



**Documentation**

# **Stepper motor AS1000**

**Version:** 3.6  
**Date:** 2017-07-26

**BECKHOFF**



# 1 Documented motors

AS10xx-xxxx	Standstill torque [Nm]	Rated current [A]	Rotor moment of inertia [kg cm <sup>2</sup> ]	Resolution [Steps]	Weight [kg]
AS1010-0000	0,38	1,0	0,056	1,8° / 200 Steps	0,31
AS1020-0xxx	0,5	1,0	0,074		0,39
AS1030-0000	0,6	1,5	0,21		0,68
AS1050-0xxx	1,2	5,0	0,36		1,00
AS1060-xxxx	5,0	5,0	3,0		2,85

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## 2 Foreword

### 2.1 Notes on the documentation

This description is only intended for the use of trained specialists in control and automation engineering who are familiar with the applicable national standards.

It is essential that the documentation and the following notes and explanations are followed when installing and commissioning the components.

It is the duty of the technical personnel to use the documentation published at the respective time of each installation and commissioning.

The responsible staff must ensure that the application or use of the products described satisfy all the requirements for safety, including all the relevant laws, regulations, guidelines and standards.

#### Disclaimer

The documentation has been prepared with care. The products described are, however, constantly under development.

We reserve the right to revise and change the documentation at any time and without prior announcement. No claims for the modification of products that have already been supplied may be made on the basis of the data, diagrams and descriptions in this documentation.

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EP1590927, EP1789857, DE102004044764, DE102007017835

with corresponding applications or registrations in various other countries.

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## 2.2 Documentation Issue Status

Issue	Comment
3.6	<b>Chapter update:</b> EC Declaration of conformity; Disposal <b>4.5</b>
3.5	<b>Chapter update:</b> Connection diagram AS1xxx <b>9.4 – 9.10</b>
3.4	<b>Chapter update:</b> Technical data AS1010 – AS1060 <b>11.2 – 11.6</b>
3.3	<b>Chapter update:</b> Foreword 1.0 and Safety 3.0; 2.0
3.2	<b>Chapter update:</b> 7.3.1; 10.1
3.1	<b>New chapter:</b> Documented motors <b>Chapter update:</b> 7.4; 8.3.1; 8.4; 8.5; 8.6; 8.7; 8.8; 8.9; 10.2; 10.3; 10.4; 10.5; 10.6
3.0	<b>General revision</b>
2.2	<b>Chapter revision:</b> <ul style="list-style-type: none"> <li>• Product description – Dimensions</li> <li>• Installation and operation - Installation</li> </ul>
2.1	<b>Chapter revision:</b> <ul style="list-style-type: none"> <li>• Product description – Technical data</li> </ul>
2.0	<b>Chapter revision:</b> <ul style="list-style-type: none"> <li>• Product description – Features and characteristics</li> <li>• Product description – Technical data</li> <li>• Product description – Dimensions</li> <li>• Product description – Accessories</li> <li>• Product description - Installation</li> </ul>
1.2	<ul style="list-style-type: none"> <li>• Speed – torque curves added</li> </ul>
1.1	<ul style="list-style-type: none"> <li>• Technical data section amended</li> <li>• Technical drawings added</li> </ul>
1.0	<b>First edition</b>



## 2.3 Appropriate use

Stepper motors of the AS1000 series are mainly intended as actuators for handling equipment, textile machines, machine tools, packaging machines and similar machines. The motors of the AS1000 series are **exclusively** intended for operation based on speed and / or position control via stepper motor output stages from Beckhoff Automation GmbH & Co. KG.

 <p><b>CAUTION</b></p>	<p><b>Danger for persons, the environment or equipment</b></p> <p>The motors are operated in the drive system in conjunction with Beckhoff stepper motor output stages. Please observe the entire documentation which consists of:</p> <ul style="list-style-type: none"> <li>• AS1000 documentation (this manual)</li> <li>• Complete documentation (online and paper) for Beckhoff stepper motor output stages available at <a href="http://www.beckhoff.com">www.beckhoff.com</a>.</li> <li>• Complete machine documentation (provided by the machine manufacturer)</li> </ul>
 <p><b>WARNING</b></p>	<p><b>Caution - Risk of injury!</b></p> <p>Electronic equipment is not fail-safe. The machine manufacturer is responsible for ensuring that the connected motors and the machine are brought into a safe state in the event of a fault in the drive system.</p>
 <p><b>Note</b></p>	<p><b>Special safety instructions for AS1000!</b></p> <p>For the installation and commissioning of the components the observance of the <u>general</u> [<a href="#">▶ 11</a>] and <u>special safety instructions</u> [<a href="#">▶ 12</a>] and explanations is essential. Carefully read the chapters carefully.</p>

The stepper motors from the AS1000 series are designed for installation as components in electrical systems or machines and may be operated only as integrated system or machine components. The motors may **only** be operated under the ambient conditions defined in this documentation.

### 3 Guidelines and Standards

**Danger for persons, the environment or equipment**

Stepper motors of the AS1000 series are **not** products as defined by the EC Machinery Directive. Operation of the stepper motors in machines or systems is only permitted once the machine or system manufacturer has provided evidence of CE conformity of the complete machine or system.

#### 3.1 EC Declaration of Conformity

We,

Beckhoff Automation GmbH & Co. KG  
Hülshorstweg 20  
33415 Verl  
Germany.

hereby declare, under our sole responsibility, that the product range

**Motor series stepper motors AS1000**

(types AS1010, AS1020, AS1030, AS1050, AS1060)

The components mentioned herein have been developed, designed and manufactured in accordance with the Low Voltage Directive 2006/95/EC (until 19.04.2016) and 2014/35/EU (from 20.04.2016) as well as EMC Directive 2004/108/EC (until 19.04.2016) and 2014/30/EU (from 20.04.2016).

The following standards have been used:

**Product Standard:**

EN 61800-3:2004+A1:2012

Adjustable speed electrical power drive systems – EMC requirements and specific test methods

**Product Standard:**

EN 60034-1:2010+Corr.:2010

Rotating electrical machines – Rating and performance

**Attachment of the CE marking:**

2016

**Issued by:**

Managing Director  
H. Beckhoff  
Verl, 21.07.2016

# 4 Safety

## 4.1 Safety instructions

### Safety regulations

Please note the following safety instructions and explanations!  
 Product-specific safety instructions can be found on following pages or in the areas mounting, wiring, commissioning etc.

### Exclusion of liability







All the components are supplied in particular hardware and software configurations appropriate for the application. Modifications to hardware or software configurations other than those described in the documentation are not permitted, and nullify the liability of Beckhoff Automation GmbH & Co. KG.

### Personnel qualification

This description is only intended for trained specialists in control, automation and drive engineering who are familiar with the applicable national standards.



### Description of symbols

In this documentation the following symbols are used with an accompanying safety instruction or note. The safety instructions must be read carefully and followed without fail!

 <b>DANGER</b>	<p><b>Serious risk of injury!</b>                  Failure to follow the safety instructions associated with this symbol directly endangers the life and health of persons.</p>
 <b>WARNING</b>	<p><b>Risk of injury!</b>                  Failure to follow the safety instructions associated with this symbol endangers the life and health of persons.</p>
 <b>CAUTION</b>	<p><b>Personal injuries!</b>                  Failure to follow the safety instructions associated with this symbol can lead to injuries to persons.</p>
 <b>Attention</b>	<p><b>Damage to the environment or devices</b>                  Failure to follow the instructions associated with this symbol can lead to damage to the environment or equipment.</p>
 <b>Note</b>	<p><b>Tip or pointer</b>                  This symbol indicates information that contributes to better understanding.</p>
	<p><b>UL pointer</b>                  This symbol indicates important information about the UL-compliant.</p>

## 4.2 Special safety instructions for AS1000

The safety instructions are designed to avert danger and must be followed during installation, commissioning, production, troubleshooting, maintenance and trial or test assemblies. The stepper motors of the AS1000 series are not designed for stand-alone operation and are always installed in a machine or system. After installation, the documentation the documentation and the safety instructions provided by the machine manufacturer must be read and applied.

 <b>WARNING</b>	<b>Serious risk of injury through hot surfaces!</b> <ul style="list-style-type: none"><li>• The surface temperature may exceed 100 °C, resulting in a risk of burns.</li><li>• Avoid touching the housing during or shortly after operation.</li><li>• Leave the stepper motor to cool down for at least 15 minutes after it is switched off.</li><li>• Use a thermometer to check whether the surface has cooled down sufficiently.</li></ul>
 <b>Attention</b>	<b>Danger for persons, the environment or equipment</b> <ul style="list-style-type: none"><li>• Please read this manual carefully before using the stepper motor. Follow all safety instructions. If there are sections you do not understand, please contact your sales office and refrain from working with the stepper motor.</li><li>• Only well trained, qualified electricians with sound knowledge of drive equipment may work on the device.</li><li>• During installation, adhere to the ventilation clearances and climatic conditions. Further information can be found in the "Technical data" and "Mechanical installation" sections.</li><li>• If a stepper motor is installed in a machine it must not be commissioned until proof of compliance of the machine with the latest version of the EC Machinery Directive has been provided. This includes all relevant harmonized standards and regulations required for implementation of this Directive in national legislation.</li></ul>

## 5 Handling

### 5.1 Transport

- Climate category: 2K3 according to EN 60721
- Transport temperature: -25 °C - +70 °C, max. fluctuation 20 K/hour
- Transport humidity: relative humidity 5% - 95%, non-condensing
- The stepper motor may only be transported by qualified personnel and in the manufacturer's original recyclable packaging.
- Avoid hard impacts, particularly at the shaft end.
- If the packaging is damaged, check the motor for visible damage. Inform the transport company and, if necessary, the manufacturer.

### 5.2 Packaging

- Cardboard packaging

#### Motor without installed gear unit

Motor type	Max. stacking height
AS1010	5
AS1020	5
AS1030	5
AS1050	5
AS1060	3

#### Motor with installed gear unit

Motor and gear type	Max. stacking height
AS1030 with AG1000-PM052.00x	3
AS1050 with AG1000-PM052.00x	3
AS1060 with AG1000-PM081.00x	2

### 5.3 Storage

- Climate category: 2K3 according to EN 60721
- Storage temperature: -25 °C - +55 °C, max. fluctuation 20 K/hour
- Air humidity: relative humidity 5% - 95%, non-condensing
- Max. stacking height: see table Packaging
- Storage time: without limitation
- Store only in the manufacturer's original recyclable packaging.

## 5.4 Maintenance / Cleaning

- Maintenance and cleaning only by qualified personnel.
- The ball bearings have a grease filling. The actual life of the bearings depends on various factors, including the radial load, shear load, operating temperature and motor speed.
- Check the motor for bearing noise every 2,500 operating hours or once per year. If any noises are heard, stop the operation of the motor. The bearings must be replaced.
- Opening the motor invalidates the warranty.
- Clean the housing with isopropanol or similar.



**Attention**

### **Destruction of the stepper motor**

Never immerse or spray the stepper motor.

## 5.5 Disposal

In accordance with the WEEE 2012/19/EU Directives we take old devices and accessories back for professional disposal, provided the transport costs are taken over by the sender.

Send the devices with the note "For disposal" to:


Beckhoff Automation GmbH & Co. KG  
Huelshorstweg 20  
D-33415 Verl

## 6 Product identification

### 6.1 AS1000 supply schedule

Please check that the delivery includes the following items:

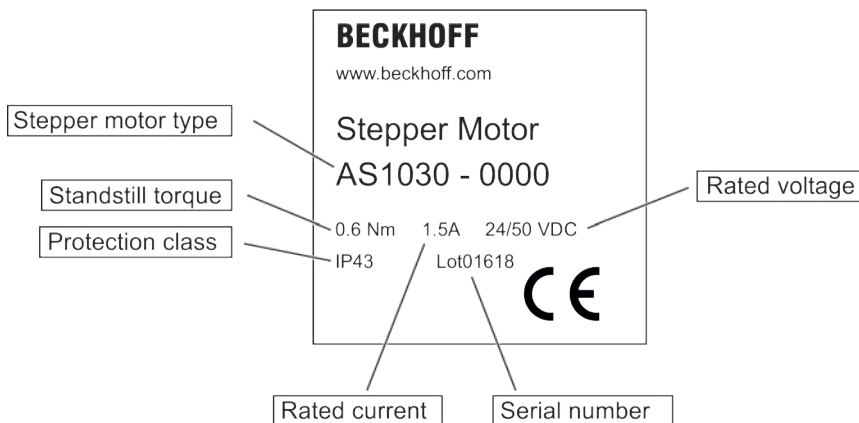
- AM1000 series motor
- Connecting cable with 4-pin M12 connector (underside firmly connected)
- Online documentation at [www.beckhoff.de](http://www.beckhoff.de)

 <b>Note</b>	<p><b>Scope of supply</b></p> <p>The M12 mating connectors are not included!</p>
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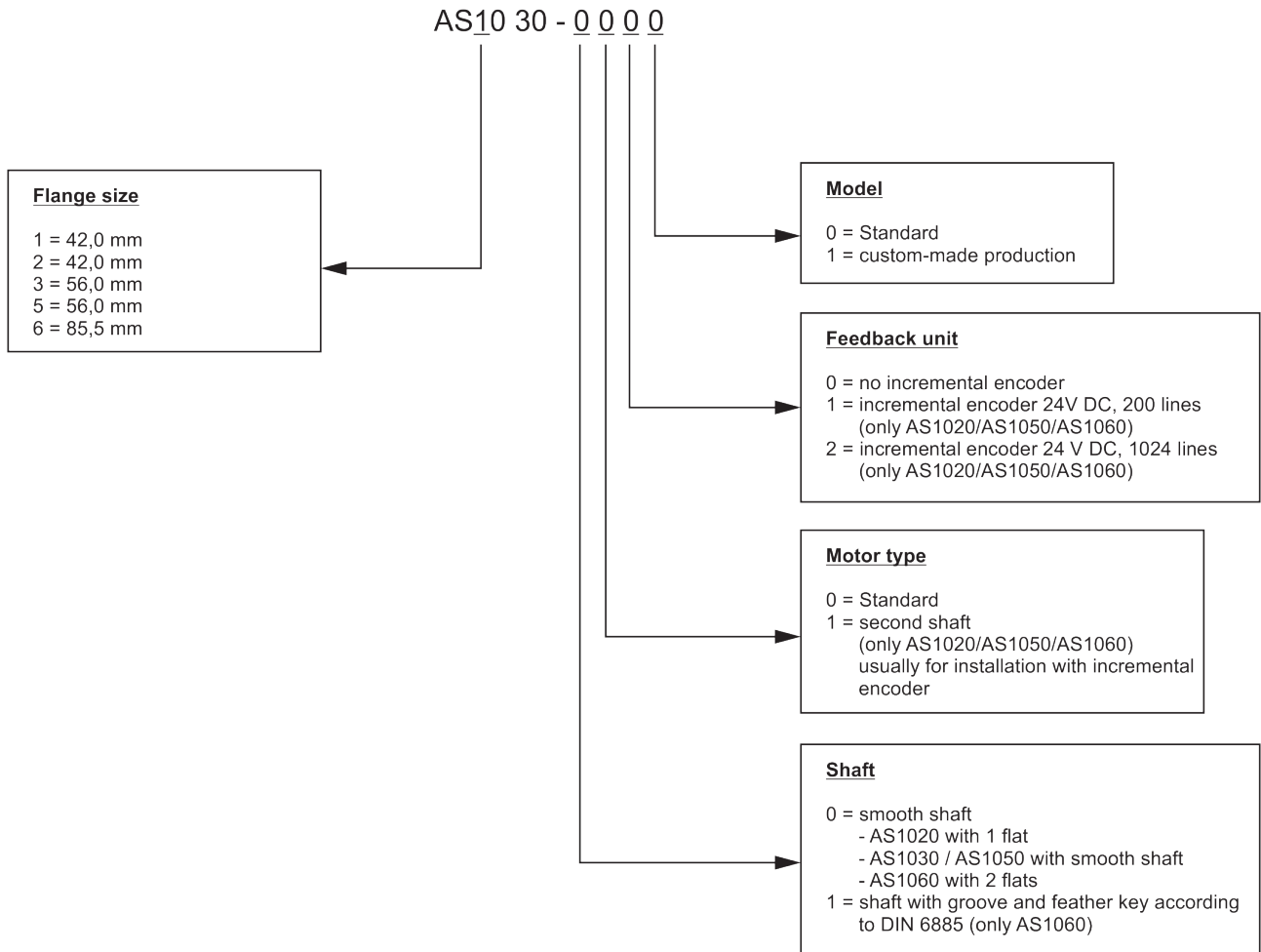
The following accessories are available on request:

- Second shaft end for AS1020, AS1050 and AS1060
- Encoder with connection cable and 5-pin, screened M12 socket
- Preassembled motor and feedback cable
- Planetary gear, AG1000 series

### 6.2 AS1000 name plate



### 6.3 AS1000 type key

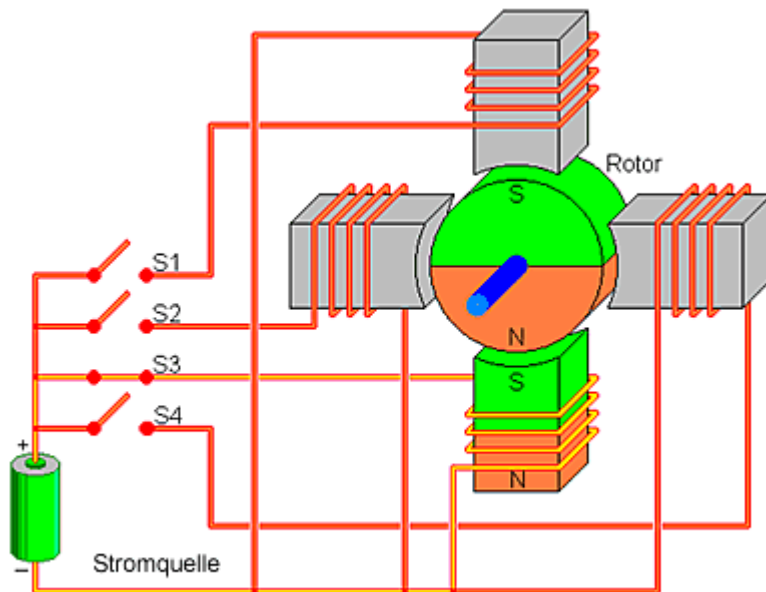




## 7 Technical description

### 7.1 Design of the motors

Beckhoff stepper motors of the AS1000 series are synchronous motors with a large number of poles. They are classified as direct drives. The stepper motors of the AS1000 series are characterized by a high holding torque and very good positioning capability. Thanks to sophisticated control of the stator windings in full-step or micro-step mode, individual steps or partial steps can be executed directly without a feedback system. This feature distinguishes stepper motors from servomotors, thus representing a cost-effective alternative approach. Excessive acceleration and fast load cycles can result in the stepper motor being unable to follow the rotating field and therefore "losing steps". The encoder option can improve matters in this situation.



The stepper motor has its highest torque in the lower speed range. At standstill, the stepper motor is characterized by a very high holding torque. In many applications, this eliminates the need for a holding brake. In the Beckhoff stepper motor terminals a suitable current curve can be stored for any speed or load profile. This serves to optimally adapt the thermal load of the motor. Beckhoff stepper motors are used as actuators or auxiliary axes in machine construction and automation applications. In conjunction with the stepper motor output stages and the Beckhoff TwinCAT automation system, this facilitates integration of cost-effective axes into the overall application. In order to simplify the electrical connection, the stepper motors are equipped with pre-assembled plug connectors. Planetary gear units, incremental encoders and pre-assembled connection cables are available as accessories.

## 7.2 General technical data

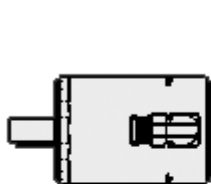
<b>Insulation class</b>	Class B (130°C) according to IEC60085
<b>Temperature change at rated current</b>	Max. 80 K
<b>Insulation resistance</b>	≥ 100 MΩ
<b>Permissible ambient temperature (operation)</b>	-10 °C to +50 °C
<b>Permissible ambient temperature (transport/storage)</b>	-25 °C to +70 °C
<b>Permissible air humidity</b>	20% to 90%, non-condensing
<b>Permissible level of contamination</b>	Contamination level 2 according to EN60204/EN50178
<b>Corrosion protection</b>	Under extreme operating conditions, special measures must be agreed with the manufacturer, and implemented by the user.
<b>Permissible operating altitude</b>	Up to 1000 m above sea level
<b>Maximum cable length between motor and terminal</b>	10 m
<b>Special operating conditions</b>	The applicability of the Beckhoff AS1000 stepper motor is to be determined for each individual case. Application in harsh operating or environmental conditions requires coordination between manufacturer and user.
<b>Correct installation position</b>	Horizontal or vertical
<b>Ventilation</b>	Ensure adequate ventilation of the motors.
<b>Protection class (doesn't apply to the shaft bushing)</b>	AS1010 – AS1050: IP43 AS1060: IP20

## 7.3 Standard features

### 7.3.1 Style

The design of the AS1010 and AS1020 stepper motors is intended for flange mounting based on installation types IM B14, IM V18 and IM V19.

The design of the AS1030/AS1050 and AS1060 stepper motors is intended for flange mounting based on installation types IM B5, IM V1 and IM V3.



IM B 5 (B5)  
IM B 14 (B14)



IM V 3 (V3)  
IM V 19 (V19)



IM V 1 (V1)  
IM V 18 (V18)

The permitted mounting positions are specified in the technical data.



**Attention**

#### **Destruction of the motors**

Installation positions IM V1 and IM V3 may result in liquid entering the motor and associated damage.

### 7.3.2 Shaft end, A-side

The force transfer is friction-locked (backlash-free), via a clutch, via the cylindrical shaft end A, or optionally as a form-locking connection via a feather key groove according to DIN6885.

**Radial force**

If the motors drive via pinions or toothed belts, then high radial forces will occur.

**Axial force**

Axial forces occur when assembling pinions or pulleys on the shaft.

**Coupling**

Double-coned collets, possibly in association with metal bellows couplings, have proven themselves as excellent, zero backlash coupling elements.

### 7.3.3 Flange

Flange dimensions according to IEC standard, fit j6, accuracy according to DIN 60034-7

Tolerance class: **N**

### 7.3.4 Connection technology

The motors are equipped with connecting cables (300 mm) and M12 connectors for the power supply and the feedback signals (encoders only).

The mating connectors are not included in the scope of supply. Ready-made extension cables in different lengths are available as accessories.

### 7.3.5 Feedback system


Feedback system	Resolution	Comment
Incremental encoders	200 increments	Only for AS1020/AS1050/AS1060
Incremental encoders	1024 increments	Only for AS1020/AS1050/AS1060

## 7.4 Options

**Feather key**

Only the AS1060 is optionally available with groove and feather key.

## 7.5 Transport, assembly and disassembly

 <b>CAUTION</b>	<p><b>Personal injuries!</b></p> <p>Protective clothing, protective gloves and safety boots must be worn at all times during transport, assembly and disassembly. Do not step under suspended motors.</p>
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The motors of the AS1000 series can be moved without auxiliary equipment.

## 8 Mechanical installation

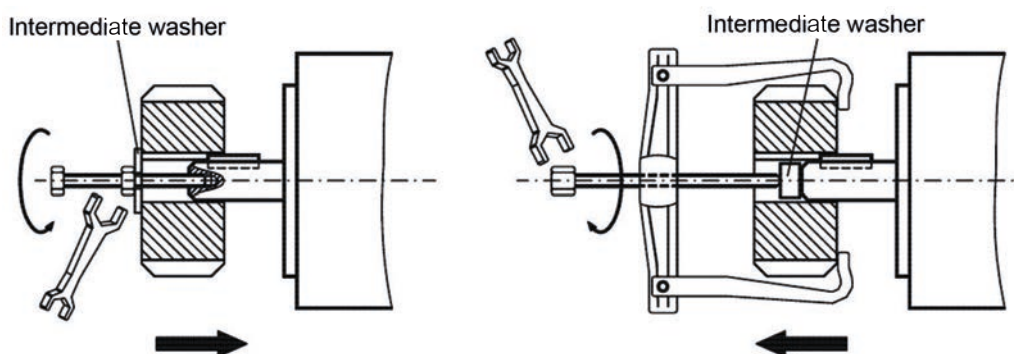
### 8.1 Important notes



#### Attention

#### Destruction of the motors

- Protect the motors from unacceptable stresses. Take care, especially during transport and handling, that components are not bent and that insulation clearances are not altered.
- The site must be free of conductive and aggressive material. For V1/V3-mounting (shaft end upwards), make sure that no liquids can enter the bearings. If an encapsulated assembly is required, please consult our applications department beforehand.
- Ensure unhindered ventilation of the motors and observe the permissible ambient and flange temperatures. For ambient temperatures above 50 °C please consult our applications department beforehand.
- Stepper motors are precision devices. The flange and shaft are especially vulnerable during storage and assembly. It is important to use the locking thread which is provided to tighten up couplings, gear wheels or pulleys and warm up the drive components, where possible. Blows or the use of force will lead to damage to the ball bearings, the shaft, the holding brake and the feedback system.



- Wherever possible, use only backlash-free, frictionally-locking collets or couplings. Ensure correct alignment of the couplings. A displacement will cause unacceptable vibration and the destruction of the ball bearings and the coupling.
- For toothed belts, it is vital to observe the permissible radial forces. An excessive radial load on the shaft will significantly shorten the service life of the motor.
- Avoid axial loads on the motor shaft, as far as possible. Axial loading significantly shortens the service life of the motor and can result in malfunction of the brake.
- In any case, avoid creating a mechanically constrained motor shaft mounting by using a rigid coupling with additional external bearings (e.g. in a gearbox).
- Check compliance with the permitted radial and axial loads  $F_R$  and  $F_A$ . When using a toothed belt drive, the **minimum** permitted diameter of the pinion follows from the equation:

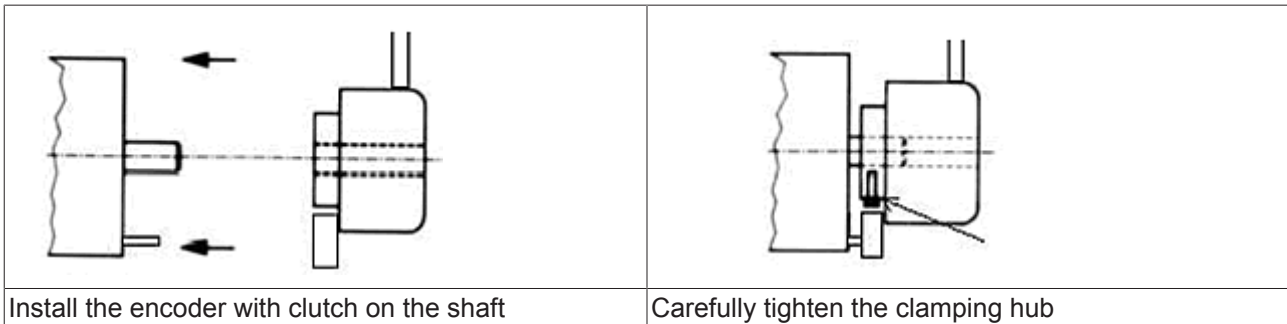
$$d_{\min} \geq \frac{M_0}{F_R} \times 2$$

## 8.2 Installing the stepper motor

When assembling, make sure that the fastening of the stepper motor is not mechanically overdetermined. Avoid warping, particularly when assembling the shaft.

## 8.3 Installing the incremental encoder (type 2420)

If the stepper motor is ordered with the incremental encoder, the motor and the encoder are fitted in the factory. Retrospective installation of the encoder is only possible, if the stepper motor was ordered with a second shaft end and a hole for the locating pin. The locating pin provides torque support and must be secured with industrial adhesive (e.g. Loctite).



### 8.3.1 Technical data of the encoder

Stepper motors are designed for positioning tasks. Beckhoff stepper motors have a step angle of 1.8° (which is 200 steps/rotation). Stepper motor terminals enable each individual step to be approached. This enables positioning without feedback / encoder. The micro-stepping mode of the stepper motor terminal can be used to improve the physical resolution further. This causes the physical resolution to be multiplied by the micro-step factor. The stepping pattern can be adjusted from full steps, through half steps down to 64 micro-steps. It is possible that, when overloaded, a stepper motor cannot keep up with the desired number of steps. This is referred to as the stepper motor "losing steps". It is therefore possible, optionally, to add an incremental encoder. This requires a second shaft end at the stepper motor.

For stepper motors with incremental encoder, the stepper motor output stage KL2541 / EL7041 / EL7037 or EP7041-3002 must be used.

Mechanical properties for 200 and 1024 steps per revolution	
Speed	Max. 6,000 rpm
Moment of inertia of the rotor	Approx. $0.1 \times 10^{-6} \text{ kgm}^2$
Starting torque	< 0.01 Nm
Weight	Approx. 0.06 kg
Protection class according to EN 60 529	IP 64 (for housing)
Working temperature range	-20 °C...+75 °C
Operating temperature range	-20 °C...+80 °C
Shaft	Shaft: Brass Housing: Aluminium
Shock resistance	In accordance with DIN-IEC 68-2-27: 1000 m/s <sup>2</sup> , (6 ms)
Vibration resistance	In accordance with DIN-IEC 06/02/1968: 100 m/s <sup>2</sup> , (10 to 2000 Hz)

Electrical properties for 200 and 1024 steps per revolution	
Output circuit	push-pull
Supply voltage	11 ... .30 V <sub>DC</sub>
Current consumption (no load)	Standard: 45 mA Maximum 150 mA
Permitted load/channel	± 30 mA
Pulse frequency	Max. 200 kHz
Signal level high	Min. UB-3 V
Signal level low	Max. 2,5 V
Rise time tr	Max. 1 μs
Fall time tf	Max. 1 μs
Short-circuit protected outputs	Yes
CE conform	according to EN 61000-6-1, EN 61000-6-2, EN 61000-6-3 and EN 61000-6-4

## 8.4 Installing the planetary gear

If the stepper motor is ordered together with the planetary gear, the motor and the gear unit are fitted in the factory. For retrospective installation please note the following:

- The planetary gear of the AG1000-xxxx series are supplied with a separate adapter shaft and integrated sun wheel.
- Slide the adapter shaft onto the stepper motor shaft up to the end stop and secure it with a heat resistant, industrial adhesive (e.g. Loctite).
- Before applying the adhesive to the adapter shaft, clean the motor shaft with a suitable solvent.
- A cotter pin (not included) can be inserted through the mounting hole.
- Slide the gear unit onto the adapter shaft. Screw the gear flange to the motor flange. Ensure the screws are tightened evenly to avoid tensions in the component.

### 8.4.1 Technical data of the planetary gear units

Beckhoff offers planetary gears for stepper motors in order to increase the torque or to improve the mass inertia ratio. Stepper motors whose flanges have dimensions of 56 mm or above can be fitted with low-play planetary gears.




	AG1000-+PM052.00x	AG1000-+PM081.00x
Rated torque	4 Nm	20 Nm
Acceleration torque	6 Nm	30 Nm
Gear play	≤ 0,7°	≤ 0,5°
Max. radial power	200 N	400 N
Max. axial power	60 N	80 N
Stepper motors	AS1030 and AS1050	AS1060
Fastening screws	4 x M4	4 x M6
Tightening torque	2.8 Nm	9 Nm

x = ratio 4 (3.7 exactly or 63/17 as a fraction), ratio 7 (6.75 exactly or 27/4 as a fraction)

Gear rim and planet wheels in steel design, straight-toothed. Lubricant Klübersynth GE14-151

## 9 Electrical installation

### 9.1 Important notes

 <p><b>DANGER</b></p>	<p><b>Serious risk of injury through electric shock!</b></p> <ul style="list-style-type: none"> <li>• Only staff qualified and trained in electrical engineering are allowed to wire up the motor.</li> <li>• Check the assignment of the stepper motor output stage and the motor. Compare the rated voltage and the rated current of the devices.</li> <li>• Always make sure that the motors are de-energized during assembly and wiring, i.e. no voltage may be switched on for any piece of equipment which is to be connected. Ensure that the control cabinet remains turned off (barrier, warning signs etc.). The individual voltages will only be turned on again during commissioning.</li> <li>• Control and power leads may be live, even if the motor is not running.</li> </ul>
 <p><b>Attention</b></p>	<p><b>Smooth operation</b></p> <ul style="list-style-type: none"> <li>• Ensure that the motor is grounded properly. See below for further information regarding EMC shielding and earthing. Earth the mounting plate and motor housing. Further details of connection types can be found in Section 8.2</li> <li>• Use only cables approved by Beckhoff for use with the AS1000 stepper motors.</li> <li>• Wiring: <ul style="list-style-type: none"> <li>⇒ Connecting the feedback cable (optional)</li> <li>⇒ Connect the motor cables</li> <li>⇒ Shielding at both ends (shield terminal or EMC plug)</li> </ul> </li> </ul>
 <p><b>Attention</b></p>	<p><b>HF interference</b></p> <ul style="list-style-type: none"> <li>• The ground symbol , which you will find in the wiring diagrams, indicates that you must provide an electrical connection, with as large a surface area as possible, between the unit indicated and the mounting plate in the control cabinet. This connection is to suppress HF interference and must not be confused with the PE (protective earth) symbol (protective measure according to EN 60204). Follow the instructions in the circuit diagrams in Sections 8.3 to 8.6</li> </ul>

## 9.2 Connection of motors with preassembled cables

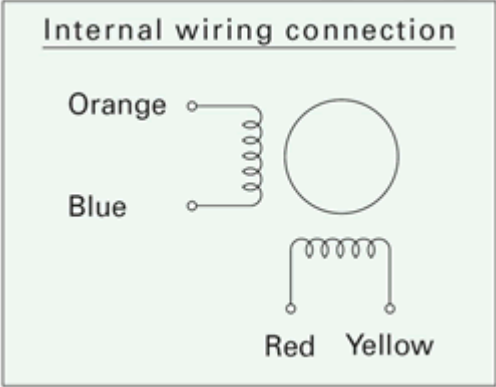

Beckhoff offers preassembled motor and feedback cables for safe, faster and flawless installation of the motors. Beckhoff cables have been tested with regard to the materials, shielding and connectors used. They ensure proper functioning and compliance with statutory regulations such as EMC, UL etc. The use of other cables may lead to unexpected interference and invalidate the warranty.

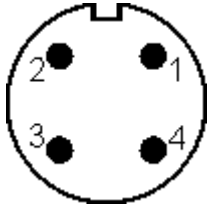
- Carry out the wiring in accordance with the valid standards and regulations.
- Only use our preassembled shielded cables for the power and feedback connections.
- The shielding should match the specifications in sections 8.4 to 8.10. Incorrectly installed shielding inevitably leads to EMC interference.
- The motor connector and the mating connector of the Beckhoff motor cable is a special version with 5 A current-carrying capacity. The use of other M12 connector can lead to overload.



## 9.3 Electrical components


### 9.3.1 Motor connector

Motor winding	Motor connector
 <p>Internal wiring connection</p> <p>Orange</p> <p>Blue</p> <p>Red Yellow</p>	 <p>View X</p>
<p>The stepper motors are equipped with a 300 mm long connection cable and a preassembled M12 connector plug.</p>	

Contact	Color of conductor	Signal	Round connector – 4-pin (view “x”)
1	Red	Phase 1	
2	Yellow	Phase 2	
3	Orange	Phase 3	
4	Blue	Phase 4	

### 9.3.2 Encoder connector

The optional encoder is equipped with a 300 mm long, screened connection cable and a screened, preassembled M12 connector plug.

Pin	Color of conductor	Signal	Round connector – 5-pin (view “X”)
1	White	0 V	
2	Brown	+Ub	
3	Green	Track A	
4	Yellow	Track B	
5	Grey	Track 0	

## 9.4 Connection diagram KL2531

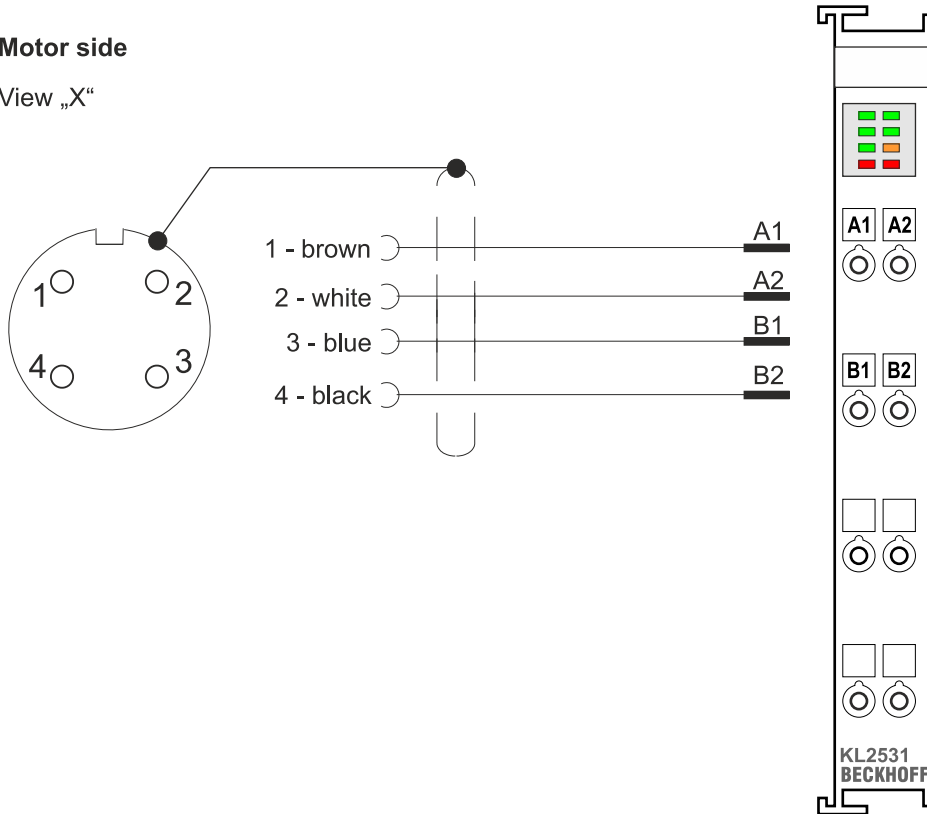
### Stepper motor terminal KL2531

for AS1010, AS1020 and AS1030 without incremental encoder

Motor cable

Motor side

View „X“



### Motor cable ZK4000-6700-2xxx

assembled at both ends, (4 x 0,5 mm<sup>2</sup>), shielded



## 9.5 Connection diagram KL2541

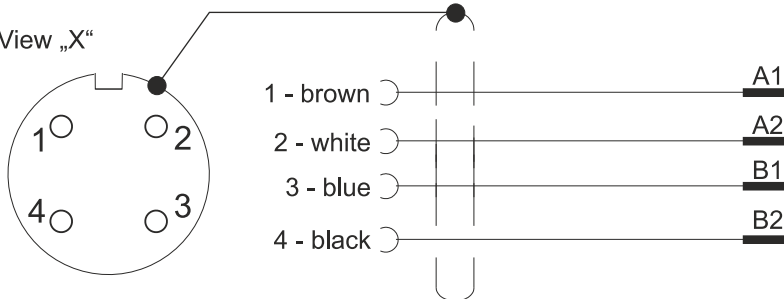
### Stepper motor terminal KL2541

for AS1020, AS1050 and AS1060 with incremental encoder

Motor cable

Motor side

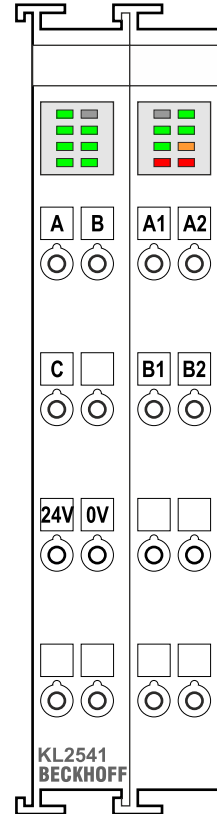
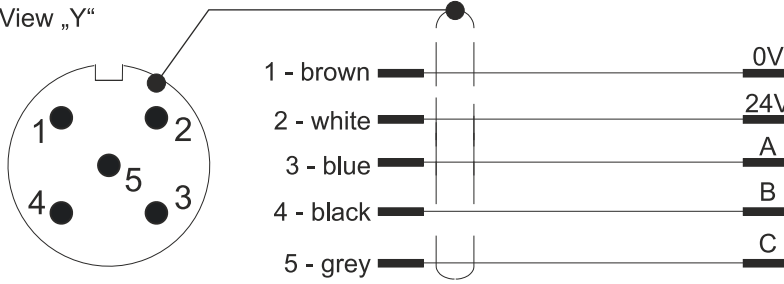
View „X“



Encoder cable

Encoder side

View „Y“



### Motor cable ZK4000-6700-2xxx

assembled at both ends, (4 x 0,5 mm<sup>2</sup>), shielded



### Encoder cable ZK4000-5100-2xxx

assembled at both ends, (5 x 0,25 mm<sup>2</sup>), shielded



## 9.6 Connection diagram EL7031

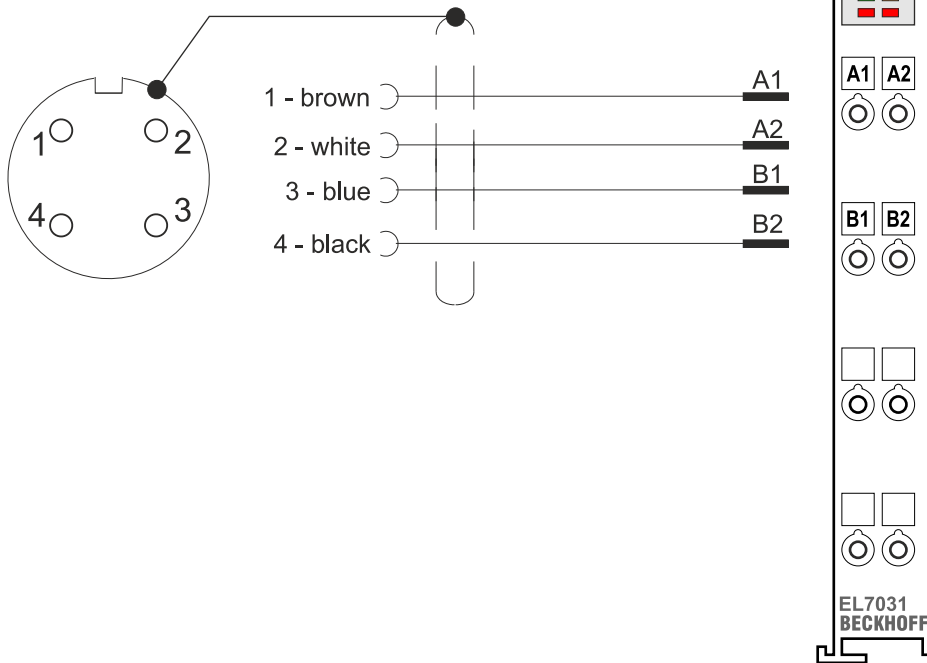
### Stepper motor terminal EL7031

for AS1010, AS1020 and AS1030 without incremental encoder

Motor cable

Motor side

View „X“



### Motor cable ZK4000-6700-2xxx

assembled at both ends, (4 x 0,5 mm<sup>2</sup>), shielded



## 9.7 Connection diagram EL7041

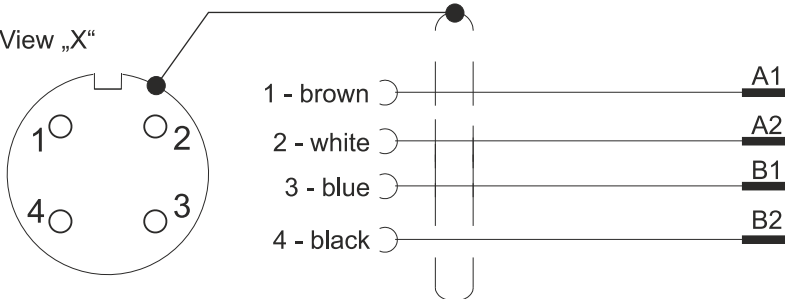
### Stepper motor terminal EL7041

for AS1020, AS1050 and AS1060 with incremental encoder

Motor cable

Motor side

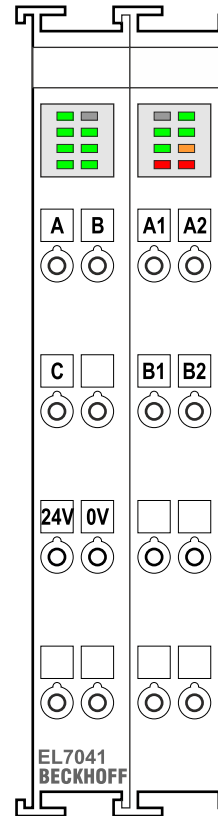
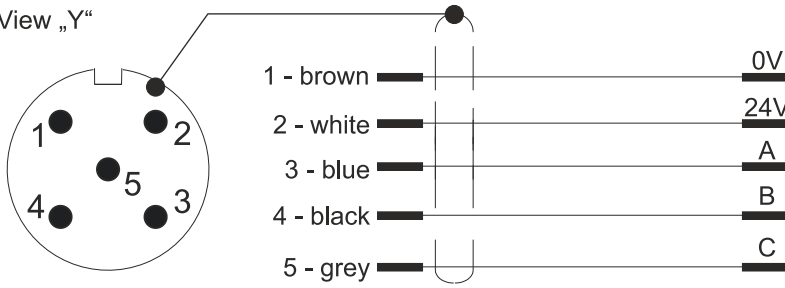
View „X“



Encoder cable

Encoder side

View „Y“



### Motor cable ZK4000-6700-2xxx

assembled at both ends, (4 x 0,5 mm<sup>2</sup>), shielded



### Encoder cable ZK4000-5100-2xxx

assembled at both ends, (5 x 0,25 mm<sup>2</sup>), shielded



## 9.8 Connection diagram EL7037

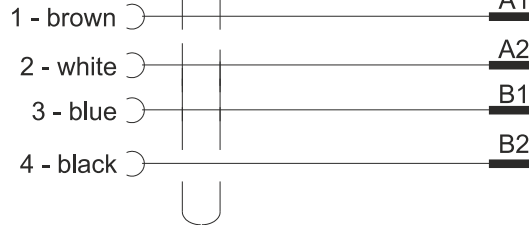
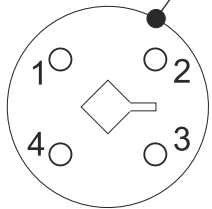
### Stepper motor terminal EL7037

for AS1020-0120 with incremental encoder for field-oriented control

Motor cable

Motor side

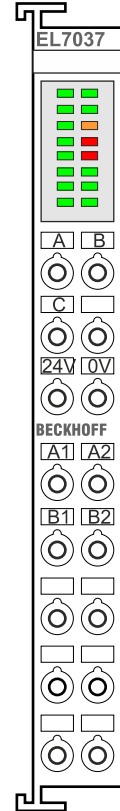
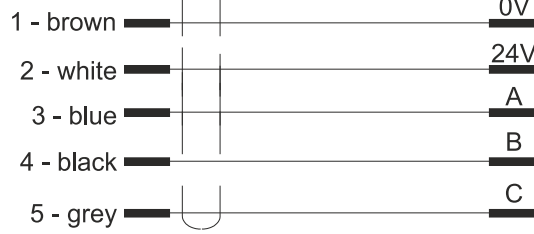
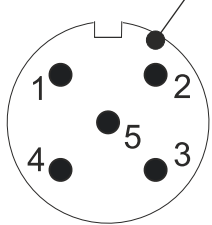
View „X“



Encoder cable

Encoder side

View „Y“



### Motor cable ZK4000-6700-xxxx

assembled at both ends, (4 x 0,5 mm<sup>2</sup>), shielded



### Encoderleitung ZK4000-5100-2xxx

assembled at both ends, (5 x 0,25 mm<sup>2</sup>), shielded



## 9.9 Connection diagram EL7047

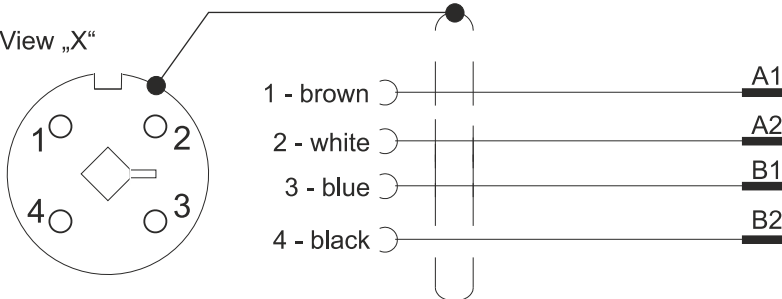
### Stepper motor terminal EL7047

for AS1020-0120, AS1050-0120, AS1060-0120 with incremental encoder for field-oriented control

Motor cable

Motor side

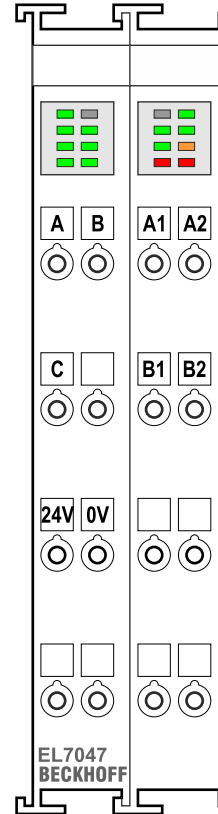
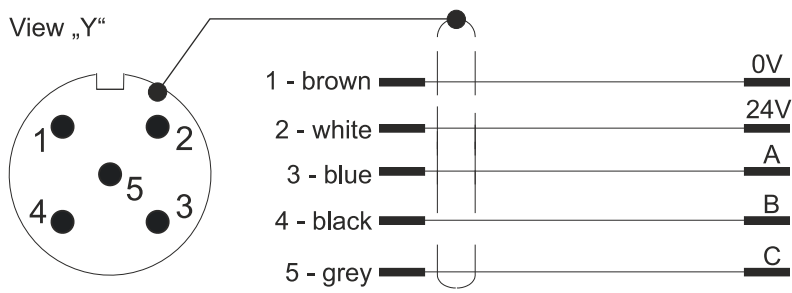
View „X“



Encoder cable

Encoder side

View „Y“



### Motor cable ZK4000-6700-2xxx

assembled at both ends, (4 x 0,5 mm<sup>2</sup>), shielded



### Encoder cable ZK4000-5100-2xxx

assembled at both ends, (5 x 0,25 mm<sup>2</sup>), shielded



## 9.10 Connection diagram EP7041-3002

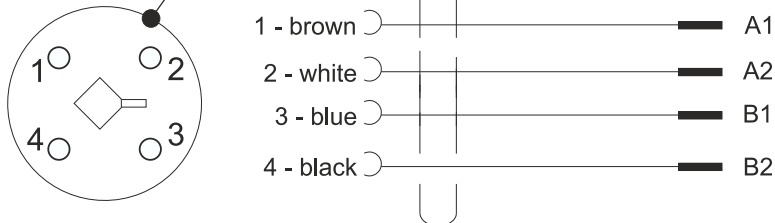
### Stepper motor terminal EP7041-3002

for AS1xxx with incremental encoder for highspeed-applications

Motor cable

Motor side

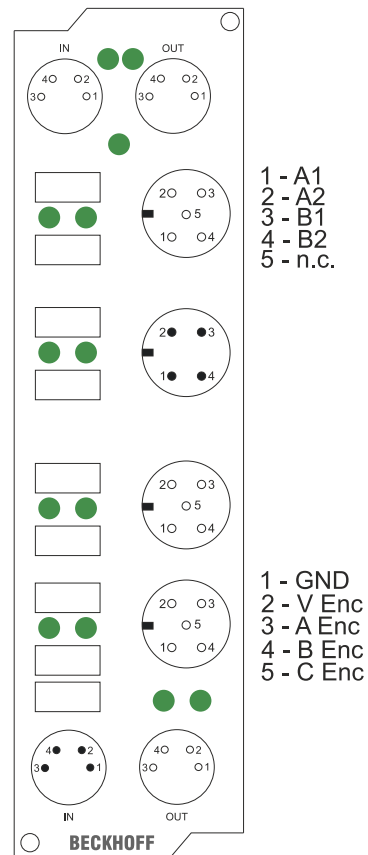
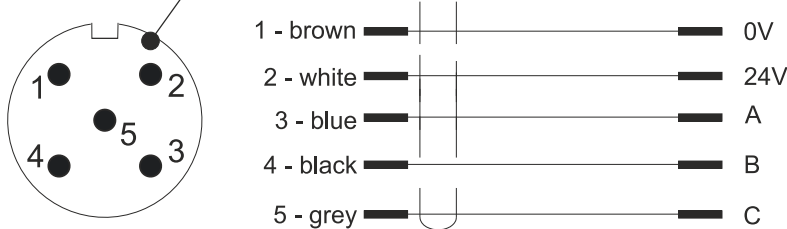
View „X“



Encoder cable

Encoder side

View „Y“



### Motor cable ZK4000-6261-xxxx

assembled on both ends, (4 x 0,5 mm<sup>2</sup>)



View X

### Encoder cable ZK4000-5151-xxxx

assembled on both ends, (5 x 0,35 mm<sup>2</sup>)





View Y



## 10 Commissioning

### 10.1 Important notes

 <p><b>DANGER</b></p>	<p><b>Serious risk of injury!</b></p> <ul style="list-style-type: none"> <li>• Only specialist personnel with extensive knowledge in the areas of electrical engineering / drive technology are allowed to install and commission the equipment.</li> <li>• The surface temperature of the motor can exceed 100 °C in operation. Check (measure) the temperature of the motor. Wait until the motor has cooled down below 40 °C before touching it.</li> <li>• Make sure that, even if the drive starts to move unintentionally, no danger can result for personnel or machinery.</li> </ul>
 <p><b>Attention</b></p>	<p><b>Overloading of the gear!</b></p> <p>With motor / gear combinations can in case of failure (mechanical blockage of the power train) due to high ratio, the gear will be overloaded.</p> <p><b>To prevent this, make sure that the motor rated torque and the motor peak torque is limited in the servo drive.</b></p> <p>Example:</p> <ul style="list-style-type: none"> <li>• Motor rated torque / motor peak torque: 1 Nm / 5 Nm</li> <li>• Gear rated torque / gear peak torque: 15 Nm / 24 Nm</li> <li>• Gear ratio: <math>i = 10</math></li> <li>• The motor rated torque is not limited. The motor peak torque is limited to 2,4 Nm.</li> </ul>

### 10.2 Guide for commissioning

The procedure for commissioning is described as an example.

A different method may be appropriate or necessary, depending on the application of the equipment.

- Check the assembly and orientation of the motor.
- Check the drive components (coupling, gear unit, pulley) for the correct seating and setting (observe the permissible radial and axial forces).
- Check the wiring and connections to the motor and the servo drive. Check that the earthing is correct.
- Check whether the rotor of the motor revolves freely (release the brake, if necessary). Listen out for grinding noises.
- Check that all the required measures against accidental contact with live and moving parts have been carried out.
- Carry out any further tests which are specifically required for your system.
- Now commission the motor according to the commissioning instructions.

## 10.3 Troubleshooting

The following table is to be seen as a “First Aid” box. There can be a large number of different reasons for a fault, depending on the particular conditions in your system. The fault causes described below are mostly those which directly influence the motor.

Our applications department can give you further help with your problems.

<b>Error</b>	<b>Possible cause</b>	<b>Measures to remove the cause of the fault</b>
Motor doesn't rotate	Break in setpoint lead Motor phases in wrong sequence Drive is mechanically blocked	Check setpoint lead Correct the phase sequence Check mechanism
Motor runs away	Motor phases in wrong sequence	Correct the phase sequence
Motor oscillates	Break in the shielding of the feedback cable Amplification to high	Replace the feedback cable Use motor default values
Error message: output stage fault	Motor cable has short circuit or earth leakage Motor has short circuit or earth leakage	Replace motor cable Replace motor
Error message: feedback	Connector is not properly plugged in Break in cable, cable crushed or similar	Check the plug connector Check cables

# 11 Technical data

All data valid for 40 °C ambient temperature and 100 K overtemperature of the winding. The data can have a tolerance of +/- 10%.

If a gear unit is attached the power may be reduced by up to 20 %. This loss in performance has thermal reasons, since a gear unit that is subject to warming is installed at the motor flange intended for heat dissipation.

## Term definitions

### Standstill torque $M_0$ [Nm]

The standstill torque can be maintained indefinitely at a speed  $n < 100$  rpm and rated ambient conditions.

### Rotor moment of inertia $J$ [kgcm<sup>2</sup>]

The constant  $J$  is a measure of the acceleration capability of the motor. For instance, at  $I_0$  the acceleration time  $t_b$  from 0 to 3000 rpm is given as:

$$t_b [S] = \frac{3000 \times 2\pi}{M_0 \times 60s} \times \frac{m^2}{10^4 \text{ cm}^2} \times J \quad \text{with } M_0 \text{ in Nm and } J \text{ in kgcm}^2$$

### Winding inductance $L$ [mH]

The winding inductance indicates the motor inductance. It is the average value for one motor revolution, with two energized phases, at 1 kHz. Saturation of the motor must be taken into account.

## 11.1 Step mode and limit speeds

The Beckhoff stepper motor terminals are capable of approx. 125,000 steps per second. Beckhoff stepper motors have a step angle of 1.8° or 200 steps per revolution.

Step mode	Limit speed [rpm]
Full step	37.500 (theoretical)
1/2	18.750 (theoretical)
1/4	9.375 (theoretical)
1/8	4,688 (theoretical)
1/16	2.344
1/32	1,171
1/64	585

In practice, the design and construction of the stepper motor limit the maximum speed of rotation. Normally, stepper motors are in fact only used for applications with rated rotation speeds well below 1000 per minute.

**11.2 AS1010-0000**

Technical data	Symbol [Unit]	AS1010
Rated supply voltage	$V_{DC}$	24 – 50
Rated current	A	1,0
Rated power	W	8,4
Standstill torque	$M_o$ [Nm]	0,38
Winding resistance Ph-Ph	$R_{20}$ [ $\Omega$ ]	4,10
Winding inductance Ph-Ph	L [mH]	9,50
Rotor moment of inertia	J [kg cm <sup>2</sup> ]	0,056
Resolution	[steps]	1,8° / 200 full steps
Weight	[kg]	0.31
Cogging torque	$M_r$ [Nm]	0.014 ~ 0.016

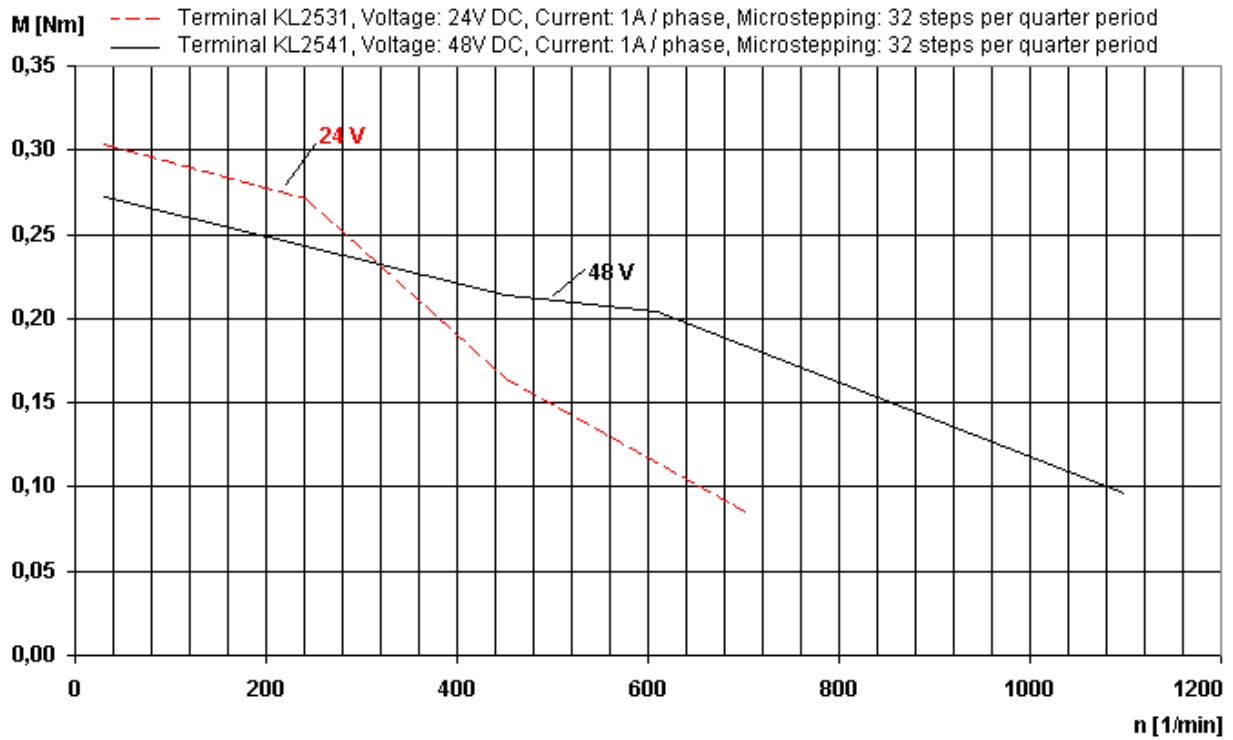
Mechanical data	Symbol [Unit]	AS1010
Axial load	[N]	10
Radial load 0 mm from the shaft end	[N]	22
Radial load 5 mm from the shaft end	[N]	26
Radial load 10 mm from the shaft end	[N]	33
Radial load 15 mm from the shaft end	[N]	46
Backlash at standstill	[°]	± 0,09
Axial backlash max. <sup>1)</sup>	[mm]	0,075
Radial backlash max. <sup>2)</sup>	[mm]	0,025
Bearing life	[h]	30.000

1) measured at a load of 4.4 N (AS1010 / AS1020)

2) measured at a load of 4.4 N

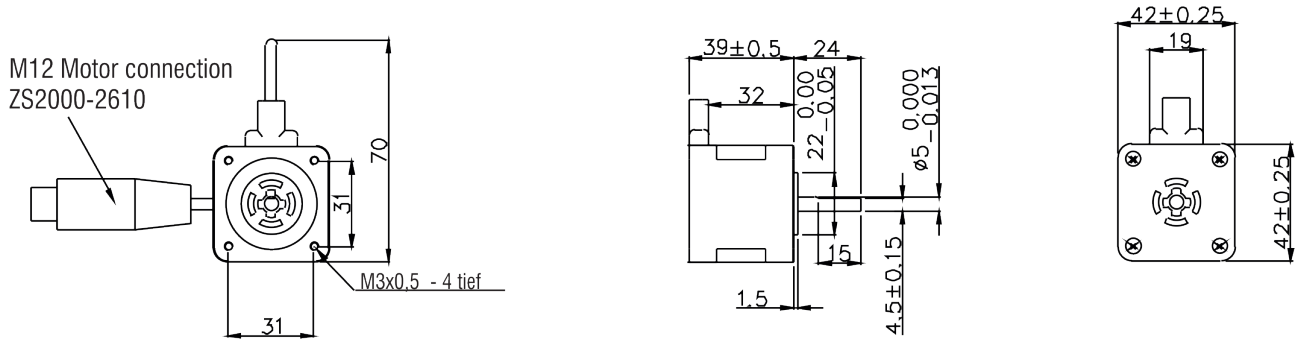
### 11.2.1 Characteristic curve diagram for AS1010-0000

#### Charakteristische Kurven des AS1010



## 11.2.2 Dimensional drawing AS1010-0000

AS1010-0000



### 11.3 AS1020-0xxx

Technical data	Symbol [Unit]	AS1020
Rated supply voltage	$V_{DC}$	24 – 50
Rated current	A	1,0
Rated power	W	10,0
Standstill torque	$M_o$ [Nm]	0,5
Winding resistance Ph-Ph	$R_{20}$ [ $\Omega$ ]	4,80
Winding inductance Ph-Ph	L [mH]	9,50
Rotor moment of inertia	J [kg cm <sup>2</sup> ]	0,074
Resolution	[steps]	1.8° / 200 full steps
Weight	[kg]	0,39
Cogging torque	$M_r$ [Nm]	0.019 ~ 0.023

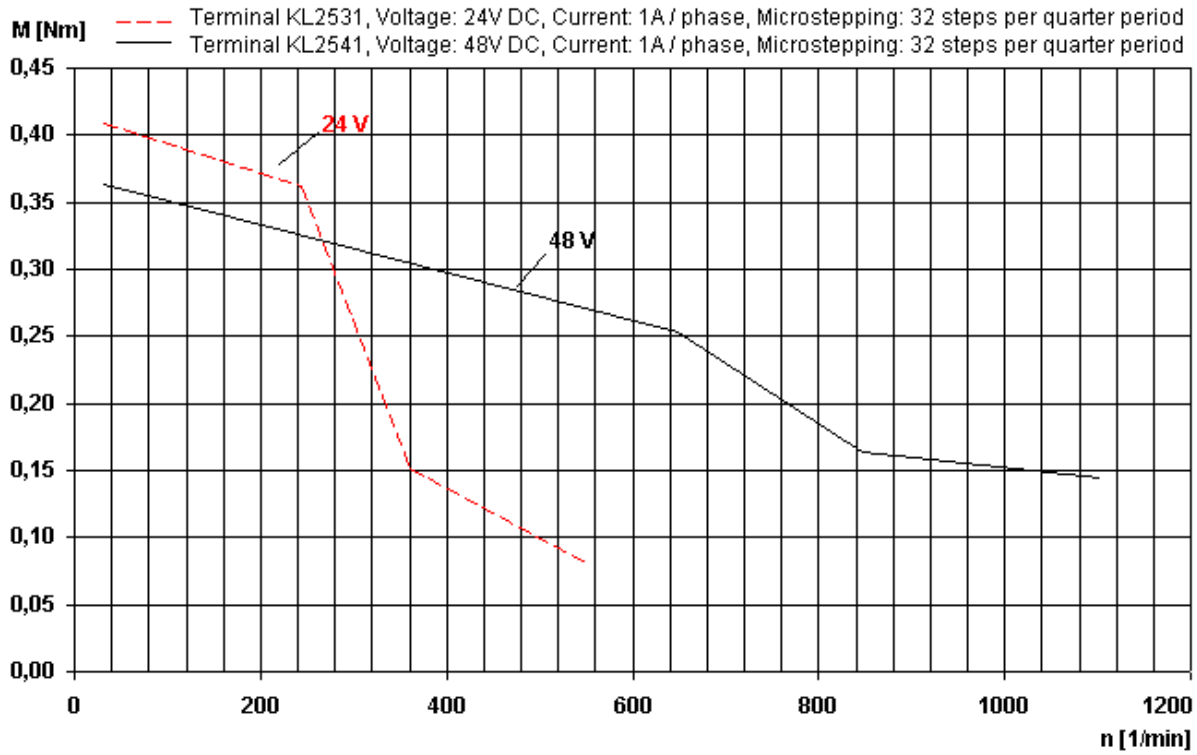
Mechanical data	Symbol [Unit]	AS1020
Axial load	[N]	10
Radial load 0 mm from the shaft end	[N]	22
Radial load 5 mm from the shaft end	[N]	26
Radial load 10 mm from the shaft end	[N]	33
Radial load 15 mm from the shaft end	[N]	46
Backlash at standstill	[°]	± 0,09
Axial backlash max. <sup>1)</sup>	[mm]	0,075
Radial backlash max. <sup>2)</sup>	[mm]	0,025
Bearing life	[h]	30.000

1) measured at a load of 9 N

2) measured at a load of 4.4 N

### 11.3.1 Characteristic curve diagram for AS1020-0xxx

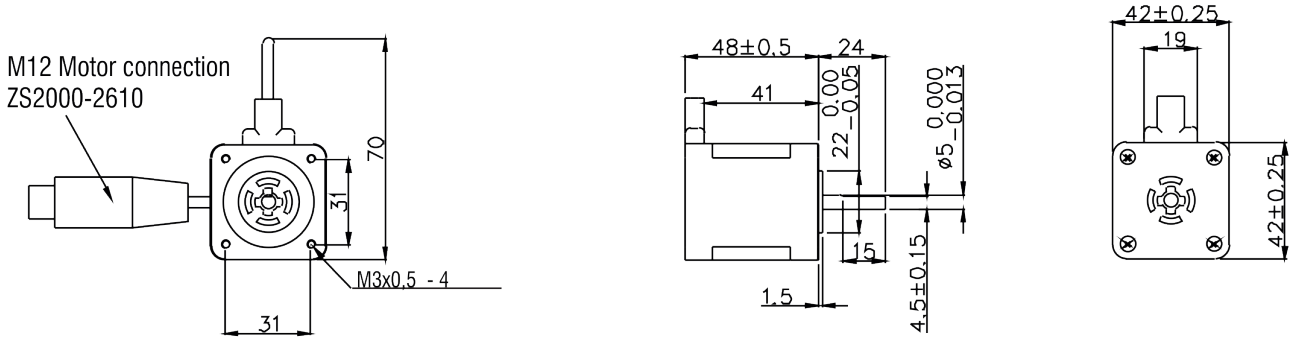
#### Charakteristische Kurven des AS1020



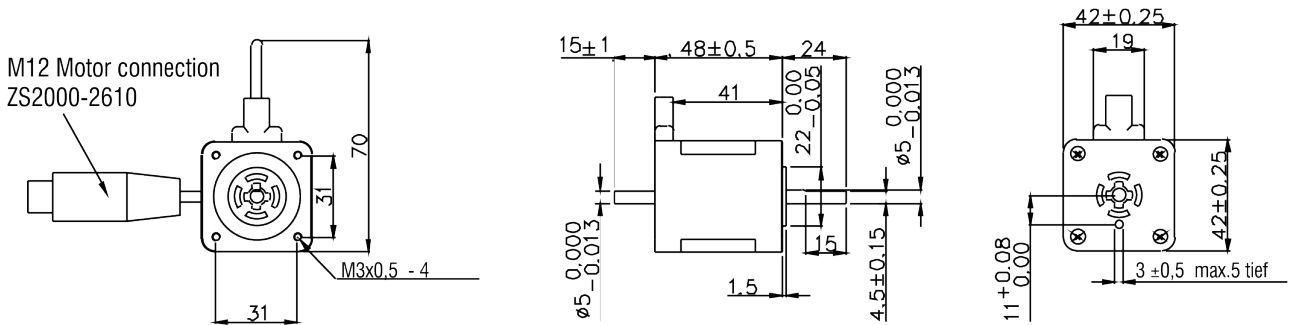


### 11.3.2 Dimensional drawing AS1020-0xxx

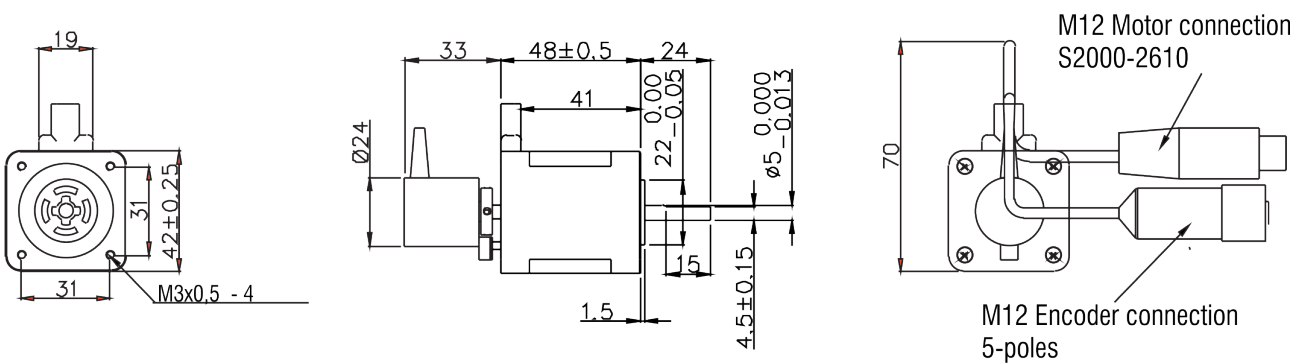
AS1020-0000



AS1020-0100



AS1020-0110



## 11.4 AS1030-0000

Technical data	Symbol [Unit]	AS1030
Rated supply voltage	$V_{DC}$	24 – 50
Rated current	A	1,5
Rated power	W	19,5
Standstill torque	$M_o$ [Nm]	0,6
Winding resistance Ph-Ph	$R_{20}$ [ $\Omega$ ]	0,80
Winding inductance Ph-Ph	L [mH]	3,80
Rotor moment of inertia	J [kg cm <sup>2</sup> ]	0,21
Resolution	[steps]	1.8° / 200 full steps
Weight	[kg]	0,68
Cogging torque	$M_r$ [Nm]	0.029 ~ 0.032

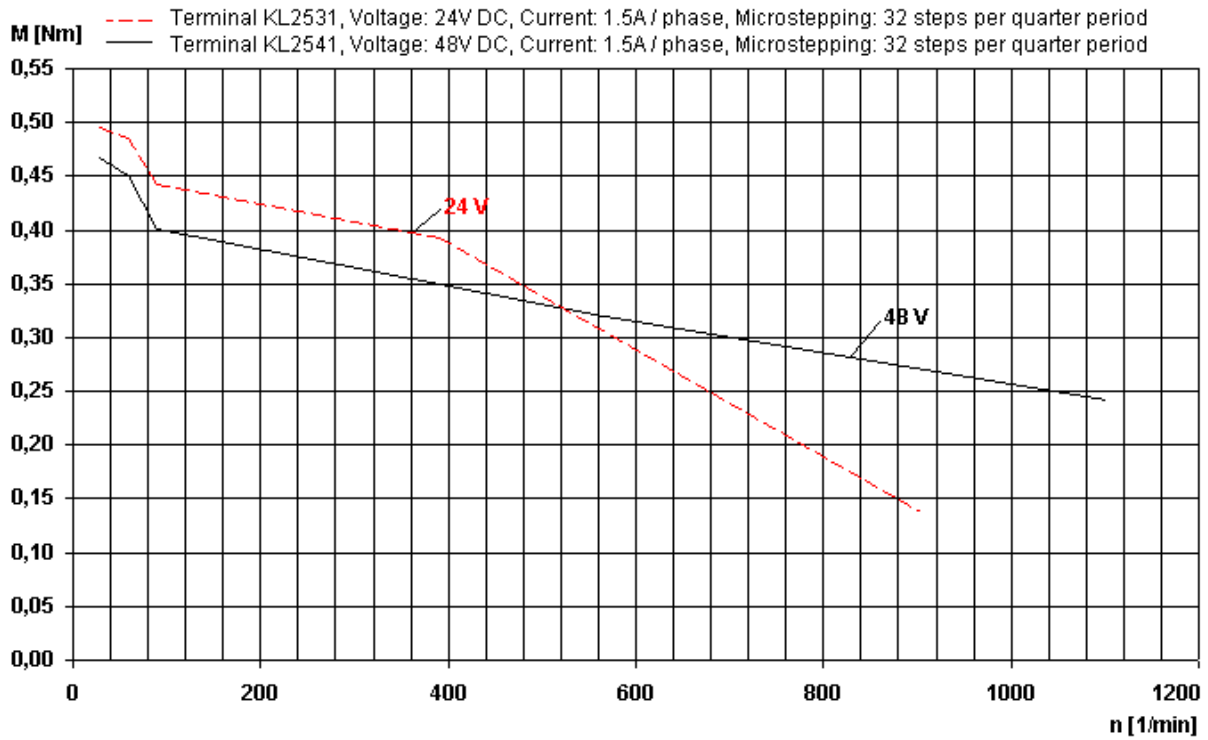
Mechanical data	Symbol [Unit]	AS1030
Axial load	[N]	15
Radial load 0 mm from the shaft end	[N]	52
Radial load 5 mm from the shaft end	[N]	65
Radial load 10 mm from the shaft end	[N]	85
Radial load 15 mm from the shaft end	[N]	123
Backlash at standstill	[°]	± 0,054
Axial backlash max. <sup>1)</sup>	[mm]	0,075
Radial backlash max. <sup>2)</sup>	[mm]	0,025
Bearing life	[h]	30.000

1) measured at a load of 9 N

2) measured at a load of 4.4 N

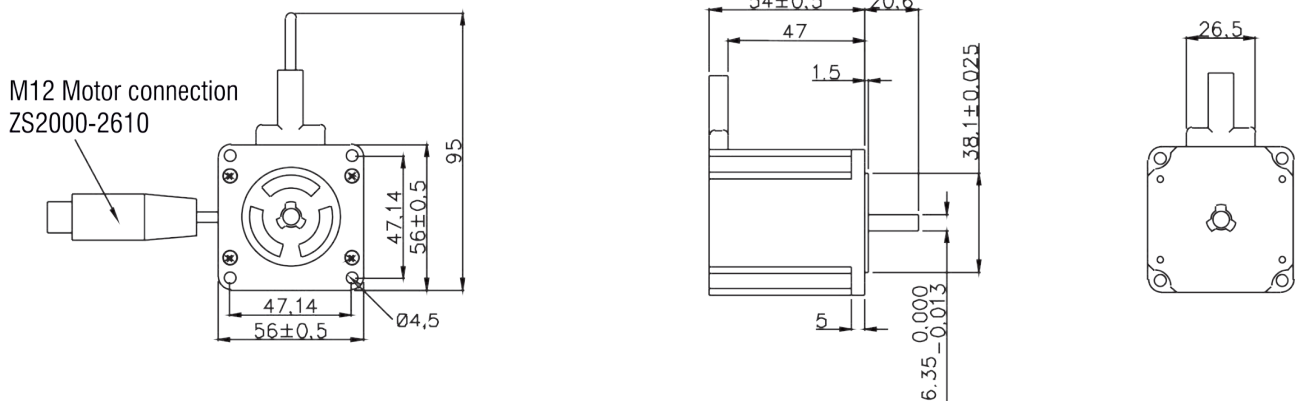
### 11.4.1 Characteristic curve diagram for AS1030-0000

#### Charakteristische Kurven des AS1030



### 11.4.2 Dimensional drawing AS1030-0000

AS1030-0000



## 11.5 AS1050-0xxx

Technical data	Symbol [Unit]	AS1050
Rated supply voltage	$V_{DC}$	24 - 50
Rated current	A	5,0
Rated power	W	27,5
Standstill torque	$M_o$ [Nm]	1,2
Winding resistance Ph-Ph	$R_{20}$ [ $\Omega$ ]	0,28
Winding inductance Ph-Ph	L [mH]	0,86
Rotor moment of inertia	J [kg cm <sup>2</sup> ]	0,36
Resolution	[steps]	1.8° / 200 full steps
Weight	[kg]	1,00
Cogging torque	$M_r$ [Nm]	0.046 ~ 0.058

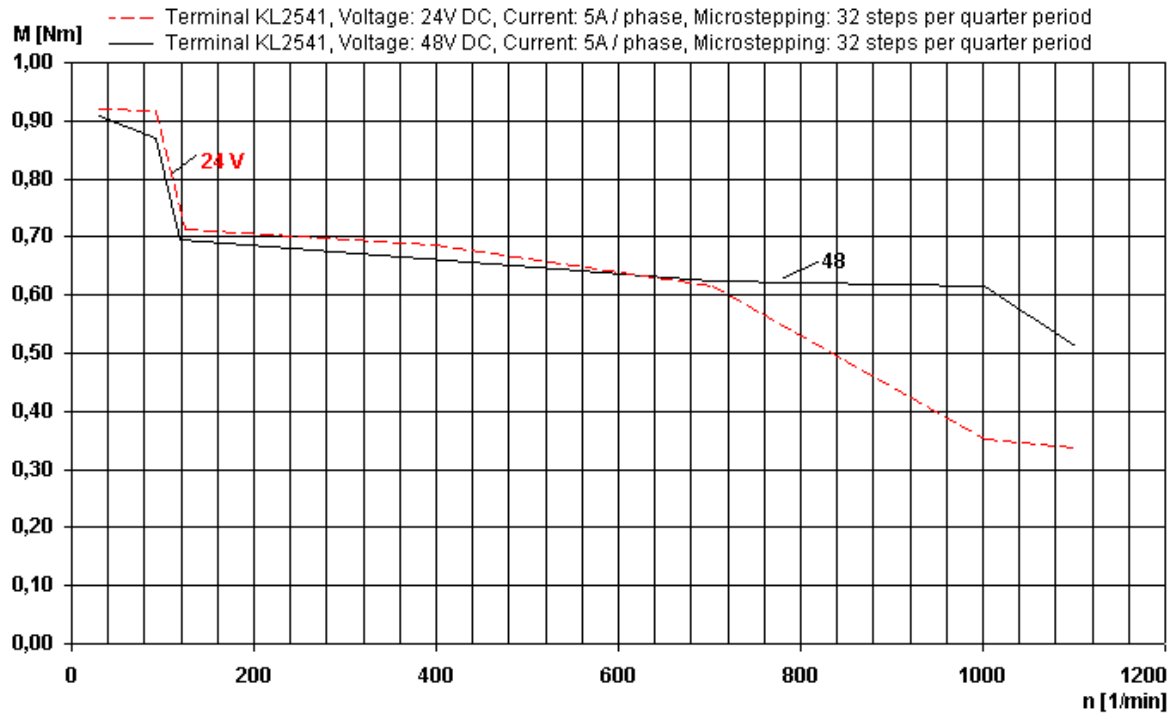
Mechanical data	Symbol [Unit]	AS1050
Axial load	[N]	15
Radial load 0 mm from the shaft end	[N]	52
Radial load 5 mm from the shaft end	[N]	65
Radial load 10 mm from the shaft end	[N]	85
Radial load 15 mm from the shaft end	[N]	123
Backlash at standstill	[°]	± 0,054
Axial backlash max. <sup>1)</sup>	[mm]	0,075
Radial backlash max. <sup>2)</sup>	[mm]	0,025
Bearing life	[h]	30.000

1) measured at a load of 9 N

2) measured at a load of 4.4 N

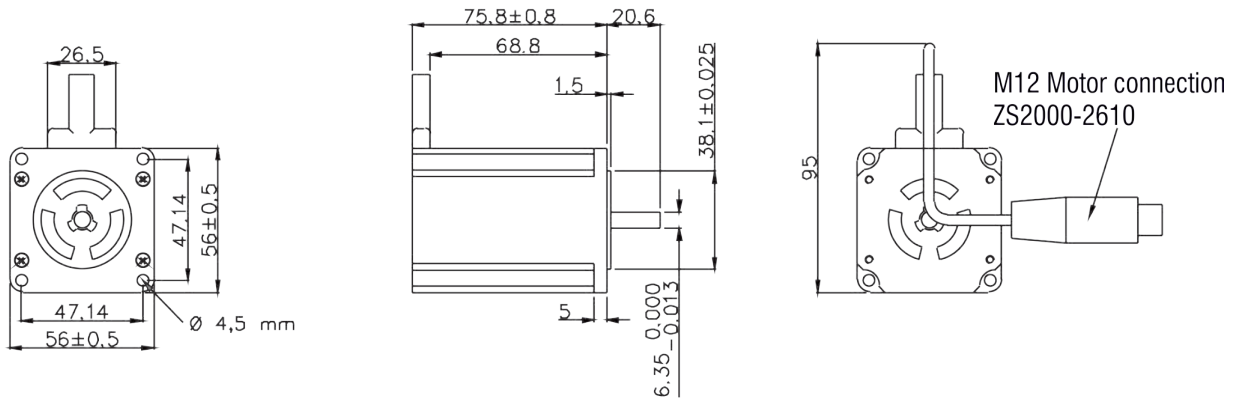
### 11.5.1 Characteristic curve diagram for AS1050-0xxx

#### Charakteristische Kurven des AS1050

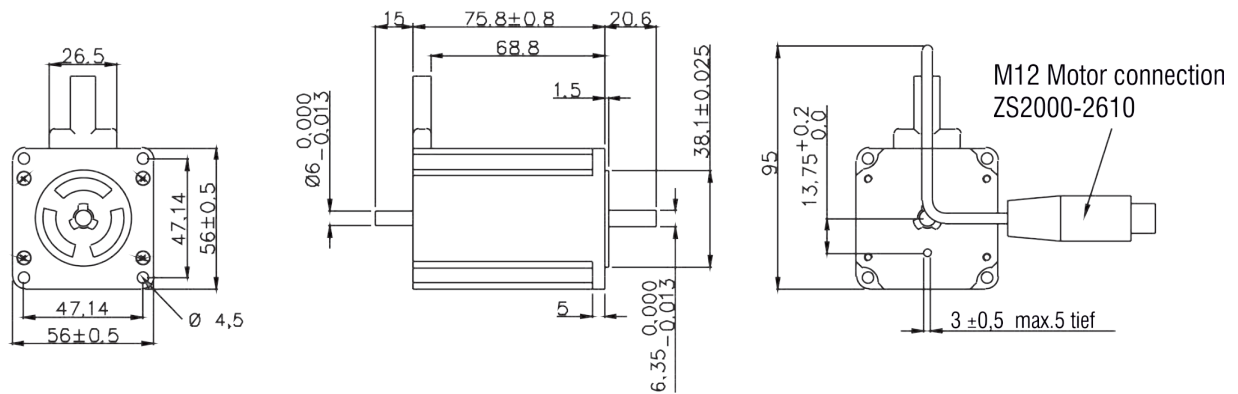


### 11.5.2 Dimensional drawing AS1050-0xxx

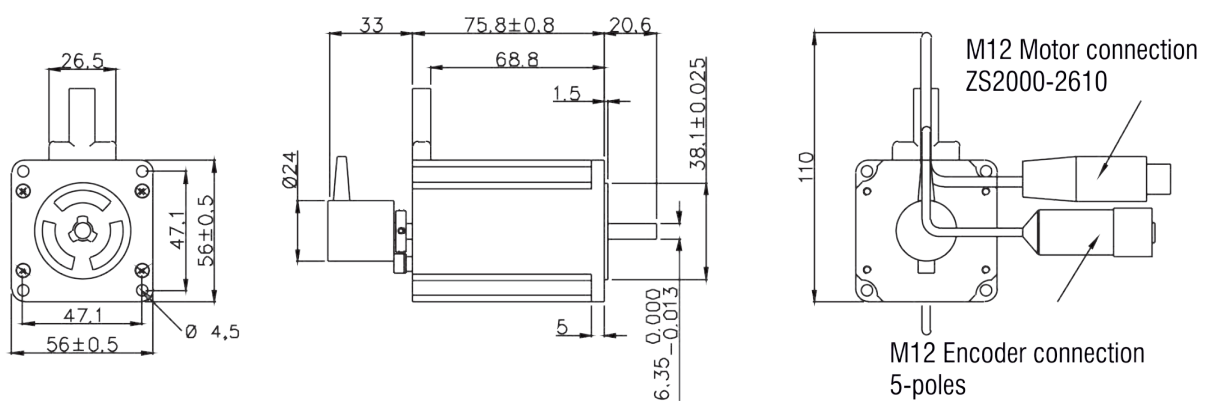
AS1050-0000



AS1050-0100



AS1050-0110



**11.6 AS1060-xxxx**

Technical data	Symbol [Unit]	AS1060
Rated supply voltage	$V_{DC}$	24 – 50
Rated current	A	5,0
Rated power	W	68,8
Standstill torque	$M_o$ [Nm]	5,0
Winding resistance Ph-Ph	$R_{20}$ [ $\Omega$ ]	0,36
Winding inductance Ph-Ph	L [mH]	2,80
Rotor moment of inertia	J [kg cm <sup>2</sup> ]	3,0
Resolution	[steps]	1.8° / 200 full steps
Weight	[kg]	2,85
Cogging torque	$M_r$ [Nm]	0.147 ~ 0.215

Mechanical data	Symbol [Unit]	AS1060
Axial load	[N]	60
Radial load 0 mm from the shaft end	[N]	191
Radial load 5 mm from the shaft end	[N]	234
Radial load 10 mm from the shaft end	[N]	301
Radial load 15 mm from the shaft end	[N]	421
Backlash at standstill	[°]	± 0,09
Axial backlash max. <sup>1)</sup>	[mm]	0,075
Radial backlash max. <sup>2)</sup>	[mm]	0,025
Bearing life	[h]	30.000

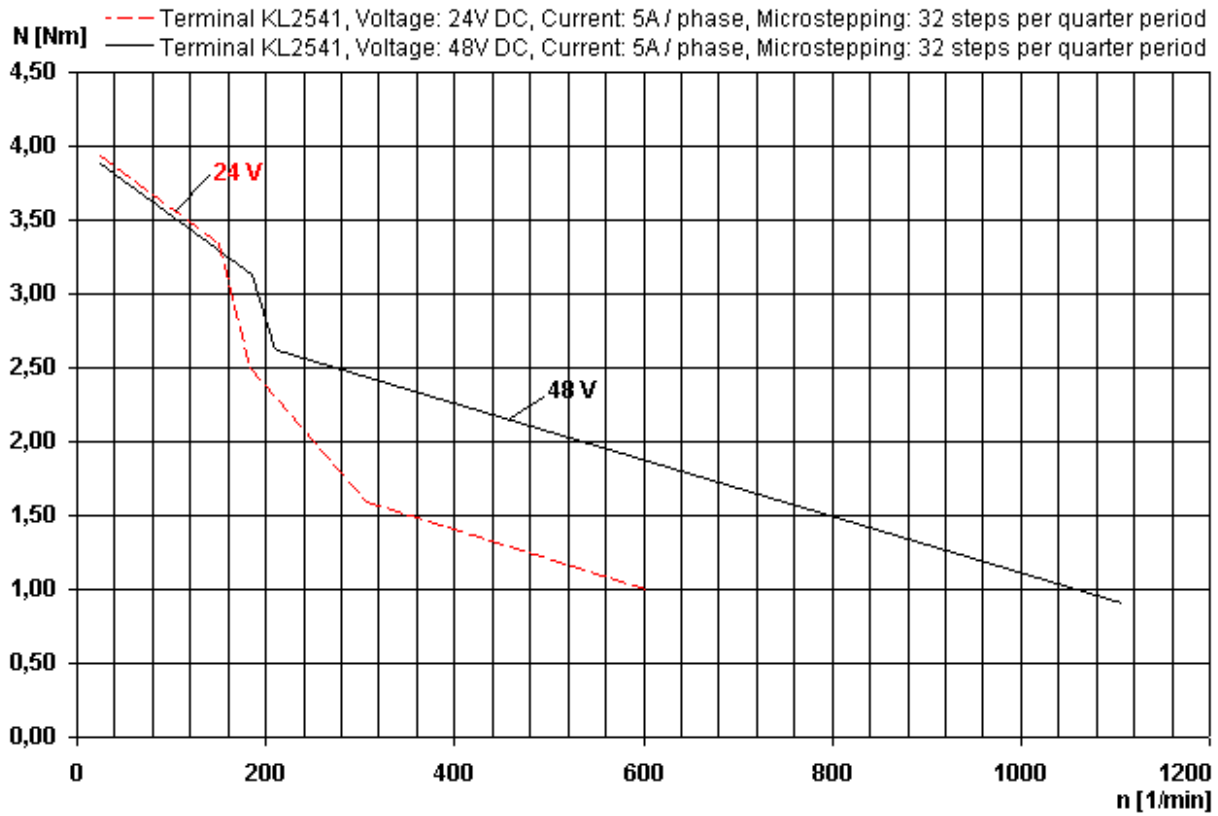
1) measured at a load of 9 N

2) measured at a load of 4.4 N



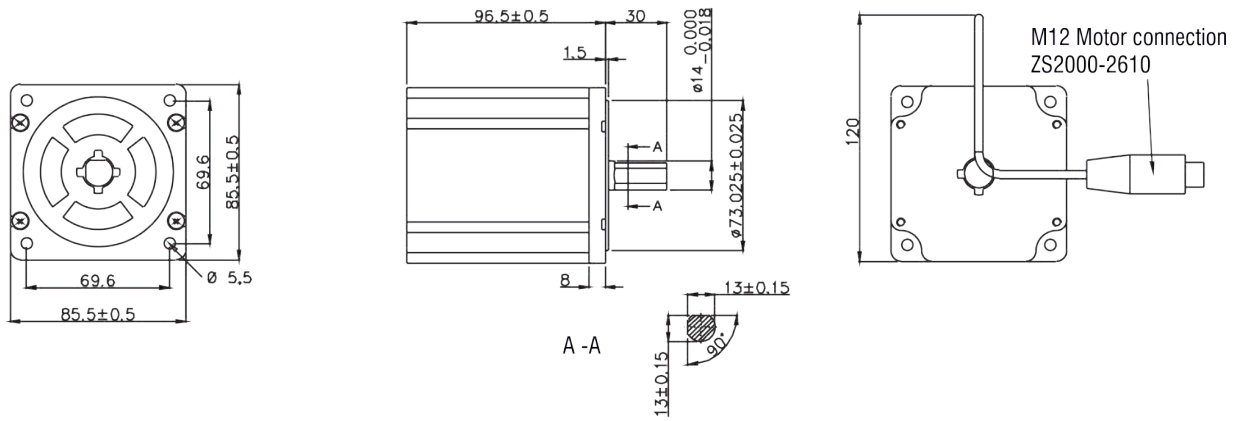
### 11.6.1 Characteristic curve diagram for AS1060-xxxx

#### Charakteristische Kurven des AS1060

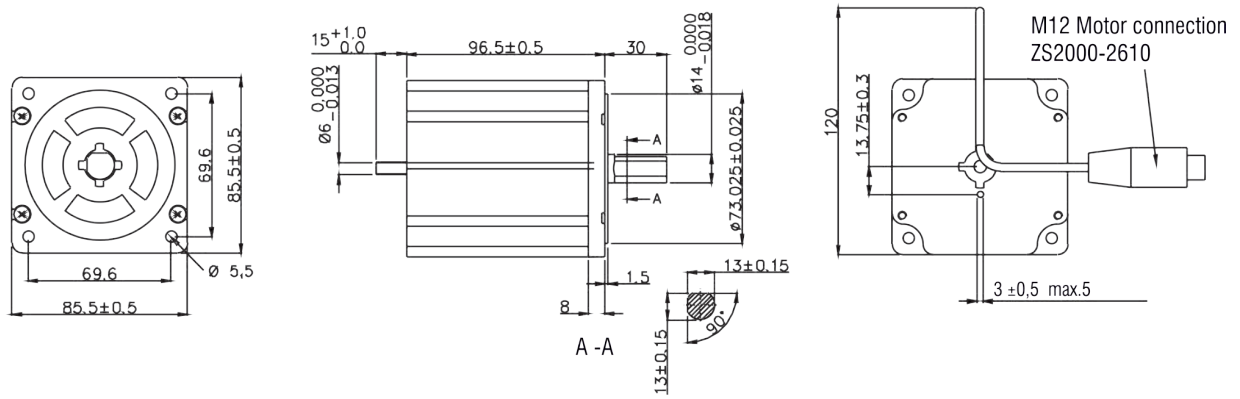


### 11.6.2 Dimensional drawing AS1060-0xxx

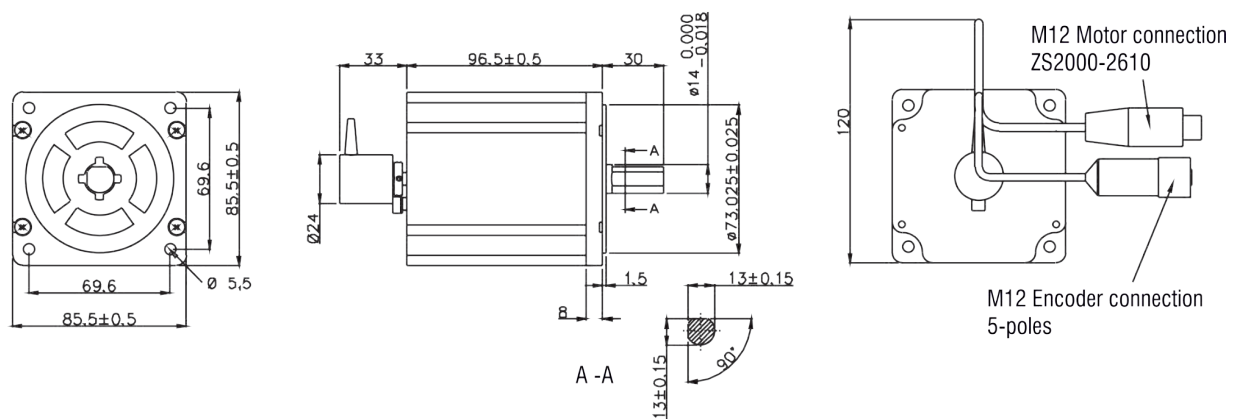
#### AS1060-0000



#### AS1060-0100

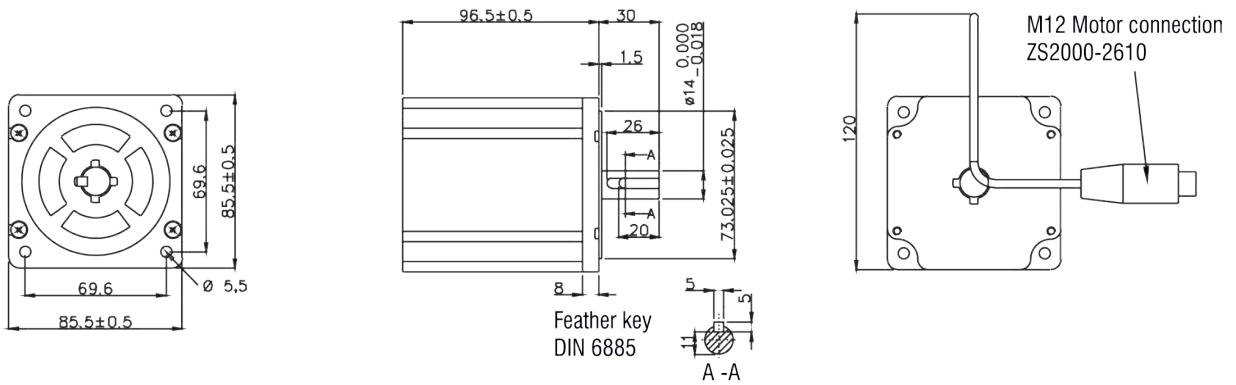


#### AS1060-0110

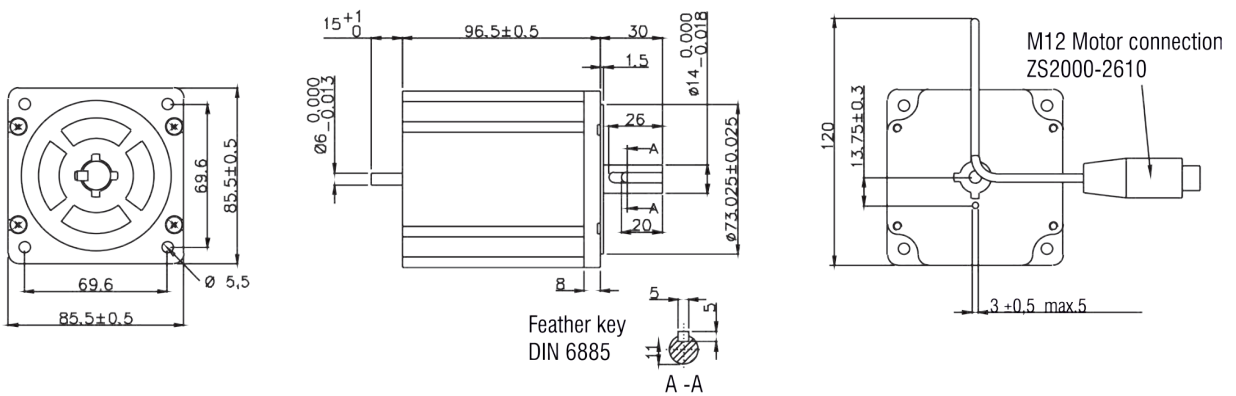


### 11.6.3 Dimensional drawing AS1060-1xxx

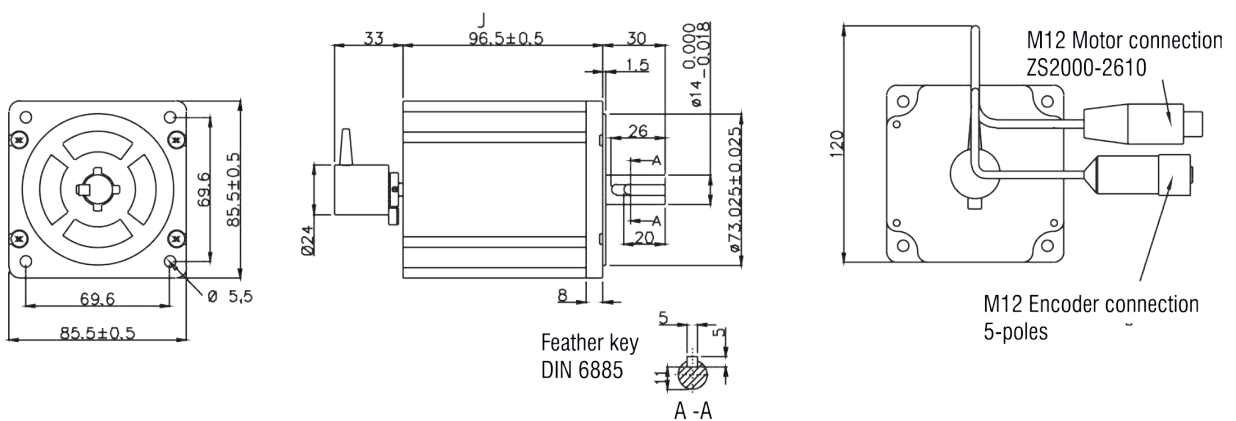
#### AS1060-1000



#### AS1060-1100



#### AS1060-1110



## 12 Appendix

### 12.1 Support and Service

Beckhoff and their partners around the world offer comprehensive support and service, making available fast and competent assistance with all questions related to Beckhoff products and system solutions.

#### **Beckhoff's branch offices and representatives**

Please contact your Beckhoff branch office or representative for [local support and service](#) on Beckhoff products!

The addresses of Beckhoff's branch offices and representatives round the world can be found on her internet pages:

<http://www.beckhoff.com>

You will also find further [documentation](#) for Beckhoff components there.

#### **Beckhoff Headquarters**

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e-mail:	info@beckhoff.com

#### **Beckhoff Support**

Support offers you comprehensive technical assistance, helping you not only with the application of individual Beckhoff products, but also with other, wide-ranging services:

- support
- design, programming and commissioning of complex automation systems
- and extensive training program for Beckhoff system components

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Fax:	+49(0)5246/963-9157
e-mail:	support@beckhoff.com

#### **Beckhoff Service**

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- on-site service
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- spare parts service
- hotline service

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