Operating Manual

Rev. 1.3

Integrated Synchronous Servo Drives

HFI22xx / HFI26xx
HFI32xx / HFI37xx

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Document History

Document	Date (dd.mm.yyyy)	Rev	Changes
HFI_BA_Rev1.0_180627_de	27.06.2018	1.0	First revision of HFI_BA
HFI_BA_Rev1.1_180912_en	12.09.2018	1.1	Update of the reference standards in chapters 4 and 6
HFI_BA_Rev1.2_190628_en	28.06.2019	1.2	Update of System Data
HFI_BA_Rev1.3_201125_en	25.11.2020	1.3	- Addition of internal wiring of DOs in installation plan (10.2) - Complementation of Requirements of the STO line (10.1.3) - Complementation of chapter Digital inputs/limit switches (8.3) - Revision of chapter I²t monitoring (8.5)

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HFI_BA_Rev1.3_201125_en
Technical changes reserved

1 Introduction

This document describes the technical data and functions of the HFI series of integrated synchronous servo drives. It explains the functional capabilities of the drives, serves for the drive project design and explains the correct procedure for installation and commissioning of the devices.

The drives of the HFI series are optionally equipped with different communication modules. The specific communication protocols are described in the corresponding documents (**CANopen® Manual**, **EtherCAT® Manual** …).

2 Symbols used in this document

Symbol	Signal Word	Meaning
	Attention!	This symbol refers to safety and warning notices. Non-observance can result in personal injury and/or damage to property.
	Note!	This symbol refers to useful hints, which should help to avoid or find errors.

3 Abbreviations used in this document

Abbreviation	Meaning
AI	**A**nalogue **I**nput
CAN	**C**ontroller **A**rea **N**etwork
CANopen	communication protocol for CAN-Bus systems
CiA	**C**AN **i**n **A**utomation - CAN users' and manufacturers' organization
DO	**D**igital **O**utput
DI	**D**igital **I**nput
DSP 402	CANopen device profile for drives and motion control
I/F	**I**nter**f**ace
Node-ID	CAN Node Identifier
PMSM	**P**ermanent **M**agnet **S**ynchronous **M**otor
RPM	**R**evolutions **p**er **M**inute

4 Safety information and instructions for use

Attention!

The safety instructions must be observed!
Non-observance of the safety instructions can result in personal injury and damage to property.

- During the installation, commissioning and maintenance, the applicable safety and accident prevention regulations must be observed for the specific application.
- The device applies as electronic equipment and is intended for operation in machines. The safety instructions of the Machinery Directive (2006/42/EC) must be observed.
- Prior to commissioning, it must be ensured that the drive does not pose any hazards and that no uncontrolled movements can occur.
- Do not plug or unplug connectors while energized!

The following regulations apply with no claim to completeness:

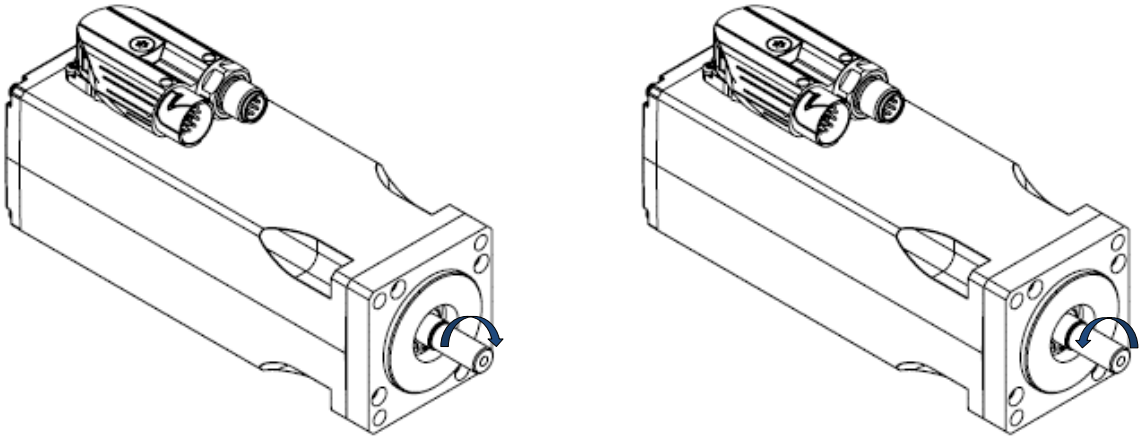
VDE 0100	Low-voltage electrical installations
EN 60204-1	Safety of machinery – Electrical equipment of machines
EN 61800	Adjustable speed electrical power drive systems

Attention!

Functional Safety
For devices with functional safety (HFIxxxx-**S**x00-xx**)** the operating instructions supplement *Integrated Drives HFI equipped with STO-Module* must **also** be consulted.

4.1 Definition of the direction of rotation for motors

In accordance with DIN EN 60034-8 the direction of rotation is the direction viewed from the drive end. I.e. with clockwise rotation the shaft turns clockwise and with counter-clockwise rotation the shaft turns counter-clockwise (viewing direction onto the shaft end).



clockwise rotation (cw) counter-clockwise rotation (ccw)

Figure 4-1: Direction of rotation for motors

5 Functional description

In the HFI series of integrated drives, powerful and dynamic synchronous servo motor systems (PMSM) designed in concentrated winding technology are combined with compact electronics to form high-quality drive systems. The devices are designed for operation at low voltage, their cascaded current, speed and position control loops provide a dynamic operation. The integrated positioning control offers a temporally optimised point-to-point positioning with trapezoidal or jerk-limited speed progression.

Operation of the device is possible either via fieldbus or via digital and analogue inputs and outputs. The flexibility of the devices is provided through communication modules. The following variants are currently supported:

- **EtherCAT**-communication module (Anybus CompactCom™ 40-series)
- **PROFINET**-communication module (Anybus CompactCom™ 40-series)
- **EtherNet/IP**-communication module (Anybus CompactCom™ 40-series)

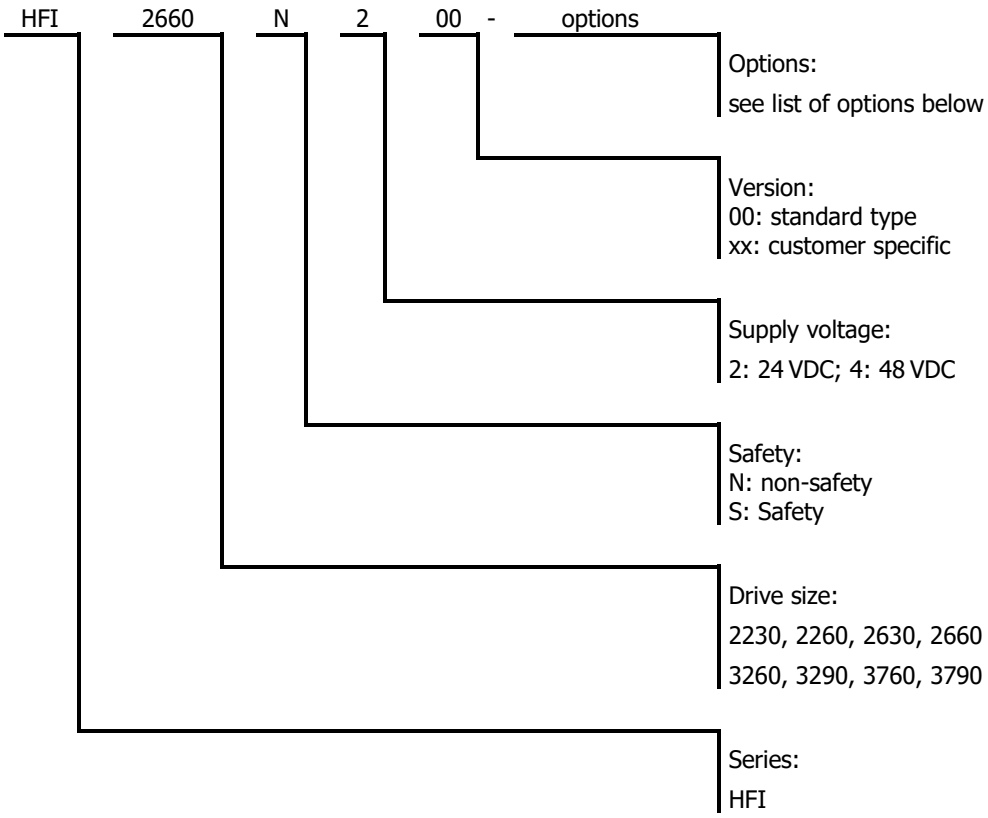
Furthermore, the device is available in a CAN-variant. In this variant no communication module is required. Communication takes place via **CANopen** according to CiA DSP 402 V2.0.

The simple parameterisation/configuration of the device takes place with the parameterisation software **DServ** (WINDOWS, COM-Port).

Overview of features:

- dynamic compact drives for decentralised use; no space in the control cabinet required
- powerful designs with up to 1.8 Nm rated torque and 4.0 Nm peak torque
- designs for operation at 24 VDC or 48 VDC
- separated logic supply providing runtime data retention during power down conditions
- short cycle times of the PI current (100 µs), PI speed (100 µs) and P position (200 µs) controllers with a powerful signal processor
- point to point positioning functionality with linear or Sin² speed ramp
- 12-bit high-resolution angle sensor system
- variable fieldbus interface via communication module (optional)
- CAN-interface (optional), galvanically isolated. CANopen® with implementation of device specification CiA® DSP 402 V2.0.
- available with permanent magnet parking brake
- available with planetary gear
- high protection class IP54 (higher protection class on request)
- parameterisation/configuration with the parameterisation software **DServ** (WINDOWS, COM-Port)

5.1 Type key



List of options (non-exhaustive)

HB	parking brake	permanent magnetic, installed in the motor
CO	CANopen Interface	additional M12 connector
EC	EtherCAT	fieldbus communication module
EI	EtherNet/IP	fieldbus communication module
PN	PROFINET	fieldbus communication module
SC	surface coating	housing
GPK-xxx	planetary gear GPK	mounted onto the motor, gear reduction xxx : 1

Attention!

Functional Safety
For devices with functional safety (HFIxxxx-**S**x00-xx**)** the operating instructions supplement *Integrated Drives HFI equipped with STO-Module* must **also** be consulted.

6 Technical Data

6.1 System Data

Designation	Unit	Value	additional information
Input Voltage*1)	VDC	24 / 48	±20 %
Ambient Temperature	°C	0 ... 40	No condensation permissible
Storage Temperature	°C	-25 ... 60	No condensation permissible
Number of poles		6	
Protection Class		IP54	(higher protection class on request)
Analogue Inputs			
AI1 (differential input)		±10 V, 12 bit, R_i=22 kΩ	can optionally be used as digital input (DI6)
Digital Inputs			
DI1 ... DI8	V	0.0 ≤ U_{off} ≤ 5.0 15.0 ≤ U_{on} ≤ 30	DI1 = control enable DI4/DI5 can optionally be used as digital output DO2/DO1
Digital Outputs			
DO1, DO2		24 V, 50 mA	open collector, ground switching*3), 33 Ω series resistance, without pull-up resistor, can optionally be used as inputs
Serial Interfaces			
		RS232	Communication with DSerV parameterisation software
		CAN 2.0B (max. 1 MBit/s)	galvanically isolated without termination resistor
Electromagnetic compatibility			
Emission *2)		DIN EN 61800-3: 2012-09	second environment/limited availability (Cat. C3)
Immunity		DIN EN 61800-3: 2012-09	second environment

*1) Observe chapter 6.6.1 Regenerative operation

*2) Cable-conducted emissions must be suppressed through appropriate filtering measures in the energy supply (e.g. power supply unit) of the device.

*3) Internal wiring of DOs see chapter 10.2 Installation diagram.

6.2 System Data HFI22xx

Designation	Unit	Value		additional information
		HFI2230	HFI2260	
Rated speed	min^{-1}	4000	3000	
Peak speed	min^{-1}	5000	4000	
Rated input current*1)	ADC	6.1 / 3.0	7.1 / 3.6	24V-Type/48V-Type
Rated motor current*2)	A_{spk}	9.5 / 4.8	12.3 / 6.2	24V-Type/48V-Type
Peak motor current*2)	A_{spk}	19.5 / 9.8	25.0 / 12.5	24V-Type/48V-Type
Motor current measurement range	A	27.5 / 13.8	55.0 / 27.5	24V-Type/48V-Type
Rated power*3)	W	95	120	
Rated torque*3)	Nm	0.23	0.38	
Peak torque	Nm	0.50	0.8	
Torque constant	Nm/A	0.027 / 0.054	0.033 / 0.066	24V-Type/48V-Type
Voltage constant	$V/1kmin^{-1}$	3.3 / 6.6	4.0 / 8.0	24V-Type/48V-Type
Flange dimension	mm^2	47 x 47		
Drive length (without fieldbus module)*4)	mm	129 / 161	159 / 191	without/with parking brake
Weight	kg	0.85 / 1.0	1.15 / 1.3	without/with parking brake
Parking Brake (optional)**:**				automatically operated
Static braking torque	Nm	1.0		
Power (electric)	W	10		

*1) The rated input current is the direct current drawn in nominal operation (rated torque at rated speed) from the input voltage (24 VDC or 48 VDC). The current drawn from the input voltage is proportional to the converted power, not to be confused with the torque-building motor current, which is displayed as sine peak value in **DSerV** and is proportional to the motor torque.
Please also observe that the supply line is lossy. This leads to a reduction in voltage and speed at the motor system and to increased power consumption of the device. A connection line with a nominal cross-section of 1.5 mm^2 already has an overall loss resistance of approx. 2 x 12.5 mΩ/m (conductors and return conductors)! Appropriate power reserves must be provided in the supply!

*2) Motor phase current as a sine peak value, which is required for the generation of the rated or peak torque. Motor phase current is displayed in **DSerV**. Not to be confused with the current taken from the supply.

*3) The specified values apply for the installation of the drive on a system surface made of aluminium (A = 0.1 m^2, d = 10 mm). It must be taken into consideration that the specified continuous output power must be derated for thermally unfavourable couplings.

*4) With fieldbus module the length of the drive increases by 14 mm.

6.2.1 HFI2230 characteristics

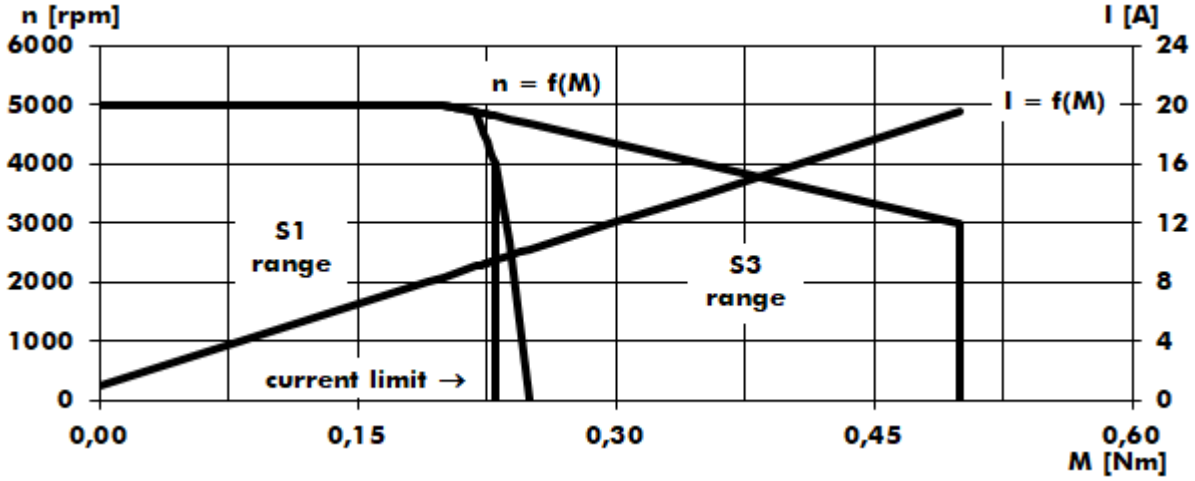


Figure 6-1: HFI2230 characteristics, 24 V, 4000/5000 rpm

6.2.2 HFI2260 characteristics

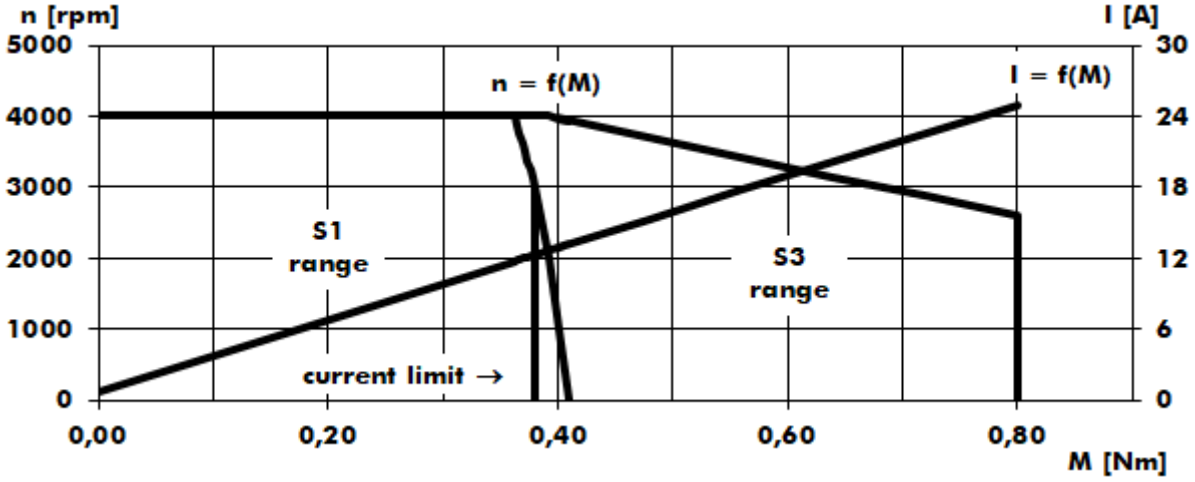


Figure 6-2: HFI2260 characteristics, 24 V, 3000/4000 rpm

6.3 System Data HFI26xx

Designation	Unit	Value		additional information
		HFI2630	HFI2660	
Rated speed	min^{-1}	4000	3000	
Peak speed	min^{-1}	5000	4000	
Rated input current*1)	ADC	8.8 / 4.4	10.6 / 5.3	24V-Type/48V-Type
Rated motor current*2)	A_{spk}	13.2 / 6.8	17.9 / 8.9	24V-Type/48V-Type
Peak motor current*2)	A_{spk}	26.5 / 13.7	37.5 / 18.5	24V-Type/48V-Type
Motor current measurement range	A	55.0 / 27.5		
Rated power*3)	W	150	190	
Rated torque*3)	Nm	0.36	0.61	
Peak torque	Nm	0.75	1.30	
Torque constant	Nm/A	0.030 / 0.058	0.036 / 0.073	24V-Type/48V-Type
Voltage constant	$V/1kmin^{-1}$	3.6 / 7.0	4.4 / 8.8	24V-Type/48V-Type
Flange dimension	mm^2	55 x 55		
Drive length (without fieldbus module)*4)	mm	136 / 166	166 / 196	without/with parking brake
Weight	kg	1.2 / 1.45	1.6 / 1.85	without/with parking brake
Parking Brake (optional)**:**				automatically operated
Static braking torque	Nm	2.0		
Power (electric)	W	10		

*1) The rated input current is the direct current drawn in nominal operation (rated torque at rated speed) from the input voltage (24 VDC or 48 VDC). The current drawn from the input voltage is proportional to the converted power, not to be confused with the torque-building motor current, which is displayed as sine peak value in **DSerV** and is proportional to the motor torque.
Please also observe that the supply line is lossy. This leads to a reduction in voltage and speed at the motor system and to increased power consumption of the device. A connection line with a nominal cross-section of 1.5 mm^2 already has an overall loss resistance of approx. 2 x 12.5 mΩ/m (conductors and return conductors)! Appropriate power reserves must be provided in the supply!

*2) Motor phase current as a sine peak value, which is required for the generation of the rated or peak torque. Motor phase current is displayed in **DSerV**. Not to be confused with the current taken from the supply.

*3) The specified values apply for the installation of the drive on a system surface made of aluminium (A = 0.1 m^2, d = 10 mm). It must be taken into consideration that the specified continuous output power must be derated for thermally unfavourable couplings.

*4) With fieldbus module the length of the drive increases by 14 mm.

6.3.1 HFI2630 characteristics

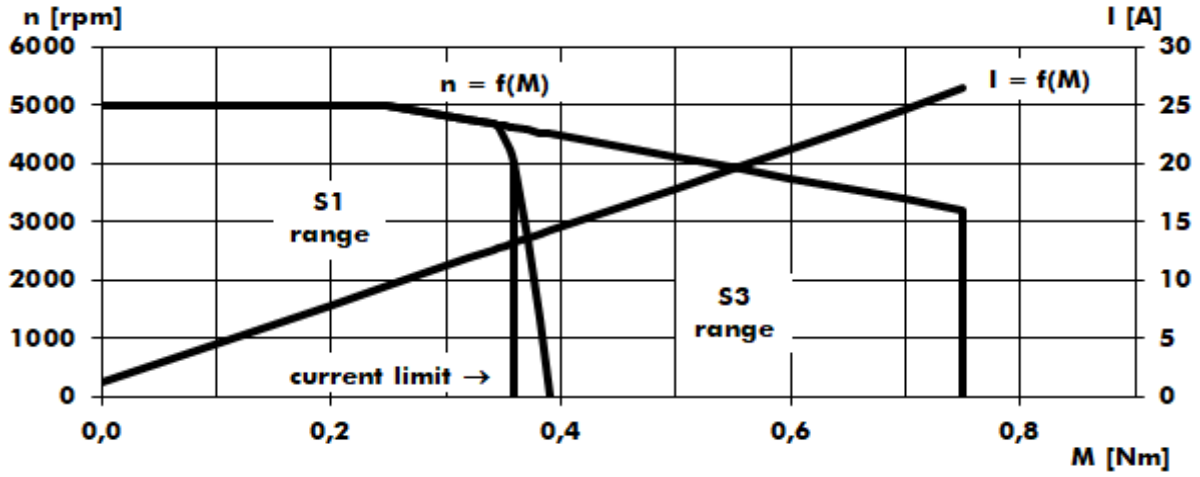


Figure 6-3: HFI2630 characteristics, 24 V, 4000/5000 rpm

6.3.2 HFI2660 characteristics

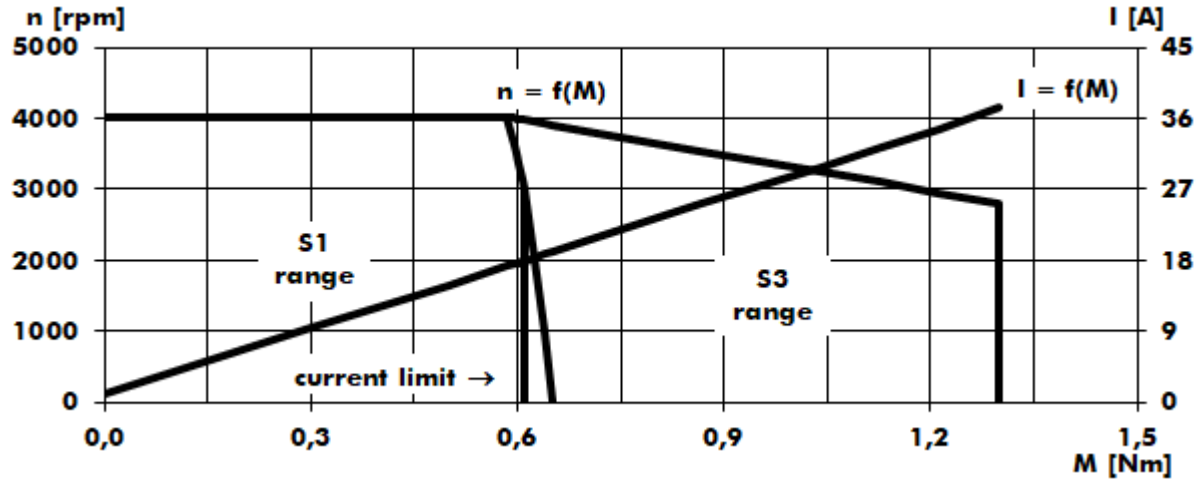


Figure 6-4: HFI2660 characteristics, 24 V, 3000/4000 rpm

6.4 System Data HFI32xx

Designation	Unit	Value		additional information
		HFI3260	HFI3290	
Rated speed	min^{-1}	2600 / 3000	- / 3000	24V-Type/48V-Type
Peak speed	min^{-1}	4000		
Rated input current*1)	ADC	14.0 / 8.0	- / 10.8	24V-Type/48V-Type
Rated motor current*2)	A_{spk}	25.3 / 13.7	- / 18.9	24V-Type/48V-Type
Peak motor current*2)	A_{spk}	51.5 / 26.8	- / 39.5	24V-Type/48V-Type
Motor current measurement range	A	75		
Rated power*3)	W	260 / 315	440	
Rated torque*3)	Nm	0.95 / 1.00	1.40	
Peak torque	Nm	2.00	3.00	
Torque constant	Nm/A	0.040 / 0.077	- / 0.078	24V-Type/48V-Type
Voltage constant	$V/1kmin^{-1}$	4.8 / 9.3	- / 9.4	24V-Type/48V-Type
Flange dimension	mm^2	65 x 65		
Drive length (without fieldbus module)*4)	mm	163 / 193	193 / 223	without/with parking brake
Weight	kg	2.1 / 2.4	2.7 / 3.0	without/with parking brake
Parking Brake (optional)**:**				automatically operated
Static braking torque	Nm	3.5		
Power (electric)	W	12		

*1) The rated input current is the direct current drawn in nominal operation (rated torque at rated speed) from the input voltage (24 VDC or 48 VDC). The current drawn from the input voltage is proportional to the converted power, not to be confused with the torque-building motor current, which is displayed as sine peak value in **DSerV** and is proportional to the motor torque.
Please also observe that the supply line is lossy. This leads to a reduction in voltage and speed at the motor system and to increased power consumption of the device. A connection line with a nominal cross-section of 1.5 mm^2 already has an overall loss resistance of approx. 2 x 12.5 mΩ/m (conductors and return conductors)! Appropriate power reserves must be provided in the supply!

*2) Motor phase current as a sine peak value, which is required for the generation of the rated or peak torque. Motor phase current is displayed in **DSerV**. Not to be confused with the current taken from the supply.

*3) The specified values apply for the installation of the drive on a system surface made of aluminium (A = 0.1 m^2, d = 10 mm). It must be taken into consideration that the specified continuous output power must be derated for thermally unfavourable couplings.

*4) With fieldbus module the length of the drive increases by 14 mm.

6.4.1 HFI3260 characteristics

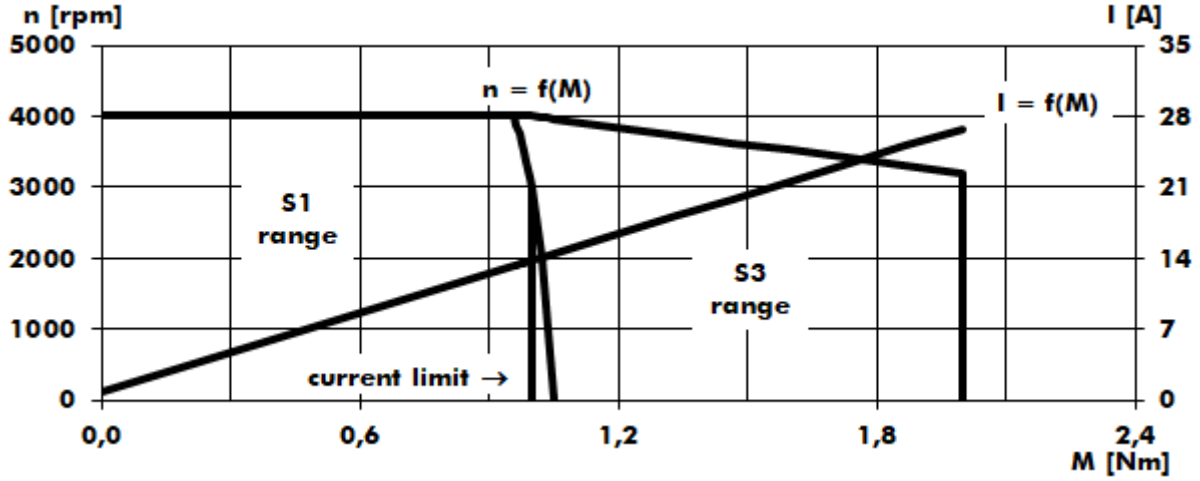


Figure 6-5: HFI3260 characteristics, 48 V, 3000/4000 rpm

6.4.2 HFI3290 characteristics

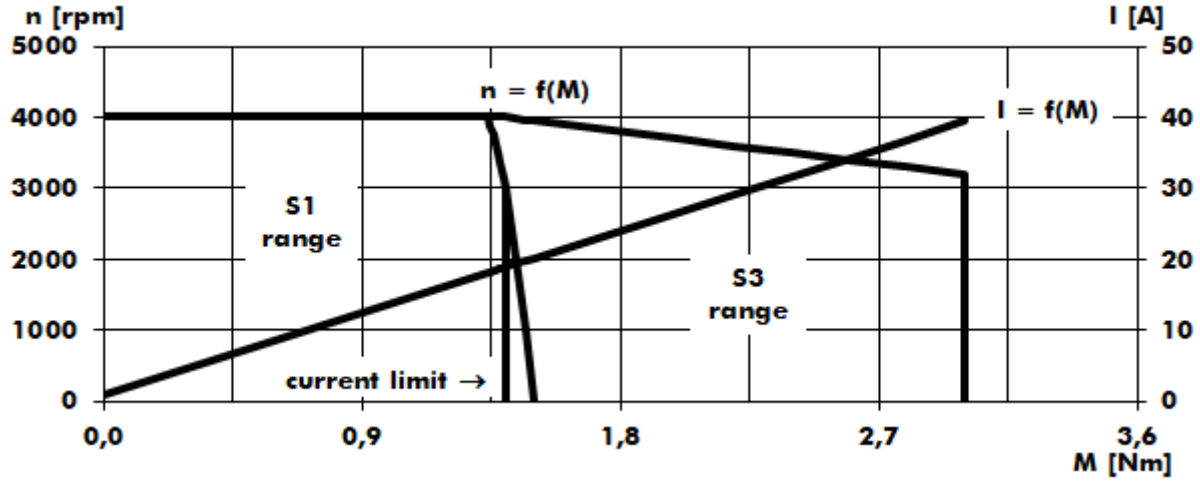


Figure 6-6: HFI3290 characteristics, 48 V, 3000/4000 rpm

6.5 System Data HFI37xx

Designation	Unit	Value		additional information
		HFI3760	HFI3790	
Rated speed	min^{-1}	3000		
Peak speed	min^{-1}	4000		
Rated input current*1)	ADC	- / 10.7	- / 13.4	24V-Type/48V-Type
Rated motor current*2)	A_{spk}	- / 19.2	- / 23.9	24V-Type/48V-Type
Peak motor current*2)	A_{spk}	- / 40.0	- / 52.0	24V-Type/48V-Type
Motor current measurement range	A	75		
Rated power*3)	W	440	565	
Rated torque*3)	Nm	1.4	1.8	
Peak torque	Nm	3.00	4.00	
Torque constant	Nm/A	- / 0.077	- / 0.079	24V-Type/48V-Type
Voltage constant	$V/1kmin^{-1}$	- / 9.3	- / 9.5	24V-Type/48V-Type
Flange dimension	mm^2	75 x 75		
Drive length (without fieldbus module)*4)	mm	168 / 198	198 /228	without/with parking brake
Weight	kg	2.95 / 3.5	3.8 / 4.15	without/with parking brake
Parking Brake (optional)**:**				automatically operated
Static braking torque	Nm	3.5		
Power (electric)	W	12		

*1) The rated input current is the direct current drawn in nominal operation (rated torque at rated speed) from the input voltage (24 VDC or 48 VDC). The current drawn from the input voltage is proportional to the converted power, not to be confused with the torque-building motor current, which is displayed as sine peak value in DSerV and is proportional to the motor torque.
Please also observe that the supply line is lossy. This leads to a reduction in voltage and speed at the motor system and to increased power consumption of the device. A connection line with a nominal cross-section of 1.5 mm^2 already has an overall loss resistance of approx. 2 x 12.5 mΩ/m (conductors and return conductors)! Appropriate power reserves must be provided in the supply!

*2) Motor phase current as a sine peak value, which is required for the generation of the rated or peak torque. Motor phase current is displayed in DSerV. Not to be confused with the current taken from the supply.

*3) The specified values apply for the installation of the drive on a system surface made of aluminium (A = 0.1 m^2, d = 10 mm). It must be taken into consideration that the specified continuous output power must be derated for thermally unfavourable couplings.

*4) With fieldbus module the length of the drive increases by 14 mm.

6.5.1 HFI3760 characteristics

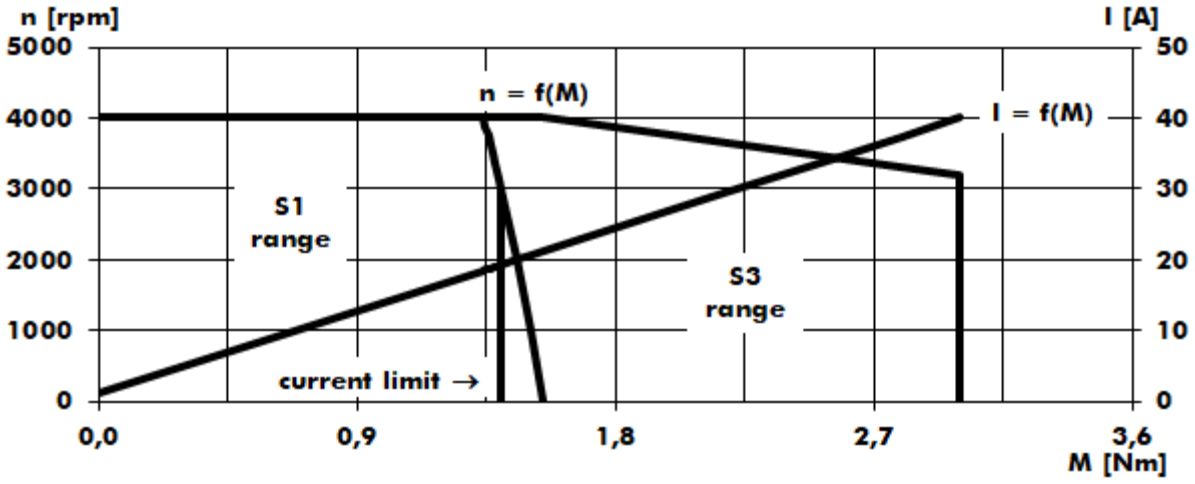


Figure 6-7: HFI3760 characteristics, 48 V, 3000/4000 rpm

6.5.2 HFI3790 characteristics

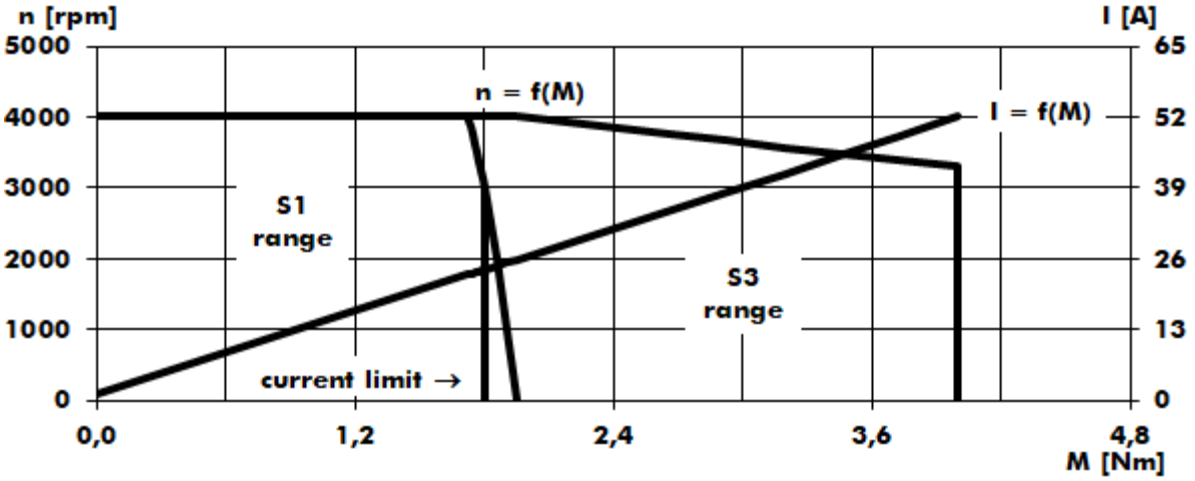


Figure 6-8: HFI3790 characteristics, 48 V, 3000/4000 rpm

6.6 Important technical Information

6.6.1 Regenerative operation

Attention!

Regenerative operation (generator mode) leads to an increase in operational voltage!
Observe permissible voltage values of the power supply and consumers connected in parallel!

The device is equipped with an internal ballast circuit (brake chopper), which is capable of converting a low brake power into heat for a short duration. Brake power conversion leads to a temperature rise in the motor system. Together with the intermediate circuit (DC-link) capacity, dynamically occurring brake energies can be accommodated.

If the device operates quasi-statically in generator mode, suitable measures must be taken for the removal/conversion of the energy (e.g. through an external ballast circuit).

Regenerated energy leads to an increase of the DC-link voltage, which is returned directly to the power connection of the device and/or to the feeding direct current source (if necessary, provide a diode for the decoupling of the operating voltage). The effect of the voltage increase when braking can be reduced, if necessary, by selecting a less abrupt, that is a longer deceleration ramp.

If applicable, regenerated energy can be distributed to other loads connected to the supply voltage in parallel.

If regenerated braking energy cannot be converted, the terminal voltage rises until an **overvoltage error** (Error 4) is triggered (see chapter 12.2 General error messages). The following voltage limits are specified in the devices:

Devices with 24 V operating voltage:

Ballast circuit working voltages:	$V_{Ballast\ ON}$	≥ 30 V , $V_{Ballast\ OFF}$ ≤ 27 V
Triggering of the overvoltage error:	V_{Error4}	≥ 32 V

Devices with 48 V operating voltage:

Ballast circuit working voltages:	$V_{Ballast\ ON}$	≥ 60 V , $V_{Ballast\ OFF}$ ≤ 55 V
Triggering of the overvoltage error:	V_{Error4}	≥ 65 V

6.6.2 Lead fuses

The device is not internally fused. A suitable external fuse must be provided (see chapter 10.2 Installation diagram and chapter 8.5 I²t monitor).

6.6.3 Service life expectancy

The service life of the device is largely determined by the stress of the DC-link capacitors. With an ambient temperature of 40 °C and motor current = motor rated current, a service life expectancy of approx. 15,000 h can be assumed. With lower motor currents and/or lower ambient temperatures, higher service life expectancies arise.

6.6.4 Safety installations

The device has extensive sensor equipment for the monitoring of the controller, power stage, motor and communication with the outside. All occurring errors lead to the shut-down of the power stage (motor de-energised, no torque) and are signalled by the red LED of the status display with a blinking code. Switching the power stage on again is only possible if the cause of the error has been remedied and the error has been acknowledged by the control enable or – with fieldbus control – has been reset via fieldbus.

The following safety functions are implemented:

- The **overcurrent**/**short-circuit monitor** detects excessive current flow in the motor phases.
- The **I²t monitor** protects the motor and power stage from thermal overload by limiting the motor current to the **rated current** (see chapter 8.2.1.4 Parameters of the current control loop) after the lapse of a permissible overload duration. The overload duration depends on various factors. For a detailed description of the I²t monitor see chapter 8.5 I²t monitor.
- The **overvoltage monitor** triggers as soon as the DC-link voltage exceeds a maximum permissible value (see chapter 6.6.1 Regenerative operation).
- The **undervoltage monitor** triggers as soon as the DC-link voltage falls below 18 V.
- The **temperature** of the power stage is measured and the power stage is switched off when the temperature exceeds 90 °C.
- The **signals of the internal angle sensor system** are monitored for valid statuses. Invalid signal combinations lead to the shut-down of the power stage.

7 DSerV service software

The DSerV service software provides a simple and clearly laid out configuration of the devices. Important operating statuses, such as speed, current, enable, etc. can be seen at a quick glance. Scalings, current limits and operating modes are adjustable through menus. Device settings can be saved on the hard disk of the PC. The program language is selectable: German/English.

7.1 System requirements

For the installation and operation of the DSerV service software, the following requirements apply:

- **PC/Laptop with Microsoft Windows XP, Windows 7, Windows 8, Windows 10**
- **CDROM-Drive**
- **RS232 serial interface (COM1 ... COM99):**
  On-Board or USB/RS232 converter, supported baud rate at least 115,2 kBaud
- **serial connection cable** (see chapter 10.2 Installation diagram)

7.2 Installation and start-up of the program

Note!

Read the licence agreement on the provided data carrier of the software before installation. With the installation of the DSerV service software, you agree to the conditions of the license agreement.

7.2.1 Installation of the software

For the installation of DSerV it is sufficient to copy the program files to a working directory:

1. Start WINDOWS.
2. Insert the CDROM with DSerV service software in an appropriate drive.
3. Start WINDOWS Explorer and display CDROM contents (main directory).

Alternative 1 (recommended):

4. Start the file DSerV.exe directly from the CDROM. An installation menu opens.

   Note: The installation menu only opens, if DSerV.exe is started from a removable data carrier such as a CDROM.

5. Follow the further instructions in the installation menu.

Alternative 2:

6. Manually copy the entire directory tree from the CDROM to a previously created working directory on the internal hard disk of the PC.

   (This process can also be applied if the software was supplied in electronic form and not on CDROM.)

7.2.2 Program start

Before starting the program, the device must be supplied with operating voltage and the connection to the PC/Laptop must be established with a serial connection cable (see chapter 10.2 Installation diagram).

The **DSerV** service software is started through execution of the file DSerV.exe from the working directory on the hard disk. (Note: The program start from a removable data carrier is not possible.)

After the start-up of the service software the **DSerV** program window appears and the communication to the connected device is automatically established.

7.2.2.1 Error messages after program start

If the error message **DAV file not found** appears, please check if a *.dav file in the working directory corresponds to the type of device and firmware used. If necessary, contact the ENGEL customer support.

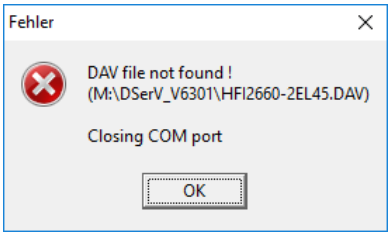


*Figure 7-1: Error message if *.dav file is missing*

If the error message **No connection to the drive** appears, then please check the following points:

- Is the serial cable plugged in the PC/Laptop and the device?
- Is the device switched on?
- Is the correct interface port selected in **DSerV Options** → **COM port** (see chapter 7.3.5 Options menu)

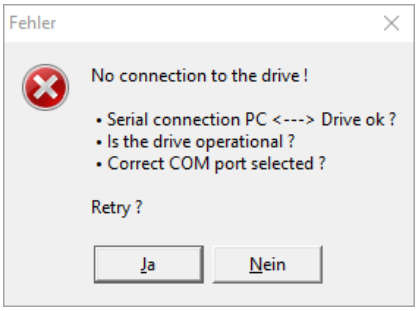


Figure 7-2: Error message in case of connection problems

7.2.2.2 Starting multiple instances of DSerV

If more than one device is connected to the PC, there is the possibility to open multiple instances of DSerV. This allows the parallel control of all connected drives.

1. Create a shortcut to ***DSerV.exe*** in the working directory.
2. Rename the shortcut as you like (e.g. Drive_1).
3. Open the shortcut's ***Properties*** window and append ***/instance="Name"*** at the end of the ***Target*** line, where ***Name*** is recommended to be the name of the shortcut (e.g. */instance=Drive_1*), but may as well be any other, unique name.

   Note: Do not forget the space before the slash (/) and do not use any of the following characters in ***Name***: \ / : * ? " < > | !
4. Click OK to close the ***Properties*** window.

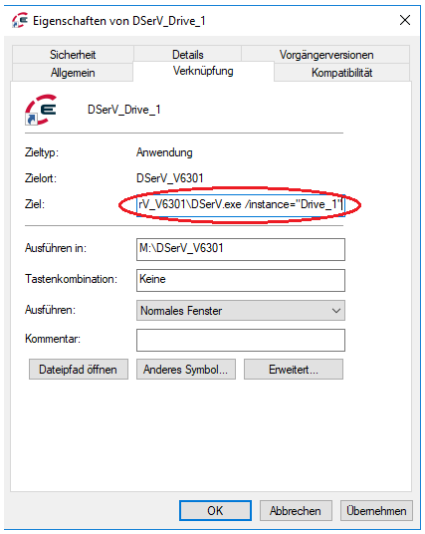


Figure 7-3: Naming of instances

5. Double-click the shortcut to start the new DSerV instance.

   When a DSerV instance is started, an initialisation file „Name".ini (e.g. Drive_1.ini) will be created that holds all program settings (like the COM port to be used) for the specific instance.

   Remember that at first start-up of this instance **DSerV** may not automatically connect to the intended device. Use the serial number displayed in the **Drive** status bar to check whether the connection has already been established to the desired device. If necessary, choose the COM port related to the device under **Options → COM port** (see chapter 7.3.5 Options menu). This COM port will be saved in the initialisation file, when **DSerV** is closed. With the next start-up **DSerV** will then automatically connect to the device at this port.

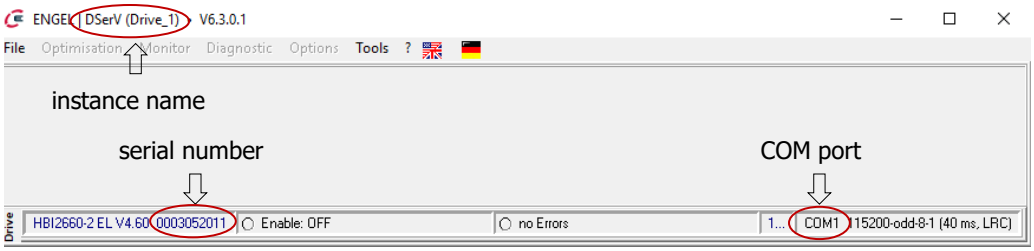


Figure 7-4: Opened instance of DSerV

7.3 Using the DSerV service software

Menu bar
Function selection

Monitor functions
Display of:

- Setpoints and actual values
- I²t monitor
- Temperatures
- Input/output status

etc.

Fieldbus status bar:
Network status, state machine, Node-ID, bit rate

Drive status bar:
Device type, firmware, serial number, enable, error messages

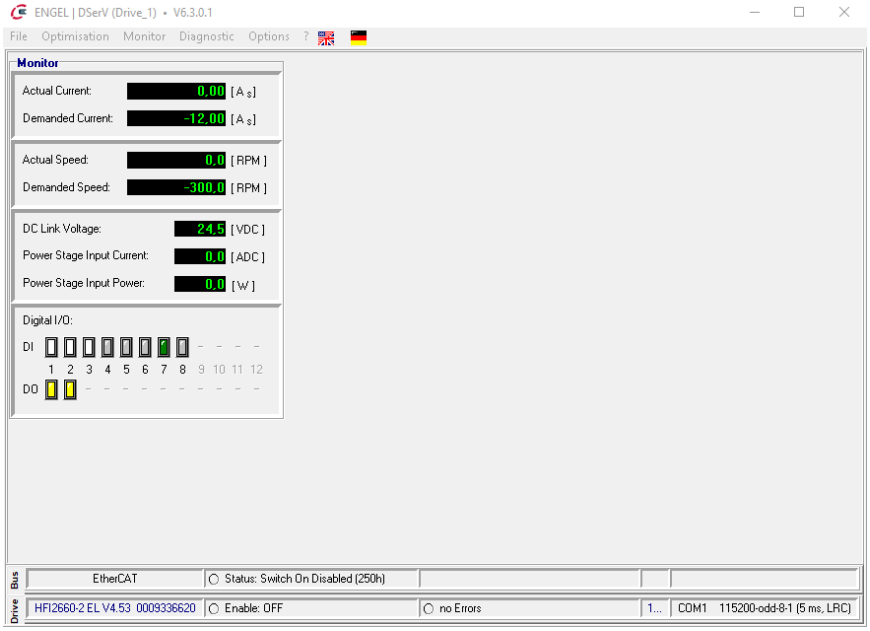


Figure 7-5: DSerV program window

When you click on one of the **Drive status** fields lettered in blue, the device information and the overall operating hours will be displayed. The overall operating hours comprise the hours of operation (supply voltage applied) and the enable hours (power stage enabled).

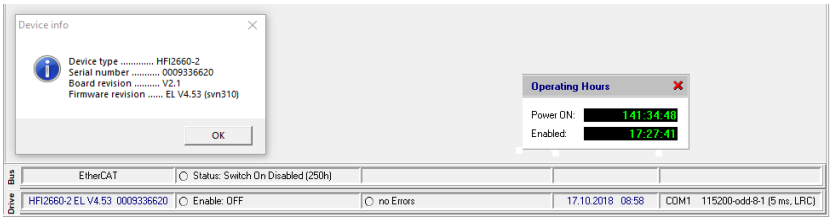


Figure 7-6: Drive status bar

The **DSerV** software is a largely intuitive software with a common Windows user interface. The menu functions of **DSerV** are explained below:

7.3.1 File menu

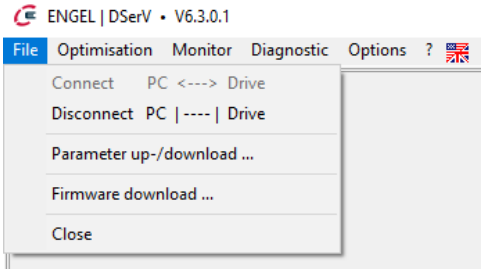


Figure 7-7: File menu

The following functions can be selected in the **file menu**:

- **Connect**: Starts the communication with the device.
- **Disconnect**: Stops the communication with the device.
- **Parameter Up-/Download**

  Upload transfers the current device settings to a parameter file (*.par).
  The parameter files can be saved to hard disk or removable media. Before saving, you will be asked to enter a file description. The description can later be edited by clicking the button **Edit description...**.

  Download transfers the selected parameter file to the device.
  A list view presents an overview of the existing parameter files along with their descriptions and additional information. To transfer a parameter file to the drive, select an entry from the list, then click the **Download** button. The new parameters will be stored *permanently* in the drive, replacing all previous parameters.

  The circle in front of the file name indicates the compatibility of the parameter file with the device (see Figure 7-8, column Description).

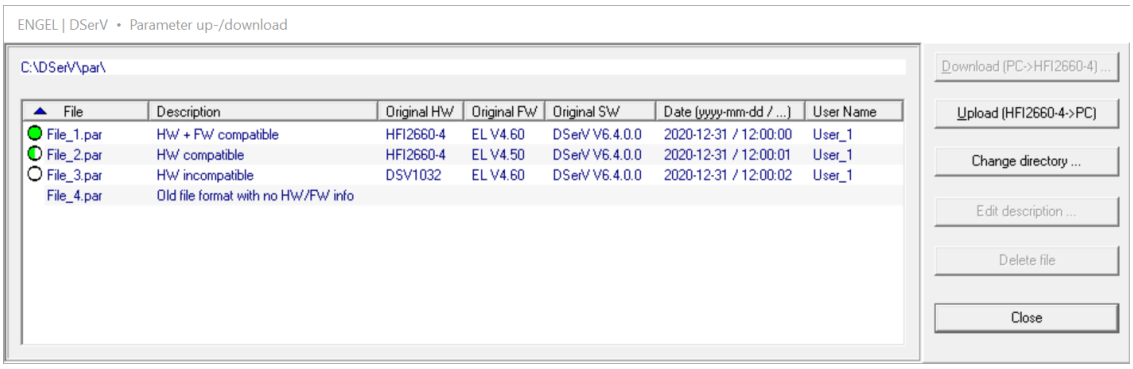


Figure 7-8: Parameter Up-/Download dialogue

Note!

When you click the button **Delete file**, the selected entry is removed from the list, but the file itself still exists in the directory. It is only renamed as *.~par. To delete the file completely, an external tool like the Windows Explorer may be used.

- **Firmware Download**: Opens the dialogue for the firmware update of the device. Follow the instructions on the screen. During the update **DSerV** transmits a new software to the device via the existing connection. Firmware files (*.hex) are available on request, please contact the ENGEL customer support.

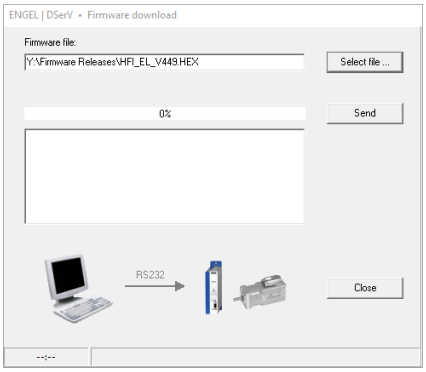


Figure 7-9: Firmware Download dialogue

- **Close**: Closes **DSerV**.

7.3.2 Optimisation menu

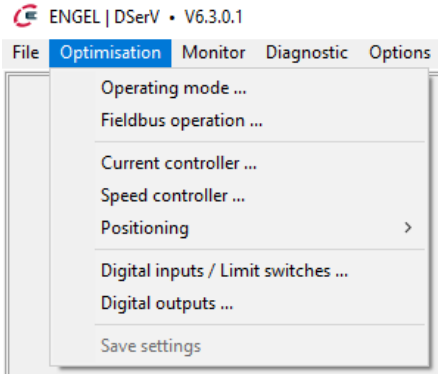


Figure 7-10: Optimisation Menu

The **Optimisation** menu allows you to parameterise the device.

> **Note!**
>
> Parameter settings that are sent via any of the submenus' **Send** button have an immediate effect on the device, but are not stored in the non-volatile memory of the device (i.e. after a reset they are no longer effective).
>
> Changes are only adopted to the non-volatile memory with the command **Optimisation→ Save settings** and then remain effective even after a power-on or other kind of reset.

The following submenus are available in the **Optimisation** menu (for a detailed description see chapter 8 Parameterisation):

- **Operating mode**: Selection between current control, speed control, and positioning mode. Selection of set-point source.
- **Fieldbus operation**: Activation of fieldbus mode, address setting, bit rate setting.
- **Current controller**: Adjustment of current limits and parameters of the current controller. Specification of the motor pole number and angle sensor offset determination.
- **Speed controller:** Adjustment of setpoint scaling, setpoint ramp and parameters of the speed controller.
- **Positioning**: Parameterisation of positioning and homing.
- **Digital inputs/limit switches**: Setup of limit switch polarity and limit switch monitoring.
- **Digital outputs**: Function assignment to the digital outputs.
- **Save settings**: Menu item becomes available after the transmission of a parameter. Saves changed parameters/settings in the non-volatile memory of the device.

7.3.3 Monitor menu

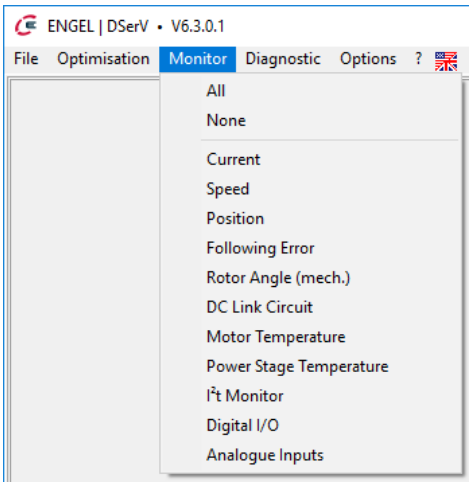


Figure 7-11: Monitor menu

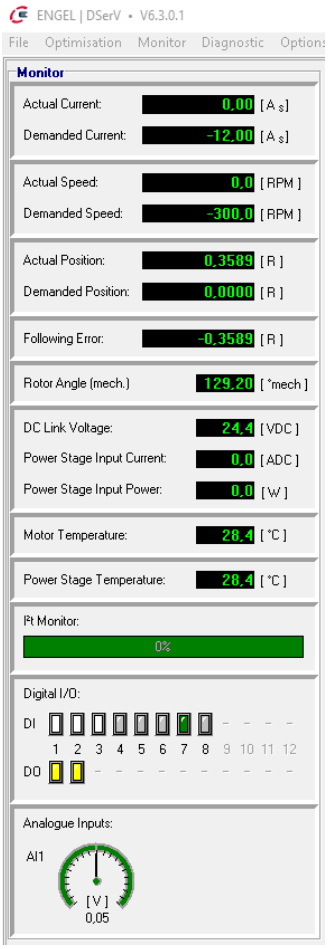


Figure 7-12: View of monitor values

In the **Monitor menu** a set of runtime values and status information can be selected or deselected individually for display.

> **Note!**
>
> With an increasing number of open monitor windows, the refresh rate of the individual values may decrease. Close unneeded windows.

The following displays are available in the **Monitor** menu:

- **Current:** Actual Current, Demanded Current
- **Speed**: Actual Speed, Demanded Speed
- **Position**: Actual Position, Demanded Position
- **Following Error**: Deviation of the actual position from the setpoint position in positioning mode
- **Rotor Angle (mech.**): The motor shaft's angular position (-180° … +180°)
- **DC Link Circuit**: DC Link Voltage, Power Stage Input Current, Power Stage Input Power
- **Motor Temperature**: For integrated drives, motor temperature = power stage temperature.
- **Power Stage Temperature**: Temperature of the power stage
- **I²t Monitor:** Shows the overcurrent capability of the device.
  Rising values: Overcurrent condition
  When reaching 100 %, the motor current is automatically reduced to motor rated current.
  When falling below 50 %, overcurrent capability is resumed.
- **Digital I/O**: Shows the actual status of the digital inputs and outputs.

  Colour Overview:

	Function = True		Function = False	
DI in use	light green		white	
DI idle	dark green		grey	
DO in use	light yellow		white	
DO idle	dark yellow		grey	

- **Analogue Inputs:** Shows the voltage value of the analogue input.

7.3.4 Diagnostic menu

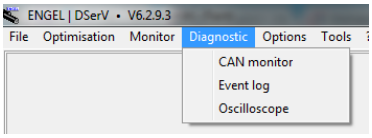


Figure 7-13: Diagnostic menu

The **Diagnostic** menu offers additional utilities for setting up and evaluating the device:

- **CAN monitor**: Display of the current CANopen object contents. Up to 10 objects can be displayed at the same time. Object contents can be displayed individually in binary, decimal or hexadecimal system. To change the numeral system, right click on the appropriate value field and choose the desired numeral system.

  Objects with write access can be changed via the CAN editor, which opens when you double click the object's value field. A new value is transmitted to the drive by clicking the green arrow or by hitting the enter button.

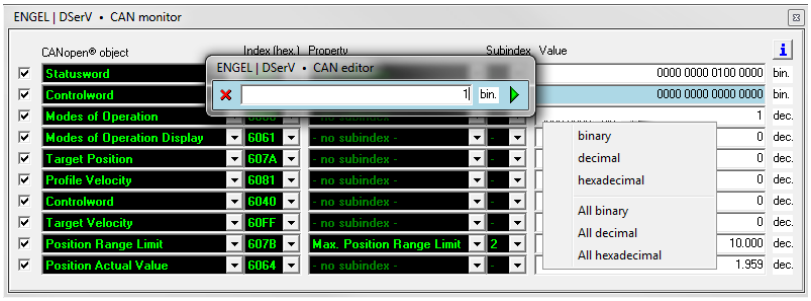


Figure 7-14: CAN monitor

- **Oscilloscope**: The oscilloscope function can be used to record time-continuous analogue and digital signals of the drive.

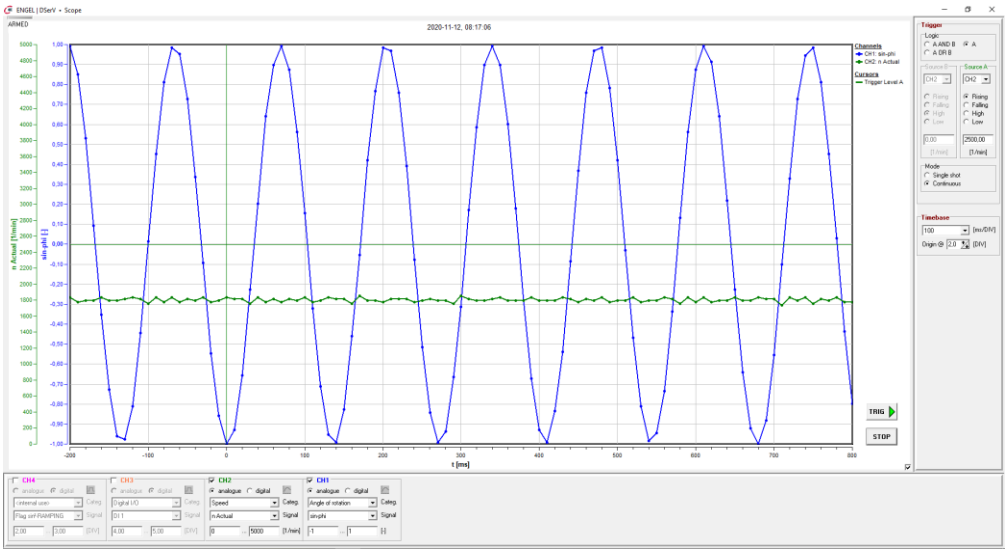


Figure 7-15: Oscilloscope view

- **Event log**: When you open the event log, all events stored in the internal memory of the device are displayed. There are 3 types of entries: Errors, warnings and info.

  With the **Erase** button you can choose to delete the list view or the log buffer.

  Deleting the *list view* deletes the contents of the event log window, so that only new events that occur after deletion are displayed.

  When the *log buffer* is cleared, the entries are deleted from the internal memory of the device. At the same time, a new info entry is generated that indicates when the memory was last deleted.

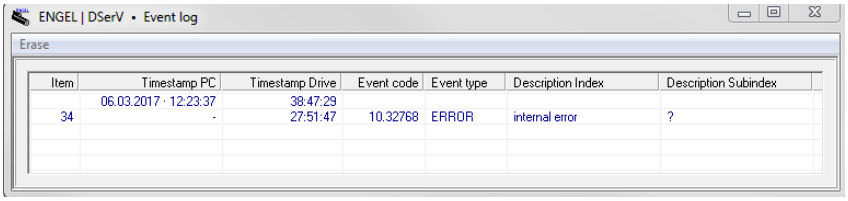


Figure 7-16: Event log

7.3.5 Options menu

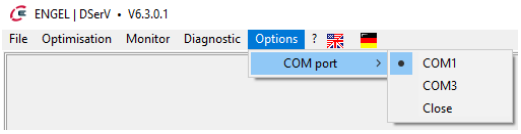


Figure 7-17: Options menu

In the **Options menu** the COM port to be used can be selected. It may take a few seconds until all COM ports (COM1 … COM99) are scanned and the ones that were found are displayed. When a COM port is selected, **DSerV** immediately tries to establish a connection to the device via this port.

7.3.6 ? menu

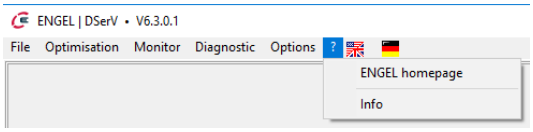


Figure 7-18: ? menu

- **ENGEL Homepage**: Link to the ENGEL Homepage
- **Info**: Shows the DSerV software version

7.3.7 Note on language selection

In **DSerV** you can choose between German and English. Please note, however, that the display of the decimal/thousand separators does not change when switching. For this to happen, the *regional format* must be set to the selected language in the Windows system settings.

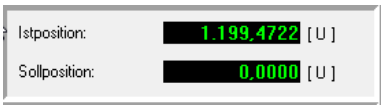


Figure 7-19: german number format

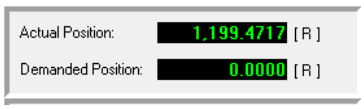


Figure 7-20: english number format

8 Parameterisation

The integrated drives can be used as current (i.e. torque), speed or position controllers. The parameterisation of the devices takes place through an RS232 serial interface with the parameterisation software **DSerV**. Changed parameters have an immediate effect on the drive, but are only adopted with the menu item **Optimisation → Save settings** in the non-volatile memory.

8.1 Control interface selection

DSerV menu **Optimisation → Fieldbus operation**

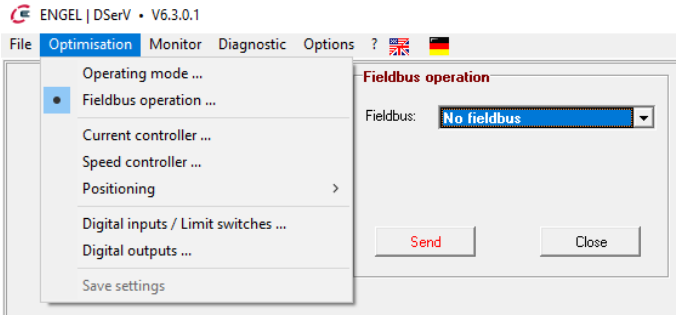


Figure 8-1: I/O interface selection

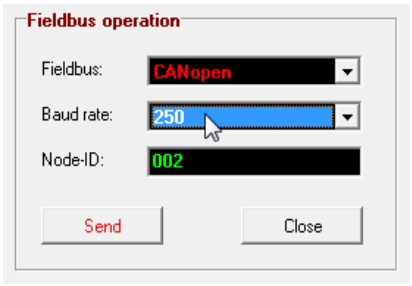


Figure 8-2: Fieldbus interface selection

The devices feature 2 types of control interfaces:

- **I/O interface**: operation via digital and analogue inputs and outputs
- **Fieldbus interface**: operation via pre-installed fieldbus (order option)

The activation/deactivation of the corresponding fieldbus interface as well as the selection of the transmission parameters like Node-ID and bit rate take place through the DSerV menu **Optimisation → Fieldbus operation**. After clicking the Send button, you will be asked if you want to save the settings. Answer „Yes“ and then reset the device to activate the chosen control interface.

The description of the device functions in this document assumes operation without fieldbus (**I/O mode**). In **fieldbus mode** the same functionality is basically available and is described in detail in the corresponding fieldbus manuals. For reference, the relevant **fieldbus objects/signals** are also listed in this document.

Notes for fieldbus operation!

- All parameters can be changed via the corresponding **DSerV menus**. Some parameters can additionally be addressed as **objects** via **fieldbus**. If parameters are changed in **DSerV**, the new values are immediately visible in the corresponding **objects** (if available).
- If the parameters are changed via **fieldbus**, the new values are also immediately visible in the **DSerV CAN monitor**. In contrast, other **DSerV menus** that are already open are not constantly updated and must be closed and reopened to reflect the parameter changes.
- The drive's PROFINET implementation uses communication modules, which translate the PROFIdrive protocol into the CANopen protocol. All PROFIdrive **objects** from 0x2001 – 0xE9FC are mapped one-to-one to CANopen **objects** 0x2001 – 0xE9FC. Thus, every **object** in this range can be addressed with the same object index as in CANopen. For cyclic data exchange the PROFIdrive standard telegrams 1 and 9 and the ENGEL specific telegram 100 are provided.

8.2 Operating mode selection

The drives feature the following operating modes:

- **Current control:**
  - current control without speed limitation
  - current control with speed limitation
- **Speed control:**
  - speed control without current limitation
  - speed control with current limitation
- **Positioning:**
  - homing
  - linear positioning mode
  - turntable positioning mode

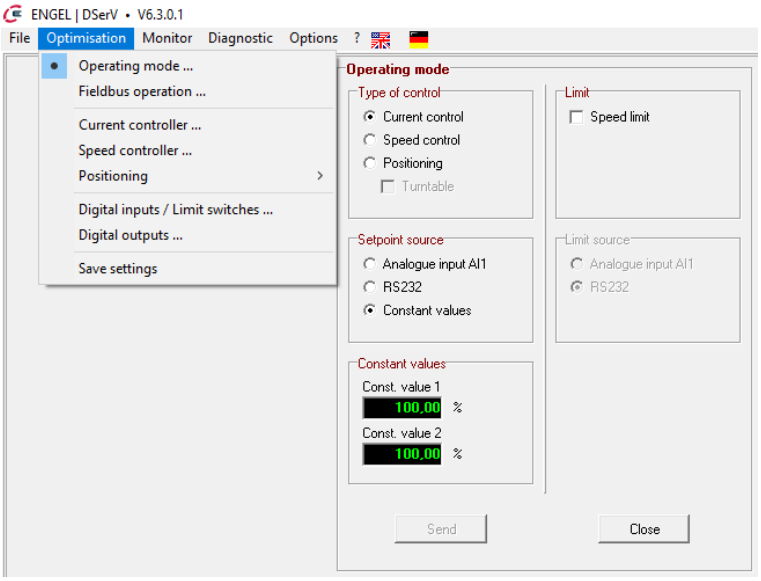


Figure 8-3: Selection menu for operating modes and setpoint sources

The operating modes can be selected as follows depending on the control interface type:

Control I/F	Menu, Object, Telegram
I/O mode	Optimisation → Operating mode
CANopen	Modes of Operation [6060_h]
EtherCAT	Modes of Operation [6060_h]
EtherNet/IP	Modes of Operation [6060_h]
PROFINET	Standard Telegram 1 and 9, ENGEL Telegram 100

8.2.1 Current control/torque control mode

The inner torque of PMSM motors is strictly proportional to the torque producing current i_q. Only in case of overload, where T >> T_{nom}, a noticeable non-linearity occurs. Because of the proportionality the current and torque control are set equal here, but in reality the current is the controlled variable and not the torque.

The torque-to-current ratio is determined by the torque constant of the motor (in Nm/A) as stated in the data sheet.

8.2.1.1 Current control with/without speed limitation

Current control can be carried out with or without speed limitation. Current control with speed limitation can be used, for example, to limit a current-controlled drive to a defined speed when there is no load. Without limitation the drive would accelerate to its maximum possible speed.

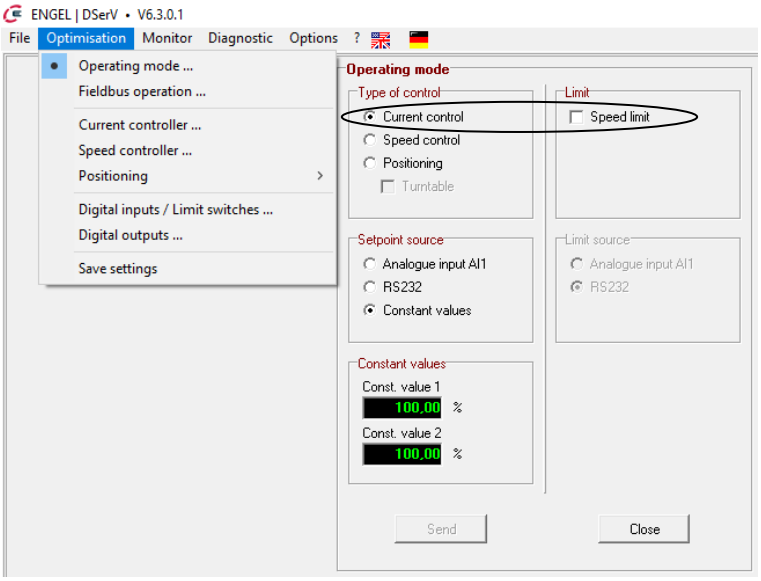


Figure 8-4: Selection of current control without speed limitation

Current control without speed limitation can be selected as follows depending on the control interface type:

Control I/F	Menu, Object, Telegram
I/O mode	Optimisation → Operating mode → Current control
CANopen	Modes of Operation [6060_h] = 4
EtherCAT	Modes of Operation [6060_h] = 4
EtherNet/IP	Modes of Operation [6060_h] = 4
PROFINET	ENGEL Telegram 100: Modes of Operation [6060_h] = 4 (not available via standard telegrams)

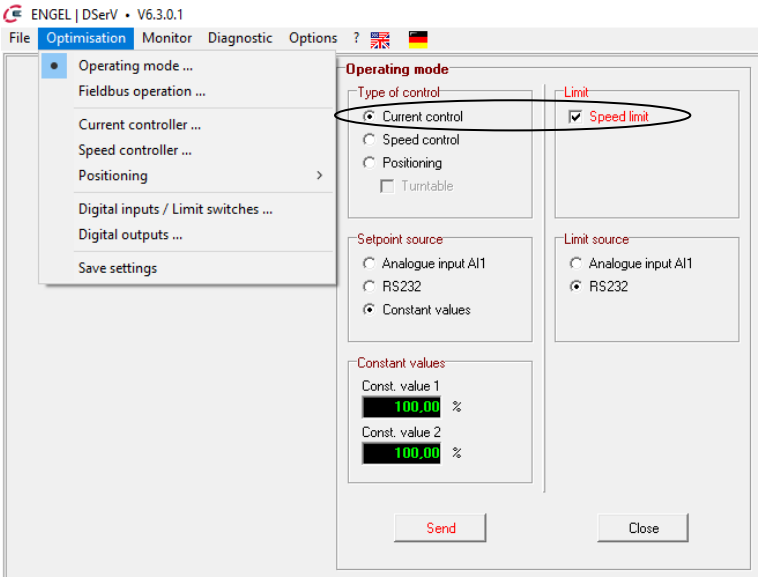


Figure 8-5: Selection of current control with speed limitation

Current control with speed limitation can be selected as follows depending on the control interface type:

Control I/F	Menu, Object, Telegram
I/O mode	Optimisation → Operating mode → Current control + Speed limit
CANopen	Modes of Operation [6060_h] = -4
EtherCAT	Modes of Operation [6060_h] = -4
EtherNet/IP	Modes of Operation [6060_h] = -4
PROFINET	ENGEL Telegram 100: Modes of Operation [6060_h] = -4 (not available via standard telegrams)

Note!

For the proper function of the **current control mode with speed limitation**, the parameters of the speed controller must also be set. The acceleration and deceleration ramps must be switched off („Ramps inactive“), see chapter 8.2.2.4 Parameters of the speed control loop).

8.2.1.2 Current setpoint

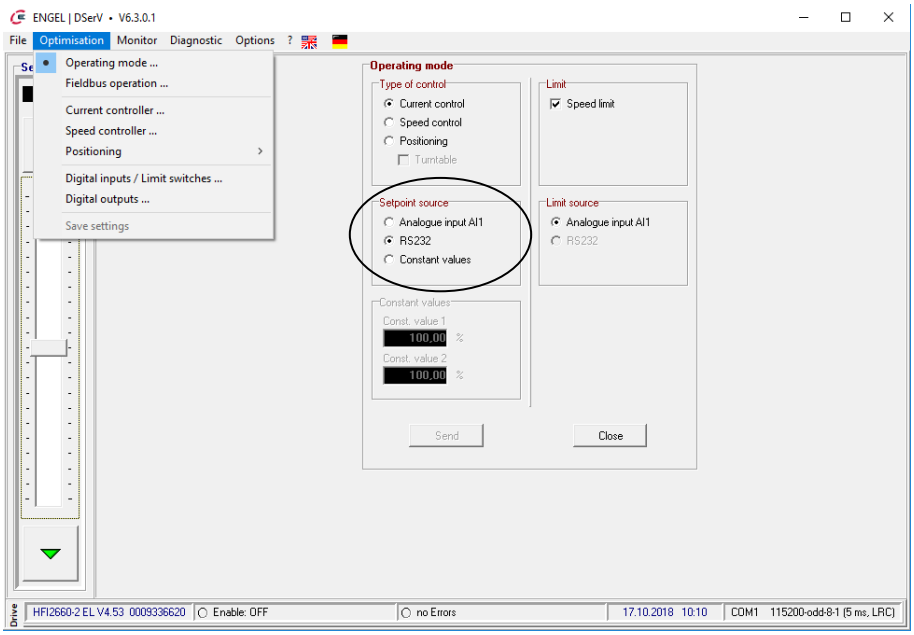


Figure 8-6: Selection of setpoint source

The current setpoint can be selected as follows depending on the control interface type:

Control I/F	Menu, Object, Telegram
I/O mode	**Optimisation → Operating mode → Setpoint source** The following current setpoint sources can be chosen: • **AI1** Differential analogue input voltage, ±10 V ≙ ±100 %. • **RS232 (test function)** If RS232 is selected as setpoint source, a setpoint slider appears automatically on the left side of the DSerV window. A coarse adjustment of the setpoint is possible with the slider. The setpoint can be changed in 10 % steps using the arrow keys and in 0.1 % steps by left-clicking in the free space of the slider component. • **Constant values** Two fixed setpoints can be defined via **constant value 1/2**. Digital input DI6 switches between the constant values 1/2 (see chapter 8.3 Digital inputs/limit switches). The setpoint values are defined as a percentage of the **motor rated current** (adjustable via **Optimisation → Current controller → Motor rated current**), i.e. 100 % = **motor rated current**.
CANopen	Target Torque [6071_h]
EtherCAT	Target Torque [6071_h]
EtherNet/IP	Target Torque [6071_h]
PROFINET	ENGEL Telegram 100: Target Torque [6071_h] (not available via standard telegrams)

Notes!

- Setpoints via **RS232** are for test purposes only.
- Current setpoints take effect without delay, i.e. without setpoint ramp.
- The **polarity** parameter setting (see chapter 8.2.3.2 General positioning parameters) is also active in **current control** mode. Here, if polarity is negative, current setpoints will be inverted.

8.2.1.3 Speed limit source

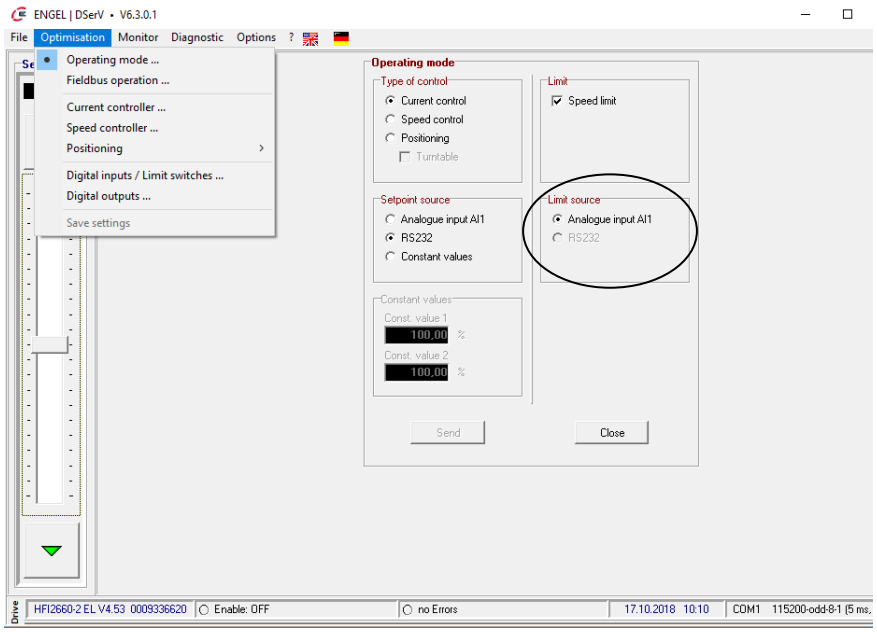


Figure 8-7: Selection of limit source

A limit source can only be selected, if **speed limit** is activated. The limit value can be selected as follows depending on the control interface type:

Control I/F	Menu, Object, Telegram
I/O mode	**Optimisation → Operating mode → Limit Source** The following speed limit sources can be chosen: • **AI1** Differential analogue input voltage, ±10 V ≙ ±100 %. • **RS232 (test function)** If RS232 is selected as limit source, a setpoint slider appears automatically on the left side of the DSerV window. A coarse adjustment of the limit value is possible with the slider. The limit value can be changed in 10 % steps using the arrow keys and in 0.1 % steps by left-clicking in the free space of the slider component. The limit values are defined as a percentage of the **Setpoint Scaling** (adjustable via **Optimisation → Speed Controller → Setpoint Scaling**), i.e. 100 % = **Setpoint Scaling** value (see chapter 8.2.2.4 Parameters of the speed control loop). The limit values are evaluated by amount, i.e. a negative limit value has the same effect as a positive limit value. This applies in both directions of rotation.
CANopen	Dynamic Speed Limit [2003_h]
EtherCAT	Dynamic Speed Limit [2003_h]
EtherNet/IP	Dynamic Speed Limit [2003_h]
PROFINET	ENGEL Telegram 100: Dynamic Speed Limit [2003_h] (not available via standard telegrams)

Note!

Limit values via **RS232** are for test purposes only.

8.2.1.4 Parameters of the current control loop

DSerV menu **Optimisation → Current controller**

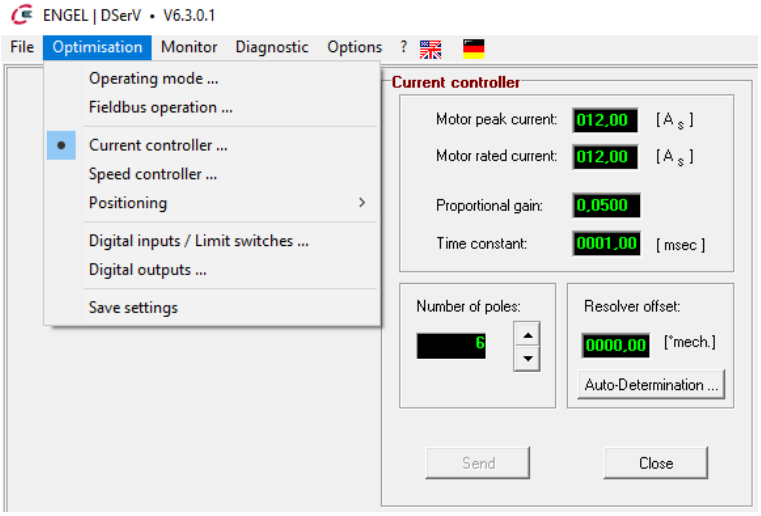


Figure 8-8: Parameters of the current control loop

This menu item allows to set the parameters of the current control loop. Parameters for which no fieldbus object is specified below can only be changed here.

- **Motor peak current**: A boost current which is made available by the drive temporarily (typically a few seconds), e.g. during motor acceleration. Motor peak current is the highest possible motor current in the operating modes **speed control** and **positioning**. (In current control mode the motor current is limited to motor rated current, instead.)
  Motor peak current is freely selectable, but must not exceed the value specified in the data sheet.

Control I/F	Menu, Object, Telegram
I/O mode	Setup via **DSerV**
CANopen	Max Current [6073_h]
EtherCAT	Max Current [6073_h]
EtherNet/IP	Max Current [6073_h]
PROFINET	Max Current [6073_h] (not available via telegrams, must be directly addressed)

- **Motor rated current**: The current that the motor and electronics can carry permanently without thermal overload.
  With **I/O control**, a current setpoint of 100 % corresponds to motor rated current.
  With **fieldbus control**, current setpoints *(Target Torque)* greater than motor rated current can be set, but will internally be limited to motor rated current.
  Furthermore, the motor current will also be limited to motor rated current, when the **I²t monitor** is active (see chapter 8.5I²t monitor).
  Motor rated current is freely selectable, but must not exceed the value specified in the data sheet.

Control I/F	Menu, Object, Telegram
I/O mode	Setup via **DSerV**
CANopen	Motor Rated Current [6075_h]
EtherCAT	Motor Rated Current [6075_h]
EtherNet/IP	Motor Rated Current [6075_h]
PROFINET	Motor Rated Current [6075_h] (not available via telegrams, must be directly addressed)

> **Note!**
>
> Motor current values are stated as sine peak values.

- **Proportional gain**: Proportional gain of the PI-type current control loop (k_{p_i} = 0.0000 … 1.0000).

Control I/F	Menu, Object, Telegram
I/O mode	Setup via **DSerV**
CANopen	Torque Control Parameters [$60F6_h$ sub1] → k_{p_i}
EtherCAT	Torque Control Parameters [$60F6_h$ sub1] → k_{p_i}
EtherNet/IP	Torque Control Parameters [$60F6_h$ sub1] → k_{p_i}
PROFINET	Torque Control Parameters [$60F6_h$ sub1] → k_{p_i} (not available via telegrams, must be directly addressed)

- **Time constant**: Integral time of the PI-type current control loop (t_{n_i} = 0.1 … 3,276.7 ms).

Control I/F	Menu, Object, Telegram
I/O mode	Setup via **DSerV**
CANopen	Torque Control Parameters [$60F6_h$ sub2] → t_{n_i}
EtherCAT	Torque Control Parameters [$60F6_h$ sub2] → t_{n_i}
EtherNet/IP	Torque Control Parameters [$60F6_h$ sub2] → t_{n_i}
PROFINET	Torque Control Parameters [$60F6_h$ sub2] → t_{n_i} (not available via telegrams, must be directly addressed)

- **Number of poles**: Number of magnetic motor poles.
- **Angle sensor offset**: Offset between the zero angle of the motor system and the zero angle of the angle sensor.

Notes!

- k_{p_i} and t_{n_i} are optimally preset by the manufacturer and should not be changed!
- Number of motor poles and angle sensor offset are also preset by the manufacturer and should not be changed!
- Keep in mind the function and influence of the digital inputs DI2, DI3 (see chapter 8.3 Digital inputs/limit switches).

8.2.2 Speed control mode

8.2.2.1 Speed control with/without torque limitation

Speed control can be carried out with or without torque limitation. Speed control with torque limitation can be used to limit a speed-controlled drive to a defined torque (i.e. current). In this way it can be prevented, for example, that unintentionally high forces are generated at the output if the motor is blocked.

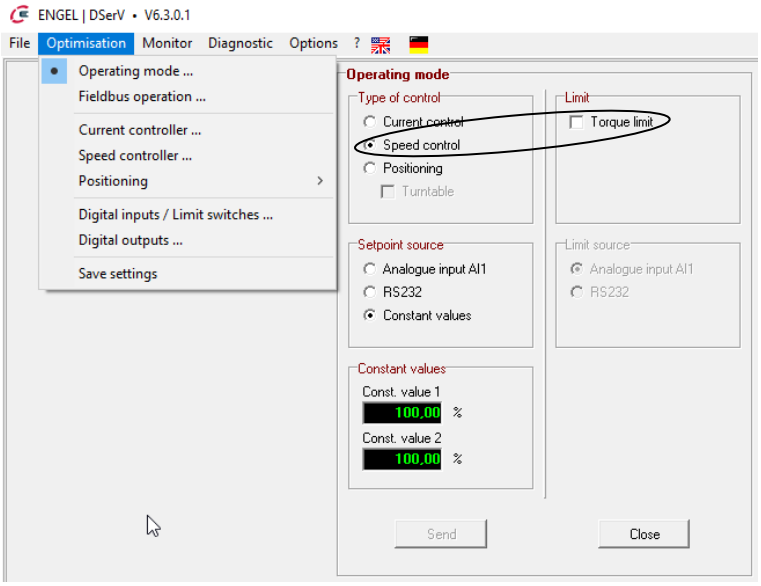


Figure 8-9: Selection of speed control without torque limitation

Speed control without torque limitation can be selected as follows depending on the control interface type:

Control I/F	Menu, Object, Telegram
I/O mode	Optimisation → Operating Mode → Speed Control
CANopen	Modes of Operation [6060_h] = 3
EtherCAT	Modes of Operation [6060_h] = 3
EtherNet/IP	Modes of Operation [6060_h] = 3
PROFINET	Standard Telegram 1 or ENGEL Telegram 100: Modes of Operation [6060_h] = 3

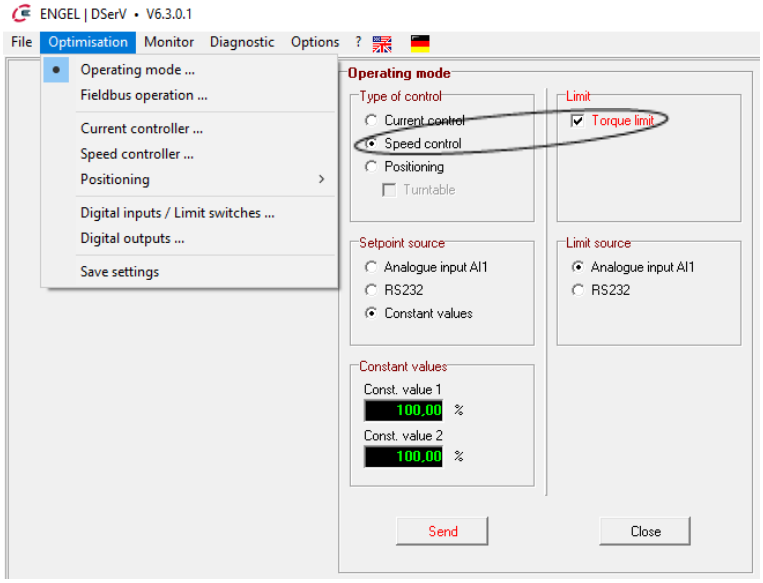


Figure 8-10: Selection of speed control with torque limitation

Speed control with torque limitation can be selected as follows depending on the control interface type:

Control I/F	Menu, Object, Telegram
I/O mode	Optimisation → Operating mode → Speed control + Torque limit
CANopen	Modes of Operation [6060_h] = -3
EtherCAT	Modes of Operation [6060_h] = -3
EtherNet/IP	Modes of Operation [6060_h] = -3
PROFINET	ENGEL Telegram 100: Modes of Operation [6060_h] = -3 (not available via standard telegrams)

Notes!

- Prior to setting-up or operating the speed controller, make sure that the current limits and the parameters of the current controller are set correctly (see chapter 8.2.1.4 Parameters of the current control loop). The optimisation of current and speed controller is described in chapter 13 Controller optimisation!

8.2.2.2 Speed setpoint

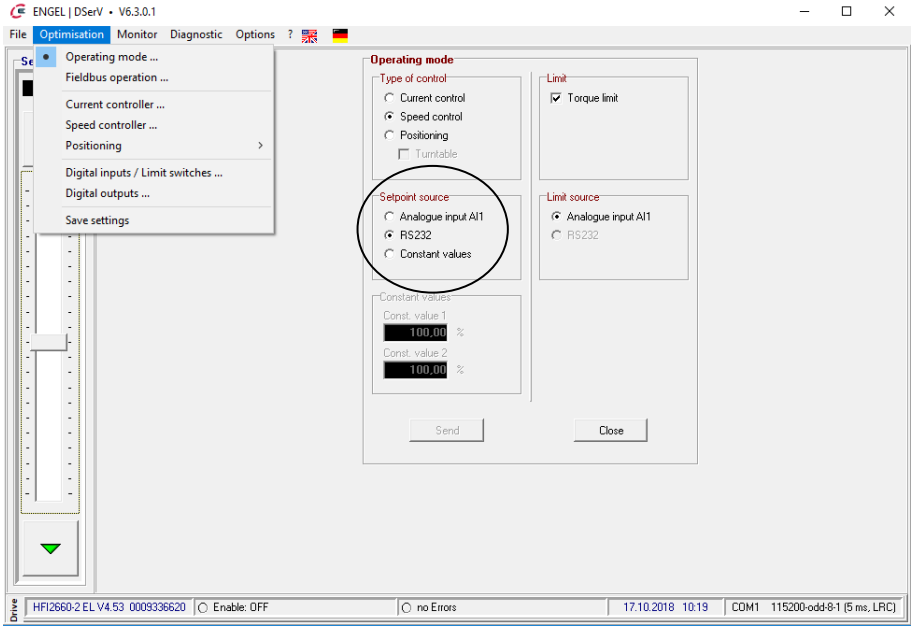


Figure 8-11: Selection of setpoint source

The speed setpoint can be selected as follows depending on the control interface type:

Control I/F	Menu, Object, Telegram
I/O mode	**Optimisation → Operating mode → Setpoint source** The following speed setpoint sources can be chosen: • **AI1** Differential analogue input voltage, ±10 V ≙ ±100 %. • **RS232 (test function)** If RS232 is selected as setpoint source, a setpoint slider appears automatically on the left side of the DServ window. A coarse adjustment of the setpoint is possible with the slider. The setpoint can be changed in 10 % steps using the arrow keys and in 0.1 % steps by left-clicking in the free space of the slider component. • **Constant values** Two fixed setpoints can be defined via **constant value 1/2**. Digital input DI6 switches between the constant values 1/2 (see chapter 8.3 Digital inputs/limit switches). The setpoint values are defined as a percentage of the **setpoint scaling** (adjustable via **Optimisation → Speed Controller → Setpoint Scaling**), i.e. 100 % = **Setpoint Scaling**.
CANopen	Target Velocity [60FF$_h$]
EtherCAT	Target Velocity [60FF$_h$]
EtherNet/IP	Target Velocity [60FF$_h$]
PROFINET	Standard Telegram 1: NSOLL_A or ENGEL Telegram 100: Target Velocity [60FF$_h$]

Notes!

- Setpoints via **RS232** are for test purposes only.
- The **polarity** parameter setting (see chapter 8.2.3.2 General positioning parameters) is also effective in **speed control** mode. Here, if polarity is negative, speed setpoints will be inverted.

8.2.2.3 Torque limit source

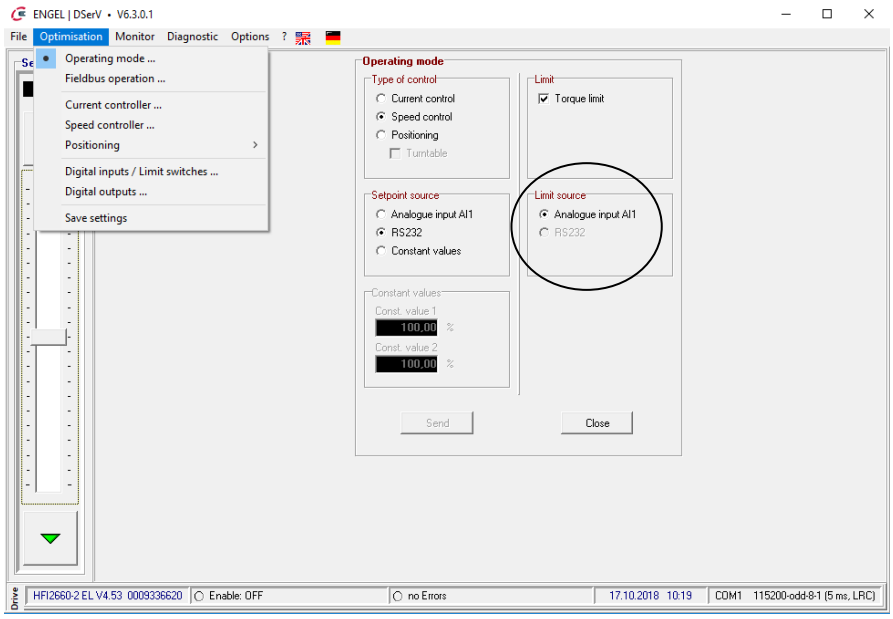


Figure 8-12: Selection of limit source

A limit source can only be selected, if **torque limit** is activated. The limit value can be selected as follows depending on the control interface type:

Control I/F	Menu, Object, Telegram
I/O mode	**Optimisation → Operating mode → Limit source** The following torque limit sources can be chosen: • **AI1** Differential analogue input voltage, ±10 V ≙ ±100 %. • **RS232 (test function)** If RS232 is selected as limit source, a setpoint slider appears automatically on the left side of the DSerV window. A coarse adjustment of the limit value is possible with the slider. The limit value can be changed in 10 % steps using the arrow keys and in 0.1 % steps by left-clicking in the free space of the slider component. Torque limitation is internally achieved by limiting the torque producing current. Thus, the limit values are defined as a percentage of the **motor peak current** (**Optimisation → Current controller → Motor peak current**), i.e. 100 % = **motor peak current** (see chapter 8.2.1.4 Parameters of the current control loop). The limit values are evaluated by amount, i.e. a negative limit value has the same effect as a positive limit value. This applies in both directions of rotation.
CANopen	Dynamic Torque Limit [2004_h]
EtherCAT	Dynamic Torque Limit [2004_h]
EtherNet/IP	Dynamic Torque Limit [2004_h]
PROFINET	ENGEL Telegram 100: Dynamic Torque Limit [2004_h] (not available via standard telegrams)

Notes!

- Limit values via **RS232** are for test purposes only.
- Regardless of the operating mode, the I²t monitor is always enabled to protect the motor against overcurrent. If the I²t limitation becomes active, the motor current is limited to **motor rated current** (see chapter 8.2.1.4 Parameters of the current control loop) and, therefore, is possibly smaller than the current limit set via the limit source.

8.2.2.4 Parameters of the speed control loop

DSerV menu **Optimisation → Speed controller**

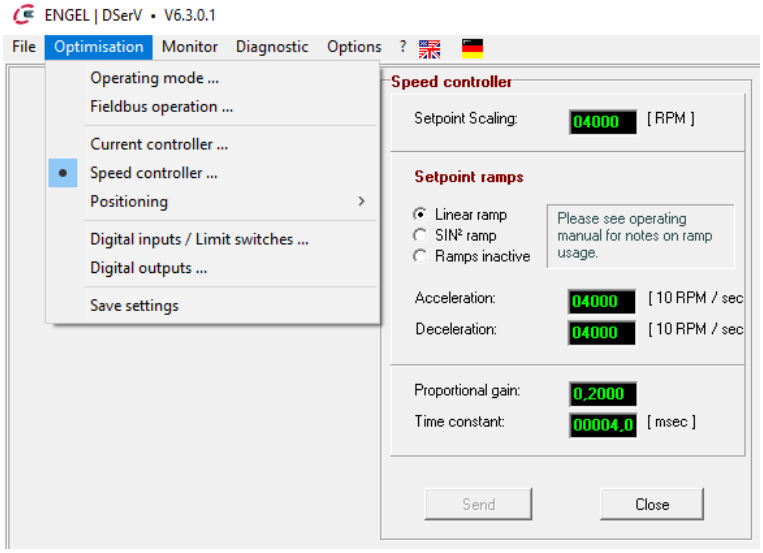


Figure 8-13: Parameters of the speed control loop

This menu item allows to set the parameters of the speed control loop. Parameters for which no **fieldbus object** is specified below can only be changed here.

- **Setpoint Scaling**:

  With **I/O control**, a speed setpoint of 100 % corresponds to the **Setpoint Scaling** value.

  Example with AI1 as setpoint source:
  AE1 = 2 V, Setpoint scaling = 3000 RPM ⇒ Speed setpoint = 2 V/10 V * 3000 RPM = 600 RPM

  With **fieldbus control,** the speed setpoint is not normalized to a maximum speed (see corresponding fieldbus manual).

Setpoint ramp: With this menu item the ramp characteristic of the speed setpoint can be selected and parameterised. This applies in the **speed control** mode and in all operating modes with subordinate speed control (homing mode and all positioning modes).

- **Linear ramp**: The external setpoint setting is limited to the parameterised rates of change (acceleration and deceleration, Unit: 10 RPM/s).

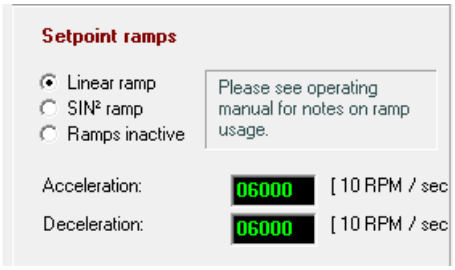


Figure 8-14: Selection of Linear Ramp

Control I/F	Menu, Object, Telegram
I/O mode	Linear ramp, Acceleration, Deceleration
CANopen	Motion Profile Type [6086_h] = 0 Profile Acceleration [6083_h] Profile Deceleration [6084_h]
EtherCAT	Motion Profile Type [6086_h] = 0 Profile Acceleration [6083_h] Profile Deceleration [6084_h]
EtherNet/IP	Motion Profile Type [6086_h] = 0 Profile Acceleration [6083_h] Profile Deceleration [6084_h]
PROFINET	Motion Profile Type [6086_h] = 0 MDI_ACC or ENGEL Telegram 100: Profile Acceleration [6083_h] MDI_DEC or ENGEL Telegram 100: Profile Deceleration [6084_h] (not available via standard telegram 1)

Note!

Notice the units of 10 RPM/s. If you want the motor to accelerate with 1000 RPM/s, for example, you must enter a value of 100!

- **SIN² ramp**: A setpoint step is converted into a jerk limited speed profile for the parameterised time interval. The parameters *Acceleration* and *Deceleration* define the ramp time (unit: ms).

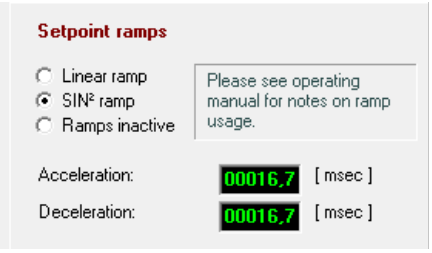


Figure 8-15: Selection of SIN² ramp

Control I/F	Menu, Object, Telegram
I/O mode	SIN² ramp, Acceleration, Deceleration
CANopen	Motion Profile Type [6086_h] = 1 Profile Acceleration [6083_h] Profile Deceleration [6084_h]
EtherCAT	Motion Profile Type [6086_h] = 1 Profile Acceleration [6083_h] Profile Deceleration [6084_h]
EtherNet/IP	Motion Profile Type [6086_h] = 1 Profile Acceleration [6083_h] Profile Deceleration [6084_h]
PROFINET	Motion Profile Type [6086_h] = 1 MDI_ACC or ENGEL Telegram 100: Profile Acceleration [6083_h] MDI_DEC or ENGEL Telegram 100: Profile Deceleration [6084_h] (not available via standard telegram 1)

Notes!

- With **I/O control**, the SIN² ramp is not available in **speed control mode**.
  With **fieldbus control**, the SIN² ramp is available in **speed control mode**.
- With **I/O control**, DSerV allows a time interval each to be entered for the acceleration and deceleration ramp.
  With **fieldbus control**, the time intervals to be set must be converted into the corresponding *Profile Acceleration* and *Profile Deceleration* object values (please see the formula in the fieldbus manual).
- With **I/O control** and **positioning mode**, only one acceleration time and one deceleration time can be defined for all positioning targets. Therefore, both times should be suitable (i.e. not too short) for the largest expected velocity setpoint step.

- **Ramps inactive**: Undelayed speed setpoint setting with no acceleration/deceleration ramp.

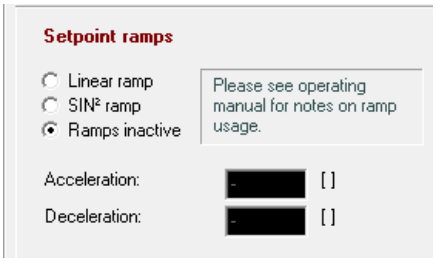


Figure 8-16: Selection of Ramps inactive

Control I/F	Menu, Object, Telegram
I/O mode	Ramps inactive
CANopen	Motion Profile Type [6086_h] = -1
EtherCAT	Motion Profile Type [6086_h] = -1
EtherNet/IP	Motion Profile Type [6086_h] = -1
PROFINET	Motion Profile Type [6086_h] = -1 (not available via telegrams, must be directly addressed)

Notes!

- In some applications the deactivation of the ramps may be necessary, e.g. if the speed ramps are provided by an external source (e.g. a PLC) and further delays are not desired.
  If not explicitly requested, the ramps should **normally** not be switched off.
- The **positioning mode** requires a ramp. The selection **Ramp inactive** is ignored in the positioning mode, instead the **linear ramp** with the last set acceleration/deceleration parameters is automatically used.

- **Proportional gain**: Proportional gain of the PI-type speed control loop (k_{p_n} = 0.0000 … 0.9999).
  For optimal setting of k_{p_n} see chapter 13.3 Speed controller adjustment.

Control I/F	Menu, Object, Telegram
I/O mode	Setup via **DSerV**
CANopen	Velocity Control Parameter Set [$60F9_h$ sub1] → k_{p_n}
EtherCAT	Velocity Control Parameter Set [$60F9_h$ sub1] → k_{p_n}
EtherNet/IP	Velocity Control Parameter Set [$60F9_h$ sub1] → k_{p_n}
PROFINET	Velocity Control Parameter Set [$60F9_h$ sub1] → k_{p_n} (not available via telegrams, must be directly addressed)

- **Time constant:** Integral time of the PI-type speed control loop (t_{n_n} = 0.1 … 3,276.7 ms).
  For optimal setting of t_{n_n} see chapter 13.3 Speed controller adjustment.

Control I/F	Menu, Object, Telegram
I/O mode	Setup via **DSerV**
CANopen	Velocity Control Parameter Set [$60F9_h$ sub2] → t_{n_n}
EtherCAT	Velocity Control Parameter Set [$60F9_h$ sub2] → t_{n_n}
EtherNet/IP	Velocity Control Parameter Set [$60F9_h$ sub2] → t_{n_n}
PROFINET	Velocity Control Parameter Set [$60F9_h$ sub2] → t_{n_n} (not available via telegrams, must be directly addressed)

Notes!

- Please note the function and influence of the digital inputs DI2, DI3 (see chapter 8.3 Digital inputs/limit switches).
- The **polarity** parameter setting (see chapter 8.2.3.2 General positioning parameters) is also effective in **speed control** mode. Here, if polarity is negative, speed setpoints will be inverted.

8.2.3 Positioning mode

The **positioning** mode allows point-to-point positioning with time-optimised (trapezoidal) or jerk limited (sin²) speed characteristics. There are two possible types of positioning: **Linear positioning** and **Turntable positioning**. Homing is required before using each positioning mode to ensure correct positioning. This is done by means of a reference run, during which a defined machine position is determined.

- **Linear positioning**: The positioning takes place within a parameterisable positioning range (see chapter 8.2.3.2 General positioning parameters).
  Positioning range: $\pm 2^{19} = \pm 524{,}288$ revolutions (max.)
  Positioning resolution: $360° / 2^{12} = 0.088°$ (approx.)

Control I/F	Menu, Object, Telegram
I/O mode	Optimisation → Operating mode → Positioning
CANopen	Modes of Operation [6060_h] = 1
EtherCAT	Modes of Operation [6060_h] = 1
EtherNet/IP	Modes of Operation [6060_h] = 1
PROFINET	Standard Telegram 9 or Engel Telegram 100

- **Turntable positioning:** The turntable positioning mode is suitable for operating rotary indexing tables or other devices with a repetitive positioning range. Here, when the system reaches a preset maximum position (see chapter 8.2.3.2 General positioning parameters) the position counter is deliberately reset to zero.
  Positioning range: 1.0000 … 100,000.0000 revolutions
  Positioning resolution: $360° / 2^{12} = 0{,}088°$ (approx.)

Control I/F	Menu, Object, Telegram
I/O mode	Optimisation → Operating mode → Positioning + Turntable
CANopen	Modes of Operation [6060_h] = -5
EtherCAT	Modes of Operation [6060_h] = -5
EtherNet/IP	Modes of Operation [6060_h] = -5
PROFINET	ENGEL Telegram 100: Modes of Operation [6060_h] = -5 (not available via standard telegrams)

- **Homing**: A reference run serves for the detection of a defined machine position. It is normally mandatory with the use of angle sensors with „single turn“ characteristic. Homing works with a subordinate speed control. Therefore, a ramp characteristic must be selected under **Optimisation → Speed controller → Setpoint ramps** (see chapter 8.2.2.4 Parameters of the speed control loop). Exception: Homing to the current position.

- **Positioning procedure**: Before starting a positioning movement, the position at which the braking process must begin is calculated from the target position, the travel speed and the deceleration slope or deceleration time (see chapter 8.2.2.4 Parameters of the speed control loop). This is to ensure that the target position will be hit as accurately as possible.
  The positioning movement is speed controlled, but at the same time the difference between the demanded position and the current position (following error) is monitored. If necessary, the position controller dynamically adjusts the travel speed to keep the following error to a minimum (see chapter 8.2.3.2 General positioning parameters). At the braking point the braking process is started with the selected deceleration. In case the target position is not exactly reached at the end of the braking process, the position controller corrects this with a correction speed.

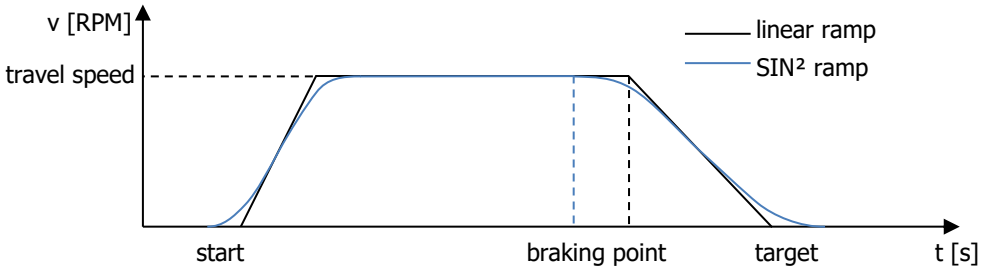


Figure 8-17: Positioning procedure

8.2.3.1 Homing

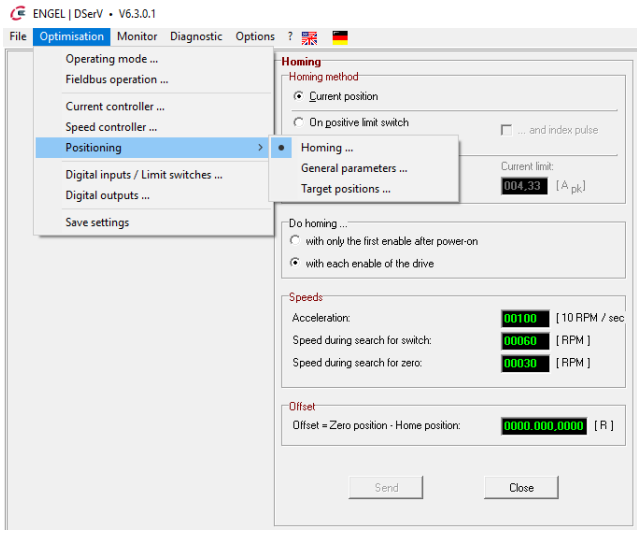


Figure 8-18: Homing menu

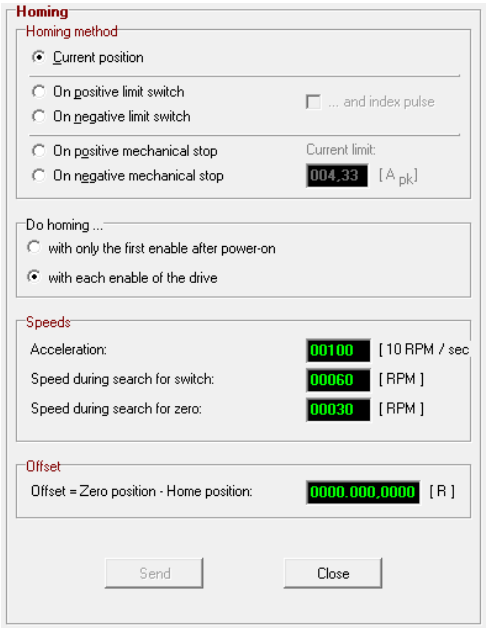


Figure 8-19: Homing parameters

Homing can be selected as follows depending on the control interface type:

Control I/F	Menu, Object, Telegram
I/O mode	**Optimisation → Positioning → Homing** In I/O mode the homing starts automatically, whereby it is possible to choose whether the homing should only be carried out the first time the drive is enabled after power-on or every time the drive is enabled. After successful referencing, the drive automatically switches to positioning mode.
CANopen	Modes of Operation [6060_h] = 6
EtherCAT	Modes of Operation [6060_h] = 6
EtherNet/IP	Modes of Operation [6060_h] = 6
PROFINET	Standard Telegram 9 or ENGEL Telegram 100: Modes of Operation [6060_h] = 6

The **Homing** menu item allows to set the parameters for the reference run. Parameters for which no **fieldbus object** is specified can only be changed via **DSerV**.

Homing method: Determines the direction of movement and the type of homing (e.g. limit switch or mechanical stop).

- **Current Position**: This method adopts the current position as home position. No movement of the drive takes place.

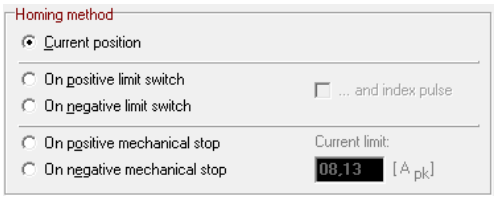


Figure 8-20: Selection of homing on current positon

Control I/F	Menu, Object, Telegram
I/O mode	Current position
CANopen	Homing Method [6098_h] = 35
EtherCAT	Homing Method [6098_h] = 35
EtherNet/IP	Homing Method [6098_h] = 35
PROFINET	Standard Telegram 9: SATZANW = 1xxx xxxx 0010 0011 (not available via ENGEL telegram 100)

- **pos./neg. limit switch**: With inactive limit switches the homing starts with Speed during search for switch, for the positive switch (DI2) in a cw direction of rotation, for the negative switch (DI3) in a ccw direction of rotation. Note that the direction of rotation is unaffected by the polarity parameter (see chapter 8.2.3.2 General positioning parameters). If the switch is already active or if it gets activated, the drive reverses and moves down from the switch with a low Speed during search for zero. The position at which the switch goes inactive is interpreted as home position and the movement stops. (See also chapter 8.3 Digital inputs/limit switches.)

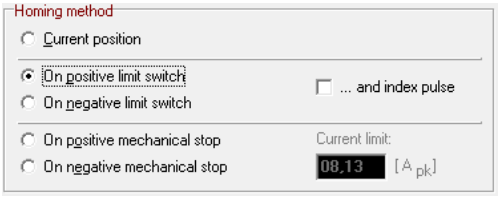


Figure 8-21: Selection of pos./neg. limit switch

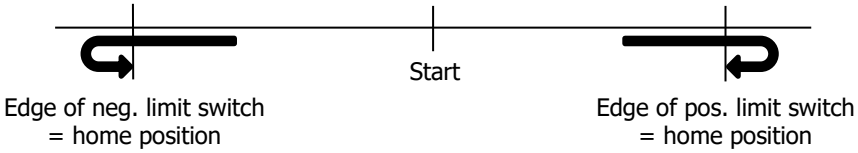


Figure 8-22: Homing on pos./neg. limit switch

Control I/F	Menu, Object, Telegram
I/O mode	positive: On positive limit switch negative: On negative limit switch
CANopen	positive: Homing Method [6098_h] = 18 negative: Homing Method [6098_h] = 17
EtherCAT	positive: Homing Method [6098_h] = 18 negative: Homing Method [6098_h] = 17
EtherNet/IP	positive: Homing Method [6098_h] = 18 negative: Homing Method [6098_h] = 17
PROFINET	positive: Standard Telegram 9: SATZANW = 1xxx xxxx 0001 0010 negative: Standard Telegram 9: SATZANW = 1xxx xxxx 0001 0001 (not available via ENGEL telegram 100)

- **pos./neg. limit switch + index pulse:** Same procedure as described above, but with the following difference: The position at which the switch goes inactive and where the movement stops is not interpreted as home position. Instead, the next index pulse (= zero crossing of the ±180° rotor angle) is interpreted as home positon. This method eliminates tolerances of the switching point of the limit switch.

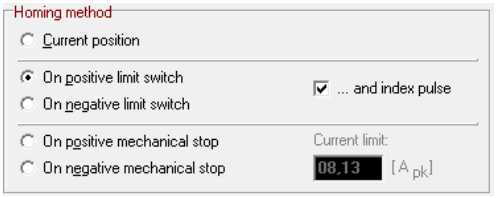


Figure 8-23: Selection of pos./neg. limit switch + index pulse

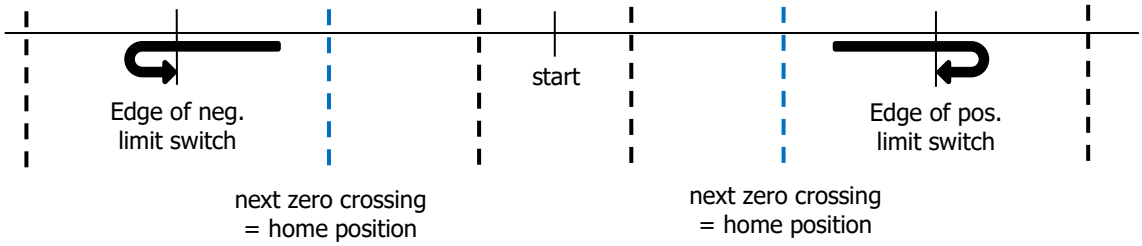


Figure 8-24: Homing on pos./neg. limit switch + index pulse

Control I/F	Menu, Object, Telegram
I/O mode	positive: On positive limit switch + index pulse negative: On negative limit switch + index pulse
CANopen	positive: Homing Method [6098_h] = 2 negative: Homing Method [6098_h] = 1
EtherCAT	positive: Homing Method [6098_h] = 2 negative: Homing Method [6098_h] = 1
EtherNet/IP	positive: Homing Method [6098_h] = 2 negative: Homing Method [6098_h] = 1
PROFINET	positive: Standard Telegram 9: SATZANW = 1xxx xxxx 0000 0010 negative: Standard Telegram 9: SATZANW = 1xxx xxxx 0000 0001 (not available via ENGEL telegram 100)

Note!

The switching point of the limit switch should be adjusted as precisely as possible to the centre between two adjacent zero crossings of the rotor angle, i.e. ideally to the +180°/-180° transition. The display of the rotor angle under DSerV **Monitor → Rotor angle (mech.)** can be used as an aid for this purpose.

- **pos./neg. mechanical stop**: The drive travels with Speed during search for zero and with the set Current limit in the specified direction against a mechanical stop that should be designed as firm as possible. The spontaneous current increase in conjunction with the speed decrease down to zero is used as a criterion that the home position has been reached. The adjustable current limit is also used to limit the torque acting on the mechanical stop. A value smaller than the **motor rated current** should be selected here, because higher currents could be temporarily prevented by the **I²t limitation**, which in turn would lead to a very delayed detection of the mechanical stop. Regardless of the **polarity** parameter (see chapter 8.2.3.2 General positioning parameters) a reference run on a positive or negative mechanical stop is carried out in cw and ccw direction of rotation, respectively. After detection of the mechanical stop the motor current is switched off.

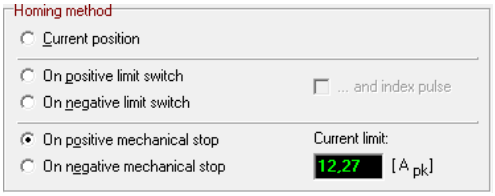


Figure 8-25: Selection of pos./neg. mechanical stop

Control I/F	Menu, Object, Telegram
I/O mode	positive: On positive mechanical stop negative: On negative mechanical stop
CANopen	positive: Homing Method [6098_h] = -18 negative: Homing Method [6098_h] = -17
EtherCAT	positive: Homing Method [6098_h] = -18 negative: Homing Method [6098_h] = -17
EtherNet/IP	positive: Homing Method [6098_h] = -18 negative: Homing Method [6098_h] = -17
PROFINET	positive: Standard Telegram 9: SATZANW = 1xxx xxxx 1110 1110 negative: Standard Telegram 9: SATZANW = 1xxx xxxx 1110 1111 (not available via ENGEL telegram 100)

Current limit: Specifies the current limit for homing on pos./neg. mechanical stop.

Control I/F	Menu, Object, Telegram
I/O mode	Value in [A_{spk}] (sine peak value)
CANopen	Current Threshold Homing [2009_h]
EtherCAT	Current Threshold Homing [2009_h]
EtherNet/IP	Current Threshold Homing [2009_h]
PROFINET	Current Threshold Homing [2009_h] (not available via telegrams, must be directly addressed)

Attention!

When referencing against a mechanical stop …

… specify the lowest possible speed to keep dynamic forces acting on the mechanical stop to a minimum!

… high output forces may occur!

⇒ Calculate or estimate the force arising from the specified **current limit** and take its effect on the system into account.

Do homing: In **I/O mode** the homing starts automatically, whereby it is possible to choose whether the homing should only be carried out the first time the drive is enabled after power-on or every time the drive is enabled. In **fieldbus mode** the homing is under user control and is started by a bit change in a fieldbus object (see corresponding fieldbus manual).

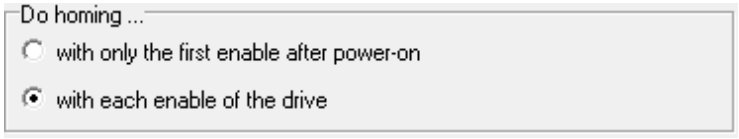


Figure 8-26: Selection of Do homing

Control I/F	Menu, Object, Telegram
I/O mode	**with only the first enable after power-on**: Homing starts automatically with the *first* enable of the drive. **with each enable of the drive**: Homing starts automatically with *every* enable of the drive.
CANopen	Controlword [6040_h] → Bit 4 = 0 to 1 transition
EtherCAT	Controlword [6040_h] → Bit 4 = 0 to 1 transition
EtherNet/IP	Controlword [6040_h] → Bit 4 = 0 to 1 transition
PROFINET	Standard Telegram 9: STW1 → Bit 11 = 0 to 1 transition or ENGEL Telegram 100: Controlword [6040_h] → Bit 4 = 0 to 1 transition

Speeds: This menu item is used to parameterise the speed profile to be used for the reference run.

- **Acceleration**: Specifies the ramp slope (unit: 10 RPM/s) or the ramp time (unit: ms) of the speed ramp depending on whether a **linear ramp** or a **SIN² ramp** is selected. This value applies to all speed changes throughout the reference run, i.e. it applies to both acceleration and deceleration phases.

Figure 8-27: Acceleration with linear ramp

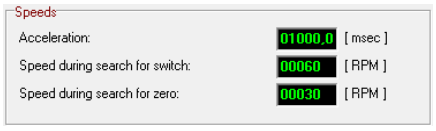


Figure 8-28: Acceleration with SIN² ramp

Control I/F	Menu, Object, Telegram
I/O mode	Setup via **DSerV**
CANopen	Homing Acceleration [$609A_h$]
EtherCAT	Homing Acceleration [$609A_h$]
EtherNet/IP	Homing Acceleration [$609A_h$]
PROFINET	Standard Telegram 9: MDI_ACC (not available via ENGEL telegram 100)

Note!

In **I/O mode** a value can only be entered if a ramp function (linear / SIN²) has been selected under **Optimisation → Speed controller → setpoint ramps** (see chapter 8.2.2.4 Parameters of the speed control loop). If **ramps inactive** is selected here, the **linear ramp** with the last set acceleration parameter will be automatically used instead.

- **Speed during search for switch**: Speed at which the limit switch is approached.

Control I/F	Menu, Object, Telegram
I/O mode	Setup via **DSerV**
CANopen	Homing Speeds [6099_h sub1] → speed during search for switch
EtherCAT	Homing Speeds [6099_h sub1] → speed during search for switch
EtherNet/IP	Homing Speeds [6099_h sub1] → speed during search for switch
PROFINET	Standard Telegram 9: MDI_VELOCITY (not available via ENGEL telegram 100)

- **Speed during search for zero**: Travel speed for determining the switching position of the limit switch or when referencing against a mechanical stop.

Control I/F	Menu, Object, Telegram
I/O mode	Setup via **DSerV**
CANopen	Homing Speeds [6099_h sub2] → speed during search for zero
EtherCAT	Homing Speeds [6099_h sub2] → speed during search for zero
EtherNet/IP	Homing Speeds [6099_h sub2] → speed during search for zero
PROFINET	Standard Telegram 9: MDI_VELOCITY (not available ENGEL telegram 100)

Offset: Offset between the home position determined in the reference run and the zero position of the machine.

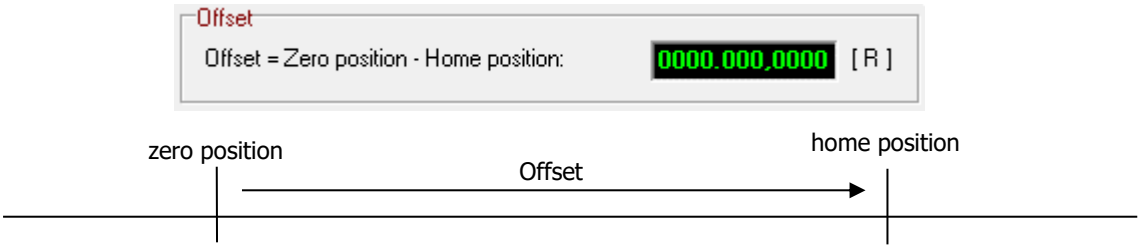


Figure 8-29: Home offset

Control I/F	Menu, Object, Telegram
I/O mode	Setup via **DSerV**
CANopen	Home Offset [$607C_h$]
EtherCAT	Home Offset [$607C_h$]
EtherNet/IP	Home Offset [$607C_h$]
PROFINET	Home Offset [$607C_h$] (not available via telegrams, must be directly addressed)

Notes!

- The homing stops after detecting the switching position of the limit switch or after reaching the mechanical stop. At this point the negative Offset value is assigned to the actual position counter.
- When the negative Offset value is assigned to the actual position counter, the specified **positioning range** (see chapter 8.2.3.2 General positioning parameters) must not be violated!

  ⇒ Permissible offset value range for …

  linear positioning: [-min. positioning range … -max. positioning range]
  turntable positioning: [-turntable positioning range ... 0.0000 R]

8.2.3.2 General positioning parameters

DSerV-Menu **Optimisation → Positioning → General parameters**

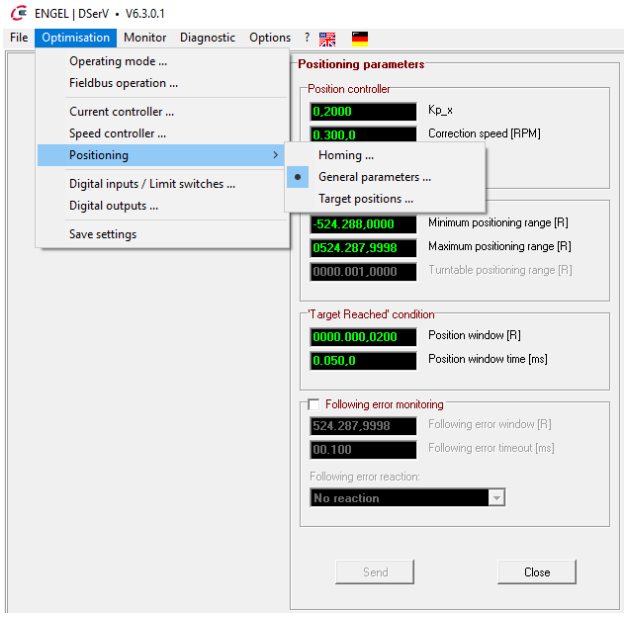


Figure 8-30: Selection of General positioning parameters

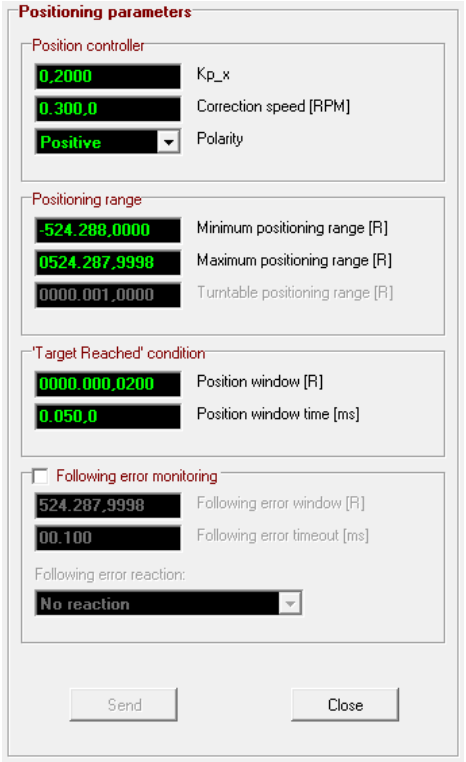


Figure 8-31: General positioning parameters

This menu item allows to set the general parameters of the positioning mode. Parameters for which no **Fieldbus object** is specified can only be changed via **DSerV**.

Position controller: During a positioning run, the position controller continuously attempts to minimise the difference between the demanded position and the actual position value. For this purpose, it increases or decreases the demanded speed, whose maximum permissible deviation from the pre-calculated trajectory speed is specified by the Correction speed parameter.

Example:

With a travel speed of 3000 rpm and a Correction speed of 300 rpm, the position controller can adjust the demanded speed in a range of 2700 ... 3300 rpm.

After completion of a positioning run, the Correction speed also serves to adjust the actual position to the target position.

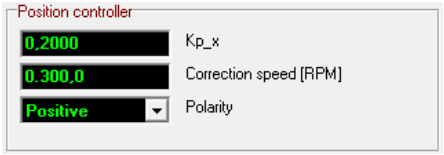


Figure 8-32: Position controller parameters

- **kp_x**: Proportional gain of the P-type position control loop (k_{p_x} = 0.0000 ... 0.9999).

Control I/F	Menu, Object, Telegram
I/O mode	Setup via **DServ**
CANopen	Position Control Parameter Set [60F9$_h$ sub1] → k_{p_x}
EtherCAT	Position Control Parameter Set [60F9$_h$ sub1] → k_{p_x}
EtherNet/IP	Position Control Parameter Set [60F9$_h$ sub1] → k_{p_x}
PROFINET	Position Control Parameter Set [60F9$_h$ sub1] → k_{p_x} (not available via telegrams, must be directly addressed)

- **Correction speed**: Limits the adjustment range of the position controller. This parameter influences the dynamic behaviour when reaching the target position (typical values: approx. 100 ... 500 rpm).

Control I/F	Menu, Object, Telegram
I/O mode	Setup via **DServ**
CANopen	Position Control Parameter Set [60F9$_h$ sub2] → $v_{korrigier}$
EtherCAT	Position Control Parameter Set [60F9$_h$ sub2] → $v_{korrigier}$
EtherNet/IP	Position Control Parameter Set [60F9$_h$ sub2] → $v_{korrigier}$
PROFINET	Position Control Parameter Set [60F9$_h$ sub2] → $v_{korrigier}$ (not available via telegrams, must be directly addressed)

- **Polarity:** This parameter allows the internal reversal of the positioning direction for adaptation to the mechanical conditions of the application:

  Polarity positive ⇒ increasing position values with motor shaft rotating cw
  Polarity negative ⇒ increasing position values with motor shaft rotating ccw

Control I/F	Menu, Object, Telegram
I/O mode	Setup via **DServ**
CANopen	Polarity [607E$_h$]
EtherCAT	Polarity [607E$_h$]
EtherNet/IP	Polarity [607E$_h$]
PROFINET	Polarity [607E$_h$] (not available via telegrams, must be directly addressed)

Note!

The setting of the **polarity** parameter is also effective in **current control mode** and in **speed control mode**. Here, if polarity is negative, current setpoints and speed setpoints will be inverted, respectively.

Positioning Range: The positioning range defines the position limits, within which positioning is permitted. The maximum permissible value range is [-524,288.000 R … 524,287.9998 R] for **linear positioning** and [0.0000 R … 100,000.0000 R] for **turntable positioning**.

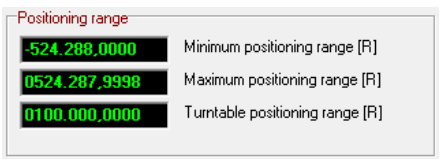


Figure 8-33: Positioning range parameters

- **Minimum positioning range**: Negative limitation of the positioning range. If, after referencing, the setpoint or actual position falls below the parameterised value, a positioning error is triggered (see chapter 12.3 Error messages in positioning mode).

Control I/F	Menu, Object, Telegram
I/O mode	Setup via **DSerV**
CANopen	Software Position Limit [607D$_h$ sub1] → Min Position Limit
EtherCAT	Software Position Limit [607D$_h$ sub1] → Min Position Limit
EtherNet/IP	Software Position Limit [607D$_h$ sub1] → Min Position Limit
PROFINET	Software Position Limit [607D$_h$ sub1] → Min Position Limit (not available via telegrams, must be directly addressed)

- **Maximum positioning range**: Positive limitation of the positioning range. If, after referencing, the setpoint or actual position rises above the parameterised value, a positioning error is triggered (see chapter 12.3 Error messages in positioning mode).

Control I/F	Menu, Object, Telegram
I/O mode	Setup via **DSerV**
CANopen	Software Position Limit [607D$_h$ sub2] → Max Position Limit
EtherCAT	Software Position Limit [607D$_h$ sub2] → Max Position Limit
EtherNet/IP	Software Position Limit [607D$_h$ sub2] → Max Position Limit
PROFINET	Software Position Limit [607D$_h$ sub2] → Max Position Limit (not available via telegrams, must be directly addressed)

- **Turntable positioning range**: Position where the position counter overflows and is reset to zero when in **turntable positioning mode.**

Control I/F	Menu, Object, Telegram
I/O mode	Setup via **DSerV**
CANopen	Position Range Limit [607B$_h$ sub2] → Max Position Range Limit
EtherCAT	Position Range Limit [607B$_h$ sub2] → Max Position Range Limit
EtherNet/IP	Position Range Limit [607B$_h$ sub2] → Max Position Range Limit
PROFINET	Position Range Limit [607B$_h$ sub2] → Max Position Range Limit (not available via telegrams, must be directly addressed)

Note!

The Turntable positioning range must be parameterised with a precision of 4 decimal places.

Permissible value range: **[1.0000 R ... 100,000.0000 R]**

Important:

The design of the mechanical reduction for the system must be selected such that the turntable positioning range is a decimal number with a maximum of 4 decimal places!

Examples:

Turntable positioning range = 10.0625 U ✓ (4 decimal places!)
Turntable positioning range = 10.03125 U × (too many decimal places!)
Turntable positioning range = $10.\overline{3}$ ... U × (too many decimal places!)

If decimal places are truncated or rounded when entered, then the approached positions drift further and further away with every time the turntable limits are exceeded in the same direction!

Please note the special scaling of the object *Position Range Limit [607B$_h$]:* $\frac{1}{10000}$ R

Target reached condition: The target reached condition defines the condition under which the positioning process is considered completed and a new positioning process can be started.

Figure 8-34: Target Reached Condition parameters

Control I/F	Menu, Object, Telegram
I/O mode	output via **DO**
CANopen	Statusword [6041_h] Bit 10
EtherCAT	Statusword [6041_h] Bit 10
EtherNet/IP	Statusword [6041_h] Bit 10
PROFINET	Standard Telegram 9: ZSW1 Bit10 or ENGEL Telegram 100: Statusword [6041h] Bit 10

- **Position window**: The value parameterised under Position window defines a tolerance range around the target position. The actual position must be within this range for a defined period of time (Position window time), before the positioning process is considered completed.

Figure 8-35: Position window

Control I/F	Menu, Object, Telegram
I/O mode	Setup via **DSerV**
CANopen	Position Window [6067_h]
EtherCAT	Position Window [6067_h]
EtherNet/IP	Position Window [6067_h]
PROFINET	Position Window [6067_h] (not available via telegrams, must be directly addressed)

- **Position window time**: The value parameterised under Position window time defines how long the actual position must be in the Position window, before the positioning process is considered completed.

Control I/F	Menu, Object, Telegram
I/O mode	Setup via **DSerV**
CANopen	Position Window Time [6068_h]
EtherCAT	Position Window Time [6068_h]
EtherNet/IP	Position Window Time [6068_h]
PROFINET	Position Window Time [6068_h] (not available via telegrams, must be directly addressed)

Note!

The target reached condition is only evaluated after the positioning process has reached the braking phase and before a subsequent positioning process is initiated (see Figure 8-17 Positioning procedure).

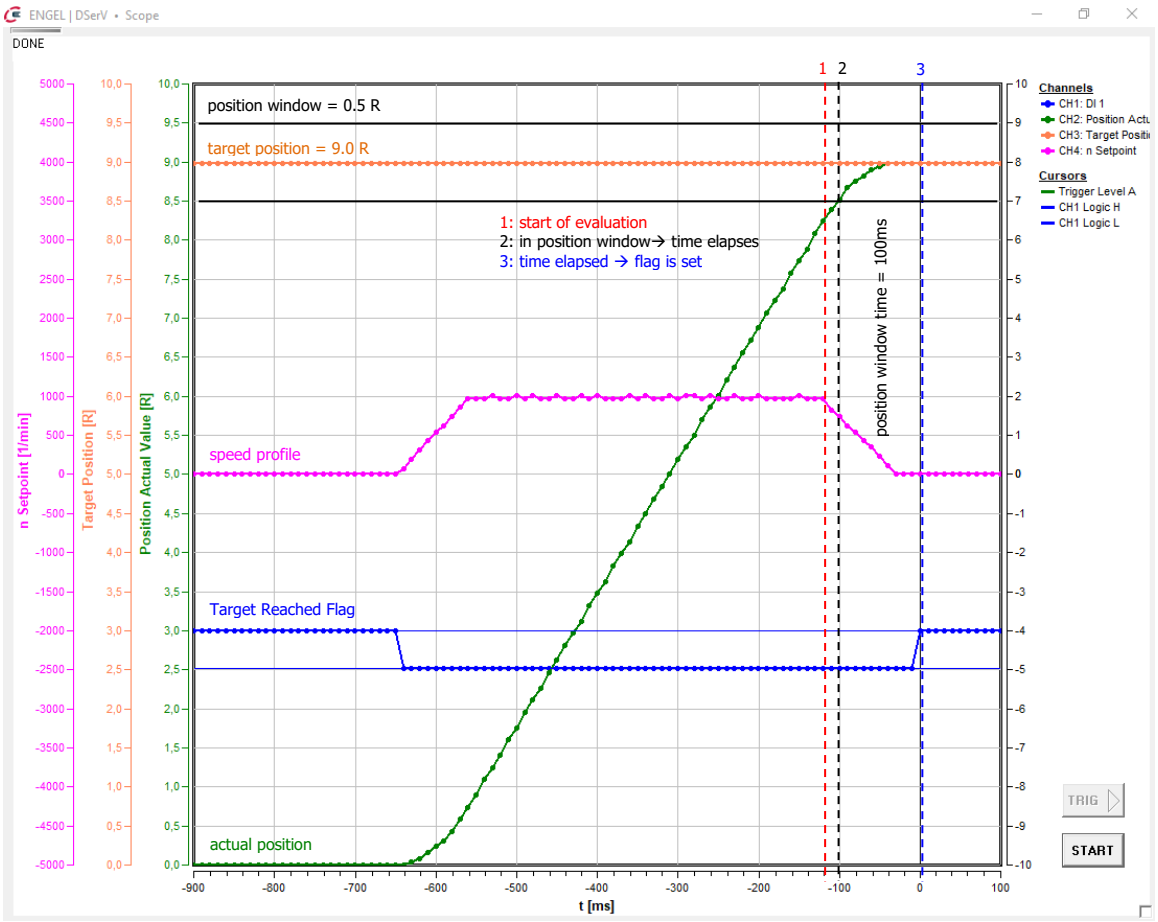


Figure 8-36: Target reached condition

Following error monitoring: The following error is the difference between the actual position and the setpoint position of the drive. A following error can occur if, for example, the mechanical load is too high or the parameterised acceleration/deceleration ramp is too fast.

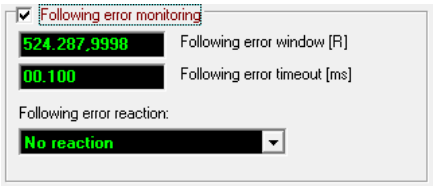


Figure 8-37: Following error monitoring parameters

- **Following error window**: A following error event is present if, for a defined period of time (Following error timeout), the absolute value of the difference between actual position and setpoint position is greater than the value parameterised under Following error window.

Control I/F	Menu, Object, Telegram
I/O mode	Setup via **DSerV**
CANopen	Following Error Window [6065_h] The following error monitoring is active, if Bit 31 = 0. Bits 0 … 30 define the size of the window.
EtherCAT	Following Error Window [6065_h] The following error monitoring is active, if Bit 31 = 0. Bits 0 … 30 define the size of the window.
EtherNet/IP	Following Error Window [6065_h] The following error monitoring is active, if Bit 31 = 0. Bits 0 … 30 define the size of the window.
PROFINET	Following Error Window [6065_h] The following error monitoring is active, if Bit 31 = 0. Bits 0 … 30 define the size of the window. (not available via telegrams, must be directly addressed)

- **Following error timeout**: The value parameterised under Following error timeout defines how long the absolute value of the difference between actual position and setpoint position is allowed to be greater than the value specified under Following error window.

Control I/F	Menu, Object, Telegram
I/O mode	Setup via **DSerV**
CANopen	Following Error Timeout [6066_h]
EtherCAT	Following Error Timeout [6066_h]
EtherNet/IP	Following Error Timeout [6066_h]
PROFINET	Following Error Timeout [6066_h] (not available via telegrams, must be directly addressed)

- **Following error reaction:** If Following error monitoring is active, following error events are signalled and a following error reaction is triggered, which can be parameterised as follows:

  No reaction:

Control I/F	Menu, Object, Telegram
I/O mode	No reaction
CANopen	Signalisation in object ***Statusword [6041_h]*** (Bit13)
EtherCAT	Signalisation in object ***Statusword [6041_h]*** (Bit13)
EtherNet/IP	Signalisation in object ***Statusword [6041_h]*** (Bit13)
PROFINET	Standard Telegram 9: no signalisation in STW1 ENGEL Telegram 100: signalisation in object ***Statusword [6041_h]*** (Bit13)

Positioning error (see chapter 12.3 Error messages in positioning mode):

Control I/F	Menu, Object, Telegram
I/O mode	Positioning error is shown in status bar and the motor is turned off.
CANopen	Signalisation in object ***Statusword [6041$_h$]*** (Bit13) and triggering of a positioning error that leads to the power stage being switched off.
EtherCAT	Signalisation in object ***Statusword [6041$_h$]*** (Bit13) and triggering of a positioning error that leads to the power stage being switched off.
EtherNet/IP	Signalisation in object ***Statusword [6041$_h$]*** (Bit13) and triggering of a positioning error that leads to the power stage being switched off.
PROFINET	Standard Telegram 9: no signalisation in STW1 ENGEL Telegram 100: Signalisation in object ***Statusword [6041$_h$]*** (Bit13) and triggering of a positioning error that leads to the power stage being switched off.

If Following error monitoring is deactivated, no following error events are signalled and no following error reaction is triggered.

Note!

The Following error reaction can only be parameterised via **DSerV**.

8.2.3.3 Target positions

DSerV-Menu **Optimisation → Positioning → Target positions**

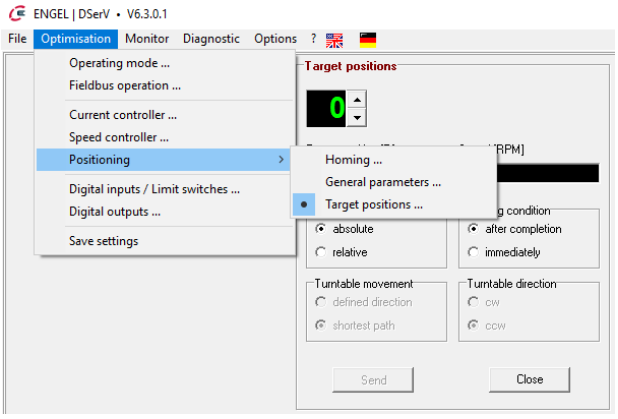


Figure 8-38: Selection of target positions

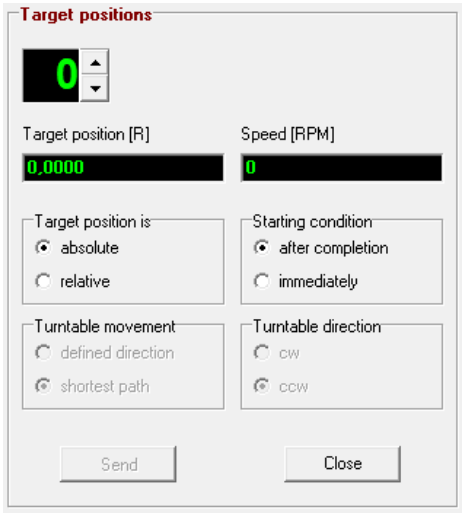


Figure 8-39: Target position parameters

This menu item allows to set the target positions and travel speeds for the positioning in **I/O mode**. Parameters for which no **Fieldbus object** is specified can only be changed via **DSerV**. Positioning mode works with subordinate speed control, therefore a ramp characteristic must be selected under **Optimisation → Speed controller → Setpoint ramps** (see chapter 8.2.2.4 Parameters of the speed control loop).

- **Target ID**: In **I/O mode** a set of target records, comprising target positions (relative or absolute) and corresponding travel speeds, can be stored in the parameter memory. The selection of the target record as well as the start command for the positioning process is carried out via the digital inputs (see chapter 8.3 Digital inputs/limit switches). Note: The numbering of the target IDs starts at 0!

  Example: DI8 | DI7 | DI6 = 1 | 1 | 0 (bin) = 6 (dec.) → Target ID #6

- **Target position**: – The target position is the end position to be approached by the positioning control.

Control I/F	Menu, Object, Telegram
I/O mode	Setup via **DSerV**
CANopen	Target Position [$607A_h$]
EtherCAT	Target Position [$607A_h$]
EtherNet/IP	Target Position [$607A_h$]
PROFINET	Standard Telegram 9: MDI_TARPOS or ENGEL Telegram 100: Target Position [$607A_h$].

- **Speed**: Speed defines the absolute value of the travel speed (rotational speed) to the Target position. The direction of motion is not determined by the sign of the speed value. The ramp characteristic to be used is selected under **Optimisation → Speed controller → Setpoint ramps** (see chapter 8.2.2.4 Parameters of the speed control loop). If **ramps inactive** is selected, the **linear ramp** with the last set acceleration/deceleration parameters will be used.

Control I/F	Menu, Object, Telegram
I/O mode	Setup via **DSerV**
CANopen	Profile Velocity [6081_h]
EtherCAT	Profile Velocity [6081_h]
EtherNet/IP	Profile Velocity [6081_h]
PROFINET	Standard Telegram 9: MDI_VELOCITY or ENGEL Telegram 100: Profile Velocity [6081_h]

Target position is: The Target position can either be specified as absolute or relative value.

- **absolute**: new target position = Target position

Control I/F	Menu, Object, Telegram
I/O mode	absolute
CANopen	Controlword [6040_h] → Bit 6 = 0
EtherCAT	Controlword [6040_h] → Bit 6 = 0
EtherNet/IP	Controlword [6040_h] → Bit 6 = 0
PROFINET	Standard Telegram 9: MDI_MOD → Bit 0 = 0 or ENGEL Telegram 100: Controlword [6040h] → Bit 6 = 0

- **relative**: new target position = last target position + Target position

Control I/F	Menu, Object, Telegram
I/O mode	relative
CANopen	Controlword [6040_h] → Bit 6 = 1
EtherCAT	Controlword [6040_h] → Bit 6 = 1
EtherNet/IP	Controlword [6040_h] → Bit 6 = 1
PROFINET	Standard Telegram 9: MDI_MOD → Bit 0 = 1 or ENGEL Telegram 100: Controlword [6040h] → Bit 6 = 1

Note!

Turntable positioning mode: If **relative** is selected under Target position is, the direction of movement is determined solely by the sign of the target position. Positive target positions will be approached in cw rotation, negative target positions in ccw rotation. The shortest path option is not available in this case.

Starting condition: It can be selected whether a new positioning process is only started after a still active positioning process is completed or whether a still active positioning process is aborted and a new positioning process is started directly.

- **after completion**: New positioning process starts after completion of a still active positioning process.

Control I/F	Menu, Object, Telegram
I/O mode	after completion
CANopen	Controlword [6040_h] → Bit 5 = 0
EtherCAT	Controlword [6040_h] → Bit 5 = 0
EtherNet/IP	Controlword [6040_h] → Bit 5 = 0
PROFINET	ENGEL Telegram 100: Controlword [6040h] → Bit 5 = 0 (not available via standard telegrams)

- **immediately**: New positioning process starts directly and aborts a still active positioning process.

Control I/F	Menu, Object, Telegram
I/O mode	immediately
CANopen	Controlword [6040_h] → Bit 5 = 1
EtherCAT	Controlword [6040_h] → Bit 5 = 1
EtherNet/IP	Controlword [6040_h] → Bit 5 = 1
PROFINET	ENGEL Telegram 100: Controlword [6040h] → Bit 5 = 1 (not available via standard telegrams)

Turntable movement: If in **turntable positioning mode** the Target position is specified as an absolute value, it can be selected whether the Target position is to be approached in a defined direction of rotation or whether it is to be approached by the shortest path.

- **defined direction**: The target position is always approached in the direction of rotation specified under Turntable direction.

Control I/F	Menu, Object, Telegram
I/O mode	defined direction
CANopen	Controlword [6040_h] → Bit 6 = 0 AND Bit11 = 0
EtherCAT	Controlword [6040_h] → Bit 6 = 0 AND Bit11 = 0
EtherNet/IP	Controlword [6040_h] → Bit 6 = 0 AND Bit11 = 0
PROFINET	Standard Telegram 9: MDI_MOD → Bit1 OR Bit 2 ≠ 0 or ENGEL Telegram 100: Controlword [6040_h] → Bit 6 = 0 AND Bit11 = 0

- **shortest path**: The target position is always approached by the shortest path, the direction of rotation may vary.

Control I/F	Menu, Object, Telegram
I/O mode	shortest path
CANopen	Controlword [6040_h] → Bit 6 = 0 AND Bit11 = 1
EtherCAT	Controlword [6040_h] → Bit 6 = 0 AND Bit11 = 1
EtherNet/IP	Controlword [6040_h] → Bit 6 = 0 AND Bit11 = 1
PROFINET	Standard Telegram 9: MDI_MOD → Bit1 AND Bit2 = 0 or ENGEL Telegram 100: Controlword [6040h] → Bit 6 = 0 AND Bit 11 = 1

Turntable direction: If the Target position is specified as an absolute value with a defined direction of rotation, the direction of rotation can be specified here.

- **cw**: The turntable movement is performed in a clockwise direction of rotation.

Control I/F	Menu, Object, Telegram
I/O mode	cw
CANopen	Controlword [6040_h] → BIT 6 = 0 AND BIT11 = 0 AND BIT 12 = 0
EtherCAT	Controlword [6040_h] → BIT 6 = 0 AND BIT11 = 0 AND BIT 12 = 0
EtherNet/IP	Controlword [6040_h] → BIT 6 = 0 AND BIT11 = 0 AND BIT 12 = 0
PROFINET	Standard Telegram 9: MDI_MOD → Bit 1 = 1 or ENGEL Telegram 100: Controlword [6040h] → BIT 6 = 0 AND BIT 11 = 0 AND BIT 12 = 0

- **ccw**: The turntable movement is performed in a counter-clockwise direction of rotation.

Control I/F	Menu, Object, Telegram
I/O mode	ccw
CANopen	Controlword [6040_h] → BIT 6 = 0 AND BIT 11 = 0 AND BIT 12 = 1
EtherCAT	Controlword [6040_h] → BIT 6 = 0 AND BIT 11 = 0 AND BIT 12 = 1
EtherNet/IP	Controlword [6040_h] → BIT 6 = 0 AND BIT 11 = 0 AND BIT 12 = 1
PROFINET	Standard Telegram 9: MDI_MOD → Bit 2 = 1 or ENGEL Telegram 100: Controlword [6040h] → BIT 6 = 0 AND BIT 11 = 0 AND BIT 12 = 1

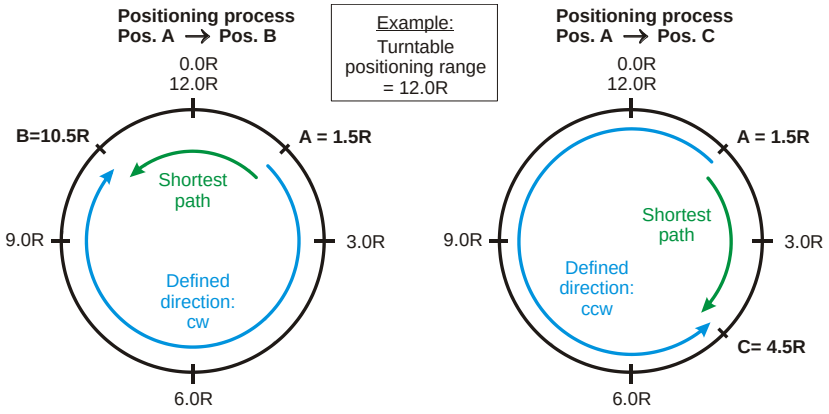


Figure 8-40: Example of absolute turntable positioning

Notes concerning turntable positioning!

The direction of rotation shown, cw/ccw and the clockwise arrangement of the positions assumes, ...

a) ... that motor and Turntable direction are the same and **polarity** is set to „positive“ or

b) ... that motor and Turntable direction are opposite and **polarity** is set to „negative“.

Through the **polarity** parameter (see chapter 8.2.3.2General positioning parameters) the arrangement of the positions – and thus the direction of rotation – can be globally inverted. (Note: The sign of the parameterised travel speed has no influence on the direction of rotation).

Note concerning turntable positioning!

Permissible value range for Target position in turntable positioning mode:

a) with *absolute* positioning:

[0.0000 R ... Turntable positioning range]

If an *absolute* positioning process is started, whereby the new target position is identical to the current setpoint position, no positioning movement will be initiated.

b) with *relative* positioning:

[-Turntable positioning range ... +Turntable positioning range]

If a *relative* positioning process is started over ±Turntable positioning range, a positioning movement will be initiated.

Note concerning fieldbus mode!

Please note the special scaling of the object *Position Range Limit [607B$_h$]:* $\frac{1}{10000}$ R

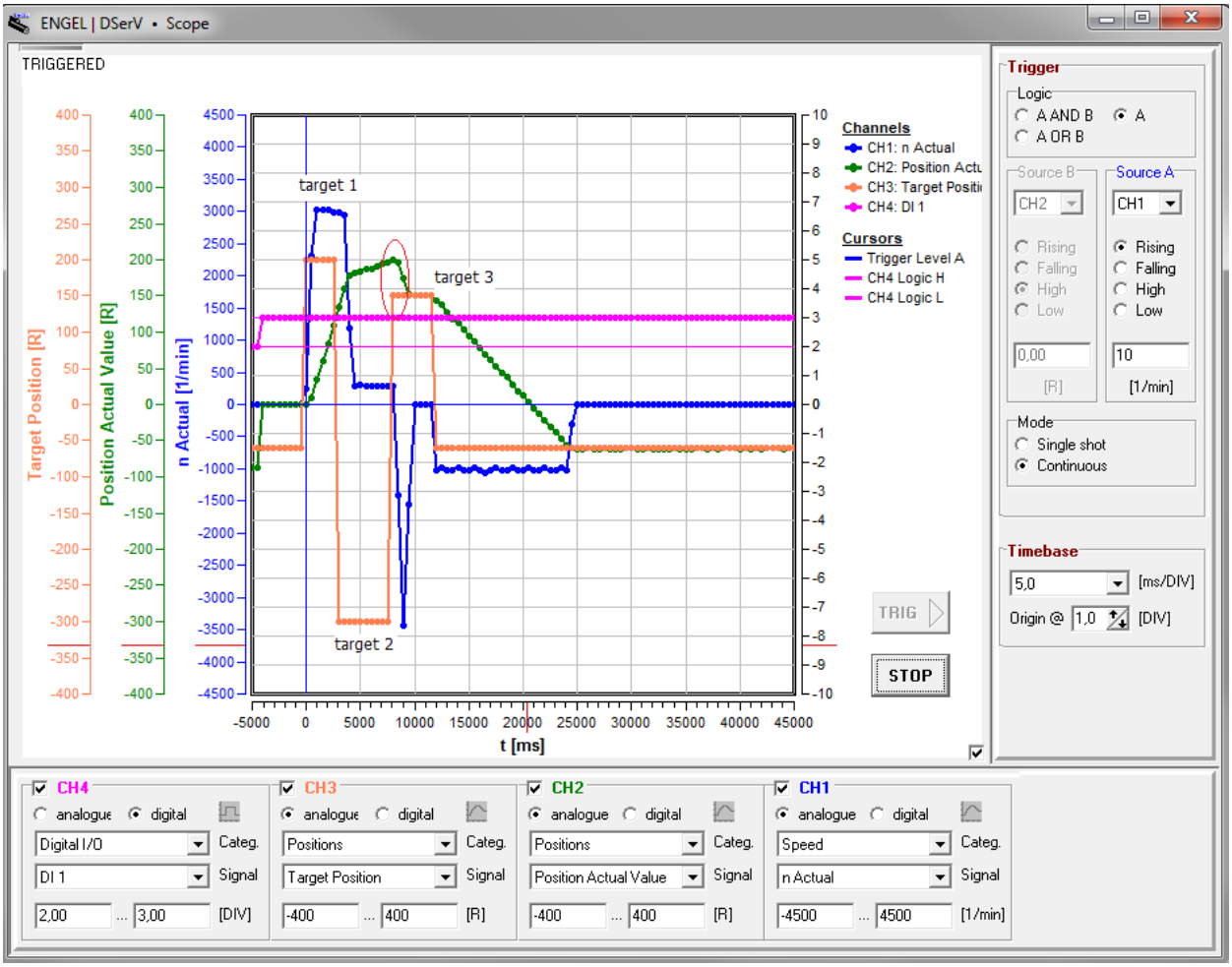


Figure 8-41: Linear positioning with several target positions

Note concerning the „after completion“ attribute!

If several consecutive positioning operations are started with the „after completion“ attribute while another positioning operation is still running, they are not queued. Instead, only the last positioning command issued will prevail and will be executed as soon as the current positioning operation is finished. This must be taken into account for the timing of the positioning jobs.

Example:
Figure 8-41 shows a positioning job #1 (Target 1 = 200 R), followed quickly by positioning job #2 (Target 2 = -300 R) and positioning job #3 (Target 3 = 150 R). Positioning job #1 only ends when positioning job #3 has already been issued. This causes positioning job #2 to be lost.

8.3 Digital inputs/limit switches

The device has 8 digital inputs DI1 … DI8, which are permanently assigned with different functions. In **I/O mode**, these functions are mainly determined by the operating mode (*current control, speed control, positioning)*, which can be selected under **Optimisation → Operating mode**, see the table below. In **fieldbus mode** only the digital inputs DI1 … DI3 are assigned with functions.

Digital Inputs DI4 / DI5 are a special case. They can also be used as digital outputs if they are not assigned with an input function. For available output functions see chapter 8.4 Digital outputs.

The function of the digital inputs DI2, DI3 is additionally depending on the selection of Limit switch monitoring, which can be set under the menu item **Optimisation → Digital inputs/Limit switches.**
Depending on the requirements of the application, optional limit switches can be used. Limit switches serve as restriction of the movement range of the drive and can also be used as reference switches to determine the home position (see chapter 8.2.3.1 Homing).
If no limit switches are to be used, parameterize the selection shown in Figure 8-42 which also corresponds to the factory default.

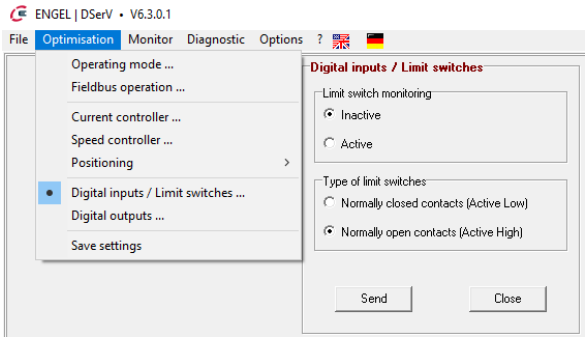


Figure 8-42: Digital inputs/Limit switches parameters

The limit switch parameterisation can only be changed via **DSerV.**

Limit switch monitoring

- **Inactive**: Function varies depending on operating mode (see footnotes under DI function table below).
- **Active**: Function varies depending on operating mode (see footnotes under DI function table below).

Type of limit switch

- **Normally closed contacts (Active Low) -** An activated switch interrupts the 24 V signal voltage to the DI.
- **Normally open contacts (Active High) -** An activated switch applies the 24 V signal voltage to the DI.

Notes concerning normally closed contacts!

- With **Normally closed contacts**, if only one limit/reference switch exists (e.g. at digital input DI2), the other limit switch input (e.g. digital input DI3) must be tied to 24 V. Otherwise, the input is considered active and a positioning or reference error will be triggered (see chapter 12.3 Error messages in positioning mode).
- With **Normally closed contacts** a broken cable has the same effect as an activated limit switch.

Digital Input	Operating Mode			Limit switch monitoring
	Current control	Speed control	Positioning	
DI1	Enable	Enable	Enable	-
DI2	Setpoint = 0 / HALT[1,6]	Setpoint = 0 / HALT[1,6]	Positive limit switch[4]	Inactive
	Positive limit switch[2]	Positive limit switch[2]	Positive limit switch[5]	Active
DI3	Setpoint = inverse[1]	Setpoint = inverse[1]	Negative limit switch[4]	Inactive
	Negative limit switch[3]	Negative limit switch[3]	Negative limit switch[5]	Active
DI4 *(DO2)*	*(DO function)*	*(DO function)*	Start positioning[1]	-
DI5 *(DO1)*	*(DO function)*	*(DO function)*	*(DO function)*	-
DI6	Constant value 1 / 2[1]	Constant value 1 / 2[1]	Target ID Bit 0[1]	-
DI7	-	-	Target ID Bit 1[1]	-
DI8	-	-	Target ID Bit 2[1]	-

[1]Function only effective in **I/O mode**. No function in **fieldbus mode**.

[2]Positive setpoints are suppressed; the controller switches to P-characteristics in order to prevent torques in the positive direction. Negative setpoints are not influenced.

[3]Negative setpoints are suppressed; the controller switches to P-characteristics in order to prevent torques in the negative direction. Positive setpoints are not influenced.

[4]An actuated limit switch does not trigger a positioning error.

[5]An actuated limit switch triggers a positioning error.

[6]Digital input DI2 can be assigned one of two possible functions: Setpoint = 0 or HALT. Currently this setting is not user-selectable and can only be preset at the factory. Default setting: Setpoint = 0.

Description of the DI functions

- **Enable**: The digital input DI1 operates as enable input in each operating mode.
  - ▸ I/O mode: After a reset (e.g. Power-ON) a rising edge at DI1 is required. ⇒ Do not hard-wire DI1!
  - ▸ Fieldbus mode: DI1 must be active to reach the **Operation Enabled** status or the **Operation** status (see fieldbus manual). No rising edge necessary.
- **Setpoint = 0**: Sets the setpoint to zero regardless of the external setpoint specification.
  - ▸ Current Control: The motor is nearly torque-free. Ramp settings remain active.
  - ▸ Speed control: The drive is not drift free!
- **HALT**: When the HALT function is activated, the motor stops and the **positioning mode** temporarily replaces the previous mode to actively hold the current position.
  - ▸ Current control: The drive is not torque-free.
  - ▸ Speed control: The drive is drift-free.
- **Setpoint = inverse:** Inverts the sign of the current setpoint or speed setpoint value. The set speed ramps remain active.

- **Pos./Neg. limit switches**: The specific function of the limit switches varies depending on the selected operating mode and Limit switch monitoring (see footnotes above). Please note that digital inputs DI2 and DI3 are used as a pair and that it is not possible to assign the limit switch function to only one digital input.
- **Constant value 1/2**: In **current control** and **speed control** operating modes one of two parameterisable fixed setpoints is selected. (for parameterisation see chapters 8.2.1.2 Current setpoint, 8.2.2.2 Speed setpoint).
- **Start positioning**: A rising edge starts the next positioning process, either immediately or after the completion of a still active positioning process, depending on the parameterisation (see chapter 8.2.3.3 Target positions).
- **Target ID Bit 0-2**: Selection of a target record (ID 0 ... 7, binary coded), which will be activated with the next start of a positioning process. A target record mainly comprises a target position and a corresponding travel speed (see chapter 8.2.3.3 Target positions).

For the connector pin assignment of the digital inputs see chapter 9.1 X1 – Supply and signals.
For the electrical characteristics of the digital inputs see chapter 6.1 System Data.

Note!

The DI functions are activated with a signal level of +15 V ... +30 V and are deactivated with a signal level of 0 ... +5 V.

Exception:
The **limit switch** DI function with **normally closed contacts** setting works with inverse signal level assignment.

8.4 Digital outputs

The device has 2 digital outputs DO1/DO2, which can be freely assigned with a function from a predefined list of functions.

Note!
Each DO pin can alternatively be used as a digital input (DO1/DI5, DO2/DI4). Therefore, a digital output is only available if the corresponding digital input is not required.

The following DO availability arises depending on the operating mode:

	Current control	Speed control	Positioning
I/O mode	✓ DO1 ✓ DO2	✓ DO1 ✓ DO2	✓ DO1 ✘ DO2
Fieldbus mode	✓ DO1 ✓ DO2	✓ DO1 ✓ DO2	✓ DO1 ✓ DO2

See also the tabular overview in chapter 8.3Digital inputs/limit switches.

In **fieldbus mode** both DOs are always available, as DI4 is not required here as start signal for the positioning runs.

The function of digital outputs DO1/DO2 can be configured via the DServ menu **Optimisation → Digital outputs**:

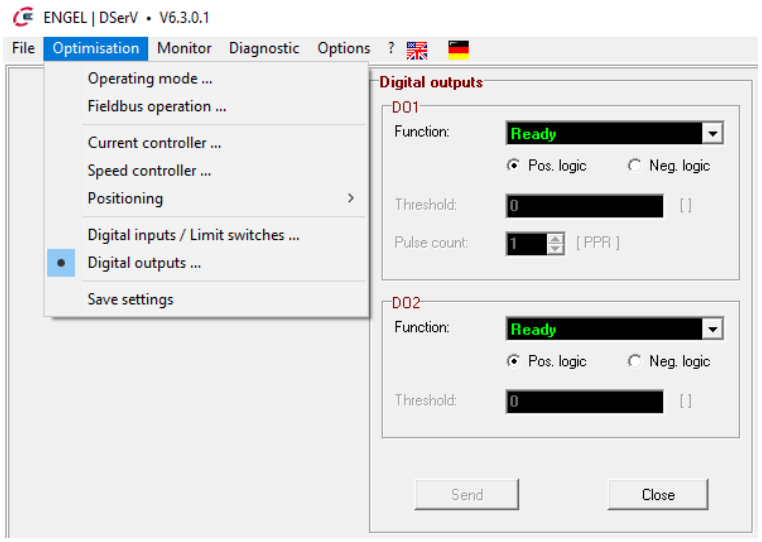


Figure 8-43: Digital outputs menu

The configuration of the digital outputs can only be changed via **DSerV**.

Function: The following DO functions can be assigned to the digital outputs via the drop-down menu:

- **No operation** — Permanently FALSE. No function is assigned to the digital output.
- **Enable** — TRUE, if the drive is error-free and enabled.
- **Speed > Threshold** — TRUE, if |actual speed| > threshold value.
- **Current > Threshold** — TRUE, if |actual current| > threshold value.
- **I²t active** — TRUE, if I^2t limiting is active.
- **Target reached** — TRUE, after successfully completed positioning process or after finished homing process or during HALT (see also *Position reached*).
- **Ready** — TRUE, if drive is error-free.
- **Following error > Threshold** — TRUE, if |following error| > threshold value.
- **Encoder output channel A/B** — Emulation of an encoder output channel, track A/B.
- **Position reached** — TRUE, only after successfully completed positioning process (see also *Target reached*).
- **Ready/Travelling/Error** — TRUE, if the drive is error-free. Toggles (8 Hz) during positioning or homing runs. FALSE, if the drive is in an error state.

Pos. logic: A function, as described above, is assigned to the DO.

Neg. logic: A function, as described above, is **inverted** before it is assigned to the DO.

The **Ready** function, for example, becomes a **Not Ready** function if **negative logic** is selected.
In this example, the function is TRUE if the drive is in an error state and FALSE if the drive is error-free.

Threshold: If one of the threshold functions is selected (see above), the threshold value can be parameterised here.

Pulse count: 1 … 20 pulses per revolution (only with function „Encoder output channel A/B“)

For the connector pin assignment of the digital outputs see chapter 9.1 X1 – Supply and signals
For the electrical characteristics of the digital outputs see chapter 6.1 System Data

Note!

Both digital outputs are ground-switching open-collector outputs, which can only output a HIGH voltage, if they are equipped with an external pull-up resistor (e.g. 1 kΩ/1 W to +24 VDC, see chapter 10.2 Installation diagram).

Please note the digital outputs' maximum driving capability (see chapter 6.1 System Data)

Note!

The return value of the DO function and the DO signal level are related as follows:

- TRUE ≙ HIGH (Pull-up resistor required, see above)
- FALSE ≙ LOW

Note!

All functions that compare a physical quantity with a parameterised threshold work without debouncing. Minimum time interval of successive DO switching edges: ≥ 1.5 ms.

8.5 I²t monitoring

The I²t monitoring protects the motor and the power stage against thermal overload by limiting the motor current to **motor rated current** (see chapter 8.2.1.4 Parameters of the current control loop) after a permissible overload duration has elapsed.

I_{rated} = rated current (normally equal to the rated motor current)
I_{max} = maximum current (normally equal to the peak motor current)
I_{actual} = actual motor current

When $I_{actual} > I_{rated}$, the I²t function is activated. When the I²t function is active, the difference between the squared I_{actual} and I_{rated} values is added up as $\Sigma(I_{actual}^2 - I_{rated}^2)$. As soon as the sum exceeds a defined threshold value, I_{actual} is limited to I_{rated}. The threshold is chosen for an overload duration of approx. 5 s at an overload of $I_{actual} = 2 * I_{rated}$.

As soon as the sum falls below 50 % of the threshold value again, it is possible to operate in overcurrent mode again, taking into account that the sum is not yet zero at this point. This means that the maximum overload duration is considerably reduced if the overcurrent operation is repeated while the sum is not yet at zero. The I²t function is deactivated when the sum reaches the value 0.

The maximum overload duration at motor currents $I_{rated} \leq I_{actual} \leq I_{max}$ is determined by the ratio of I_{actual} to I_{rated}.

Example: I_{actual} = $2 * I_{rated}$ → Overload duration: approx. 5 s

I_{actual} = $4 * I_{rated}$ → Overload duration: approx. 1 s

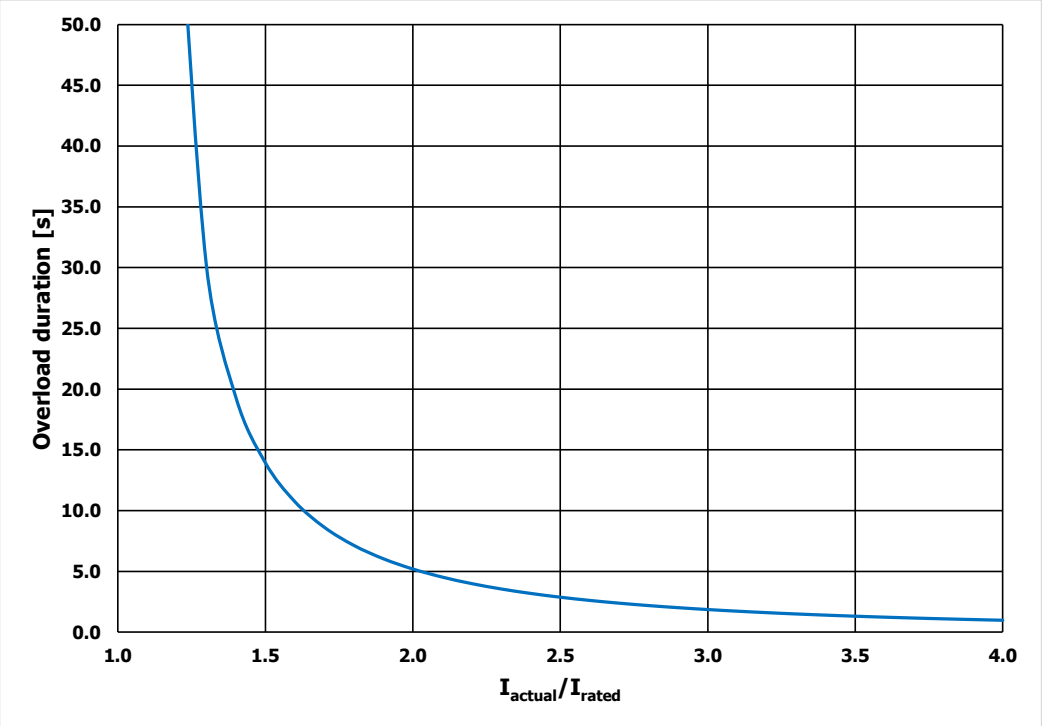


Figure 8-44: Overload duration as a function of I_{actual}/I_{rated}

Example: For a specific application, a motor must be able to reliably supply an overload torque (current) for 10 s during start-up. To ensure this, the actual current must not exceed approx. 1.6 times the rated current.

9 Connection assignment

Depending on the fieldbus option selected, the HFI series has different connection variants, but with identical contact arrangement and signal assignment of the connector pins. Figure 9-1 shows the variant with CANopen on the left and a variant with fieldbus module on the right. For more detailed information regarding the available connection variants, please contact the ENGEL sales department.

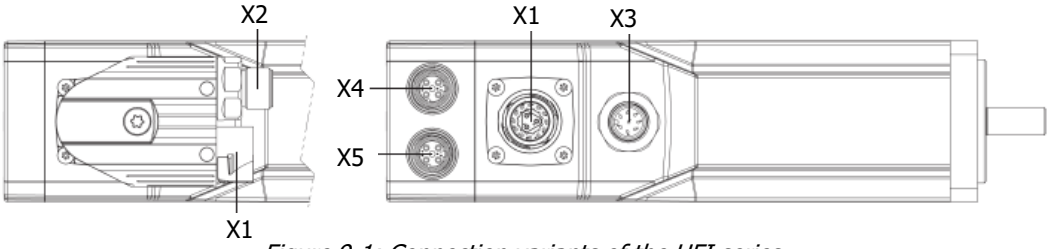


Figure 9-1: Connection variants of the HFI series

9.1 X1 – Supply and signals

Connector on the device (Var1): ytec-/itec angled receptacle (Intercontec series 615/915, with insert 12+3-pol. male)
Connector on the device (Var2): itec straight receptacle (Intercontec series 615/915, with insert 12+3-pol. male)
Mating plug: plug (Intercontec series 915, with insert 12+3-pol. female)

Pin-No.	Wire[1]		Name	Description	Value
A	BN	3 x 1.5 mm²	+Ub	Supply 24 VDC / 48 VDC (logic circuit and power stage)	depending on device design
B	BU		0V	Supply 0 V (reference potential for +Ub and +Ubl) [2]	
C	BK		+Ubl	Logic supply 24 VDC [3]	
1	WH	12 x 0.14 mm²	DI1	Digital input 1 (enable input)	L: 0 ... 5 V, H: 15 ... 30 V
2	BN		DI2	Digital input 2 (setpoint = 0/Halt/positive limit switch)	L: 0 ... 5 V, H: 15 ... 30 V
3	GN		DI3	Digital input 3 (setpoint = inverse/negative limit switch)	L: 0 ... 5 V, H: 15 ... 30 V
4	YE		DO1	Digital output 1 (configurable function)	Open Coll. (24 V, 50 mA)
			DI5	Digital input 5 (currently not usable as DI)	L: 0 ... 5 V, H: 15 ... 30 V
5	GY		DO2	Digital output 2 (configurable function)	Open Coll. (24 V, 50 mA)
			DI4	Digital input 4 (start positioning process) [4]	L: 0 ... 5 V, H: 15 ... 30 V
6	PK		AI1+	Analogue input 1 (differential input: analogue setpoint) [6]	0 ... ±10 V
7	BU		AI1-	Analogue input 1 (differential input: analogue setpoint)	
			DI6	Digital input 6 (Target ID Bit 0 [4]/constant value 1/2 [5]) [6]	L: 0 ... 5 V, H: 15 ... 30 V
8	BK		GND	Reference potential (signal ground) [2]	
9	RD		DI7	Digital input 7 (Target ID Bit 1) [4]	L: 0 ... 5 V, H: 15 ... 30 V
10	VT		TxD	RS232: Transmit Data	
11	GY-PK		RxD	RS232: Receive Data	
12	BU-RD		DI8	Digital input 8 (Target ID Bit 2) [4]	L: 0 ... 5 V, H: 15 ... 30 V

[1] Wire colours and cross-sections apply for ENGEL standard connection cables.
[2] Supply 0 V and GND are connected internally through a self-resetting fuse.
[3] +Ubl supply is not mandatory. For the principle of the separate logic supply, see chapter 10.2 Installation diagram
[4] Function only in positioning mode.
[5] Function only in speed control mode with constant setpoints selectable through digital input.
[6] When using AI1- as digital input DI6: connect AI1+ to GND!

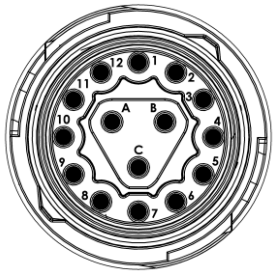


Figure 9-2: Pin layout X1 – View on mating side of receptacle

9.2 X2 – CAN signal plug

Connector on the device: ytec angled receptacle (Intercontec series 615/915) with insert
5-pin M12 circular connector (male A-coded)
Mating plug: 5-pin M12 circular connector (female A-coded)

Pin-N0.	Wire[1]		Name	Description
1	-	-	(Shield)[2]	CAN-Shield
2	RD	2 x 1.04 mm²	n.c.	-
3	BK		CAN_GND	CAN reference potential
4	WH	2 x 0.52 mm²	CAN_H	CAN-High signal
5	BU		CAN_L	CAN-Low signal

[1] Wire colours and cross-sections apply for ENGEL standard connection cables.
[2] If a shielded cable is used, the shield connection should preferably be made via the connector housing. In addition, the shield can also be contacted via Pin 1.

The CAN interface is galvanically isolated.

A network terminating resistor is not integrated and may need to be connected externally, see also chapter 10 Installation.

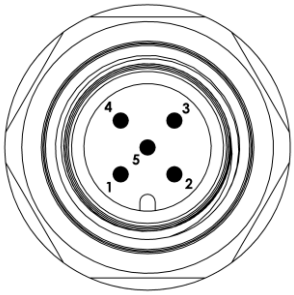


Figure 9-3: Pin layout X2 – View on mating side of receptacle

9.3 X3 – STO signal plug

Connector on the device: 8-pin M12 circular connector (male, A-coded)
Mating plug: 8-pin M12 circular connector (female, A-coded)

Pin-No.	Name	Description
1	Status+	potential-free status output (positive potential, collector)
2	Status-	potential-free status output (negative potential, emitter)
3	STO1-	supply STO-channel 1, reference potential, 0V
4	STO1+	supply STO-channel 1, positive potential, 24V
5	n.c.	
6	STO2+	supply STO-channel 2, positive potential, 24V
7	STO2-	supply STO-channel 2, reference potential, 0V
8	n.c.	

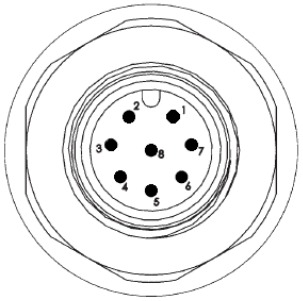


Figure 9-4: Pin layout X3 - View on mating side of receptacle

9.4 X4, X5 – Fieldbus modules

Connector on the device: 4-pin M12 circular connector (female, D-coded)
Mating plug: 4-pin M12 circular connector (male, D-coded)

Pin-No.	Wire[1]		Name	Description
1	YE	2 x 2 x 0,34 mm²	TX+	Transmit Data +
2	WH		RX+	Receive Data +
3	OG		TX-	Transmit Data -
4	BU		RX-	Receive Data -

[1] Wire colours and cross-sections apply for ENGEL standard connection cables.

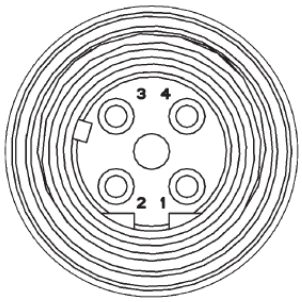


Figure 9-5: Pin layout X4, X5 - View on mating side of receptacle

Note!

For **EtherCAT**, connector X4 is the signal input and X5 is the signal output!
For the other fieldbuses, both ports are equivalent.

10 Installation

10.1 Cable type, cable length and shielding

Warning!

This product may cause high-frequency interference, which may require interference suppression measures.

For the optimal operation of the drives, ENGEL offers cable assemblies in various standard lengths.

10.1.1 Requirements on the supply/signal line (connection to X1)

- Recommended wire cross-section for power supply: 1.5 mm² (Please note the voltage drop along the line!)
- The power supply wires should be stranded in pairs and have shielding
- Minimum wire cross-section for signals: 0.14 mm²
- Flexibility and temperature range in accordance with the specific application.
- Connect the overall shield with the lowest possible impedance to functional earth.

Type recommendation: **ENGEL original accessories:**

- **Item.-No. 9900000575 (2 m)**
- **Item.-No. 9900000576 (5 m)**

Cable assembly with connection plug, open on one end,
3 x 1.5 mm² (shielded) + 12 x 0.14 mm² (shielded), suitable for drag chains.

10.1.2 Requirements on the CAN line (connection to X2)

- Twisted pair leads recommended for signal pair
- Minimum wire cross-section: 0.25 mm²
- Overall shield
- Flexibility and temperature range in accordance with the specific application.

Type recommendation: **ENGEL original accessories:**

- **Item.-No. 9900000577 (6 m)**

Cable assembly with M12 connection plug, open on one end,
2 x 0.52 mm² (shielded) + 2 x 1.04 mm² (shielded), suitable for drag chains.

A CAN network comprised of multiple drives can be easily wired in bus topology by means of the following standard components, which are available from several manufacturers:

- Y-connector, 1x male/2x female, 5-pin, 180°-cod., 1:1, M12: e.g. Lumberg, Item no. 0906 UTP 101 **or**
- T-connector, 1x male/2x female, 5-pin, 1:1, M12: e.g. Lapp Kabel, Item no. 22260765

- CANopen® Bus cable, 1x male/1x female, 5-pin, M12: e.g. Lapp Kabel, Item no. 22260795 - 22260799
- CANopen® Terminating resistor, M12: e.g. Lapp Kabel, Item no. 22260766

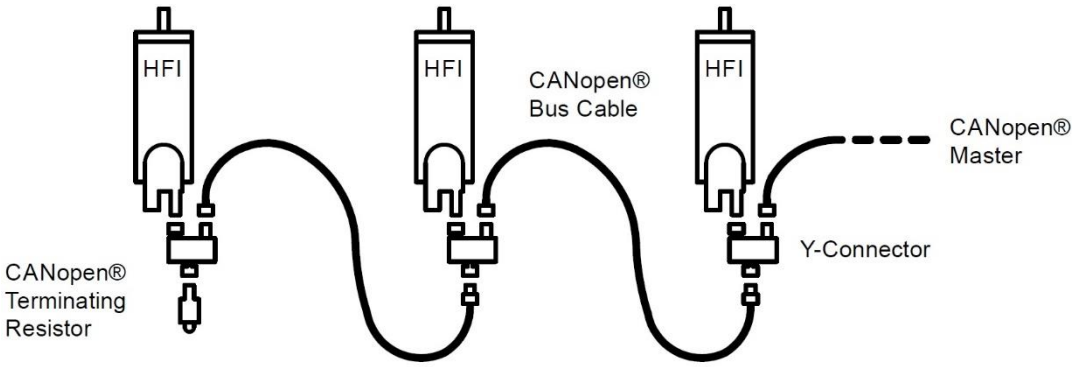


Figure 10-1: CAN network with Y-connector

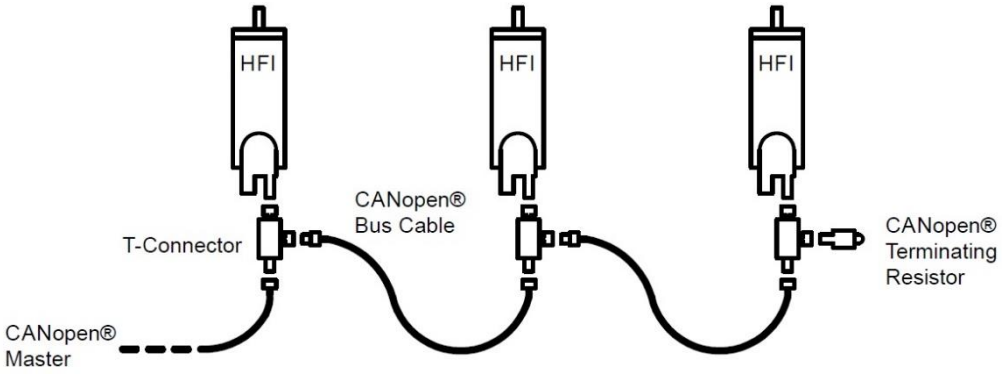


Figure 10-2: CAN network with T-connector

Note:
With the use of a T-connector, rotating receptacles for the drives can no longer be completely turned towards the motor shaft. With the use of a Y-connector, the full range of rotation of the receptacle is available.

Common Y-connectors with 45°/225° coding of the contact inserts are normally not mechanically suitable for use on HFI drives! Check for usability before use!

10.1.3 Requirements on the STO line (connection to X3)

- Minimum wire cross-section: 0,25 mm²
- Overall shield
- Cable length max. 20 m
- Flexibility and temperature range in accordance with the specific application.

Type recommendation: **ENGEL original accessories:**

- **Item.-No. 9900000650 (5 m)**
- **Item.-No. 9900000651 (15 m)**

Cable assembly with M12 connection plug, open on one end,
8x 0,25mm² (shielding applied on sleeve nut)

10.1.4 Requirements on the fieldbus lines (connection to X4 and X5)

- Cat 5e or higher category cable
- Overall shield
- Flexibility and temperature range in accordance with the specific application.

Type recommendation: **ENGEL original accessories:**

- **Item.-No. 9900000634 (2 m)**
- **Item.-No. 9900000635 (5 m)**

Standard cable assembly for Industrial-Ethernet/PROFINET (Type C, Cat 5e) with M12 connection plug (straight, D-coded), open on one end, 4 x 0.34 mm² (shielded), suitable for drag chains.

10.2 Installation diagram

The following installation diagram shows an example for the connection of the drive and does not represent all wiring options.

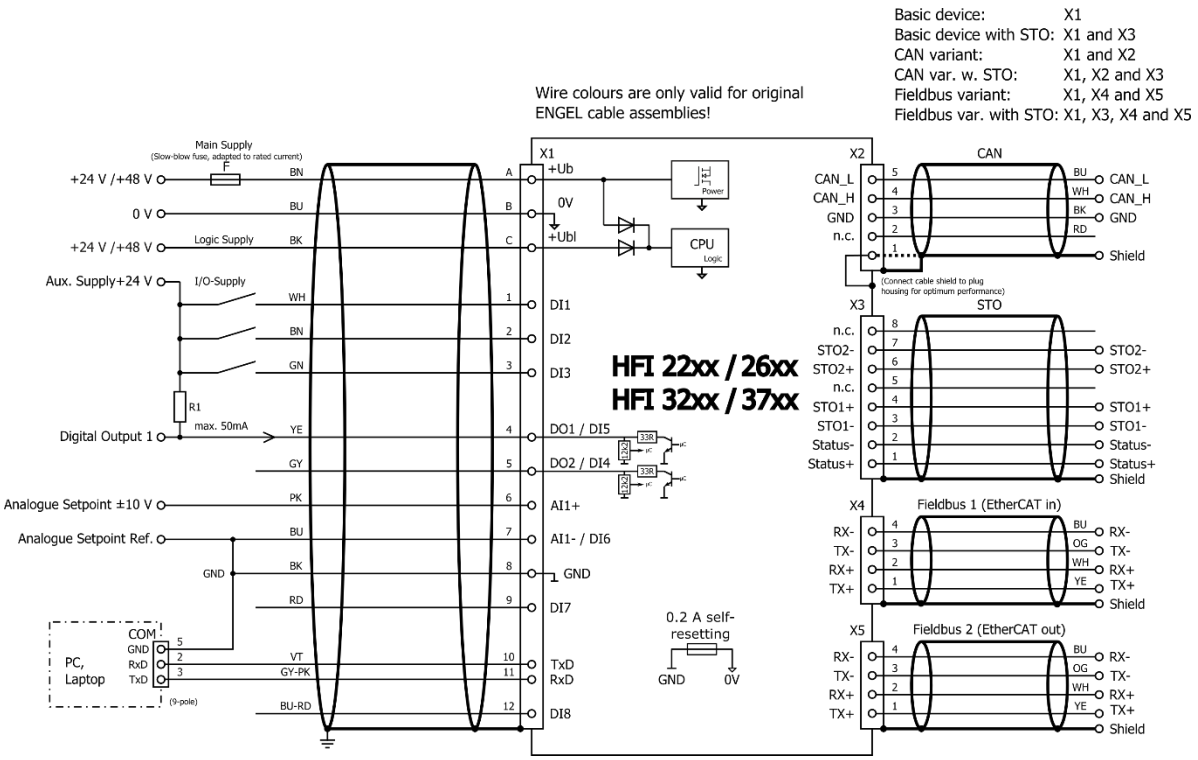


Figure 10-3: Example installation diagram

Notes!

- Digital outputs:
  Digital outputs of the drive are ground switching (attention: internal 12k2 parallel resistance, see installation diagram) and designed without a pull-up resistor. Normally an external pull-up resistor is required for reading to a controller (e.g. R1 = 1 kΩ / 1 W to +24 VDC).
- Separate logic supply:
  To maintain the data on shut-down or failure of the main supply +Ub (+24 VDC/+48 VDC), it is possible to feed a separate logic supply voltage +Ubl (+24 VDC/+48 VDC) to X1. The reference potential of each of the two voltage supplies is to be connected to X1/Pin B (0 V).
- Analogue Input:
  For correct functionality of the differential analogue input (AI1+/AI1-), it is not only necessary to connect AI1+ and AI1- to the analogue signal source, but AI1- must also be connected to GND.

Attention!

Functional Safety

For devices with functional safety (HFIxxxx-**S**x00-xx**)** the operating instructions supplement *Integrated Drives HFI equipped with STO-Module* must **also** be consulted.

11 Commissioning

Warning!

Movements of the drive occur during the commissioning. Prior to commissioning, it must be ensured that no dangers may emanate from the drive and that uncontrolled movements cannot occur.

Note!

The devices are factory-set to **I/O interface**, **speed control mode** and setpoint setting via analogue input AI1. The commissioning description is based on these settings.

We recommend the following procedure for the commissioning:

Step 1: Installation

- Install the device in accordance with the installation diagram and wire the digital inputs and outputs required for the application.

Step 2: Adjust non-critical signal processes

- Adjust the externally specified setpoints to the minimum.
- Withdraw the controller enable (DI1 = OFF).

Step 3: Switch on the supply voltage

- The green LED of the status display will blink constantly („Drive ready").

Remedy for errors with red flashing status LED:
See table of errors in chapter 12.2 General error messages.

Step 4: Start the DSerV service software

- Connect COMx (x = 1 … 99) of your PC / laptop and connector X1 of the drive according to chapter 10.2Installation diagram, then start the **DSerV** service software. The status bar of the program will show the type and version of the connected device (see chapter 7.3 Using the DSerV service software).

Remedy for faulty communication:
See chapter 7.2 Installation and start-up of the program.

Step 5: Review the parameter set

- Check the set current limits under the menu item **Optimisation → Current controller** to ensure that the parameter set is adapted to the connected drive.
  If this is not the case, load a suitable parameter set into the drive or optimise the current and speed controller according to chapter 13 Controller optimisation.

Step 6: Enable the power stage

- Switch on the controller enable DI1: The green LED of the status display switches to continuously illuminated.
- With a slight increase of the speed setpoint, the motor shaft must begin to rotate. The shaft rotates cw (looking onto the shaft end) if both the setpoint and the polarity parameter are positive.

Remedy for errors with red flashing status LED:
See table of errors in chapter 12.2 General error messages.

Step 7: Assure the functionality of the application

- Check the connected input and output signals for correct function.

12 Status display, error messages

An internal error memory enables the display of even short-term error signals.

The occurrence of an error leads to the shut-down of the power stage, i.e. the motor power is disconnected. Errors are shown with the red LED of the status display by means of a blink code, whereby the number of light pulses corresponds to the error code. The error table provides an indication of the cause of error. The **DSerV** service software shows the cause of error in plain text (see chapter 7.3 Using the DSerV service software). If multiple causes of error are present at the same time, the highest error code is displayed.

After rectification of the corresponding cause of error, an error message can be reset by switching the enable input DI1 **OFF-ON**. The power stage and the controller are only activated after switching the enable input **OFF-ON** a second time (only applies to **I/O mode,** for **fieldbus mode** see CANopen user manual):

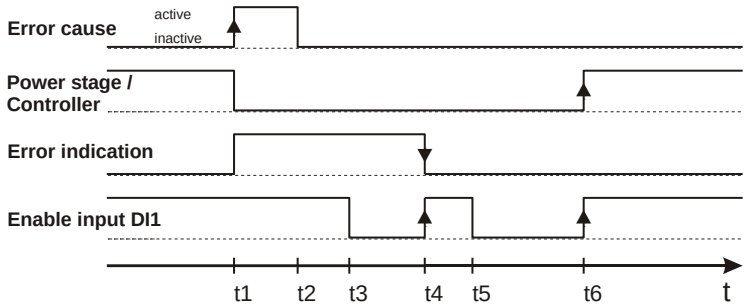


Figure 12-1: Error logic in I/O mode

t1: Occurrence of an error: Power stage disabled immediately; error message active.
t2: Error cause is rectified.
t3: Enable input set to inactive by user.
t4: Enable input set to active by user (1st rising edge): Power stage/controller remains disabled.
t5: Enable input set to inactive by user: Error message is reset, ready message follows.
t6: Enable input set to active by user (2nd rising edge): Power stage and controller become active.

The resetting of an error message is also possible by switching the device off and on again.

Note!

Error 10 (see chapter 12.2 General error messages) can only be reset via a device reset (e.g. power-on reset).

12.1 Status display

12.1.1 HFI without communication module

A red/green LED provides a general indication of the device's operating status. In error state, the red LED flashes 1 … 14 times (corresponding to the active error). Unlike the models equipped with a communication module, the models with on-board CAN bus do **not** have a separate fieldbus status LED. CAN bus errors are indicated by the general status LED.

LED green	LED red		Operating status
blinking	OFF	⇨	Drive ready, controller/power stage **disabled**
ON	OFF	⇨	Drive ready, controller/power stage **enabled**
OFF	blinking	⇨	Error status → Red LED indicates the highest active error code.
OFF	OFF	⇨	- Device has no function → Check input voltage - Firmware download mode active (red LED glows weakly) - RESET active (e.g. on start-up)

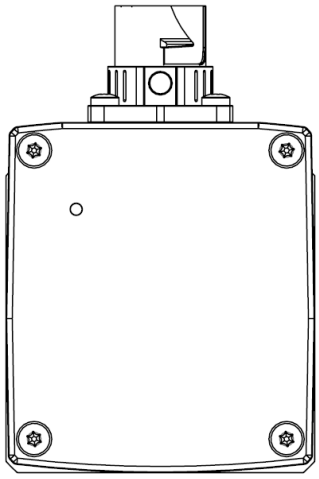


Figure 12-2: HFI without communication module (rear view)

12.1.2 HFI with communication module

If a communication module is installed, the device has 3 LEDs. The HFI/S LED in the middle is the general operating status LED (see above). LED1 and LED2 are the fieldbus status LEDs. The meaning of these two LEDs depends on the installed communication module (see following chapters).

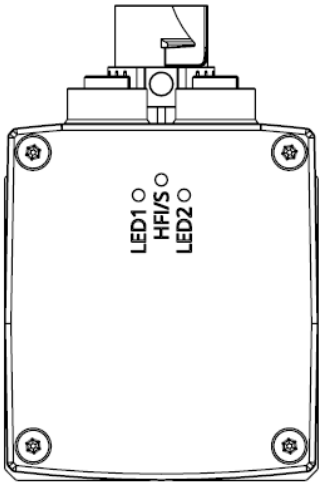


Figure 12-3: HFI with communication module (rear view)

12.1.2.1 EtherNet/IP

LED1 = Network Status

LED green	LED red		Operating Status
OFF	OFF	⇨	No power or no IP address
ON	OFF	⇨	Online, one or more connections established
blinking	OFF	⇨	Online, no connections established
OFF	ON	⇨	Duplicate IP address, fatal error
OFF	blinking	⇨	One or more connections timed out

LED2 = Module Status

LED green	LED red		Operating Status
OFF	OFF	⇨	No power
ON	OFF	⇨	Controlled by a scanner in run state
blinking	OFF	⇨	Not configured or scanner in idle state
OFF	ON	⇨	Major fault
OFF	blinking	⇨	Recoverable fault(s). Module is configured, but stored parameters differ from currently used parameters

Note!

A test sequence is performed on these LEDs during start up.

12.1.2.2 EtherCAT

LED1 = RUN LED

LED green	LED red		Operating Status
OFF	OFF	⇨	Module in INIT-state (or no power)
ON	OFF	⇨	Module in OPERATIONAL-state
blinking	OFF	⇨	Module in PRE-OPERATIONAL-state
1 flash	OFF	⇨	Module in SAFE-OPERATIONAL-state
flickering	flickering	⇨	Module in BOOT-state
OFF	ON	⇨	Fatal error

LED2 = ERR LED

LED green	LED red		Operating Status
OFF	OFF	⇨	No error (or no power)
OFF	blinking	⇨	State change received from master is not possible due to invalid register or object settings
OFF	1 flash	⇨	Slave device application has changed the EtherCAT state autonomously
OFF	2 flashes	⇨	Sync Manager watchdog timeout
OFF	ON	⇨	Module in EXCEPTION (fatal error)
flickering	flickering	⇨	Booting error detected

12.1.2.3 PROFINET

LED1 = Network Status

LED green	LED red		Operating State
OFF	OFF	⇨	- No power - No connection to IO Controller
ON	OFF	⇨	- connection to IO Controller established - IO Controller in RUN state
1 flash	OFF	⇨	Connection to IO Controller established - IO Controller in STOP state - IO data bad - IRT synchronization not finished
blinking	OFF	⇨	Used by engineering tools to identify the node on the network
OFF	ON	⇨	Major internal error (this indication is combined with a red module status LED)
OFF	1 flash	⇨	Station Name not set
OFF	2 flashes	⇨	IP address not set
OFF	3 flashes	⇨	Expected Identification differs from Real Identification

LED2 = Module Status

LED green	LED red		Operating State
OFF	OFF	⇨	- No power - Module in SETUP or NW_INIT state
ON	OFF	⇨	Normal Operation (module has shifted from NW_INIT state)
1 flash	OFF	⇨	Diagnostic event(s) present
OFF	ON	⇨	- Exception error (Device in state EXCEPTION) - Major internal error (this indication is combined with a red network status LED)
alternating red/green		⇨	Firmware update (Do not power off the device. Powering off the device during this phase can cause permanent damage.)

12.2 General error messages

The following table shows the possible error messages of the general status display. In case of an error, the general status LED blinks red with a number of pulses corresponding to the error code, followed by a short pause. This sequence is repeated continuously.

Displayed error code	Meaning	Cause/Measures for error rectification
1	*Error code not present*	
2	Power stage temperature > 90 °C	Check installation conditions. Ambient temperature too high? If necessary, provide appropriate cooling.
3	*Error code not present*	
4	Overvoltage	The DC-link voltage is higher than the allowable value, possibly as a result of regenerative feedback operation. If necessary, adjust the deceleration ramp or provide an external ballast circuit (brake chopper).
5	Angle sensor error	Internal defect, no remedy possible.
6	Undervoltage	Check input voltage. Short-term voltage drop can be caused by fast, power demanding accelerations.
7	Overcurrent	Check that the motor currents and parameters of the current controller are adjusted according to the factory settings.
8	Parameter memory checksum error	The contents of the parameter memory were read incorrectly. If the error occurs again after a power-on reset, then … ⇨ Download a well-proven parameter set or ⇨ Check all parameter settings in the DSerV **Optimisation** menu, then save them with the **Save settings** menu.
9	Faulty parameter set	The parameter set transferred via the **Parameter Download** menu is faulty and therefore cannot be saved in the device. ⇨ Switch the device off and on again to restore the last saved parameter set or ⇨ Download another parameter set into the device.
10	Internal error	No remedy by the user. **DSerV** displays an additional error number for error 10, which provides more detailed information on the cause of error.
11	Positioning error	**DSerV** displays an additional error number for error 11, which provides more detailed information on the cause of error. ⇨ see chapter 12.3 Error messages in positioning mode
12	Fieldbus error	Error of the fieldbus interface (implemented only for CAN) ⇨ see chapter 12.5 CAN
13	Functional safety error	Check the voltage on the STO inputs (see operating supplement *Integrated Drives HFI equipped with STO-Module*).
14	Motor phase frequency > 600 Hz	Operating point with impermissibly high rpm value (would violate the EU Dual-Use regulation) → reduce speed setpoint

12.3 Error messages in positioning mode

Assignment of additional error numbers (displayed in **DSerV**) on occurrence of a positioning error:

Displayed error code	Meaning	Cause/Measures for error rectification
1	Actual position < Minimum position	Actual position of the drive is below the parameterised positioning range.
2	Actual position > Maximum position	Actual position of the drive is above the parameterised positioning range
3	Target position < Minimum position	Specified target position is below the parameterised positioning range.
4	Target position > Maximum position	Specified target position is above the parameterised positioning range.
5	Faulty parameterisation of the positioning range	Illegal parameterisation of the positioning range limits (min > max).
6	Limit switch monitoring	At least one of the two limit switches, which limit the positioning range, was unexpectedly activated.
7	Homing	With **fieldbus control:** - Incorrectly parameterised (unknown) homing method. When referencing to a **limit switch**: - The opposite limit switch was actuated during the homing run.
8	Following error monitoring	In positioning mode the maximum permissible position deviation (i.e. the difference between the actual position and the setpoint position) has been exceeded for too long. Adjust motion profile: ⇨ Select slower speed ramps. ⇨ If necessary, reduce the travel speed. see chapter 8.2.2 Speed control mode Adjust the parameters of the following error monitoring: ⇨ Enlarge the permissible following error window. ⇨ Increase the following error timeout. ⇨ If necessary, deactivate the following error monitoring. see chapter 8.2.3 Positioning mode Optimize the settings of the speed and/or position controller.

12.4 CAN status display

The integrated drives of the HFI series do **not** have a separate CAN status display (LED). Errors of the CAN bus are signalled through the general operating status LED by means of **Error code 12** (see chapter 12.2 General error messages).

A detailed error message is provided on the fieldbus status bar of the **DSerV** parameterisation software (see chapter 7.3 Using the DSerV service software).

12.5 CAN error messages

Displayed error no.	Meaning	Cause/Measures for error rectification
1	CAN Controller overflow	Bus load too high, cannot be processed. ⇨ Reduce the CAN bit rate, if applicable. ⇨ Optimise the PDO communication.
2	CAN bus off	Communication switched off due to disrupted transmission. ⇨ Check that the correct baud rate has been set. ⇨ Check that the Node-ID is correct.
3	CAN error passive	Nodes behave passively due to disrupted communication.
4	Buffer overflow	Bus load too high, cannot be processed. ⇨ Reduce the CAN bit rate, if applicable. ⇨ Optimise the PDO communication.
5	*Error code not present*	
6	Reset Communication	NMT command **Reset Communication** was received.
7	Communication stopped	NMT command **Stop Remote Node** was received.

13 Controller optimisation

The integrated drives are supplied with factory preset parameters. The drives are ready for immediate operation without additional adjustments or settings.

The parameters of the current controller are optimally specified. The current limits conform to the corresponding rated and peak value. The parameters of the speed controller are adjusted to idle run without external load. If necessary, they may have to be optimised to the load conditions at a later time. The same applies for the parameters of the position control circuit.

The drives are factory preset for control via **I/O interface**, the operating mode is set for **speed control** with setpoint specification through the **analogue input AI1**.

13.1 Current controller

The parameters of the current controller are factory preset.
In order to restore the condition as supplied, load the originally supplied parameter set into the device.

13.2 Angle sensor offset determination, motor pole number

The parameters for the motor pole number (see chapter 6.1 System Data) and angle sensor offset are factory preset and should not normally be changed!

In the **DServ** menu **Optimisation→Current controller** (see chapter 8.2.1.4 Parameters of the current control loop) the parameters for motor pole number and angle sensor offset can be entered directly. Furthermore, a function for the automatic adjustment of the angle sensor offset is provided. This function can only be activated in **I/O mode**.

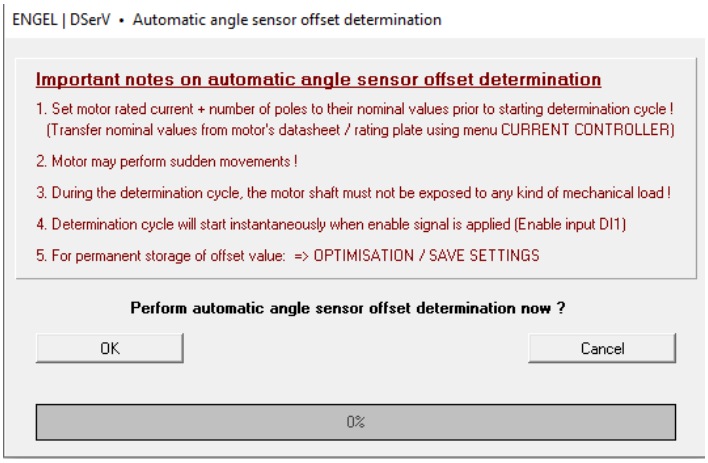


Figure 13-1: Activation of the automatic angle sensor offset determination

Attention!

During the automatic angle sensor offset determination, jerky movements can occur on the drive!

Make sure that the requirements for the automatic angle sensor offset determination are fulfilled:

- The motor shaft can rotate freely and is not loaded.
- The parameters for the current controller are adjusted and transmitted according to chapter 8.2.1.4 Parameters of the current control loop.
- The number of motor poles is adjusted and transmitted.

After clicking OK: Enable the drive via digital input DI1.

13.3 Speed controller adjustment

> **Note!**
>
> Prerequisite for the speed controller adjustment are correctly set control parameters of the current controller (see chapter 8.2.1.4 Parameters of the current control loop).

Step 1: Installed drive, ready for operation in accordance with Step 1 … 4 of the commissioning instructions in chapter 11 Commissioning.

Step 2: Make sure that current limits and control parameters of the current controller are correctly adjusted. If necessary, make settings according to chapter 8.2.1.4 Parameters of the current control loop.

Step 3: To optimise the speed controller, the speed curve of the drive must be assessed, i.e. the actual speed must be measured (you can use the oscilloscope function of **DSerV**).

Step 4: The parameters of the speed controller are accessible through the menu **Optimisation → Speed controller** (see chapter 8.2.2.4 Parameters of the speed control loop).
To optimise the speed controller the **setpoint ramp** must be switched off („Ramps inactive“) or set to maximum acceleration. The **setpoint scaling value** must be set according to the speed required in the application.

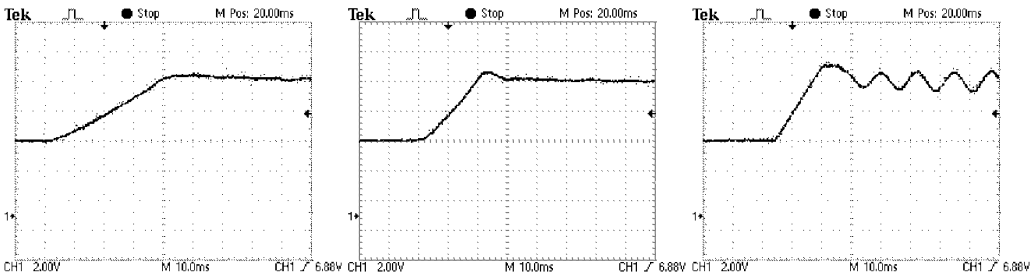
The control parameters of the speed controller must initially be set to non-critical values, i.e. low **proportional gain** (k_{p_n} = 0.0500 ... 0.1000) and a large **time constant**.

Step 5: The drive must now be enabled with a speed setpoint of approx. 75 % of the **setpoint scaling value**. Once the speed curve is acquired, remove the enable signal. Assess the speed curve.

Step 6: Increase the speed controller's **proportional gain** by a few hundredths, enable the drive again and assess the speed curve.

Adjust the **proportional gain** so that an oscillation of the speed is clearly visible. Then reduce the **proportional gain** to the point where no more oscillation occurs.

For optimisation, reduce the **time constant** of the speed controller until the setpoint speed is reached with a single overshoot (approx. 4-10 % of the setpoint).



a) proportional gain too low
time constant too large

b) optimal proportional gain
optimal time constant

c) proportional gain too high
time constant too small

Figure 13-2: Speed step response for different speed controller settings

14 Mechanical dimensions

The following figures show only **one** possible variant of the connectors.

14.1 HFI 2230 / HFI 2260

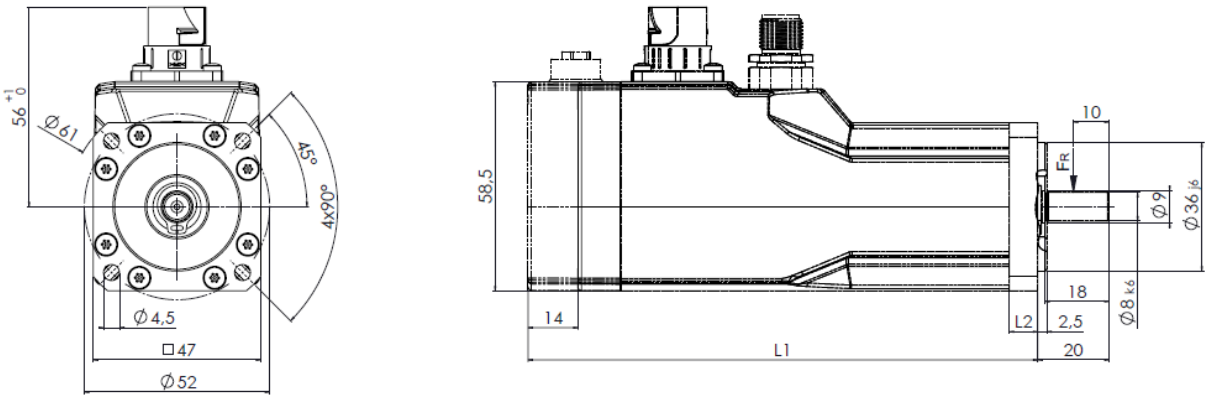


Figure 14-1: HFI22xx dimensions

Motor Type	Dimension L1 (without module)	Dimension L1 (with module)	Dimension L2
HFI2230	129	143	8
HFI2230 with parking brake	161	175	10
HFI2260	159	173	8
HFI2260 with parking brake	191	205	10

14.2 HFI 2630 / HFI 2660

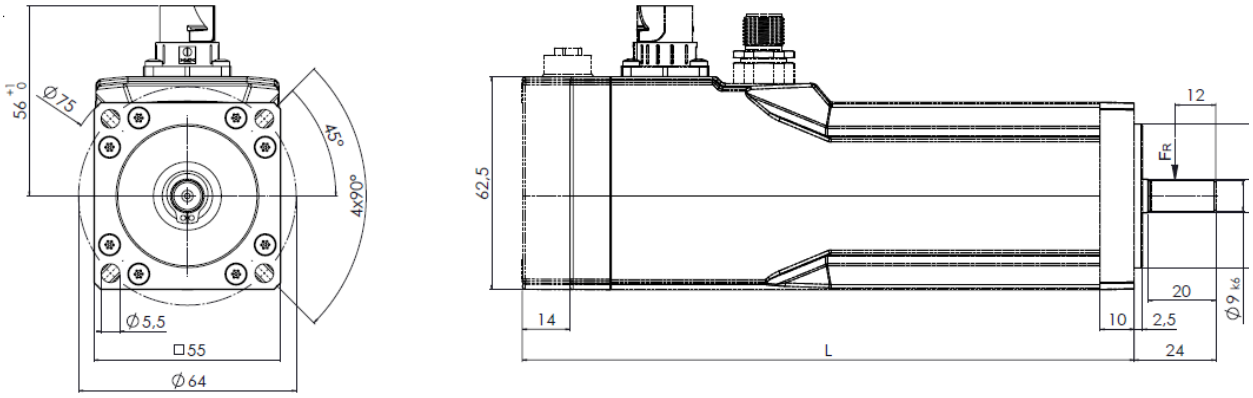


Figure 14-2: HFI26xx dimensions

Motor Type	Dimension L (without module)	Dimension L (with module)
HFI2630	136	150
HFI2630 with parking brake	166	180
HFI2660	166	180
HFI2660 with parking brake	196	210

14.3 HFI 3260 / HFI 3290

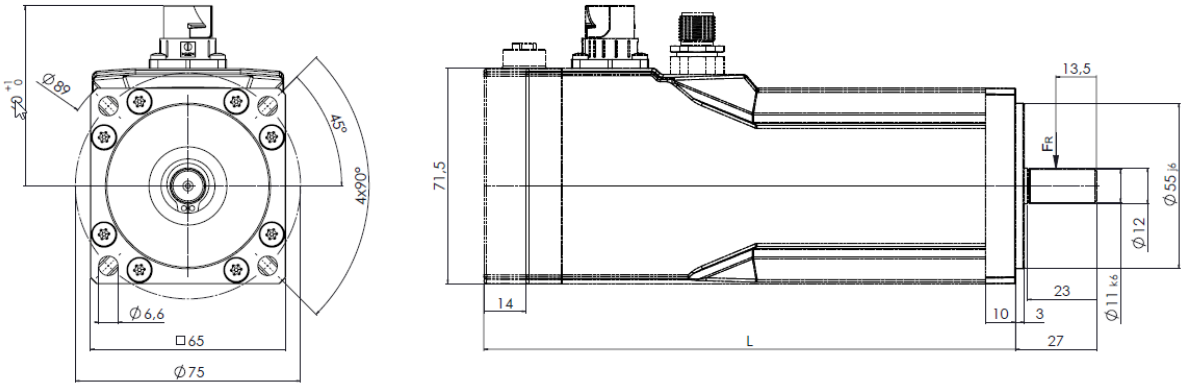


Figure 14-3: HFI32xx dimensions

Motor Type	Dimension L (without module)	Dimension L (with module)
HFI3260	163	177
HFI3260 with parking brake	193	207
HFI3290	193	207
HFI3290 with parking brake	223	237

14.4 HFI 3760 / HFI 3790

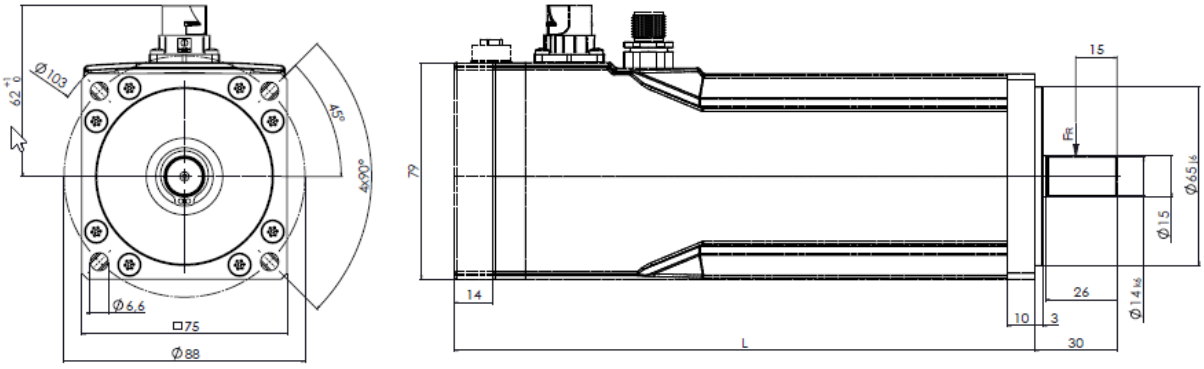
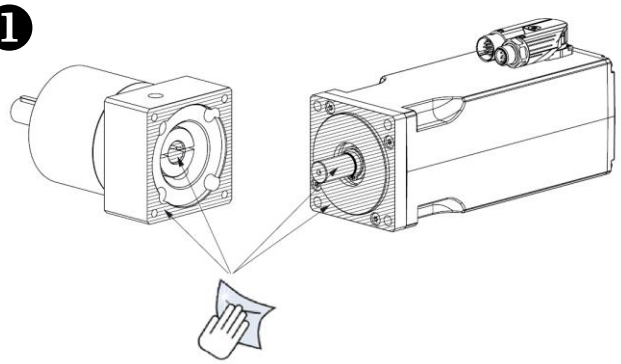


Figure 14-4: HFI37xx dimensions

Motor Type	Dimension L (without module)	Dimension L (with module)
HFI3760	168	182
HFI3760 with parking brake	198	212
HFI3790	198	212
HFI3790 with parking brake	228	242

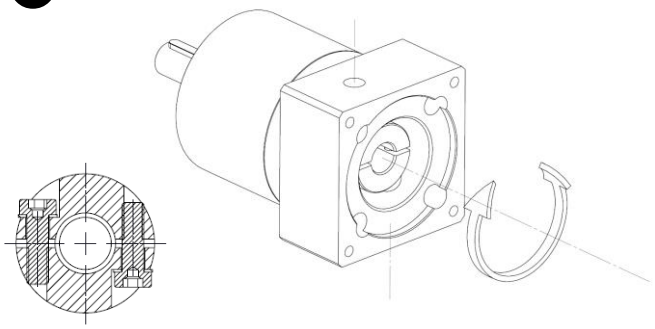
14.5 Mounting instructions for planetary gear GPK

❶



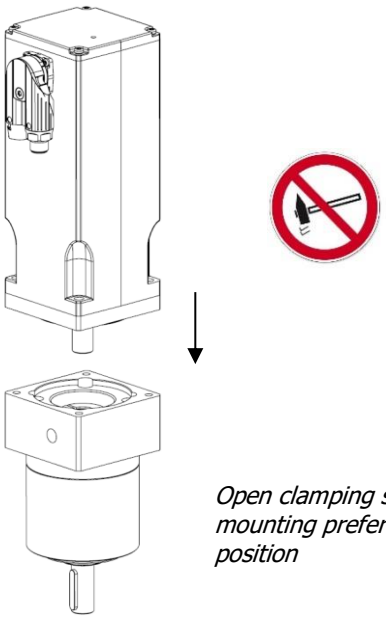
Ensure contact surfaces are intact and thoroughly degreased!

❷



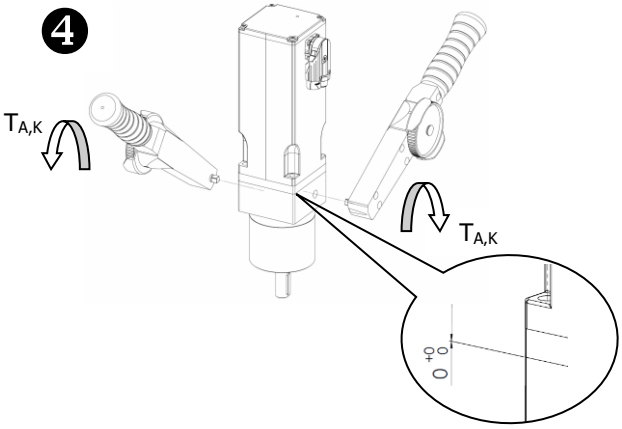
Remove plastic covers, turn to align holes with set screws

❸



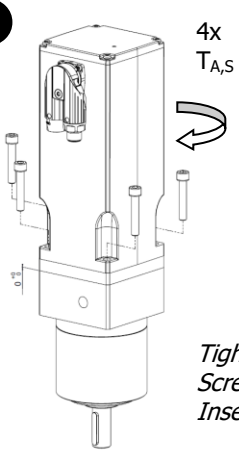
Open clamping screws – motor mounting preferred in vertical position

❹



Flange must be flush with the gearbox, tighten screws with torque ($T_{A,K}$), fit plastic covers!

❺



Tighten screws crosswise.
Screws must be secured!
Insert plastic covers.

Chart tightening torque clamping unit ($T_{A,K}$)				
gearbox size	*Ø-motor shaft*	*Screws (8.8)*	*Width across flat*	*Tightening torque (Nm)*
GPK45	8	M4	3	4.5
GPK55	9	M4	3	4.5
GPK65	11	M4	3	4.5
GPK75	14	M5	4	9.5

Chart tightening torque connecting screws ($T_{A,S}$)			
gearbox size	*Screws (8.8)*	*Width across flat*	*Tightening torque (Nm)*
GPK45	M4	3	3.5
GPK55	M5	4	5.5
GPK65	M6	5	8.5
GPK75	M6	5	8.5