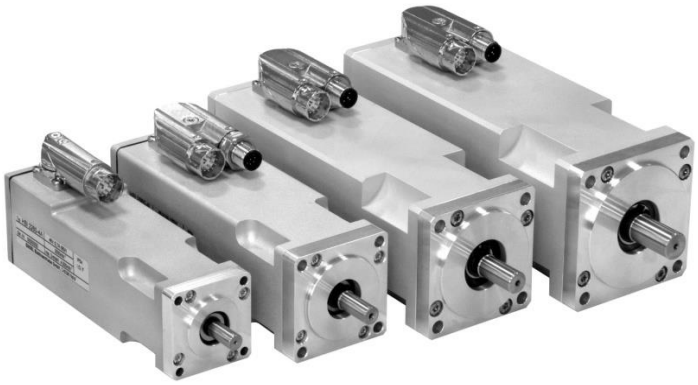
Operating Manual

Rev. 1.6

Integrated Synchronous Servo Drives

HBI22xx / HBI26xx
HBI32xx / HBI37xx



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HBI22_37_BA_Rev1.6_170606_en
Technical changes reserved

Introduction

This document describes the technical data and the functions of the HBI 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 **CANopen® manual** contains information for the fieldbus mode of the integrated HBI drives.

Document	Date	Rev.	Description of change
HBI22_26_BA_081222	22/12/2008	-	Creation of HBI_OM, preliminary version
HBI22_26_BA_090209	09/02/2009	-	Supplements
HBI22_26_BA_090626	26/06/2009	-	Incremental output
HBI22_37_BA_100101_en	05/01/2010	-	Revision, HBI32/37 added (starting from FW EL3.55, starting from DSerV 6.103)
HBI22_37_BA_100114_en	14/01/2010	-	Various corrections
HBI22_37_BA_110801	01/08/2011	1.5	Complete revision, valid from Board Rev. V3.x, FW EL V3.80, DSerV 6.200
HBI22_37_BA_120615_en	15/06/2012	1.6	CAN: 1MBit/sec from FW EL V3.81, following error monitoring from FW EL V3.83
HBI22_37_BA_Rev1.6_150601_en	01/06/2015	1.6	New page layout
HBI22_37_BA_Rev1.6_170606_en	06/06/2017	1.6	New syntax of phone numbers

Copyright

1 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 property damage.

- During the installation, commissioning and maintenance, the applicable safety and accident prevention regulations must be observed for the specific application.
- The earth conductor must be connected first for the installation.
- The device applies as electronic equipment and is intended for operation in machines. The safety instructions of the Machinery Directive (89/392/EEC) must be observed.
- Prior to commissioning, it must be ensured that no dangers may emanate from the drive and that uncontrolled movements cannot occur.
- Do not insert or pull out plug connectors with voltage applied!

The following regulations apply without a claim to completeness:

VDE 0100	Regulations for the erection of high-voltage systems up to 1000 volt
VDE 0113	Electrical systems with electronic equipment
VDE 0160	Equipment of high-voltage systems with electronic equipment

2 Functional description

In the HBI integrated drives, powerful and dynamic synchronous servo motor systems 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 devices operate through CANopen® in accordance with CiA® DSP 402 V2.0 or through control signals on digital and/or analogue inputs. The integrated positioning control offers a temporally optimised point-to-point positioning with trapezoidal or jerk free speed progression.

The simple parameterisation / configuration of the devices takes place with the parameterisation software DSerV (WINDOWS®, COM port) provided free of charge.

Overview of features:

- Dynamic compact drives for decentralised use; no space in the switch cabinet required.
- Powerful designs with up to 1.55 Nm rated torque and 3.1 Nm peak torque.
- Designs for operation at 24VDC or 48VDC (HBI22xx and HBI26xx).
- Logic circuit and power stage can optionally be supplied from separate voltage sources providing runtime data retention during power down conditions.
- Short cycle times of PI current, PI speed and P position controllers (100µs, 100µs, 200µs) with a powerful signal processor.
- Point to point positioning functionality with linear or Sin² ramp.

- 12-bit high-resolution angle sensor system.
- Two-colour status LED to display the operating status.

- Incremental output 1024 pulses / revolution, RS422, tracks A, B, Z. (optional)
- CAN interface (optional), CANopen® with implementation of the device specification CiA® DSP 402 V2.0.

- Can be combined with planetary gears of the series GPK (one and two-stage up to i=49:1).
- Designs with parking brake (optional).

- High protection class - IP54 (higher protection class on request).
- Parameterisation / configuration with the parameterisation software DSerV (WINDOWS®, COM port) provided free of charge.

2.1 Type key / accessories

HBI XXXX-XXX

HBI **XXXX**-xxx	Drive size:	**2230** = HBI2230 **2260** = HBI2260 **2630** = HBI2630 **2660** = HBI2660 **3260** = HBI3260 **3290** = HBI3290 **3760** = HBI3760 **3790** = HBI3790
HBI xxxx-**X**xx	Supply voltage:	**2** = 24VDC *1) **4** = 48VDC
HBI xxxx-x**X**x	Functionality:	**A** = analogue setpoint (itec single plug connector) **C** = with CAN interface and CANopen® protocol **I** = with incremental output 1024 pulse A, B, Z
HBI xxxx-xx**X**	Parking brake:	**B** = design with parking brake

*1) HBI32xx / HBI37xx only available in 48VDC design.

3 Technical data

3.1 HBI22xx system data

		HBI2230	HBI2260	
Peak speed	rpm	6000	4000	
Rated speed	rpm	3000	3000	
Rated voltage *2)	VDC	24 / 48	24 / 48	± 20%
Rated current *3)	ADC	3.5 / 1.8	5.3 / 2.7	24V type / 48V type
Rated power *1)	W	53	90	
Rated torque *1)	Nm	0.17	0.28	
Peak torque	Nm	0.34	0.56	max. 5sec.
Motor rated current *6)	Aspk	7.5 / 3.8	9.7 / 4.9	24V type / 48V type
Motor peak current *6)	Aspk	14.5 / 7.3	18.7 / 9.4	24V type / 48V type
Motor current measurement range	A	25.4 / 25.4	42.3 / 25.4	24V type / 48V type
Torque constant *3)	Nm/A	0.025 / 0.049	0.031 / 0.061	24V type / 48V type
Voltage constant	V/1k rpm	3.0 / 5.9	3.8 / 7.4	24V type / 48V type
Number of poles		6	6	
Ambient temperature	°C	0°C ... 40°C		No condensation permissible
Storage temperature	°C	-25°C ... 60°C		No condensation permissible
Flange dimension	mm	45		
Drive length	mm	125 / 157	155 / 187	without / with parking brake
Protection class		IP54		
Weight	kg	0.72 / 0.95	1.00 / 1.25	without / with parking brake
Parking brake:				
Static braking torque	Nm	1.0		in design "-xxB" automatically operated
Power (electric)	W	10		

For additional data, see the current version of the data sheet for HBI22
For data for operation with a planetary gear, see data sheet HBI22-GPK45

3.1.1 HBI2230 / HBI2260 characteristics

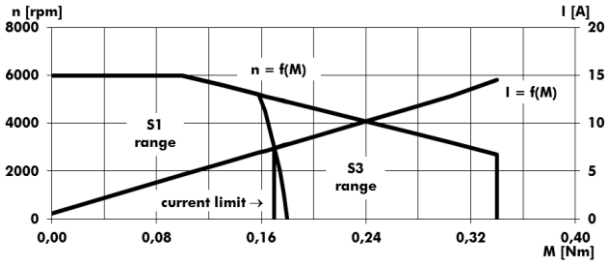


Fig.: HBI2230 characteristics, 24V, 3000/6000rpm

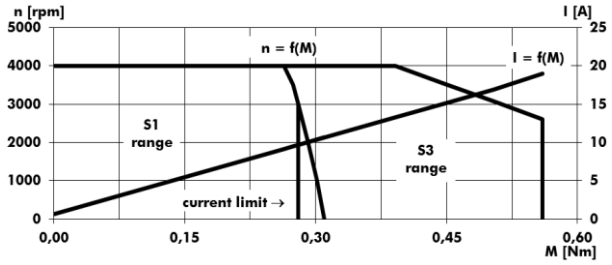


Fig.: HBI2260 characteristics, 24V, 3000/4000rpm

3.2 HBI26xx system data

		HBI2630	HBI2660	
Peak speed	rpm	6000	4000	
Rated speed	rpm	3000	3000	
Rated voltage *2)	V_{DC}	24 / 48	24 / 48	± 20%
Rated current *3)	A_{DC}	5.4 / 2.8	9.5 / 4.8	24V type / 48V type
Rated power *1)	W	90	160	
Rated torque *1)	Nm	0.28	0.51	
Peak torque	Nm	0.56	1.02	max. 5sec.
Motor rated current *6)	A_{spk}	12.5 / 6.5	16.2 / 8.1	24V type / 48V type
Motor peak current *6)	A_{spk}	24.0 / 12.5	31.2 / 15.6	24V type / 48V type
Motor current measurement range	A	42.3 / 25.4	42.3 / 25.4	24V type / 48V type
Torque constant *3)	Nm/A	0.025 / 0.048	0.034 / 0.068	24V type / 48V type
Voltage constant	V/1k rpm	3.0 / 5.8	4.1 / 8.2	24V type / 48V type
Number of poles		6	6	
Ambient temperature	°C	0°C ... 40°C		No condensation permissible
Storage temperature	°C	-25°C ... 60°C		No condensation permissible
Flange dimension	mm	55		
Installation length	mm	133 / 163	163 / 193	without / with parking brake
Protection class		IP54		
Weight	kg	1.2 / 1.5	1.55 / 1.85	without / with parking brake
Parking brake:				
Static braking torque	Nm	2.0		in design "-xxB" automatically operated
Power (electric)	W	10		

For additional data, see the current version of the data sheet for HBI26
For data for operation with a planetary gear, see data sheet HBI26-GPK55

3.2.1 HBI2630 / HBI2660 characteristics

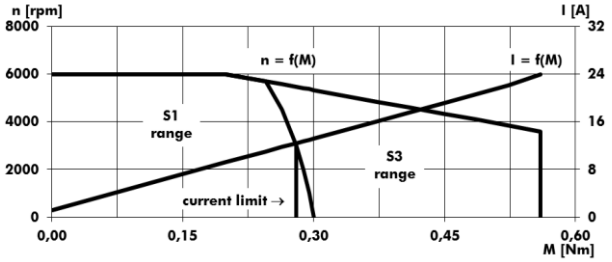


Fig.: HBI2630 characteristics, 24V, 3000/6000rpm

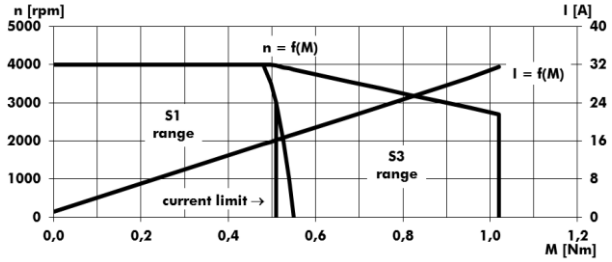


Fig.: HBI2660 characteristics, 24V, 3000/4000rpm

3.3 HBI32xx system data

		HBI3260	HBI3290	
Peak speed	rpm	4000	4000	
Rated speed	rpm	3000	3000	
Rated voltage *2)	V_{DC}	48	48	± 20%
Rated current *3)	A_{DC}	8.0	10.5	
Rated power *1)	W	265	360	
Rated torque *1)	Nm	0.85	1.15	
Peak torque	Nm	1.70	2.30	max. 5sec.
Motor rated current *6)	A_{spk}	12.5	16.1	
Motor peak current *6)	A_{spk}	24.3	31.5	
Motor current measurement range	A	45.8	45.8	
Torque constant *3)	Nm/A	0.072	0.075	
Voltage constant	V/1k rpm	8.7	9.1	
Number of poles		6	6	
Ambient temperature	°C	0°C ... 40°C		No condensation permissible
Storage temperature	°C	-25°C ... 60°C		No condensation permissible
Flange dimension	mm	65		
Installation length	mm	160 / 190	190 / 210	without / with parking brake
Protection class		IP54		
Weight	kg	2.15 / tbd	2.7 / tbd	without / with parking brake
Parking brake:				
Static braking torque	Nm	3.5		in design "-xxB" automatically operated
Power (electric)	W	12		

For additional data, see the current version of the data sheet for HBI32
For data for operation with a planetary gear, see data sheet HBI32-GPK65

3.3.1 HBI3260 / HBI3290 characteristics

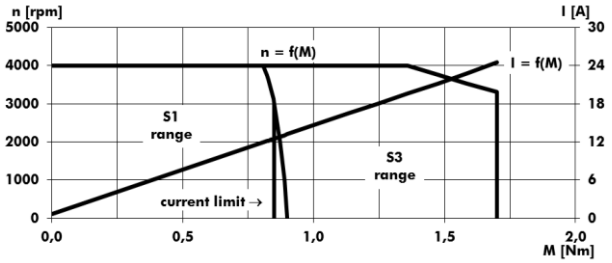


Fig.: HBI3260 characteristics, 48V, 3000/4000rpm

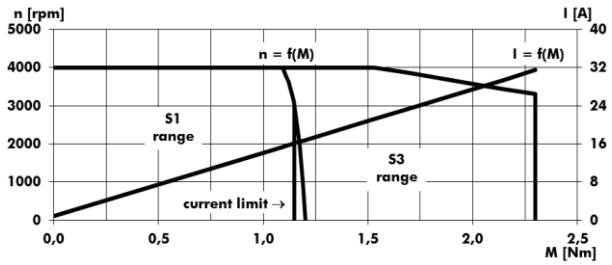


Fig.: HBI3290 characteristics, 48V, 3000/4000rpm

3.4 HBI37xx system data

		HBI3760	HBI3790	
Peak speed	rpm	4000	4000	
Rated speed	rpm	3000	3000	
Rated voltage *2)	V_{DC}	48	48	± 20%
Rated current *3)	A_{DC}	10.4	13.5	
Rated power *1)	W	360	485	
Rated torque *1)	Nm	1.15	1.55	
Peak torque	Nm	2.30	3.10	max. 5sec.
Motor rated current *6)	A_{spk}	15.9	20.5	
Motor peak current *6)	A_{spk}	31.1	40.1	
Motor current measurement range	A	45.8	45.8	
Torque constant *3)	Nm/A	0.076	0.079	
Voltage constant	V/1k rpm	9.2	9.5	
Number of poles		6	6	
Ambient temperature	°C	0°C ... 40°C		No condensation permissible
Storage temperature	°C	-25°C ... 60°C		No condensation permissible
Flange dimension	mm	75		
Drive length	mm	165 / 195	195 / 215	without / with parking brake
Protection class		IP54		
Weight	kg	3.0 / tbd	3.7 / tbd	without / with parking brake
Parking brake:				
Static braking torque	Nm	3.5		in design "-xxB" automatically operated
Power (electric)	W	12		

For additional data, see the current version of the data sheet for HBI37
For data for operation with a planetary gear, see data sheet HBI37-GPK75

3.4.1 HBI3760 / HBI3790 characteristics

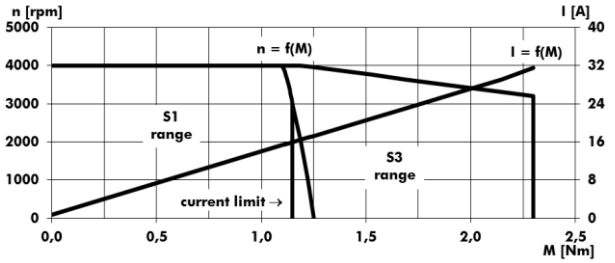


Fig.: HBI3760 characteristics, 48V, 3000/4000rpm

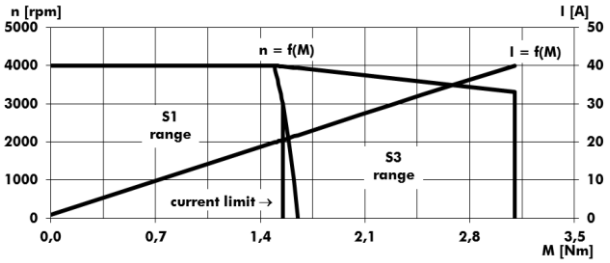


Fig.: HBI3790 characteristics, 48V, 3000/4000rpm

3.5 Integrated control electronics technical data

Control electronics supply	approx. 50mA	Control electronics power requirement 24V supply, disabled power stage (X1.A or. X1.C see chapter 5.1)
Analogue inputs AI1 (differential input)	±10V, 10bit, R_i=20kΩ	
Digital inputs DI1 ... DI8	0.0V ≤ U_{off} ≤ 5.0V 15.0V ≤ U_{on} ≤ 30V	DI1 = control enable. DI4/DI5 can optionally be used as output DO2/DO1
Digital outputs DO1 ... DO2	24V, 50mA	o.C., ground switching, 33Ω series resistance, without pull-up resistance, can optionally be used as an input
Serial interfaces	RS232	Communication with DSerV parameterisation software
	CAN 2.0B (Max. 1MBit/s)	only "-xCx" design Without galvanic isolation by default. *7) Without terminating resistor.
Incremental output only "-xIx" design	A,A/,B,B/,Z,Z/ RS422 , 1024 increments/revolution	Hysteresis approx. 0.17° Linearity error approx. 1.0° min. edge spacing: 2µs *8)
Electromagnetic compatibility *4) Emission	DIN EN 61800-3: 2004, 2005-07	second environment / limited availability (Cat. C3)
Immunity	DIN EN 61800-3: 2004, 2005-07	second environment

*1) The specified values apply for the installation of the drive on a system surface made of aluminum (A=0.1m²,d=10mm). It must be taken into consideration that the specified continuous output power must be derated for thermally unfavourable couplings.

*2) Observe chapter 3.6.1 Regenerative operation

*3) The rated current is the direct current drawn in nominal operation (n=3000rpm M=M_N) from the supply voltage (+Ub=24V or 48V). The current drawn from the supply voltage is proportional to the converted power, not 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 1.5mm² already has an overall loss resistance of approx. 25mΩ/m (conductors and return conductors)! Appropriate power reserves must be provided in the supply!

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

*5) Tolerance -10%

*6) 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.

*7) With the drives HBI32xx / HBI37xx, a galvanic isolation of the CAN interface is available on request.

*8) For the proper detection of the incremental signals, a counter with a count frequency of ≥ 500kHz is required.

3.6 Important technical information

3.6.1 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 HBI drives are 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 devices operate 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 brake 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 increases until the triggering of an overvoltage error. The following voltage limits are specified in the devices:

Devices with 24V operating voltage:
Ballast circuit working voltages: $U_{Ballast\ ON} \geq 30\ V$, $U_{Ballast\ OFF} \leq 27\ V$
Triggering of the overvoltage error: $U_{Error4} \geq 32\ V$

Devices with 48V operating voltage:
Ballast circuit working voltages : $U_{Ballast\ ON} \geq 60\ V$, $U_{Ballast\ OFF} \leq 55\ V$
Triggering of the overvoltage error: $U_{Error4} \geq 65\ V$

3.6.2 Lead fuses

The integrated HBI drives are not internally fused. A suitable external fuse must be provided.

3.6.3 Service life expectancy

The service life of the integrated HBI drives 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. 15,000h can be assumed. With lower motor currents and/or lower ambient temperatures, higher service life expectancies arise.

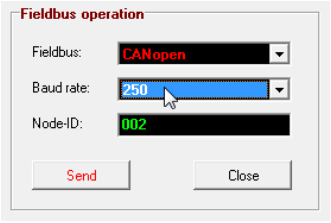
3.7 Safety installations

The integrated HBI drives have 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.

- The **overcurrent** and/or **short-circuit monitor** recognises short-circuits between the motor phases.
- The **I²t monitor** protects the motor and power stage from thermal overload by limiting the motor current to rated current after the lapse of a permissible overload duration.
- **The overvoltage monitor** triggers as soon as the DC-link voltage exceeds a maximum permissible value.
- The **temperature** of the power stage is measured and the power stage is switched off when the temperature exceeds 85°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.

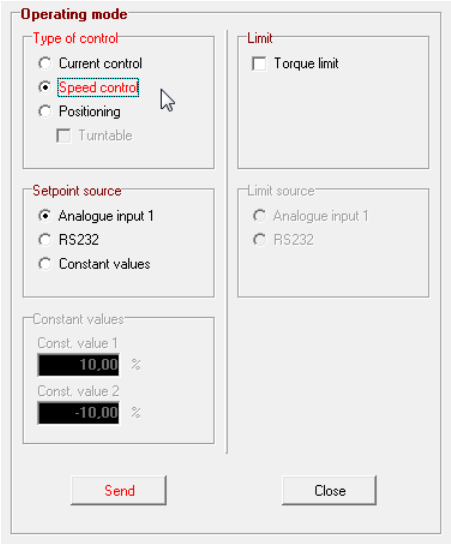
4 Operating modes

The integrated HBI drives can be used as current (i.e. torque), speed or position controllers. The parameterisation of the devices takes place through a serial interface RS232 with the PC parameterisation software "DSerV". Changed parameters have an immediate effect on the drive and are only adopted with the menu item ***OPTIMISATION / SAVE SETTINGS*** in the non-volatile memory.



The HBI drives are operated through digital / analogue inputs and outputs **(I/O mode)** and also optionally operated through CANopen® **(CANopen® mode only in "-xCx" design).**

The activation / deactivation of the CANopen® interface as well as the specification of node ID and bit rate take place through the DSerV menu ***OPTIMISATION / FIELDBUS OPERATION.***



The description of the device functions in this document assumes operation without fieldbus (no bus mode ⇒ **I/O mode**). In fieldbus mode the same functionality is basically available as documented in the CANopen® manual.

When operated without fieldbus (I/O mode) the operating mode and setpoint sources can be set under ***OPTIMISATION / OPERATING MODE.***

4.1 Speed control operating mode

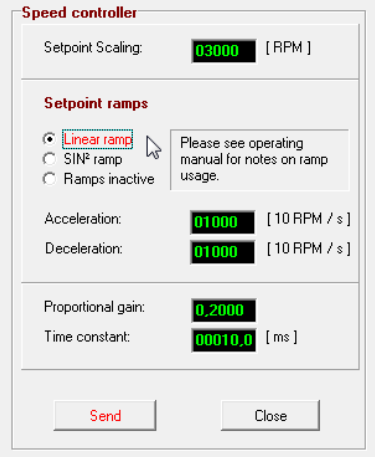
The adjustment of the speed setpoint takes place through one of three setpoint sources:

- Analogue input AI1 (differential input for voltage setpoint ±10V, cw and ccw rotation)
- RS232 (through DSerV service software under menu ***SETPOINT RS232***)
- Two fixed speeds **(constant values)** defined as relative amounts for the value **Setpoint scaling.** Digital input DI6 dynamically selects between the two constant values 1 / 2. (see chapter 4.4.2 Digital inputs).

The control enable always takes place through digital input DI1 (+15... +30V ⇒ enable).

Note:
Prior to the adjustment and/or operation of the speed controller, it must be ensured that the current limits and control parameters of the current controller are correctly set. The optimisation of current and speed controllers is described in chapter 9 Controller optimisation.

- Sin² ramp not possible with analogue speed specification!
- For the function and influence of the digital inputs DI2, DI3, see chapter 4.4.2 Digital inputs.
- The setting of the parameter **Polarity** (see chapter 4.3 Positioning operating mode) also takes effect in speed control operating mode.



In the menu ***OPTIMISATION / SPEED CONTROLLER*** the parameters of the speed controller are set.

Setpoint scaling:

Target velocity for a setpoint value of 100% through
- analogue input or
- constant values or
- RS232 setpoint.

Setpoint ramps:

Acceleration and deceleration ramp of the speed setpoint.
The input values correspond to the CAN objects ***profile acceleration*** and ***profile deceleration*** and apply for the operating modes with subordinate speed control.
The object ***motion profile type*** contains the selected ramp characteristics (linear / sin² / inactive).

• Linear ramp:

A setpoint step-change is limited to a fixed rate of change (slope) which can be parameterised.
Unit: [10 RPM / sec]

- **Sin² ramp:**

A setpoint step-change is converted in a jerk free speed profile for the parameterised time interval.
Note:
- Sin² ramp is not applicable with speed control in I/O mode.
- DSerV permits the direct entry of the time interval; through CAN the necessary value for a specified time interval can be calculated as follows:
  Unit: [approx. 100sec^{-1}]
  Example: Calculation for ramp time t=0.25sec:
  profile_acceleration = 100sec^{-1} / 0.25sec = 400

- **Ramp inactive:**

Non-delayed setpoint step-change without setpoint ramp.
Note:
- The positioning mode requires a ramp. The "Ramp inactive" selection is ignored in positioning mode.

Proportional gain: Proportional gain of the speed control loop (0.0000...0.9999), see also chapter 9.3 Speed controller adjustment.

Time constant: Integral part (reset time) of the speed control loop, see also chapter 9.3 Speed controller adjustment.

4.2 Current control / torque control operating mode

> **Note:**
> The setting of the parameter **Polarity** (see chapter 4.3 Positioning operating mode) also takes effect in current control operating mode.

- The current control operating mode is selected under ***OPTIMISATION / OPERATING MODE.***
- The setpoint specified through the active setpoint source is interpreted as a current setpoint.
- The scaling of the current setpoint is always based on the value adjusted in the parameter "Motor rated current" (***OPTIMISATION / CURRENT CONTROLLER***).
- Current setpoints take effect without delay, i.e. without setpoint ramp.

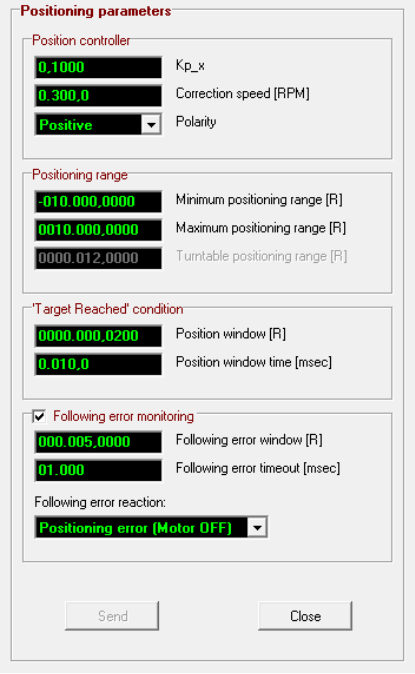
The control enable always takes place through digital input DI1 (+15...+30V ⇒ enable).

4.3 Positioning operating mode

The positioning operating mode enables point-to-point positioning with time-optimised (trapezoidal) or jerk free ($\sin^2$) speed progression.

Positioning range: $\pm 2^{19} = \pm 524{,}288$ revolutions

Position resolution: approx. 360° / 4,096 = 0.088°



The general positioning parameters can be adjusted through both CANopen® and the parameterisation program DServV.

The positioning operating mode is selected in the parameterisation program DServV under ***OPTIMISATION / OPERATING MODE***.

The parameters of the positioning operating mode are available under ***OPTIMISATION / POSITIONING / GENERAL PARAMETERS***.

kp_x

Proportional gain of the position control loop, value range: 0.0000...0.9999
Object: ***position control parameter set*** *[60F9h sub1]*

Correction speed

Limitation of the adjustment range of the position control loop. This parameter influences the dynamic behaviour on reaching the target position.
Unit: [RPM] ⇒ Typical values: approx. 100 ... 500
Object: ***position control parameter set*** *[60F9h sub2]*

Polarity

This parameter enables the internal reversal of the positioning direction for the adjustment to mechanical circumstances of the user:
Positive polarity ⇒ increasing position with motor shaft rotating clockwise
Negative polarity ⇒ increasing position with motor shaft rotating counter clockwise
Object: ***polarity*** *[607Eh]*

Note:
The parameter **Polarity** also takes effect in current and speed control operating modes.

Minimum positioning range

Negative limitation of the positioning range. If the setpoint or current position undercuts the parameterised value, a positioning error is triggered.
Unit: Revolutions of the motor shaft [R]
Object: ***software position limit*** *[607Dh]*

Maximum positioning range

Positive limitation of the positioning range. If the setpoint or current position exceeds the parameterised value, a positioning error is triggered.
Unit: Revolutions of the motor shaft [R]
Object: ***software position limit*** *[607Dh]*

Position window

A positioning process applies as completed if the deviation of the current position to the target position for a duration defined in "Position window time" is less than the value parameterised under "Position window".
Unit: Revolutions of the motor shaft [R]
Object: ***position window*** *[6067h]*

Position window time

see Position window
Unit: Milliseconds [msec]
Object: ***position window time*** *[6068h]*

Following error monitoring

A following error is present if the deviation of the current position to the setpoint position for a duration defined in "Following error timeout" is greater than the value parameterised under "Following error window".
With following error monitoring activated, following error events are signalled in the CANopen® status word (Bit 13) and a parameterisable "following error reaction" is triggered - both under CANopen® and I/O mode.
With following error monitoring deactivated, following error events are not signalled and no "following error reaction" is triggered.
Object: ***following error window*** *[6065h] – Bit31 (0 = active)*

Following error window

see Following error monitoring
Unit: Revolutions of the motor shaft [R]
Object: ***following error window*** *[6065h] – Bit30 ... Bit0*

Following error timeout

see Following error monitoring
Unit: Milliseconds [msec]
Object: ***following error timeout*** *[6066h]*

Following error reaction

see Following error monitoring
- **No reaction:** only signalled in CANopen® status word (Bit13).
- **Positioning error:** dto., however an additional positioning error is triggered, which leads to the shut-down of the power stage.

Not available as CANopen® object.

The specification of the positioning targets and travel speeds takes place with the following significant parameters, and/or CANopen® objects :

Target position

Specifies the target position, interpreted as relative / absolute position value and with selectable starting condition
Object: ***target position*** *[607Ah]*
Unit: Revolutions of the motor shaft [R]

Target position is

- absolute: New target position is absolute
- relative: New target position = previous target position + set value

Object: Control bits in ***controlword*** *[6040h]*

Starting condition

- after completion: New positioning process starts after the end of a still active positioning process.
- immediately: New positioning process is performed and aborts a still active positioning process.

Object: Control bits in ***controlword*** *[6040h]*

Speed

Travel speed (rotational speed) to the target position.
Object: ***profile velocity*** *[6081h]*
Unit: [RPM]

Speed ramps can be adjusted under ***OPTIMISATION / SPEED CONTROLLER*** or be specified as CANopen® objects ***profile acceleration*** *[6083h]*, ***profile deceleration*** *[6084h]*.

4.3.1 Positioning function in I/O mode (without fieldbus)

In fieldbus mode (CANopen®) the full positioning functionality is available.

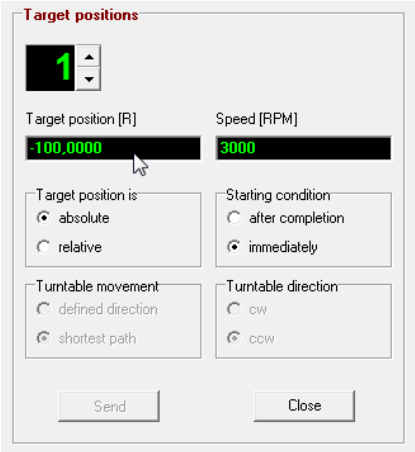
In I/O mode up to 8 target positions (relative or absolute) with corresponding travel speeds can be stored in the parameter memory. The selection of the current target position as well as the start command for the positioning take place through digital inputs.

The referencing (homing) automatically starts in I/O mode either
- with only the first enable after power-on, or
- with each enable of the drive (selectable).

After the successful referencing, the drive automatically switches from homing mode to positioning mode.

Functions of the digital inputs for the positioning function in I/O mode (see also chapter 4.4.2 Digital inputs):

Signal	Function	Note
DI1	Enable input	
DI2	Positive limit switch	
DI3	Negative limit switch	
DO2/DI4	Start positioning process	Pin DO2/DI4 is used as a digital input.
DO1/*DI5*	Digital output with selectable function	Pin DO1/DI5 is used as a digital output. Function can be assigned with DSerV (e.g. "Target Reached")
AI1-/DI6	Positioning target selection (Bit0)	Pin AI1-/DI6. Analogue input is used as a digital input.
DI7	Positioning target selection (Bit1)	
DI8	Positioning target selection (Bit2)	



Under ***OPTIMISATION / POSITIONING / TARGET POSITIONS*** a maximum of 8 positioning targets can be defined, which can be called up through the digital inputs DI6...DI8.

Target position
Target position specification (shown for target address 1), interpreted as relative / absolute position value and with selectable starting condition
Unit: Revolutions of the motor shaft [R]

Target position is
- absolute: New target position is absolute
- relative: New target position = previous target position + set value

Starting condition
- after completion: New positioning process starts after the end of a still active positioning process.
- immediate: New positioning process is performed and aborts a still active positioning process.

Speed

Travel speed (rotational speed) to the target position.
Unit: [RPM]

The speed ramps can be adjusted under ***OPTIMISATION / SPEED CONTROLLER*** ; they are valid for all positioning targets.

Turntable movement / Turntable direction

see chapter 4.3.4 Turntable positioning mode

4.3.2 Homing

Homing serves for the detection of a defined machine position. It is normally mandatory with the use of angle sensors with "single turn" characteristics.

In I/O mode the homing starts automatically with the first or each new enable of the drive (selectable).
In CANopen® mode the homing takes place through selection with ***modes of operation*** and starts through the ***controlword***.

The drives support various homing methods:

- Referencing to limit switches / reference switches (***homing method***: 17, 18)
  The drive initially approaches the active edge of the switch at "Speed during search for switch", reverses and then travels from the switch with a slower "Speed during search for zero". The position at which the inactive edge of the switch appears is evaluated as the reference position.

- Referencing to limit switches / reference switches in consideration of the index pulse (***homing method***: 1, 2)
  This method eliminates tolerances of the switching point of the limit switch. The drive initially approaches the active edge of the switch at "Speed during search for switch", reverses and then travels from the switch with a slower "Speed during search for zero" and remains there. After the recognition of the inactive edge, the next zero pulse, i.e. the next zero crossing of the rotor angle detection, is interpreted as the reference position.

  The switching point of the limit switch should be adjusted as close as possible to the centre of two zero crossings. The display of the rotor angle under DSerV ***MONITOR / ROTOR ANGLE*** can be used as an aid for this purpose.

- Referencing to a mechanical stop (***homing method:*** -17, -18)
  The drive moves with "Speed during search for zero" and with the adjusted current limit in the specified direction against a (hard, insofar as possible) mechanical stop. The spontaneous rise in current as well as the abrupt halt is used as a criterion for reaching the reference position.

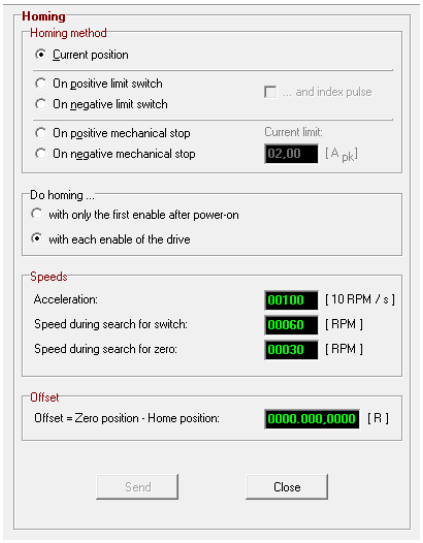
  

  Attention !
  When referencing against mechanical stops...

  ... specify the lowest possible speeds to keep dynamic forces to a minimum on reaching the stop!

  ... high output forces can arise!
  ⇒ Calculate or estimate the force arising from the specified current limit and test its effect on the system.

- Referencing to current position (***homing method:*** 35)
  This method adopts the current position as the reference position. No movement of the drive takes place.



The homing parameters are adjustable through both CAN and the parameterisation program DSerV.

In DSerV the represented window appears under ***OPTIMISATION / POSITIONING / HOMING*** .

Homing method

Determines the direction of movement and type of homing (limit switch or mechanical stop).
Object: ***homing method*** *[6098h]*

Do homing

Defines whether the homing is carried out once after the initial enable or each time the enable is issued.
(Only in I/O mode. Not applicable in CANopen® mode)

Acceleration

Speed ramp (rotational speed ramp) for all speeds of the homing process. The characteristics of the ramp are effective as specified in the ***motion profile type*** (linear / $\sin^2$).
Object: ***homing acceleration*** *[609Ah]*
Unit: [10 RPM / sec] => input value 1000 = 10,000 RPM / sec

Speed during search for switch

Speed with which the limit switch is approached.
Object: ***homing speeds*** *[6099h sub1]*
Unit: [RPM]

Speed during search for zero

Speed for the detection of the switch position of the limit switch and
travel speed when referencing against mechanical stops.
Object: ***homing speeds*** *[6099h sub2]*
Unit: [RPM]

Offset

Offset between the reference position (determined with the homing) and the zero position of the machine deviating from this, if applicable.
Note:
The homing stops after the detection of the switch position of the limit switch or after reaching the mechanical stop. This reference position corresponds to the negative offset.
Object: ***home offset*** *[607Ch]*
Unit: Revolutions of the motor shaft [R]

4.3.3 Limit switches

The limit switches serve as limitation of the movement range of the drive and can also be used as reference switches to determine the reference position. Under ***OPTIMISATION / LIMIT SWITCHES*** the following settings are possible:

Limit switch monitoring

Inactive: see chapter 4.4.2 Digital inputs
Active: see chapter 4.4.2 Digital inputs

Type of limit switches

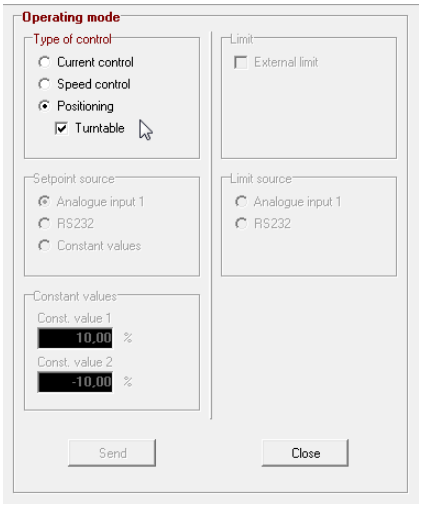
Normally closed contacts: an actuated switch delivers 0V to the digital input
Normally open contacts: an actuated switch delivers 24V to the digital input

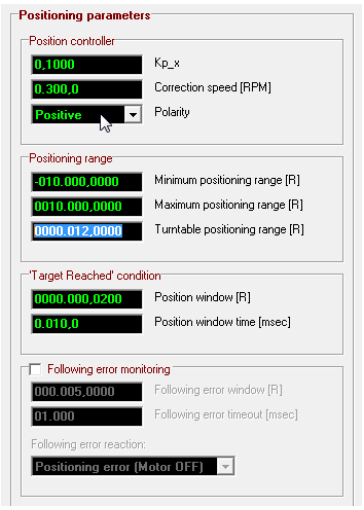
Note:
The setting under "Limit switch monitoring" also determines the function of the digital inputs DI2, DI3 and thus the behaviour of the drive. See chapter 4.4.2 Digital inputs

4.3.4 Turntable positioning mode

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 (I/O mode: ***Turntable positioning range***; CANopen®: Object ***Max Position Range Limit*** *[607Bh, Subindex 2];*) the position counter is deliberately reset to zero.

The Turntable positioning mode is parameterised via the corresponding selection in the DSerV menu ***OPTIMISATION / OPERATING MODE*** (I/O mode) or selected via ***Modes of Operation*** *[6060h]* = -5 (CANopen®).

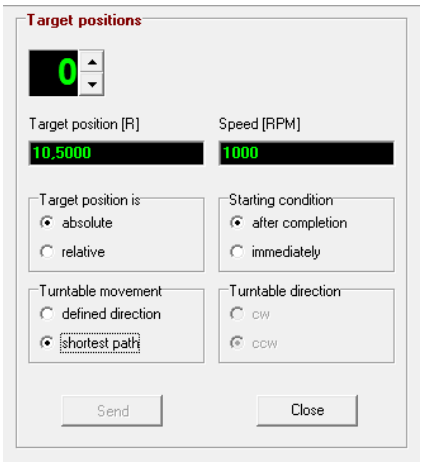


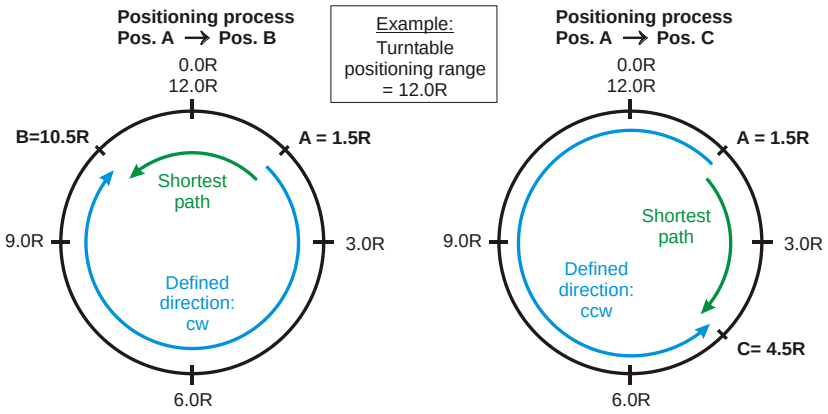


Target positions can be selected either as absolute or relative values:

a) With *relative* positioning the direction of rotation is determined by the sign of the target position. Positive target positions are approached in a clockwise rotation 1, negative target positions in a counter-clockwise rotation 1. (The parameterised turntable movement (see below) or direction of turntable rotation (see below) do not apply with relative positioning!)

b) With *absolute* positioning it is necessary to configure whether the (here fundamentally positive) target positions should be approached with a defined direction of rotation (e.g. always clockwise [1]) or whether the shortest path should be used. In the latter case alternating rotational directions can arise, depending on the location of the target position relative to the current position (see example). The specification takes place in I/O mode via corresponding selection under **OPTIMISATION / POSITIONING / TARGET POSITIONS** (see below) or in CANopen® via Bit11 and Bit12 of the ***Controlword*** *[6040h]*.





Example: Absolute positioning in Turntable mode 1

[1] The direction of rotation shown, cw / ccw and the clockwise arrangement of the positions assumes …,
a) ... that the rotational direction of the motor and the turntable are the same and that **Polarity** is set to "Positive" or
b) ... that the rotational direction of the motor and the turntable are opposite and that **Polarity** is set to "Negative".
The arrangement of the positions – and thus the direction of rotation – can be globally inverted via the **Polarity** parameter (CANopen®: ***Polarity****[607Eh]*), if required.
(Note: The sign of the parameterised positioning speed has no influence on the direction of rotation.)

A detailed description of all parameters relevant to turntable operation can be found in chapter 4.3 Positioning operating mode .

Note:
The **Turntable positioning range** [2] must be parameterised with a precision of 4 decimal places.
Permissible value range: **[1.0000 R … 260,000.0000 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!

Example: Turntable positioning range = 10.0625 R ✔ *(4 decimal places)*
Turntable positioning range = 10.03125 R ✘ *(too many decimal places!)*
Turntable positioning range = $10.\overline{3}$... R ✘ *(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!

Note:
Permissible value range for **Target positions** [3] 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, then there will be no positioning movement initiated.

b) *with relative positioning:*

[– Turntable positioning range ... + Turntable positioning range]

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

Note:
Before using any positioning mode it is necessary to carry out a referencing run (homing), whereby the current position value will be determined from the homing parameter **Offset** (see also chapter 4.3.2 Homing). In the process, the position counter must not be assigned a position value that lies outside the specified turntable positioning range.

⇒ Permissible value range for **Offset** [4] in turntable positioning mode:

[– Turntable positioning range ... 0.0000 R]

Observe the different scaling with CANopen®!

[2] Corresp. object ***Max Position Range Limit*** *[607Bh, Subindex 2]*, which represents the positioning range as a multiple of $\frac{1}{10000}$ R. (Replaces the former object ***Max Turntable Position*** *[2006h]*, which represented the positioning range as a multiple of $\frac{1}{4096}$ R)

[3] Corresp. object ***Target Position*** *[607Ah]*, which represents the target position as a multiple of $\frac{1}{4096}$ R.

[4] Corresp. object ***Home Offset*** *[607Ch]*, which represents the offset as a multiple of $\frac{1}{4096}$ R.

4.4 Additional functions

4.4.1 External torque / speed limiting

All HBI drives offer the possibility of external, dynamic speed limiting or torque limiting.

The speed limiting operating mode can be used, to limit a current-controlled drive without a load to a defined speed. Without limiting, the drive would accelerate out of control to its maximum possible speed.

In I/O mode the limiting is activated in the menu ***OPTIMISATION / OPERATING MODE*** and is based on the selected operating mode. The specification of the external limit value takes place through the existing analogue input (or also for testing purposes through the parameterisation program via the RS232 interface).

In CANopen® this operating mode is selected through ***modes of operation*** and limit values are specified through the objects ***dynamic speed limit*** or ***dynamic torque limit.***

• Torque limiting in speed control mode

In speed control mode, a limit value for the maximum torque is additionally specified to the speed setpoint specification.

In CANopen® this mode is set with ***modes of operation*****=** -3 and the limit value is specified with ***dynamic torque limit***.

Note:
The I²t limiting for the protection of the motor remains active; in other words on triggering of the I²t limiting, the motor current is reduced to the motor rated current and thus eventually lower than the externally specified limit.

• Speed limiting in current control / torque control mode

In torque control mode, a limit value for the maximum speed is additionally specified to the current setpoint specification.

In CANopen® this mode is set with ***modes of operation*****=** -4 and the limit value is specified with ***dynamic speed limit.***

Note:
For the proper function of the torque control mode with speed limiting, the parameters of the speed controller must also be set. The speed setpoint ramp must be switched off or adjusted to the highest possible acceleration.
(*DSerV: Setpoint ramp = 30,000 [10 RPM / sec]*).

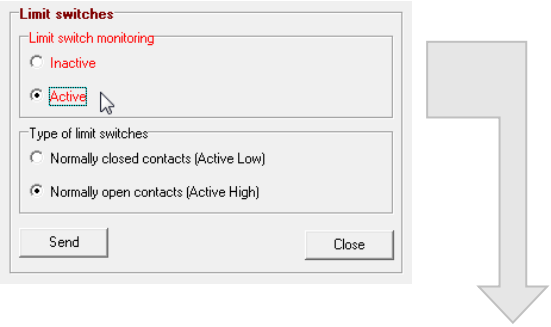
4.4.2 Digital inputs

The integrated HBI drives have 8 digital inputs, DI1...DI8, which are permanently assigned with different functions. The DI functions are largely determined by the operating mode (current control, speed control, positioning) selected under ***OPTIMISATION / OPERATING MODE***, see the table below.

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 4.4.3 Digital outputs.

A DI function is activated by default with a signal level of +15...+30V and deactivated with 0...+5V.
Exception: DI function Limit switch with parameterisation Normally closed contacts ⇒ inverse level assignment.

The function of the digital inputs DI2, DI3 is additionally dependent on the selection of limit switch monitoring in the menu ***OPTIMISATION / LIMIT SWITCHES.***



Digital input	Operating mode			Limit switch monitoring
	Current control	**Speed control**	**Positioning**	
DI1	enable	enable	enable	
DI2	Setpoint = 0 [1]	Setpoint = 0 [1]	Pos. limit switch [4]	Inactive
	Pos. limit switch [2]	Pos. limit switch [2]	Pos. limit switch [5]	Active
DI3	Setpoint = inverse [1]	Setpoint = inverse [1]	Neg. limit switch [4]	Inactive
	Neg. limit switch [3]	Neg. limit switch [3]	Neg. limit switch [5]	Active
DI4 *(DO2)*	*(DO function)*	*(DO function)*	Start positioning [1]	
DI5 *(DO1)*	*(DO function)*	*(DO function)*	*(DO function)*	
DI6 *(AI1-)*	Const. value 1 / 2 [1]	Const. value 1 / 2 [1]	Pos. target Bit 0 [1]	
DI7	-	-	Pos. target Bit 1 [1]	
DI8	-	-	Pos. target Bit 2 [1]	

[1] Function only effective in I/O mode. No function under CANopen®.
(See below for additional footnotes)

Description of the DI functions

Pos. / neg. limit switch

The exact function of the limit switches varies depending on the selected operating mode and limit switch monitoring (see the footnotes below for the table above):

[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.

For additional information about limit switch management,
see chapter 4.3.3 Limit switches

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!
- CANopen®: DI1 must be active to reach the "Operation enabled" status.

Setpoint = 0

Sets the setpoint to zero regardless of the external specification.

- Current control: The motor is nearly torque-free.
  Ramp settings remain active.
- Speed control: The drive is not drift-free!
  (optional "Halt" function: Drive remains drift-free/ position-controlled)

Setpoint = inverse

Inverts the leading sign of the external current or speed setpoint. The set speed ramp remains active.

Constant value 1 / 2

Selects one of two parameterisable fixed setpoints in the operating modes current control and speed control.
(for parameterisation see chapter 4.1 Speed control operating mode).

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 also chapter 4.3.1 Positioning function in I/O mode (without fieldbus).

Positioning target Bit 0-2

Selection of a positioning data set (0...7, binary coded), which will be activated with the next start of a positioning process,
see also chapter 4.3.1 Positioning function in I/O mode (without fieldbus).

For the pin assignment of the digital inputs, see chapter 5.1 X1 – Supply and signals
For electrical characteristics of the digital inputs, see chapter 3.5 Integrated control electronics technical data

4.4.3 Digital outputs

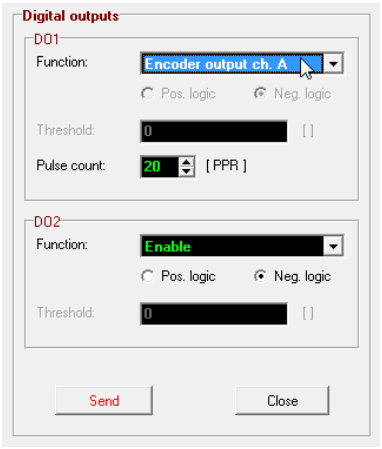
The integrated HBI drives have two digital outputs (DO1, DO2), which can be freely assigned with a function from a predefined list of functions.

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
CANopen®	✔ DO1 ✔ DO2	✔ DO1 ✔ DO2	✔ DO1 ✔ DO2

see also the tabular overview in chapter 4.4.2 Digital inputs.

The function of the digital outputs DO1 and DO2 can be configured in the menu ***OPTIMISATION / DIGITAL OUTPUTS*** in the parameterisation software DSerV:



Note:
Both digital outputs are ground switching open collector outputs. In order to be able to output a "high" voltage level, they must be externally wired with a pull-up resistor.
(e.g. R = 1kΩ / 1W to +24VDC)
Observe the digital output's driver capability!

Description of the DO functions

Enable	Active, if the drive is error-free and enabled
Speed threshold	Active, if actual speed > threshold value
Current threshold	Active, if actual current > threshold value
I²t active	Active, if I^2t limiting is active
Target reached	Active, after successfully completed positioning process.
Ready	Active, if the drive is error-free
Following error threshold	Active, if following error > threshold value
Encoder output channel A/B	Emulation of an encoder output channel, track A/B (1...20 pulses / revolution)

Note:
Functions which compare an actual value with a specified threshold operate without debouncing. Minimum time interval for consecutive DO switching edges: ≥ 1.5msec

For the pin assignment of the digital outputs, see chapter 5.1 X1 – Supply and signals
For the electrical characteristics of the digital outputs, see chapter 3.5 Integrated control electronics technical data

5 Connection assignment

5.1 X1 – Supply and signals

Connector on the device: ytec/itec angled receptacle (Intercontec series 615/915 with insert 12+3 pin, male)
Mating plug: plug (Intercontec series 915, 12+3 pin: E ST B 205 NN 00 13 0003 000)

Pin no.	Wire [1]		Name	Description	Value
A	BN	3x 1.5 mm²	+Ub	Supply 24VDC / 48VDC (logic circuit and power stage)	depending on device design
B	BU		0V	Supply 0V (reference potential for +Ub and +Ub1) [2]	
C	BK		+Ubl *n.c.* [4]	Logic supply 24VDC [3] *- not used -*	
1	WH	12x 0.14 mm²	DI1	Digital input 1 (enable input)	L: 0...5V, H: 15...30V
2	BN		DI2	Digital input 2 (setpoint=0 / halt / pos. limit switch)	L: 0...5V, H: 15...30V
3	GN		DI3	Digital input 3 (setpoint=inverse / neg. limit switch)	L: 0...5V, H: 15...30V
4	YE		DO1	Digital output 1 (configurable function)	Open Coll. (24V, 50mA)
			DI5	Digital input 5 (- currently not usable as DI -)	L: 0...5V, H: 15...30V
5	GY		DO2	Digital output 2 (configurable function)	Open Coll. (24V, 50mA)
			DI4	Digital input 4 (start positioning process) [5]	L: 0...5V, H: 15...30V
6	PK		AI1+	Analogue input 1 (differential input: analogue setpoint) [7]	0... ±10V
7	BU		AI1-	Analogue input 1 (differential input: analogue setpoint)	
			DI6	Digital input 6 (selection: positioning target Bit 0) [5, 7] (selection: constant value 1 / 2) [6, 7]	L: 0...5V, H: 15...30V
8	BK		GND	Reference potential (signal ground) [2, 3]	
9	RD		DI7	Digital input 7 (selection: positioning target Bit 1) [5]	L: 0...5V, H: 15...30V
			+Ubl [4]	*Logic supply 24VDC (only HBI32 / HBI37)* [3]	
10	VT		TxD	RS232: Transmit Data	
11	GY-PK		RxD	RS232: Receive Data	
12	BU-RD		DI8	Digital input 8 (selection: positioning target Bit 2) [5]	L: 0...5V, H: 15...30V
			PGM [4]	*RS232: DTR line of the PC activates firmware download* [8]	*Active: +3...+12V* *Inactive: 0...-12V or n.c.*

For a tabular overview of DI / DO functions, see chapter 4.4.2 Digital inputs / 4.4.3 Digital outputs
For the electrical characteristics of the connections, see chapter 3.5 Integrated control electronics technical data

[1] Wire colours and cross-sections apply for original ENGEL cable assemblies.
[2] Supply 0V and GND are connected internally through a self-resetting fuse.
[3] +Ub1 supply is not mandatory. For the principle of the separate logic supply, see chapter 6.2 Installation diagram.
[4] Entries in italics - if present - describe the earlier status until the board revision V2.x [*)].
[5] Function only in positioning mode. Digital inputs DI7, DI8 are only available starting with board revision V3.x [*)]!
[6] Function only in speed control mode with constant setpoints selectable through digital input.
[7] With use of AI1- as digital input DI6: connect AI1+ to GND!
[8] Only with drives up to board revision V2.x [*)]:
For the firmware download, X1 / Pin12 must be connected to the DTR line of the PC (COMx, DSub 9 / Pin4). Please also observe the notes for USB-to-RS232 converters in chapter 8 Status display, error messages.
[*)] Board revision is displayed in DSerV status bar.

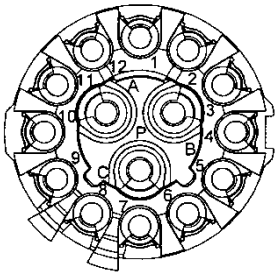


Fig.:
X1 pin layout
Viewed on plug side
of the angled receptacle

5.2 X2a – CAN signal plug (device design "-xCx")

Connector on the device: ytec angled receptacle (Intercontec series 615/915) with insert 5-pin M12 circular connector (a-coded, male contacts)

Mating plug: 5-pin M12 circular connector (a-coded, female contacts)

Pin no.	Wire [1]		Signal
1	-	-	(Shield) [2]
2	RD	2x 0.32 mm²	n.c.
3	BK		GND
4	WH	2x 0.32 mm²	CAN_H
5	BU		CAN_L

[1] Wire colours and cross-sections apply for original ENGEL cable assemblies.

[2] With use of a shielded cable, the shield application should preferentially be made over the plug connector housing. The shield can also be contacted over Pin1.

The CAN interface of the HBI drives is not galvanically isolated by default. With the drives HBI32xx / HBI37xx, however, a galvanic isolation of the CAN interface is available on request.

The signal levels refer to GND.

A network terminating resistor is not integrated and must be connected externally, if necessary, see also chapter 6 Installation .

5.3 X2b – Incremental output signals (device design "-xIx")

Connector on the device: ytec angled receptacle (Intercontec series 615/915) with insert 8-pin M12 circular connector (a-coded, male contacts)

Mating plug: 8-pin M12 circular connector (a-coded, female contacts)

Pin no.	Wire [1]		Signal
1	WH	8x 0.25 mm²	A
2	BN		A/
3	GN		B
4	YE		B/
5	GY		Z
6	PK		Z/
7	BU		GND
8	RD		n.c.

[1] Wire colours and cross-sections apply for original ENGEL cable assemblies.

6 Installation

6.1 Cable types, cable lengths, shielding

EMC note:
In the test lab, the adherence to the limit values specified by the EMC product standard DIN EN 61800-3 (VDE 0160-103): 2005-07, EN 61800-3:2004 has been confirmed:
Emission[1)]: second environment / limited availability (Category C3)
Immunity: second environment

[1)] Cable-based emissions must be suppressed through appropriate filtering measures in the energy supply (e.g. power supply unit) of the device.

The following recommendations for installation have been created in accordance with test lab conditions.

Warning
In a residential area this product can cause high-frequency disturbances, which may necessitate interference suppression measures.

For the optimal operation of the HBI series drives, ENGEL offers cable assemblies in various standard lengths (see below). Deviating lengths on request.

Requirements on the supply / signal line:

- Recommended wire cross-section for voltage supply: 1.5mm² (Observe voltage drop on the lead!)
- The voltage supply should be stranded in pairs and have shielding
- Minimum wire cross-section for signals: 0.14mm²
- Flexibility in accordance with the specific application, max. operating temperature ≤80°C.
- Connect the overall shield with the lowest possible impedance to protective earth.

Type recommendation:

ENGEL original accessories:
- **Item no. 9900000575 (2m)**
- **Item no. 9900000576 (5m)**

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

Requirements on the CAN line:

- Twisted pair leads recommended for signal pair (CAN_H, CAN_L).
- Minimum wire cross-section: 0.25mm²
- Overall shield
- Flexibility in accordance with the specific application, upper operating temperature ≤80°C.

Type recommendation:

ENGEL original accessories:

- **Item no. 9900000577 (6m)**
  Cable assembly with M12 connection plug, open on one end,
  2x 0.32mm² (shielded) + 2x 0.32mm² (shielded), suitable for drag chains.

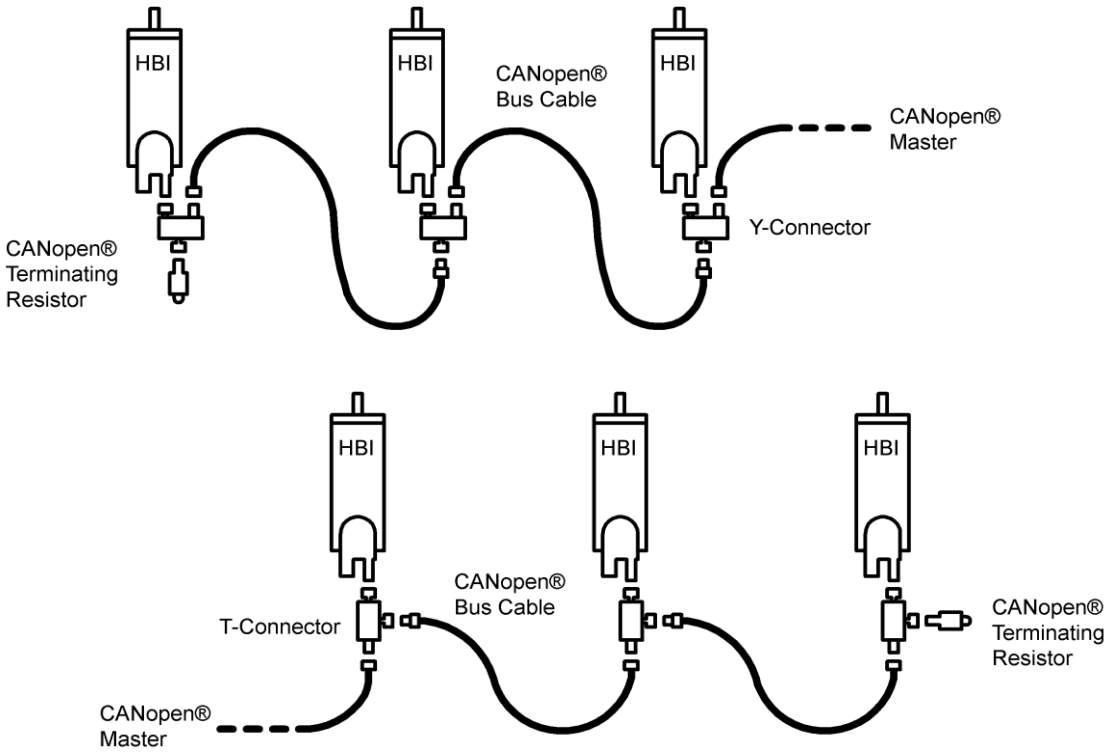
Other providers:

- **CAN bus cable RKC5722-6M (6m, PVC)**
- **CAN bus cable RKC5723-6M (6m, PUR)**
  - as above -
  Reference: Hans Turck GmbH & Co. KG, Mülheim a. d. Ruhr, www.turck.com

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

Reference: U.I. Lapp GmbH, Stuttgart, www.lappkabel.de
Lumberg Automation, Schalksmühle, www.lumberg-automation.de



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

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

Requirements on the incremental line:

- Cable with twisted pair leads recommended.
- Minimum wire cross-section: 0.25mm²
- Connect the overall shield with the lowest possible impedance to protective earth.
- Flexibility in accordance with the specific application, max. operating temperature ≤80°C.

Type recommendation: **ENGEL original accessories:**

- **Item no. 9900000578 (5m)**

Cable assembly with M12 connection plug, open on one end,
8x 0.25mm² (shielding applied on sleeve nut)

Other providers:

- **Cable assembly with M12 connection plug WAKS8-2/S366 (2m)**
- **Cable assembly with M12 connection plug WAKS8-5/S366 (5m)**
- **Cable assembly with M12 connection plug WAKS8-10/S366 (10m)**

- as above -
Reference: ESCHA Bauelemente GmbH, Halver, www.escha.de

6.2 Installation diagram

The installation diagram shows an example for the connection of the HBI drives.

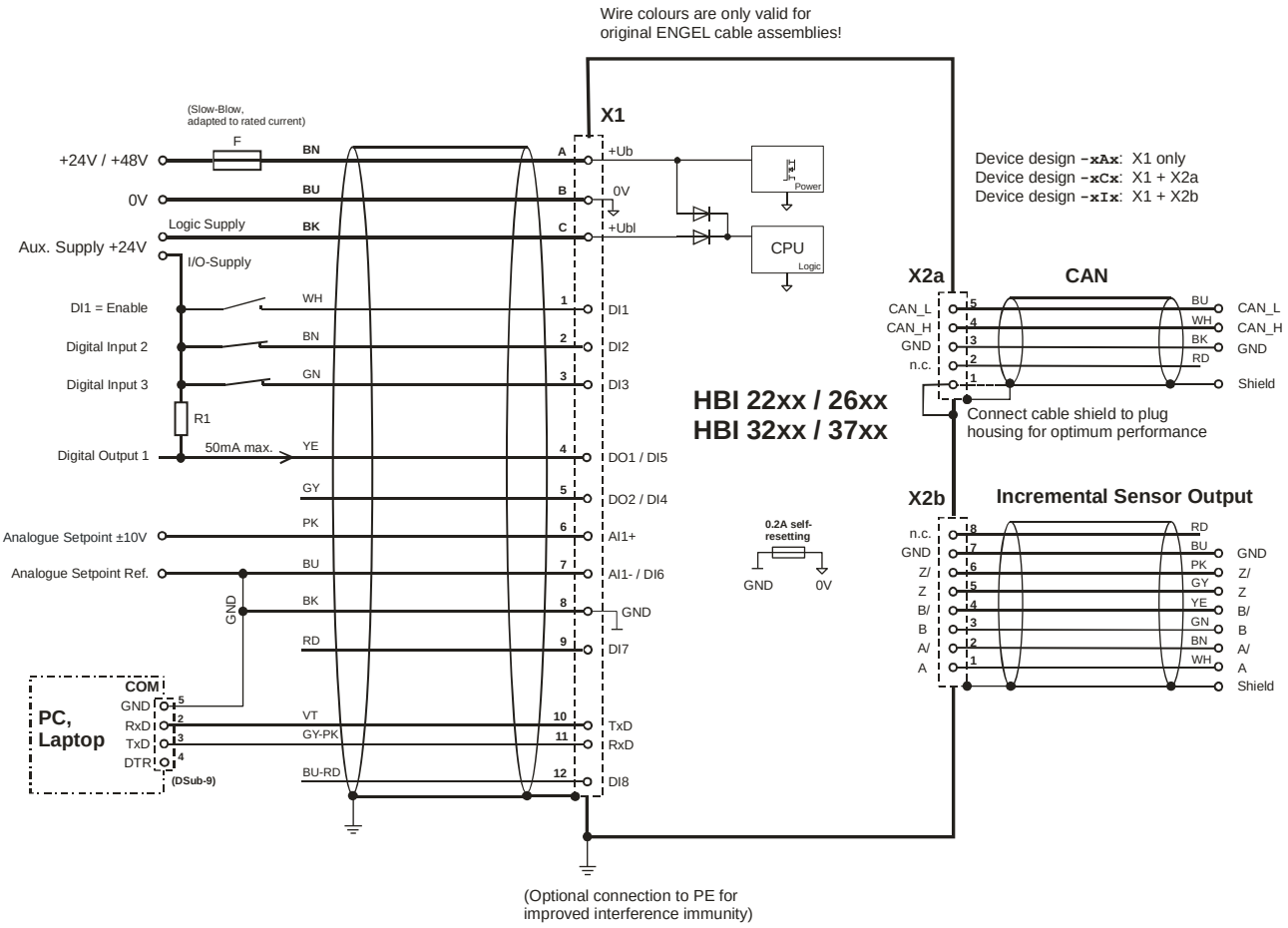


Fig.: Installation diagram (example)

Note:

- Digital outputs:
  Digital outputs of the HBI are ground switching and designed without pull-up resistor. Normally a pull-up resistor is required for reading to a controller (e.g. R1 = 1kΩ / 1W to +24VDC).
- Separate logic supply:
  To maintain the data on shut-down or failure of the main supply +Ub (+24VDC / +48VDC), it is possible to feed a separate logic supply voltage +Ubl (+24VDC) to X1. The reference potential of each of the two voltage supplies is to be connected to X1 / Pin B (0V).
- X1 connection assignment:
  The X1 connection assignment shown applies for HBI drives starting from board revision V3.x! For HBI drives up to board revision V2.x, the X1 connection assignment can be gathered from chapter 5.1 X1 – Supply and signals.
  (Board revision is displayed in DSerV status bar.)

7 Commissioning of the integrated HBI drives

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.

We recommend the following procedure for the commissioning of the integrated drives:

Step 1: Installation
- Install the drive in accordance with the installation diagram and wire the digital inputs and outputs required for the application.

Step 2: Check the installation
- Check the installation for any potential errors.

Step 3: Adjust non-critical signal processes
- Adjust the externally specified setpoints to the minimum.
- Withdraw the controller enable (DI1=OFF).

Step 4: Switch on the supply voltage
- The green LED of the status display on the rear side of the device will blink constantly.

Remedy for typical errors:
see table of errors in chapter 8.1 General error messages.

Step 5: Start the DSerV service software
- Connect COMx (x = 1...99) of your PC / laptop and X1 of the drive in accordance with chapter 6.2 Installation diagram and start the DSerV service software.
The type and version of the connected device appears in the status bar of the program.
Remedy for faulty communication in chapter 11.2 Installation and start-up of the program.

Step 6: Review the set of parameters
- Review under ***OPTIMISATION / CURRENT CONTROLLER*** on the basis of the set current limits whether the adjusted set of parameters correlates with the connected motor.
If this is not the case, load a suitable set of parameters in the drive or
optimise the current and speed controller in accordance with chapter 9 Controller optimisation.

Step 7: Enable power stage
- Switch on the controller enable: The green LED of the status display switches to continuously illuminated.
- With a slight increase of the speed setpoint, the drive must begin to rotate. The motor rotates clockwise if the setpoint is positive (looking towards the shaft).

Remedy for typical errors:
see table of errors in chapter 8.1 General error messages.

Step 8: Assure the functionality of the application
- Check the connected input and output signals for correct function.

8 Status display, error messages

A red / green LED on the rear side of the device provides a general indication of the operating status of the drive:

Green LED	Red LED		Operating status
blinking	OFF	⇨	Controller / power stage disabled (Drive ready)
ON	OFF	⇨	Controller / power stage enabled
OFF	blinking	⇨	Error status. Red LED indicates the highest active error code.
OFF	ON	⇨	- RESET active (e.g. on start-up) [3] or - Firmware download mode active [3]
OFF	OFF	⇨	- Device has no function. Check input voltage. - RESET active (e.g. on start-up) [2] or - Firmware download mode active [1, 2]

[1] Some USB-to-RS232 converters can unintentionally activate the firmware download mode, as long as they have not been initialised by DSerV yet. Remedy: Switch off the supply voltage. Only connect the RS232 cable once the supply is switched on.
[2] Only with HBI3x and HBI2x up to board revision V2.x
[3] Only with HBI3x and HBI2x starting from board revision V3.x

Attention !
The power supply must be switched off before you begin with the troubleshooting!

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 service software DSerV shows the cause of error in plain text. 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:

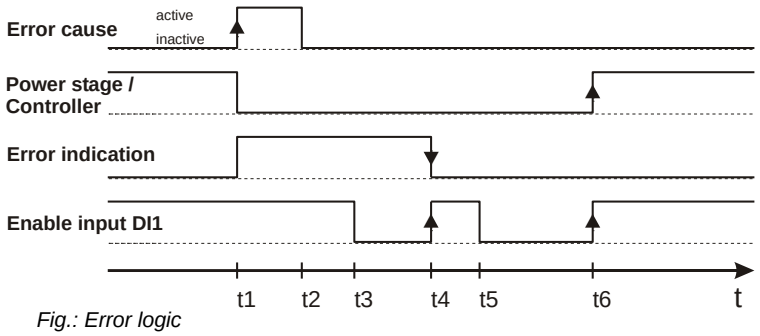


Fig.: Error logic

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 drive off and on again. Note: Error 10 "internal error" cannot be reset with the enable input.

8.1 General error messages

The following table shows the possible error messages of the status display:

Displayed error code	Meaning	Measures for error rectification
1	*Error code not present*	
2	Power stage temperature greater than 85°C	Check installation conditions. Environmental temperature too high? If necessary, provide appropriate cooling.
3	*Error code not present*	
4	DC-link voltage greater than maximum value	Regenerative feedback mode. If necessary, adjust ramp or provide external voltage limiting.
5	Angle sensor error	internal defect, no remedy possible
6	Undervoltage	Check input voltage. Error occurs eventually with powerful, short-term accelerations.
7	Overcurrent	Motor currents and control parameters of the current controller parameterised in accordance with factory specifications?
8	Checksum parameter memory	The contents of the parameter memory were read incorrectly. Does the error occur again after restarting? ⇨ Download a well-proven parameter set or ⇨ Check the parameter settings with DSerV service software and save with ***OPTIMISATION / SAVE SETTINGS***.
9	Faulty parameter set	The parameter set transferred by "Download" is faulty. The download cannot be saved. ⇨ Switch the device off and on in order to activate a previously saved parameter set or ⇨ Use a different parameter set.
10	Internal error	No remedy by the user. DSerV displays an additional error number for Error 10, which provides an indication of the cause of error.
11	Positioning error	DSerV displays an additional error number for Error 11, which provides an indication of the cause of error. ⇨ See chapter 8.2 Error messages in positioning mode
12	Fieldbus error	Errors of the fieldbus interface. ⇨ See chapter 8.4 CAN bus error messages

8.2 Error messages in positioning mode

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

Displayed Error no.	Meaning	Cause / Measures
1	Actual position < Minimum positioning range	Actual position of the drive undercuts the parameterised positioning range.
2	Actual position > Maximum positioning range	Actual position of the drive exceeds the parameterised positioning range.
3	Setpoint position < Minimum positioning range	Specified setpoint position undercuts the parameterised positioning range.
4	Setpoint position > Maximum positioning range	Specified setpoint position exceeds the parameterised positioning range.
5	Faulty parameterisation of positioning range	Illegal parameterisation of the positioning range limits: (min>max)
6	Limit switch monitoring	The positioning range limited by the limit switches was unexpectedly left
7	Homing	With control through CANopen®: - Incorrectly parameterised (unknown) homing method. When referencing to a limit switch: - The opposite limit switch was actuated during the homing process.
8	Following error monitoring	In positioning mode the maximum permissible position deviation (actual position vs. setpoint position) is temporally exceeded. - Adjust motion profile: • Flatten out speed ramps. • If necessary, reduce target speed. - Adjust following error monitoring: • Enlarge permissible following error window. • Increase following error timeout. • If necessary, deactivate monitoring. ⇨ see chapter 4.3 Positioning operating mode ⇨ see chapter 4.1 Speed control operating mode

8.3 CAN status display

The integrated HBI drives 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.

A detailed error message is provided on the CAN status bar of the DSerV parameterisation software.
(see chapter 11.3 Operation of the DSerV service software)

8.4 CAN bus error messages

Error no.	Meaning	Cause / Measures
1	CAN Controller overflow	Bus load too high, cannot be processed. ⇨ reduce the CAN bit rate, if applicable ⇨ Optimise PDO communication
2	CAN bus off	Communication switched off due to disrupted transmission. Correct CAN bit rate set? Node ID specification OK?
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 PDO communication
5	*Error code not present*	
6	Reset Communication	NMT command "Reset communication" was received.
7	Communication stopped	NMT command "Stop" was received.

9 Controller optimisation

The integrated HBI drives are supplied ex works with 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 with 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 drive is configured ex works for I/O mode, the operating mode is set for speed control with setpoint specification through the analogue input AI1.

9.1 Current controller

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

9.2 Angle sensor offset determination, motor pole number

The parameters for the motor pole number (see chapter 3 Technical data) and angle sensor offset are adjusted ex works.

In the DSerV menu ***OPTIMISATION / CURRENT CONTROLLER*** either of those two parameters can directly be entered. Furthermore, a function for the automatic adjustment of the angle sensor offset is provided.

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:

- Drive shaft of the drive rotates freely and is not loaded.
- Parameters for the current controller are adjusted and transmitted in accordance with chapter 9.1 Current controller.
- Motor pole number adjusted and transmitted.
- Follow the instructions on the screen.

9.3 Speed controller adjustment

> **Note:**
> Correctly adjusted control parameters for the current controller are required for the speed controller adjustment.

Step 1: Installed drive ready for operation in accordance with Step 5 of the commissioning instructions in chapter 7 Commissioning of the integrated HBI drives.

Step 2: Make sure that current limits and control parameters of the current controller are correctly adjusted. If necessary, make settings according to chapter 9.1 Current controller.

Step 3: For the optimisation of the speed controller, the speed progression of the drive must be determined.

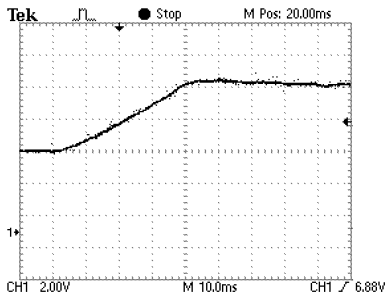
Step 4: The parameters of the speed controller are accessible through the menu ***OPTIMISATION / SPEED CONTROLLER***.
For the optimisation of the speed controller the setpoint ramp is to be switched off or the maximum incline is to be set and the setpoint scaling value is to be adjusted in accordance with the speed required in the application.
The control parameters of the speed controller are to be initially set to non-critical values, which means low proportional gain (approx. 0.05 ... 0.1) and a large time constant.

Step 5: The drive is now enabled with a speed setpoint of approx. 75%.
. The progression of the speed is determined. Withdraw controller enable.

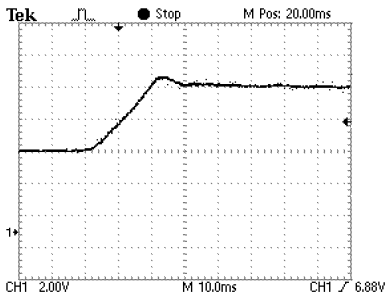
Step 6: Increase the speed controller's proportional gain by a few hundredths and enable the drive again and determine the speed progression.

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

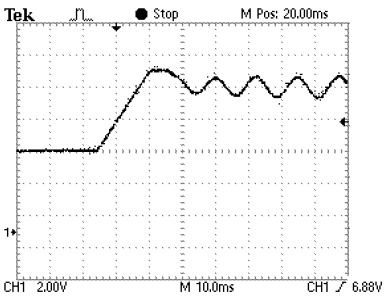
For the optimisation, reduce the speed controller time constant until the setpoint speed is reached with a single overshoot (approx. 4-10% of the setpoint).



a) proportional gain too low
time constant too large



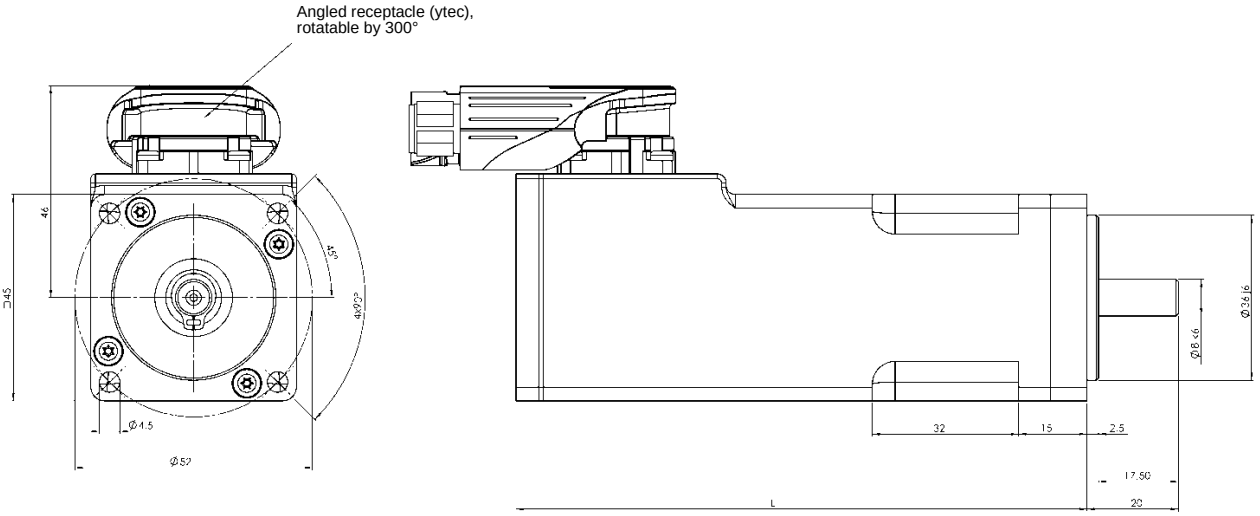
b) optimal proportional gain / time constant



c) proportional gain too high
time constant too small

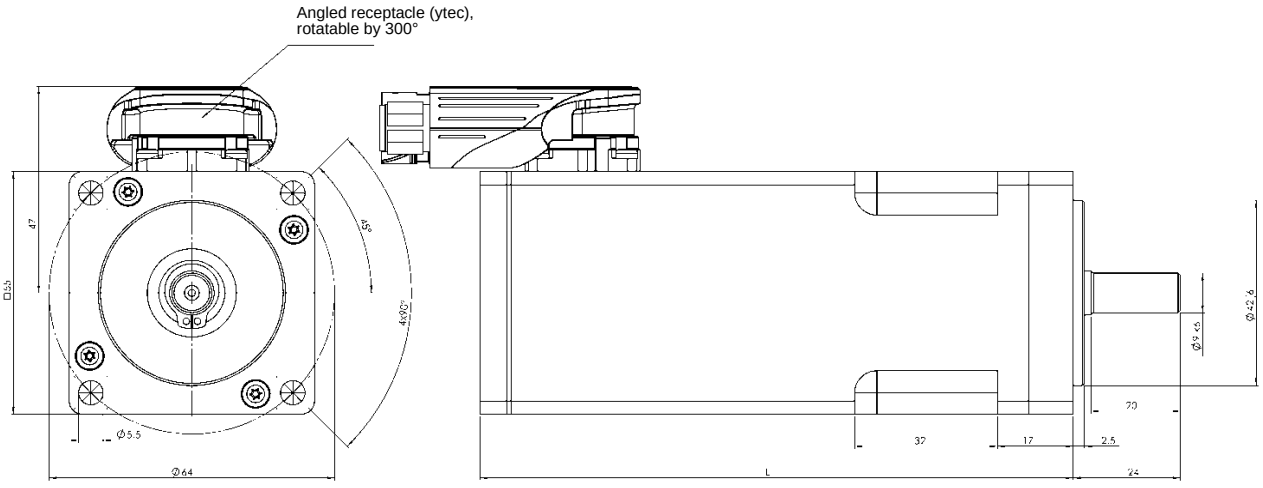
Fig.: Speed step responses with variation of the speed controller settings

10 Mechanical dimensions



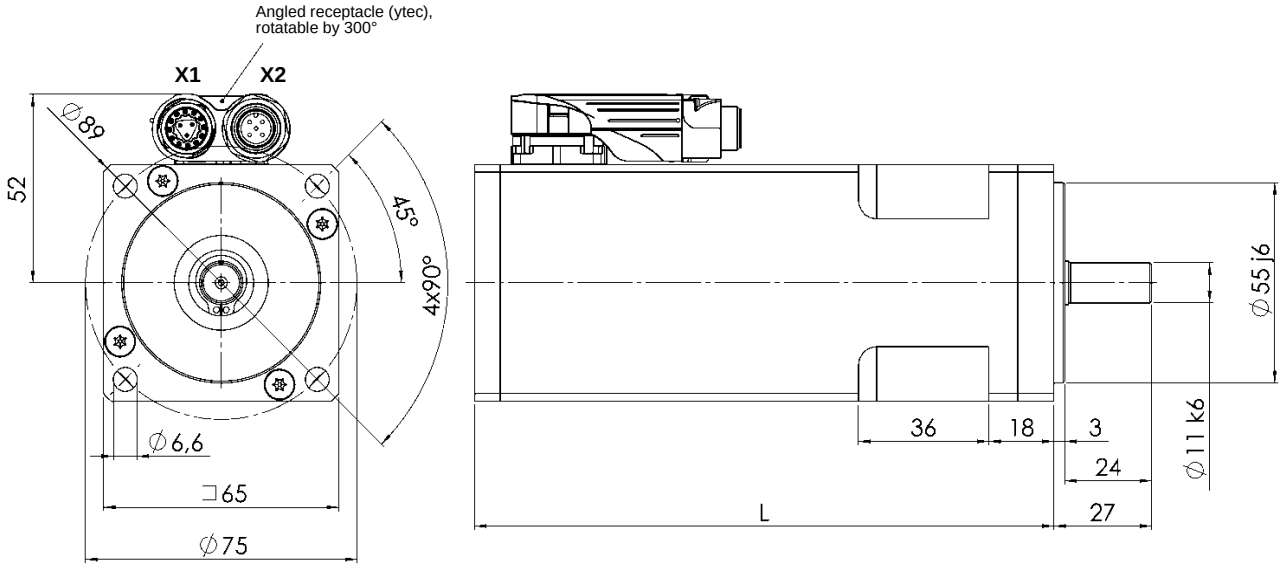
Type	Meas. L [mm]
HBI2230	125
HBI2230 with brake	157
HBI2260	155
HBI2260 with brake	187

Fig.: HBI22xx dimensions



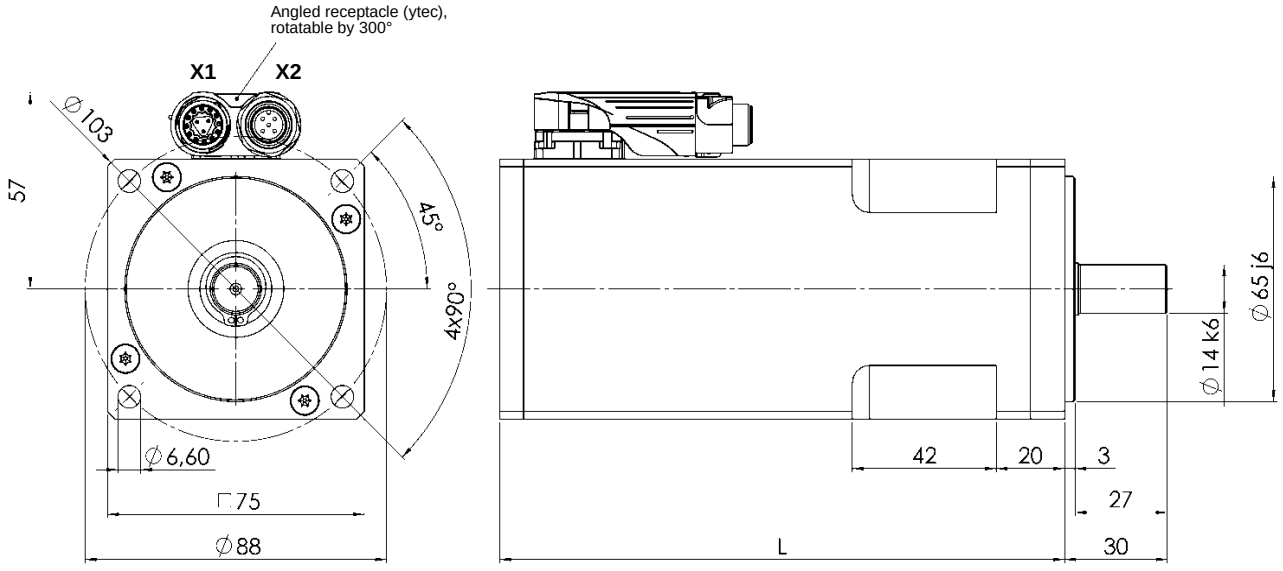
Type	Meas. L [mm]
HBI2630	133
HBI2630 with brake	163
HBI2660	163
HBI2660 with brake	193

Fig.: HBI26xx dimensions



Type	Meas. L [mm]
HBI3260	160
HBI3260 with brake	190
HBI3290	190
HBI3290 with brake	220

Fig.: HBI32xx dimensions



Type	Meas. L [mm]
HBI3760	165
HBI3760 with brake	195
HBI3790	195
HBI3790 with brake	225

Fig.: HBI37xx dimensions

11 "DSerV" PC service software

The DSerV service software provides a simple and clearly laid out configuration of the drives. 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 / French.

11.1 System requirements

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

- **IBM compatible PC (laptop), Pentium or higher, with at least 16MB RAM**
- **At least 10MB free hard disk space**
- **Microsoft WINDOWS® 95, 98, NT 4.0, 2000, XP**
- **CD-ROM drive**
- **Serial interface COM1...COM99:**
  On-board or USB-to-RS232 converter, supported baud rate at least 115.2 kBaud
- **Serial connection cable** (see chapter 6.2 Installation diagram)

11.2 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.

Installation

The installation of DSerV is limited to the copying of the program files to a working directory:

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

Alternative 1 (recommended):

4. **Start the file DSerV.exe directly from the CD-ROM. An installation menu opens up.**
   Comment: The installation menu only opens if DSerV.exe is started from a removable data carrier, such as CD-ROM.
5. **Follow the further instructions in the installation menu.**

Alternative 2:

4. **Manually copy the entire directory tree from the CD-ROM 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 CD-ROM.)

Program start

Before starting the program, the HBI drive must be supplied with operating voltage and the connection to the PC / laptop must be established with a serial connection cable (see chapter 6.2 Installation diagram).

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

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

Note:
If no communication to the drive is established after the program start, check the following:

- Is the correct interface port selected on the PC / laptop? (***Options*** / ***Com-Port***)
- Is the drive switched on?
- Is the serial cable plugged in at the PC / laptop and the drive?
  (If necessary, only plug in the serial cable after the drive has been supplied with operating voltage.)
- Does the *.dav file in the working directory correspond to the type of drive and the firmware used?

11.3 Operation of the DSerV service software

Menu bar
Function selection

Monitor functions
Display of...
Setpoint and actual values,
I²t monitor,
Temperatures,
Input/output status

CAN status bar:
Node ID, CAN bit rate,
Statemachine, Network status

Drive status bar:
Device type, Serial number,
Firmware revision, Enable,
Error messages

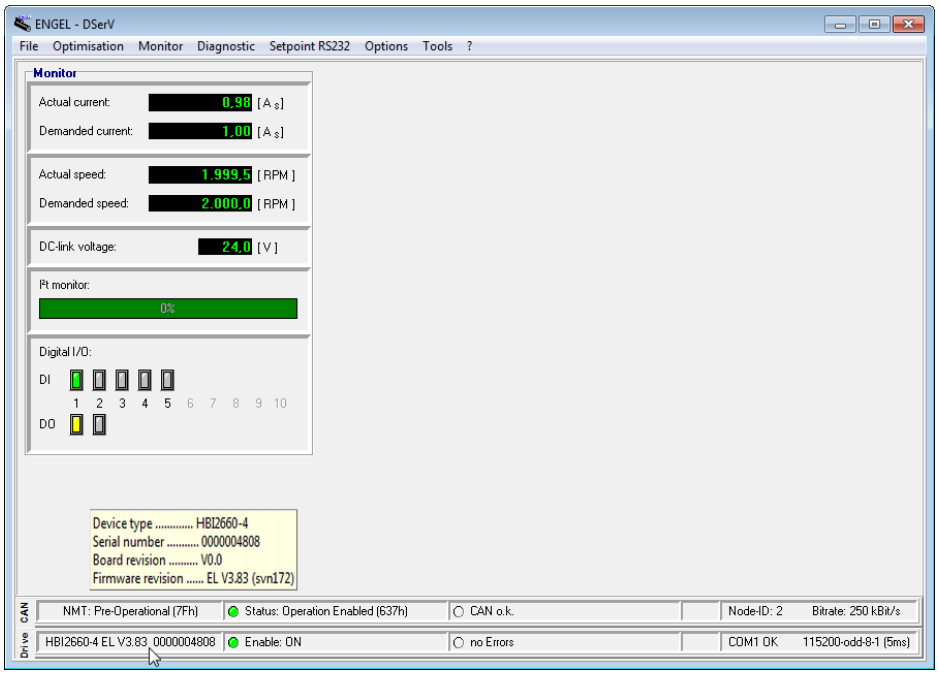


Fig.: DSerV program window

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

11.3.1 File Menu

The following functions can be selected in the “File” menu:

Connect : Starts the communication with the drive through the serial interface.

Disconnect: Stops the communication with the drive.

Parameter up/download: **Upload** transmits the settings of the drive to a parameter file.
The parameter files can be saved with corresponding information text on hard disk / diskette.

Download transmits a parameter file to the drive.
For a clear layout of the selection, the available parameter files are displayed with corresponding information text in a list.

Firmware download: Opens the dialogue for the firmware update of the device. Follow the instructions. DSerV loads new firmware into the device through the existing RS232 connection during the firmware update. For this purpose, you receive the required firmware file (*.hex) on request.

Close: Closes DSerV.

11.3.2 Optimisation menu

The optimisation menu enables the manual adjustment of the drive.

Note:
Parameter settings which are set with the **Send** button have an immediate effect on the device.

Changes are only adopted to the non-volatile memory with the command ***OPTIMISATION / SAVE SETTINGS*** and are then available again the next time the drive is switched on.

The following submenus are available in the optimisation menu:

Operating mode:	Selection between current control, speed control and positioning mode. Selection of the setpoint source.
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 outputs:	Function assignment to digital outputs.
Limit switches:	Adjustment of limit switch polarity and monitoring.
Fieldbus mode:	Activation of fieldbus mode (CANopen® / optional DeviceNet™) address setting, CAN bit rate setting
Save settings:	Menu item becomes active after the transmission of a parameter. Saves changed parameters / setting values in the non-volatile memory of the drive.

11.3.3 Monitor menu

In the Monitor menu drive-specific factors 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.

Speed: Actual speed value, speed setpoint

Current: Actual current value, current setpoint

Position: Current position, target position

Following error: Deviation of the current position from the setpoint position in positioning mode

I²t monitor: Shows the overcurrent capability of the integrated drive.
Rising display: Overcurrent condition
On reaching 100% the motor current is reduced to motor rated current
(When 50% is undercut, overcurrent capability is resumed)

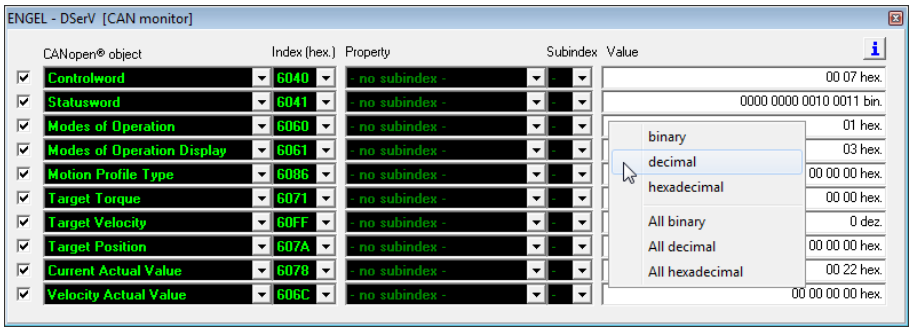
Power stage temperature: Temperature of the power stage

Digital I/O: Shows the current status of the digital inputs and outputs.

11.3.4 Diagnostic menu

The Diagnostic menu offers additional utilities for setting up and assessing the drive:

CAN-Monitor: Display of the current CANopen® object contents. Up to 10 objects can be shown at the same time. Object contents can be displayed individually in binary, decimal or hexadecimal system.



Oscilloscope: (in preparation) Display of time-continuous factors of the drives.

11.3.5 Setpoint RS232 menu

The activation of the ***Setpoint RS232*** menu opens a slider with which the setpoint (current or speed setpoint) can be specified through the serial interface.

In order to react to this setpoint, the setpoint source RS232 must be selected in the ***OPTIMISATION / OPERATING MODE*** menu.

11.3.6 Options menu

COM port: Selection of the serial interface (COM port) used.
Language: Language selection German / English / French

11.3.7 Info menu

Display of the present DSerV program version.