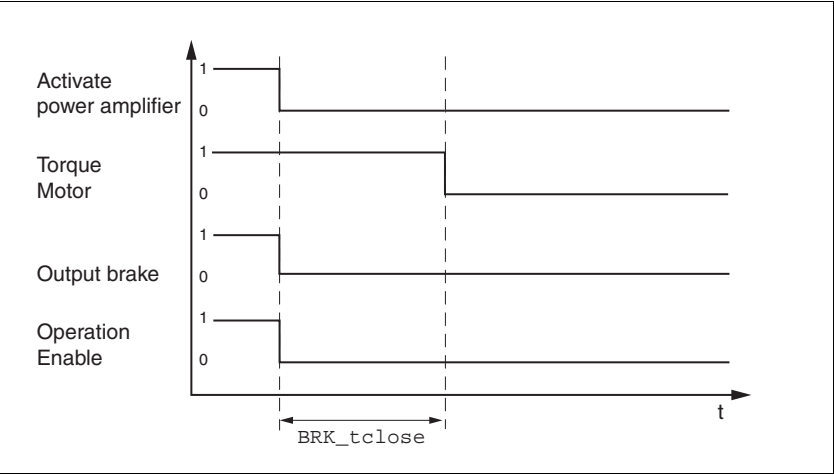
Figure 7.12   Applying the holding brake

Parameter Name Code HMI menu, Code	Description	Unit Minimum value Default value Maximum value	Data type R/W persistent Expert	Parameter address via fieldbus
BRK_tclose BTCL DRC-*btCL*	Time delay when closing the brake(7-29)	ms 0 0 1000	UINT16 R/W per. -	Modbus 1296

Voltage reduction   If the voltage reduction on the HBC is activated, the voltage of the holding brake output is reduced after a delay time. This reduces the power loss of the holding brake by approx. 44%.

▶ Set the voltage reduction depending on the motor type with the switch "Voltage reduction".
Follow the instructions in the motor manual.

(On)   voltage reduction on, e.g. for motor type BRH
(Off)   voltage reduction off, e.g. for motor type BSH

When switching on the supply voltage, the holding brake control and the function of the HBC button are reset. There is no voltage at the control terminals of the brake, the LED "Brake released" of the HBC is off.

7.6.7 Configurable inputs and outputs

⚠️ **WARNING**

Unforeseen behaviour 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.

*   Check that the wiring is appropriate for the settings.
*   Only start the system if there are no persons or materials in the danger zone and the system can be operated safely.
*   When commissioning carefully run tests for all operating statuses and fault cases.

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

Description   The digital signal inputs and the digital signal outputs can be assigned to various functions.

The parameters IOfunct_LI1, IOfunct_LI2, IOfunct_LI4, IOfunct_LI5 and IOfunct_LI6 are available for the signal inputs. The parameters IOfunct_LO1, IOfunct_LO2, IOfunct_LO3 and IOfunct_LO4 are available for the signal outputs.

The digital signal inputs and outputs are assigned with functions depending on the start-up operating mode.

The signal input ENABLE is an exception. This signal input is always assigned with the "enable" function, see 7.3 "Operating states".

Current status   The parameters _IO_in_act and _IO_out_act can be used to display the current status of the digital signal inputs and signal outputs.

Parameter Name Code HMI menu, Code	Description	Unit Minimum value Default value Maximum value	Data type R/W persistent Expert	Parameter address via fieldbus
_IO_LI_act

- | Status of the digital inputs()

Coding of the individual signals: Bit0: LI1 Bit1: LI2 ... | -

- | UINT16 R/-

-
- | Modbus 2078 |
| _IO_LO_act

- | Status of the digital outputs()

Coding of the individual signals: Bit0: LO1_OUT Bit1: LO2_OUT ... | -

- | UINT16 R/-

-
- | Modbus 2080 |

Factory settings   The table below shows the factory settings depending on the start-up operating mode.

Pin Signal	Jog	Pulse control	Speed control	Current control
CN1.34 LI1	Jog negative	No function / free available	No function / free available	No function / free available
CN1.35 LI2	Jog positive	Fault reset	Fault reset	Fault reset
CN1.36 LI3	Enable [1]	Enable	Enable [1]	Enable [1]
CN1.37 LI4	Jog fast/slow	Halt	Halt	Halt
CN1.38 LI5	No function / free available	No function / free available	No function / free available	No function / free available
CN1.39 LI6	No function / free available	No function / free available	No function / free available	No function / free available
CN1.31 LO1_OUT	No fault	No fault	No fault	No fault
CN1.32 LO2_OUT	Brake release	Brake release	Brake release	Brake release
CN1.33 LO3_OUT	No function / free available	No function / free available	No function / free available	No function / free available
CN5.4 LO4_OUT	No function / free available	No function / free available	No function / free available	No function / free available

1) Function cannot be modified.

After modifying the start-up operating mode and switching the device off and on the signal inputs and signal outputs are preassigned corresponding to the factory settings.

7.6.7.1 Description of functions of the signal inputs

No function / free available   The "No function / free available" function does not have an internal-device function. The parameter `_IO_LI_act.`

Fault reset   An error message is reset with the function, see 7.3 "Operating states".

Enable   The power amplifier is enabled with the function, see 7.3 "Operating states".

Halt   A "Halt" is triggered with the function, see 7.6.5 "Halt".

Enable positive motor move   This function releases or blocks positive reference values via a position switch. When the switching edge of the positive position switch is traversed the positive reference value are blocked and the motor stops. Only negative reference values are executed until the motor is traversed back over the switching edge.

The function is available in jog, speed control and Pulse control. The position switches must be correctly wired, see Chapter 6.4.9 "Check signals of position switch".

Enable negative motor move   This function corresponds to the functioning of "Enable positive motor move", except that negative reference values are released or blocked via a position switch.

Speed limitation   A speed limitation is enabled with the function. The value for the speed limitation is set with the parameter `SPVn_lim`.

	Jog positive	A jog movement in clockwise rotation is executed with the function, see 7.5.1 "Operating mode Jog".
	Jog negative	A jog movement in counterclockwise rotation is executed with the function, see 7.5.1 "Operating mode Jog".
	Jog fast/slow	The device switches between slow and fast jog with the function, see 7.5.1 "Operating mode Jog".

Parameter Name Code HMI menu, Code	Description	Unit Minimum value Default value Maximum value	Data type R/W persistent Expert	Parameter address via fieldbus
SPVn_lim NLIM SET-nLifl	Speed limitation via input() a speed limitation can be activated via a digital input.	1/min 1 10 9999	UINT16 R/W per. -	Modbus 1596

7.6.7.2   Configuration of signal inputs

The parameters `IOfunct_LI1` to `IOfunct_LI6` can be used to assign functions to the digital inputs.

The table below shows an overview of the signal inputs to which a function can be assigned. The table also shows the dependence on the start-up operating mode.

Function	Jog	Pulse control	Speed control	Current control
No function / free available	LI1, LI2, LI4, LI5, LI6	LI1, LI2, LI4, LI5, LI6	LI1, LI2, LI4, LI5, LI6	LI1, LI2, LI4, LI5, LI6
Fault reset	LI2	LI2	LI2	LI2
Enable	LI3 [1]	LI3 [1]	LI3 [1]	LI3 [1]
Halt	LI4	LI4	LI4	LI4
Enable positive motor move	LI1, LI2, LI4, LI5, LI6	LI1, LI2, LI4, LI5, LI6	LI1, LI2, LI4, LI5, LI6	
Enable negative motor move	LI1, LI2, LI4, LI5, LI6	LI1, LI2, LI4, LI5, LI6	LI1, LI2, LI4, LI5, LI6	
Speed limitation		LI1, LI2, LI4, LI5, LI6	LI1, LI2, LI4, LI5, LI6	LI1, LI2, LI4, LI5, LI6
Jog positive	LI1, LI2, LI4, LI5, LI6			
Jog negative	LI1, LI2, LI4, LI5, LI6			
Jog fast/slow	LI1, LI2, LI4, LI5, LI6			

1) signal input cannot be configured.

Parameter Name Code HMI menu, Code	Description	Unit Minimum value Default value Maximum value	Data type R/W persistent Expert	Parameter address via fieldbus
IOfunct_LI1 LI1 I-O-*Lı 1*	Function input LI1(7-31) **1 / No function / free available / nonE**: no function / freely available **6 / Enable positive motor move / posM**: release positive motor movement **7 / Enable negative motor move / negM**: release negative motor movement **8 / Speed limitation / nLiM**: speed limitation to parameter value **9 / JOG positive / JoGn**: jog right **10 / JOG negative / JoGn**: jog left **11 / JOG fast/slow / JoGF**: jog fast/slow :	- - - -	UINT16 R/W per. -	Modbus 1794
IOfunct_LI2 LI2 I-O-*Lı 2*	Function input LI2(7-31) **1 / No function / free available / nonE**: no function / freely available **2 / Fault reset / Fres**: reset error message **6 / Enable positive motor move / posM**: release positive motor movement **7 / Enable negative motor move / negM**: release negative motor movement **8 / Speed limitation / nLiM**: speed limitation to parameter value **9 / JOG positive / JoGn**: jog right **10 / JOG negative / JoGn**: jog left **11 / JOG fast/slow / JoGF**: jog fast/slow :	- - - -	UINT16 R/W per. -	Modbus 1796
IOfunct_LI4 LI4 I-O-*Lı 4*	Function input LI4(7-31) **1 / No function / free available / nonE**: no function / freely available **4 / Halt / HALt**: Halt **6 / Enable positive motor move / posM**: release positive motor movement **7 / Enable negative motor move / negM**: release negative motor movement **8 / Speed limitation / nLiM**: speed limitation to parameter value **9 / JOG positive / JoGn**: jog right **10 / JOG negative / JoGn**: jog left **11 / JOG fast/slow / JoGF**: jog fast/slow :	- - - -	UINT16 R/W per. -	Modbus 1800
IOfunct_LI5 LI5 I-O-*Lı 5*	Function input LI5(7-31) **1 / No function / free available / nonE**: no function / freely available **6 / Enable positive motor move / posM**: release positive motor movement **7 / Enable negative motor move / negM**: release negative motor movement **8 / Speed limitation / nLiM**: speed limitation to parameter value **9 / JOG positive / JoGn**: jog right **10 / JOG negative / JoGn**: jog left **11 / JOG fast/slow / JoGF**: jog fast/slow :	- - - -	UINT16 R/W per. -	Modbus 1802

Parameter Name Code HMI menu, Code	Description	Unit Minimum value Default value Maximum value	Data type R/W persistent Expert	Parameter address via fieldbus
IOfunct_LI6 LI6 I-O-*Lı 6*	Function input LI6(7-31) **1 / No function / free available / nonE**: no function / freely available **6 / Enable positive motor move / posM**: release positive motor movement **7 / Enable negative motor move / negM**: release negative motor movement **8 / Speed limitation / nLiM**: speed limitation to parameter value **9 / JOG positive / JoGn**: jog right **10 / JOG negative / JoGn**: jog left **11 / JOG fast/slow / JoGF**: jog fast/slow :	- - - - -	UINT16 R/W per. -	Modbus 1804

7.6.7.3 Description of functions of the signal outputs

No function / free available The "No function / free available" function has the option of setting an output directly with the parameter IO_LO_set.

No fault The function shows the error status, see 7.3.3 "Displaying the operating states".

Active The function shows the operating status "Operation enable", see 7.3.3 "Displaying the operating states".

Motor move disable The function shows whether a reference value is preset in a blocked direction of rotation. The function "Enable positive motor move" or "Enable negative motor move" must be configured for this.

In position window The function monitors whether the motor is within a specific position deviation for a specific time. The position deviation determines the variation between the reference value default and the actual value. The parameter SPVp_DiffWin is used to define the position deviation. The parameter SPVChkWinTime is used to define the time.

In speed window The function monitors whether the motor is within a specific speed deviation for a specific time. The speed deviation determines the variation between the reference value default and the actual value. The parameter SPVn_DiffWin is used to define the speed deviation. The parameter SPVChkWinTime is used to define the time.

Speed threshold reached The function shows whether the motor is below a specific speed value for a specific time. The parameter SPVn_Threshold is used to define this speed value. The parameter SPVChkWinTime is used to define the time.

Current threshold reached The function shows whether the motor is below a specific current value for a specific current value. The parameter SPVi_Threshold is used to set this current value. The parameter SPVChkWinTime is used to define the time.

Halt acknowledge The function shows that the function "Halt" was triggered and the motor is at standstill.

Brake release The function offers the option of using the signal as a control signal for a holding brake controller, see 7.3.3 "Displaying the operating states".
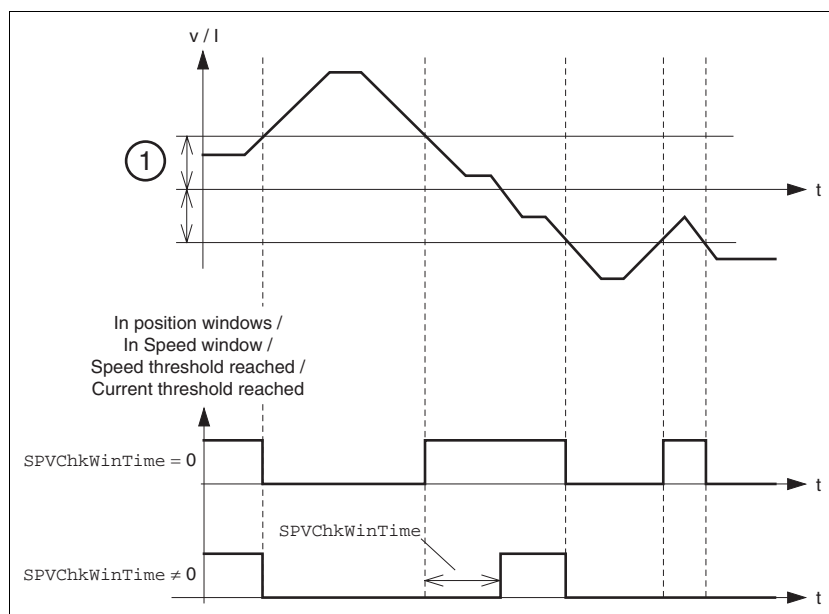
Figure 7.13   Outpusignals depending on `SPVChkWinTime`

(1)   Position deviation at "In position window"
            Speed deviation at "In speed window"
            Speed value at "Speed threshold reached"
            Current value at "Current threshold reached"

Parameter Name Code HMI menu, Code	Description	Unit Minimum value Default value Maximum value	Data type R/W persistent Expert	Parameter address via fieldbus
IO_LO_set -	Setting digital outputs directly() Write access to output bits is only effective if the signal pin exists as output and the function of the output was set to 'freely available'. Coding of the individual signals: Bit0: LO1_OUT Bit1: LO2_OUT ...	- -	UINT16 R/W - -	Modbus 2082
SPVChkWinTime WINT SET-ᶙᵢ nᵗ	Monitoring of time window() Setting of a time for the monitoring of position deviation, speed of rotation deviation, speed of rotation value and current value. If the control value for the set time is within the monitoring range, then the result of the monitoring is valid. The status can be output via a programmable output.	ms 0 0 9999	UINT16 R/W per. -	Modbus 1594

Parameter Name Code HMI menu, Code	Description	Unit Minimum value Default value Maximum value	Data type R/W persistent Expert	Parameter address via fieldbus
SPVp_DiffWin IN-P SET-ı n-P	Position deviation for "In position window"() It is checked whether the motor is below the deviation defined here for the time programmed via 'SPVChkWinTime'. The status can be output via a programmable output.	revolution 0.0000 0.0010 0.9999 **Fieldbus** 0 10 9999	UINT16 R/W per. -	Modbus 1586
SPVn_DiffWin IN-N SET-ı n-n	Speed deviation for "In speed window"() It is checked whether the motor is below the deviation defined here for the time programmed via 'SPVChkWinTime'. The status can be output via a programmable output.	1/min - - -	UINT16 R/W per. -	Modbus 1588
SPVn_Threshold NTHR SET-nthr	Speed value for "Speed threshold reached"() It is checked whether the motor is below the value defined here for the time programmed via 'SPVChkWinTime'. The status can be output via a programmable output.	1/min - - -	UINT16 R/W per. -	Modbus 1590
SPVi_Threshold ITHR SET-ı thr	Current value for "Current threshold reached"() It is checked whether the motor is below the value defined here for the time programmed via 'SPVChkWinTime'. The status can be output via a programmable output. As a comparative value the value from the parameter '_Idq_act' is used.	A_{pk} 0.00 0.00 99.99 **Fieldbus** 0 0 9999	UINT16 R/W per. -	Modbus 1592

7.6.7.4 Configuration of signal outputs

The parameters `IOfunct_LO1` to `IOfunct_LO4` can be used to assign functions to the digital outputs.

The table below shows an overview of the functions depending on the start-up operating mode.

Function	Jog	Electronic gear	Speed control	Current control
No function / free available	•	•	•	•
No fault	•	•	•	•
Active	•	•	•	•
Motor move disable	•	•	•	
In position window		•		
In speed window	•	•	•	
Speed threshold reached	•	•	•	•
Current threshold reached				•
Halt acknowledge	•	•	•	•
Brake release	•	•	•	•

"•" means that the function is available at `LO1_OUT`, `LO2_OUT`, `LO3_OUT` and `LO4_OUT`.

Parameter Name Code HMI menu, Code	Description	Unit Minimum value Default value Maximum value	Data type R/W persistent Expert	Parameter address via fieldbus
IOfunct_LO1 LO1 I-O-*Lo1*	Function output LO1_OUT() **1 / No function / free available / nonE**: no function / freely available **2 / No fault / nFlt**: no error **3 / Active / Acti**: operating readiness **4 / Motor move disable / MdiS**: direction of motion blocked **5 / In position window / in-p**: position deviation within window **6 / In speed window / in-n**: speed of rotation deviation within window **7 / Speed threshold reached / itHr**: motor speed of rotation below programmed value **8 / Current threshold reached / ctHr**: motor current below programmed value **9 / Halt acknowledge / HALT** Halt validation **10 / Brake release / Brak**: actuation of holding brake	- - - -	UINT16 R/W per. -	Modbus 1810

Parameter Name Code HMI menu, Code	Description	Unit Minimum value Default value Maximum value	Data type R/W persistent Expert	Parameter address via fieldbus
IOfunct_LO2 LO2 I-O-*Lo2*	Function output LO2_OUT() **1 / No function / free available / nonE**: no function / freely available **2 / No fault / nFlt**: no error **3 / Active / Acti**: operating readiness **4 / Motor move disable / MdiS**: direction of motion blocked **5 / In position window / in-p**: position deviation within window **6 / In speed window / in-n**: speed of rotation deviation within window **7 / Speed threshold reached / itHr**: motor speed of rotation below programmed value **8 / Current threshold reached / ctHr**: motor current below programmed value **9 / Halt acknowledge / HALT** Halt validation **10 / Brake release / Brak**: actuation of holding brake	- - - -	UINT16 R/W per. -	Modbus 1812
IOfunct_LO3 LO3 I-O-*Lo3*	Function output LO3_OUT() **1 / No function / free available / nonE**: no function / freely available **2 / No fault / nFlt**: no error **3 / Active / Acti**: operating readiness **4 / Motor move disable / MdiS**: direction of motion blocked **5 / In position window / in-p**: position deviation within window **6 / In speed window / in-n**: speed of rotation deviation within window **7 / Speed threshold reached / itHr**: motor speed of rotation below programmed value **8 / Current threshold reached / ctHr**: motor current below programmed value **9 / Halt acknowledge / HALT** Halt validation **10 / Brake release / Brak**: actuation of holding brake	- - - -	UINT16 R/W per. -	Modbus 1814
IOfunct_LO4 LO4 I-O-*Lo4*	Function output LO4_OUT() **1 / No function / free available / nonE**: no function / freely available **2 / No fault / nFlt**: no error **3 / Active / Acti**: operating readiness **4 / Motor move disable / MdiS**: direction of motion blocked **5 / In position window / in-p**: position deviation within window **6 / In speed window / in-n**: speed of rotation deviation within window **7 / Speed threshold reached / itHr**: motor speed of rotation below programmed value **8 / Current threshold reached / ctHr**: motor current below programmed value **9 / Halt acknowledge / HALT** Halt validation **10 / Brake release / Brak**: actuation of holding brake	- - - -	UINT16 R/W per. -	Modbus 1816

7.6.8 Reversal of direction of rotation

The parameter POSdirOfRotat can be used to change the direction of rotation of the motor. Note that changing the parameter value will only be effective after switching the device off and on again.

Parameter Name Code HMI menu, Code	Description	Unit Minimum value Default value Maximum value	Data type R/W persistent Expert	Parameter address via fieldbus
POSdirOfRotat PROT DRC-*Prot*	Definition of direction of rotation(7-40) **0 / clockwise / clw**: Clockwise **1 / counter clockwise / cclw**: Counterclock-wise Interpretation: The drive rotates clockwise with positive speeds, looking onto the motor shaft at the flange. IMPORTANT: A change of the setting is not activated until the unit is switched on again	- 0 0 1	UINT16 R/W per. -	Modbus 1560

If the direction of rotation of the motor must be reversed, all parameter values can be imported unchanged.

The absolute position of the motor is changed by reversing the direction of rotation _p_absworkusr,which is read from the encoder, and the actual position calculated by the device _p_actusr.

The direction of rotation should therefore be set at commissioning to the state which will be required later for the operation of this motor.

7.6.9 Restoring default values

7.6.9.1 Restore status after "First Setup"

The parameter `PARuserReset` is used to restore the status after "First setup".

Parameter Name Code HMI menu, Code	Description	Unit Minimum value Default value Maximum value	Data type R/W persistent Expert	Parameter address via fieldbus
PARuserReset -	Resetting the user parameters(7-41) 1: Set the user parameters to default values. All parameters are reset, with the exception of: - communications parameters - definition of direction of rotation - signal selection of position interface - device control - logic type - start-up operating mode for 'Local Control Mode' - IO functions IMPORTANT: The new settings are not backed up to the EEPROM!	- 0 - 1	UINT16 R/W - -	Modbus 1040

All parameter values set by the user are lost during this process.
It is possible at any time to save all parameter values set for a device as a configuration using the commissioning software.

7.6.9.2 Restore factory settings

The parameter `PARfactorySet` is used to restore the factory settings. All parameter values are reset to the default values.

▶ Remove the connection to the fieldbus in order to avoid conflicts by simultaneous access.

Parameter Name Code HMI menu, Code	Description	Unit Minimum value Default value Maximum value	Data type R/W persistent Expert	Parameter address via fieldbus
PARfactorySet FCS DRC-FCS	Restore factory settings (default values)(7-41) 1: Set all parameters to default values and back up in the EEPROM. A factory setting can be triggered by HMI or commissioning software. The storing process is complete if a 0 is returned when reading the parameters. IMPORTANT: The default state only becomes active at the next start-up.	- 0 - 3	R/W - -	

Factory setting via HMI	▶ Set *drC* and then *FCS* on the HMI and confirm your selection with *YES*.

All parameter values are reset to the default values. See "First Setup", page 6-11
The new settings only become effective after switching off and switching on the device again.

Factory settings via commissioning software	The factory settings are set via the menu points Configuration => Factory Settings. All parameter values are reset to the default values. See "First Setup", page 6-11
The new settings only become effective after switching off and switching on the device again.

> **i** *All parameter values set by the user are lost during this process.*
> *It is possible at any time to save all parameter values set for a device as a configuration using the commissioning software.*

7.6.9.3 Duplicate existing device settings

Application and advantage	• Multiple devices should have the same settings, e.g. when devices are replaced.
• "First setup" does not need to be carried out using the HMI.
Requirements	Device type, motor type and device firmware must be identical. The tool is the Windows-based commissioning software. The controller supply voltage must be switched on at the device.
Export device settings	The commissioning software installed on a PC can apply the settings of a device as configuration.
▶ Load the configuration of the device into the commissioning software with "Action - Transfer".
▶ Highlight the configuration and select "File - Export".
Import device settings	A stored configuration can be imported into a device of the same type. Please note that the fieldbus address is also copied with this information.
▶ In the commissioning software select the menu item "File - Import" and load the desired configuration.
▶ Highlight the configuration and select "Action - Configure".

8 Examples

8.1 Wiring example
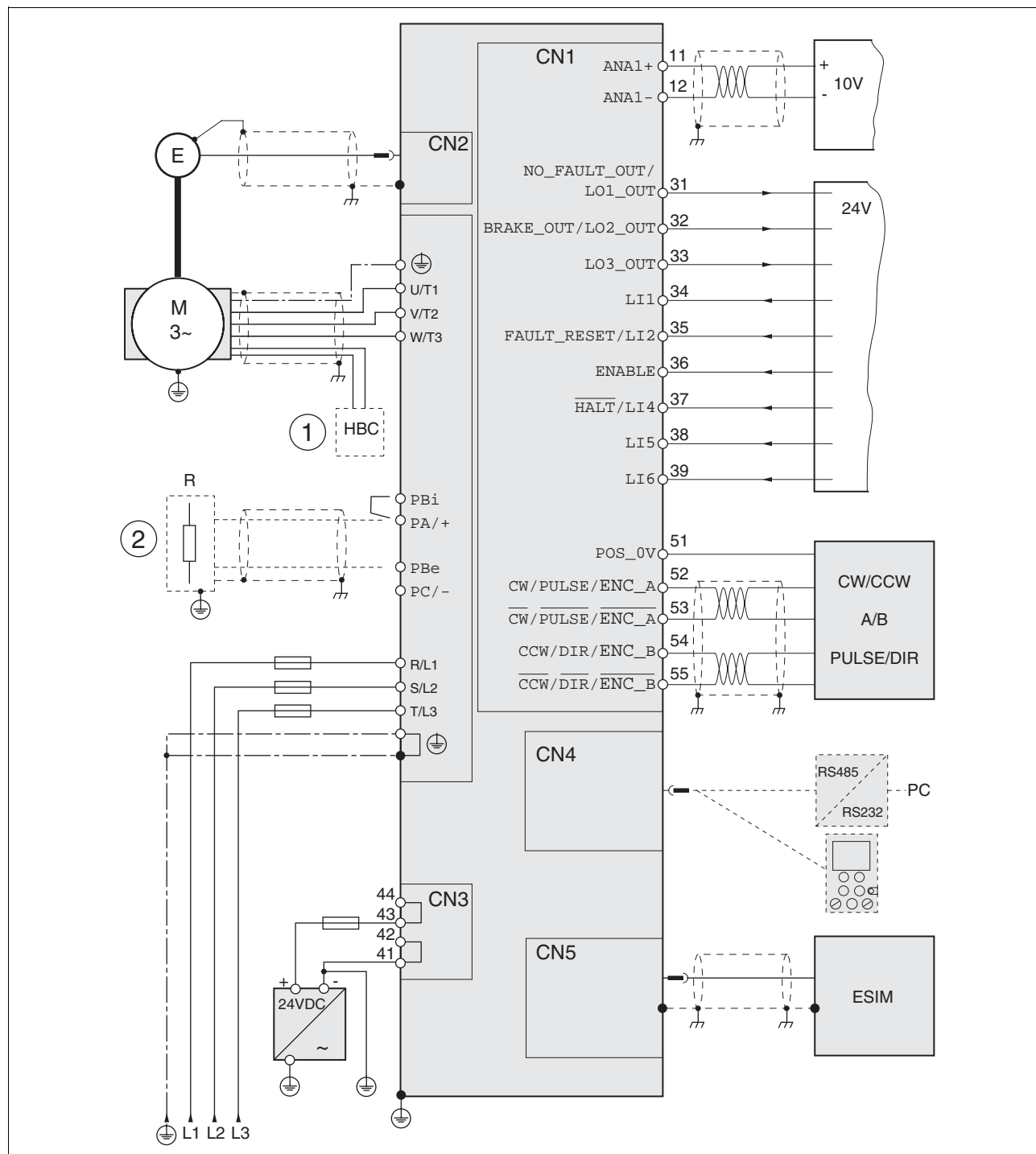
Figure 8.1 Wiring example

(1) Optional: Holding brake controller
(2) Optional: external braking resistor

8.2 Settings as examples

The following examples show settings for the current control, speed control and Pulse control modes. The reference value default is set via the analogue input.

The parameters are set on the HMI in the following examples.

Requirements:

- The motor shaft should not yet be coupled with the system mechanism.

- The analogue inputs are already wired up.

- The "First Setup" and the settings for the basic parameters and limiting values have been carried out during commissioning.

- The power amplifier is ready to switch on, i.e the status display on the HMI shows *rdY*.

Example A: Current control
▶ Set the default operating mode to current control. Under *drC- / i o-N* select the entry *Curr*

▶ The set current should be preset to 200 mA at 10V using ANA1+. Select under *SEt- / A i5* the value *0.20*.

▶ Start the motor for this (input signal $\overline{\text{ENABLE}}$). Set ANA1+ to maximum. Read off the speed value under *StA- / nACt*.

▶ Check the actual current value. Read off the value under *StA- / i ACt*.

Example B: Speed control
▶ Set the default operating mode to speed control. Under *drC- / i o-N* select the entry *SPEd*

▶ The motor speed should be preset to 1500 r.p.m. at 10V using ANA1+. Select under *SEt- / A in5* the value *1500*.

▶ Start the motor for this (input signal $\overline{\text{ENABLE}}$). Set ANA1+ to maximum. Read off the current value under *StA- / i ACt*.

▶ Check the current speed. Read off the value under *StA- / nACt*.

Example C: Pulse control
▶ Set the default operating mode to Pulse control. Under *drC- / i o-N* select the entry *PuL5*.

▶ The gear ratio should be selected from a list of presets and should be 2000. Select under *SEt- / GFAC* the value *2000*.

▶ Check the current speed. Input the reference signals (CW/CCW, pulse/direction or A/B) at the CN1 interface and start the motor (input signal $\overline{\text{ENABLE}}$). Read off the value under *StA- / nACt*.

9   Diagnostics and troubleshooting

⚠ **DANGER**
Electric shock, fire or explosion
• Only qualified personnel who are familiar with and understand the contents of this manual are authorised to work on and with this drive system.
• The system manufacturer is responsible for compliance with all applicable regulations relevant to earthing the drive system.
• Many components, including printed wiring boards, operate at mains voltage. **Do not touch**. Do **not** touch unshielded components or screws of the terminals with voltage present.
• Install all covers and close the housing doors before applying power.
• The motor generates voltage when the shaft is rotated. Lock the shaft of the motor to prevent rotation before starting work on the drive system.
• Before working on the drive system:
– Switch off power to all terminals.
– Place a sign "DO NOT SWITCH ON" on the switch and lock to prevent switching on.
– **Wait 6 minutes** (for discharge of DC bus capacitors). Do **not** short-circuit DC bus
– Measure voltage at DC bus and check for <45V. (The DC bus LED is not a safe indication for absence of the DC bus voltage).
Failure to follow these instructions will result in death or serious injury.

9.1   Service

If you cannot resolve the fault yourself please contact your appointed sales partner. Have the following details available:

• Type, identification number and serial number of the product (type plate)

• Type of fault (possibly with fault number)

• Previous and concurrent conditions

• Your own ideas regarding the cause of the fault

Include this information if you return the product for inspection or repair.

9.2 Error responses and error classes

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

Error class	Response	Description
0	Warning	Message only, no interruption of movement mode.
1	Quick Stop	Motor stops with "Quick Stop", power amplifier and controller remain switched on and active.
2	Quick Stop with switch-off	Motor stops with "Quick Stop", power amplifier and controller switch off when at standstill.
3	Fatal error	Power amplifier and controller switch off immediately, without stopping the motor first.
4	Uncontrolled operation	Power amplifier and controller switch off immediately, without stopping the motor first. Error response can only be reset by switching the device off.

The occurrence of an event is signalled by the device as follows:

Event	Status	HMI-display	Entry for last interruption cause (_StopFault)	Entry in error memory
Halt	Operation Enabled	*hALt*	-	-
Error with error class 1, e.g. tracking error with error class 1	Quick Stop active	*StoP A320*	E A320	E A320
Error with error class>1, e.g. tracking error with error class 3	Fault	*FLt A320*	E A320	E A320

9.3 Error display

The last cause of interruption and the last 10 error messages are stored. The HMI allows the last cause of interruption to be displayed; the commissioning software and the fieldbus allow, in addition to the last cause of interruption, the last 10 error messages also to be displayed. A description of all the error numbers can be seen from page 9-9.

9.3.1 State diagram

After switching on and at the start of an operating mode, a sequence of operating states is progressed through.

The relationship between the operating states and the state transitions is shown in the state diagram (state machine).

The operating states are internally monitored and influenced by monitoring and system functions, such as temperature and current monitoring

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

Figure 9.1   Status diagram

Operating states   The operating states are displayed as standard by the HMI and the commissioning software.

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Display	Status	State description
ınıt	**1** Start	Controller supply voltage, electronics is initialised
nrdY	**2** Not ready to switch on	The power amplifier is not ready to switch on [1]
dıS	**3** Switch on disabled	Switching on the power amplifier is disabled
rdY	**4** Ready to switch on	The power amplifier is ready to switch on
Son	**5** Switched on	Motor not under current Power amplifier ready No operating mode active
run hALt	**6** Operation enable	RUN: device running in the selected operating mode HALT: The motor is stopped with active power amplifier
StoP	**7** Quick Stop active	"Quick Stop" is executed
FLt	**8** Fault Reaction active	Error detected, error response is enabled
FLt	**9** Fault	device is in fault condition

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

Status transitions Status transitions are triggered by an input signal or as a response to a monitoring signal.

Transi-tion	Operating status	Condition / result [1]	Response
T0	**1** -> **2**	• Motor speed below switch-on limit • device electronics successfully initialised	Check motor encoder
T1	**2** -> **3**	• First commissioning is completed	-
T2	**3** -> **4**	• Motor encoder check successful, DC bus voltage active, actual speed: <1000 1/min	-
T3	**4** -> **5**	• Input signal ENABLE 0 -> 1	
T4	**5** -> **6**	• Automatic transition if input signal ENABLE still set	Activate power amplifier motor phases, earth, user parameters are checked release brake
T7	**4** -> **3**	• DC bus undervoltage • Actual speed: >1000 1/min (e.g. by auxiliary drive)	-
T9	**6** -> **3**	• Input signal ENABLE 1 -> 0	Deactivate power amplifier immediately
T10	**5** -> **3**	• Input signal ENABLE 1 -> 0	
T11	**6** -> **7**	• Class 1 error	Interrupt travel command with "Quick Stop"
T12	**7** -> **3**	• Input signal ENABLE 1 -> 0	Deactivate power amplifier immediately, even if "Quick Stop" still active
T13	**x** -> **8**	• Errors Class 2, 3 or 4	Error response is carried out, see "error response"
T14	**8** -> **9**	• Error response completed • 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"	Specified operating mode is automatically continued (cause of error must be corrected).

1) It is sufficient to fulfil one point to trigger the status transition

9.3.2   Error display on HMI

State display ULoU The display shows ULoU (ULOW) when initialised. The voltage of the control supply is too low .

▶ Check the control supply.

State display nrdY The product persists in switch-on state nrdY (NRDY).

▶ After "First Setup", you need to switch the unit off and switch it on again.

▶ Check the installation.
If the installation is correct, then there is an internal fault. To diagnose, read the error memory using the commissioning software. If you cannot resolve the fault yourself please contact your local sales partner.

Status display diS If the product remains in the status diS (DIS), there is no DC bus voltage.

▶ Check the following:

• Check the installation of the analogue and digital signal connections. Pay particular attention to the minimum assignment, see page 5.3.13 "Connection of digital inputs/outputs (CN1)".

• Is the mains voltage to the power amplifier switched on and does the voltage correspond to the details in the technical data?

Status display FLt The display flashes alternately with FLt (FLT) and a 4 digit error number. The error number can also be found in the error memory list.

▶ Check especially:

• Is a suitable motor connected?

• Is the motor encoder cable correctly wired and connected? The device cannot correctly start up the motor without a motor encoder signal.

Status display StoP The HMI displays StoP (STOP) when a "Quick Stop" has been triggered. This can be caused by a software stop, a hardware limit switch or by an error of error class 1.

▶ Correct the cause of the error and reset the error message.

State display WdoG The display shows WdoG (WDOG) when initialised. The internal monitor has sensed a fault by means of the Watchdog.

▶ Contact the Technical Support of your local sales partner. Advise the peripheral conditions (operating mode, application event) when the fault occurs:

▶ The error can be reset by switching the unit off and on again.

Last cause of interruption ▶ Press the ENT button on the HMI to reset the current error message.

▶ Change to the FLt menu. The last cause of interruption (parameter) _StopFault) is displayed as an error number, see .

9.3.3   Error display with commissioning software

■ You will need a PC with the commissioning software and a functional connection to the product, see 5.3.17 "Connection to PC or remote terminal (CN4)" from page 5-44.

▶ Select "Diagnosis error memory". A dialogue box which displays the error messages appears.

The commissioning software shows a 4 digit error number in the list of the error memory with an "E" in front.

Error messages are displayed showing status, error class, time when 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 current error message with the "reset" button in the command bar of the program.
In the case of class 4 errors, you will need to switch off the controller supply voltage and switch it on again.

9.4   Troubleshooting

9.4.1   Resolution of malfunctions

Malfunction	Cause	Correction
Motor not turning	Motor blocked by brake	Release holding brake, check wiring
	Break in the motor cable	Check motor cable and connection. One or more motor phases are not connected.
	No torque	Set the parameters for max. current, max. speed to greater than zero
	Incorrect operating mode selected	Set the input signal and parameters for the operating mode you want
	Drive system switched off	Switch on drive system, generate release signal
	Motor phases reversed	Correct the sequence of the motor phases
	Motor mechanically blocked	Check ancillary devices
	Current limiting activated ()	Correct the current limit
The motor jerks briefly	Motor phases reversed	Check motor cable and connection: connect motor phases U, V and W in the same way on the motor and device sides
Motor vibrating	Amplification factor KP too high	reduce KP (speed controller)
	Fault in the motor encoder system	Check motor encoder
Motor running too soft	Integration time TNn too high	Reduce Tn (speed controller)
	Amplification factor KPn too low	Increase KPn (speed controller)
Motor running too rough	Integration time TNn too low	Increase TNn (speed controller)
	Amplification factor KPn too high	Reduce KPn (speed controller)
Error message communication error	Drive system switched off	Switch on the drive system
	Wiring error	Check wiring
	Wrong PC interface selected	Select correct interface

9.4.2   Error resolution sorted by error bit

For an improved overview when troubleshooting, all error numbers are categorised with so-called error bits. The error bit can be read in the parameter `_SigLatched`. The signal state "1" marks an error or warning message.

Error bit	Description	Error class	Cause	Troubleshooting
0	General error	0		
2	Area of travel exceeded (software limit switch, tuning range)	1	Motor outside area of travel	Check area of travel, re-reference the drive
3	"Quick Stop" by fieldbus	1	fieldbus command	
5	reserved			
6	RS485 error, commissioning software communication		Interruption of the communication, only with RS485 e.g. commissioning software	Check communication cables
8	reserved			
9	Reference signals faulty (frequency too high)		frequency too high, malfunction	EMC measures, maintain maximum frequency (technical data)
10	Error in processing of the current operating mode	2	Processing error in Pulse control, reference movement or jog mode.	Detailed information see under additional information in the error memory
11	reserved			
13	reserved			
14	DC bus undervoltage	2	DC bus voltage under threshold value for "Quick Stop"	Check or increase mains voltage
		3	DC bus voltage under threshold value for switch-off of the drive	Check for power failure
15	DC bus overvoltage	3	DC bus overvoltage, braking too fast	Extend braking, Apply external brake resistor
16	Power supply faulty (phase fault, earth fault)	par. [1]	Short circuit or earth fault	Check fuse and installation
			Supply voltage connected incorrectly (e.g. 1-phase instead of 3-phase)	
17	Connection to motor (motor phase interrupted, earth fault, commutation)	3	Short circuit or earth fault in the motor wiring or encoder wiring. Motor faulty. External torque exceeds the motor torque (preset motor current too low).	Check connections, change motor cable or encoder cable. Change motor. Reduce external torque or increase the setting of the motor current.
18	Motor overload (phase current too high)	3	I^2t monitoring for motor	Reduce load, use a motor with a higher nominal power
19	Encoder in motor signals error or connection to encoder faulty	3-4	No signal from the motor encoder, encoder faulty	Check encoder cable and encoder, replace cable
20	undervoltage from controller supply voltage		Controller supply voltage has fallen below the minimum value	Secure controller supply voltage. Check short-term voltage failures during load changes

Error bit	Description	Error class	Cause	Troubleshooting
21	Temperature too high (power amplifier, braking resistor or motor)	3	The power amplifier is overheating	Fan faulty or blocked, switch on time for peak current, reduce load or peak torque
			Motor is overheating Temperature sensor not connected	Allow motor to cool down, reduce load, use motor with greater nominal power, temperature sensor faulty, check/change motor and encoder cables
22	Tracking error	par. [1] 1-3	Tracking error	Reduce external load or acceleration, error response is adjustable via "Flt_pDiff"
23	Maximum speed exceeded		Exceeding the maximum motor speed during feed operations	Reduce vertical loading
25..28	reserved			
29	error in EEPROM	3-4	Checksum in EEPROM incorrect	"First setup" to be carried out, user parameters to be stored in the EEPROM, consult your local sales partner
30	system run-up faulty (hardware or parameter fault)	3-4	Cause of error in accordance with error display	Resolution dependent upon error display
31	Internal system error (e.g. Watchdog)	4	Internal system error	Switch device off and on, replace device
			System error e.g. division by 0 or time-out checks, inadequate EMC	Comply with EMC protective measures, switch device off and on, contact your local service representative

1) par. = configurable

9.5   Table of error numbers

The cause of error for each error message is stored coded as an error number in the parameter FLT_err_num. The following table shows all the error numbers and their meaning If "par." is shown under the error class, then the error class is can be set as a parameter. Please note that in the HMI, the error number is shown without the preceding "E".

The error numbers are structured:

Error number	Error in range
E 1xxx	General error
E 2xxx	Excess current error
E 3xxx	Voltage error
E 4xxx	Temperature error
E 5xxx	Hardware error
E 6xxx	Software error
E 7xxx	Interface error, wiring error
E Axxx	Drive error, movement error
E Bxxx	Communication error

Information on error class can be found on page 9-2.
Information on error bits and measures for correcting errors can be found on page 9-8.

Error number	Class	Bit	Description
E 1100	0	0	parameter out of permissible range
E 1101	0	0	parameter does not exist
E 1102	0	0	parameter does not exist
E 1103	0	0	parameter write not permissible (READ only)
E 1104	0	0	write access denied (no access authorisations)
E 1106	0	0	Command not allowed while power amplifier is active
E 1107	0	0	Access via other interface blocked
E 1108	0	0	parameter not readable (Block Upload)
E 1109	1	0	Data that are saved following a power failure are invalid
E 110A	0	0	System error: boot loader not present
E 110B	3	30	Initialisation error (additional info=modbus register address)
E 110D	1	0	Basic configuration of controller required after factory setting.
E 110E	0	0	Parameters are changes that are only active after restarting the controller
E 1310	3	9	Reference signal frequency too high
E 1311	0	0	The selected input or output function cannot be configured
E 1312	0	0	Limit or reference switch signal in I/O functions not defined
E 1603	0	0	Capture memory occupied by other function
E 1606	0	0	Recording still active
E 1607	0	0	Recording: no trigger defined
E 1608	0	0	Recording: trigger option not permissible
E 1609	0	0	Recording: no channel defined
E 160A	0	0	Recording: no data present
E 160B	0	0	parameter not recordable
E 160C	1	0	Autotuning: moment of inertia outside permissible range
E 160D	1	0	Autotuning: the value of parameter 'AT_n_tolerance' may be too low for the identified mechanical system
E 160E	1	0	Autotuning: Test movement could not be started
E 160F	1	0	Autotuning: Power amplifier cannot be enabled
E 1610	1	0	Autotuning: Processing discontinued
E 1611	1	0	System error: Autotuning internal write access
E 1612	1	0	System error: Autotuning internal read access
E 1613	1	0	Autotuning: max. permissible positioning range exceeded
E 1614	0	0	Autotuning: already active
E 1615	0	0	Autotuning: this parameter cannot be changed while autotuning is active
E 1616	1	0	Autotuning: static friction for selected speed jump height 'AT_n_ref' too high
E 1617	1	0	Autotuning: Frictional or load moment too great
E 1618	1	0	Autotuning: optimisation aborted
E 1619	0	0	Autotuning: the speed jump height 'AT_n_ref' is too small compared to 'AT_n_tolerance'
E 1620	1	0	Autotuning: load torque too high
E 1A00	0	0	System error: FIFO memory overflow

Error number	Class	Bit	Description
E 1A01	3	19	motor has been changed
E 1A02	3	19	motor has been changed
E 1B00	4	31	System error: faulty parameter for motor or power amplifier
E 1B01	3	30	User parameter max. speed of rotation too high
E 1B02	3	30	User parameter max. current, holding current or Quick Stop current too high
E 1B03	4	30	Encoder is not supported by current operating system
E 1B04	3	30	ESIM resolution too high with selected n_max
E 2300	3	18	power amplifier overcurrent
E 2301	3	18	braking resistor overcurrent
E 3100	par.	16	mains power supply phase fault
E 3200	3	15	DC bus overvoltage
E 3201	3	14	DC bus undervoltage (switch-off threshold)
E 3202	2	14	DC bus undervoltage (Quick Stop threshold)
E 3203	4	19	Motor encoder supply voltage
E 3206	0	11	DC bus undervoltage, no mains phase (warning)
E 4100	3	21	Power amplifier overtemperature
E 4101	0	1	warning power amplifier overtemperature
E 4102	0	4	Power amplifier overload (I^2t) warning
E 4200	3	21	device overtemperature
E 4300	3	21	motor overtemperature
E 4301	0	2	warning motor overtemperature
E 4302	0	5	Motor overload (I^2t) warning
E 4402	0	6	Braking resistor overload (I^2t) warning
E 5200	4	19	Fault in connection to motor encoder
E 5201	4	19	errors in motor encoder communication
E 5202	4	19	Motor encoder is not supported
E 5203	4	19	Fault in connection to motor encoder
E 5204	3	19	Connection to motor encoder lost
E 5205	4	19	Connected motor (motor family) is not supported
E 5430	4	29	System error: EEPROM read error
E 5431	3	29	System error: EEPROM write error
E 5435	4	29	System error: EEPROM not formatted
E 5437	4	29	System error: EEPROM checksum error in manufacturer data
E 5438	3	29	System error: EEPROM checksum error in user-defined parameter
E 543A	4	29	System error: EEPROM hardware info invalid
E 543B	4	29	System error: EEPROM Manufacturer data invalid
E 543D	3	29	System error: EEPROM user parameter invalid
E 543E	3	29	System error: EEPROM checksum error NoInit parameter
E 5450	3	29	System error: error in program transfer to the FPGA
E 5600	3	17	motor connection phase fault

Error number	Class	Bit	Description
E 5601	4	19	Interruption or faulty encoder signals
E 5602	4	19	Interruption or faulty encoder signals
E 5603	4	17	Commutation error
E 6107	0	0	Parameters outside value range (calculation error)
E 6108	0	0	Function not available
E 6109	0	0	System error: internal range overflow
E 610A	2	0	System error: calculation value cannot be shown as 32-bit value
E 610D	0	0	Error in selection parameter
E 610E	4	28	System error: 24VDC has not reached PowerDown threshold
E 610F	4	30	System error: Internal time base failed (Timer0)
E 7120	4	19	Invalid motor data
E 7121	2	19	System error: errors in motor encoder communication
E 7122	4	30	Motor data not acceptable
E 7123	4	30	motor current offset outside permissible range
E 7124	4	19	System error: Motor encoder faulty
E 7126	0	19	No answer has been received yet
E 7200	4	30	System error: calibration of analogue/digital converter
E 7201	4	30	System error: motor encoder initialising (quadrant evaluation)
E 7327	4	19	System error: position sensor not ready
E 7328	4	19	Motor encoder sends: position capture errors
E 7329	0	8	Motor encoder sends: Warning
E 7330	4	19	System error: motor encoder (Hiperface)
E 7331	4	30	System error: Motor encoder initialisation
E 7333	4	30	System error: Discrepancy during calibration of analogue/digital converter
E 7334	0	0	System error: Analogue/digital converter offset too big
E 7335	0	8	Communication to motor encoder occupied
E 7336	3	0	Offset with Sincos drift compensation too high
E 7337	1	8	Offset could not be successfully written
E 7338	0	13	No valid motor absolute position
E 7400	0	31	System error: illegal interrupt (XINT2)
E 7500	0	9	RS485/Modbus: overrun error
E 7501	0	9	RS485/Modbus: framing error
E 7502	0	9	RS485/Modbus: Parity-error
E 7503	0	9	RS485/Modbus: receive error
E 7601	4	19	System error encoder type is not supported
E A060	2	10	Calculation error with Pulse control
E A061	2	10	Change in reference value with Pulse control too great
E A300	0	0	Braking procedure after stop request still active
E A301	0	0	Drive in status 'QuickStopActive'
E A305	0	0	Power amplifier cannot be activated in current operating status of status machine

Error number	Class	Bit	Description
E A306	1	3	Interruption by user initiated software stop
E A307	0	0	Interruption by internal software stop
E A308	0	0	Drive in 'Fault' status
E A309	0	0	Drive not in 'OperationEnable' status
E A310	0	0	Power amplifier not active
E A312	0	0	Profile generating interrupted
E A313	0	0	Position overrun (pos_over=1), reference point is therefore no longer defined (ref_ok=0)
E A314	0	0	No reference position
E A316	0	0	Overflow on acceleration calculation
E A317	0	0	Drive not at standstill
E A318	0	0	Operating mode active (x_end = 0)
E A319	1	2	Manual/Autotuning: distance range overflow
E A31A	0	0	Manual/Autotuning: amplitude/offset set too high
E A31B	0	0	HALT requested
E A31D	0	0	Speed range overflow (CTRL_n_max)
E A320	par.	22	position tracking error
E A321	0	0	RS422 position interface not defined as input signal
E A322	0	0	error in ramp calculation
E A331	3	0	No run-up operating mode with local control mode selected
E A332	1	10	Error with jog (additional info = detailed error number)
E A334	2	0	Timeout at Standstill window monitor
E A337	0	10	Operating mode cannot be continued
E A338	0	0	mode dies not exist
E B100	0	9	RS485/Modbus: unknown service
E B200	0	9	RS485/Modbus: Protocol error
E B201	2	6	RS485/Modbus: Nodeguard error
E B202	0	9	RS485/Modbus: Nodeguard Warning
E B203	0	9	RS485/Modbus: number of monitor objects incorrect
E B204	0	9	RS485/Modbus: service too long

10 Parameters

This chapter provides an overview of the parameters which can be addressed for the operation of the product.

⚠ **WARNING**

Unintentional behaviour due to parameters

The behaviour of the drive system is governed by numerous parameters. Improper parameter values can trigger unintentional movements or signals or deactivate monitoring functions.

- Change only parameters whose meaning you understand.

- Only start the system if there are no persons or materials in the danger zone and the system can be operated safely.

- When commissioning carefully run tests for all operating statuses and fault cases.

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

10.1 Representation of the parameters

The parameter display contains, on the one hand, information which is needed for positive identification of a parameter. On the other hand, the parameter display can also provide information on setting options, presets and parameter properties.

A parameter display has the following features:

Parameter Name Code HMI menu, Code	Description	Unit Minimum value Default value Maximum value	Data type R/W persistent Expert	Parameter address via fieldbus
Example_Name BSPI MENUE-*b5P,*	Example parameter (cross-reference) Details and selection values **1 / selection value1 / WRT1**: declaration 1 **2 / selection value2 / WRT2**: declaration 2	A_{pk} 0.00 3.00 300.00 **Fieldbus** 0 300 30000	UINT16 R/W per. -	Modbus 1234

The most important terms in the heading line of a parameter table are explained in the following.

Parameter Name   The parameter name is displayed with the commissioning software in the "Designation" column.

Code and HMI Code   The Code is represented on a 7 segment display on the HMI (HMI-Code).

Cross reference   If there is more information available for these parameters you can find this under this cross-reference.

Selection values   In the case of parameters which offer a selection of settings, the selection number via fieldbus and the designation of the values when inputting with commissioning software and HMI are quoted.

1	Selection value over the fieldbus
Selection value 1	Commissioning tool display
WRT1	HMI display

Default value   Factory settings.

Data type   The data type determines the valid range of values, especially when a parameter does not have explicit minimum and maximum values.

Data type	Byte	Min value	Max value
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   Note on reading and writing the values
"R/-" values are read-only
"R/W" values are read and write.

persistent   Designation of whether the value of the parameter is persistent, i.e. after switching off the unit it is retained in the memory. When changing a value via commissioning software or fieldbus, the user must explicitly store the value change in the persistent memory.

10.2 List of all parameters

Parameter Name Code HMI menu, Code	Description	Unit Minimum value Default value Maximum value	Data type R/W persistent Expert	Parameter address via fieldbus
_acc_pref -	Acceleration of setpoint generation() Advance sign corresponding to the change of the value for speed: Increase in speed: pos. advance sign Reduction in speed: neg. advance sign	(1/min)/s - 	INT32 R/- - -	Modbus 7954
_AccessInfo -	Current access channels for action objects(7-1) Low byte: 0: Occupied by the channel in High byte 1: Exclusively occupied by channel in High byte High byte: Current assignment of the access channel 0: reserved 1: IO 2: HMI 3: Modbus 4: CANopen 5: CANopen via second SDO channel 6: Profibus 7: DeviceNet	- - 	UINT16 R/- - -	Modbus 280
_actionStatus -	Action word(7-14) Signal state: 0: not activated 1: activated Bit0: Class 0 error Bit1 Class 1 error Bit2: Class 2 error Bit3 Class 3 error Bit4 Class 4 error Bit5 reserved Bit6: drive stopped (actual speed _n_act [1/min] < 9) Bit7: drive rotates in positive direction Bit8: drive rotates in negative direction Bit9: drive within position window (pwin) Bit10: reserved Bit11: Profile generator stopped (setpoint speed is 0) Bit12: Profile generator decelerating Bit13: Profile generator accelerating Bit14: Profile generator moves in constant mode Bit15: reserved	- - 	UINT16 R/- - -	Modbus 7176
_l2t_act_M -	Overload motor current(7-14)	% - 	INT16 R/- - -	Modbus 7218

Parameter Name Code HMI menu, Code	Description	Unit Minimum value Default value Maximum value	Data type R/W persistent Expert	Parameter address via fieldbus
_I2t_act_PA -	Overload power amplifier current(7-14)	% - 	INT16 R/- - -	Modbus 7212
_I2t_mean_M I2TM STA-ı $2t\Pi$	Motor load(7-14)	% - 	INT16 R/- - -	Modbus 7220
_I2t_mean_PA I2TP STA-ı $2tP$	Power amplifier load(7-14)	% - 	INT16 R/- - -	Modbus 7214
_I2t_peak_RES -	Overload braking resistor maximum value(7-14) Maximum overload braking resistor that has occurred in the last 10 sec.	% - 	INT16 R/- - -	Modbus 7210
_I2t_peak_M -	Overload motor maximum value(7-14) Maximum overload motor that has occurred in the last 10 sec.	% - 	INT16 R/- - -	Modbus 7222
_I2t_peak_PA -	Overload power amplifier maximum value(7-14) Maximum overload power amplifier that has occurred in the last 10 sec.	% - 	INT16 R/- - -	Modbus 7216
_I2tl_act_RES -	Actual overload braking resistor(7-14)	% - 	INT16 R/- - -	Modbus 7206
_I2tl_mean_RES I2TR STA-ı $2tr$	Braking resistor load(7-14)	% - 	INT16 R/- - -	Modbus 7208
_Id_act -	current motor current d components() in 0.01 Apk steps	A_{pk} 0.00 - 0.00	INT16 R/- - -	Modbus 7684
_Id_ref -	Set motor current d component (field weakening)() in 0.01 Apk steps	A_{pk} 0.00 - 0.00	INT16 R/- - -	Modbus 7714
_Idq_act IACT STA-ı $R\mathcal{L}t$	Total motor current (vector sum of d and q components() in 0.01 Apk steps	A_{pk} 0.00 - 0.00	INT16 R/- - -	Modbus 7686

Parameter Name Code HMI menu, Code	Description	Unit Minimum value Default value Maximum value	Data type R/W persistent Expert	Parameter address via fieldbus
_IO_act IOAC STA-ı ₒᴿᴵ	Physical status of the digital inputs and out-puts(6-19) Assignment of 24V inputs: Bit 0: JOG_N / LI1 Bit 1: JOG_P / FAULT_RESET / LI2 Bit 2: ENABLE Bit 3: JOG_F/S / HALT / LI4 Bit 4: LI5 Bit 5: LI6 Bit 6: reserved Bit 7: reservedassignment of 24V outputs: Bit 8: NO_FAULT_OUT / LO1 Bit 9: BRAKE_OUT / LO2 Bit10: LO3 Bit11: LO4	- -	UINT16 R/- - -	Modbus 2050
_IO_LI_act -	Status of the digital inputs() Coding of the individual signals: Bit0: LI1 Bit1: LI2 ...	- -	UINT16 R/- - -	Modbus 2078
_IO_LO_act -	Status of the digital outputs() Coding of the individual signals: Bit0: LO1_OUT Bit1: LO2_OUT ...	- -	UINT16 R/- - -	Modbus 2080
_Iq_act -	current motor current q components() in 0.01 Apk steps	A_{pk} 0.00 - 0.00	INT16 R/- - -	Modbus 7682
_Iq_ref IQRF STA-ı ۹ᵣF	Set motor current q component (torque-crea-ting)() in 0.01 Apk steps	A_{pk} 0.00 - 0.00	INT16 R/- - -	Modbus 7712
_LastWarning -	Last warning as number() Number of the last warning generated. If the warning becomes inactive again, the number is retained until the next fault reset. Value 0: No warning generated	- -	UINT16 R/- - -	Modbus 7186
_n_act NACT STA-ₙᴿᴵᵗ	Actual speed of the motor(7-14)	1/min - -	INT16 R/- - -	Modbus 7696
_n_actRAMP -	Actual speed of the travel profile genera-tor(7-14)	1/min - -	INT32 R/- - -	Modbus 7948

Parameter Name Code HMI menu, Code	Description	Unit Minimum value Default value Maximum value	Data type R/W persistent Expert	Parameter address via fieldbus
_n_I_act -	Optimised read access to current values of speed of rotation and current() High-Word: Actual speed _n_act [1/min] Low-Word: Actual current [Apk]	- -	INT32 R/- - -	Modbus 7726
_n_pref -	Speed of setpoint generation()	1/min -	INT32 R/- - -	Modbus 7950
_n_ref -	Setpoint speed of the speed controller()	1/min -	INT16 R/- - -	Modbus 7694
_n_targetRAMP -	Target speed of the travel profile generator()	1/min -	INT32 R/- - -	Modbus 7946
_OpHours OPH STA-oPh	Operating hours counter()	s -	UINT32 R/- - -	Modbus 7188
_p_absENCusr -	Absolute position based on motor encoder work stroke in user-defined units(6-24) Value range is set by encoder type With Singleturn motor encoders the value is set with reference to one motor revolution, with Multiturn motor encoders with reference to the total work stroke of the encoder (e.g. 4096 revs) IMPORTANT: Position is only valid after determination of the motor absolute position. With invalid motor absolute position: _WarnLatched _WarnActive Bit 13=1: absolute position of motor not yet detected	usr -	UINT32 R/- - -	Modbus 7710
_p_absmodulo -	Absolute position based on one motor revolution in internal units() IMPORTANT: Position is only valid after determination of the motor absolute position. With invalid motor absolute position: _WarnLatched _WarnActive Bit 13=1: absolute position of motor not yet detected	Inc -	UINT32 R/- - -	Modbus 7708

Parameter Name Code HMI menu, Code	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() IMPORTANT: Actual position of motor is only valid after determination of the motor absolute position. With invalid motor absolute position: _WarnLatched _WarnActive Bit 13=1: absolute position of motor not yet detected	Inc	INT32 R/- - -	Modbus 7700
_p_actPosintf -	Actual position at position interface() Counted position increments at RS422 signal interface CN5 if signal direction is defined as input (see parameter IOposInterface)	Inc -2147483648 - 2147483647	INT32 R/- - -	Modbus 2058
_p_actusr PACU STA-_PACu_	Actual position of the motor in user-defined units(7-14) IMPORTANT: Actual position of motor is only valid after determination of the motor absolute position. With invalid motor absolute position: _WarnLatched _WarnActive Bit 13=1: absolute position of motor not yet detected	usr -	INT32 R/- - -	Modbus 7706
_p_actRAMPusr -	Actual position of the travel profile generator(7-14) in user-defined units	usr -	INT32 R/- - -	Modbus 7940
_p_addGEAR -	Start position of electronic gear() With an inactive gearing the setpoint position can be calculated here at the position controller that was set when the gear was enabled with the selection 'Synchronisation with compensation movement'.	Inc	INT32 R/- - -	Modbus 7942
_p_dif PDIF STA-_Pdif_	Current variation between reference and actual position(7-14) Corresponds to the current control deviation of the position controller without consideration of any dynamic components. Note: difference from SPV_p_maxDiff	revolution -214748.3648 - 214748.3647 **Fieldbus** -2147483648 2147483647	INT32 R/- - -	Modbus 7716
_p_DifPeak -	Value of max. reached tracking errors of the position controller(7-14) The tracking error is the current position regulation offset minus the speed-dependent position regulation offset. Further information see SPV_p_maxDiff. A write operation resets the value again.	revolution 0.0000 - 429496.7295 **Fieldbus** 0 4294967295	UINT32 R/W - -	Modbus 4382
_p_ref -	Setpoint position in internal units() Value represents the setpoint position of the position controller	Inc	INT32 R/- - -	Modbus 7698

Parameter Name Code HMI menu, Code	Description	Unit Minimum value Default value Maximum value	Data type R/W persistent Expert	Parameter address via fieldbus
_p_refusr -	Setpoint position in user-defined units() Value represents the setpoint position of the position controller	usr -	INT32 R/- - -	Modbus 7704
_p_tarRAMPusr -	Target position of the travel profile generator() Absolute position value of the profile generator calculated from transferred relative and absolute position values. in user-defined units	usr -	INT32 R/- - -	Modbus 7938
_Power_act -	current output power()	W -	INT16 R/- - -	Modbus 7194
_Power_mean -	average output power()	W -	INT16 R/- - -	Modbus 7196
_prgNoDEV _PNR INF--*Pnr*	Firmware program number() Example: PR840.1 Value is entered decimally as: 8401	- 0.0 - 0.0	UINT16 R/- - -	Modbus 258
_prgVerDEV _PVR INF--*PⱓUr*	Firmware version() Example: V4.201 Value is entered decimally: 4201	- - - -	UINT16 R/- - -	Modbus 260
_serialNoDEV -	device serial number() Serial number: Unique number for identification of the product	- 0 - 4294967295	UINT32 R/- per. -	Modbus 302
_SigActive -	Current state of the monitoring signals(7-14) Meaning see _SigLatched	- -	UINT32 R/- - -	Modbus 7182

Parameter Name Code HMI menu, Code	Description	Unit Minimum value Default value Maximum value	Data type R/W persistent Expert	Parameter address via fieldbus
_SigLatched SIGS STA-5ı G5	Stored state of the monitoring signals(7-14) Signal state: 0: not activated 1: activated Bit assignment Bit0: general error Bit1: limit switch (LIMP/LIMN/REF) Bit2: range exceeded (software limit switch, tuning) Bit3: Quick Stop via fieldbus Bit4: inputs PWRR are 0 Bit6: error RS485 Bit7: error CAN Bit9: frequency of reference signal too high Bit10: error current operating mode Bit12: Profibus error Bit14: undervoltage DC bus Bit15: overvoltage DC bus Bit16: no mains phase Bit17: connection to motor faulty Bit18. motor overcurrent/short circuit Bit19. error in motor encoder Bit20: undervoltage 24VDC Bit21: overtemperature (power amplifier, motor) Bit22: tracking error Bit23: max. speed exceeded Bit24: PWRR inputs different Bit29: error in EEPROM Bit30: system run-up (hardware or parameter fault) Bit31: System error (e.g. Watchdog) monitoring depends on the product.	- - -	UINT32 R/- - - -	Modbus 7184
_StopFault STPF FLT-5ŁPF	Fault number of the last interruption cause(7-14)	- -	UINT16 R/- - -	Modbus 7178
_Temp_act_DEV TDEV STA-ŁdEʮ	device temperature(7-14)	°C -	INT16 R/- - -	Modbus 7204
_Temp_act_M -	Temperature motor(7-14) reasonable display is not possible for switching temperature sensors (for type of temperature sensor see parameter M_TempType)	°C -	INT16 R/- - -	Modbus 7202
_Temp_act_PA TPA STA-ŁPR	Temperature of the power amplifier(7-14)	°C -	INT16 R/- - -	Modbus 7200
_Ud_ref -	Set motor voltage d components() in 0.1V steps	V 0.0 - 0.0	INT16 R/- - -	Modbus 7690

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Parameter Name Code HMI menu, Code	Description	Unit Minimum value Default value Maximum value	Data type R/W persistent Expert	Parameter address via fieldbus
_UDC_act UDCA STA-udСА	DC bus voltage() in 0.1V steps	V 0.0 - 0.0	UINT16 R/- - -	Modbus 7198
_Udq_ref -	Total motor voltage (vector sum of d and q components() Root from (_Uq_ref^2 + _Ud_ref^2) in 0.1 V steps	V 0.0 - 0.0	INT16 R/- - -	Modbus 7692
_Uq_ref -	Set motor voltage q components() in 0.1V steps	V 0.0 - 0.0	INT16 R/- - -	Modbus 7688
_v_act_Posintf -	Actual speed at position interface() Calculated pulse frequency at RS422 signal interface CN5 if signal direction is defined as input (see parameter IOposInterface)	Inc/s -2147483648 - 2147483647	INT32 R/- - -	Modbus 2060
_VoltUtil -	Power/space ratio of DC bus voltage() 100% means that the drive is at the voltage limit. _VoltUtil = (_Udq_ref / _Udq_ref) * 100%	% -	INT16 R/- - -	Modbus 7718
_WarnActive -	Active warnings bit-coded(7-14) Meaning of Bits see _WarnLatched	- -	UINT16 R/- - -	Modbus 7190

Parameter Name Code HMI menu, Code	Description	Unit Minimum value Default value Maximum value	Data type R/W persistent Expert	Parameter address via fieldbus
_WarnLatched WRNS STA-ᑌᴦᴫ5	Stored warnings bit-coded(7-14) Stored warning bits are erased in the event of a FaultReset. Bits 10,11,13 are automatically deleted. Signal state: 0: not activated 1: activated Bit assignment Bit 0: general warning (see _LastWarning) Bit 1: power amplifier temperature high Bit 2: motor temperature high Bit 3: reserved Bit 4: overload (I²t) power amplifier Bit 5: overload (I²t) motor Bit 6: overload (I²t) braking resistor Bit 7: CAN warning Bit 8: Motor Encoder warning Bit 9: RS485 protocol warning Bit 10: PWRR_A and/or PWRR_B Bit 11: DC bus undervoltage, faulty mains phase Bit 12: Profibus warning Bit 13: Position not yet valid (position detection continuing) Bit 14: reserved Bit 15: reserved monitoring is product-dependent	- - 	UINT16 R/- - -	Modbus 7192
AccessLock -	Blocking of other access channels(7-1) 0: Other access channels enabled 1: Other access channels blocked This parameter allows the fieldbus to block active access to the device for the following access channels: - commissioning software - HMI - a second fieldbus The processing of the input signals (e.g. Halt input) cannot be blocked.	- 0 - 1	UINT16 R/W - -	Modbus 316
ANA1_act A1AC STA-Яɪᴦᴄ	Voltage value analogue input ANA1()	mV -10000 - 10000	INT16 R/- - -	Modbus 2306
ANA1_I_scale A1IS SET-Яɪ 5	Setpoint current in current control operating mode at 10V on ANA1() An inversion of the evaluation of the analogue signal can be run with a neg. advance sign	A_pk -300.00 3.00 300.00 **Fieldbus** -30000 300 30000	INT16 R/W per. -	Modbus 8198

Parameter Name Code HMI menu, Code	Description	Unit Minimum value Default value Maximum value	Data type R/W persistent Expert	Parameter address via fieldbus
ANA1_n_scale A1NS SET-*R in5*	Setpoint speed in speed control operating mode at 10V on ANA1() The internal maximum speed is limited to the current setting in CTRL_n_max A negative advance sign can be used to effect an inversion of the evaluation of the analogue signal	1/min -30000 3000 30000	INT16 R/W per. -	Modbus 8454
ANA1_offset A1OF SET-*R ioF*	Offset at analogue input ANA1() The ANA1 analogue input is corrected/relocated by the offset. A defined zero-voltage window acts in the range of the zero crossing of the corrected ANA1 analogue input.	mV -5000 0 5000	INT16 R/W per. -	Modbus 2326
ANA1_Tau -	Analog1: filter time constant() Low-pass filter first order (PT1) filter time constant. Filter affects analogue input ANA1. (sampling time PT1 filter: 250µsec)	ms 0.00 0.00 327.67 **Fieldbus** 0 0 32767	UINT16 R/W per. -	Modbus 2308
ANA1_win A1WN SET-*R iun*	Zero voltage window on analogue input ANA1() Value up to which an input voltage is interpreted as 0V Example: Setting 20mV ->range from -20 .. +20mV is interpreted as 0mV	mV 0 0 1000	UINT16 R/W per. -	Modbus 2322
AT_dir DIR TUN-*dir*	Direction of rotation autotuning(6-28) **1 / pos-neg-home / pnh**: first positive direction, then negative direction with return to initial position**2 / neg-pos-home / nph**: first negative direction, then positive direction with return to initial position **3 / pos-home / p-h**: only positive direction with return to initial position **4 / pos / p--**: only positive direction without return to initial position **5 / neg-home / n-h**: only negative direction with return to initial position **6 / neg / n--**: only negative direction without return to initial position	- 1 1 6	UINT16 R/W - -	Modbus 12040
AT_dis DIST TUN-*di 5t*	Movement range autotuning(6-28) Range in which the automatic optimisation processes of the controller parameters are run. The range is input relative to the current position. IMPORTANT: with "movement in only one direction" (parameter AT_dir) the specified range is used for every optimisation step. The actual movement typically corresponds to 20 times the value, but is not limited.	revolution 1.0 1.0 999.9 **Fieldbus** 10 10 9999	UINT32 R/W - -	Modbus 12038

Parameter Name Code HMI menu, Code	Description	Unit Minimum value Default value Maximum value	Data type R/W persistent Expert	Parameter address via fieldbus
AT_gain GAIN TUN-_GAin_	Adapting controller parameters (tighter/looser)(6-30) Measure of the degree of tightness of the regulation. The value 100 represents the theoretical optimum. Values larger than 100 mean that the regulation is tighter and smaller values mean that the regulation is looser.	% -	UINT16 R/W - -	Modbus 12052
AT_J -	Inertia of the entire system(6-30) is automatically calculated during the autotuning process in 0.1 kgcm^2 steps	kg cm^2 0.1 0.1 6553.5 **Fieldbus** 1 1 65535	UINT16 R/W per. -	Modbus 12056
AT_M_friction -	System friction torque() is determined during the autotuning process in 0.01Apk steps	A$_{pk}$ 0.00 - 0.00	UINT16 R/- - -	Modbus 12046
AT_M_load -	Constant load torque() is determined during the autotuning process in 0.01Apk steps	A$_{pk}$ 0.00 - 0.00	INT16 R/- - -	Modbus 12048
AT_mechanics MECH TUN-_MECh_	System coupling type(6-28) 1: direct coupling (J ext. to J motor <3:1) 2: medium coupling () 3: medium coupling (short toothed belt) 4: medium coupling () 5: soft coupling (J ext. to J motor between 5:1 and 10:1, linear axis)	- 1 1 5	UINT16 R/W - -	Modbus 12060
AT_n_ref NREF TUN-_nrEF_	Speed jump for motor starting()	1/min 10 100 1000	UINT16 R/W - -	Modbus 12044
AT_progress -	Autotuning progress(6-30)	% 0 0 100	UINT16 R/- - -	Modbus 12054
AT_start -	Start Autotuning(6-28) 0: End 1: Activate	- 0 - 1	UINT16 R/W - -	Modbus 12034
AT_state -	Autotuning status(6-30) Bit15: auto_tune_err Bit14: auto_tune_end Bit13: auto_tune_process Bit 10..0: last processing step	- -	UINT16 R/- - -	Modbus 12036
AT_wait WAIT TUN-_uAit_	Waiting time between autotuning steps(6-30)	ms 300 1200 10000	UINT16 R/W - -	Modbus 12050

Parameter Name Code HMI menu, Code	Description	Unit Minimum value Default value Maximum value	Data type R/W persistent Expert	Parameter address via fieldbus
BRK_trelease BTRE DRC-btrE	Time delay when opening/release of brake(7-29)	ms 0 0 1000	UINT16 R/W per. -	Modbus 1294
BRK_tclose BTCL DRC-btCL	Time delay when closing the brake(7-29)	ms 0 0 1000	UINT16 R/W per. -	Modbus 1296
CTRL_I_max IMAX SET-iMAX	Current limiting(6-15) Value must not exceed max. permissible current of motor or power amplifier. Default is the smallest value of M_I_max and PA_I_max	A_{pk} 0.00 - 299.99 **Fieldbus** 0 29999	UINT16 R/W per. -	Modbus 4610
CTRL_I_max_fw -	Field-shunting control max. field current() maximum value is approx. half of the lower value of the nominal current of the power amplifier and the motor.	A_{pk} 0.00 0.00 327.67 **Fieldbus** 0 0 32767	UINT16 R/W per. expert	Modbus 4376
CTRL_KFDn -	Speed controller pilot control D factor()	- 0 0 3175	UINT16 R/W per. expert	Modbus 4618
CTRL_KFPp -	Speed pilot control position controller() Over-control up to 110% possible.	% 0.0 0.0 110.0 **Fieldbus** 0 0 1100	UINT16 R/W per. -	Modbus 4624
CTRL_KPid -	Current controller longitudinal (d) P factor() Is calculated from motor parameters. In 0.1V/A steps	V/A 0.5 - 1270.0 **Fieldbus** 5 12700	UINT16 R/- per. -	Modbus 4354
CTRL_KPiq -	Current controller transverse (q) P factor() Value is calculated from motor parameters in 0.1 V/A steps	V/A 0.5 - 1270.0 **Fieldbus** 5 12700	UINT16 R/- per. -	Modbus 4358

Parameter Name Code HMI menu, Code	Description	Unit Minimum value Default value Maximum value	Data type R/W persistent Expert	Parameter address via fieldbus
CTRL_KPn --	Speed controller P-factor(6-34) Default value is calculated from motor para-meters	A/(1/min) 0.0001 - 1.2700 **Fieldbus** 1 12700	UINT16 R/W per. --	Modbus 4614
CTRL_KPp --	Position controller P-factor(6-39) Default value is calculated	1/s 2.0 - 495.0 **Fieldbus** 20 4950	UINT16 R/W per. --	Modbus 4620
CTRL_n_max NMAX SET-nΠAH	Speed limiter(6-15) Setting value must not exceed max. speed of rotation of motor Default is max. speed of motor (see M_n_max)	1/min 0 - 13200	UINT16 R/W per. --	Modbus 4612
CTRL_Nfbandw --	Bandwidth notch filter current() The bandwidth is defined as follows: Fb/F0	% 10 30 99	UINT16 R/W per. expert	Modbus 4646
CTRL_Nfdamp --	Damping notch filter current()	% 1.0 10.0 45.0 **Fieldbus** 10 100 450	UINT16 R/W per. expert	Modbus 4644
CTRL_Nffreq --	Frequency notch filter current() The filter is disabled at the value of 15000.	Hz 50.0 1500.0 1500.0 **Fieldbus** 500 15000 15000	UINT16 R/W per. expert	Modbus 4642
CTRL_Pcdamp --	Damping Posicast filter speed() The filter is disabled at the value of 1000.	% 50.0 100.0 100.0 **Fieldbus** 500 1000 1000	UINT16 R/W per. expert	Modbus 4648

Parameter Name Code HMI menu, Code	Description	Unit Minimum value Default value Maximum value	Data type R/W persistent Expert	Parameter address via fieldbus
CTRL_Pcdelay -	Time delay Posicast filter speed() The filter is disabled at the value of 0.	ms 0.00 0.00 25.00 **Fieldbus** 0 0 2500	UINT16 R/W per. expert	Modbus 4650
CTRL_TAUiref -	Filter time constant reference value filter of the reference current value()	ms 0.00 1.20 4.00 **Fieldbus** 0 120 400	UINT16 R/W per. -	Modbus 4640
CTRL_TAUnref -	Filter time constant reference value filter of the reference speed value(6-34)	ms 0.00 9.00 327.67 **Fieldbus** 0 900 32767	UINT16 R/W per. -	Modbus 4626
CTRL_TNid -	Current controller longitudinal (d) setting time() Value is calculated from motor parameters in 0.01ms steps	ms 0.13 - 327.67 **Fieldbus** 13 32767	UINT16 R/- per. -	Modbus 4356
CTRL_TNiq -	Current controller lateral (q) setting time() Value is calculated from motor parameters in 0.01ms steps	ms 0.13 - 327.67 **Fieldbus** 13 32767	UINT16 R/- per. -	Modbus 4360
CTRL_TNn -	Speed controller correction time(6-34)	ms 0.00 9.00 327.67 **Fieldbus** 0 900 32767	UINT16 R/W per. -	Modbus 4616

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Parameter Name Code HMI menu, Code	Description	Unit Minimum value Default value Maximum value	Data type R/W persistent Expert	Parameter address via fieldbus
CUR_I_target -	Setpoint current in current control operating mode(7-8)	A_{pk} -300.00 0.00 300.00 **Fieldbus** -30000 0 30000	INT16 R/W - -	Modbus 8200
ENC_pabsusr -	Setting position of the motor encoder directly(6-24) Value range depends on the encoder type. SEK52 (Singleturn): 0..max_pos_usr/rev. - 1 max_pos_usr/rev.: maximum user position for one motor revolution, with default position scaling this value is 16384. IMPORTANT: * If the process is to be conducted with direction inversion function, it must be set before setting the motor encoder position * The setting value will only be active when the controller is switched on the next time. After the write access a wait of at least 1 second is required until the controller is switched off. * Changing the value also changes the position of the virtual index pulse and the index pulse displaced at ESIM function.	usr 0 - 2147483647	UINT32 R/W - -	Modbus 1324
ESIMscale ESSC DRC-E55C	Encoder simulation - setting the resolution(6-23) the complete value range is available for the resolution. For resolutions that can be divided by 4 the index pulse must be at A=high and B=high. IMPORTANT: A change of the setting is not activated until the device is switched on again. After the write access a wait of at least 1 second is required until the controller is switched off.	Inc 8 4096 65535	UINT16 R/W per. -	Modbus 1322
FLTAmpOnCyc -	ENABLE cycles up to time of error() Number of power amplifier turn-on processes after switching on the power supply (control voltage) up to the appearance of the error	- - -	UINT16 R/- - -	Modbus 15370

Parameter Name Code HMI menu, Code	Description	Unit Minimum value Default value Maximum value	Data type R/W persistent Expert	Parameter address via fieldbus
FLTAmpOnTime -	Time error occurs after ENABLE()	s - 	UINT16 R/- - -	Modbus 15372
FLT_class -	Error class() 0: Warning (no reaction) 1: error (Quick Stop -> status 7) 2: error (Quick Stop -> status 8, 9) 3: Fatal error (state 9, resettable) 4: Fatal error (state 9, not resettable)	- 0 - 4	UINT16 R/- - -	Modbus 15364
FLT_del_err -	Erase error memory() 1: Erases all entries in the error memory The erasing process is complete when a 0 is returned when reading.	- 0 - 1	UINT16 R/W - -	Modbus 15112
FLT_err_num -	Error number() Reading this parameter brings the complete error entry (error class, time of error ...) into an intermediate memory from which all components of the error can be read. In addition, the read indicator of the error memory is automatically switched forward to the next error entry.	- 0 - 65535	UINT16 R/- - -	Modbus 15362
FLT_Idq -	Motor current at error time() in 10 mA steps	A 0.00 - 0.00	UINT16 R/- - -	Modbus 15378
FLT_MemReset -	Reset the error memory read pointer() 1: Set error memory read pointer to oldest error entry.	- 0 - 1	UINT16 R/W - -	Modbus 15114
FLT_n -	Speed at error time()	1/min - 	INT16 R/- - -	Modbus 15376
FLT_powerOn POWO INF-*PoUo*	Number of turn-on processes()	- 0 - 4294967295	UINT32 R/- - -	Modbus 15108
FLT_Qual -	Error additional information() This entry contains additional information about the error, depending on the error number. Example: a parameter address	- 0 - 65535	UINT16 R/- - -	Modbus 15368
FLT_Temp_DEV -	device temperature at error time()	°C - -	INT16 R/- - -	Modbus 15382

Parameter Name Code HMI menu, Code	Description	Unit Minimum value Default value Maximum value	Data type R/W persistent Expert	Parameter address via fieldbus
FLT_Temp_PA -	Power amplifier temperature at error time()	°C - -	INT16 R/- - -	Modbus 15380
FLT_Time -	Error time() referenced to the operating hours counter	s 0 - 536870911	UINT32 R/- - -	Modbus 15366
FLT_UDC -	DC bus voltage at error time() in 100mV steps	V 0.0 - 0.0	UINT16 R/- - -	Modbus 15374
GEARdenom -	Gear ratio denominator() see description GEARnum	- 1 1 2147483647	INT32 R/W per. -	Modbus 9734
GEARdir_enabl -	Enabled direction of motion of the gear processing() **1 / positive** : pos. direction **2 / negative**: neg. direction **3 / both**: both directions (default) This can be used to enable a return motion lock.	- 1 3 3	UINT16 R/W per. -	Modbus 9738
GEARnum -	Gear ratio numerator() $$\text{Gear ratio} = \frac{\text{GEARnum}}{\text{GEARdenom}}$$ The new gear ratio is enabled when the numerator value is transferred.	- -2147483648 1 2147483647	INT32 R/W per. -	Modbus 9736
GEARratio GFAC SET-*GFAC*	Selection of special gear ratios() 0: Use of the specified gear ratio from GEARnum/GEARdenom 1: 200 2: 400 3: 500 4: 1000 5: 2000 6: 4000 7: 5000 8: 10000 9: 4096 10: 8192 11: 16384 Changing the reference variable by the stated value results in one motor rotation.	- 0 0 11	UINT16 R/W per. -	Modbus 9740
HMIDispPara SUPV DRC-*SuPU*	HMI display while motor rotates() 0: device status (default) 1: current speed of rotation (n_act) 2: current motor current	- 0 0 2	UINT16 R/W per. -	Modbus 14852

Parameter Name Code HMI menu, Code	Description	Unit Minimum value Default value Maximum value	Data type R/W persistent Expert	Parameter address via fieldbus
HMIlocked -	Block HMI(7-1) 0: HMI not blocked 1: HMI blocked When the HMI is blocked the following actions are no longer possible: - Change parameters - Manual mode (Jog) - Autotuning - FaultReset	- 0 0 1	UINT16 R/W per. -	Modbus 14850
IO_AutoEnable IOAE DRC-, *oRE*	Automatic Enable at PowerOn, if ENABLE input is active() **0 / off**: active Enable at PowerOn does not cause switch-on of power amplifier (Default) **1 / on**: active Enable at PowerOn causes switch-on of the power amplifier	- 0 0 1	UINT16 R/W per. -	Modbus 1292
IO_GearMode IOGM DRC-, *oGN*	Processing mode electr. gearing () 1: Real-time synchronisation 2: synchronisation with compensation movement	- 1 1 2	UINT16 R/W per. -	Modbus 1326
IO_LI_invert -	Inversion of digital inputs(7-31) Bit0: inversion LI1 Bit1: inversion LI2 ... Coding of bits: 0: no inversion 1: inversion	- -	UINT16 R/W per. -	Modbus 2084
IO_LO_invert -	Inversion of digital outputs(7-31) Bit0: inversion LO1_OUT Bit1: inversion LO2_OUT ... Coding of bits: 0: no inversion 1: inversion	- -	UINT16 R/W per. -	Modbus 2086
IO_LO_set -	Setting digital outputs directly() Write access to output bits is only effective if the signal pin exists as output and the function of the output was set to 'freely available'. Coding of the individual signals: Bit0: LO1_OUT Bit1: LO2_OUT ...	- -	UINT16 R/W - -	Modbus 2082

Parameter Name Code HMI menu, Code	Description	Unit Minimum value Default value Maximum value	Data type R/W persistent Expert	Parameter address via fieldbus
IOdefaultMode IO-M DRC-ı o-Ⲏ	Start-up of operating mode (6-11) **0 / none / none** : none **1 / CurrentControl / Curr**: Current control (reference value from ANA1) **2 / SpeedControl / Sped**: Speed control (reference value of ANA1) **3 / PulseControl / Puls**: Pulse control **5 / JOG mode / JoG**: Jog IMPORTANT: The operating mode is auto-matically enabled when the drive switches to the 'OperationEnable' status and "IODevice / IO" is set in DEVcmdinterf.	- 0 3 5	UINT16 R/W per. -	Modbus 1286
IOfunct_LI1 LI1 I-O-Lı ı	Function input LI1(7-31) **1 / No function / free available / nonE**: no function / freely available **6 / Enable positive motor move / posM**: release positive motor movement **7 / Enable negative motor move / negM**: release negative motor movement **8 / Speed limitation / nLiM**: speed limitation to parameter value **9 / JOG positive / JoGn**: jog right **10 / JOG negative / JoGn**: jog left **11 / JOG fast/slow / JoGF**: jog fast/slow :	- - - -	UINT16 R/W per. -	Modbus 1794
IOfunct_LI2 LI2 I-O-Lı 2	Function input LI2(7-31) **1 / No function / free available / nonE**: no function / freely available **2 / Fault reset / Fres**: reset error message **6 / Enable positive motor move / posM**: release positive motor movement **7 / Enable negative motor move / negM**: release negative motor movement **8 / Speed limitation / nLiM**: speed limitation to parameter value **9 / JOG positive / JoGn**: jog right **10 / JOG negative / JoGn**: jog left **11 / JOG fast/slow / JoGF**: jog fast/slow :	- - - -	UINT16 R/W per. -	Modbus 1796
IOfunct_LI4 LI4 I-O-Lı 4	Function input LI4(7-31) **1 / No function / free available / nonE**: no function / freely available **4 / Halt / HALt**: Halt **6 / Enable positive motor move / posM**: release positive motor movement **7 / Enable negative motor move / negM**: release negative motor movement **8 / Speed limitation / nLiM**: speed limitation to parameter value **9 / JOG positive / JoGn**: jog right **10 / JOG negative / JoGn**: jog left **11 / JOG fast/slow / JoGF**: jog fast/slow :	- - - -	UINT16 R/W per. -	Modbus 1800

Parameter Name Code HMI menu, Code	Description	Unit Minimum value Default value Maximum value	Data type R/W persistent Expert	Parameter address via fieldbus
IOfunct_LI5 LI5 I-O-L₁5	Function input LI5(7-31) **1 / No function / free available / nonE**: no function / freely available **6 / Enable positive motor move / posM**: release positive motor movement **7 / Enable negative motor move / negM**: release negative motor movement **8 / Speed limitation / nLiM**: speed limitation to parameter value **9 / JOG positive / JoGn**: jog right **10 / JOG negative / JoGn**: jog left **11 / JOG fast/slow / JoGF**: jog fast/slow :	- - - -	UINT16 R/W per. -	Modbus 1802
IOfunct_LI6 LI6 I-O-L₁6	Function input LI6(7-31) **1 / No function / free available / nonE**: no function / freely available **6 / Enable positive motor move / posM**: release positive motor movement **7 / Enable negative motor move / negM**: release negative motor movement **8 / Speed limitation / nLiM**: speed limitation to parameter value **9 / JOG positive / JoGn**: jog right **10 / JOG negative / JoGn**: jog left **11 / JOG fast/slow / JoGF**: jog fast/slow :	- - - -	UINT16 R/W per. -	Modbus 1804
IOfunct_LO1 LO1 I-O-Lo1	Function output LO1_OUT() **1 / No function / free available / nonE**: no function / freely available **2 / No fault / nFlt**: no error **3 / Active / Acti**: operating readiness **4 / Motor move disable / MdiS**: direction of motion blocked **5 / In position window / in-p**: position deviation within window **6 / In speed window / in-n**: speed of rotation deviation within window **7 / Speed threshold reached / itHr**: motor speed of rotation below programmed value **8 / Current threshold reached / ctHr**: motor current below programmed value **9 / Halt acknowledge / HALT** Halt validation **10 / Brake release / Brak**: actuation of holding brake	- - - -	UINT16 R/W per. -	Modbus 1810

Parameter Name Code HMI menu, Code	Description	Unit Minimum value Default value Maximum value	Data type R/W persistent Expert	Parameter address via fieldbus
IOfunct_LO2 LO2 I-O-ᴸₒ2	Function output LO2_OUT() **1 / No function / free available / nonE**: no function / freely available **2 / No fault / nFlt**: no error **3 / Active / Acti**: operating readiness **4 / Motor move disable / MdiS**: direction of motion blocked **5 / In position window / in-p**: position deviation within window **6 / In speed window / in-n**: speed of rotation deviation within window **7 / Speed threshold reached / itHr**: motor speed of rotation below programmed value **8 / Current threshold reached / ctHr**: motor current below programmed value **9 / Halt acknowledge / HALT** Halt validation **10 / Brake release / Brak**: actuation of holding brake	- - - -	UINT16 R/W per. -	Modbus 1812
IOfunct_LO3 LO3 I-O-ᴸₒ3	Function output LO3_OUT() **1 / No function / free available / nonE**: no function / freely available **2 / No fault / nFlt**: no error **3 / Active / Acti**: operating readiness **4 / Motor move disable / MdiS**: direction of motion blocked **5 / In position window / in-p**: position deviation within window **6 / In speed window / in-n**: speed of rotation deviation within window **7 / Speed threshold reached / itHr**: motor speed of rotation below programmed value **8 / Current threshold reached / ctHr**: motor current below programmed value **9 / Halt acknowledge / HALT** Halt validation **10 / Brake release / Brak**: actuation of holding brake	- - - -	UINT16 R/W per. -	Modbus 1814
IOfunct_LO4 LO4 I-O-ᴸₒ4	Function output LO4_OUT() **1 / No function / free available / nonE**: no function / freely available **2 / No fault / nFlt**: no error **3 / Active / Acti**: operating readiness **4 / Motor move disable / MdiS**: direction of motion blocked **5 / In position window / in-p**: position deviation within window **6 / In speed window / in-n**: speed of rotation deviation within window **7 / Speed threshold reached / itHr**: motor speed of rotation below programmed value **8 / Current threshold reached / ctHr**: motor current below programmed value **9 / Halt acknowledge / HALT** Halt validation **10 / Brake release / Brak**: actuation of holding brake	- - - -	UINT16 R/W per. -	Modbus 1816

Parameter Name Code HMI menu, Code	Description	Unit Minimum value Default value Maximum value	Data type R/W persistent Expert	Parameter address via fieldbus
IOLogicType IOLT DRC-ı oLt	Logic type of the digital inputs/outputs(6-11) **0 / source / sou**: for current supply outputs (default) **1 / sink / sin**: for outputs drawing current IMPORTANT: A change of the setting is not activated until the device is switched on again.	- 0 0 1	UINT16 R/W per. -	Modbus 1288
IOposInterfac IOPI DRC-ı oPı	Signal selection at position interface(6-11) RS422 IO interface (Pos) as: **0 / ABinput / AB**: input ENC_A, ENC_B, ENC_I (index pulse) 4x evaluation **1 / PDinput /PD**: input PULSE, DIR, ENABLE2 **3 / CW-CCW / CWCC**: CW-CCW IMPORTANT: A change of the setting is not activated until the unit is switched on again.	- 0 3 3	UINT16 R/W per. -	Modbus 1284
JOGn_fast NFST JOG-nF5t	Speed for fast jog(7-6) The setting value is internally limited to the current parameter setting in RAMPn_max.	1/min 1 180 13200	UINT16 R/W per. -	Modbus 10506
JOGn_slow NSLW JOG-n5Lu	Speed for slow jog(7-6) The setting value is internally limited to the current parameter setting in RAMPn_max.	1/min 1 60 13200	UINT16 R/W per. -	Modbus 10504
JOGstepusr -	Inching movement before continuous operation(7-6) 0: direct activation of continuous operation >0: positioning section per inching cycle	usr 0 20	INT32 R/W per. -	Modbus 10510
JOGtime -	Waiting time before continuous operation(7-6) Time is only effective if an inching distance not equal to 0 has been set, otherwise direct transition to continuous operation.	ms 1 500 32767	UINT16 R/W per. -	Modbus 10512
LIM_I_maxHalt LIHA SET-Lı hA	Current limiting for Halt(7-28) Max. current during braking after Halt or termination of an operating mode. Maximum and default value settings depend on motor and power amplifier in 0.01Apk steps	A_{pk} - - -	UINT16 R/W per. -	Modbus 4364
LIM_I_maxQSTP LIQS SET-Lı 95	Current limiting for Quick Stop(7-27) Max. current during braking via torque ramp resulting from an error with error class 1 or 2, and when a software stop is triggered Maximum and default value setting depend on motor and power amplifier in 0.01Apk steps	A_{pk} - - -	UINT16 R/W per. -	Modbus 4362

AC servo drive

Parameter Name Code HMI menu, Code	Description	Unit Minimum value Default value Maximum value	Data type R/W persistent Expert	Parameter address via fieldbus
M_I_0 -	Motor constant current at standstill() in 0.01 Apk steps	A_{pk} - - -	UINT16 R/- - -	Modbus 3366
M_I_max MIMA INF-_n̄ _n̄_Ā	Motor maximum current() in 0.01 Apk steps	A_{pk} - - -	UINT16 R/- - -	Modbus 3340
M_I_nom MINO INF-_n̄_ _n̄o_	Motor nominal current() in 0.01 Apk steps	A_{pk} - - -	UINT16 R/- - -	Modbus 3342
M_I2t -	max. allowable time for M_I_max()	ms - - -	UINT16 R/- - -	Modbus 3362
M_Jrot -	Motor moment of inertia() in 0.1 kgcm^2 steps	kg cm^2 - - -	UINT16 R/- - -	Modbus 3352
M_kE -	Motor e.m.f. constant kE() Voltage constant in Vpk at 1000 1/min	- - - -	UINT16 R/- - -	Modbus 3350
M_L_d -	Motor inductance d-direction() in 0.01 mH steps	mH - - -	UINT16 R/- - -	Modbus 3358
M_L_q -	Motor inductance q-direction() in 0.01 mH steps	mH - - -	UINT16 R/- - -	Modbus 3356
M_M_max -	Motor peak torque()	N cm - - -	UINT16 R/- - -	Modbus 3346
M_M_nom -	Motor nominal torque()	N cm - - -	UINT16 R/- - -	Modbus 3344
M_n_max -	maximum permissible motor speed()	1/min - - -	UINT16 R/- - -	Modbus 3336
M_n_nom -	Nominal motor speed()	1/min - - -	UINT16 R/- - -	Modbus 3338
M_Polepair -	Number of motor pole pairs()	- - - -	UINT16 R/- - -	Modbus 3368

Parameter Name Code HMI menu, Code	Description	Unit Minimum value Default value Maximum value	Data type R/W persistent Expert	Parameter address via fieldbus
M_R_UV -	Motor termination resistance() in 10mΩ steps	Ω - - -	UINT16 R/- - -	Modbus 3354
M_Sensor -	Motor encoder type() **0 / unknown**: unknown **1**: reserved **2** reserved **3 / SRS** SinCos 1024 marks Singleturn **4 / SRM**: SinCos 1024 marks Multiturn **5 / SKS**: SinCos 128 marks Singleturn **6 / SKM**: SinCos 128 marks Multiturn **7 / SEK**: SinCos 16 marks Singleturn	- - - -	UINT16 R/- - -	Modbus 3334
M_serialNo -	Motor serial number()	- - - -	UINT32 R/- - -	Modbus 3330
M_T_max -	max. motor temperature(7-14)	°C 	INT16 R/- - -	Modbus 3360
M_T_warn -	Motor temperature warning threshold()	°C 	INT16 R/- - -	Modbus 3370
M_TempType -	Type of temperature sensor() 0: PTC switching 1: NTC linear	- - - -	UINT16 R/- - -	Modbus 3364
M_Type -	Motor type() 0: no motor selected >0: connected motor type	- - - -	UINT32 R/- - -	Modbus 3332
M_U_nom -	Motor nominal voltage() Voltage in 100mV steps	V - - -	UINT16 R/- - -	Modbus 3348
MBadr MBAD COM-ⁿbⁿd	Modbus address(6-11) valid addresses: 1 ... 247	- 1 1 247	UINT16 R/W per. -	Modbus 5640
MBbaud MBBD COM-ⁿbbd	Modbus baud rate(6-11) Allowed baud rates: 9600 19200 38400 IMPORTANT: A change of the setting is not activated until the unit is switched on again.	- 9600 19200 38400	UINT16 R/W per. -	Modbus 5638

Parameter Name Code HMI menu, Code	Description	Unit Minimum value Default value Maximum value	Data type R/W persistent Expert	Parameter address via fieldbus
MBdword_order MBWO COM-*ЛЬЬ₀*	Modbus word sequence for double words (32 bit values)() Send High Word first or Low Word first **0 / HighLow / HiLo**: HighWord-LowWord, High Word first -> Modicon Quantum (default) **1 / LowHigh / LoHi** : LowWord-HighWord Low Word first -> Premium, HMI (Telemecanique)	- 0 0 1	UINT16 R/W per. -	Modbus 5646
MBformat MBFO COM-*ЛЬF₀*	Modbus data format() **1 / 8Bit NoParity 1Stop / 8n1**: 8 bit, no parity bit, 1 stop bit **2 / 8Bit EvenParity 1Stop / 8e1**: 8 bit, even parity bit, 1 stop bit (default) **3 / 8Bit OddParity 1Stop / 8o1**: 8 bit, odd parity bit, 1 stop bit **4 / 8Bit NoParity 2Stop / 8n2**: 8 bit, no parity bit, 2 stop bits IMPORTANT: A change of the setting is not activated until the unit is switched on again.	- 1 2 4	UINT16 R/W per. -	Modbus 5642
MBnode_guard -	Modbus Node Guard() Connection monitoring 0: inactive (default) >0: Monitoring time	ms 0 0 10000	UINT16 R/W - -	Modbus 5644
MT_dismax -	Max. permissible distance() If the maximum permissible distance is exceeded with an active reference value, a class 1 error is triggered. value 0 disables the monitoring.	revolution 0.0 1.0 999.9 **Fieldbus** 0 10 9999	UINT16 R/W - -	Modbus 11782
PA_I_max PIMA INF-*PᵢЛЯ*	Maximum current of power amplifier() Current in 10 mA steps	A_pk - - -	UINT16 R/- per. -	Modbus 4100
PA_I_nom PINO INF-*Pᵢ ₀₀*	Nominal current of power amplifier() Current in 10 mA steps	A_pk - - -	UINT16 R/- per. -	Modbus 4098
PA_T_max -	maximum permissible temperature of the power amplifier(7-14)	°C	INT16 R/- per. -	Modbus 4110
PA_T_warn -	Temperature limit of the power amplifier(7-14)	°C	INT16 R/- per. -	Modbus 4108

Parameter Name Code HMI menu, Code	Description	Unit Minimum value Default value Maximum value	Data type R/W persistent Expert	Parameter address via fieldbus
PA_U_maxDC ‑	max. permissible DC bus voltage() Voltage in 100mV steps	V - - -	UINT16 R/- per. -	Modbus 4102
PA_U_minDC ‑	DC bus undervoltage threshold for drive switch-off() Voltage in 100mV steps	V - - -	UINT16 R/- per. -	Modbus 4104
PA_U_minStopDC ‑	DC bus undervoltage threshold for Quick Stop() At this threshold the drive carries out a Quick Stop Voltage in 100mV steps	V - - -	UINT16 R/- per. -	Modbus 4116
PAR_CTRLreset RES TUN-rE5	Reset controller parameter() 1: Control parameters of the speed and position controllers are reset The current controller is automatically set according to the connected motor.	- 0 - 1	UINT16 R/W - -	Modbus 1038
PAReeprSave ‑	Back up the parameters in the EEPROM memory() Bit 0=1: Back up the user parameters. The current parameters are backed up in the non-volatile memory (EEPROM). The storing process is complete if a 0 is returned when reading the parameters.	- - - -	UINT16 R/W - -	Modbus 1026
PARfactorySet FCS DRC-FC5	Restore factory settings (default values)(7-41) 1: Set all parameters to default values and back up in the EEPROM. A factory setting can be triggered by HMI or commissioning software. The storing process is complete if a 0 is returned when reading the parameters. IMPORTANT: The default state only becomes active at the next start-up.	- 0 - 3	R/W - -	

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Parameter Name Code HMI menu, Code	Description	Unit Minimum value Default value Maximum value	Data type R/W persistent Expert	Parameter address via fieldbus
PARuserReset -	Resetting the user parameters(7-41) 1: Set the user parameters to default values. All parameters are reset, with the exception of: - communications parameters - definition of direction of rotation - signal selection of position interface - device control - logic type - start-up operating mode for 'Local Control Mode' - IO functions IMPORTANT: The new settings are not backed up to the EEPROM!	- 0 - 1	UINT16 R/W - -	Modbus 1040
POSdirOfRotat PROT DRC-$Prot$	Definition of direction of rotation(7-40) **0 / clockwise / clw**: Clockwise **1 / counter clockwise / cclw**: Counterclockwise Interpretation: The drive rotates clockwise with positive speeds, looking onto the motor shaft at the flange. IMPORTANT: A change of the setting is not activated until the unit is switched on again	- 0 0 1	UINT16 R/W per. -	Modbus 1560
POSscaleDenom -	Denominator of the position scaling factor(7-23) Description see numerator (POSscaleNum) Acceptance of a new scaling factor is by transfer of the numerator	usr 1 16384 2147483647	INT32 R/W per. -	Modbus 1550
POSscaleNum -	Numerator of the position scaling factor(7-23) :Definition of scaling factor Motor revolutions[U] -- Change in user position [usr] Acceptance of a new scaling factor takes place on the entry of the numerator User limits can be reduced when internal system factors are taken into account	revolution 1 1 2147483647	INT32 R/W per. -	Modbus 1552

Parameter Name Code HMI menu, Code	Description	Unit Minimum value Default value Maximum value	Data type R/W persistent Expert	Parameter address via fieldbus
PWM_fChop	Switching frequency of power amplifier(6-15)	- 0 0 1	UINT16 R/W per. expert	Modbus 1308
-	Switching frequency of the power amplifier **0 / 4kHz**: 4kHz **1 / 8kHz**: 8kHz factory setting: for motors of the BSH family: the factory setting is automatically made for all other motors depending on the connected motor: 4KHz			
RAMP_TAUjerk	Jolt limiting()	ms 0 0 128	UINT16 R/W per. -	Modbus 1562
-	**0**: off **>0**: Setting for filter processing time The following values can be set: 0: inactive 1 2 4 8 16 32 64 128 Limits the acceleration change (jerk) of the setpoint position generation during the positioning transitions: Standstill - acceleration acceleration - constant movement constant movement - deceleration deceleration - standstill Processing in the following operating modes: - profile velocity - point-to-point - jog - homing Setting is only possible with inactive operating mode (x_end=1).			
RAMPacc	Profile generator acceleration(7-26)	(1/min)/s 30 600 3000000	UINT32 R/W per. -	Modbus 1556
-				
RAMPdecel	Profile generator deceleration(7-26)	(1/min)/s 750 750 3000000	UINT32 R/W per. -	Modbus 1558
-				

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Parameter Name Code HMI menu, Code	Description	Unit Minimum value Default value Maximum value	Data type R/W persistent Expert	Parameter address via fieldbus
RAMPsym -	symmetrical ramp() Acceleration and delay of the profile generator (16-bit value) in 10 (1/min)/s Write access changes the values under RAMPacc as well as RAMPdecel, the limit value test occurs using the limit values there. Reading access delivers the greater value of RAMPacc/RAMPdecel. If the current setting value cannot be mapped as a 16-bit value, then the max. UINT16 value is transferred	usr -	UINT16 R/W - -	Modbus 1538
RESext_P -	Nominal power of external braking resistor(6-15)	W 1 10 32767	UINT16 R/W per. -	Modbus 1316
RESext_R -	Resistance value of external braking resistor(6-15)	Ω 0.01 100.00 327.67 **Fieldbus** 1 10000 32767	UINT16 R/W per. -	Modbus 1318
RESext_ton -	max. permissible switch-in time for external braking resistor(6-15)	ms 1 1 30000	UINT16 R/W per. -	Modbus 1314
RESint_ext -	Control of braking resistor(6-15) **0 / internal**: internal braking resistor **1 / external**: external braking resistor	- 0 0 1	UINT16 R/W per. -	Modbus 1298
RESint_P -	Nominal power of internal braking resistor()	W	UINT16 R/- per. -	Modbus 4114
RESint_R -	Internal braking resistor() in 10 mOhm steps	Ω - - -	UINT16 R/- per. -	Modbus 4112
SPEEDn_target -	Setpoint speed in speed control mode(7-9) The internal maximum speed is limited by the current setting in CTRL_n_max	1/min -30000 0 30000	INT16 R/W - -	Modbus 8456
SPV_Flt_AC -	Error response to failure of a mains phase with 3-phase devices(7-14) **1 / ErrorClass1**error class 1 **2 / ErrorClass2**: error class 2 **3 / ErrorClass3**: error class 3	- 1 2 3	UINT16 R/W per. -	Modbus 1300

Parameter Name Code HMI menu, Code	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(7-14) **1 / ErrorClass1**error class 1 **2 / ErrorClass2**: error class 2 **3 / ErrorClass3**: error class 3	- 1 3 3	UINT16 R/W per. -	Modbus 1302
SPV_EarthFlt -	Earth fault monitoring(7-21) **0 / off**: Off **1 / on**: On (default) In exceptional cases deactivation may be required, e.g.: - parallel connection of multiple devices - operation on an IT mains - long motor lines Disable the monitoring only if it responds when not wanted	- 0 1 1	UINT16 R/W per. expert	Modbus 1312
SPV_MainsVolt -	Monitoring mains phases with 3-phase devices(7-22) **0 / off**: Off **1 / on**: On (default) 3-phase devices must only be connected and operated on 3-phase mains. In exceptional cases it may be necessary to disable it, e.g.: - supply via the DC bus	- 0 1 1	UINT16 R/W per. expert	Modbus 1310
SPV_p_maxDiff -	Max. permissible tracking error of position controller(7-14) The tracking error is the current position regulation offset minus the speed-dependent position regulation offset. Actually, only the position offset caused by the moment requirements is still referred to for tracking error monitoring.	revolution 0.0001 1.0000 200.0000 **Fieldbus** 1 10000 2000000	UINT32 R/W per. -	Modbus 4636
SPVChkWinTime WINT SET-ᵾᵢₙₜ	Monitoring of time window() Setting of a time for the monitoring of posi-tion deviation, speed of rotation deviation, speed of rotation value and current value. If the control value for the set time is within the monitoring range, then the result of the monitoring is valid. The status can be output via a program-mable output.	ms 0 0 9999	UINT16 R/W per. -	Modbus 1594
SPVcommutat -	Monitoring commutation(7-20) **0 / off**: off **1 / on**: on (default)	- 0 1 1	UINT16 R/W per. -	Modbus 1290

Parameter Name Code HMI menu, Code	Description	Unit Minimum value Default value Maximum value	Data type R/W persistent Expert	Parameter address via fieldbus
SPVi_Threshold ITHR SET-ıthr	Current value for "Current threshold reached"() It is checked whether the motor is below the value defined here for the time programmed via 'SPVChkWinTime'. The status can be output via a programmable output. As a comparative value the value from the parameter '_Idq_act' is used.	A_{pk} 0.00 0.00 99.99 **Fieldbus** 0 0 9999	UINT16 R/W per. -	Modbus 1592
SPVn_DiffWin IN-N SET-ın-n	Speed deviation for "In speed window"() It is checked whether the motor is below the deviation defined here for the time programmed via 'SPVChkWinTime'. The status can be output via a programmable output.	1/min - - -	UINT16 R/W per. -	Modbus 1588
SPVn_lim NLIM SET-nLıM	Speed limitation via input() a speed limitation can be activated via a digital input.	1/min 1 10 9999	UINT16 R/W per. -	Modbus 1596
SPVn_Threshold NTHR SET-nthr	Speed value for "Speed threshold reached"() It is checked whether the motor is below the value defined here for the time programmed via 'SPVChkWinTime'. The status can be output via a programmable output.	1/min - - -	UINT16 R/W per. -	Modbus 1590
SPVp_DiffWin IN-P SET-ın-P	Position deviation for "In position window"() It is checked whether the motor is below the deviation defined here for the time programmed via 'SPVChkWinTime'. The status can be output via a programmable output.	revolution 0.0000 0.0010 0.9999 **Fieldbus** 0 10 9999	UINT16 R/W per. -	Modbus 1586

Parameter Name Code HMI menu, Code	Description	Unit Minimum value Default value Maximum value	Data type R/W persistent Expert	Parameter address via fieldbus
StartUpMessage -	Start-up messages() Read: Start-up messages write: validation Read: Bit 0=1: First Setup Bit 1 = 1: Motor changed Bit 2 = 1: EEPROM data corrupt Bit 3 = 1: no motor connected Bit 4 = 1: change of a parameter that is only active after start-up Bit 5..15: reserved Write: Bit 0=1: First Setup validation Bit 1 = 1: motor changed validation Bit 2..3: reserved Bit 4 = 1: validation of change of a start-up parameter Bit 5..15: reserved The availability of the individual bits depends on the product	- - 	UINT32 R/W - -	Modbus 312

11   Accessories and spare parts

11.1   Optional accessories

Description	Order number
Peripheral control terminal	VW3A31101
PC connection kit, converter RS485 to RS232	VW3A8106
USIC (Universal Signal Interface Converter), for signal adaptation to RS422 standard	VW3M3102
Reference Value Adapter RVA for distribution of A/B or pulse/direction signals to 5 devices with 24VDC power supply device to 5VDC sensor power supply	VW3M3101
Holding brake control HBC	VW3M3103

11.2   External braking resistors

Description	Order number
braking resistor IP65; 10 ohm; 400W; 0.75m connector cable	VW3A7601R07
braking resistor IP65; 10 ohm; 400W; 2m connector cable	VW3A7601R20
braking resistor IP65; 10 ohm; 400W; 3m connector cable	VW3A7601R30
braking resistor IP65; 27 ohm; 100W; 0.75m connector cable	VW3A7602R07
braking resistor IP65; 27 ohm; 100W; 2m connector cable	VW3A7602R20
braking resistor IP65; 27 ohm; 100W; 3m connector cable	VW3A7602R30
braking resistor IP65; 27 ohm; 200W; 0.75m connector cable	VW3A7603R07
braking resistor IP65; 27 ohm; 200W; 2m connector cable	VW3A7603R20
braking resistor IP65; 27 ohm; 200W; 3m connector cable	VW3A7603R30
braking resistor IP65; 27 ohm; 400W; 0.75m connector cable	VW3A7604R07
braking resistor IP65; 27 ohm; 400W; 2m connector cable	VW3A7604R20
braking resistor IP65; 27 ohm; 400W; 3m connector cable	VW3A7604R30
braking resistor IP65; 72 ohm; 100W; 0.75m connector cable	VW3A7605R07
braking resistor IP65; 72 ohm; 100W; 2m connector cable	VW3A7605R20
braking resistor IP65; 72 ohm; 100W; 3m connector cable	VW3A7605R30
braking resistor IP65; 72 ohm; 200W; 0.75m connector cable	VW3A7606R07
braking resistor IP65; 72 ohm; 200W; 2m connector cable	VW3A7606R20
braking resistor IP65; 72 ohm; 200W; 3m connector cable	VW3A7606R30
braking resistor IP65; 72 ohm; 400W; 0.75m connector cable	VW3A7607R07
braking resistor IP65; 72 ohm; 400W; 2m connector cable	VW3A7607R20
braking resistor IP65; 72 ohm; 400W; 3m connector cable	VW3A7607R30

11.3   Motor cables

These cables are **suitable for BSH motors only**.

BRH motors **cannot**be connected with them. Connector sets for BRH motors can be found in the motor manual.

Description	Order number
Motor cable 3m for Servomotor, 4*1.5mm² and 2*1.0mm² screened; Motor end 8-pole round plug, other cable end open	VW3M5101R30
Motor cable 5m for Servomotor, 4*1.5mm² and 2*1.0mm² screened; Motor end 8-pole round plug, other cable end open	VW3M5101R50
Motor cable 10m for Servomotor, 4*1.5mm² and 2*1.0mm² screened; Motor end 8-pole round plug, other cable end open	VW3M5101R100
Motor cable 15m for Servomotor, 4*1.5mm² and 2*1.0mm² screened; Motor end 8-pole round plug, other cable end open	VW3M5101R150
Motor cable 20m for Servomotor, 4*1.5mm² and 2*1.0mm² screened; Motor end 8-pole round plug, other cable end open	VW3M5101R200
Motor cable 3m for Servomotor, 4*2.5mm² and 2*1.0mm² screened; Motor end 8-pole round plug, other cable end open	VW3M5102R30
Motor cable 5m for Servomotor, 4*2.5mm² and 2*1.0mm² screened; Motor end 8-pole round plug, other cable end open	VW3M5102R50
Motor cable 10m for Servomotor, 4*2.5mm² and 2*1.0mm² screened; Motor end 8-pole round plug, other cable end open	VW3M5102R100
Motor cable 15m for Servomotor, 4*2.5mm² and 2*1.0mm² screened; Motor end 8-pole round plug, other cable end open	VW3M5102R150
Motor cable 20m for Servomotor, 4*2.5mm² and 2*1.0mm² screened; Motor end 8-pole round plug, other cable end open	VW3M5102R200
motor cable 3m for Servomotor, 4*4.0mm² and 2*1.0mm² shielded; motor end 8-pole M40 circular plug, other cable end open	VW3M5103R30
motor cable 5m for Servomotor, 4*4.0mm² and 2*1.0mm² shielded; motor end 8-pole M40 circular plug, other cable end open	VW3M5103R50
motor cable 10m for Servomotor, 4*4.0mm² and 2*1.0mm² shielded; motor end 8-pole M40 circular plug, other cable end open	VW3M5103R100
motor cable 15m for Servomotor, 4*4.0mm² and 2*1.0mm² shielded; motor end 8-pole M40 circular plug, other cable end open	VW3M5103R150
motor cable 20m for Servomotor, 4*4.0mm² and 2*1.0mm² shielded; motor end 8-pole M40 circular plug, other cable end open	VW3M5103R200

11.4   Encoder cables

These cables are **suitable for BSH motors only**.

BRH motors **cannot**be connected with them. Connector sets for BRH motors can be found in the motor manual.

Description	Order number
Encoder cable 3m for Servomotor, 5*(2*0.25mm²) and 1*(2*0.5mm²) screened; Motor end 12-pole round plug, unit end 12-pole plug	VW3M8101R30
Encoder cable 5m for Servomotor, 5*(2*0.25mm²) and 1*(2*0.5mm²) screened; Motor end 12-pole round plug, unit end 12-pole plug	VW3M8101R50

Description	Order number
Encoder cable 10m for Servomotor, 5*(2*0.25mm²) and 1*(2*0.5mm²) screened; Motor end 12-pole round plug, unit end 12-pole plug	VW3M8101R100
Encoder cable 15m for Servomotor, 5*(2*0.25mm²) and 1*(2*0.5mm²) screened; Motor end 12-pole round plug, unit end 12-pole plug	VW3M8101R150
Encoder cable 20m for Servomotor, 5*(2*0.25mm²) and 1*(2*0.5mm²) screened; Motor end 12-pole round plug, unit end 12-pole plug	VW3M8101R200

11.5   Crimping tool and connector / contacts

Description	Order number
Crimping pliers for CN2 and CN5: Molex 69008-0982	
Extraction tool for crimped contacts: Molex 11-03-0043	
5* connector set Molex 10-pin for CN5	VW3M8212
5* connector set Molex 12-pin for CN2	VW3M8213

11.6   RS 422: pulse/direction, ESIM and A/B

Description	Order number
Cable pulse/direction, ESIM, A/B, unit end 10 pole, other end open, 0.5m	VW3M8201R05
Cable pulse/direction, ESIM, A/B, unit end 10 pole, other end open, 1.5m	VW3M8201R15
Cable pulse/direction, ESIM, A/B, unit end 10 pole, other end open, 3m	VW3M8201R30
Cable pulse/direction, ESIM, A/B, unit end 10 pole, other end open, 5m	VW3M8201R50
Cable pulse/direction, ESIM, AB on Premium CAY, 0.5m, 10-pole + 15-pole SubD	VW3M8203R05
Cable pulse/direction, ESIM, AB on Premium CAY, 1.5m, 10-pole + 15-pole SubD	VW3M8203R15
Cable pulse/direction, ESIM, AB on Premium CAY, 3m, 10-pole + 15-pole SubD	VW3M8203R30
Cable pulse/direction, ESIM, AB on Premium CAY, 5m, 10-pole + 15-pole SubD	VW3M8203R50
Cable pulse/direction, ESIM, AB on Premium CFY, 0.5m, 10-pin connector, other end open	VW3M8214R05
Cable pulse/direction, ESIM, AB on Premium CFY, 1.5m, 10-pin connector, other end open	VW3M8214R15
Cable pulse/direction, ESIM, AB on Premium CFY, 3m, 10-pin connector, other end open	VW3M8214R30
Cable pulse/direction, ESIM, AB on Premium CFY, 5m, 10-pin connector, other end open	VW3M8214R50
Cable pulse/direction, ESIM, AB on RVA, USIC or WP/WPM311, 0.5m	VW3M8209R05
Cable pulse/direction, ESIM, AB on RVA, USIC or WP/WPM311, 1.5m	VW3M8209R15
Cable pulse/direction, ESIM, AB on RVA, USIC or WP/WPM311, 3m	VW3M8209R30
Cable pulse/direction, ESIM, AB on RVA, USIC or WP/WPM311, 5m	VW3M8209R50
cable pulse/direction, USIC, 15-pin SubD, other end off, 0.5m	VW3M8210R05
cable pulse/direction, USIC, 15-pin SubD, other end off, 1.5m	VW3M8210R15
cable pulse/direction, USIC, 15-pin SubD, other end off, 3m	VW3M8210R30
cable pulse/direction, USIC, 15-pin SubD, other end off, 5m	VW3M8210R50
cascader cable for RVA, 0.5m	VW3M8211R05

11.7   Mains filters

Description	Order number
mains filter 1~; 9A; 115/230VAC	VW3A31401
mains filter 1~; 16A; 115/230VAC	VW3A31403
mains filter 3~; 15A; 230/480VAC	VW3A31404
mains filter 1~; 22A; 115/230VAC	VW3A31405
mains filter 3~; 25A; 230/480VAC	VW3A31406
mains filter 3~; 47A; 230/480VAC	VW3A31407

11.8   Mains reactor s

Description	Order number
Mains reactor 1~; 50-60Hz; 7A; 5mH; IP00	VZ1L007UM50
Mains reactor 1~; 50-60Hz; 18A; 2mH; IP00	VZ1L018UM20
Mains reactor 3~; 50-60Hz; 10A; 4mH; IP00	VW3A66502
Mains reactor 3~; 50-60Hz; 16A; 2mH; IP00	VW3A66503
Mains reactor 3~; 50-60Hz; 30A; 1mH; IP00	VW3A66504
Mains reactor 3~; 50-60Hz; 60A; 0.5mH; IP00	VW3A66505

11.9   Installation material

Description	Order number
adapter plate for top-hat rail mounting, width 77.5mm	VW3A11851
adapter plate for top-hat rail mounting, width 105mm	VW3A31852
EMC kit size 1	VW3M2101
EMC kit size 2 & 3	VW3M2102
EMC kit size 4	VW3M2103

12   Service, maintenance and disposal

⚠ DANGER

Electric shock, fire or explosion

- Only qualified personnel who are familiar with and understand the contents of this manual are authorised to work on and with this drive system.

- The system manufacturer is responsible for compliance with all applicable regulations relevant to earthing the drive system.

- Many components, including printed wiring boards, operate at mains voltage. **Do not touch**. Do **not** touch unshielded components or screws of the terminals with voltage present.

- Install all covers and close the housing doors before applying power.

- The motor generates voltage when the shaft is rotated. Lock the shaft of the motor to prevent rotation before starting work on the drive system.

- Before working on the drive system:

  – Switch off power to all terminals.

  – Place a sign "DO NOT SWITCH ON" on the switch and lock to prevent switching on.

  – **Wait 6 minutes** (for discharge of DC bus capacitors). Do **not** short-circuit DC bus

  – Measure voltage at DC bus and check for <45V. (The DC bus LED is not a safe indication for absence of the DC bus voltage).

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

⚠ CAUTION

Destruction of system components and loss of control monitoring

Excessive currents can be created at the signal connections if the negative connection to the controller supply voltage is interrupted.

- Do not interrupt the negative connection between power supply unit and load with a fuse or switch

- Check for correct connection before switching on.

- Never connect the controller supply voltage or change its wiring while there is supply voltage present.

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

ℹ️ *You cannot carry out repairs yourself. The repair should only be carried out by a certified customer service organisation. No warranty or liability is accepted for repairs made by the customer.*

12.1 Service address

If you cannot resolve the fault yourself please contact your appointed sales partner. Have the following details available:

• Type, identification number and serial number of the product (type plate)

• Type of fault (possibly with fault number)

• Previous and concurrent conditions

• Your own ideas regarding the cause of the fault

Include this information if you return the product for inspection or repair.

If you have any questions please contact your local dealer.
Your dealer will be happy to give you the name of a
customer service outlet in your area.

http://www.telemecanique.com

12.2 Maintenance

The product is maintenance free.

12.3 Replacing units

┌───┐
│   ⚠ **WARNING**   │
├───┤
│ **Unexpected behaviour**   │
│   │
│ The behaviour of the drive system is governed by numerous stored │
│ data or settings. Unsuitable settings or data may trigger unexpec- │
│ ted movements or reactions to signals and disable monitoring func- │
│ tions.   │
│   │
│ • Do not operate a drive system with unknown settings or data. │
│   │
│ • Check the stored data or settings.   │
│   │
│ • When commissioning carefully run tests for all operating statu- │
│   ses and fault cases.   │
│   │
│ • Check 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 materials in │
│   the danger zone and the system can be operated safely. │
│   │
│ **Failure to follow these instructions can result in death, se-** │
│ **rious injury or equipment damage.**   │
└───┘

Prepare a list with the parameters required for the functions
in use.

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Observe the following procedure when changing the devices.

▶ Store all parameter settings in your PC with the commissioning soft-ware, see 7.6.9.3 "Duplicate existing device settings" page 7-42.

▶ Switch off all power supplies. Make sure that power is no longer connected (safety instructions).

▶ Label all connections and remove the product.

▶ Note the identification number and the serial number from the pro-duct nameplate for later identification.

▶ Install the new product as specified in chapter 5 "Installation"

▶ If the product that you are installing was previously used in a diffe-rent part of the system, the factory settings must be reset before commissioning. See 7.6.9.2 "Restore factory settings" from page 7-41.

▶ Carry out commissioning in accordance with chapter 6 "Commissio-ning". Note that with the same motor setting the motor position will no longer match when the device is replaced. This also changes the position of the virtual index point. The motor position associated with the motor installation must be redefined, see parameter ENC_pabsusr.

12.4   Changing the motor

> ⚠ **WARNING**
>
> **Unexpected movement**
>
> Drives can make unexpected movements if incorrectly connected or because of other faults.
>
> • Operate the device with approved motors only. Even if motors are similar, different adjustment of the encoder system may be a source of danger.
>
> • Check the wiring. Compatibility is not ensured even with mat-ching connectors on power connection and encoder system.
>
> **Failure to follow these instructions can result in death, se-rious injury or equipment damage.**

▶ Switch off all power supplies. Make sure that power is no longer connected (safety instructions).

▶ Label all connections and remove the product.

▶ Note the identification number and the serial number from the pro-duct nameplate for later identification.

▶ Install the new product as specified in chapter 5 "Installation"

If the motor originally fitted is changed for a different one, the motor data set is reread. If the device recognises a different motor type, the control parameters are recalculated and *nou* is shown on the HMI.

When the motor is replaced the parameters for the encoder must also be reset, see chapter 6.4.11 "Setting parameters for encoder".

Change motor type temporarily only ▶ Press ESC if you only want to operate the new motor type temporarily on this device.

◁ The newly calculated control parameters are not stored in the EEPROM. This means that the original motor can be put back into operation using the previously stored control parameters.

Change motor type permanently ▶ Press ENT if you wish to operate the new motor type permanently in this device.

◁ The newly calculated control parameters are stored in the EEPROM.

12.5   Shipping, storage, disposal

Note the ambient conditions on page 3-1!

Shipping   The product must be protected against shocks during transport. Use the original packaging for this purpose.

Storage   Store the product only under the specified, approved environmental conditions for room temperature and humidity.
Protect the product against 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

13 Glossary

13.1 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 metres [m] to yards [yd]
5 m / 0.9144 = 5.468 yd

13.1.1 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	-

13.1.2 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	/ 0.453592370	/ 0.02834952	/ 14.5939	-	* 1000
g	/ 453.592370	/ 28.34952	/ 14593.9	/ 1000	-

13.1.3 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	/ $9.807*10^{-3}$	* $100*10^{3}$	-

13.1.4 Power

	HP	W
HP	-	* 745.72218
W	/ 745.72218	-

13.1.5 Rotation

	1/min (RPM)	rad/s	deg./s
1/min (RPM)	-	* π / 30	* 6
rad/s	* 30 / π	-	* 57.295
deg./s	/ 6	/ 57.295	-

13.1.6 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	/ $10*10^6$	/ $98.066*10^6$	/ $0.9806*10^6$	-

13.1.7 Moment of inertia

	lb·in²	lb·ft²	kg·m²	kg·cm²	kp·cm·s²	oz·in²
lb·in²	-	/ 144	/ 3417.16	/ 0.341716	/ 335.109	* 16
lb·ft²	* 144	-	* 0.04214	* 421.4	* 0.429711	* 2304
kg·m²	* 3417.16	/ 0.04214	-	* $10*10^3$	* 10.1972	* 54674
kg·cm²	* 0.341716	/ 421.4	/ $10*10^3$	-	/ 980.665	* 5.46
kp·cm·s²	* 335.109	/ 0.429711	/ 10.1972	* 980.665	-	* 5361.74
oz·in²	/ 16	/ 2304	/ 54674	/ 5.46	/ 5361.74	-

13.1.8 Temperature

	°F	°C	K
°F	-	(°F - 32) * 5/9	(°F - 32) * 5/9 + 273.15
°C	°C * 9/5 + 32	-	°C + 273
K	(K - 273.15) * 9/5 + 32	K - 273.15	-

13.1.9 Conductor cross section

AWG	1	2	3	4	5	6	7	8	9	10	11	12	13
mm²	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
mm²	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

13.2   Terms and Abbreviations

AC	Alternating Current
Actual position	Current absolute or relative position of moving components in the drive system.
DC	Direct current
Default value	Factory settings.
Direction of rotation	Rotation of the motor shaft in a positive or negative direction of rotation. A positive direction of rotation is defined as the motor shaft rotating clockwise as the observer faces the end of the protruding shaft.
Drive system	The drive system consists of the controller, power amplifier and motor.
EMC	Electromagnetic compatibility.
Encoder	Sensor for recording the angular position of a rotating element. The encoder is mounted on the motor and signals the angular position of the rotor.
Error class	Classification of operational faults into groups corresponding to the error responses
EU	European Union
FI	Fault current
Holding brake	brake that only prevents the motor from rotating without power after it has stopped (e.g. a vertikal-axis lowering). It must not be used as a service brake for braking motion.
I^2t-monitoring	Predictive temperature monitoring. The expected temperature rise of unit components is calculated in advance on the basis of the motor current. If a limit value is exceeded, the drive system reduces the motor current.
I/O	Inputs/Outputs
Inc	Increment
Index pulse	Encoder signal for referencing the rotor position in the motor. The encoder sends one index pulse per revolution.
Internal units	Resolution of the power amplifier with which the motor is directed to the new setpoint. Internal units are given in increments.
IT mains	Mains in which all active components are isolated from earth or are earthed by a high impedance. IT: isolé terre (French), isolated earth. Opposite: earthed networks, see TT/TN network
Limit switch	Switch that signals an overrun of the permissible travel range.
NTC	resistance with negative temperature coefficient. Resistance value is reduced as the temperature rises.
Parameter	Device functions and values that can be set and called by the user.
PC	Personal Computer
PELV	Protective Extra Low Voltage, functional low voltage with safe isolation.
persistent	Designation of whether the value of the parameter is persistent, i.e. after switching off the unit it is retained in the memory. When changing a value

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via commissioning software or fieldbus, the user must explicitly store the value change in the persistent memory.

PLC	Programmable Logic Controller
Power amplifier	A device that generates current for controlling the motor in accordance with the positioning signals from the controller.
Protection class	The protection class is a standardised specification for electrical equipment that describes the protection against the ingress of foreign bodies and water (for example, IP20).
PTC	resistance with positive temperature coefficient. Resistance value is increased as the temperature rises.
Pulse control	An input speed is recalculated by the drive system using the values of an adjustable gear factor to derive a new output speed for the motor movement.
Pulse direction signals	Digital signals with variable pulse frequencies which signal changes in position and rotation direction via separate signal wires.
Quick Stop	Quick stop, function used to provide quick braking of the motor via a command or in the event of a fault.
Releasing the brake	Drive may move when unbraked
rms	RMS value of a voltage (V_{rms}) or a current (A_{rms}); abbreviation of "Root Mean Square".
RS485	Fieldbus interface compliant with EIA-485, which enables serial data transmission with multiple devices.
Scaling factor	This factor gives the relationship between an internal unit and the user unit.
TT mains, TN mains	Earthed mains, distinguished by the PE conductor connection. Opposite: unearthed networks, see IT mains
User-defined unit	Unit whose reference to motor rotation can be determined by the user via parameters.
Watchdog	Equipment that monitors cyclic basic functions in the drive system. Power amplifier and outputs are switched off in the event of error.

13.3 Product name

LXM05C	AC servo amplifier
PowerSuite	PC software for commissioning
HBC	Holding brake controller
Peripheral control terminal	hand-held operating unit
USIC	(Universal Signal Interface Converter) adapter for RS422 standard
RVA	Reference value adapter for distribution of A/B or pulse/direction signals to 5 units

14   Extract

This extract does not replace the manual. It simply provides a brief over-
view of the device, but it is definitely not sufficient for correct commissio-
ning. The manual must always be read carefully before commissioning
to prevent errors in connection or installation.

14.1   Electromagnetic compatibility, EMC

Note the EMC specifications and instructions in the chapter on "Instal-
lation". Make sure that all national regulations are observed.

14.2   Compact installation

> ### ⚠ WARNING
>
> **Loss of control over controller**
>
> • Observe the accident prevention regulations. (For USA see
>   also NEMA ICS1.1 and NEMA ICS7.1)
>
> • The system manufacturer must take the potential error possibi-
>   lities of the signals and the critical functions into account to
>   ensure a safe status during and after errors. Some examples
>   are: emergency stop, final position limitation, power failure and
>   restart.
>
> • The assessment of error possibilities must also include unex-
>   pected delays and the failure of signals or functions.
>
> • Suitable redundant control paths must be in place for dange-
>   rous functions.
>
> • Check that measures taken are effective.
>
> **Failure to follow these instructions can result in death or se-
> rious injury.**

*The chapter on engineering contains basic information that
you should know before starting the installation.*

Figure 14.1   Wiring overview

(1)   The layout of the power connections depends on the device type, for the exact assignment see "Installation"

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14.3 Compact commissioning

> ⚠ **WARNING**
>
> **Unexpected movement**
>
> When the drive is operated for the first time there is a high risk of unexpected movement because of possible wiring errors or unsuitable parameters.
>
> • If possible, run the first test movement without coupled loads.
>
> • Make sure that a functioning button for EMERGENCY STOP is within reach.
>
> • Also anticipate a movement in the incorrect direction or oscillation of the drive.
>
> • Make sure that the system is free and ready for the movement before starting the function.
>
> **Failure to follow these instructions can result in death, serious injury or equipment damage.**
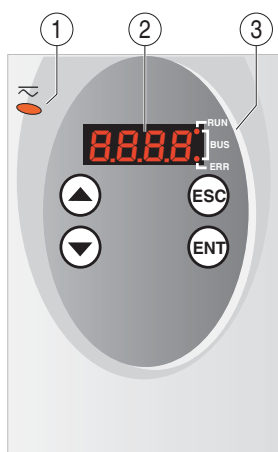
(1)	Red LED on: voltage applied at DC bus
(2)	Status display
(3)	LEDs
ESC	• Closing a menu or parameter
	• Return from displayed to last saved value
ENT	• Calling a menu or parameter
	• Save the displayed value in the EEPROM
▲	• Switch to previous menu or parameter
	• Increase the displayed value
▼	• Switch to next menu or parameter
	• Reduce the displayed value

14.3.1 HMI menu structure
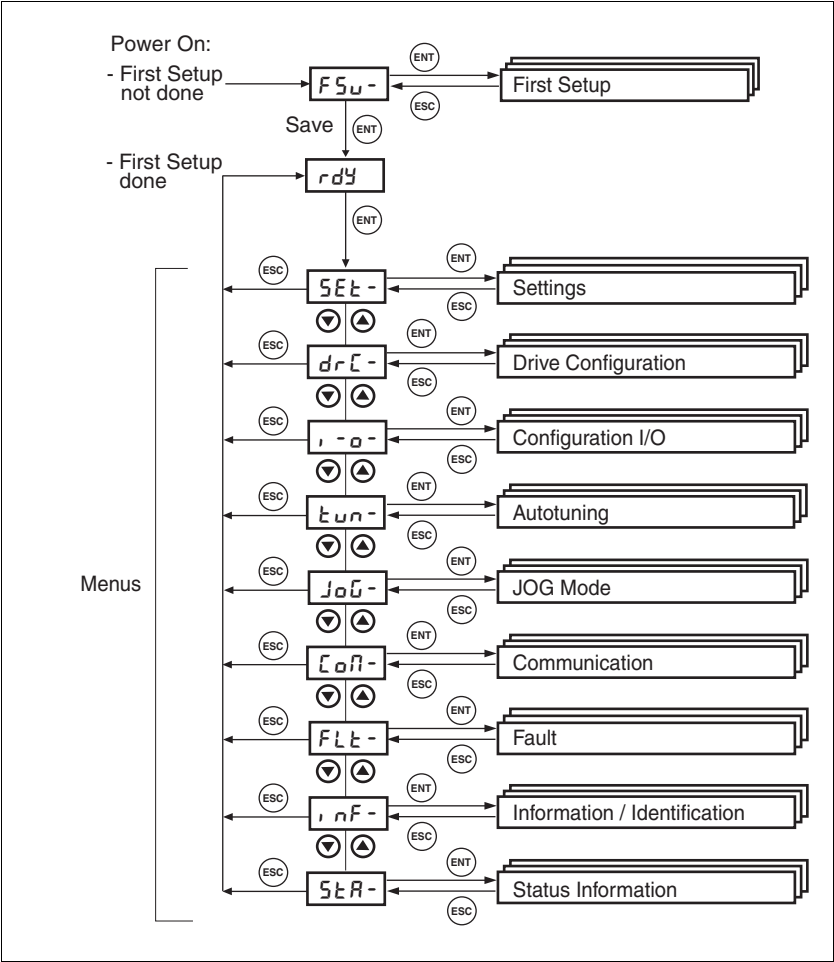
Figure 14.2   HMI menu structure

HMI, example of parameter setting
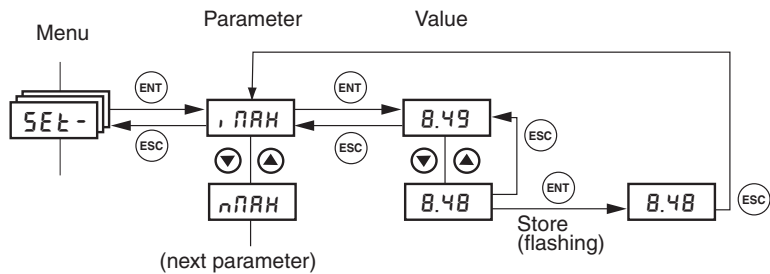
The adjacent figure shows an example for calling a parameter (second level) and the input or selection of a parameter value (third level).

When you press ENT, the selected value is accepted. Confirmation is indicated by the display flashing once. The modified value is saved in the EEPROM immediately.

14.3.2 "First Setup" (FSU) via HMI

For "First setup" with the HMI run the following steps and make selections corresponding to the application.

For more information see "Commissioning".

```
FSu-
 │
ENT
 │
ioPi ◄──ENT──► Rb        ENT
 ▼▲   ◄─ESC─   Pd
              CuCC
              ▼▲
```
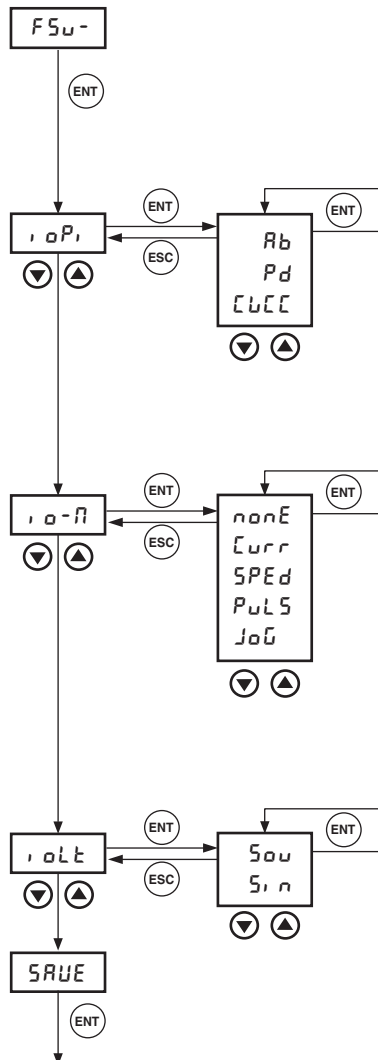
▶ *ioPi* : select interface mode for electronic gear operating mode (CN1 Pin 51-55):
A/B signals (*Rb*), pulse/direction signal (*Pd*) or CW/CCW (*CuCC*)

Rb	A/B signals
Pd	Pulse/direction signals
cucc	Pulse CW/CCW (clockwise/counterclockwise)

```
io-M ◄──ENT──► nonE      ENT
 ▼▲   ◄─ESC─   Curr
              SPEd
              PuLS
              JoG
              ▼▲
```

▶ *io-M*: select operating mode

Curr	Current control
SPEd	Speed control
GERr	Electronic gear
JoG	Manual mode

```
ioLt ◄──ENT──► Sou       ENT
 ▼▲   ◄─ESC─   Sin
              ▼▲
```

▶ *ioLt*: select logic type (see "Engineering"):
source (*Sou*) or sink (*Sin*)

▶ Save settings.

SAVE	Save settings in device.

```
SAVE
 │
ENT
 │
 ▼
```

◁ The device saves all set values in the EEPROM and displays the status *nrdY*, *rdY* or *diS* on the HMI.

▶ Switch controller supply voltage off and on again.

Proceed as follows to restore the factory settings:

▶ Set *drC* and then *FCS* on the HMI and confirm your selection with *YES*.

The new settings only become effective after switching off and switching on the device again.

14.3.3 Jog

For a simple initial commissioning the motor should not be connected to the system. If the motor is connected to the system, all limiting parameters must be checked and an EMERGENCY STOP button must be within reach before the first motor movement, see product manual.

If the inertia ratio of Jext/Jmotor > 10 (external load on motor), the initial setting of the controller parameter may result in an unstable controller
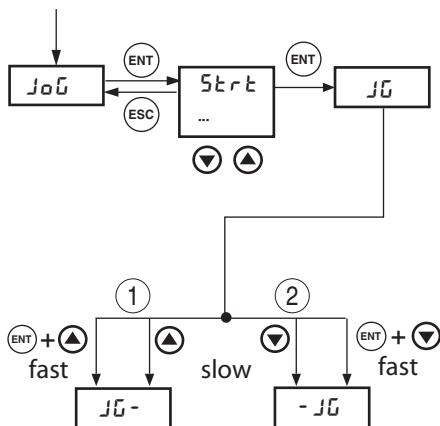
▶ Start the jog operating mode. (HMI: *JoG- / Strt*)

◁ HMI display: *JG*

▶ Start a movement in clockwise rotation (1)
(HMI: "up arrow")

◁ The motor rotates in the clockwise rotation. HMI display *JG-*

▶ Start a movement in counterclockwise rotation (2)
(HMI: "down arrow")

◁ The motor rotates in counterclockwise direction of rotation. HMI display: *-JG*

You can change from slow to fast movement by simultaneously pushing the ENT-button.

If the motor does not rotate:

• Is the controller supply voltage switched on?

• Is the power amplifier supply voltage switched on?

• Is the device in status *rdY*?

• Has "First Setup" been conducted or have device settings been imported? Was the controller supply voltage switched off and on after that?

• Does the display show an error number? For more information on the error numbers see "Diagnostics and troubleshooting"

14.3.4 Duplicate existing device settings

Application and advantage • Multiple devices should have the same settings, e.g. when devices are replaced.

• "First setup" does not need to be carried out using the HMI.

Requirements Device type, motor type and device firmware must be identical. The tool is the Windows-based commissioning software. The controller supply voltage must be switched on at the device.

Export device settings The commissioning software installed on a PC can apply the settings of a device as configuration.

▶ Load the configuration of the device into the commissioning software with "Action - Transfer".

▶ Highlight the configuration and select "File - Export".

Import device settings A stored configuration can be imported into a device of the same type. Please note that the fieldbus address is also copied with this information.

▶ In the commissioning software select the menu item "File - Import" and load the desired configuration.

▶ Highlight the configuration and select "Action - Configure".

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