FAULHABER

Miniature Drive Systems

WE CREATE MOTION

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Imprint

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Technologies driving the Future

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Encoders

Brushless DC-Motors

Planetary Gearheads

Drive Electronics

Stepper Motors

Linear DC-Servomotors

Flat DC-Micromotors

The success story of the „FAULHABER“ brand began over 60 years ago with the development of the self-supporting, skew-wound ironless rotor coil by Dr. Fritz Faulhaber. As a symbol of quality the brand is the cornerstone of FAULHABER’s pioneering platform of innovative, high precision drive technologies which have unlocked new opportunities for a host of cutting edge applications.

Some of Dr. Faulhaber sen. first models of the self-supporting skew–wound ironless rotor coil

Today, the tradition of ironless coil technology leadership is carried on using state of the art development and production technologies

Seamless Partnership

Drive Electronics

Motor with integrated Encoder

Precision Gearhead

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The optimal whole is the sum of unique parts

FAULHABER offers the largest consolidated portfolio of miniature and micro drive technologies available in the world today. This unique basis provides almost limitless possibilities for innovation.

Based on decades of application experience in a myriad of high-tech areas of application, FAULHABER developes new drive systems tailormade to the ever more challenging needs of our customers. These drive systems find application in industries where high precision, reliability, and miniaturization are essential elements for success.

Commitment and experience define our mutual success

The prerequisite for success is the dialog with our customers. Only through a focused exchange of information and ideas can the customer's needs be fully understood and the most efficient solution provided. Our staff is committed to providing their experience and know-how to understand our customer's needs and to help guide them to the best solution for their individual miniature drive system requirements.

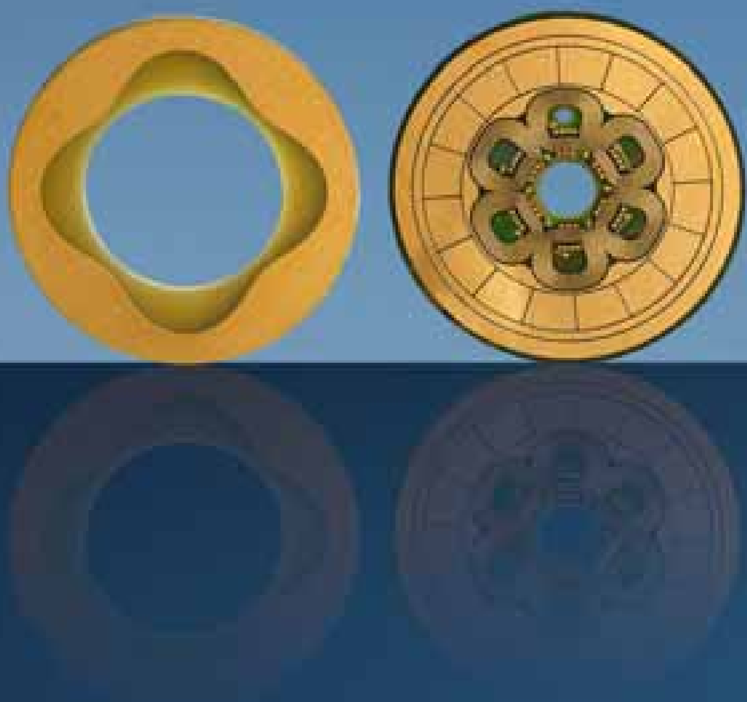
CONSULTING AND CONCEPT

We create Motion

Moving in new directions for continuous innovation

In each of its dedicated research and development departments FAULHABER is hard at work on the future of miniature and micro drive system technologies.

From the idea, to the prototype, and through to the innovative new products that we bring to the market year after year, FAULHABER utilizes state-of-the-art tools and methods to support and enhance its research and development capabilities. Computer aided 3D design, advanced simulation tools, and preventative methods like matix FMEA's, are par for the course not to mention our uncompromising focus on quality and providing the customer with the most efficient production and logistical solution available.



Our philosophy is market driven technology leadership

For over 60 years the name FAULHABER has been synonymous with inventions and innovations that have written countless chapters in the history of miniature and micro drive technology. The pioneering spirit of Dr. Fritz Faulhaber sen. that drove him to continuously set new standards in the market lives on today in the hearts and minds of our highly motivated and creative engineering team.

Multiple awards for innovative development and implementation of detailed technical solutions

The Standard is High-tech

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The highest power in the most compact dimensions

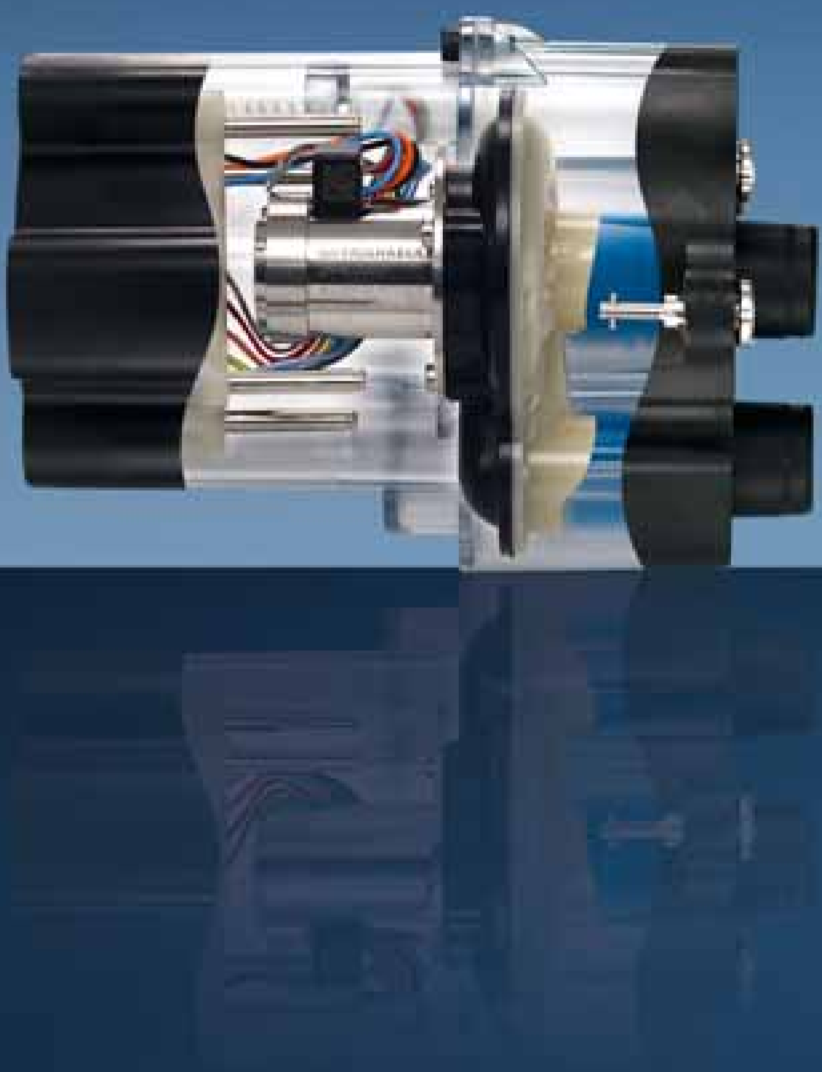
FAULHABER miniature and micro drive systems are electromechanical masterpieces. In today's high-tech market, miniaturization and an ever increasing need to integrate intelligent features into our systems are common challenges.

Through decades of research and development experience FAULHABER has aquired the high degree of know-how in the various specialized processes, manufacturing, and logistical techniques that are necessary to efficiently produce complex miniature and micro drive systems.

Our globalized network of state-of-the-art production facilities with 1,300 qualified employees provide an integrated, highly competitive, efficient production platform focused on on-time delivery and uncompromising quality.

Efficient and effective processes from manual production to highly automated production and testing

A Vision of Innovation



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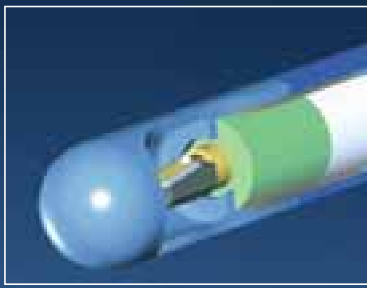
Unique applications demand unique solutions

Decades of drive systems applications know-how and experienced engineers combined with the widest portfolio of high precision drive technologies in the industry, make FAULHABER the ideal partner for a multitude of custom drive system solutions.

We provide a strong basis for your success

FAULHABER's service portfolio ranges from custom design of drive components to the design of complete drive systems based on strategic partnerships with our innovative customers which includes coordinated development and production support.

This close partnership in the creation of custom drive solutions provides our visionary customers the opportunity to focus on their core capabilities in order to assure the future market success of their product.



The areas of application of FAULHABER custom solutions are as diverse as they are challenging; anything from critical medical care to high end automation

FAULHABER completes the drive system with custom designed electronics, software and sensor components

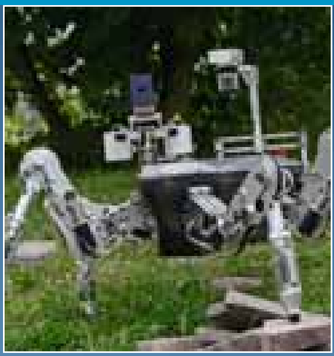
Applications driving the Future

Medical & Laboratory Equipment

- Analysis & dialysis equipment
- Arthroscopic tools
- Artificial limbs
- Blood extraction pumps
- Chemotherapy pumps
- Dental equipment
- EGG & EEG recorders
- Hearing aids
- Mammographs
- Opthalmic tools
- Orthopaedic equipment
- Peristaltic pumps
- Respiratory aids
- Safety equipment
- Syringe drivers
- X-Ray equipment

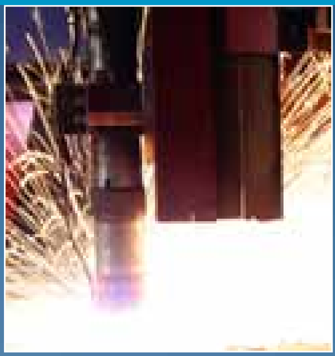
Instrumentation

- Balances, scales
- Densitometers
- Display boards
- Fibre optics splicers
- Geotechnical measurements
- Laser levelling devices
- Laser measuring equipment
- Measuring equipment
- Micrometers
- Valves
- Potentiometers
- Plotters
- Scanners
- Solar displays
- Photo spectrometers
- Surface roughness meters
- Thermoprinters



Factory Automation & Robotics

- Handling equipment
- Screwdrivers
- Remote inspection devices
- PCB automated handling
- Robots, educational robots
- SMD, SMT



Industrial Machinery & Equipment

- Automatic weighting systems
- CD production machines
- Industrial sawing machines
- Laser cutting systems
- Laser marker machines
- Paper industry
- Positioning devices
- Battery operated devices
- Power nailers
- Printing industry
- Surface roughness scanners
- Textile machines
- Tool changers
- Welding equipment
- Winding machines

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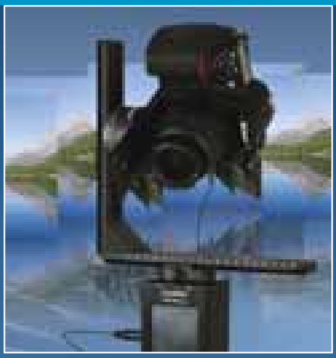

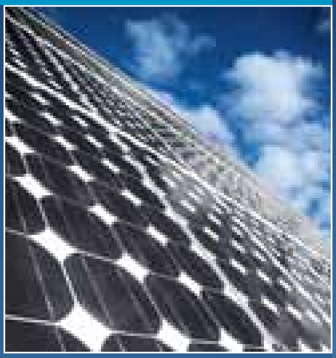

Office, Security & Communications

- Access systems
- Card readers
- Copiers & Printers
- Data processing equipment
- Data storage equipment
- Voice recorders
- Labelling & franking machines
- Personal emergency senders
- Locking systems
- Paper cutters
- Pagers
- Payphones
- Ticket printers & dispensers
- Vending devices

Aerospace & Aviation

- Aircraft instrumentation
- Flap controls
- Flight recorders
- Flight simulators
- Gyros
- High altitude cameras
- Infrared pyrometers
- Radar
- Range finders
- Thermal imagers

Optical, Audio & Video

- Camera lens adjustments
- CCTV
- Concert lighting
- Film winders
- Microfilm readers
- Microscopes
- Movie & photo cameras
- Photographic aerial applications
- TV studio equipment
- Video recorders

Environmental & Safety

- Air sampling monitors
- Emissions supervision devices
- Forced air gasmasks

Total Quality Commitment

We believe that the commitment to total quality is the responsibility of each and every employee

For FAULHABER, quality assurance is not just a technical certification but also an employee philosophy. An atmosphere of solution oriented cooperation and dialog contribute to the total quality consciousness that is embodied by each and every employee in our Group.

A clearly defined quality system supports our employees from the first contact with a customer through to delivery and after sales service and contributes to the uncompromising quality and high performance of our products and services.

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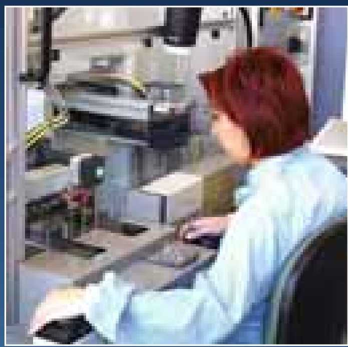

Periodical ISO audits guarantee that we ful- fill the accepted international standards and we profit from an external view of our management processes and procedures. The will for continuous improvement and the implementation of state-of-the-art test procedures enhances the value of our products and services for our customers.

ISO 13485

ISO 9001

FAULHABER drive systems are considered components according to the EG rules for CE compliance. They are intended for use by our customers, who are considered experts in their individual fields of application, as an integrated part of an application and thereby do not require the CE mark

Naturally efficient

The basis for a responsible use of resources

The reduction of CO_2 emissions and the responsible use of energy play a key roll in protecting our environment in all its natural beauty for future generations.

FAULHABER is doing its part through the conscientious development of highly energy and resource efficient drive systems which help to lower overall energy use in a myriad of high-tech applications.

FAULHABER maintains a high standard of environmental consciousness in each aspect of its organization. This transparent commitment to a responsible relationship to the environment is confirmed by our certification according to the ISO 14001 standard.

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In practice for FAULHABER this means energy efficient production, disciplined recycling, and a commitment to energy efficient infrastructure and facilities worldwide.

The most recent addition to the FAULHABER facility in Schönaich, Germany, was constructed with a conscious focus on energy and resource efficiency

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Brushless DC-Micromotors

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Brushless DC-Servomotors

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Brushless DC-Servomotors – 4 Pole Technology

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Brushless Flat DC-Micromotors & DC-Gearmotors

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Brushless DC-Motors

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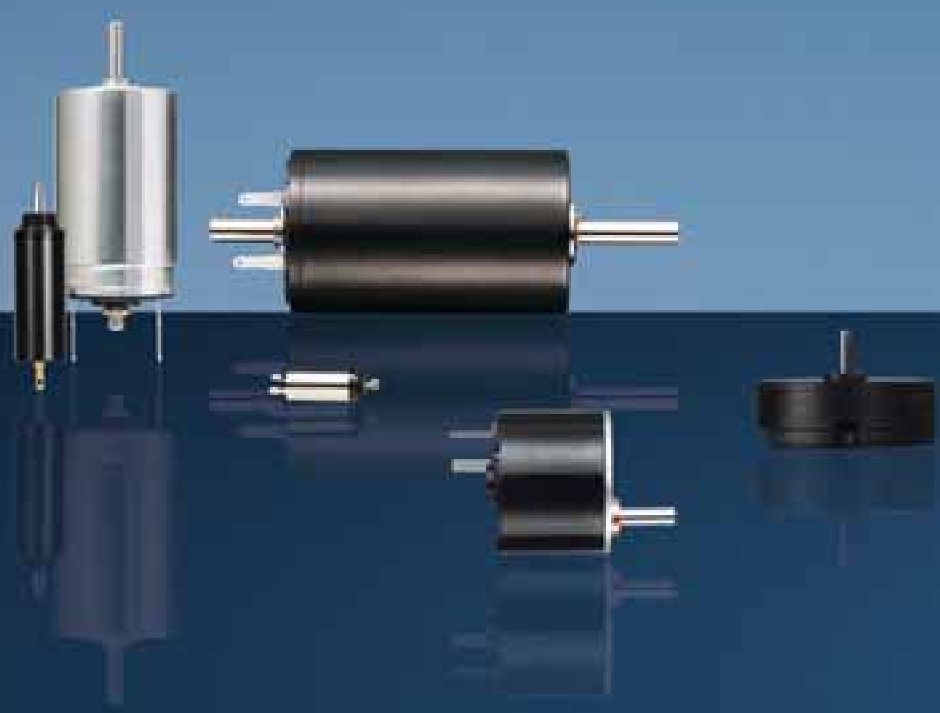
DC-Micromotors



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DC-Micromotors

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	1016 … G	Precious Metal Commutation	0,48 mNm	33
	1024 … S	Precious Metal Commutation	1,28 mNm	34
	1219 … G	Precious Metal Commutation	0,6 mNm	35
	1224 … S	Precious Metal Commutation	1,0 mNm	36
	1224 … SR	Precious Metal Commutation	1,8 mNm	37
	1319 … SR	Precious Metal Commutation	1,3 mNm	38
	1331 … SR	Precious Metal Commutation	3,2 mNm	39
NEW	1336 … CXR	Graphite Commutation	4,0 mNm	40
	1516 … S	Precious Metal Commutation	0,4 mNm	41
	1516 … SR	Precious Metal Commutation	0,8 mNm	42
	1524 … SR	Precious Metal Commutation	2,5 mNm	43
	1624 … S	Precious Metal Commutation	1,5 mNm	44
	1717 … SR	Precious Metal Commutation	2,0 mNm	45
	1724 … SR	Precious Metal Commutation	4,2 mNm	46
	1727 … C	Graphite Commutation	5,0 mNm	47
NEW	1741 … CXR	Graphite Commutation	8,0 mNm	48
	2224 … SR	Precious Metal Commutation	5,0 mNm	49
	2230 … S	Precious Metal Commutation	2,5 mNm	50
	2232 … SR	Precious Metal Commutation	10 mNm	51
	2233 … S	Precious Metal Commutation	3,0 mNm	52
	2237 … CXR	Graphite Commutation	11 mNm	53
	2342 … CR	Graphite Commutation	16 mNm	54
	2642 … CXR	Graphite Commutation	23 mNm	55
	2642 … CR	Graphite Commutation	28 mNm	56
	2657 … CXR	Graphite Commutation	35 mNm	57
	2657 … CR	Graphite Commutation	44 mNm	58
	3242 … CR	Graphite Commutation	35 mNm	59
	3257 … CR	Graphite Commutation	70 mNm	60
NEW	3272 … CR	Graphite Commutation	120 mNm	61
	3557 … CS	Graphite Commutation	50 mNm	62
	3863 … C	Graphite Commutation	110 mNm	63
NEW	3863 … CR	Graphite Commutation	150 mNm	64

Flat DC-Micromotors and DC-Gearmotors

			Page
1506 … SR	Precious Metal Commutation	0,3 mNm	66
1506 … SR IE2-8	with integrated Encoder	0,3 mNm	67 – 68
1512 … SR	with integrated Gearhead	30 mNm	69
1512 … SR IE2-8	with integrated Gearhead and Encoder	30 mNm	70 – 71
2607 … SR	Precious Metal Commutation	3,0 mNm	72
2607 … SR IE2-16	with integrated Encoder	2,0 mNm	73 – 74
2619 … SR	with integrated Gearhead	100 mNm	75
2619 … SR IE2-16	with integrated Gearhead and Encoder	100 mNm	76 – 77

General information

The lifetime, depending on the application type, may exceed the 10 000 hours. Higher speeds cause accelerated mechanical wear, resulting in reduced lifetime.
Also excessively high current and temperature shortens the lifetime. On the average, lifetime of up to 1 000 hours for metal brushes, and more than 3 000 hours for graphite brushes can be expected when the motors are operated within recommended values indicated on the data sheet. These values do not influence each other. It is advisable that the current under load in continuous operation should not be higher than one third of the stall current. In motors with graphite brushes the relationship between stall current and current under load depends on the delivered power and frame size. The motors should not be operated at the stall torque M_H, otherwise after a short period of time, the commutation or the windings could be damaged.

The motor develops its maximum power $P_{2\,max.}$ at exactly half the stall torque M_H which also corresponds to half the speed. For reasons of life performance, this working point should only be selected for intermittent periods.
For exceptional long life performance, brushless DC-Motors are available.

Unspecified tolerances:
Tolerances in accordance with ISO 2768 medium.

≤	**6**	**= ± 0,1 mm**
≤	**30**	**= ± 0,2 mm**
≤	**120**	**= ± 0,3 mm**

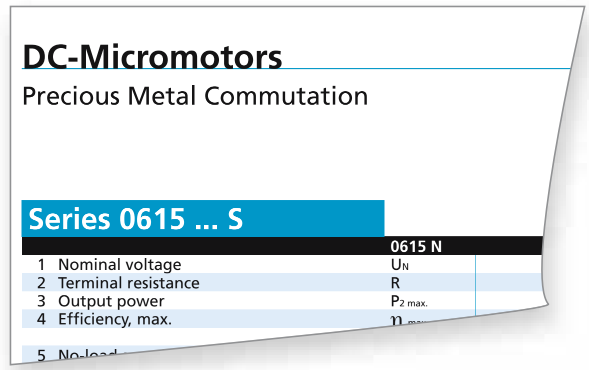
Motors with tighter tolerances and tolerances of values not specified are given on request.

Bearing options:

– Standard:	Unless otherwise stated, vacuum impregnated sintered bearings are used
– Optional:	Shielded ball bearings

Motor shaft:
All dimensions with shaft pushed against motor.

Motor choice:
The listed motor types represent standardised executions. However, a variety of further coil possibilities are available.



Notes on technical data

All values at 22 °C.
All values at nominal voltage, motor only, without load.

Nominal voltage U_N [Volt]
The nominal voltage at which all other characteristics indicated are measured.

Terminal resistance R [Ω] ±12%
The resistance measured across the motor terminals. The value is directly affected by the coil temperature (temperature coefficient: α_{22} = 0,004 K^{-1}).

Output power $P_{2\,max.}$ [W]
The maximum obtainable mechanical power achieved at the nominal voltage.

$$P_{2\,max.} = \frac{R}{4} \cdot \left(\frac{U_N}{R} - I_o\right)^2$$

Efficiency $\eta_{max.}$ [%]
The max. ratio between the absorbed electrical power and the obtained mechanical power of the motor.
It does not always correspond to the optimum working point of the motor.

$$\eta_{max.} = \left(1 - \sqrt{\frac{I_o \cdot R}{U_N}}\right)^2 \cdot 100$$

No-load speed n_o [rpm] ±12%
Describes the maximum speed under no-load conditions at steady state and 22 °C ambient temperature. If not otherwise defined the tolerance for the no-load speed is assumed to be ±12%.

$$n_o = (U_N - I_o \cdot R) \cdot k_n$$

No-load current I_o [A] ±50%
Describes the current consumption of the motor without load at an ambient temperature of 22°C after reaching a steady state condition. The tolerance is given at +/-50%.

The no-load current is speed and temperature dependent. Changes in ambient temperature or cooling conditions will influence the value. In addition, modifications to the shaft, bearing, lubrication, and commutation system or combinations with other components such as gearheads or encoders will all result in a change to the no-load current of the motor.

Stall torque M_H [mNm]
The torque developed by the motor at zero speed and nominal voltage. This value is greatly influenced by temperature.

$$M_H = k_M \cdot \left(\frac{U_N}{R} - I_o\right)$$

Friction torque M_R [mNm]
Torque losses caused by the friction of brushes, bearings and commutators. This value is influenced by temperature.

$$M_R = k_M \cdot I_o$$

Speed constant k_n [rpm/V]
The speed variation per Volt applied to the motor terminals at constant load.

$$k_n = \frac{n_o}{U_N - I_o \cdot R} = \frac{1\,000}{k_E}$$

Back-EMF constant k_E [mV/rpm]
The constant corresponding to the relationship between the induced voltage in the rotor at the speed of rotation.

$$k_E = \frac{2\pi \cdot k_M}{60}$$

Torque constant k_M [mNm/A]
The constant corresponding to the relationship between the torque developed by the motor and the current drawn.

Current constant k_I [A/mNm]
The constant between the current in the motor and the torque developed.

$$k_I = \frac{1}{k_M}$$

Slope of n-M curve $\Delta n/\Delta M$ [rpm/mNm]
The ratio of the speed variation to the torque variation. The smaller the value, the more powerful the motor.

$$\frac{n}{M} = \frac{30\,000}{\pi} \cdot \frac{R}{k_M^2}$$

Rotor inductance L [µH]
The inductance measured on the motor terminals at 1 kHz.

Mechanical time constant τ_m [ms]
The time required for the motor to reach a speed of 63% of its final no-load speed, from standstill.

$$\tau_m = \frac{100 \cdot R \cdot J}{k_M^2}$$

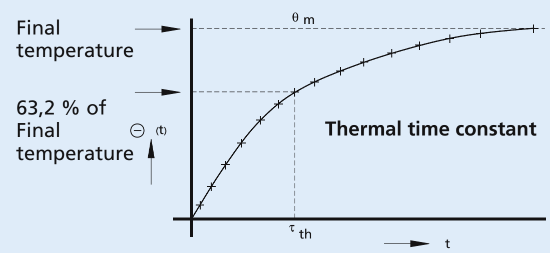
Rotor inertia J [gcm²]
Rotor's mass dynamic inertia moment.

Angular acceleration $\alpha_{max.}$ [$\cdot 10^3$ rad/s²]
The acceleration obtained from standstill under no-load-conditions and at nominal voltage.

$$\alpha_{max.} = \frac{M_H \cdot 10}{J}$$

Thermal resistance R_{th1}/R_{th2} [K/W]
R_{th1} corresponds to the value between the rotor and housing. R_{th2} corresponds to the value between the housing and the ambient air.
R_{th2} can be reduced by enabling exchange of heat between the motor and the ambient air (for example using a heat sink or forced air cooling).

Thermal time constant τ_{w1}/τ_{w2} [s]
The thermal time constant specifies the time needed for the rotor and housing to reach a temperature equal to 63% of final value.



Operating temperature range [°C]
Indicates the min. and max. motor operating temperature, as well as the maximum permitted rotor temperature.

Shaft bearings
The bearings used for the DC-Micromotors.

Shaft load max. [N]
The output shaft load at a specified shaft diameter for the primary output shaft. For motors with ball bearings the load and lifetime are in accordance with the values given by the bearing manufacturers. This value does not apply to second, or rear shaft ends.

Shaft play [mm]
The shaft play on the bearings, measured at the bearing exit.

Housing material
The housing material and the surface protection.

Weight [g]
The average weight of the basic motor type.

DC-Micromotors

Technical Information

Direction of rotation

The direction of rotation is viewed from the front face. Positive voltage to the + terminal gives clockwise rotation of the motor shaft. All motors are designed for clockwise (CW) and counterclockwise (CCW) operation; the direction of rotation is reversible.

Recommended values

The maximum recommended values for continuous operation to obtain optimum life performance are listed below. The values are independent of each other.
The values will be reduced with thermal insulation and elevated temperature but can be increased with forced cooling.

Speed $n_{e\,max.}$ [rpm]
The maximum recommended operating speed.

Torque $M_{e\,max.}$ [mNm]
The maximum recommended torque rating.

How to select a DC-Micromotor

This section reviews a step-by-step procedure on how to select a DC-Micromotor. The procedure allows calculation of the parameters in order to produce a graph of the characteristics and per-mitting the definition of the motor's behaviour. To simplify the calculation, in this example continuous operation and optimum life performance are assumed and the influence of temperature and tolerances has been omitted.

Application data:

The basic data required for any given application are:

Required torque	M	[mNm]
Required speed	n	[rpm]
Duty cycle	δ	[%]
Available supply voltage, max.	U	[V DC]
Available current source, max.	I	[A]
Available space, max.	diameter/length	[mm]
Shaft load	radial/axial	[N]

The assumed application data for the selected example are:

Output torque	M	= 3	mNm
Speed	n	= 5 500	rpm
Duty cycle	δ	= 100	%
Supply voltage	U	= 20	V DC
Current source, max.	I	= 0,5	A
Space max.	diameter	= 25	mm
	length	= 50	mm
Shaft load	radial	= 1,0	N
	axial	= 0,2	N

Preselection

The first step is to calculate the power the motor is expected to deliver:

$$P_2 = M \cdot n \; \frac{\pi}{30 \cdot 1\,000} \qquad [W]$$

$$P_2 = 3 \cdot 5\,500 \; \frac{\pi}{30 \cdot 1\,000} \qquad = 1{,}73 \quad W$$

A motor is then selected from the catalogue which will give at least 1,5 to 2 times the output power [$P_{2\,max.}$] than the one obtained by calculation, and where the nominal voltage is equal to or higher than the one required in the application data.

The physical dimensions (diameter and length) of the motor selected from the data sheets should not exceed the available space in the application.

$$P_{2\,max.} \geq P_2 \qquad\qquad U_N \geq U$$

The motor selected from the catalogue for this particular application, is **series 2233 T 024 S** with the following characteristics:

Nominal voltage		U_N	= 24	V DC
Output power, max.		$P_{2\,max.}$	= 2,47	W
Frame size:	diameter	Ø	= 22	mm
	length	L	= 33	mm
Shaft load, max.:		radial	= 1,2	N
		axial	= 0,2	N
No-load current		I_o	= 0,005	A
No-load speed		n_o	= 8 800	rpm
Stall torque		M_H	= 10,70	mNm

Caution:

Should the available supply voltage be lower than the nominal voltage of the selected DC-Micromotor, it will be necessary to calculate [$P_{2\,max.}$] with the following equation:

$$P_{2\,max.} = \frac{R}{4} \cdot \left(\frac{U_N}{R} - I_o\right)^2 \qquad [W]$$

$$P_{2\,max.}\,(20\text{ V}) = \frac{57}{4} \cdot \left(\frac{20}{57} - 0{,}005\right)^2 \qquad = 1{,}70 \quad W$$

Optimizing the preselection

To optimize the motor's operation and life performance, the required speed [n] has to be higher than half the no-load speed [n_o] at nominal voltage, and the load torque [M] has to be less than half the stall torque [M_H].

$$n \geq \frac{n_o}{2} \qquad\qquad M \leq \frac{M_H}{2}$$

From the data sheet for the DC-Micromotor, **2233 T 024 S** the parameters meet the above requirements.

$$n\ (5\,500\ \text{rpm}) \geq \frac{n_o}{2} \quad \text{is greater than} \quad \frac{8\,800}{2} = 4\,400 \quad \text{rpm}$$

$$M\ (3\ \text{mNm}) \leq \frac{M_H}{2} \quad \text{is less than} \quad \frac{10{,}70}{2} = 5{,}35 \quad \text{mNm}$$

This DC-Micromotor will be a good first choice to test in this application. Should the required speed [n] be less than half the no-load speed [n_o], and the load torque [M] be less than half the stall torque [M_H], try the next voltage motor up.

Should the required torque [M] be compliant but the required speed [n] be less than half the no-load speed [n_o], try a lower supply voltage or another smaller frame size motor.

Should the required speed be well below half the no-load speed and or the load torque [M] be more than half the stall torque [M_H], a gearhead or a larger frame size motor has to be selected.

Performance characteristics at nominal voltage (24 V DC)
A graphic presentation of the motor's characteristics can be obtained by calculating the stall current [I] and the torque [M] at its point of max. efficiency [$M_{opt.}$]. All other parameters are taken directly from the data sheet of the selected motor.

Stall current

$$I = \frac{U_N}{R} \qquad [\text{A}]$$

$$I = \frac{24}{57} \qquad = 0{,}421 \quad \text{A}$$

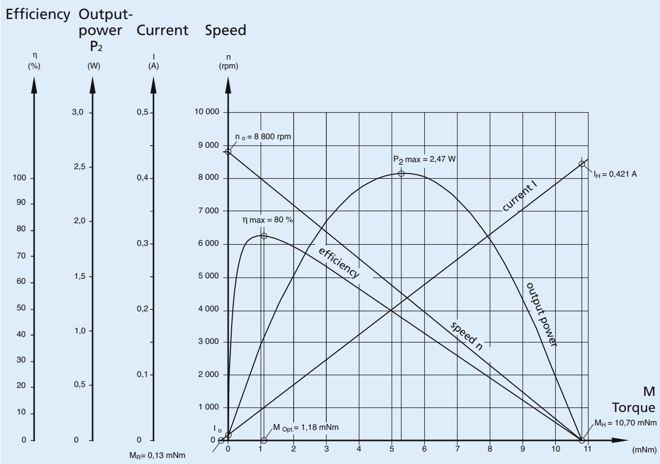
Torque at max. efficiency

$$M_{opt.} = \sqrt{M_H \cdot M_R} \qquad [\text{mNm}]$$

$$M_{opt.} = \sqrt{10{,}70 \cdot 0{,}13} \qquad = 1{,}18 \quad \text{mNm}$$

It is now possible to make a graphic presentation and draw the motor diagram (see graph 1).

Graph 1



Calculation of the main parameters

In this application the available supply voltage is lower than the nominal voltage of the selected motor.
The calculation under load therefore is made at 20 V DC.

No-load speed n_o at 20 V DC

$$n_o = \frac{U - (I_o \cdot R)}{k_E} \cdot 1\,000 \qquad [\text{rpm}]$$

inserting the values

Supply voltage	U	= 20	V DC
Terminal resistance	R	= 57	
No-load current	I_o	= 0,005	A
Back-EMF constant	k_E	= 2,690	mV/rpm

$$n_o = \frac{20 - (0{,}005 \cdot 57)}{2{,}690} \cdot 1\,000 \qquad = 7\,329 \quad \text{rpm}$$

Stall current I_H

$$I_H = \frac{U}{R} \qquad [\text{A}]$$

$$I_H = \frac{20}{57} \qquad = 0{,}351 \quad \text{A}$$

Stall torque M_H

$$M_H = k_M (I_H - I_o) \qquad [\text{mNm}]$$

inserting the value

Torque constant	k_M	= 25,70	mNm/A
M_H = 25,70 (0,351 – 0,005)		= 8,89	mNm

DC-Micromotors

Technical Information

Output power, max. $P_{2\,max.}$

$$P_{2\,max.} = \frac{R}{4} \cdot \left(\frac{U_N}{R} - I_o\right)^2 \qquad [W]$$

$$P_{2\,max.}(20\,V) = \frac{57}{4} \cdot \left(\frac{20}{57} - 0{,}005\right)^2 \qquad = 1{,}70 \quad W$$

Efficiency, max. $\eta_{max.}$

$$\eta_{max.} = \left(1 - \sqrt{\frac{I_o}{I_H}}\right)^2 \cdot 100 \qquad [\%]$$

$$\eta_{max.} = \left(1 - \sqrt{\frac{0{,}005}{0{,}351}}\right)^2 \cdot 100 \qquad = 77{,}6 \quad \%$$

At the point of max. efficiency, the torque delivered is:

$$M_{opt.} = \sqrt{M_H \cdot M_R} \qquad [mNm]$$

inserting the values

Friction torque	M_R	=	0,13	mNm
and				
Stall torque at 20 V DC	M_H	=	8,91	mNm

$$M_{opt.} = \sqrt{8{,}91 \cdot 0{,}13} \qquad = 1{,}08 \quad mNm$$

Calculation of the operating point at 20 V DC
When the torque (M = 3 mNm) at the working point is taken into consideration I, n, P_2 and η can be calculated:

Current at the operating point

$$I = \frac{M + M_R}{k_M} \qquad [A]$$

$$I = \frac{3 + 0{,}13}{25{,}70} \qquad = 0{,}122 \quad A$$

Speed at the operating point

$$n = \frac{U - R \cdot I}{k_E} \cdot 1\,000 \qquad [rpm]$$

$$n = \frac{20 - 57 \cdot 0{,}122}{2{,}690} \cdot 1\,000 \qquad = 4\,841 \quad rpm$$

Output power at the operating point

$$P_2 = M \cdot n \cdot \frac{\pi}{30 \cdot 1\,000} \qquad [W]$$

$$P_2 = 3 \cdot 4\,841 \cdot \frac{\pi}{30 \cdot 1\,000} \qquad = 1{,}52 \quad W$$

Efficiency at the operating point

$$\eta = \frac{P_2}{U \cdot I} \cdot 100 \qquad [\%]$$

$$\eta = \frac{1{,}52}{20 \cdot 0{,}122} \cdot 100 \qquad = 62{,}3 \quad \%$$

In this example the calculated speed at the working point is different to the required speed, therefore the supply voltage has to be changed and the calculation repeated.

Supply voltage at the operating point
The exact supply voltage at the operating point can now be obtained with the following equation:

$$U = R \cdot I + k_E \cdot n \cdot 10^{-3}$$

$$U = 57 \cdot 0{,}122 + 2{,}695 \cdot 5\,500 \cdot 10^{-3} \qquad = 21{,}78 \;\; V\,DC$$

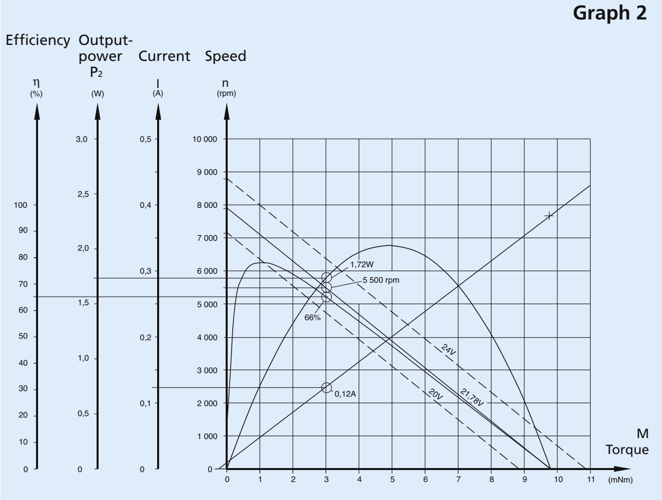
In this calculated example, the parameters at the operating point are summarized as follows:

Supply voltage	U	= 21,78	V DC
Speed	n	= 5 500	rpm
Output torque	M_N	= 3	mNm
Current	I	= 0,12	A
Output power	P_2	= 1,72	W
Efficiency	η	= 66	%

Motor characteristic curves
For a specific torque, the various parameters can be read on graph 2.

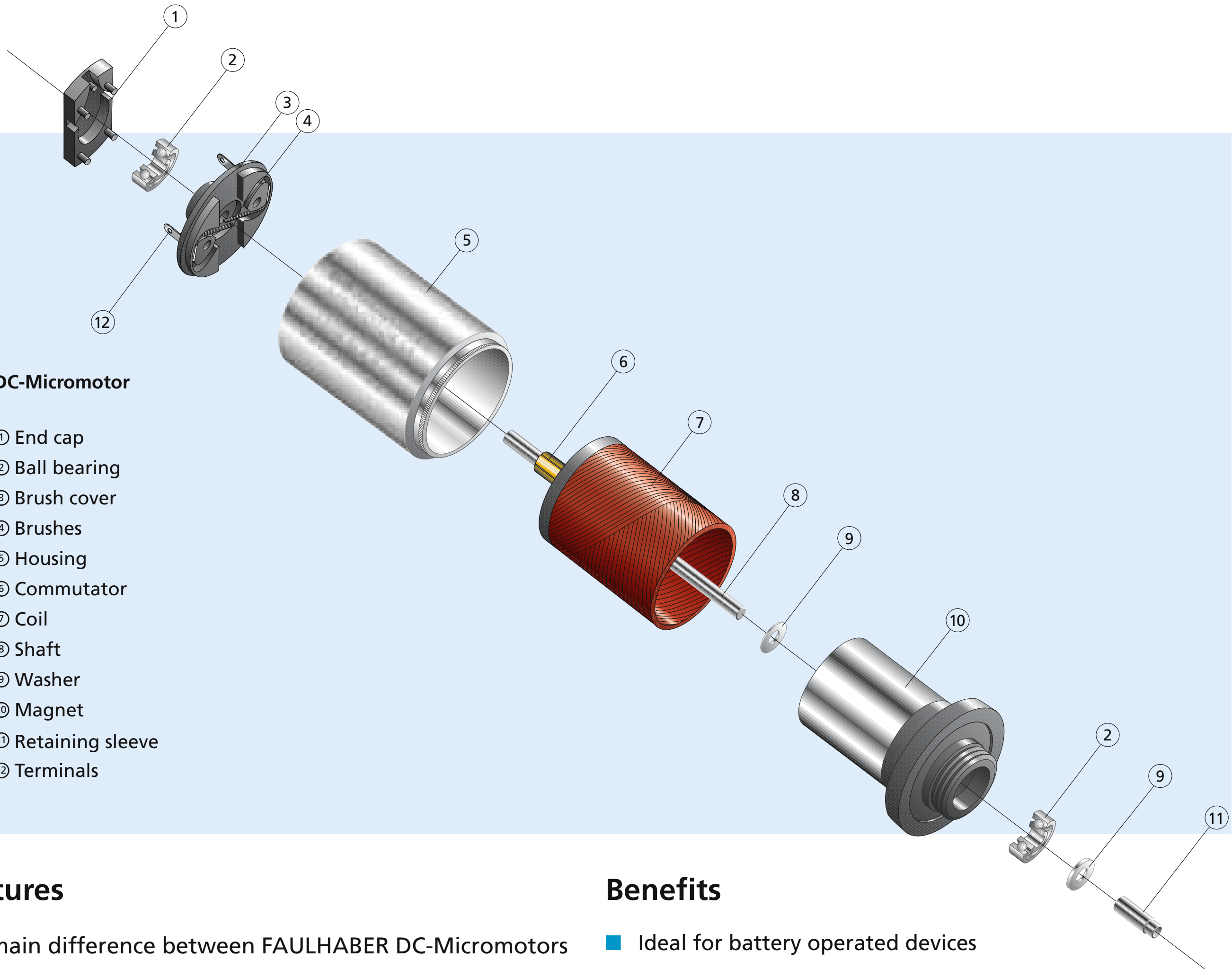
To simplify the calculation, the influence of temperature and tolerances has deliberately been omitted.
In certain cases the influence of temperature should, however, be taken into consideration.

Graph 2



DC-Micromotors

Precious Metal Commutation



DC-Micromotor

① End cap
② Ball bearing
③ Brush cover
④ Brushes
⑤ Housing
⑥ Commutator
⑦ Coil
⑧ Shaft
⑨ Washer
⑩ Magnet
⑪ Retaining sleeve
⑫ Terminals

Features

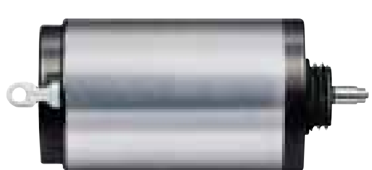
The main difference between FAULHABER DC-Micromotors and conventional DC motors is in the rotor. The winding does not have an iron core but consists of a self-supporting skew-wound copper coil. This featherweight rotor has an extremely low moment of inertia, and it rotates without cogging. The result is the outstanding dynamics of FAULHABER motors. For low power motors, commutation systems using precious metals are the optimum solution because of their low contact resistance.

FAULHABER precious metal commutated motors range in size from just 6 mm to 22 mm in diameter. FAULHABER completes the drive system by providing a variety of additional hightech standard components including high resolution encoders, precision gearheads, and drive electronics. FAULHABER specializes in the modification of their drive systems to fit the customer's particular application requirements. Common modifications include vaccuum compatibility, extreme temperature compatibility, modified shaft geometry, additional voltage types, custom motor leads and connectors, and much more.

Benefits

- Ideal for battery operated devices
- No cogging
- Extremely low current consumption – low starting voltage
- Highly dynamic performance due to a low inertia, low inductance coil
- Light and compact
- Precise speed control
- Simple to control due to the linear performance characteristics

Product Code

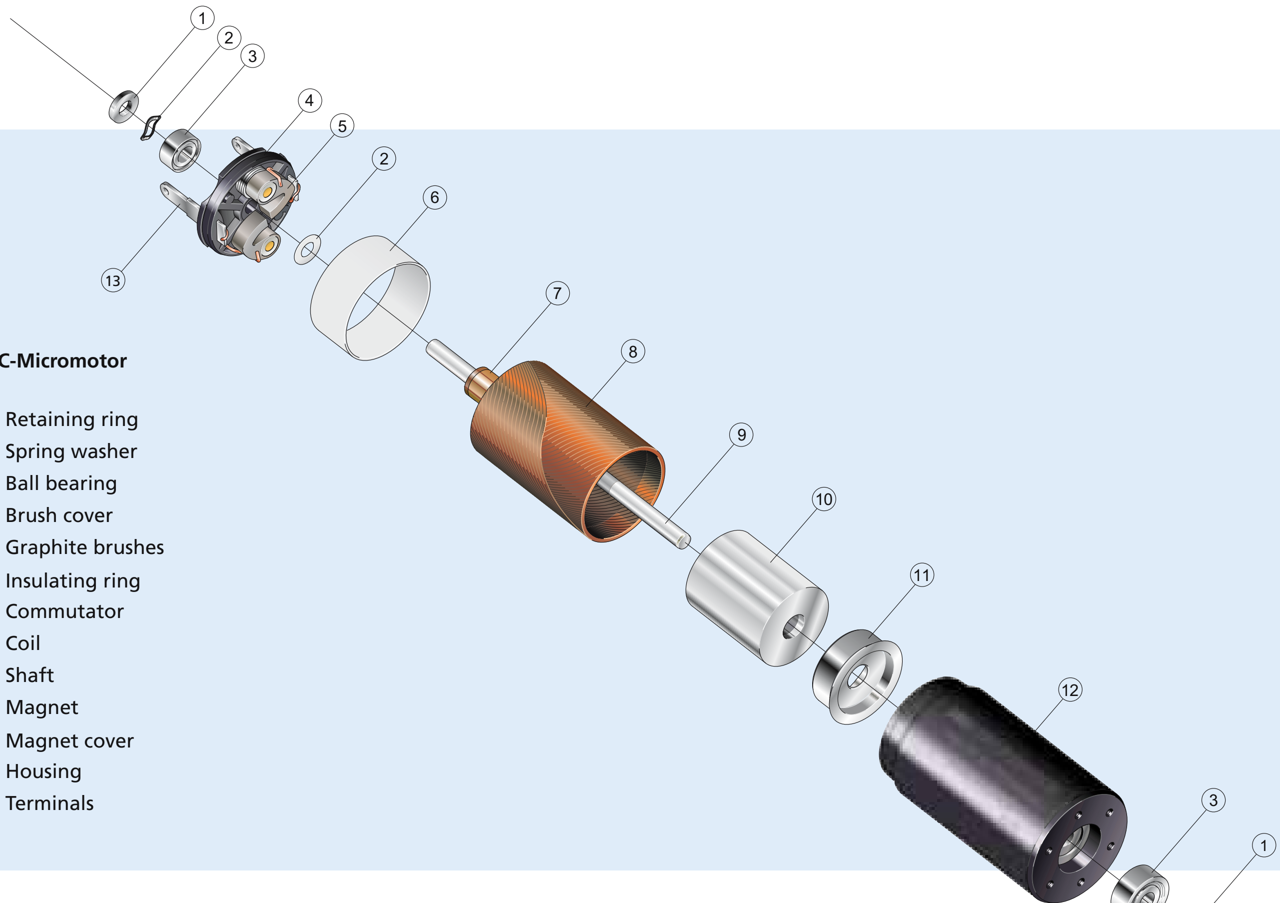


1219 N 012 G

12	Motor diameter
19	Motor length [mm]
N	Shaft type
012	Nominal voltage [V]
G	Type of commutation (precious metal)

DC-Micromotors

Graphite Commutation



DC-Micromotor

① Retaining ring
② Spring washer
③ Ball bearing
④ Brush cover
⑤ Graphite brushes
⑥ Insulating ring
⑦ Commutator
⑧ Coil
⑨ Shaft
⑩ Magnet
⑪ Magnet cover
⑫ Housing
⑬ Terminals

Features

These motors feature brushes manufactured of a sintered metal graphite material and a copper commutator. This ensures that the commutation system can withstand more power and still deliver exceptionally long operational lifetimes.

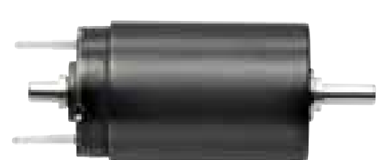
A multitude of adaptations for customer specific requirements and special executions are available.

FAULHABER motors with graphite brushes range in size from just 13 mm to 38 mm in diameter.
FAULHABER completes the drive system by providing a variety of additional high-tech standard components including high resolution encoders, precision gearheads, drive electronics, brakes and other servo componets.
FAULHABER specializes in the modification of their drive systems to fit the customer's particular application requirements. Common modifications include vaccuum compatibility, extreme temperature compatibility, modified shaft geometry, additional voltage types, custom motor leads and connectors, and much more.

Benefits

- No cogging
- High power density
- Highly dynamic performance due to a low inertia, low inductance coil
- Light and compact
- Precise speed control
- Simple to control due to the linear performance characteristics

Product Code



2342 S 024 CR

23	Motor diameter [mm]
42	Motor length [mm]
S	Shaft type
024	Nominal voltage [V]
C	Type of commutation (Graphite)
R	Version (rare earth magnet)

DC-Micromotors

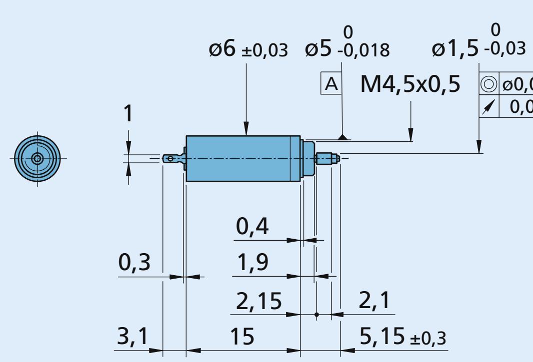
Precious Metal Commutation

0,11 mNm

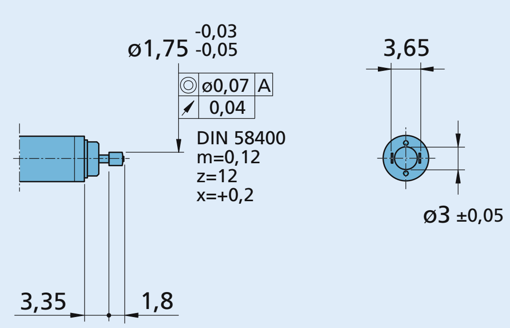
For combination with
Gearheads:
06/1
Encoders:
HXM3-64, PA2-50

Series 0615 ... S

			0615 N	1,5 S	003 S	4,5 S	
1	Nominal voltage	U_N		1,5	3	4,5	V
2	Terminal resistance	R		3,9	16,2	37,7	Ω
3	Output power	$P_{2\ max.}$		0,12	0,12	0,11	W
4	Efficiency, max.	$\eta_{max.}$		52	50	48	%
5	No-load speed	n_0		19 100	20 200	20 000	rpm
6	No-load current (with shaft ø 0,8 mm)	I_0		0,03	0,016	0,012	A
7	Stall torque	M_H		0,24	0,22	0,21	mNm
8	Friction torque	M_R		0,02	0,02	0,02	mNm
9	Speed constant	k_n		13 840	7 346	4 872	rpm/V
10	Back-EMF constant	k_E		0,072	0,136	0,205	mV/rpm
11	Torque constant	k_M		0,69	1,3	1,96	mNm/A
12	Current constant	k_I		1,449	0,769	0,51	A/mNm
13	Slope of n-M curve	$\Delta n/\Delta M$		78 224	91 538	93 713	rpm/mNm
14	Rotor inductance	L		12	39	95	µH
15	Mechanical time constant	τ_m		8	10	10	ms
16	Rotor inertia	J		0,01	0,01	0,01	gcm²
17	Angular acceleration	$\alpha_{max.}$		244	221	213	·10³rad/s²
18	Thermal resistance	$R_{th\ 1}$ / $R_{th\ 2}$	35 / 76				K/W
19	Thermal time constant	τ_{w1} / τ_{w2}	2,6 / 110				s
20	Operating temperature range:						
	– motor		-30 ... +85 (optional version -30 ... +125)				°C
	– rotor, max. permissible		+85 (optional version +125)				°C
21	Shaft bearings		sintered bearings				
22	Shaft load max.:						
	– with shaft diameter		0,8				mm
	– radial at 3 000 rpm (1,5 mm from bearing)		0,5				N
	– axial at 3 000 rpm		0,1				N
	– axial at standstill		20				N
23	Shaft play						
	– radial	≤	0,03				mm
	– axial	≤	0,15				mm
24	Housing material		steel, black coated				
25	Weight		2				g
26	Direction of rotation		clockwise, viewed from the front face				
	Recommended values - mathematically independent of each other						
27	Speed up to	$n_{e\ max.}$		13 000	13 000	13 000	rpm
28	Torque up to	$M_{e\ max.}$		0,11	0,11	0,11	mNm



0615 N ... S



0615 C ... S
for Gearhead 06/1

DC-Micromotors

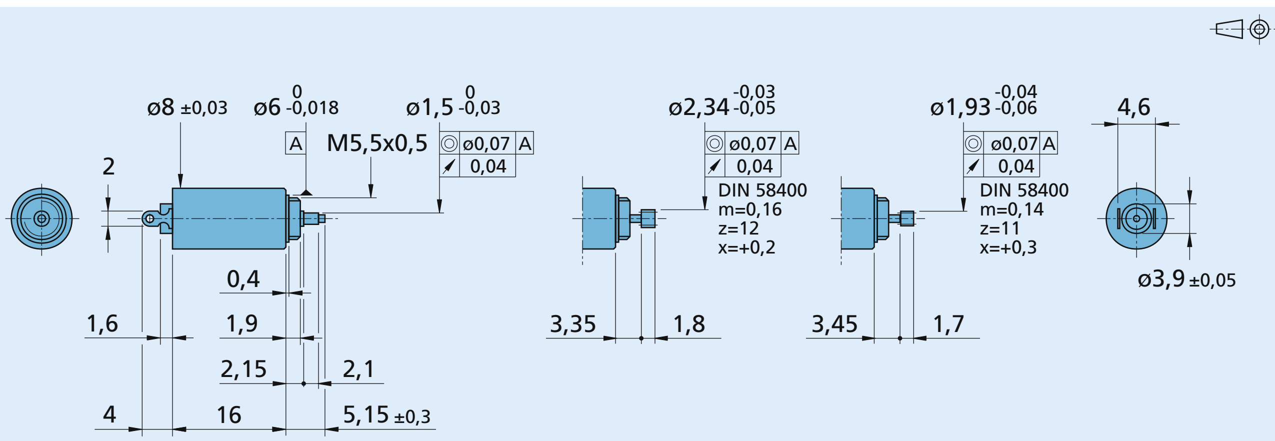
Precious Metal Commutation

0,15 mNm

For combination with
Gearheads:
08/1, 08/2, 08/3
Encoders:
HEM3-256-W, PA2-50

Series 0816 ... S

		0816 N		003 S	006 S	008 S	
1	Nominal voltage	U_N		3	6	8	V
2	Terminal resistance	R		11,5	47	75,7	Ω
3	Output power	$P_{2\,max.}$		0,17	0,16	0,18	W
4	Efficiency, max.	$\eta_{max.}$		52	51	50	%
5	No-load speed	n_0		15 700	15 800	16 500	rpm
6	No-load current (with shaft ø 1 mm)	I_0		0,016	0,008	0,006	A
7	Stall torque	M_H		0,41	0,4	0,4	mNm
8	Friction torque	M_R		0,04	0,04	0,04	mNm
9	Speed constant	k_n		5 617	2 851	2 329	rpm/V
10	Back-EMF constant	k_E		0,178	0,351	0,429	mV/rpm
11	Torque constant	k_M		1,7	3,35	4,1	mNm/A
12	Current constant	k_I		0,588	0,299	0,244	A/mNm
13	Slope of n-M curve	$\Delta n/\Delta M$		37 999	39 993	43 003	rpm/mNm
14	Rotor inductance	L		47	195	310	µH
15	Mechanical time constant	τ_m		12	13	14	ms
16	Rotor inertia	J		0,03	0,03	0,03	gcm²
17	Angular acceleration	$\alpha_{max.}$		138	132	133	$\cdot 10^3$rad/s²
18	Thermal resistance	$R_{th\,1}$ / $R_{th\,2}$	30 / 61				K/W
19	Thermal time constant	τ_{w1} / τ_{w2}	2,9 / 207				s
20	Operating temperature range:						
	– motor		-30 ... +85 (optional version -30 ... +125)				°C
	– rotor, max. permissible		+85 (optional version +125)				°C
21	Shaft bearings		sintered bearings				
22	Shaft load max.:						
	– with shaft diameter		1				mm
	– radial at 3 000 rpm (1,5 mm from bearing)		0,5				N
	– axial at 3 000 rpm		0,1				N
	– axial at standstill		20				N
23	Shaft play						
	– radial	≤	0,03				mm
	– axial	≤	0,2				mm
24	Housing material		steel, nickel plated				
25	Weight		3,5				g
26	Direction of rotation		clockwise, viewed from the front face				
	Recommended values - mathematically independent of each other						
27	Speed up to	$n_{e\,max.}$		13 000	13 000	13 000	rpm
28	Torque up to	$M_{e\,max.}$		0,15	0,15	0,15	mNm



0816 N ... S

0816 P ... S
for Gearhead 08/1

0816 D ... S
for Gearheads 08/2, 08/3

DC-Micromotors

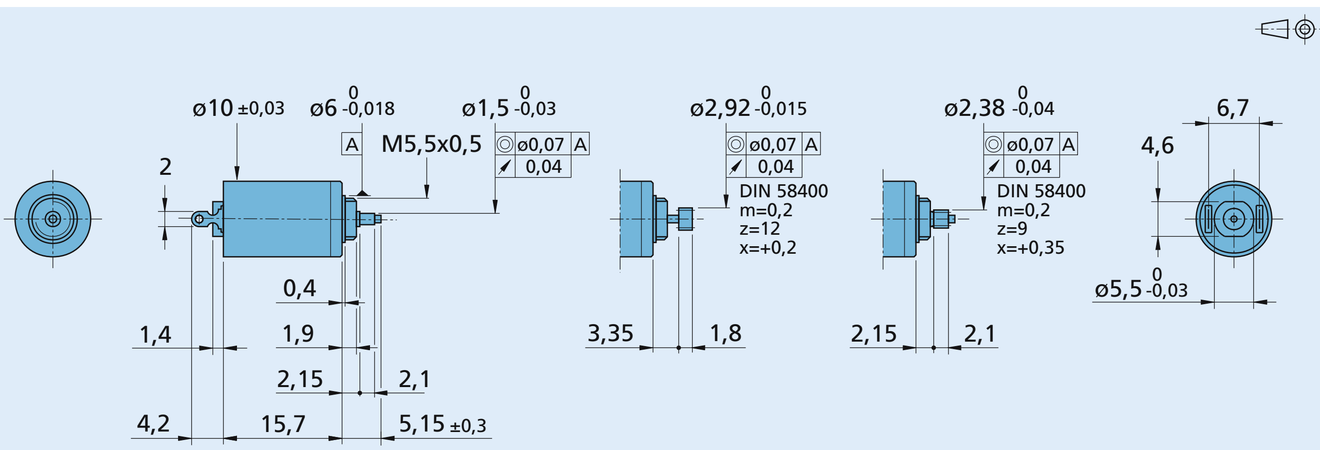
Precious Metal Commutation

0,48 mNm

For combination with
Gearheads:
10/1, 12/3
Encoders:
30B, HEM3-256-W, PA2-100

Series 1016 ... G

		1016 N			003 G	006 G	012 G	
1	Nominal voltage	U_N			3	6	12	V
2	Terminal resistance	R			8,7	20,1	95	Ω
3	Output power	$P_{2\,max.}$			0,24	0,42	0,36	W
4	Efficiency, max.	$\eta_{max.}$			63	67	68	%
5	No-load speed	n_0			14 200	18 400	16 500	rpm
6	No-load current (with shaft ø 0,8 mm)	I_0			0,015	0,01	0,004	A
7	Stall torque	M_H			0,64	0,87	0,82	mNm
8	Friction torque	M_R			0,03	0,03	0,03	mNm
9	Speed constant	k_n			4 948	3 173	1 419	rpm/V
10	Back-EMF constant	k_E			0,202	0,315	0,705	mV/rpm
11	Torque constant	k_M			1,93	3,01	6,73	mNm/A
12	Current constant	k_I			0,518	0,332	0,149	A/mNm
13	Slope of n-M curve	$\Delta n/\Delta M$			22 304	21 185	20 029	rpm/mNm
14	Rotor inductance	L			28	60	310	µH
15	Mechanical time constant	τ_m			9	13	10	ms
16	Rotor inertia	J			0,04	0,06	0,05	gcm²
17	Angular acceleration	$\alpha_{max.}$			159	145	165	·10³rad/s²
18	Thermal resistance	$R_{th\,1} / R_{th\,2}$	26 / 56					K/W
19	Thermal time constant	τ_{w1} / τ_{w2}	3,1 / 260					s
20	Operating temperature range:							
	– motor		-30 ... +85 (optional version -30 ... +125)					°C
	– rotor, max. permissible		+85 (optional version +125)					°C
21	Shaft bearings		sintered bearings	ball bearings				
22	Shaft load max.:		(standard)	(optional version)				
	– with shaft diameter		0,8	1				mm
	– radial at 3 000 rpm (1,5 mm from bearing)		0,5	5				N
	– axial at 3 000 rpm		0,1	0,5				N
	– axial at standstill		20	5				N
23	Shaft play							
	– radial	$\leq$	0,03	0,02				mm
	– axial	$\leq$	0,2	0,2				mm
24	Housing material		steel, nickel plated					
25	Weight		6,5					g
26	Direction of rotation		clockwise, viewed from the front face					
Recommended values - mathematically independent of each other								
27	Speed up to	$n_{e\,max.}$			13 000	13 000	13 000	rpm
28	Torque up to	$M_{e\,max.}$			0,48	0,48	0,48	mNm



1016 N ... G

1016 M ... G
for Gearhead 10/1

1016 E ... G
for Gearhead 12/3

DC-Micromotors

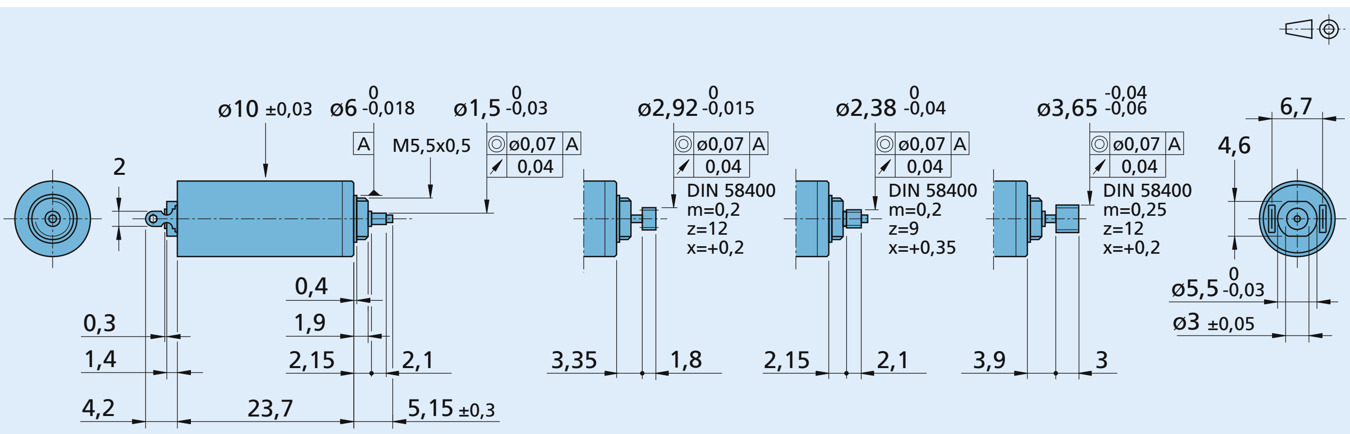
1,28 mNm

Precious Metal Commutation

For combination with
Gearheads:
10/1, 12/3, 12/4, 12/5
Encoders:
30B, HEM3-256-W, PA2-100

Series 1024 ... S

	1024 N		003 S	006 S	012 S	
1 Nominal voltage	U_N		3	6	12	V
2 Terminal resistance	R		2,3	10,8	31,6	Ω
3 Output power	$P_{2\ max.}$		0,97	0,81	1,11	W
4 Efficiency, max.	$\eta_{max.}$		79	78	79	%
5 No-load speed	n_0		13 800	13 200	14 700	rpm
6 No-load current (with shaft ø 1 mm)	I_0		0,016	0,008	0,004	A
7 Stall torque	M_H		2,69	2,34	2,89	mNm
8 Friction torque	M_R		0,03	0,03	0,03	mNm
9 Speed constant	k_n		4 658	2 231	1 240	rpm/V
10 Back-EMF constant	k_E		0,215	0,448	0,806	mV/rpm
11 Torque constant	k_M		2,05	4,28	7,7	mNm/A
12 Current constant	k_I		0,488	0,234	0,13	A/mNm
13 Slope of n-M curve	$\Delta n/\Delta M$		5 135	5 630	5 090	rpm/mNm
14 Rotor inductance	L		26	100	344	µH
15 Mechanical time constant	τ_m		6	7	6	ms
16 Rotor inertia	J		0,12	0,12	0,12	gcm²
17 Angular acceleration	$\alpha_{max.}$		224	195	241	$\cdot 10^3$rad/s²
18 Thermal resistance	R_{th1} / R_{th2}	14 / 41				K/W
19 Thermal time constant	τ_{w1} / τ_{w2}	5 / 289				s
20 Operating temperature range:						
– motor		-30 ... +85 (optional version -30 ... +125)				°C
– rotor, max. permissible		+85 (optional version +125)				°C
21 Shaft bearings		sintered bearings				
22 Shaft load max.:						
– with shaft diameter		1				mm
– radial at 3 000 rpm (1,5 mm from bearing)		0,5				N
– axial at 3 000 rpm		0,1				N
– axial at standstill		20				N
23 Shaft play						
– radial	≤	0,03				mm
– axial	≤	0,2				mm
24 Housing material		steel, black coated				
25 Weight		8,8				g
26 Direction of rotation		clockwise, viewed from the front face				
Recommended values - mathematically independent of each other						
27 Speed up to	$n_{e\ max.}$		12 000	12 000	12 000	rpm
28 Torque up to	$M_{e\ max.}$		1,27	1,21	1,28	mNm



1024 N ... S

1024 M ... S
for Gearhead 10/1

1024 E ... S
for Gearheads 12/3, 12/5

1024 A ... S
for Gearhead 12/4

DC-Micromotors

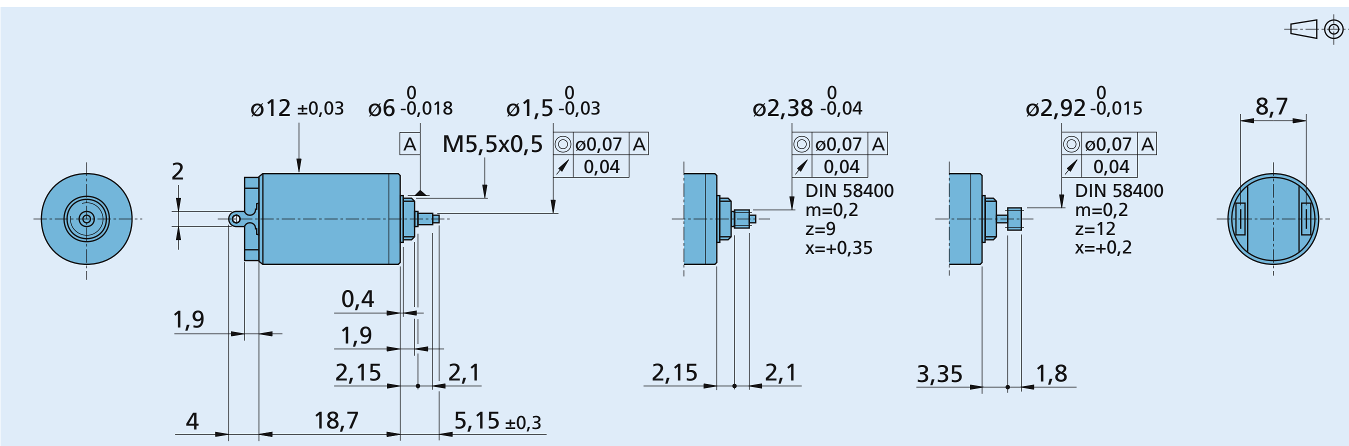
Precious Metal Commutation

0,6 mNm

For combination with
Gearheads:
10/1, 12/3
Encoders:
30B

Series 1219 ... G

	1219 N			4,5 G	006 G	012 G	015 G	
1	Nominal voltage	U_N		4,5	6	12	15	V
2	Terminal resistance	R		10,7	17,6	69	131	Ω
3	Output power	$P_{2\ max.}$		0,46	0,49	0,5	0,41	W
4	Efficiency, max.	$\eta_{max.}$		74	73	72	70	%
5	No-load speed	n_0		15 300	16 000	16 000	16 200	rpm
6	No-load current (with shaft ø 0,8 mm)	I_0		0,008	0,007	0,004	0,003	A
7	Stall torque	M_H		1,14	1,17	1,19	0,96	mNm
8	Friction torque	M_R		0,02	0,02	0,03	0,03	mNm
9	Speed constant	k_n		3 460	2 721	1 364	1 109	rpm/V
10	Back-EMF constant	k_E		0,289	0,368	0,733	0,902	mV/rpm
11	Torque constant	k_M		2,76	3,51	7	8,61	mNm/A
12	Current constant	k_I		0,362	0,285	0,143	0,116	A/mNm
13	Slope of n-M curve	$\Delta n/\Delta M$		13 413	13 642	13 447	16 875	rpm/mNm
14	Rotor inductance	L		150	300	1 200	1 600	µH
15	Mechanical time constant	τ_m		20	20	18	19	ms
16	Rotor inertia	J		0,14	0,14	0,13	0,11	gcm²
17	Angular acceleration	$\alpha_{max.}$		81	84	92	87	·10³rad/s²
18	Thermal resistance	$R_{th\,1}$ / $R_{th\,2}$	17 / 48					K/W
19	Thermal time constant	τ_{w1} / τ_{w2}	3,5 / 386					s
20	Operating temperature range:							
	– motor		-30 ... +85 (optional version -30 ... +125)					°C
	– rotor, max. permissible		+85 (optional version +125)					°C
21	Shaft bearings		sintered bearings	ball bearings				
22	Shaft load max.:		(standard)	(optional version)				
	– with shaft diameter		0,8	1				mm
	– radial at 3 000 rpm (1,5 mm from bearing)		0,5	5				N
	– axial at 3 000 rpm		0,1	0,5				N
	– axial at standstill		20	5				N
23	Shaft play							
	– radial	≤	0,03	0,02				mm
	– axial	≤	0,2	0,2				mm
24	Housing material		steel, nickel plated					
25	Weight		11					g
26	Direction of rotation		clockwise, viewed from the front face					
Recommended values - mathematically independent of each other								
27	Speed up to	$n_{e\ max.}$		12 000	12 000	12 000	12 000	rpm
28	Torque up to	$M_{e\ max.}$		0,6	0,6	0,6	0,6	mNm



1219 N ... G

1219 E ... G
for Gearhead 12/3

1219 M ... G
for Gearhead 10/1

DC-Micromotors

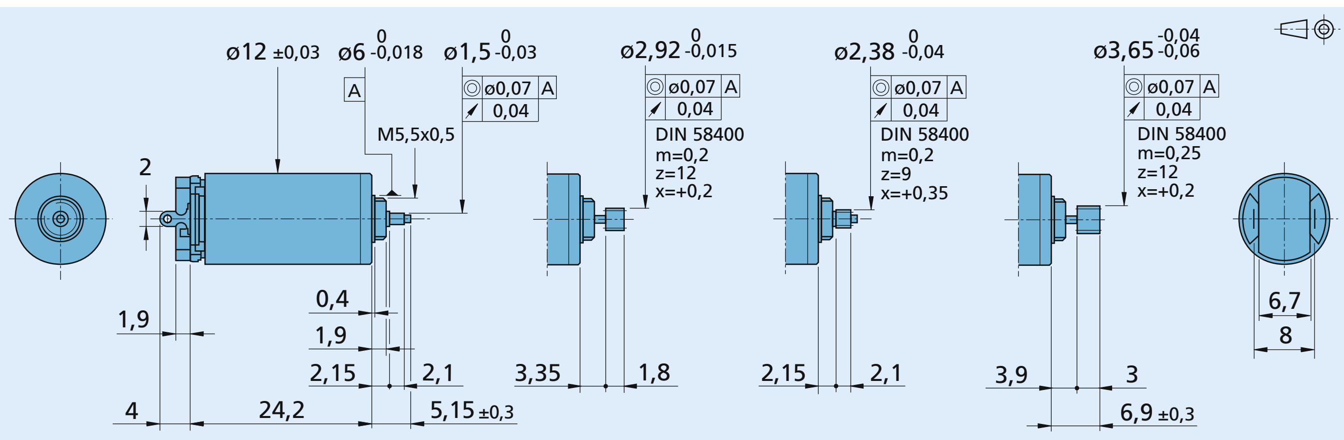
Precious Metal Commutation

1 mNm

For combination with
Gearheads:
10/1, 12/3, 12/4, 12/5
Encoders:
30B

Series 1224 ... S

		1224 N		006 S	012 S	015 S	
1	Nominal voltage	U_N		6	12	15	V
2	Terminal resistance	R		6,6	26,8	42,3	Ω
3	Output power	$P_{2\ max.}$		1,3	1,3	1,3	W
4	Efficiency, max.	$\eta_{max.}$		78	78	78	%
5	No-load speed	n_0		12 700	13 100	12 400	rpm
6	No-load current (with shaft ø 1 mm)	I_0		0,013	0,006	0,005	A
7	Stall torque	M_H		3,69	3,6	3,62	mNm
8	Friction torque	M_R		0,05	0,05	0,05	mNm
9	Speed constant	k_n		2 318	1 173	923	rpm/V
10	Back-EMF constant	k_E		0,431	0,852	1,084	mV/rpm
11	Torque constant	k_M		4,12	8,14	10,35	mNm/A
12	Current constant	k_I		0,243	0,123	0,097	A/mNm
13	Slope of n-M curve	$\Delta n/\Delta M$		3 713	3 862	3 771	rpm/mNm
14	Rotor inductance	L		65	250	450	µH
15	Mechanical time constant	τ_m		7	7	7	ms
16	Rotor inertia	J		0,18	0,18	0,18	gcm²
17	Angular acceleration	$\alpha_{max.}$		205	200	201	·10³rad/s²
18	Thermal resistance	$R_{th\ 1}$ / $R_{th\ 2}$	22 / 45				K/W
19	Thermal time constant	τ_{w1} / τ_{w2}	6,5 / 392				s
20	Operating temperature range:						
	– motor		-30 ... +85 (optional version -30 ... +125)				°C
	– rotor, max. permissible		+85 (optional version +125)				°C
21	Shaft bearings		sintered bearings				
22	Shaft load max.:						
	– with shaft diameter		1				mm
	– radial at 3 000 rpm (1,5 mm from bearing)		0,5				N
	– axial at 3 000 rpm		0,1				N
	– axial at standstill		20				N
23	Shaft play						
	– radial	≤	0,03				mm
	– axial	≤	0,2				mm
24	Housing material		steel, nickel plated				
25	Weight		13				g
26	Direction of rotation		clockwise, viewed from the front face				
	Recommended values - mathematically independent of each other						
27	Speed up to	$n_{e\ max.}$		12 000	12 000	12 000	rpm
28	Torque up to	$M_{e\ max.}$		1	1	1	mNm



1224 N ... S

1224 M ... S
for Gearhead 10/1

1224 E ... S
for Gearheads 12/3, 12/5

1224 A ... S
for Gearhead 12/4

DC-Micromotors

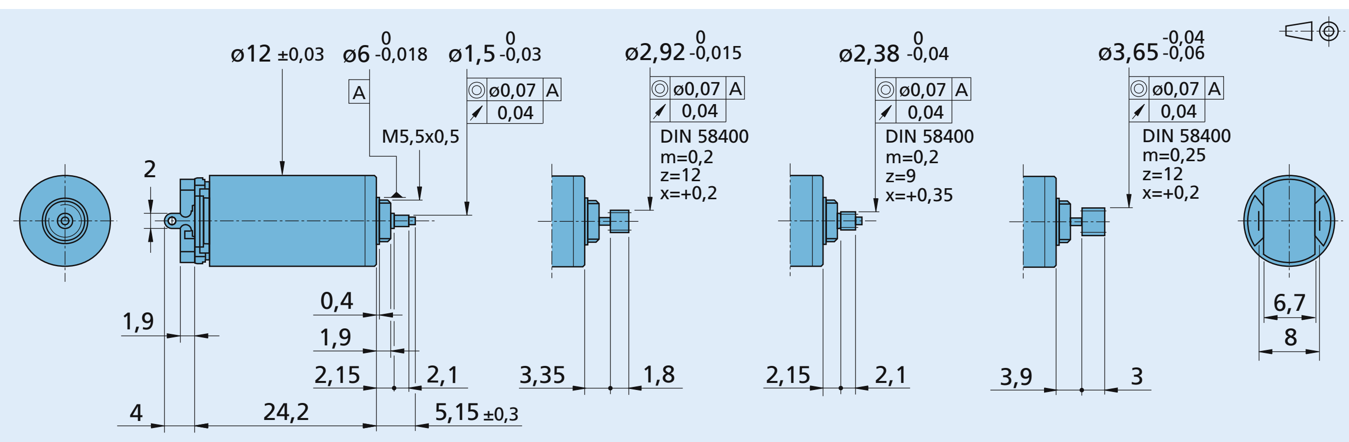
1,8 mNm

Precious Metal Commutation

For combination with
Gearheads:
10/1, 12/3, 12/4, 12/5
Encoders:
30B, HEM3-256-W, PA2-100

Series 1224 ... SR

		1224 N		006 SR	012 SR	015 SR	
1	Nominal voltage	U_N		6	12	15	V
2	Terminal resistance	R		4,6	18,2	29,4	Ω
3	Output power	$P_{2\ max.}$		1,92	1,95	1,88	W
4	Efficiency, max.	$\eta_{max.}$		82	83	83	%
5	No-load speed	n_0		13 800	13 700	13 400	rpm
6	No-load current (with shaft ø 1 mm)	I_0		0,011	0,005	0,004	A
7	Stall torque	M_H		5,31	5,43	5,36	mNm
8	Friction torque	M_R		0,05	0,05	0,05	mNm
9	Speed constant	k_n		2 323	1 151	901	rpm/V
10	Back-EMF constant	k_E		0,43	0,869	1,11	mV/rpm
11	Torque constant	k_M		4,11	8,3	10,6	mNm/A
12	Current constant	k_I		0,243	0,12	0,094	A/mNm
13	Slope of n-M curve	$\Delta n/\Delta M$		2 600	2 523	2 499	rpm/mNm
14	Rotor inductance	L		55	220	350	µH
15	Mechanical time constant	τ_m		5	5	5	ms
16	Rotor inertia	J		0,18	0,18	0,18	gcm²
17	Angular acceleration	$\alpha_{max.}$		295	302	298	·10³rad/s²
18	Thermal resistance	R_{th1} / R_{th2}	17 / 37				K/W
19	Thermal time constant	τ_{w1} / τ_{w2}	6,5 / 371				s
20	Operating temperature range:						
	– motor		-30 ... +85 (optional version -30 ... +125)				°C
	– rotor, max. permissible		+85 (optional version +125)				°C
21	Shaft bearings		sintered bearings				
22	Shaft load max.:						
	– with shaft diameter		1				mm
	– radial at 3 000 rpm (1,5 mm from bearing)		0,5				N
	– axial at 3 000 rpm		0,1				N
	– axial at standstill		20				N
23	Shaft play						
	– radial	≤	0,03				mm
	– axial	≤	0,2				mm
24	Housing material		steel, black coated				
25	Weight		13,5				g
26	Direction of rotation		clockwise, viewed from the front face				
Recommended values - mathematically independent of each other							
27	Speed up to	$n_{e\ max.}$		12 000	12 000	12 000	rpm
28	Torque up to	$M_{e\ max.}$		1,8	1,86	1,86	mNm



1224 N ... SR

1224 M ... SR
for Gearhead 10/1

1224 E ... SR
for Gearheads 12/3, 12/5

1224 A ... SR
for Gearhead 12/4

DC-Micromotors

DC-Micromotors

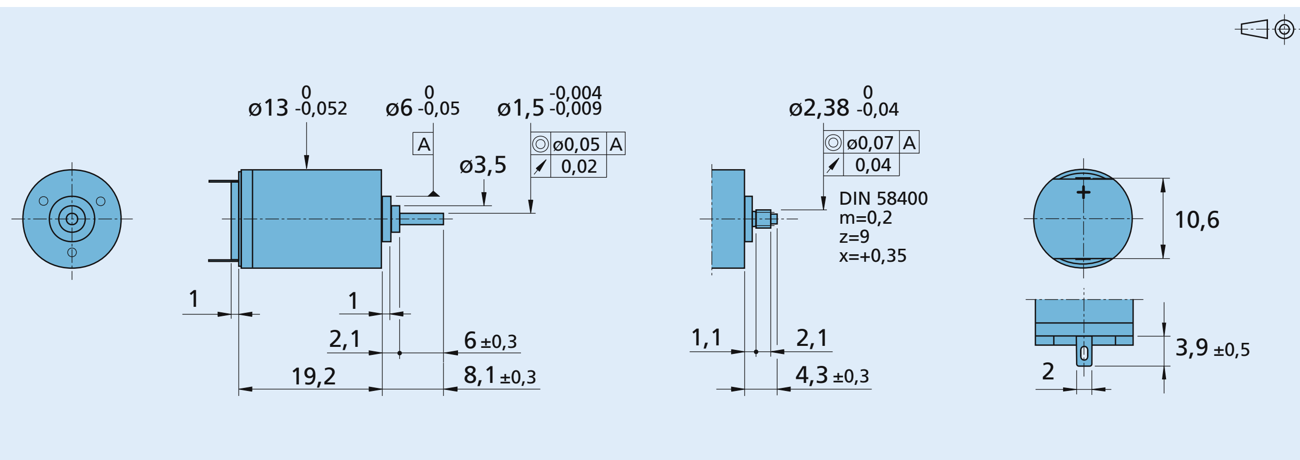
Precious Metal Commutation

1,3 mNm

For combination with
Gearheads:
13A, 14/1, 15/5(S)
Encoders:
IE2-400

Series 1319 ... SR

		1319 T		006 SR	012 SR	024 SR	
1	Nominal voltage	U_N		6	12	24	V
2	Terminal resistance	R		8,26	34,6	119	Ω
3	Output power	$P_{2\ max.}$		1	0,95	1,1	W
4	Efficiency, max.	$\eta_{max.}$		66	65	66	%
5	No-load speed	n_0		13 100	12 800	14 600	rpm
6	No-load current (with shaft ø 1,5 mm)	I_0		0,031	0,015	0,009	A
7	Stall torque	M_H		2,91	2,84	2,89	mNm
8	Friction torque	M_R		0,13	0,13	0,13	mNm
9	Speed constant	k_n		2 280	1 110	637	rpm/V
10	Back-EMF constant	k_E		0,438	0,897	1,57	mV/rpm
11	Torque constant	k_M		4,19	8,57	15	mNm/A
12	Current constant	k_I		0,239	0,117	0,067	A/mNm
13	Slope of n-M curve	$\Delta n/\Delta M$		4 500	4 510	5 050	rpm/mNm
14	Rotor inductance	L		130	530	1 600	µH
15	Mechanical time constant	τ_m		19	19	19	ms
16	Rotor inertia	J		0,4	0,4	0,36	gcm²
17	Angular acceleration	$\alpha_{max.}$		72	71	80	$\cdot 10^3$rad/s²
18	Thermal resistance	R_{th1} / R_{th2}	8 / 35				K/W
19	Thermal time constant	τ_{w1} / τ_{w2}	3,8 / 175				s
20	Operating temperature range:						
	– motor		-30 ... +85 (optional version -55 ... +125)				°C
	– rotor, max. permissible		+125				°C
21	Shaft bearings		sintered bearings				
22	Shaft load max.:						
	– with shaft diameter		1,5				mm
	– radial at 3 000 rpm (3 mm from bearing)		1,2				N
	– axial at 3 000 rpm		0,2				N
	– axial at standstill		20				N
23	Shaft play						
	– radial	≤	0,03				mm
	– axial	≤	0,2				mm
24	Housing material		steel, black coated				
25	Weight		12				g
26	Direction of rotation		clockwise, viewed from the front face				
	Recommended values - mathematically independent of each other						
27	Speed up to	$n_{e\ max.}$		12 000	12 000	12 000	rpm
28	Torque up to	$M_{e\ max.}$		1,3	1,3	1,3	mNm



1319 T ... SR

1319 E ... SR

DC-Micromotors

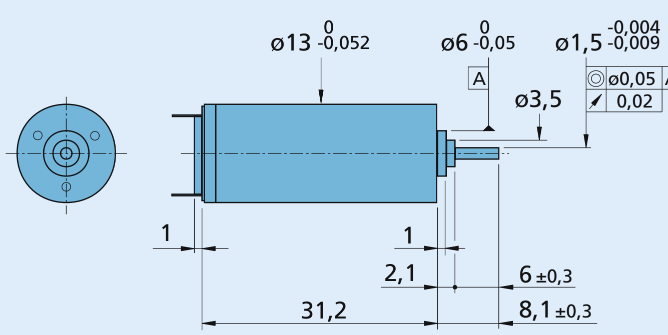
Precious Metal Commutation

3,2 mNm

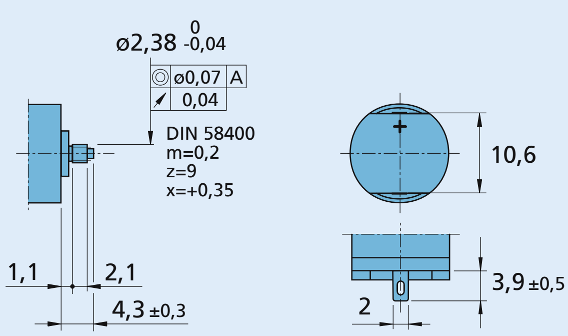
For combination with
Gearheads:
13A, 14/1, 15/5(S)
Encoders:
IE2-400

Series 1331 ... SR

		1331 T		006 SR	012 SR	024 SR	
1	Nominal voltage	U_N		6	12	24	V
2	Terminal resistance	R		2,83	13,7	52,9	Ω
3	Output power	$P_{2\,max.}$		3,11	2,57	2,66	W
4	Efficiency, max.	$\eta_{max.}$		81	80	80	%
5	No-load speed	n_0		10 600	9 900	10 400	rpm
6	No-load current (with shaft ø 1,5 mm)	I_0		0,022	0,0105	0,0055	A
7	Stall torque	M_H		11,2	9,9	9,76	mNm
8	Friction torque	M_R		0,12	0,12	0,12	mNm
9	Speed constant	k_n		1 790	835	439	rpm/V
10	Back-EMF constant	k_E		0,56	1,2	2,28	mV/rpm
11	Torque constant	k_M		5,35	11,4	21,8	mNm/A
12	Current constant	k_I		0,187	0,087	0,046	A/mNm
13	Slope of n-M curve	$\Delta n/\Delta M$		946	1 000	1 070	rpm/mNm
14	Rotor inductance	L		70	310	1 100	µH
15	Mechanical time constant	τ_m		7	7	7	ms
16	Rotor inertia	J		0,71	0,67	0,63	gcm²
17	Angular acceleration	$\alpha_{max.}$		160	150	160	·10³rad/s²
18	Thermal resistance	R_{th1} / R_{th2}	6 / 25				K/W
19	Thermal time constant	τ_{w1} / τ_{w2}	5 / 190				s
20	Operating temperature range:						
	– motor		-30 ... +85 (optional version -55 ... +125)				°C
	– rotor, max. permissible		+125				°C
21	Shaft bearings		sintered bearings				
22	Shaft load max.:						
	– with shaft diameter		1,5				mm
	– radial at 3 000 rpm (3 mm from bearing)		1,2				N
	– axial at 3 000 rpm		0,2				N
	– axial at standstill		20				N
23	Shaft play						
	– radial	≤	0,03				mm
	– axial	≤	0,2				mm
24	Housing material		steel, black coated				
25	Weight		19				g
26	Direction of rotation		clockwise, viewed from the front face				
	Recommended values - mathematically independent of each other						
27	Speed up to	$n_{e\,max.}$		12 000	12 000	12 000	rpm
28	Torque up to	$M_{e\,max.}$		3,2	3,2	3,2	mNm



1331 T ... SR



1331 E ... SR

NEW

DC-Micromotors

Graphite Commutation

FAULHABER

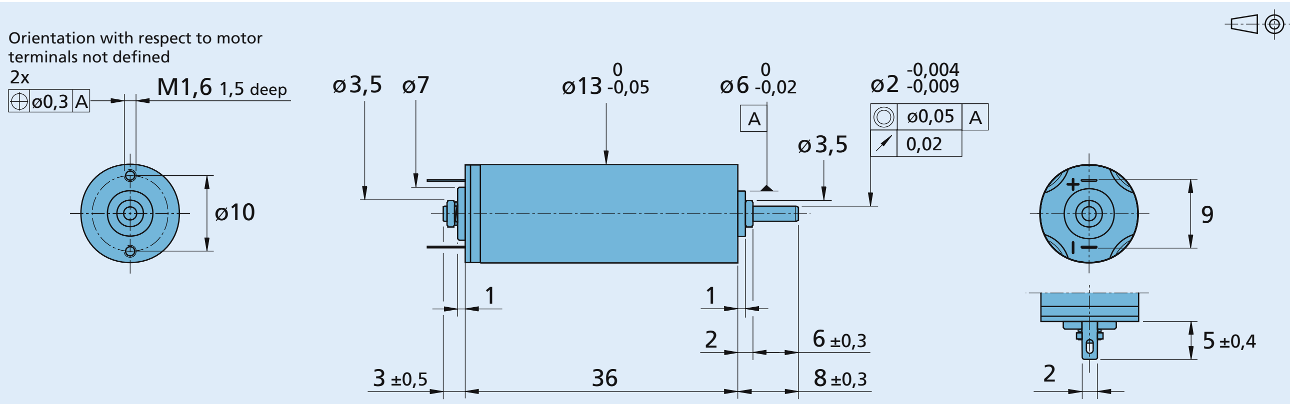
4 mNm

For combination with
Gearheads:
13A, 14/1
Encoders:
20B, 21B, 30B, IE2-1024, IE2-16

DC-Micromotors

Series 1336 ... CXR

	1336 U			006 CXR	012 CXR	024 CXR	
1	Nominal voltage	U_N		6	12	24	V
2	Terminal resistance	R		3,98	15,6	63,7	Ω
3	Output power	$P_{2\ max.}$		1,77	1,98	2,02	W
4	Efficiency, max.	$\eta_{max.}$		61	64	65	%
5	No-load speed	n_0		8 400	8 800	9 000	rpm
6	No-load current (with shaft ø 2 mm)	I_0		0,048	0,025	0,013	A
7	Stall torque	M_H		8,1	8,6	8,6	mNm
8	Friction torque	M_R		0,29	0,3	0,3	mNm
9	Speed constant	k_n		1 575	787	394	rpm/V
10	Back-EMF constant	k_E		0,635	1,271	2,538	mV/rpm
11	Torque constant	k_M		6,06	12,13	24,25	mNm/A
12	Current constant	k_I		0,165	0,082	0,041	A/mNm
13	Slope of n-M curve	$\Delta n/\Delta M$		1 035	1 012	1 034	rpm/mNm
14	Rotor inductance	L		70	280	1 100	µH
15	Mechanical time constant	τ_m		6	6	6,1	ms
16	Rotor inertia	J		0,55	0,57	0,56	gcm²
17	Angular acceleration	$\alpha_{max.}$		147	152	154	·10³rad/s²
18	Thermal resistance	$R_{th\ 1}$ / $R_{th\ 2}$	13 / 28				K/W
19	Thermal time constant	τ_{w1} / τ_{w2}	11 / 245				s
20	Operating temperature range:						
	– motor		-30 ... +100				°C
	– rotor, max. permissible		+125				°C
21	Shaft bearings		ball bearings, preloaded				
22	Shaft load max.:						
	– with shaft diameter		2				mm
	– radial at 3 000 rpm (3 mm from bearing)		8				N
	– axial at 3 000 rpm		0,8				N
	– axial at standstill		10				N
23	Shaft play						
	– radial	≤	0,015				mm
	– axial	=	0				mm
24	Housing material		steel, nickel plated				
25	Weight		21				g
26	Direction of rotation		clockwise, viewed from the front face				
Recommended values - mathematically independent of each other							
27	Speed up to	$n_{e\ max.}$		9 000	9 000	9 000	rpm
28	Torque up to	$M_{e\ max.}$		3,5	3,5	3,5	mNm



1336 U ... CXR

DC-Micromotors

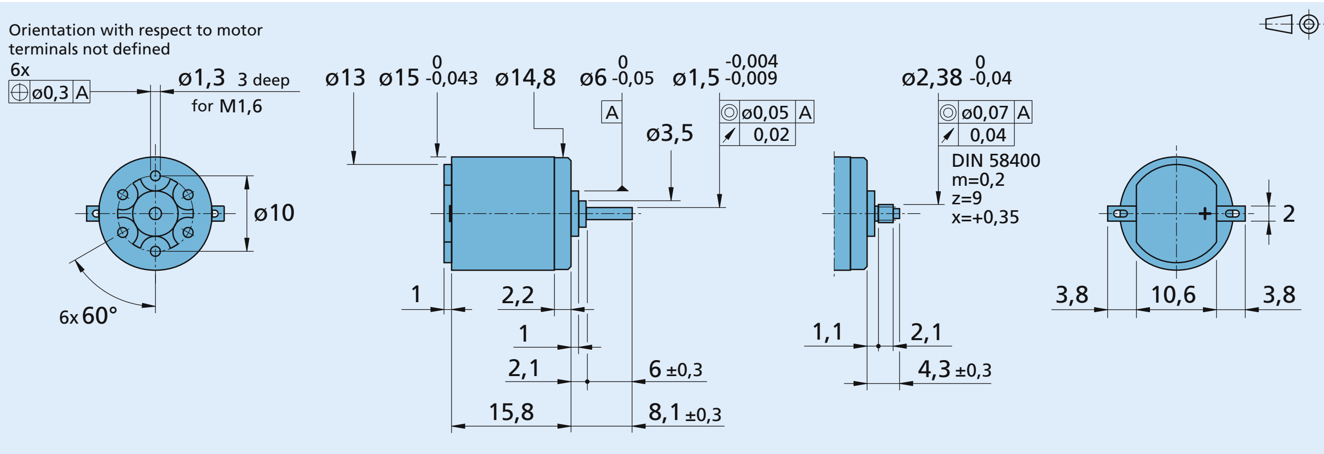
Precious Metal Commutation

0,4 mNm

For combination with
Gearheads:
15/5(S), 16A

Series 1516 ... S

		1516 T		1,5 S	002 S	4,5 S	006 S	012 S	
1	Nominal voltage	U_N		1,5	2	4,5	6	12	V
2	Terminal resistance	R		1,11	3,25	14,7	31,2	115	Ω
3	Output power	$P_{2\ max.}$		0,45	0,25	0,29	0,23	0,25	W
4	Efficiency, max.	$\eta_{max.}$		59	48	50	45	47	%
5	No-load speed	n_0		14 400	14 200	15 000	15 000	15 600	rpm
6	No-load current (with shaft ø 1,5 mm)	I_0		0,075	0,057	0,027	0,021	0,011	A
7	Stall torque	M_H		1,2	0,68	0,73	0,59	0,62	mNm
8	Friction torque	M_R		0,07	0,07	0,07	0,07	0,07	mNm
9	Speed constant	k_n		10 159	7 827	3 659	2 800	1 445	rpm/V
10	Back-EMF constant	k_E		0,098	0,128	0,273	0,357	0,692	mV/rpm
11	Torque constant	k_M		0,94	1,22	2,61	3,41	6,61	mNm/A
12	Current constant	k_I		1,064	0,82	0,383	0,293	0,151	A/mNm
13	Slope of n-M curve	$\Delta n/\Delta M$		12 000	20 800	20 600	25 600	25 100	rpm/mNm
14	Rotor inductance	L		16	27	140	240	900	µH
15	Mechanical time constant	τ_m		39	45	56	56	60	ms
16	Rotor inertia	J		0,31	0,21	0,26	0,21	0,23	gcm²
17	Angular acceleration	$\alpha_{max.}$		39	32	28	28	27	·10³rad/s²
18	Thermal resistance	$R_{th\ 1}$ / $R_{th\ 2}$	8 / 45						K/W
19	Thermal time constant	τ_{w1} / τ_{w2}	2 / 200						s
20	Operating temperature range:								
	– motor		-30 ... +65 (optional version -55 ... +125)						°C
	– rotor, max. permissible		+65 (optional version +125)						°C
21	Shaft bearings		sintered bearings		ball bearings		ball bearings, preloaded		
22	Shaft load max.:		(standard)		(optional version)		(optional version)		
	– with shaft diameter		1,5		1,5		1,5		mm
	– radial at 3 000 rpm (3 mm from bearing)		1,2		5		5		N
	– axial at 3 000 rpm		0,2		0,5		0,5		N
	– axial at standstill		20		10		10		N
23	Shaft play								
	– radial	≤	0,03		0,015		0,015		mm
	– axial	≤	0,2		0,2		0		mm
24	Housing material		steel, zinc galvanized and passivated						
25	Weight		10						g
26	Direction of rotation		clockwise, viewed from the front face						
Recommended values - mathematically independent of each other									
27	Speed up to	$n_{e\ max.}$		12 000	12 000	12 000	12 000	12 000	rpm
28	Torque up to	$M_{e\ max.}$		0,4	0,4	0,4	0,4	0,4	mNm



1516 T ... S

1516 E ... S

DC-Micromotors

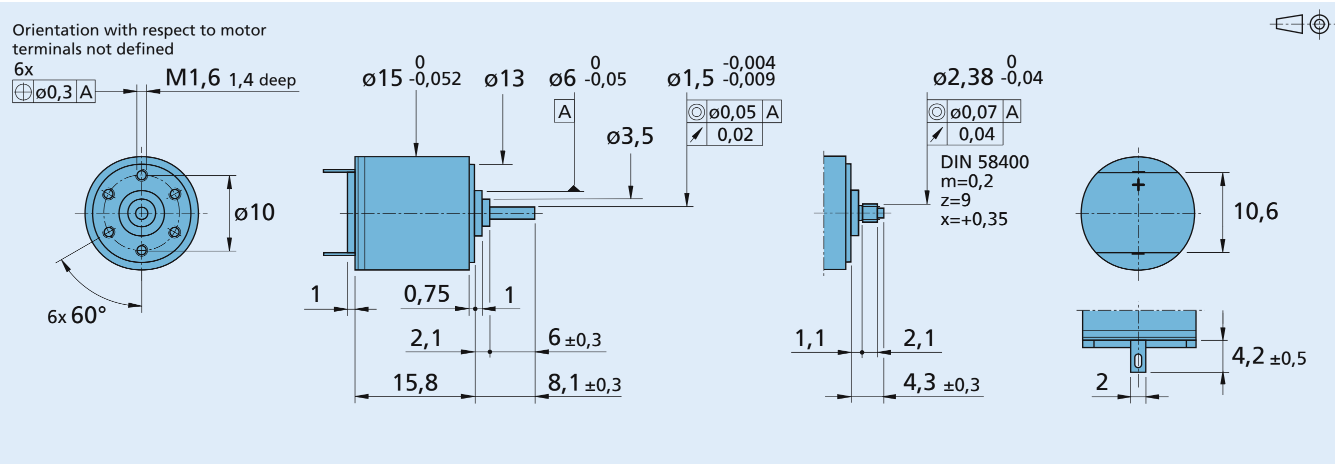
Precious Metal Commutation

0,8 mNm

For combination with
Gearheads:
15/5(S), 15/8, 15A, 16/7, 16A
Encoders:
IE2-1024, IE2-16

Series 1516 ... SR

		1516 T	006 SR	009 SR	012 SR	
1	Nominal voltage	U_N	6	9	12	V
2	Terminal resistance	R	15,2	32,5	60	Ω
3	Output power	$P_{2\ max.}$	0,51	0,54	0,52	W
4	Efficiency, max.	$\eta_{\ max.}$	57	58	58	%
5	No-load speed	n_0	12 800	12 800	12 900	rpm
6	No-load current (with shaft ø 1,5 mm)	I_0	0,029	0,019	0,014	A
7	Stall torque	M_H	1,52	1,61	1,53	mNm
8	Friction torque	M_R	0,12	0,12	0,12	mNm
9	Speed constant	k_n	2 300	1 530	1 160	rpm/V
10	Back-EMF constant	k_E	0,434	0,655	0,865	mV/rpm
11	Torque constant	k_M	4,15	6,25	8,26	mNm/A
12	Current constant	k_I	0,241	0,16	0,121	A/mNm
13	Slope of n-M curve	$\Delta n/\Delta M$	8 420	7 950	8 430	rpm/mNm
14	Rotor inductance	L	100	230	400	µH
15	Mechanical time constant	τ_m	35	35	35	ms
16	Rotor inertia	J	0,4	0,42	0,4	gcm²
17	Angular acceleration	$\alpha_{\ max.}$	38	38	39	·10³rad/s²
18	Thermal resistance	$R_{th\ 1}$ / $R_{th\ 2}$	10 / 33			K/W
19	Thermal time constant	τ_{w1} / τ_{w2}	2,9 / 190			s
20	Operating temperature range:					
	– motor		-30 ... +85 (optional version -55 ... +125)			°C
	– rotor, max. permissible		+125			°C
21	Shaft bearings		sintered bearings	ball bearings	ball bearings, preloaded	
22	Shaft load max.:		(standard)	(optional version)	(optional version)	
	– with shaft diameter		1,5	1,5	1,5	mm
	– radial at 3 000 rpm (3 mm from bearing)		1,2	5	5	N
	– axial at 3 000 rpm		0,2	0,5	0,5	N
	– axial at standstill		20	10	10	N
23	Shaft play					
	– radial	≤	0,03	0,015	0,015	mm
	– axial	≤	0,2	0,2	0	mm
24	Housing material		steel, black coated			
25	Weight		13			g
26	Direction of rotation		clockwise, viewed from the front face			
Recommended values - mathematically independent of each other						
27	Speed up to	$n_{e\ max.}$	12 000	12 000	12 000	rpm
28	Torque up to	$M_{e\ max.}$	0,8	0,8	0,8	mNm



1516 T ... SR

1516 E ... SR

DC-Micromotors

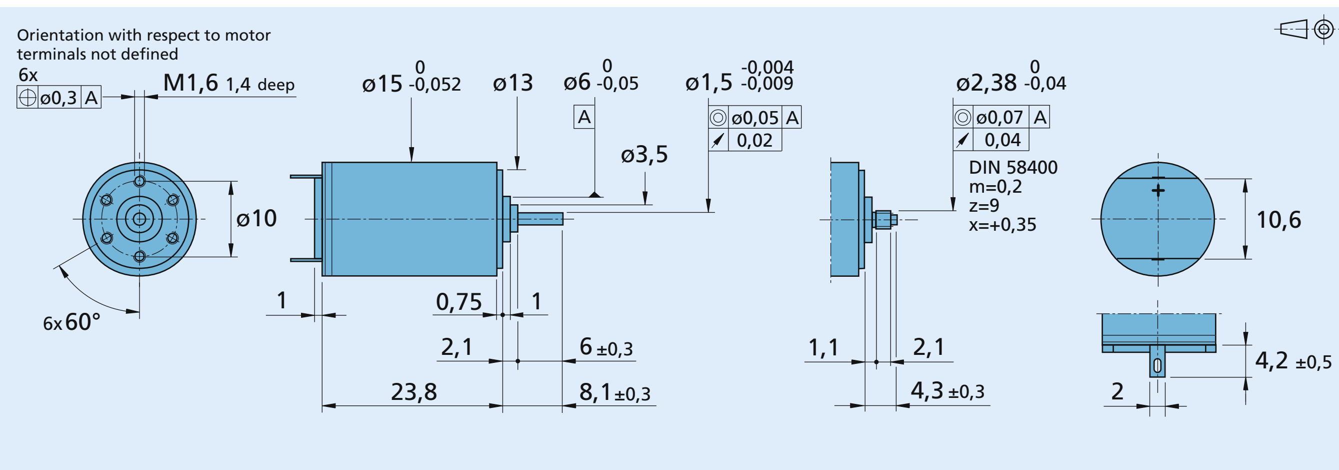
Precious Metal Commutation

2,5 mNm

For combination with
Gearheads:
15/5(S), 15/8, 15A, 16/7, 16A
Encoders:
IE2-1024, IE2-16

Series 1524 ... SR

	1524 T	003 SR	006 SR	009 SR	012 SR	018 SR	024 SR	
1 Nominal voltage	U_N	3	6	9	12	18	24	V
2 Terminal resistance	R	1,1	5,1	10,4	19,8	44	79,6	Ω
3 Output power	$P_{2\ max.}$	1,92	1,7	1,88	1,75	1,78	1,75	W
4 Efficiency, max.	$\eta_{max.}$	77	77	77	76	77	78	%
5 No-load speed	n_0	10 800	9 700	10 100	9 900	9 900	9 900	rpm
6 No-load current (with shaft ø 1,5 mm)	I_0	0,047	0,021	0,014	0,011	0,007	0,005	A
7 Stall torque	M_H	6,8	6,68	7,12	6,76	6,86	6,75	mNm
8 Friction torque	M_R	0,12	0,12	0,12	0,13	0,12	0,11	mNm
9 Speed constant	k_n	3 660	1 650	1 140	840	560	419	rpm/V
10 Back-EMF constant	k_E	0,273	0,607	0,877	1,19	1,79	2,38	mV/rpm
11 Torque constant	k_M	2,61	5,8	8,37	11,4	17,1	22,8	mNm/A
12 Current constant	k_I	0,384	0,172	0,119	0,088	0,059	0,044	A/mNm
13 Slope of n-M curve	$\Delta n/\Delta M$	1 590	1 450	1 420	1 460	1 440	1 470	rpm/mNm
14 Rotor inductance	L	17	70	150	250	560	1 000	µH
15 Mechanical time constant	τ_m	10	10	10	10	10	10	ms
16 Rotor inertia	J	0,6	0,66	0,67	0,65	0,66	0,65	gcm²
17 Angular acceleration	$\alpha_{max.}$	110	100	110	100	100	100	·10³rad/s²
18 Thermal resistance	$R_{th\,1}$ / $R_{th\,2}$	4,5 / 31						K/W
19 Thermal time constant	τ_{w1} / τ_{w2}	2,4 / 300						s
20 Operating temperature range:								
– motor		-30 ... +85 (optional version -55 ... +125)						°C
– rotor, max. permissible		+125						°C
21 Shaft bearings		sintered bearings		ball bearings		ball bearings, preloaded		
22 Shaft load max.:		(standard)		(optional version)		(optional version)		
– with shaft diameter		1,5		1,5		1,5		mm
– radial at 3 000 rpm (3 mm from bearing)		1,2		5		5		N
– axial at 3 000 rpm		0,2		0,5		0,5		N
– axial at standstill		20		10		10		N
23 Shaft play								
– radial	≤	0,03		0,015		0,015		mm
– axial	≤	0,2		0,2		0		mm
24 Housing material		steel, black coated						
25 Weight		21						g
26 Direction of rotation		clockwise, viewed from the front face						
Recommended values - mathematically independent of each other								
27 Speed up to	$n_{e\ max.}$	10 000	10 000	10 000	10 000	10 000	10 000	rpm
28 Torque up to	$M_{e\ max.}$	2,5	2,5	2,5	2,5	2,5	2,5	mNm



1524 T ... SR **1524 E ... SR**

DC-Micromotors

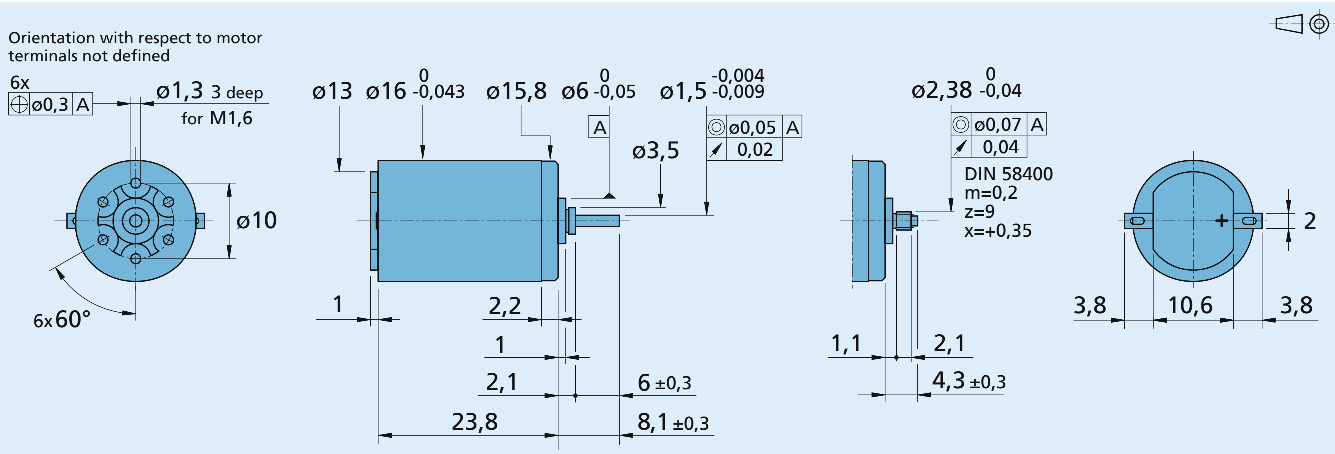
Precious Metal Commutation

1,5 mNm

For combination with
Gearheads:
15A, 16/5(S), 16/7, 16/8, 16A

Series 1624 ... S

		1624 T	003 S	006 S	009 S	012 S	018 S	024 S	
1	Nominal voltage	U_N	3	6	9	12	18	24	V
2	Terminal resistance	R	1,6	9,1	14,5	24	42	75	Ω
3	Output power	$P_{2\ max.}$	1,36	0,93	1,34	1,44	1,87	1,85	W
4	Efficiency, max.	$\eta_{max.}$	78	71	75	75	77	76	%
5	No-load speed	n_0	12 000	10 500	11 500	13 000	13 800	14 400	rpm
6	No-load current (with shaft ø 1,5 mm)	I_0	0,03	0,019	0,012	0,01	0,007	0,006	A
7	Stall torque	M_H	4,33	3,39	4,46	4,23	5,16	4,91	mNm
8	Friction torque	M_R	0,07	0,1	0,09	0,09	0,09	0,09	mNm
9	Speed constant	k_n	4 070	1 800	1 300	1 110	779	611	rpm/V
10	Back-EMF constant	k_E	0,246	0,555	0,767	0,905	1,28	1,64	mV/rpm
11	Torque constant	k_M	2,35	5,3	7,33	8,64	12,3	15,6	mNm/A
12	Current constant	k_I	0,426	0,189	0,136	0,116	0,082	0,064	A/mNm
13	Slope of n-M curve	$\Delta n/\Delta M$	2 770	3 100	2 580	3 070	2 670	2 930	rpm/mNm
14	Rotor inductance	L	85	200	400	750	1 200	3 000	µH
15	Mechanical time constant	τ_m	19	22	19	19	19	24	ms
16	Rotor inertia	J	0,65	0,68	0,7	0,59	0,68	0,78	gcm²
17	Angular acceleration	$\alpha_{max.}$	66	50	63	72	76	63	·10³rad/s²
18	Thermal resistance	$R_{th\ 1}$ / $R_{th\ 2}$	8 / 39						K/W
19	Thermal time constant	τ_{w1} / τ_{w2}	4 / 335						s
20	Operating temperature range:								
	– motor		-30 ... +85 (optional version -55 ... +125)						°C
	– rotor, max. permissible		+125						°C
21	Shaft bearings		sintered bearings		ball bearings		ball bearings, preloaded		
22	Shaft load max.:		(standard)		(optional version)		(optional version)		
	– with shaft diameter		1,5		1,5		1,5		mm
	– radial at 3 000 rpm (3 mm from bearing)		1,2		5		5		N
	– axial at 3 000 rpm		0,2		0,5		0,5		N
	– axial at standstill		20		10		10		N
23	Shaft play								
	– radial	≤	0,03		0,015		0,015		mm
	– axial	≤	0,2		0,2		0		mm
24	Housing material		steel, zinc galvanized and passivated						
25	Weight		21						g
26	Direction of rotation		clockwise, viewed from the front face						
Recommended values - mathematically independent of each other									
27	Speed up to	$n_{e\ max.}$	10 000	10 000	10 000	10 000	10 000	10 000	rpm
28	Torque up to	$M_{e\ max.}$	1,5	1,5	1,5	1,5	1,5	1,5	mNm



1624 T ... S **1624 E ... S**

DC-Micromotors

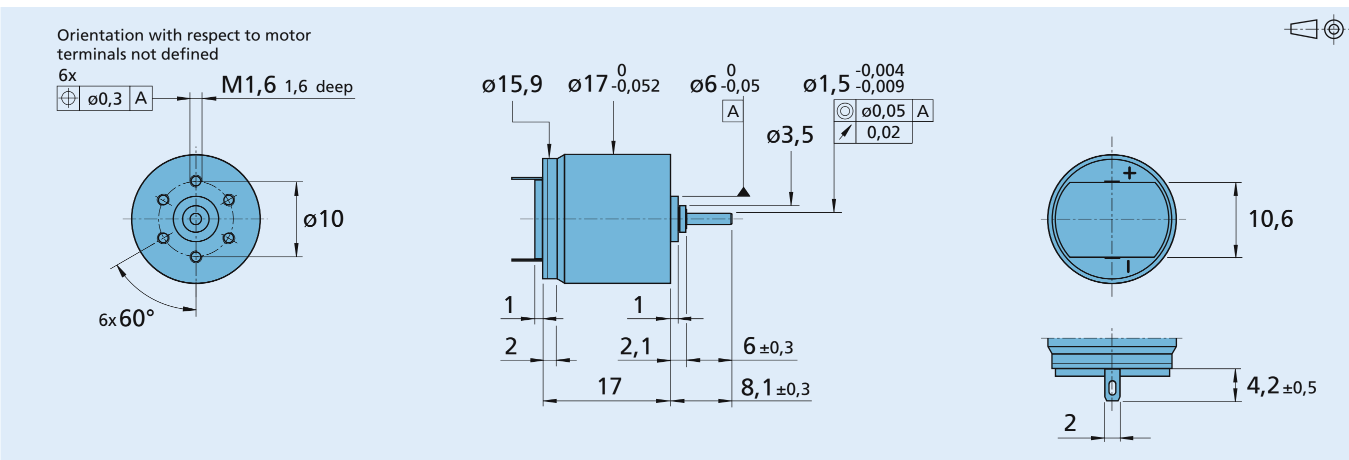
Precious Metal Commutation

2 mNm

For combination with
Gearheads:
15A, 16/7, 16A
Encoders:
IE2-1024, IE2-16

Series 1717 ... SR

		1717 T		003 SR	006 SR	012 SR	018 SR	024 SR	
1	Nominal voltage	U_N		3	6	12	18	24	V
2	Terminal resistance	R		1,07	4,3	17,1	50,1	68,8	Ω
3	Output power	$P_{2\ max.}$		1,97	1,96	1,97	1,5	1,96	W
4	Efficiency, max.	$\eta_{max.}$		69	69	70	68	70	%
5	No-load speed	n_0		14 000	14 000	14 000	12 300	14 000	rpm
6	No-load current (with shaft ø 1,5 mm)	I_0		0,091	0,046	0,023	0,013	0,011	A
7	Stall torque	M_H		5,37	5,34	5,38	4,66	5,36	mNm
8	Friction torque	M_R		0,18	0,18	0,18	0,18	0,17	mNm
9	Speed constant	k_n		4 820	2 410	1 210	709	602	rpm/V
10	Back-EMF constant	k_E		0,207	0,414	0,829	1,41	1,66	mV/rpm
11	Torque constant	k_M		1,98	3,96	7,92	13,5	15,9	mNm/A
12	Current constant	k_I		0,505	0,253	0,126	0,074	0,063	A/mNm
13	Slope of n-M curve	$\Delta n/\Delta M$		2 610	2 620	2 600	2 640	2 610	rpm/mNm
14	Rotor inductance	L		17	65	260	760	1 040	µH
15	Mechanical time constant	τ_m		16	16	16	16	16	ms
16	Rotor inertia	J		0,59	0,58	0,59	0,58	0,59	gcm²
17	Angular acceleration	$\alpha_{max.}$		92	92	92	80	92	·10³rad/s²
18	Thermal resistance	$R_{th\ 1}$ / $R_{th\ 2}$	4,5 / 27						K/W
19	Thermal time constant	τ_{w1} / τ_{w2}	2 / 210						s
20	Operating temperature range:								
	– motor		-30 ... +85 (optional version -55 ... +125)						°C
	– rotor, max. permissible		+125						°C
21	Shaft bearings		sintered bearings		ball bearings		ball bearings, preloaded		
22	Shaft load max.:		(standard)		(optional version)		(optional version)		
	– with shaft diameter		1,5		1,5		1,5		mm
	– radial at 3 000 rpm (3 mm from bearing)		1,2		5		5		N
	– axial at 3 000 rpm		0,2		0,5		0,5		N
	– axial at standstill		20		10		10		N
23	Shaft play								
	– radial	≤	0,03		0,015		0,015		mm
	– axial	≤	0,2		0,2		0		mm
24	Housing material		steel, black coated						
25	Weight		18						g
26	Direction of rotation		clockwise, viewed from the front face						
Recommended values - mathematically independent of each other									
27	Speed up to	$n_{e\ max.}$		10 000	10 000	10 000	10 000	10 000	rpm
28	Torque up to	$M_{e\ max.}$		2	2	2	2	2	mNm



1717 T ... SR

DC-Micromotors

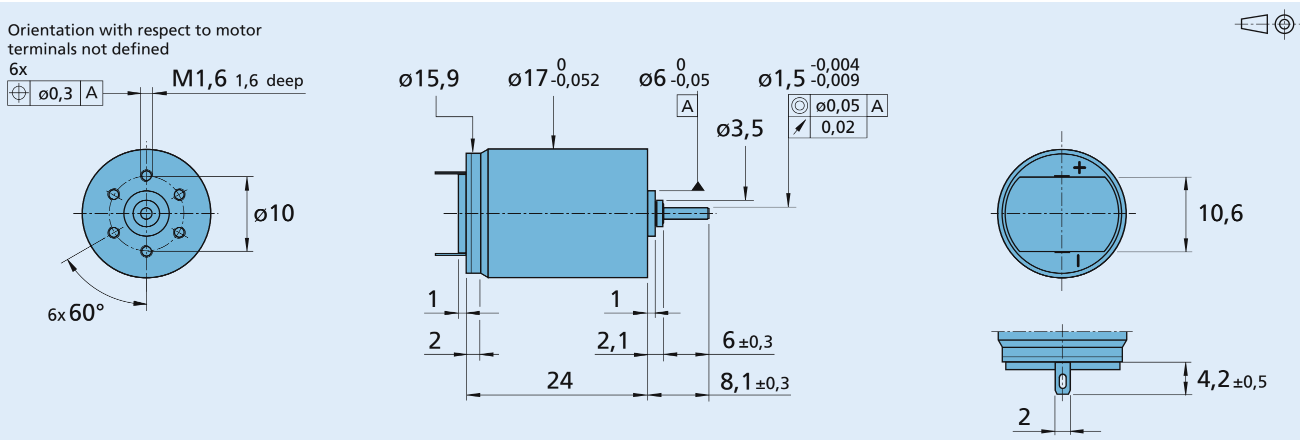
Precious Metal Commutation

4,2 mNm

For combination with
Gearheads:
15A, 16/7, 16A
Encoders:
IE2-1024, IE2-16

Series 1724 ... SR

	1724 T		003 SR	006 SR	012 SR	018 SR	024 SR	
1	Nominal voltage	U_N	3	6	12	18	24	V
2	Terminal resistance	R	0,78	3,41	16,2	32,1	54,6	Ω
3	Output power	$P_{2\ max.}$	2,83	2,58	2,17	2,47	2,58	W
4	Efficiency, max.	$\eta_{max.}$	82	81	80	81	81	%
5	No-load speed	n_0	8 200	8 600	7 900	8 400	8 600	rpm
6	No-load current (with shaft ø 1,5 mm)	I_0	0,038	0,02	0,009	0,006	0,005	A
7	Stall torque	M_H	13,2	11,5	10,5	11,2	11,5	mNm
8	Friction torque	M_R	0,13	0,13	0,13	0,12	0,13	mNm
9	Speed constant	k_n	2 760	1 450	666	472	362	rpm/V
10	Back-EMF constant	k_E	0,362	0,69	1,5	2,12	2,76	mV/rpm
11	Torque constant	k_M	3,46	6,59	14,3	20,2	26,3	mNm/A
12	Current constant	k_I	0,289	0,152	0,07	0,049	0,038	A/mNm
13	Slope of n-M curve	$\Delta n/\Delta M$	621	748	752	750	748	rpm/mNm
14	Rotor inductance	L	21	75	360	710	1 200	µH
15	Mechanical time constant	τ_m	8	8	8	8	8	ms
16	Rotor inertia	J	1,2	1	1	1	1	gcm²
17	Angular acceleration	$\alpha_{max.}$	110	110	100	100	100	·10³rad/s²
18	Thermal resistance	R_{th1} / R_{th2}	4 / 24,5					K/W
19	Thermal time constant	τ_{w1} / τ_{w2}	2,6 / 270					s
20	Operating temperature range:							
	– motor		-30 ... +85 (optional version -55 ... +125)					°C
	– rotor, max. permissible		+125					°C
21	Shaft bearings		sintered bearings	ball bearings		ball bearings, preloaded		
22	Shaft load max.:		(standard)	(optional version)		(optional version)		
	– with shaft diameter		1,5	1,5		1,5		mm
	– radial at 3 000 rpm (3 mm from bearing)		1,2	5		5		N
	– axial at 3 000 rpm		0,2	0,5		0,5		N
	– axial at standstill		20	10		10		N
23	Shaft play							
	– radial	≤	0,03	0,015		0,015		mm
	– axial	≤	0,2	0,2		0		mm
24	Housing material		steel, black coated					
25	Weight		27					g
26	Direction of rotation		clockwise, viewed from the front face					
	Recommended values - mathematically independent of each other							
27	Speed up to	$n_{e\ max.}$	8 000	8 000	8 000	8 000	8 000	rpm
28	Torque up to	$M_{e\ max.}$	4,2	4,2	4,2	4,2	4,2	mNm



1724 T ... SR

DC-Micromotors

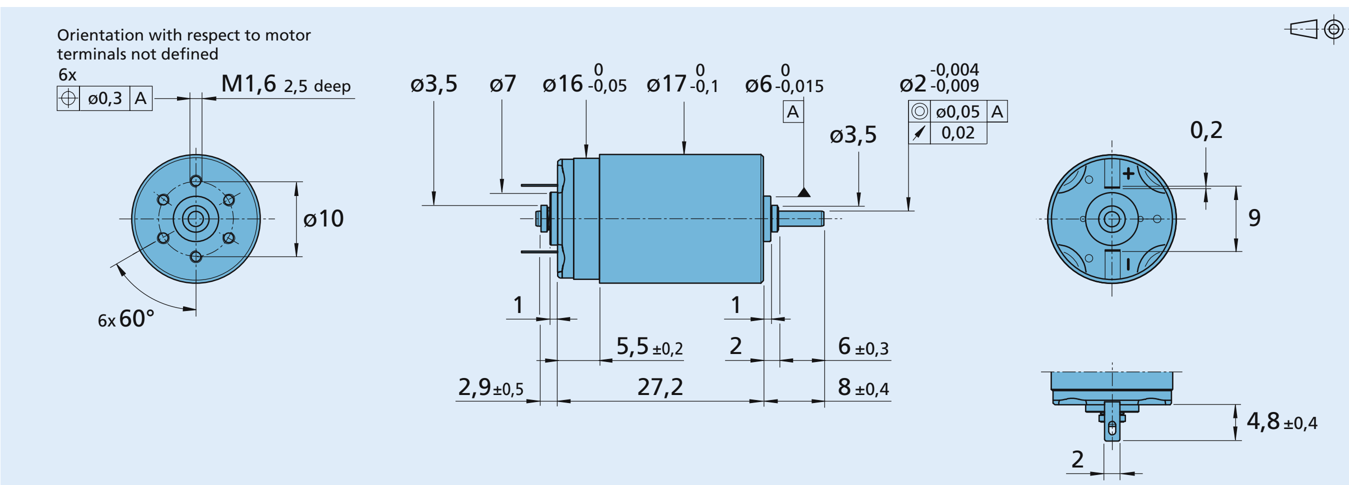
Graphite Commutation

5 mNm

For combination with
Gearheads:
16/7, 20/1
Encoders:
IE2-1024, IE2-16

Series 1727 ... C

	1727 U			006 C	012 C	024 C	
1	Nominal voltage	U_N		6	12	24	V
2	Terminal resistance	R		3	13,8	57,6	Ω
3	Output power	$P_{2\ max.}$		2,37	2,25	2,25	W
4	Efficiency, max.	$\eta_{max.}$		70	70	70	%
5	No-load speed	n_0		7 800	7 800	7 800	rpm
6	No-load current (with shaft ø 2 mm)	I_0		0,055	0,026	0,013	A
7	Stall torque	M_H		11,6	11	11	mNm
8	Friction torque	M_R		0,36	0,35	0,36	mNm
9	Speed constant	k_n		1 460	700	343	rpm/V
10	Back-EMF constant	k_E		0,684	1,43	2,92	mV/rpm
11	Torque constant	k_M		6,53	13,6	27,9	mNm/A
12	Current constant	k_I		0,153	0,073	0,036	A/mNm
13	Slope of n-M curve	$\Delta n/\Delta M$		672	709	709	rpm/mNm
14	Rotor inductance	L		80	320	1 440	µH
15	Mechanical time constant	τ_m		9	9	9	ms
16	Rotor inertia	J		1,3	1,2	1,2	gcm²
17	Angular acceleration	$\alpha_{max.}$		91	91	91	·10³rad/s²
18	Thermal resistance	$R_{th\ 1}$ / $R_{th\ 2}$	5 / 24				K/W
19	Thermal time constant	τ_{w1} / τ_{w2}	4,2 / 254				s
20	Operating temperature range:						
	– motor		-30 ... +100				°C
	– rotor, max. permissible		+125				°C
21	Shaft bearings		ball bearings, preloaded				
22	Shaft load max.:						
	– with shaft diameter		2				mm
	– radial at 3 000 rpm (3 mm from bearing)		8				N
	– axial at 3 000 rpm		0,8				N
	– axial at standstill		10				N
23	Shaft play						
	– radial	≤	0,015				mm
	– axial	=	0				mm
24	Housing material		steel, black coated				
25	Weight		28				g
26	Direction of rotation		clockwise, viewed from the front face				
	Recommended values - mathematically independent of each other						
27	Speed up to	$n_{e\ max.}$		7 000	7 000	7 000	rpm
28	Torque up to	$M_{e\ max.}$		5	5	5	mNm



1727 U ... C

NEW

DC-Micromotors

Graphite Commutation

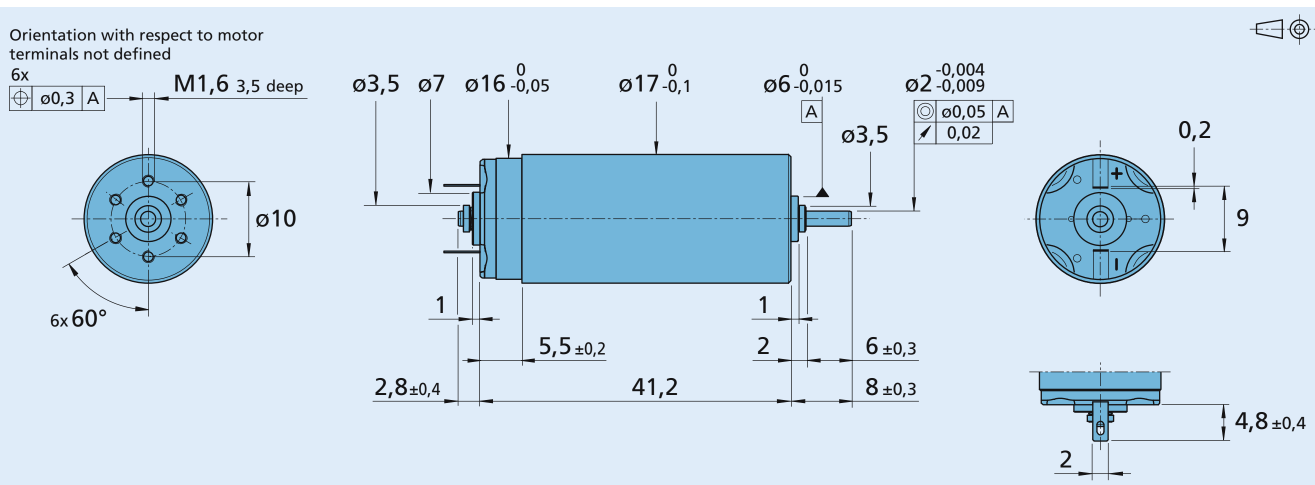
FAULHABER

8 mNm

For combination with
Gearheads:
16/7, 20/1
Encoders:
IE2-1024, IE2-16

Series 1741 ... CXR

		1741 U		006 CXR	012 CXR	018 CXR	024 CXR	
1	Nominal voltage	U_N		6	12	18	24	V
2	Terminal resistance	R		1,3	5,8	15	26,9	Ω
3	Output power	$P_{2\,max.}$		5,71	5,58	5,01	5,03	W
4	Efficiency, max.	$\eta_{max.}$		75	77	78	79	%
5	No-load speed	n_0		7 000	7 500	7 200	7 200	rpm
6	No-load current (with shaft ø 2 mm)	I_0		0,039	0,02	0,013	0,009	A
7	Stall torque	M_H		31,3	28,5	26,7	26,8	mNm
8	Friction torque	M_R		0,29	0,29	0,29	0,29	mNm
9	Speed constant	k_n		1 285	660	415	310	rpm/V
10	Back-EMF constant	k_E		0,778	1,515	2,41	3,226	mV/rpm
11	Torque constant	k_M		7,43	14,48	23,02	30,82	mNm/A
12	Current constant	k_I		0,135	0,069	0,043	0,032	A/mNm
13	Slope of n-M curve	$\Delta n/\Delta M$		225	265	270	270	rpm/mNm
14	Rotor inductance	L		35	135	340	600	µH
15	Mechanical time constant	τ_m		4,2	4,4	4,2	4,2	ms
16	Rotor inertia	J		1,8	1,6	1,5	1,5	gcm²
17	Angular acceleration	$\alpha_{max.}$		174	178	178	179	$\cdot 10^3$rad/s²
18	Thermal resistance	$R_{th\,1}$ / $R_{th\,2}$	7 / 23					K/W
19	Thermal time constant	τ_{w1} / τ_{w2}	8 / 440					s
20	Operating temperature range:							
	– motor		-30 ... +100					°C
	– rotor, max. permissible		+125					°C
21	Shaft bearings		ball bearings, preloaded					
22	Shaft load max.:							
	– with shaft diameter		2					mm
	– radial at 3 000 rpm (3 mm from bearing)		8					N
	– axial at 3 000 rpm		0,8					N
	– axial at standstill		10					N
23	Shaft play							
	– radial	≤	0,015					mm
	– axial	=	0					mm
24	Housing material		steel, zinc galvanized and passivated					
25	Weight		45					g
26	Direction of rotation		clockwise, viewed from the front face					
	Recommended values - mathematically independent of each other							
27	Speed up to	$n_{e\,max.}$		7 000	7 000	7 000	7 000	rpm
28	Torque up to	$M_{e\,max.}$		7,8	7,6	7,7	7,7	mNm



1741 U ... CXR

DC-Micromotors

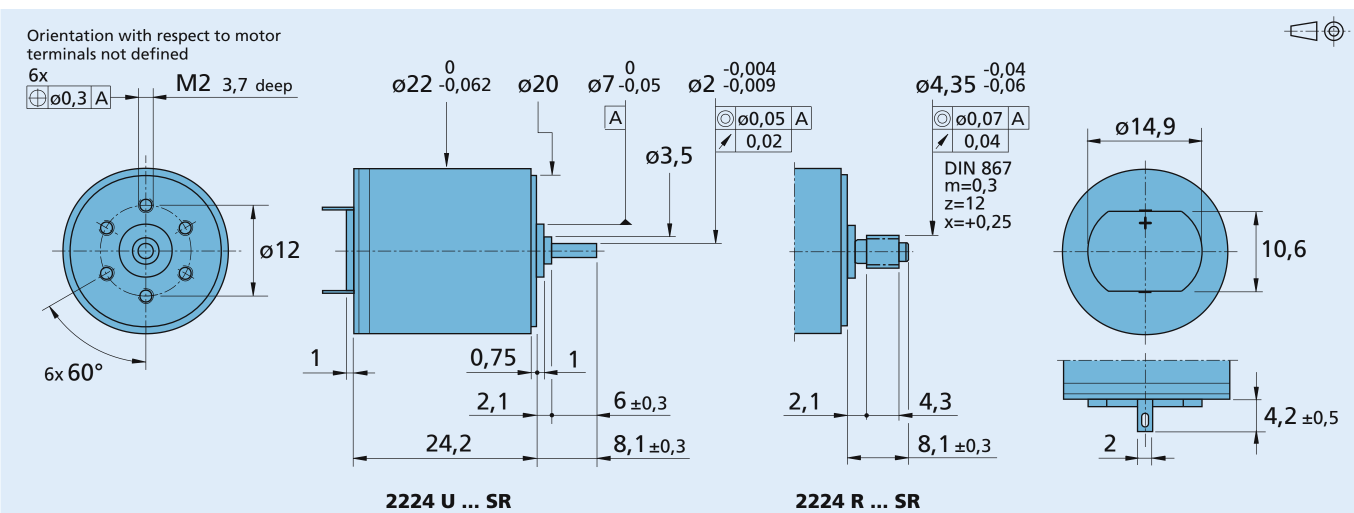
5 mNm

Precious Metal Commutation

For combination with
Gearheads:
20/1, 22/2, 22/5, 22/7, 22E, 22EKV, 22F, 23/1, 38/3
Encoders:
IE2-1024, IE2-16

Series 2224 ... SR

		2224 U	003 SR	006 SR	012 SR	018 SR	024 SR	036 SR	
1	Nominal voltage	U_N	3	6	12	18	24	36	V
2	Terminal resistance	R	0,56	1,94	8,71	17,5	36,3	91,4	Ω
3	Output power	$P_{2\ max.}$	3,92	4,55	4,05	4,54	3,88	3,46	W
4	Efficiency, max.	$\eta_{max.}$	80	82	82	82	81	80	%
5	No-load speed	n_0	8 100	8 200	7 800	8 100	7 800	7 800	rpm
6	No-load current (with shaft ø 2 mm)	I_0	0,066	0,029	0,014	0,01	0,007	0,005	A
7	Stall torque	M_H	18,5	21,2	19,8	21,4	19	16,9	mNm
8	Friction torque	M_R	0,23	0,2	0,2	0,21	0,2	0,22	mNm
9	Speed constant	k_n	2 730	1 380	657	454	328	219	rpm/V
10	Back-EMF constant	k_E	0,366	0,725	1,52	2,2	3,04	4,56	mV/rpm
11	Torque constant	k_M	3,49	6,92	14,5	21	29,1	43,5	mNm/A
12	Current constant	k_I	0,286	0,144	0,069	0,048	0,034	0,023	A/mNm
13	Slope of n-M curve	$\Delta n/\Delta M$	438	387	394	379	411	462	rpm/mNm
14	Rotor inductance	L	11	45	200	450	800	1 800	µH
15	Mechanical time constant	τ_m	11	11	11	11	11	11	ms
16	Rotor inertia	J	2,4	2,7	2,7	2,8	2,6	2,3	gcm²
17	Angular acceleration	$\alpha_{max.}$	77	78	74	77	74	74	·10³rad/s²
18	Thermal resistance	$R_{th\ 1}$ / $R_{th\ 2}$	5 / 20						K/W
19	Thermal time constant	τ_{w1} / τ_{w2}	6,8 / 440						s
20	Operating temperature range:								
	– motor		-30 ... +85 (optional version -55 ... +125)						°C
	– rotor, max. permissible		+125						°C
21	Shaft bearings		sintered bearings		ball bearings		ball bearings, preloaded		
22	Shaft load max.:		(standard)		(optional version)		(optional version)		
	– with shaft diameter		2		2		2		mm
	– radial at 3 000 rpm (3 mm from bearing)		1,5		8		8		N
	– axial at 3 000 rpm		0,2		0,8		0,8		N
	– axial at standstill		20		10		10		N
23	Shaft play								
	– radial	≤	0,03		0,015		0,015		mm
	– axial	≤	0,2		0,2		0		mm
24	Housing material		steel, black coated						
25	Weight		46						g
26	Direction of rotation		clockwise, viewed from the front face						
Recommended values - mathematically independent of each other									
27	Speed up to	$n_{e\ max.}$	8 000	8 000	8 000	8 000	8 000	8 000	rpm
28	Torque up to	$M_{e\ max.}$	5	5	5	5	5	5	mNm



DC-Micromotors

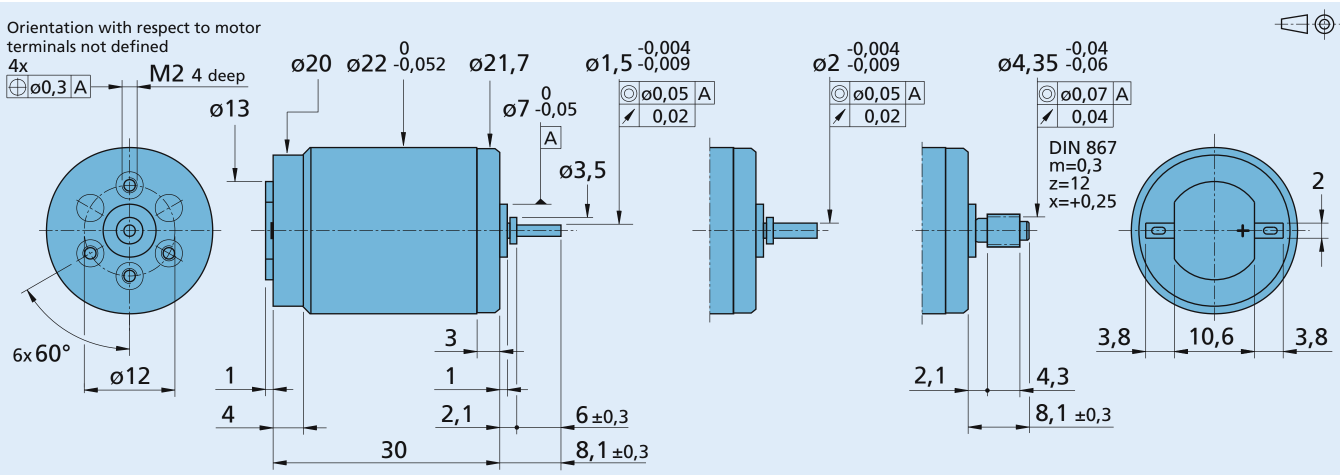
Precious Metal Commutation

2,5 mNm

For combination with
Gearheads:
20/1, 22/2, 22/5, 22/7, 22E, 22EKV, 23/1, 38/3
Encoders:
HEDL 5540, HEDM 5500, HEDS 5500, HEDS 5540

Series 2230 ... S

	2230 T	003 S	006 S	012 S	015 S	024 S	040 S	
1 Nominal voltage	U_N	3	6	12	15	24	40	V
2 Terminal resistance	R	0,6	3	10,8	21	50	193	Ω
3 Output power	$P_{2\ max.}$	3,69	2,94	3,27	2,63	2,82	2,01	W
4 Efficiency, max.	$\eta_{max.}$	83	82	83	82	81	78	%
5 No-load speed	n_0	9 600	9 300	9 500	8 400	9 000	8 200	rpm
6 No-load current (with shaft ø 1,5 mm)	I_0	0,04	0,019	0,01	0,007	0,005	0,003	A
7 Stall torque	M_H	14,7	12,1	13,2	11,9	12	9,37	mNm
8 Friction torque	M_R	0,12	0,12	0,12	0,12	0,13	0,14	mNm
9 Speed constant	k_n	3 230	1 560	799	566	379	208	rpm/V
10 Back-EMF constant	k_E	0,31	0,639	1,25	1,77	2,64	4,81	mV/rpm
11 Torque constant	k_M	2,96	6,1	12	16,9	25,2	45,9	mNm/A
12 Current constant	k_I	0,338	0,164	0,084	0,059	0,04	0,022	A/mNm
13 Slope of n-M curve	$\Delta n/\Delta M$	653	769	720	706	750	875	rpm/mNm
14 Rotor inductance	L	35	150	420	900	2 200	8 000	µH
15 Mechanical time constant	τ_m	25	20	20	20	19	22	ms
16 Rotor inertia	J	3,7	2,5	2,7	2,7	2,4	2,4	gcm²
17 Angular acceleration	$\alpha_{max.}$	40	49	50	44	50	39	·10³rad/s²
18 Thermal resistance	$R_{th\ 1}$ / $R_{th\ 2}$	4 / 28						K/W
19 Thermal time constant	τ_{w1} / τ_{w2}	4,5 / 602						s
20 Operating temperature range:								
– motor		-30 ... +85 (optional version -55 ... +125)						°C
– rotor, max. permissible		+125						°C
21 Shaft bearings		sintered bearings		ball bearings		ball bearings, preloaded		
22 Shaft load max.:		(standard)		(optional version)		(optional version)		
– with shaft diameter		1,5		2		2		mm
– radial at 3 000 rpm (3 mm from bearing)		1,2		8		8		N
– axial at 3 000 rpm		0,2		0,8		0,8		N
– axial at standstill		20		10		10		N
23 Shaft play								
– radial	≤	0,03		0,015		0,015		mm
– axial	≤	0,2		0,2		0		mm
24 Housing material		steel, zinc galvanized and passivated						
25 Weight		50						g
26 Direction of rotation		clockwise, viewed from the front face						
Recommended values - mathematically independent of each other								
27 Speed up to	$n_{e\ max.}$	8 000	8 000	8 000	8 000	8 000	8 000	rpm
28 Torque up to	$M_{e\ max.}$	2,5	2,5	2,5	2,5	2,5	2,5	mNm



2230 T ... S **2230 U ... S** **2230 F/R ... S**

DC-Micromotors

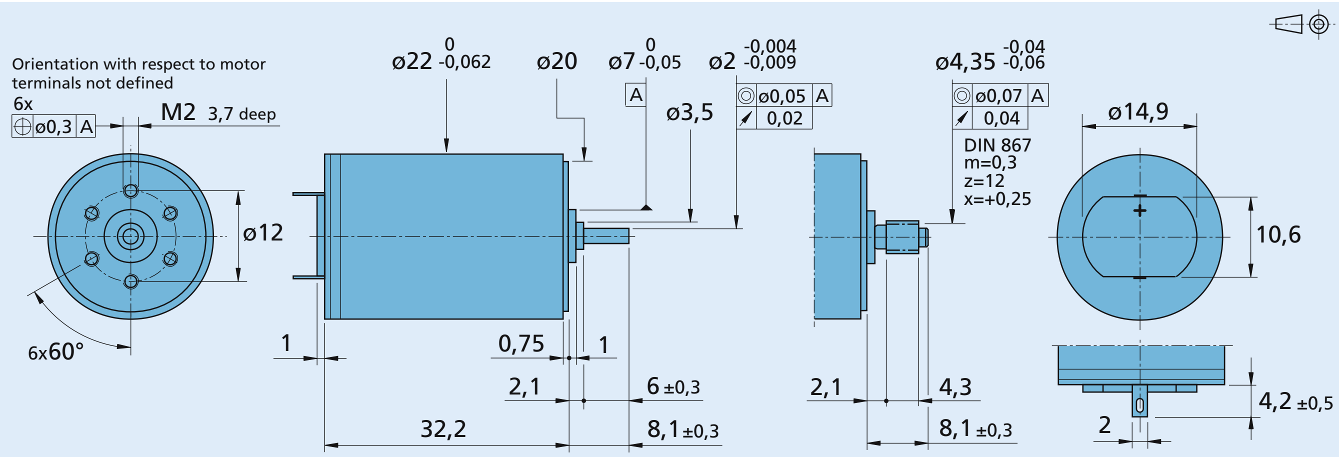
Precious Metal Commutation

10 mNm

For combination with
Gearheads:
20/1, 22/2, 22/5, 22/7, 22E, 22EKV, 22F, 23/1, 26A, 38/3
Encoders:
IE2-1024, IE2-16

Series 2232 ... SR

		2232 U	006 SR	009 SR	012 SR	015 SR	018 SR	024 SR	
1	Nominal voltage	U_N	6	9	12	15	18	24	V
2	Terminal resistance	R	0,81	2,14	4,09	6,61	9,04	16,4	Ω
3	Output power	$P_{2\ max.}$	11	9,35	8,7	8,41	8,86	8,68	W
4	Efficiency, max.	$\eta_{max.}$	87	86	86	85	86	86	%
5	No-load speed	n_0	7 100	7 400	7 100	7 100	7 100	7 100	rpm
6	No-load current (with shaft ø 2 mm)	I_0	0,035	0,0241	0,0175	0,0139	0,0116	0,0087	A
7	Stall torque	M_H	59,2	48,3	46,8	45,2	47,6	46,7	mNm
8	Friction torque	M_R	0,28	0,28	0,28	0,28	0,28	0,28	mNm
9	Speed constant	k_n	1 190	827	595	476	397	298	rpm/V
10	Back-EMF constant	k_E	0,84	1,21	1,68	2,1	2,52	3,36	mV/rpm
11	Torque constant	k_M	8,03	11,5	16	20,1	24,1	32,1	mNm/A
12	Current constant	k_I	0,125	0,087	0,062	0,05	0,042	0,031	A/mNm
13	Slope of n-M curve	$\Delta n/\Delta M$	120	153	152	157	149	152	rpm/mNm
14	Rotor inductance	L	45	90	180	280	400	710	µH
15	Mechanical time constant	τ_m	6	6	6	6	6	6	ms
16	Rotor inertia	J	4,8	3,8	3,8	3,8	3,8	3,8	gcm²
17	Angular acceleration	$\alpha_{max.}$	120	120	120	120	120	120	·10³rad/s²
18	Thermal resistance	$R_{th\,1}$ / $R_{th\,2}$	4 / 13						K/W
19	Thermal time constant	τ_{w1} / τ_{w2}	7 / 340						s
20	Operating temperature range:								
	– motor		-30 ... +85 (optional version -55 ... +125)						°C
	– rotor, max. permissible		+125						°C
21	Shaft bearings		sintered bearings		ball bearings		ball bearings, preloaded		
22	Shaft load max.:		(standard)		(optional version)		(optional version)		
	– with shaft diameter		2		2		2		mm
	– radial at 3 000 rpm (3 mm from bearing)		1,5		8		8		N
	– axial at 3 000 rpm		0,2		0,8		0,8		N
	– axial at standstill		20		10		10		N
23	Shaft play								
	– radial	≤	0,03		0,015		0,015		mm
	– axial	≤	0,2		0,2		0		mm
24	Housing material		steel, black coated						
25	Weight		62						g
26	Direction of rotation		clockwise, viewed from the front face						
Recommended values - mathematically independent of each other									
27	Speed up to	$n_{e\ max.}$	8 000	8 000	8 000	8 000	8 000	8 000	rpm
28	Torque up to	$M_{e\ max.}$	10	10	10	10	10	10	mNm



2232 U ... SR **2232 R ... SR**

DC-Micromotors

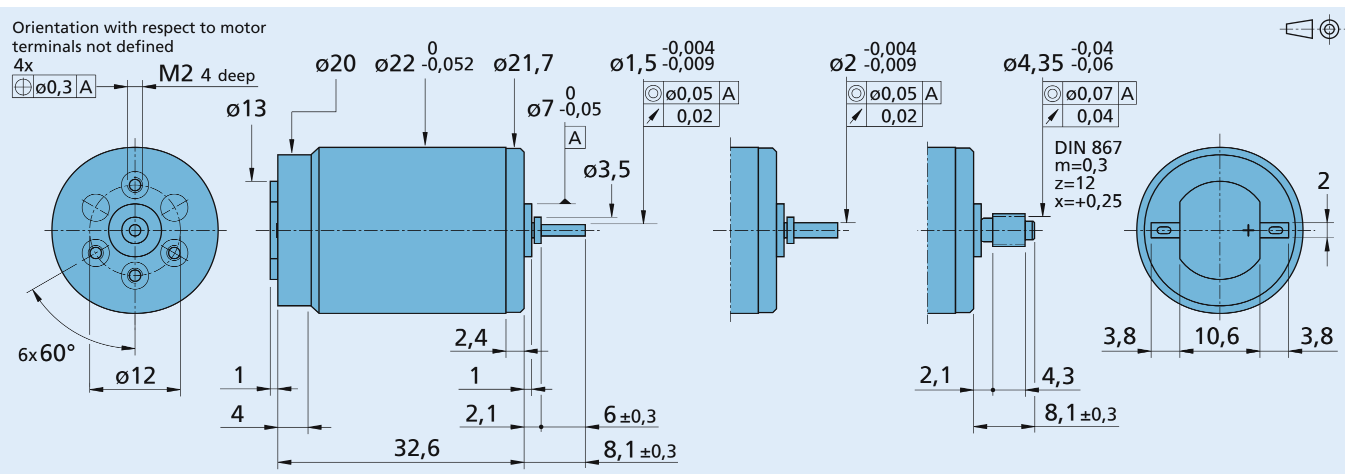
Precious Metal Commutation

3 mNm

For combination with
Gearheads:
20/1, 22/2, 22/5, 22/7, 22E, 22EKV, 23/1, 38/3
Encoders:
HEDL 5540, HEDM 5500, HEDS 5500, HEDS 5540

Series 2233 ... S

		2233 T	4,5 S	006 S	012 S	018 S	024 S	030 S	
1	Nominal voltage	U_N	4,5	6	12	18	24	30	V
2	Terminal resistance	R	1,3	2,9	9,7	25	57	105	Ω
3	Output power	$P_{2\,max.}$	3,85	3,06	3,66	3,18	2,47	2,08	W
4	Efficiency, max.	$\eta_{max.}$	86	85	84	82	80	79	%
5	No-load speed	n_0	8 000	8 000	8 500	8 700	8 800	9 300	rpm
6	No-load current (with shaft ø 1,5 mm)	I_0	0,02	0,013	0,009	0,007	0,005	0,004	A
7	Stall torque	M_H	18,4	14,6	16,4	13,9	10,7	8,56	mNm
8	Friction torque	M_R	0,11	0,09	0,12	0,14	0,13	0,12	mNm
9	Speed constant	k_n	1 790	1 340	714	488	371	314	rpm/V
10	Back-EMF constant	k_E	0,559	0,745	1,4	2,05	2,69	3,18	mV/rpm
11	Torque constant	k_M	5,34	7,12	13,4	19,6	25,7	30,4	mNm/A
12	Current constant	k_I	0,187	0,141	0,075	0,051	0,039	0,033	A/mNm
13	Slope of n-M curve	$\Delta n/\Delta M$	435	548	518	626	822	1 090	rpm/mNm
14	Rotor inductance	L	70	130	400	600	1 600	2 200	µH
15	Mechanical time constant	τ_m	12	11	12	14	11	12	ms
16	Rotor inertia	J	2,6	1,9	2,2	2,1	1,3	1,1	gcm²
17	Angular acceleration	$\alpha_{max.}$	70	76	74	65	84	81	·10³rad/s²
18	Thermal resistance	$R_{th\,1}$ / $R_{th\,2}$	4 / 27						K/W
19	Thermal time constant	τ_{w1} / τ_{w2}	4 / 660						s
20	Operating temperature range:								
	– motor		-30 ... +85 (optional version -55 ... +125)						°C
	– rotor, max. permissible		+125						°C
21	Shaft bearings		sintered bearings (standard)		ball bearings (optional version)		ball bearings, preloaded (optional version)		
22	Shaft load max.:								
	– with shaft diameter		1,5		2		2		mm
	– radial at 3 000 rpm (3 mm from bearing)		1,2		8		8		N
	– axial at 3 000 rpm		0,2		0,8		0,8		N
	– axial at standstill		20		10		10		N
23	Shaft play								
	– radial	≤	0,03		0,015		0,015		mm
	– axial	≤	0,2		0,2		0		mm
24	Housing material		steel, zinc galvanized and passivated						
25	Weight		61						g
26	Direction of rotation		clockwise, viewed from the front face						
	Recommended values - mathematically independent of each other								
27	Speed up to	$n_{e\,max.}$	8 000	8 000	8 000	8 000	8 000	8 000	rpm
28	Torque up to	$M_{e\,max.}$	3	3	3	3	3	3	mNm



2233 T ... S **2233 U ... S** **2233 F/R ... S**

DC-Micromotors

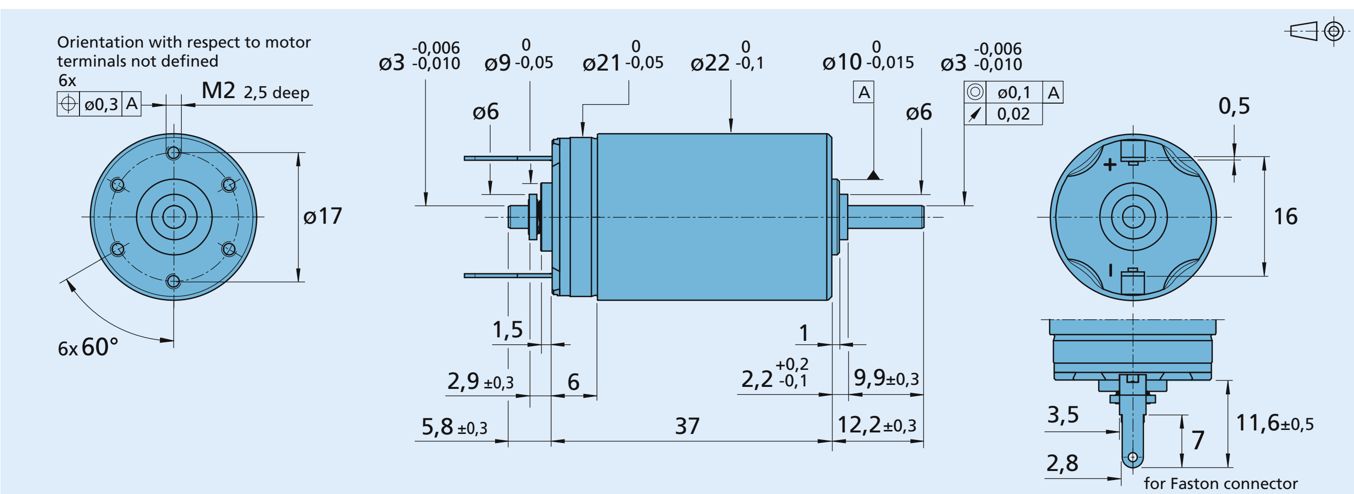
Graphite Commutation

11 mNm

For combination with
Gearheads:
22/7, 22F, 23/1, 26A
Encoders:
IE3-1024(L)

Series 2237 ... CXR

		2237 S	006 CXR	012 CXR	018 CXR	024 CXR	036 CXR	048 CXR	
1	Nominal voltage	U_N	6	12	18	24	36	48	V
2	Terminal resistance	R	0,85	3,92	8,5	15,7	33	62,8	Ω
3	Output power	$P_{2\,max.}$	8,6	8,1	8,7	8,5	9,2	8,6	W
4	Efficiency, max.	$\eta_{max.}$	68,1	70,8	72,2	72,6	73,6	73,5	%
5	No-load speed	n_0	6 900	6 800	7 000	6 900	7 200	7 000	rpm
6	No-load current (with shaft ø 3 mm)	I_0	0,124	0,058	0,039	0,029	0,02	0,015	A
7	Stall torque	M_H	47,2	45,7	47,1	46,6	48,7	47,1	mNm
8	Friction torque	M_R	0,92	0,92	0,92	0,92	0,92	0,92	mNm
9	Speed constant	k_n	1 283	601	409	301	207	150	rpm/V
10	Back-EMF constant	k_E	0,78	1,66	2,44	3,33	4,83	6,65	mV/rpm
11	Torque constant	k_M	7,44	15,9	23,3	31,8	46,2	63,5	mNm/A
12	Current constant	k_I	0,134	0,063	0,043	0,032	0,022	0,016	A/mNm
13	Slope of n-M curve	$\Delta n/\Delta M$	146	148	149	149	148	149	rpm/mNm
14	Rotor inductance	L	35	150	320	590	1 240	2 340	µH
15	Mechanical time constant	τ_m	5	5	5	5	5	5	ms
16	Rotor inertia	J	3,1	3,1	3,1	3,1	3,1	3,1	gcm²
17	Angular acceleration	$\alpha_{max.}$	152	147	152	150	157	152	·10³rad/s²
18	Thermal resistance	R_{th1} / R_{th2}	8 / 17						K/W
19	Thermal time constant	τ_{w1} / τ_{w2}	13 / 500						s
20	Operating temperature range:								
	– motor		-30 ... +100						°C
	– rotor, max. permissible		+125						°C
21	Shaft bearings		sintered bearings		ball bearings, preloaded				
22	Shaft load max.:		(standard)		(optional version)				
	– with shaft diameter		3		3				mm
	– radial at 3 000 rpm (3 mm from bearing)		2,5		15				N
	– axial at 3 000 rpm		0,3		2				N
	– axial at standstill		20		20				N
23	Shaft play								
	– radial	≤	0,03		0,015				mm
	– axial	≤	0,15		0				mm
24	Housing material		steel, zinc galvanized and passivated						
25	Weight		68						g
26	Direction of rotation		clockwise, viewed from the front face						
Recommended values - mathematically independent of each other									
27	Speed up to	$n_{e\,max.}$	7 000	7 000	7 000	7 000	7 000	7 000	rpm
28	Torque up to	$M_{e\,max.}$	10	10,5	10,5	10,5	11	11	mNm



2237 S ... CXR

DC-Micromotors

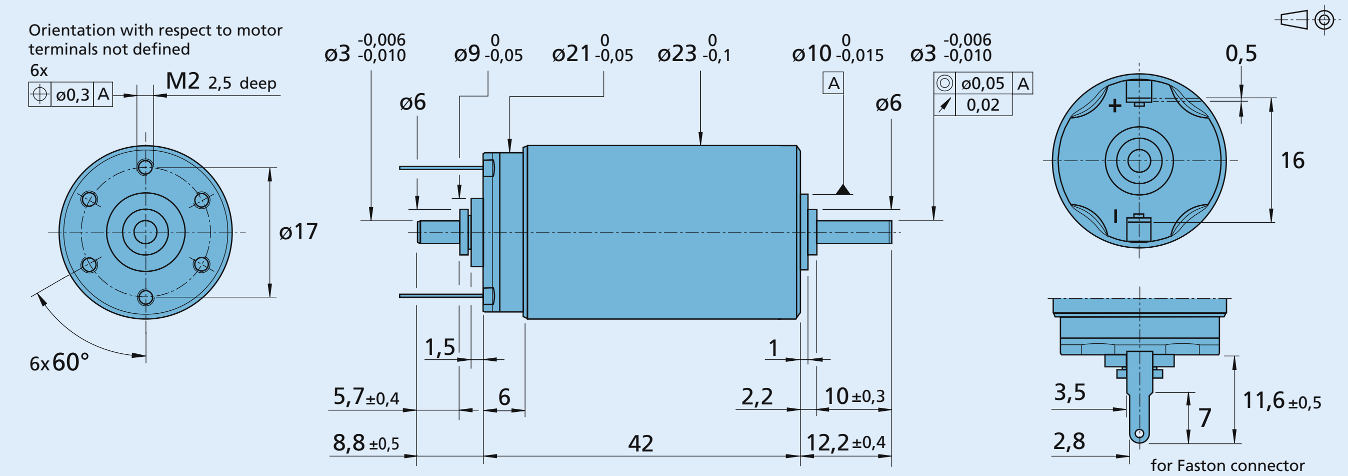
Graphite Commutation

16 mNm

For combination with
Gearheads:
22/7, 22F, 23/1, 26/1(S), 26A, 30/1(S), 38/3
Encoders:
HEDL 5540, HEDM 5500, HEDS 5500, HEDS 5540, IE2-1024, IE2-16, IE3-1024(L)

Series 2342 ... CR

		2342 S	006 CR	012 CR	018 CR	024 CR	036 CR	048 CR	
1	Nominal voltage	U_N	6	12	18	24	36	48	V
2	Terminal resistance	R	0,4	1,9	4,1	7,1	15,9	31,2	Ω
3	Output power	$P_{2\ max.}$	20,5	17	18,1	19	19,4	17,7	W
4	Efficiency, max.	$\eta_{max.}$	81	80	81	81	81	81	%
5	No-load speed	n_0	9 000	8 100	8 000	8 500	8 100	8 000	rpm
6	No-load current (with shaft ø 3 mm)	I_0	0,17	0,075	0,048	0,038	0,024	0,017	A
7	Stall torque	M_H	87,2	80	86,5	85,4	91,4	84,4	mNm
8	Friction torque	M_R	0,98	1	0,99	0,99	0,99	0,95	mNm
9	Speed constant	k_n	1 650	713	462	366	231	170	rpm/V
10	Back-EMF constant	k_E	0,604	1,4	2,16	2,73	4,34	5,87	mV/rpm
11	Torque constant	k_M	5,77	13,4	20,7	26,1	41,4	56,1	mNm/A
12	Current constant	k_I	0,173	0,075	0,048	0,038	0,024	0,018	A/mNm
13	Slope of n-M curve	$\Delta n/\Delta M$	103	101	92,5	99,5	88,6	94,8	rpm/mNm
14	Rotor inductance	L	13,5	65	150	265	590	1 050	µH
15	Mechanical time constant	τ_m	6	6	6	6	6	6	ms
16	Rotor inertia	J	5,6	5,7	6,2	5,8	6,5	6	gcm²
17	Angular acceleration	$\alpha_{max.}$	160	140	140	150	140	140	·10³rad/s²
18	Thermal resistance	R_{th1} / R_{th2}	3 / 15						K/W
19	Thermal time constant	τ_{w1} / τ_{w2}	6,5 / 490						s
20	Operating temperature range:								
	– motor		-30 ... +100						°C
	– rotor, max. permissible		+125						°C
21	Shaft bearings		ball bearings, preloaded						
22	Shaft load max.:								
	– with shaft diameter		3						mm
	– radial at 3 000 rpm (3 mm from bearing)		20						N
	– axial at 3 000 rpm		2						N
	– axial at standstill		20						N
23	Shaft play								
	– radial	≤	0,015						mm
	– axial	=	0						mm
24	Housing material		steel, black coated						
25	Weight		88						g
26	Direction of rotation		clockwise, viewed from the front face						
	Recommended values - mathematically independent of each other								
27	Speed up to	$n_{e\ max.}$	7 000	7 000	7 000	7 000	7 000	7 000	rpm
28	Torque up to	$M_{e\ max.}$	16	16	16	16	16	16	mNm



2342 S ... CR

DC-Micromotors

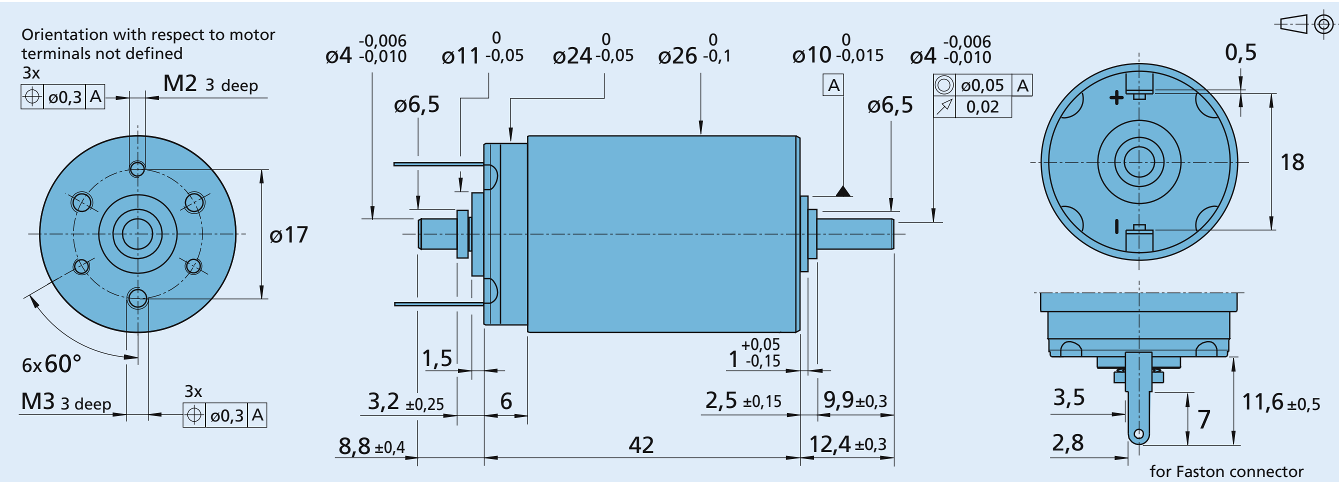
Graphite Commutation

23 mNm

For combination with
Gearheads:
26/1(S), 26A, 30/1(S), 32A
Encoders:
IE3-1024(L)

Series 2642 ... CXR

	2642 W				012 CXR	024 CXR	048 CXR	
1	Nominal voltage	U_N			12	24	48	V
2	Terminal resistance	R			1,46	5,84	24,06	Ω
3	Output power	$P_{2\,max.}$			22,1	23,1	22,9	W
4	Efficiency, max.	$\eta_{max.}$			76	78	79	%
5	No-load speed	n_0			5 800	5 900	5 900	rpm
6	No-load current (with shaft ø 4 mm)	I_0			0,092	0,045	0,022	A
7	Stall torque	M_H			144,6	150,5	149	mNm
8	Friction torque	M_R			1,7	1,7	1,7	mNm
9	Speed constant	k_n			514	252	125	rpm/V
10	Back-EMF constant	k_E			1,945	3,962	7,994	mV/rpm
11	Torque constant	k_M			18,57	37,83	76,34	mNm/A
12	Current constant	k_I			0,054	0,026	0,013	A/mNm
13	Slope of n-M curve	$\Delta n/\Delta M$			40,4	39	39,4	rpm/mNm
14	Rotor inductance	L			135	560	2 280	µH
15	Mechanical time constant	τ_m			5,1	4,9	5	ms
16	Rotor inertia	J			12	12	12	gcm²
17	Angular acceleration	$\alpha_{max.}$			121	125	124	$\cdot 10^3$rad/s²
18	Thermal resistance	$R_{th\,1}$ / $R_{th\,2}$	4,7 / 15,2					K/W
19	Thermal time constant	τ_{w1} / τ_{w2}	20 / 720					s
20	Operating temperature range:							
	– motor		-30 ... +100					°C
	– rotor, max. permissible		+125					°C
21	Shaft bearings		sintered bearings	ball bearings, preloaded				
22	Shaft load max.:		(standard)	(optional version)				
	– with shaft diameter		4	4				mm
	– radial at 3 000 rpm (3 mm from bearing)		10	20				N
	– axial at 3 000 rpm		2	2				N
	– axial at standstill		50	20				N
23	Shaft play							
	– radial	≤	0,03	0,015				mm
	– axial	≤	0,2	0				mm
24	Housing material		steel, zinc galvanized and passivated					
25	Weight		114					g
26	Direction of rotation		clockwise, viewed from the front face					
Recommended values - mathematically independent of each other								
27	Speed up to	$n_{e\,max.}$			6 000	6 000	6 000	rpm
28	Torque up to	$M_{e\,max.}$			21	22	23	mNm



2642 W ... CXR

DC-Micromotors

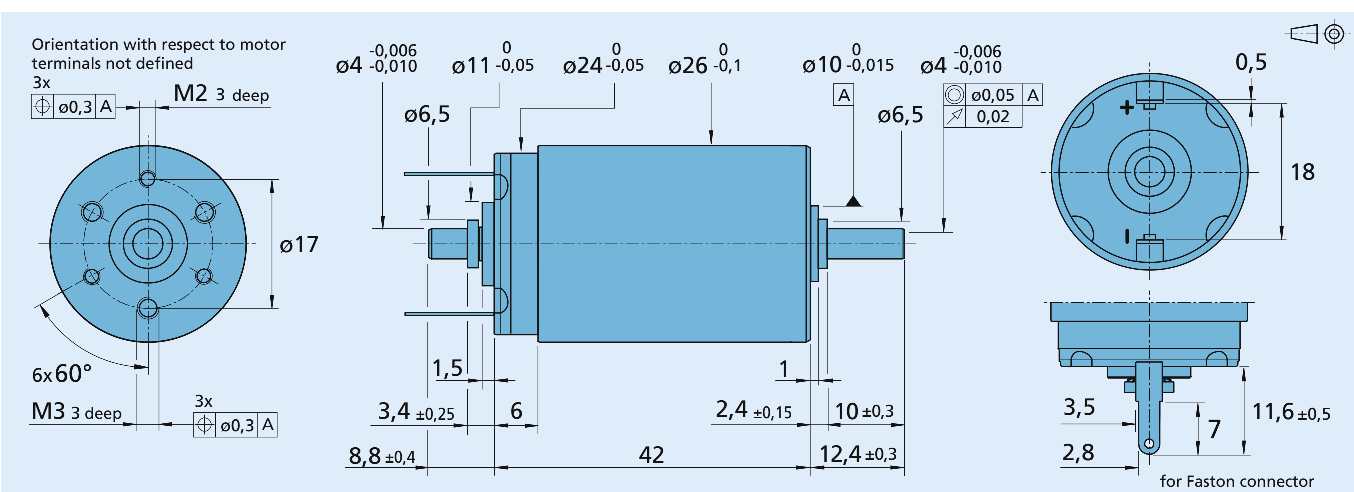
Graphite Commutation

28 mNm

For combination with
Gearheads:
26/1(S), 26A, 30/1(S), 32A
Encoders:
HEDL 5540, HEDM 5500, HEDS 5500, HEDS 5540, IE2-1024, IE2-16, IE3-1024(L)

Series 2642 ... CR

		2642 W		012 CR	024 CR	048 CR	
1	Nominal voltage	U_N		12	24	48	V
2	Terminal resistance	R		1,45	5,78	23,8	Ω
3	Output power	$P_{2\,max.}$		22,1	23,2	23	W
4	Efficiency, max.	$\eta_{max.}$		78	79	79	%
5	No-load speed	n_0		6 400	6 400	6 400	rpm
6	No-load current (with shaft ø 4 mm)	I_0		0,118	0,058	0,029	A
7	Stall torque	M_H		132	139	137	mNm
8	Friction torque	M_R		2	2	2	mNm
9	Speed constant	k_n		565	276	137	rpm/V
10	Back-EMF constant	k_E		1,77	3,62	7,31	mV/rpm
11	Torque constant	k_M		16,9	34,6	69,8	mNm/A
12	Current constant	k_I		0,059	0,029	0,014	A/mNm
13	Slope of n-M curve	$\Delta n/\Delta M$		48,5	46	46,7	rpm/mNm
14	Rotor inductance	L		130	550	2 200	µH
15	Mechanical time constant	τ_m		5,4	5,4	5,4	ms
16	Rotor inertia	J		11	11	11	gcm²
17	Angular acceleration	$\alpha_{max.}$		120	120	120	·10³rad/s²
18	Thermal resistance	$R_{th\,1} / R_{th\,2}$	2,1 / 11				K/W
19	Thermal time constant	τ_{w1} / τ_{w2}	10 / 510				s
20	Operating temperature range:						
	– motor		-30 ... +125				°C
	– rotor, max. permissible		+155				°C
21	Shaft bearings		ball bearings, preloaded				
22	Shaft load max.:						
	– with shaft diameter		4				mm
	– radial at 3 000 rpm (3 mm from bearing)		20				N
	– axial at 3 000 rpm		2				N
	– axial at standstill		20				N
23	Shaft play						
	– radial	≤	0,015				mm
	– axial	=	0				mm
24	Housing material		steel, black coated				
25	Weight		114				g
26	Direction of rotation		clockwise, viewed from the front face				
	Recommended values - mathematically independent of each other						
27	Speed up to	$n_{e\,max.}$		6 000	6 000	6 000	rpm
28	Torque up to	$M_{e\,max.}$		28	28	28	mNm



2642 W ... CR

DC-Micromotors

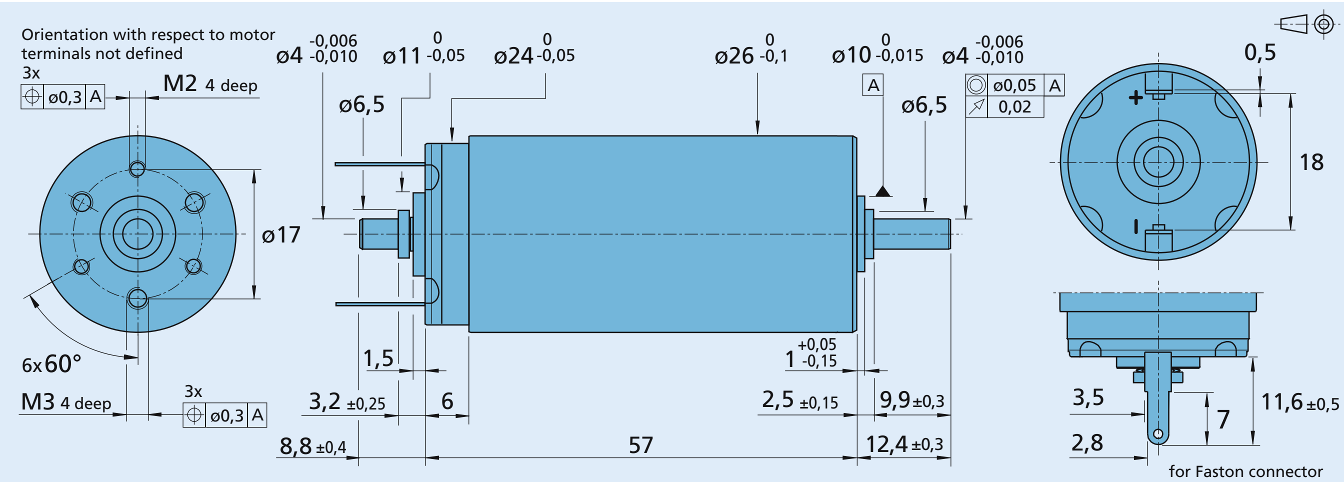
Graphite Commutation

35 mNm

For combination with
Gearheads:
26/1(S), 26A, 30/1(S), 32A
Encoders:
IE3-1024(L)

Series 2657 ... CXR

	2657 W				012 CXR	024 CXR	048 CXR	
1	Nominal voltage	U_N			12	24	48	V
2	Terminal resistance	R			0,72	2,98	12,61	Ω
3	Output power	$P_{2\ max.}$			45,3	45,7	44,1	W
4	Efficiency, max.	$\eta_{max.}$			81	83	83	%
5	No-load speed	n_0			5 600	5 800	5 800	rpm
6	No-load current (with shaft ø 4 mm)	I_0			0,104	0,052	0,026	A
7	Stall torque	M_H			306,7	302,9	283,1	mNm
8	Friction torque	M_R			2	2	2	mNm
9	Speed constant	k_n			494	247	122	rpm/V
10	Back-EMF constant	k_E			2,024	4,05	8,205	mV/rpm
11	Torque constant	k_M			19,33	38,67	78,35	mNm/A
12	Current constant	k_I			0,052	0,026	0,013	A/mNm
13	Slope of n-M curve	$\Delta n/\Delta M$			18,4	19	19,6	rpm/mNm
14	Rotor inductance	L			90	365	1 500	µH
15	Mechanical time constant	τ_m			3,3	3,4	3,5	ms
16	Rotor inertia	J			17	17	17	gcm²
17	Angular acceleration	$\alpha_{max.}$			180	178	172	$\cdot 10^3$rad/s²
18	Thermal resistance	$R_{th\ 1}$ / $R_{th\ 2}$	4,4 / 12,6					K/W
19	Thermal time constant	τ_{w1} / τ_{w2}	28 / 810					s
20	Operating temperature range:							
	– motor		-30 ... +100					°C
	– rotor, max. permissible		+125					°C
21	Shaft bearings		sintered bearings	ball bearings, preloaded				
22	Shaft load max.:		(standard)	(optional version)				
	– with shaft diameter		4	4				mm
	– radial at 3 000 rpm (3 mm from bearing)		10	20				N
	– axial at 3 000 rpm		2	2				N
	– axial at standstill		50	20				N
23	Shaft play							
	– radial	≤	0,03	0,015				mm
	– axial	≤	0,2	0				mm
24	Housing material		steel, zinc galvanized and passivated					
25	Weight		156					g
26	Direction of rotation		clockwise, viewed from the front face					
Recommended values - mathematically independent of each other								
27	Speed up to	$n_{e\ max.}$			6 000	6 000	6 000	rpm
28	Torque up to	$M_{e\ max.}$			33	34	35	mNm



2657 W ... CXR

DC-Micromotors

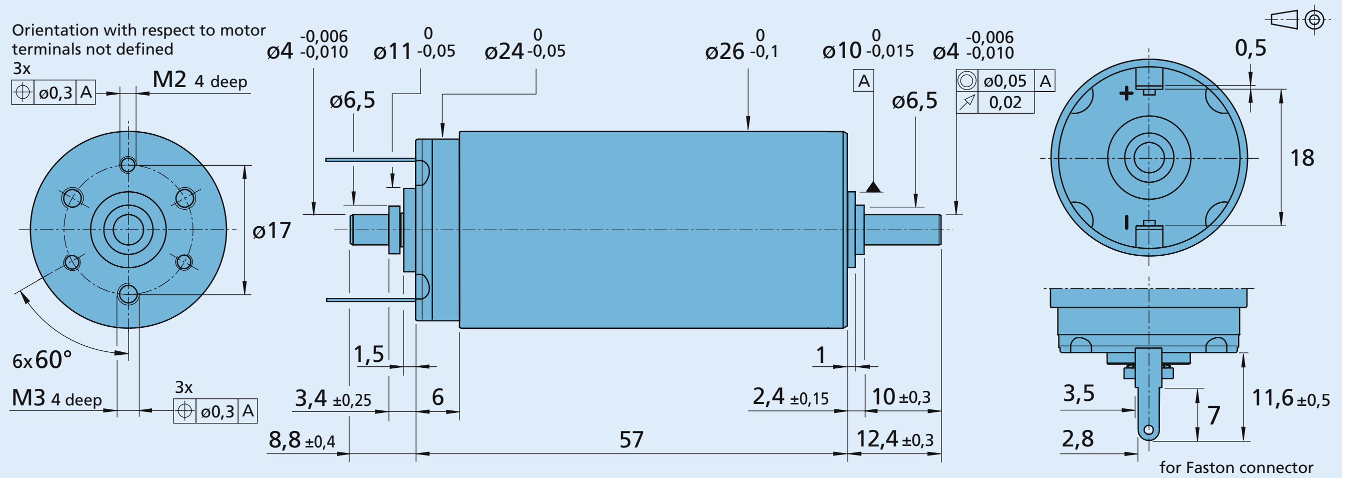
Graphite Commutation

44 mNm

For combination with
Gearheads:
26/1(S), 26A, 30/1(S), 32A
Encoders:
HEDL 5540, HEDM 5500, HEDS 5500, HEDS 5540, IE2-1024, IE2-16, IE3-1024(L)

Series 2657 ... CR

	2657 W			012 CR	024 CR	048 CR	
1	Nominal voltage	U_N		12	24	48	V
2	Terminal resistance	R		0,71	2,84	12,5	Ω
3	Output power	$P_{2\ max.}$		45,9	47,9	44,5	W
4	Efficiency, max.	$\eta_{\ max.}$		84	85	84	%
5	No-load speed	n_0		6 300	6 400	6 400	rpm
6	No-load current (with shaft ø 4 mm)	I_0		0,115	0,058	0,028	A
7	Stall torque	M_H		278	286	265	mNm
8	Friction torque	M_R		2	2	2	mNm
9	Speed constant	k_n		552	274	136	rpm/V
10	Back-EMF constant	k_E		1,81	3,65	7,37	mV/rpm
11	Torque constant	k_M		17,3	34,8	70,4	mNm/A
12	Current constant	k_I		0,058	0,029	0,014	A/mNm
13	Slope of n-M curve	$\Delta n/\Delta M$		22,7	22,4	24,2	rpm/mNm
14	Rotor inductance	L		95	380	1 550	µH
15	Mechanical time constant	$\tau_{\ m}$		3,9	3,9	3,9	ms
16	Rotor inertia	J		16	17	15	gcm²
17	Angular acceleration	$\alpha_{\ max.}$		170	170	170	·10³rad/s²
18	Thermal resistance	$R_{th\ 1}$ / $R_{th\ 2}$	1,9 / 9				K/W
19	Thermal time constant	$\tau_{\ w1}$ / $\tau_{\ w2}$	10 / 580				s
20	Operating temperature range:						
	– motor		-30 ... +125				°C
	– rotor, max. permissible		+155				°C
21	Shaft bearings		ball bearings, preloaded				
22	Shaft load max.:						
	– with shaft diameter		4				mm
	– radial at 3 000 rpm (3 mm from bearing)		20				N
	– axial at 3 000 rpm		2				N
	– axial at standstill		20				N
23	Shaft play						
	– radial	≤	0,015				mm
	– axial	=	0				mm
24	Housing material		steel, black coated				
25	Weight		156				g
26	Direction of rotation		clockwise, viewed from the front face				
Recommended values - mathematically independent of each other							
27	Speed up to	$n_{e\ max.}$		6 000	6 000	6 000	rpm
28	Torque up to	$M_{e\ max.}$		44	44	44	mNm



2657 W ... CR

DC-Micromotors

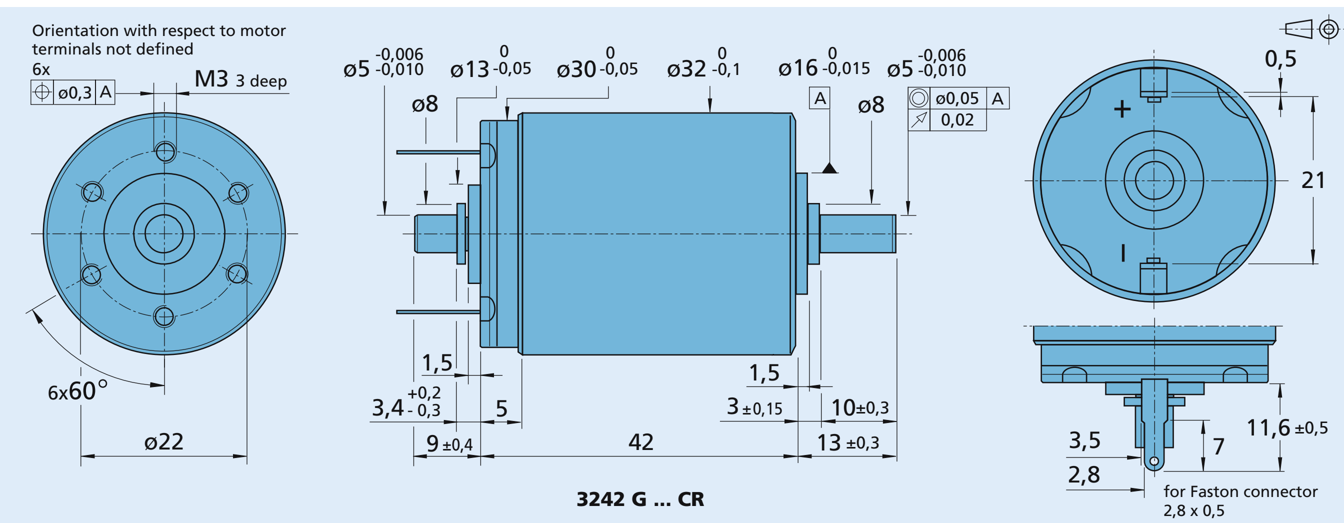
Graphite Commutation

35 mNm

For combination with
Gearheads:
32/3(S), 32A, 38/1(S), 38/2(S), 38A
Encoders:
HEDL 5540, HEDM 5500, HEDS 5500, HEDS 5540, IE2-1024, IE2-16, IE3-1024(L)

Series 3242 ... CR

		3242 G		012 CR	024 CR	048 CR	
1	Nominal voltage	U_N		12	24	48	V
2	Terminal resistance	R		1,27	5	19,7	Ω
3	Output power	$P_{2\ max.}$		24,7	26,3	27,3	W
4	Efficiency, max.	$\eta_{max.}$		72	73	73	%
5	No-load speed	n_0		5 200	5 300	5 400	rpm
6	No-load current (with shaft ø 5 mm)	I_0		0,234	0,117	0,058	A
7	Stall torque	M_H		181	189	193	mNm
8	Friction torque	M_R		4,8	4,8	4,8	mNm
9	Speed constant	k_n		464	231	116	rpm/V
10	Back-EMF constant	k_E		2,15	4,33	8,58	mV/rpm
11	Torque constant	k_M		20,6	41,3	82	mNm/A
12	Current constant	k_I		0,049	0,024	0,012	A/mNm
13	Slope of n-M curve	$\Delta n/\Delta M$		28,7	28	28	rpm/mNm
14	Rotor inductance	L		135	540	2 200	µH
15	Mechanical time constant	τ_m		7,5	7,5	7,5	ms
16	Rotor inertia	J		25	26	26	gcm²
17	Angular acceleration	$\alpha_{max.}$		73	74	75	$\cdot 10^3$rad/s²
18	Thermal resistance	$R_{th\ 1}$ / $R_{th\ 2}$	2,5 / 9				K/W
19	Thermal time constant	τ_{w1} / τ_{w2}	17 / 660				s
20	Operating temperature range:						
	– motor		-30 ... +125				°C
	– rotor, max. permissible		+155				°C
21	Shaft bearings		ball bearings, preloaded				
22	Shaft load max.:						
	– with shaft diameter		5				mm
	– radial at 3 000 rpm (3 mm from bearing)		50				N
	– axial at 3 000 rpm		5				N
	– axial at standstill		50				N
23	Shaft play						
	– radial	≤	0,015				mm
	– axial	=	0				mm
24	Housing material		steel, black coated				
25	Weight		175				g
26	Direction of rotation		clockwise, viewed from the front face				
Recommended values - mathematically independent of each other							
27	Speed up to	$n_{e\ max.}$		5 000	5 000	5 000	rpm
28	Torque up to	$M_{e\ max.}$		35	35	35	mNm



3242 G ... CR

DC-Micromotors

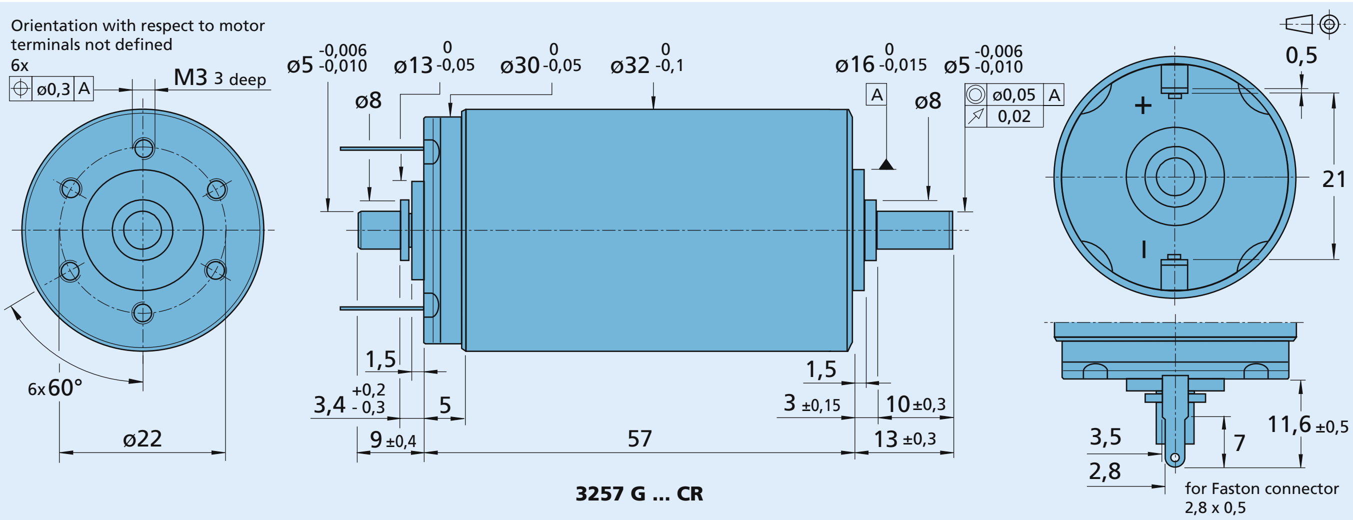
Graphite Commutation

70 mNm

For combination with
Gearheads:
32/3(S), 32A, 38/1(S), 38/2(S), 38A
Encoders:
HEDL 5540, HEDM 5500, HEDS 5500, HEDS 5540, IE2-1024, IE2-16, IE3-1024(L)

Series 3257 ... CR

	3257 G		012 CR	024 CR	048 CR	
1 Nominal voltage	U_N		12	24	48	V
2 Terminal resistance	R		0,41	1,63	6,56	Ω
3 Output power	$P_{2\,max.}$		79,2	83,2	84,5	W
4 Efficiency, max.	$\eta_{max.}$		83	83	83	%
5 No-load speed	n_0		5 700	5 900	5 900	rpm
6 No-load current (with shaft ø 5 mm)	I_0		0,258	0,129	0,064	A
7 Stall torque	M_H		531	539	547	mNm
8 Friction torque	M_R		4,9	4,9	4,9	mNm
9 Speed constant	k_n		500	253	125	rpm/V
10 Back-EMF constant	k_E		2	3,95	7,98	mV/rpm
11 Torque constant	k_M		19,1	37,7	76,2	mNm/A
12 Current constant	k_I		0,052	0,027	0,013	A/mNm
13 Slope of n-M curve	$\Delta n/\Delta M$		10,7	10,9	10,8	rpm/mNm
14 Rotor inductance	L		70	270	1 100	µH
15 Mechanical time constant	τ_m		4,7	4,7	4,7	ms
16 Rotor inertia	J		42	41	42	gcm²
17 Angular acceleration	$\alpha_{max.}$		130	130	130	·10³rad/s²
18 Thermal resistance	$R_{th\,1}$ / $R_{th\,2}$	2 / 8				K/W
19 Thermal time constant	τ_{w1} / τ_{w2}	17 / 810				s
20 Operating temperature range:						
– motor		-30 ... +125				°C
– rotor, max. permissible		+155				°C
21 Shaft bearings		ball bearings, preloaded				
22 Shaft load max.:						
– with shaft diameter		5				mm
– radial at 3 000 rpm (3 mm from bearing)		50				N
– axial at 3 000 rpm		5				N
– axial at standstill		50				N
23 Shaft play						
– radial	≤	0,015				mm
– axial	=	0				mm
24 Housing material		steel, black coated				
25 Weight		242				g
26 Direction of rotation		clockwise, viewed from the front face				
Recommended values - mathematically independent of each other						
27 Speed up to	$n_{e\,max.}$		5 000	5 000	5 000	rpm
28 Torque up to	$M_{e\,max.}$		70	70	70	mNm



3257 G ... CR

NEW

DC-Micromotors

Graphite Commutation

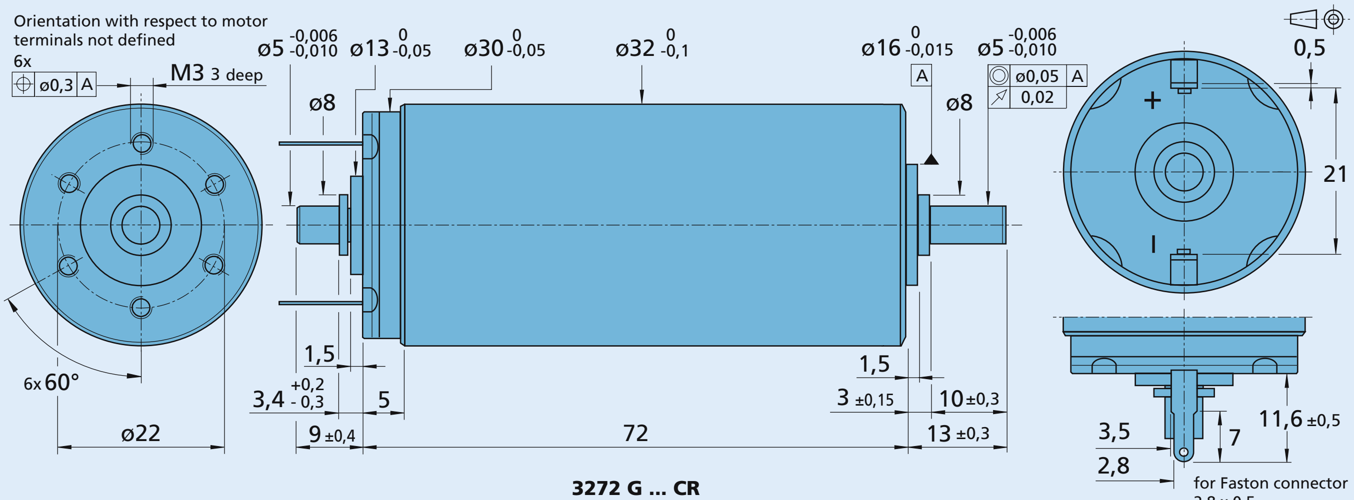
120 mNm

For combination with
Gearheads:
32A, 32ALN, 38/1(S), 38/2(S), 38A
Encoders:
HEDL 5540, HEDM 5500, HEDS 5500, HEDS 5540,
IE2-1024, IE2-16, IE3-1024(L)

DC-Micromotors

Series 3272 ... CR

	3272 G		012 CR	024 CR	048 CR	
1 Nominal voltage	U_N		12	24	48	V
2 Terminal resistance	R		0,2	0,82	3,35	Ω
3 Output power	$P_{2\,max.}$		164	167	167	W
4 Efficiency, max.	$\eta_{max.}$		85	87	88	%
5 No-load speed	n_0		5 400	5 500	5 500	rpm
6 No-load current (with shaft ø 5 mm)	I_0		0,191	0,095	0,048	A
7 Stall torque	M_H		1 192	1 188	1 177	mNm
8 Friction torque	M_R		3,9	3,9	3,9	mNm
9 Speed constant	k_n		459	230	115	rpm/V
10 Back-EMF constant	k_E		2,18	4,35	8,7	mV/rpm
11 Torque constant	k_M		20,8	41,6	83,3	mNm/A
12 Current constant	k_I		0,048	0,024	0,012	A/mNm
13 Slope of n-M curve	$\Delta n/\Delta M$		4,4	4,5	4,6	rpm/mNm
14 Rotor inductance	L		45	185	740	µH
15 Mechanical time constant	τ_m		3,1	3	2,9	ms
16 Rotor inertia	J		67	63	60	gcm²
17 Angular acceleration	$\alpha_{max.}$		178	189	196	·10³rad/s²
18 Thermal resistance	$R_{th\,1}$ / $R_{th\,2}$	2,3 / 7				K/W
19 Thermal time constant	τ_{w1} / τ_{w2}	40 / 850				s
20 Operating temperature range:						
– motor		-30 ... +125				°C
– rotor, max. permissible		+155				°C
21 Shaft bearings		ball bearings, preloaded				
22 Shaft load max.:						
– with shaft diameter		5				mm
– radial at 3 000 rpm (3 mm from bearing)		50				N
– axial at 3 000 rpm		5				N
– axial at standstill		50				N
23 Shaft play						
– radial	≤	0,015				mm
– axial	=	0				mm
24 Housing material		steel, black coated				
25 Weight		312				g
26 Direction of rotation		clockwise, viewed from the front face				
Recommended values - mathematically independent of each other						
27 Speed up to	$n_{e\,max.}$		6 000	6 000	6 000	rpm
28 Torque up to	$M_{e\,max.}$		76	130	130	mNm



3272 G ... CR

DC-Micromotors

Graphite Commutation

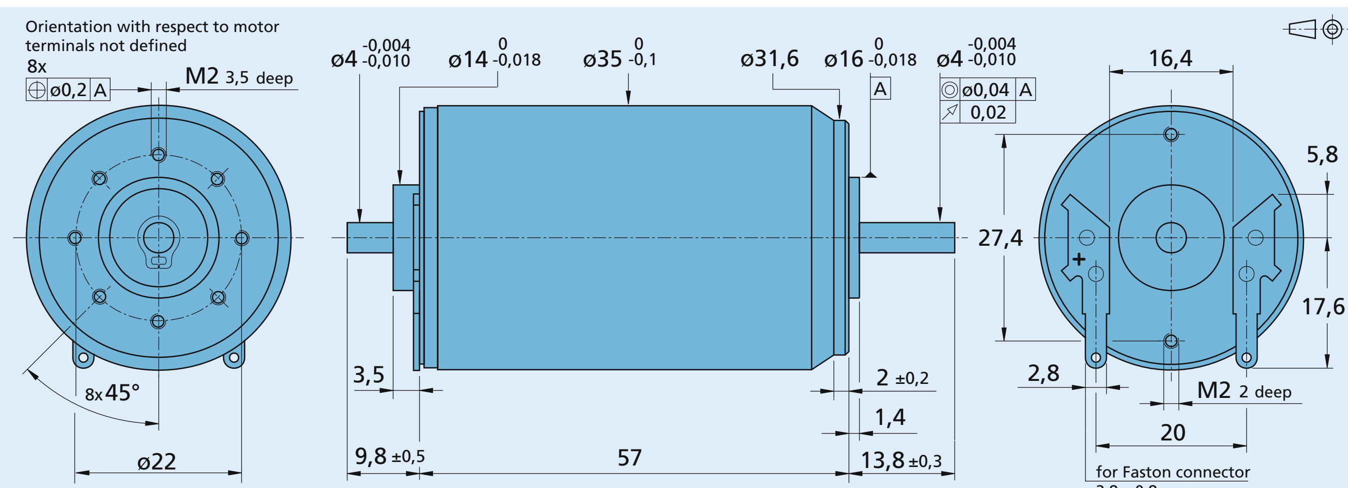
50 mNm

For combination with
Gearheads:
30/1(S), 32/3(S), 38/1(S), 38/2(S), 38A
Encoders:
HEDL 5540, HEDM 5500, HEDS 5500, HEDS 5540

Series 3557 ... CS

		3557 K		009 CS	012 CS	020 CS	024 CS	048 CS	
1	Nominal voltage	U_N		9	12	20	24	48	V
2	Terminal resistance	R		0,7	1,34	4	5,5	23	Ω
3	Output power	$P_{2\ max.}$		28,1	26,1	24,3	25,4	24,1	W
4	Efficiency, max.	$\eta_{max.}$		78	79	79	78	76	%
5	No-load speed	n_0		5 700	5 400	5 500	5 500	5 200	rpm
6	No-load current (with shaft ø 4 mm)	I_0		0,19	0,125	0,07	0,065	0,04	A
7	Stall torque	M_H		188	185	169	176	177	mNm
8	Friction torque	M_R		2,8	2,6	2,4	2,7	3,5	mNm
9	Speed constant	k_n		643	456	279	233	110	rpm/V
10	Back-EMF constant	k_E		1,56	2,19	3,59	4,3	9,05	mV/rpm
11	Torque constant	k_M		14,9	20,9	34,2	41	86,5	mNm/A
12	Current constant	k_I		0,067	0,048	0,029	0,024	0,012	A/mNm
13	Slope of n-M curve	$\Delta n/\Delta M$		30,3	29,2	32,5	31,3	29,4	rpm/mNm
14	Rotor inductance	L		100	220	630	850	3 400	µH
15	Mechanical time constant	τ_m		16	16	16	16	16	ms
16	Rotor inertia	J		50	52	47	49	52	gcm²
17	Angular acceleration	$\alpha_{max.}$		37	35	36	36	34	·10³rad/s²
18	Thermal resistance	R_{th1} / R_{th2}	1,5 / 9						K/W
19	Thermal time constant	τ_{w1} / τ_{w2}	15 / 900						s
20	Operating temperature range:								
	– motor		-30 ... +125						°C
	– rotor, max. permissible		+155						°C
21	Shaft bearings		ball bearings, preloaded						
22	Shaft load max.:								
	– with shaft diameter		4						mm
	– radial at 3 000 rpm (3 mm from bearing)		30						N
	– axial at 3 000 rpm		5						N
	– axial at standstill		50						N
23	Shaft play								
	– radial	≤	0,015						mm
	– axial	=	0						mm
24	Housing material		steel, zinc galvanized and passivated						
25	Weight		275						g
26	Direction of rotation		clockwise, viewed from the front face						
Recommended values - mathematically independent of each other									
27	Speed up to	$n_{e\ max.}$		5 000	5 000	5 000	5 000	5 000	rpm
28	Torque up to [1]	$M_{e\ max.}$		50	50	50	50	50	mNm

[1] thermal resistance $R_{th\ 2}$ by 40% reduced



3557 K ... CS

DC-Micromotors

Graphite Commutation

110 mNm

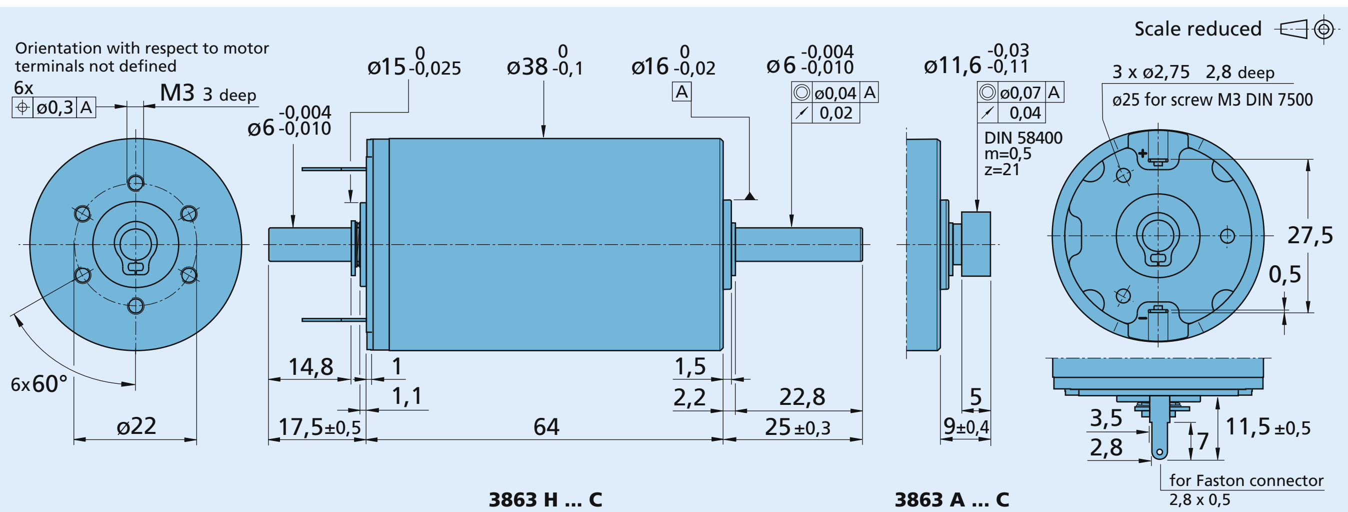
For combination with
Gearheads:
38/1(S), 38/2(S), 38A, 44/1
Encoders:
HEDL 5540, HEDM 5500, HEDS 5500, HEDS 5540, IE2-1024, IE2-16

Series 3863 ... C

	3863 H			012 C	018 C	024 C	036 C	048 C	
1	Nominal voltage	U_N		12	18	24	36	48	V
2	Terminal resistance	R		0,16	0,4	0,62	1,58	2,47	Ω
3	Output power	$P_{2\ max.}$		204	189	220	197	226	W
4	Efficiency, max.	$\eta_{max.}$		85	84	85	85	85	%
5	No-load speed	n_0		6 500	6 600	6 700	6 400	6 700	rpm
6	No-load current (with shaft ø 6 mm)	I_0		0,48	0,32	0,24	0,15	0,12	A
7	Stall torque	M_H		1 200	1 090	1 250	1 170	1 290	mNm
8	Friction torque	M_R		8,1	8	8	7,9	8,1	mNm
9	Speed constant	k_n		569	380	287	181	142	rpm/V
10	Back-EMF constant	k_E		1,76	2,63	3,49	5,51	7,05	mV/rpm
11	Torque constant	k_M		16,8	25,1	33,3	52,6	67,3	mNm/A
12	Current constant	k_I		0,06	0,04	0,03	0,019	0,015	A/mNm
13	Slope of n-M curve	$\Delta n/\Delta M$		5,4	6,1	5,4	5,5	5,2	rpm/mNm
14	Rotor inductance	L		30	70	130	280	500	µH
15	Mechanical time constant	τ_m		6	6,5	6	6	6	ms
16	Rotor inertia	J		110	100	110	100	110	gcm²
17	Angular acceleration	$\alpha_{max.}$		110	110	120	110	120	$\cdot 10^3$rad/s²
18	Thermal resistance	R_{th1} / R_{th2}	1,5 / 6						K/W
19	Thermal time constant	τ_{w1} / τ_{w2}	33 / 843						s
20	Operating temperature range:								
	– motor		-30 ... +125						°C
	– rotor, max. permissible		+155						°C
21	Shaft bearings		ball bearings, preloaded						
22	Shaft load max.:								
	– with shaft diameter		6						mm
	– radial at 3 000 rpm (3 mm from bearing)		60						N
	– axial at 3 000 rpm		6						N
	– axial at standstill		50						N
23	Shaft play								
	– radial	≤	0,015						mm
	– axial	=	0						mm
24	Housing material		steel, black coated						
25	Weight		400						g
26	Direction of rotation		clockwise, viewed from the front face						

Recommended values - mathematically independent of each other

				012 C	018 C	024 C	036 C	048 C	
27	Speed up to	$n_{e\ max.}$		8 000	8 000	8 000	8 000	8 000	rpm
28	Torque up to	$M_{e\ max.}$		110	110	110	110	110	mNm



NEW

FAULHABER

DC-Micromotors

Graphite Commutation

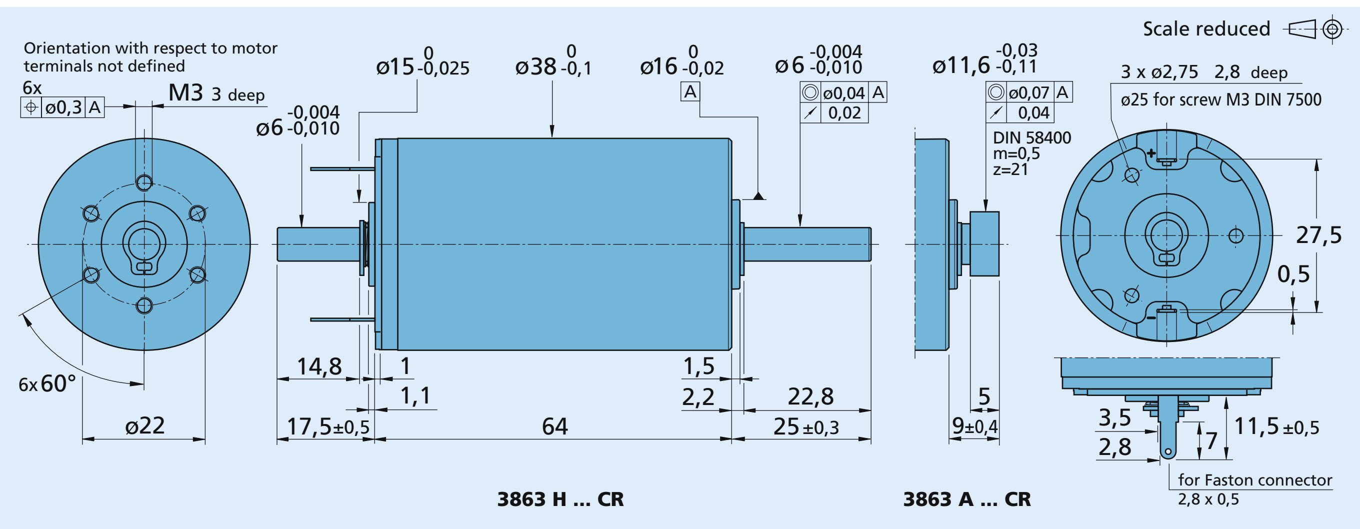
150 mNm

For combination with
Gearheads:
38/1(S), 38/2(S), 38A, 44/1
Encoders:
HEDL 5540, HEDM 5500, HEDS 5500, HEDS 5540, IE2-1024, IE2-16, IE3-1024(L)

Series 3863 ... CR

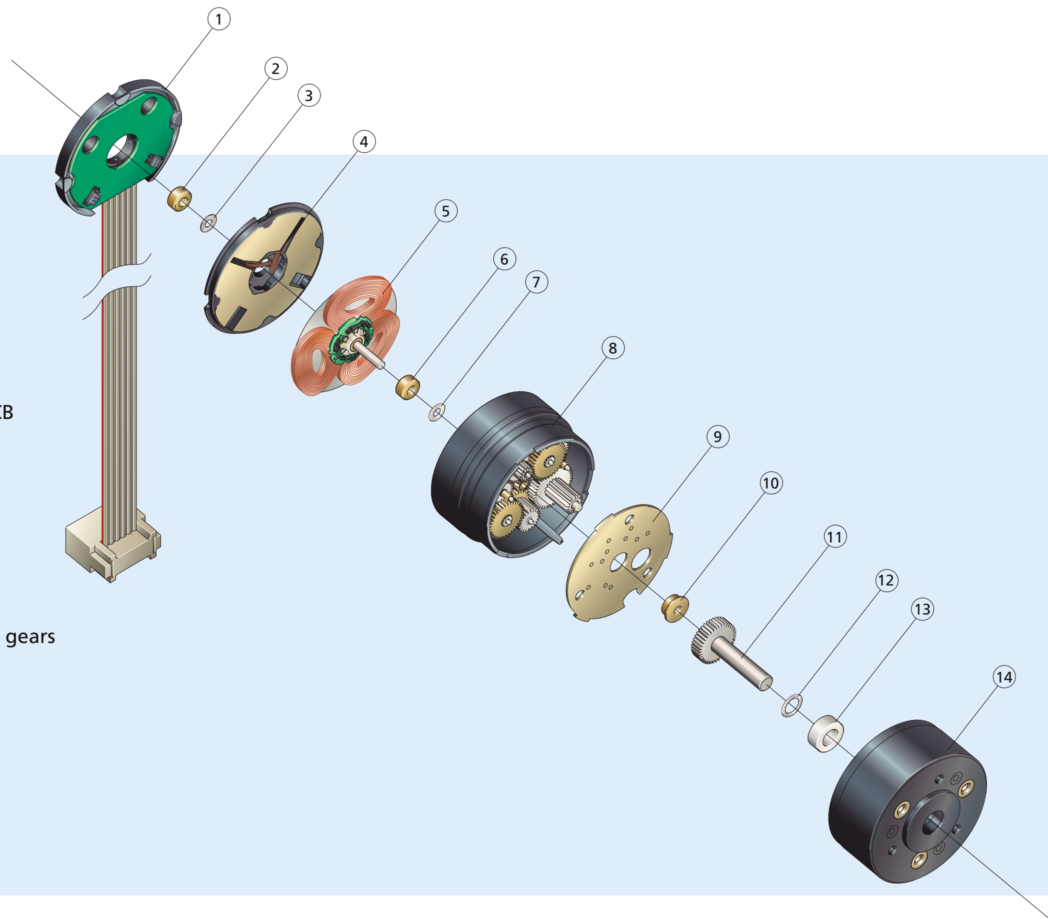
		3863 H	012 CR	018 CR	024 CR	036 CR	048 CR	
1	Nominal voltage	U_N	12	18	24	36	48	V
2	Terminal resistance	R	0,16	0,36	0,64	1,55	2,58	Ω
3	Output power	$P_{2\ max.}$	205	211	214	201	217	W
4	Efficiency, max.	$\eta_{max.}$	83	84	85	86	86	%
5	No-load speed	n_0	5 600	5 900	5 800	5 800	5 800	rpm
6	No-load current (with shaft ø 6 mm)	I_0	0,335	0,232	0,168	0,112	0,084	A
7	Stall torque	M_H	1 424	1 394	1 455	1 363	1 461	mNm
8	Friction torque	M_R	6,5	6,5	6,5	6,5	6,5	mNm
9	Speed constant	k_n	480	332	240	160	120	rpm/V
10	Back-EMF constant	k_E	2,08	3,01	4,17	6,25	8,33	mV/rpm
11	Torque constant	k_M	19,9	28,8	39,8	59,8	79,7	mNm/A
12	Current constant	k_I	0,503	0,035	0,025	0,017	0,013	A/mNm
13	Slope of n-M curve	$\Delta n/\Delta M$	3,9	4,1	3,9	4,1	3,9	rpm/mNm
14	Rotor inductance	L	45	90	180	400	700	µH
15	Mechanical time constant	τ_m	4,8	4,8	4,8	4,8	4,7	ms
16	Rotor inertia	J	120	110	120	110	115	gcm²
17	Angular acceleration	$\alpha_{max.}$	119	127	121	124	127	·10³rad/s²
18	Thermal resistance	R_{th1} / R_{th2}	2,5 / 6					K/W
19	Thermal time constant	τ_{w1} / τ_{w2}	50 / 900					s
20	Operating temperature range:							
	– motor		-30 ... +125					°C
	– rotor, max. permissible		+155					°C
21	Shaft bearings		ball bearings, preloaded					
22	Shaft load max.:							
	– with shaft diameter		6					mm
	– radial at 3 000 rpm (3 mm from bearing)		60					N
	– axial at 3 000 rpm		6					N
	– axial at standstill		50					N
23	Shaft play							
	– radial	≤	0,015					mm
	– axial	=	0					mm
24	Housing material		steel, black coated					
25	Weight		390					g
26	Direction of rotation		clockwise, viewed from the front face					
	Recommended values - mathematically independent of each other							
27	Speed up to	$n_{e\ max.}$	8 000	8 000	8 000	8 000	8 000	rpm
28	Torque up to [1]	$M_{e\ max.}$	120	150	157	153	159	mNm

[1] thermal resistance $R_{th\ 2}$ by 55% reduced



Flat DC-Micromotors

Precious Metal Commutation



DC-Gearmotor with integrated encoder

① End cap with encoder PCB
② Sintered bearing
③ Washer
④ Brush cover
⑤ Coils and collector
⑥ Sintered bearing
⑦ Washer
⑧ Housing with integrated gears
⑨ Intermediate plate
⑩ Sintered bearing
⑪ Output shaft
⑫ Washer
⑬ Sleeve bearing
⑭ Front cover

Features

The heart of these Flat DC-Micromotors is the ironless rotor made up of three flat self supporting coils.
The rotor coil has exceptionally low inertia and inductance and rotates in an axial magnetic field.

Motor torque can be increased by the addition of an integrated reduction gearhead. This also reduces the speed to fit the specifications in the application.

FAULHABER specializes in the modification of their drive systems to fit the customer's particular application requirements. Common modifications include vaccuum compatibility, extreme temperature compatability, modified shaft geometry, additional voltage types, custom motor leads and connectors, and much more.

Benefits

- No cogging
- Extremely low current consumption – low starting voltage
- Highly dynamic performance due to a low inertia, low inductance coil
- Light and compact
- Precise speed control
- Simple to control due to the linear performance characteristics

Product Code

2619 S 012 SR

26	Motor diameter [mm]
19	Motor length [mm]
S	Shaft type
012	Nominal voltage [V]
S	Type of commutation (precious metal)
R	Version (rare earth magnet)

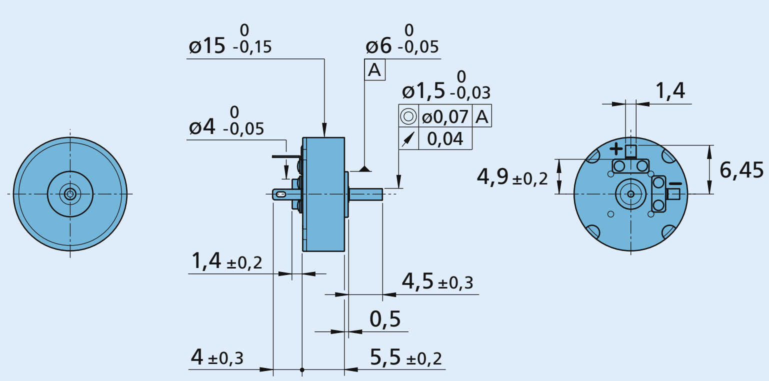
Flat DC-Micromotors

0,3 mNm

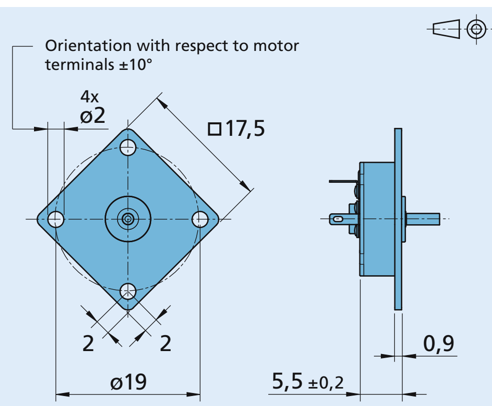
Precious Metal Commutation

Series 1506 ... SR

		1506 N		003 SR	006 SR	012 SR	
1	Nominal voltage	U_N		3	6	12	V
2	Terminal resistance	R		13,5	54,7	155	Ω
3	Output power	$P_{2\,max.}$		0,15	0,15	0,22	W
4	Efficiency, max.	$\eta_{max.}$		62	63	67	%
5	No-load speed	n_0		11 100	11 800	12 800	rpm
6	No-load current (with shaft ø 0,8 mm)	I_0		0,01	0,005	0,003	A
7	Stall torque	M_H		0,52	0,49	0,64	mNm
8	Friction torque	M_R		0,02	0,02	0,02	mNm
9	Speed constant	k_n		3 884	2 053	1 107	rpm/V
10	Back-EMF constant	k_E		0,257	0,487	0,903	mV/rpm
11	Torque constant	k_M		2,46	4,65	8,63	mNm/A
12	Current constant	k_I		0,407	0,215	0,116	A/mNm
13	Slope of n-M curve	$\Delta n/\Delta M$		21 333	24 135	19 947	rpm/mNm
14	Rotor inductance	L		275	1 157	3 550	µH
15	Mechanical time constant	τ_m		17	19	16	ms
16	Rotor inertia	J		0,08	0,08	0,08	gcm²
17	Angular acceleration	$\alpha_{max.}$		68	63	83	·10³rad/s²
18	Thermal resistance	$R_{th\,1}$ / $R_{th\,2}$	25 / 35				K/W
19	Thermal time constant	τ_{w1} / τ_{w2}	4,5 / 48,4				s
20	Operating temperature range:						
	– motor		-25 ... +80				°C
	– rotor, max. permissible		+85				°C
21	Shaft bearings		sintered bearings				
22	Shaft load max.:						
	– with shaft diameter		0,8				mm
	– radial at 3 000 rpm (3 mm from bearing)		0,5				N
	– axial at 3 000 rpm		0,1				N
	– axial at standstill		10				N
23	Shaft play						
	– radial	$\leq$	0,03				mm
	– axial	$\leq$	0,2				mm
24	Housing material		plastic				
25	Weight		4,3				g
26	Direction of rotation		clockwise, viewed from the front face				
	Recommended values - mathematically independent of each other						
27	Speed up to	$n_{e\,max.}$		10 000	10 000	10 000	rpm
28	Torque up to	$M_{e\,max.}$		0,3	0,3	0,3	mNm



1506 N ... SR



1506 N ... SR X3697

Flat DC-Micromotors

0,3 mNm

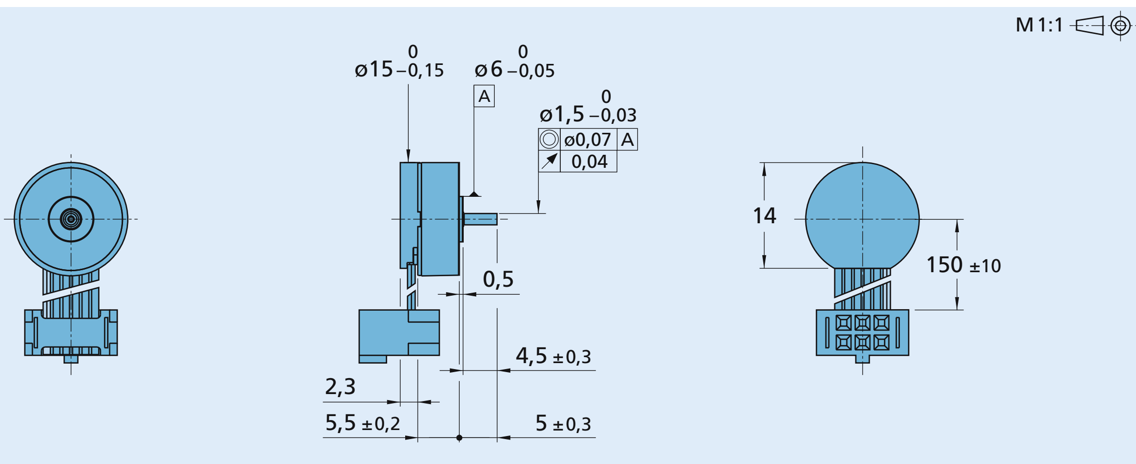
Precious Metal Commutation
with integrated Encoder

For combination with
Drive Electronics:
Speed controller

Series 1506 ... SR IE2-8

1506 N			003 SR	006 SR	012 SR	IE2-8
Nominal voltage	U_N		3	6	12	Volt
Terminal resistance	R		10,4	50,5	130	Ω
Output power	$P_{2\ max.}$		0,19	0,17	0,26	W
Efficiency	$\eta_{max.}$		68	66	70	%
No-load speed	n_o		13 400	14 300	15 500	rpm
No-load current (with shaft ø 0,8 mm)	I_o		0,010	0,005	0,003	A
Stall torque	M_H		0,54	0,46	0,64	mNm
Friction torque	M_R		0,02	0,02	0,02	mNm
Speed constant	k_n		4 640	2 480	1 340	rpm/V
Back-EMF constant	k_E		0,216	0,403	0,749	mV/rpm
Torque constant	k_M		2,06	3,84	7,15	mNm/A
Current constant	k_I		0,486	0,260	0,140	A/mNm
Slope of n-M curve	$\Delta n/\Delta M$		24 700	31 400	24 200	rpm/mNm
Rotor inductance	L		175	720	2 100	µH
Mechanical time constant	τ_m		24	30	23	ms
Rotor inertia	J		0,09	0,09	0,09	gcm^2
Angular acceleration	$\alpha_{max.}$		58	50	71	$\cdot 10^3 rad/s^2$
Thermal resistance	$R_{th\ 1}$ / $R_{th\ 2}$	36 / 61				K/W
Thermal time constant	τ_{w1} / τ_{w2}	5,4 / 190				s
Operating temperature range:		0 ... + 70				°C
Shaft bearings		sintered sleeves bearings				
Shaft load max.:						
– with shaft diameter		0,8				mm
– radial at 3000 rpm (3 mm from bearing)		0,5				N
– axial at 3000 rpm		0,1				N
– axial at standstill		10				N
Shaft play:						
– radial	≤	0,03				mm
– axial	≤	0,2				mm
Housing material		plastic				
Weight		7,1				g
Direction of rotation		clockwise, viewed from the front face				

Recommended values - mathematically independent of each other						
Speed up to	$n_{e\ max.}$		10 000	10 000	10 000	rpm
Torque up to	$M_{e\ max.}$		0,3	0,3	0,3	mNm



1506 N ... SR IE2-8

Integrated optical Encoder		IE2-8	
Lines per revolution	N	8	
Signal output, square wave		2	channels
Supply voltage	U_{DD}	3,2 ... 5,5	V DC
Current consumption, typical (U_{DD} = 5 V DC)	I_{DD}	typ. 8, max. 15	mA
Output current, max. allowable (at U_{out} < 1,5V)	I_{OUT}	5	mA
Pulse width [1]	P	180 ± 45	°e
Phase shift, channal A to B [1]	Φ	90 ± 45	°e
Signal rise/fall time, max. (C_{LOAD} = 50 pF)	tr/tf	2,5/0,3	µs
Frequency range [2], up to	f	4,5	kHz

[1] Ambient temperature 22°C (tested at 1kHz)
[2] Velocity (rpm) = f (Hz) x 60/N

Features

In this version, the DC-Micromotors have an optical encoder with two output channels. A code wheel on the shaft is optically captured and further processed. At the encoder outputs, two 90° phase-shifted rectangular signals are available with 8 impulses per motor revolution.

The encoder is suitable for the monitoring and regulation of the speed and direction of rotation and for positioning the drive shaft.

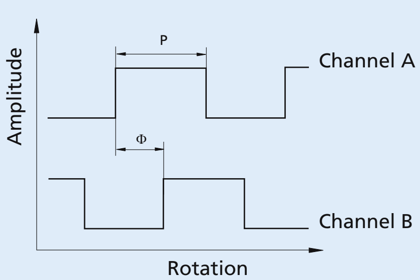
The supply voltage for the encoder and the DC-Micromotor as well as the two channel output signals are interfaced through a ribbon cable with connector.

Full product description

- Examples:
  1506N003SR IE2-8
  1506N012SR IE2-8

Output signals / Circuit diagram / Connector information

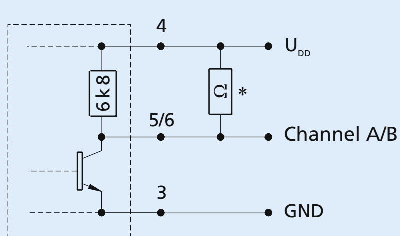
Output signals
with clockwise rotation as seen from the shaft end



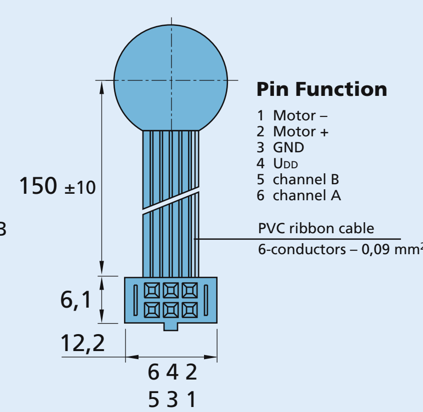
Admissible deviation of phase shift:

$$\Delta\Phi = \left| 90° - \frac{\Phi}{P} * 180° \right| \leq 45°$$

Output circuit



* An additional external pull-up resistor can be added to improve the rise time.
Caution: I_{OUT} max. 5 mA must not be exceeded!



Connector
DIN-41651
grid 2,54 mm

DC-Gearmotors

30 mNm

Precious Metal Commutation

Series 1512 ... SR

	1512 U	003 SR	006 SR	012 SR	
Nominal voltage	U_N	3	6	12	Volt
Terminal resistance	R	13,6	60,5	156	Ω
Output power	$P_{2\ max.}$	0,15	0,15	0,22	W
No-load speed (motor)	n_o	11 100	11 980	12 800	rpm
Speed constant	k_n	3 884	2 053	1 107	rpm/V
Back-EMF constant	k_E	0,257	0,487	0,903	mV/rpm
Torque constant	k_M	2,46	4,65	8,63	mNm/A
Current constant	k_I	0,407	0,215	0,116	A/mNm
Slope of n-M curve	$\Delta n/\Delta M$	21 330	24 135	19 947	rpm/mNm
Rotor inductance	L	275	1 157	3 550	µH
Rotor inertia	J	0,08	0,08	0,08	gcm^2

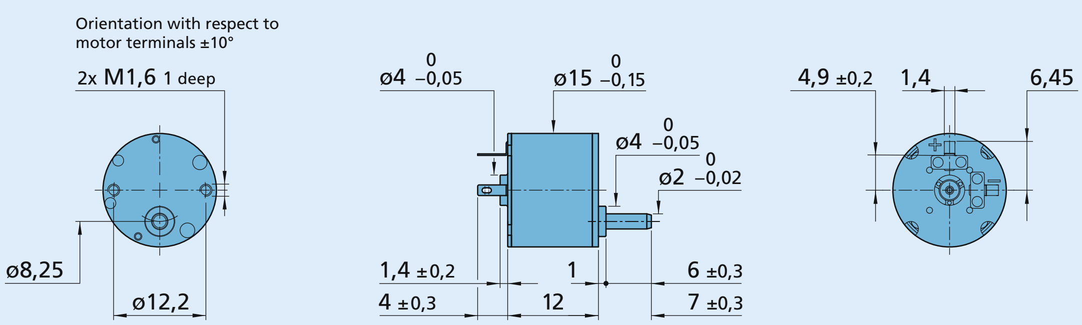
Housing material		plastic	
Geartrain material		metal	
Backlash, at no-load	≤	4	°
Bearings on output shaft		plastic / brass bearing	
Shaft load max.:			
– radial (5 mm from mounting face)	≤	1,4	N
– axial	≤	1	N
Shaft press fit force, max.	≤	15	N
Shaft play:			
– radial (5 mm from mounting face)	≤	0,08	mm
– axial	≤	0,25	mm
Operating temperature range		– 25 ... + 80	°C

Specifications

reduction ratio (rounded)	output speed up to n_{max} rpm	weight with motor g	output torque continuous operation M_{max} mNm	output torque intermittent operation M_{max} mNm	direction of rotation (reversible)	efficiency %
6 : 1	779	6,9	1,4	3	=	81
13 : 1	372	7,0	2,8	5	≠	73
39 : 1	129	7,2	7,0	10	=	60
112 : 1	45	7,4	19,8	30	≠	59
324 : 1	15	7,7	30,0	50	=	53

Note: output speed at 5000 rpm input speed. Based on motor 1506 ... SR.

M 1:1



1512 U

FAULHABER

DC-Gearmotors

Precious Metal Commutation
with integrated Encoder

30 mNm

For combination with
Drive Electronics:
Speed Controller

Series 1512 ... SR ... IE2-8

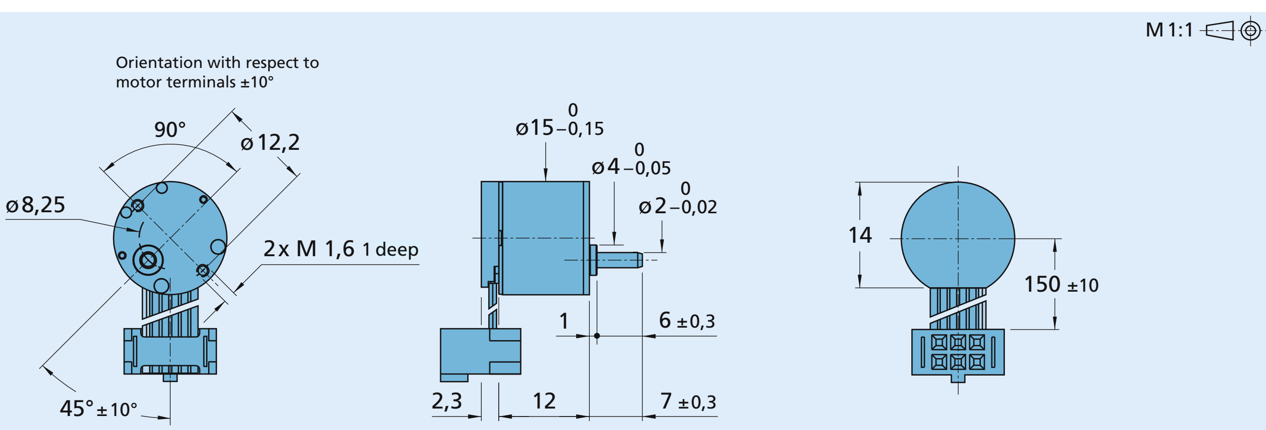
	1512 U	003 SR	006 SR	012 SR	IE2-8
Nominal voltage	U_N	3	6	12	Volt
Terminal resistance	R	10,4	50,5	130	Ω
Output power	$P_{2\ max.}$	0,19	0,17	0,26	W
No-load speed (motor)	n_o	13 400	14 300	15 500	rpm
Speed constant	k_n	4 640	2 480	1 340	rpm/V
Back-EMF constant	k_E	0,216	0,403	0,749	mV/rpm
Torque constant	k_M	2,06	3,84	7,15	mNm/A
Current constant	k_I	0,486	0,260	0,140	A/mNm
Slope of n-M curve	$\Delta n/\Delta M$	24 700	31 400	24 200	rpm/mNm
Rotor inductance	L	175	720	2 100	µH
Rotor inertia	J	0,09	0,09	0,09	gcm^2

Housing material		plastic	
Geartrain material		metal	
Backlash, at no-load	≤	4	°
Bearings on output shaft		plastic / brass bearing	
Shaft load max.:			
– radial (5 mm from mounting face)	≤	1,4	N
– axial	≤	1	N
Shaft press fit force, max.	≤	15	N
Shaft play:			
– radial (5 mm from mounting face)	≤	0,08	mm
– axial	≤	0,25	mm
Operating temperature range		0 ... + 70	°C

Specifications

reduction ratio (rounded)	output speed up to n_{max} rpm	weight with motor g	output torque continuous operation M_{max} mNm	output torque intermittent operation M_{max} mNm	direction of rotation (reversible)	efficiency %
6 : 1	779	6,9	1,4	3	=	81
13 : 1	372	7,0	2,8	5	≠	73
39 : 1	129	7,2	7,0	10	=	60
112 : 1	45	7,4	19,8	30	≠	59
324 : 1	15	7,7	30,0	50	=	53

Note: output speed at 5000 rpm input speed. Based on motor 1506 ... SR.



1512U ... SR ... IE2-8

Integrated optical Encoder		IE2-8	
Lines per revolution	N	8	
Signal output, square wave		2	channels
Supply voltage	U_{DD}	3,2 ... 5,5	V DC
Current consumption, typical (U_{DD} = 5 V DC)	I_{DD}	typ. 8, max. 15	mA
Output current, max. allowable (at U_{out} < 1,5V)	I_{OUT}	5	mA
Pulse width [1]	P	180 ± 45	°e
Phase shift, channal A to B [1]	Φ	90 ± 45	°e
Signal rise/fall time, max. (C_{LOAD} = 50 pF)	tr/tf	2,5/0,3	µs
Frequency range [2], up to	f	4,5	kHz

[1] Ambient temperature 22°C (tested at 1kHz)
[2] Velocity (rpm) = f (Hz) x 60/N

Features

In this version, the DC-Micromotors have an optical encoder with two output channels. A code wheel on the shaft is optically captured and further processed. At the encoder outputs, two 90° phase-shifted rectangular signals are available with 8 impulses per motor revolution.

The encoder is suitable for the monitoring and regulation of the speed and direction of rotation and for positioning the drive shaft.

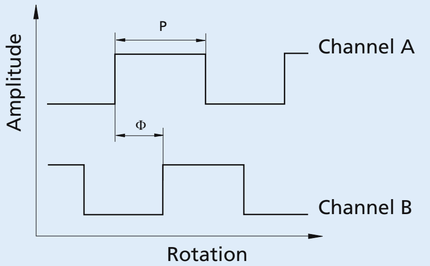
The supply voltage for the encoder and the DC-Micromotor as well as the two channel output signals are interfaced through a ribbon cable with connector.

Full product description

- Examples:
  1512U003SR 6:1 IE2-8
  1512U012SR 324:1 IE2-8

Output signals / Circuit diagram / Connector information

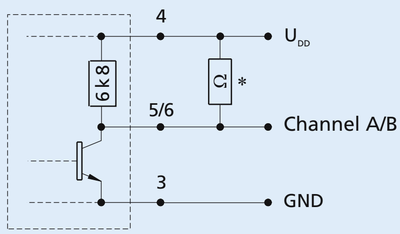
Output signals
with clockwise rotation as seen from the shaft end



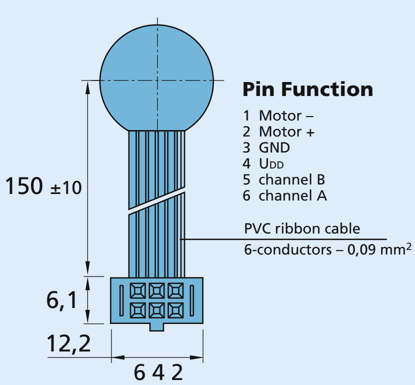
Admissible deviation of phase shift:

$$\Delta\Phi = \left| 90° - \frac{\Phi}{P} * 180° \right| \leq 45°$$

Output circuit



* An additional external pull-up resistor can be added to improve the rise time.
Caution: I_{OUT} max. 5 mA must not be exceeded!



Pin Function
1 Motor –
2 Motor +
3 GND
4 U_{DD}
5 channel B
6 channel A

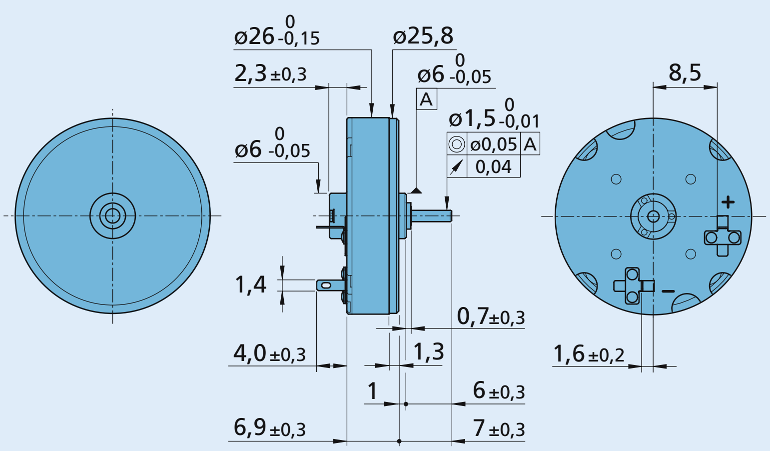
Connector
DIN-41651
grid 2,54 mm

Flat DC-Micromotors — 3 mNm

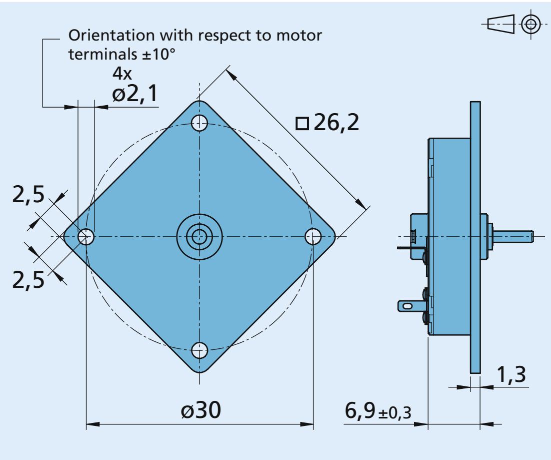
Precious Metal Commutation

Series 2607 ... SR

		2607 T			006 SR	012 SR	024 SR	
1	Nominal voltage	U_N			6	12	24	V
2	Terminal resistance	R			8,2	36,5	128	Ω
3	Output power	$P_{2\ max.}$			1,08	0,97	1,1	W
4	Efficiency, max.	$\eta_{max.}$			81	80	81	%
5	No-load speed	n_0			6 600	5 900	6 200	rpm
6	No-load current (with shaft ø 1,5 mm)	I_0			0,007	0,004	0,002	A
7	Stall torque	M_H			6,26	6,21	6,77	mNm
8	Friction torque	M_R			0,06	0,07	0,07	mNm
9	Speed constant	k_n			1 111	500	261	rpm/V
10	Back-EMF constant	k_E			0,9	2	3,83	mV/rpm
11	Torque constant	k_M			8,59	19,09	36,54	mNm/A
12	Current constant	k_I			0,116	0,052	0,027	A/mNm
13	Slope of n-M curve	$\Delta n/\Delta M$			1 055	957	917	rpm/mNm
14	Rotor inductance	L			465	2 200	8 400	µH
15	Mechanical time constant	τ_m			7,5	6,8	6,5	ms
16	Rotor inertia	J			0,68	0,68	0,68	gcm²
17	Angular acceleration	$\alpha_{max.}$			92	92	100	$\cdot 10^3$rad/s²
18	Thermal resistance	R_{th1} / R_{th2}	2,7 / 24,45					K/W
19	Thermal time constant	τ_{w1} / τ_{w2}	1,8 / 163					s
20	Operating temperature range:							
	– motor		-25 ... +80					°C
	– rotor, max. permissible		+100					°C
21	Shaft bearings		sintered bearings	ball bearings, preloaded				
22	Shaft load max.:		(standard)	(optional version)				
	– with shaft diameter		1,5	1,5				mm
	– radial at 3 000 rpm (3 mm from bearing)		1,2	5				N
	– axial at 3 000 rpm		0,2	0,5				N
	– axial at standstill		20	10				N
23	Shaft play							
	– radial	≤	0,03	0,015				mm
	– axial	≤	0,2	0,2				mm
24	Housing material		plastic					
25	Weight		16,1					g
26	Direction of rotation		clockwise, viewed from the front face					
Recommended values - mathematically independent of each other								
27	Speed up to	$n_{e\ max.}$			5 500	5 500	5 500	rpm
28	Torque up to	$M_{e\ max.}$			3	3	3	mNm



2607 T ... SR



2607 T ... SR 3697

Flat DC-Micromotors

Precious Metal Commutation with integrated Encoder

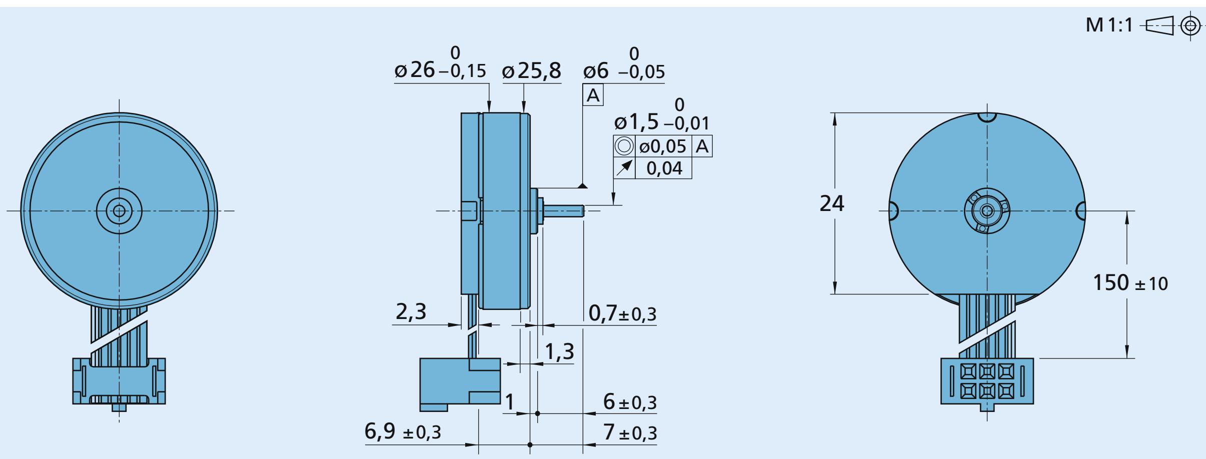
2 mNm

For combination with
Drive Electronics:
Speed Controller

Series 2607 ... SR IE2-16

	2607 T			006 SR	012 SR	024 SR	IE2-16
Nominal voltage	U_N			6	12	24	Volt
Terminal resistance	R			8	31,2	118,6	Ω
Output power	$P_{2\ max.}$			1,11	1,14	1,22	W
Efficiency	$\eta_{max.}$			80	80	80	%
No-load speed	n_o			6 700	6 900	7 200	rpm
No-load current (with shaft ø 1,5 mm)	I_o			0,010	0,005	0,0025	A
Stall torque	M_H			6,33	6,31	6,48	mNm
Friction torque	M_R			0,08	0,08	0,08	mNm
Speed constant	k_n			1 130	582	304	rpm/V
Back-EMF constant	k_E			0,884	1,72	3,29	mV/rpm
Torque constant	k_M			8,44	16,4	31,4	mNm/A
Current constant	k_I			0,118	0,061	0,032	A/mNm
Slope of n-M curve	$\Delta n/\Delta M$			1 060	1 090	1 110	rpm/mNm
Rotor inductance	L			420	1 600	5 800	µH
Mechanical time constant	τ_m			7,5	7,8	7,9	ms
Rotor inertia	J			0,68	0,68	0,68	gcm^2
Angular acceleration	$\alpha_{max.}$			94	93	95	$\cdot 10^3 rad/s^2$
Thermal resistance	$R_{th\ 1}$ / $R_{th\ 2}$	10 / 32					K/W
Thermal time constant	τ_{w1} / τ_{w2}	6 / 250					s
Operating temperature range:		0 ... + 70					°C
Shaft bearings		sintered sleeves bearings	ball bearings, preloaded				
Shaft load max.:		(standard)	(optional)				
– with shaft diameter		1,5	1,5				mm
– radial at 3000 rpm (3 mm from bearing)		1,2	5				N
– axial at 3000 rpm		0,2	0,5				N
– axial at standstill		20	10				N
Shaft play:							
– radial	≤	0,03	0,015				mm
– axial	≤	0,2	0,2				mm
Housing material		plastic					
Weight		18,6					g
Direction of rotation		clockwise, viewed from the front face					

Recommended values - mathematically independent of each other							
Speed up to	$n_{e\ max.}$			5 500	5 500	5 500	rpm
Torque up to	$M_{e\ max.}$			2	2	2	mNm



2607 T ... SR IE2-16

Integrated optical Encoder		IE2-16	
Lines per revolution	N	16	
Signal output, square wave		2	channels
Supply voltage	U_{DD}	3,2 ... 5,5	V DC
Current consumption, typical (U_{DD} = 5 V DC)	I_{DD}	typ. 8, max. 15	mA
Output current, max. allowable (at U_{out} < 1,5V)	I_{OUT}	5	mA
Pulse width [1]	P	180 ± 45	°e
Phase shift, channal A to B [1]	Φ	90 ± 45	°e
Signal rise/fall time, max. (C_{LOAD} = 50 pF)	tr/tf	2,5/0,3	µs
Frequency range [2], up to	f	4,5	kHz

[1] Ambient temperature 22°C (tested at 1kHz)
[2] Velocity (rpm) = f (Hz) x 60/N

Features

In this version, the DC-Micromotors have an optical encoder with two output channels. A code wheel on the shaft is optically captured and further processed. At the encoder outputs, two 90° phase-shifted rectangular signals are available with 16 impulses per motor revolution.

The encoder is suitable for the monitoring and regulation of the speed and direction of rotation and for positioning the drive shaft.

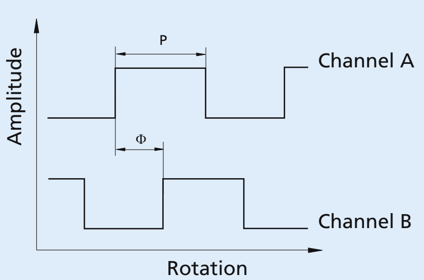
The supply voltage for the encoder and the DC-Micromotor as well as the two channel output signals are interfaced through a ribbon cable with connector.

Full product description

- Examples:
  2607T006SR IE2-16
  2607T024SR IE2-16

Output signals / Circuit diagram / Connector information

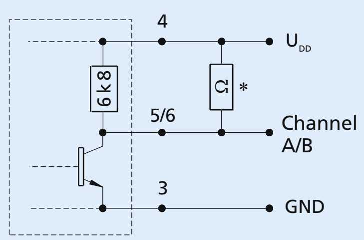
Output signals
with clockwise rotation as seen from the shaft end



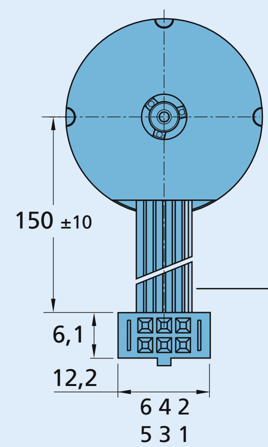
Admissible deviation of phase shift:

$$\Delta\Phi = \left| 90° - \frac{\Phi}{P} * 180° \right| \leq 45°$$

Output circuit



* An additional external pull-up resistor can be added to improve the rise time.
Caution: I_{OUT} max. 5 mA must not be exceeded!



Pin Function
1 Motor –
2 Motor +
3 GND
4 U_{DD}
5 channel B
6 channel A

PVC ribbon cable
6-conductors – 0,09 mm²

Connector
DIN-41651
grid 2,54 mm

DC-Gearmotors

100 mNm

Precious Metal Commutation

Series 2619 ... SR

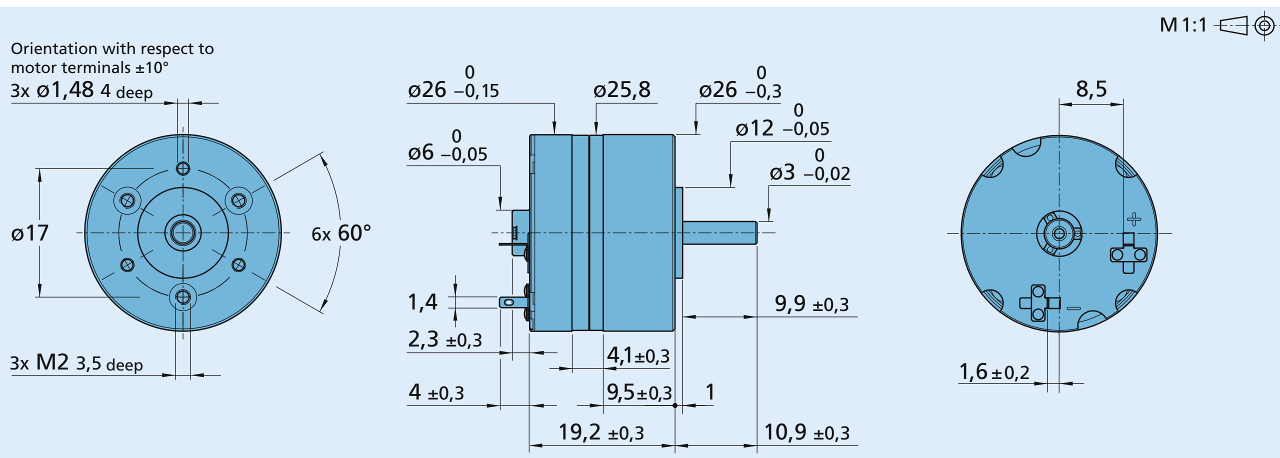
2619 S		006 SR	012 SR	024 SR	
Nominal voltage	U_N	6	12	24	Volt
Terminal resistance	R	8,2	36,5	128	Ω
Output power	$P_{2\,max.}$	1,08	0,97	1,1	W
No-load speed (motor)	n_0	6 600	5 900	6 200	rpm
Speed constant	k_n	1 111	500	261	rpm/V
Back-EMF constant	k_E	0,9	2	3,83	mV/rpm
Torque constant	k_M	8,59	19,09	36,54	mNm/A
Current constant	k_I	0,116	0,052	0,027	A/mNm
Slope of n-M curve	$\Delta n/\Delta M$	1 055	957	917	rpm/mNm
Rotor inductance	L	465	2 200	8 400	µH
Rotor inertia	J	0,68	0,68	0,68	gcm^2

Housing material		plastic		
Geartrain material		metal		
Backlash, at no-load	≤	4		°
Bearings on output shaft		brass / ceramic bearings	ball bearings, preloaded	
Shaft load max.:		(standard)	(optional)	
– radial (5 mm from mounting face)	≤	3,5	10,5	N
– axial	≤	2	5	N
Shaft press fit force, max.	≤	10	10	N
Shaft play:				
– radial (5 mm from mounting face)	≤	0,07	0,03	mm
– axial	≤	0,25	0,25	mm
Operating temperature range		– 25 ... + 80		°C

Specifications

reduction ratio (rounded)	output speed up to n_{max} rpm	weight with motor g	output torque continuous operation M_{max} mNm	output torque intermittent operation M_{max} mNm	direction of rotation (reversible)	efficiency %
8 : 1	635	25	9	30	=	81
22 : 1	223	26	23	75	≠	73
33 : 1	151	26	30	100	=	66
112 : 1	44	27	93	180	≠	59
207 : 1	24	27	100	180	=	53
361 : 1	14	27	100	180	=	53
814 : 1	6	28	100	180	=	43
1 257 : 1	4	29	100	180	=	43

Note: output speed at 5000 rpm input speed. Based on motor 2607 ... SR.



2619 S

FAULHABER

DC-Gearmotors

Precious Metal Commutation
with integrated Encoder

100 mNm

For combination with
Drive Electronics:
Speed Controller

DC-Micromotors

Series 2619 ... SR ... IE2-16

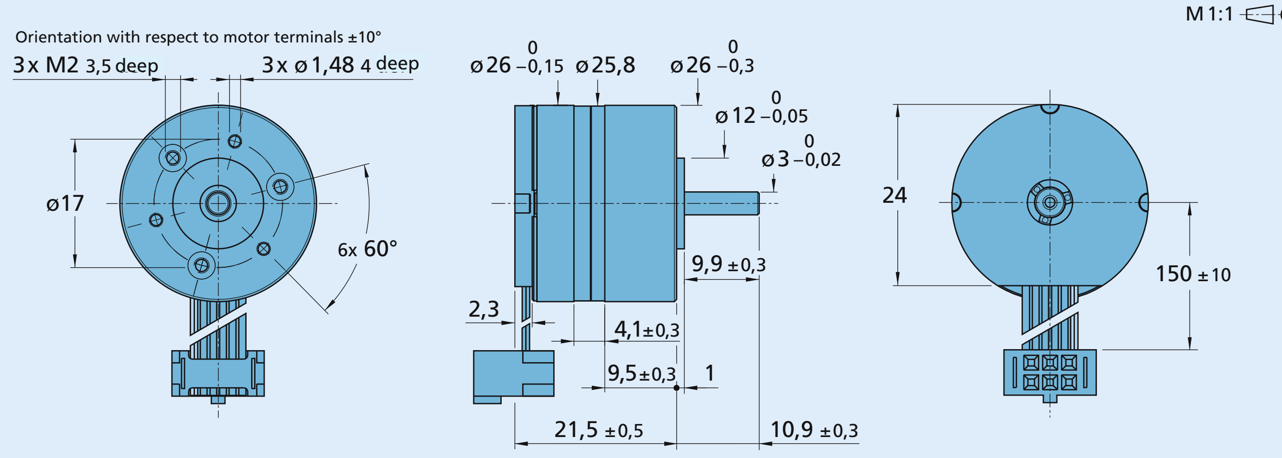
2619 S		006 SR	012 SR	024 SR	IE2-16
Nominal voltage	U_N	6	12	24	Volt
Terminal resistance	R	8	31,2	118,6	Ω
Output power	$P_{2\ max.}$	1,11	1,14	1,22	W
No-load speed (motor)	n_o	6 700	6 900	7 200	rpm
Speed constant	k_n	1 130	582	304	rpm/V
Back-EMF constant	k_E	0,884	1,72	3,29	mV/rpm
Torque constant	k_M	8,44	16,4	31,4	mNm/A
Current constant	k_I	0,118	0,061	0,032	A/mNm
Slope of n-M curve	$\Delta n/\Delta M$	1 060	1 090	1 110	rpm/mNm
Rotor inductance	L	420	1 600	5 800	µH
Rotor inertia	J	0,68	0,68	0,68	gcm^2

Housing material		plastic		
Geartrain material		metal		
Backlash, at no-load	≤	4		°
Bearings on output shaft		brass / ceramic bearings	ball bearings, preloaded	
Shaft load max.:		(standard)	(optional)	
– radial (5 mm from mounting face)	≤	3,5	10,5	N
– axial	≤	2	5	N
Shaft press fit force, max.	≤	10	10	N
Shaft play:				
– radial (5 mm from mounting face)	≤	0,07	0,03	mm
– axial	≤	0,25	0,25	mm
Operating temperature range		0 ... + 70		°C

Specifications

reduction ratio (rounded)	output speed up to n_{max} rpm	weight with motor g	output torque continuous operation M_{max} mNm	output torque intermittent operation M_{max} mNm	direction of rotation (reversible)	efficiency %
8 : 1	635	25	9	30	=	81
22 : 1	223	26	23	75	≠	73
33 : 1	151	26	30	100	=	66
112 : 1	44	27	93	180	≠	59
207 : 1	24	27	100	180	=	53
361 : 1	14	27	100	180	=	53
814 : 1	6	28	100	180	=	43
1 257 : 1	4	29	100	180	=	43

Note: output speed at 5000 rpm input speed. Based on motor 2607 ... SR.



2619S ... SR ... IE2-16

Integrated optical Encoder		IE2-16	
Lines per revolution	N	16	
Signal output, square wave		2	channels
Supply voltage	U_{DD}	3,2 ... 5,5	V DC
Current consumption, typical (U_{DD} = 5 V DC)	I_{DD}	typ. 8, max. 15	mA
Output current, max. allowable (at U_{out} < 1,5V)	I_{OUT}	5	mA
Pulse width [1]	P	180 ± 45	°e
Phase shift, channal A to B [1]	Φ	90 ± 45	°e
Signal rise/fall time, max. (C_{LOAD} = 50 pF)	tr/tf	2,5/0,3	µs
Frequency range [2], up to	f	4,5	kHz

[1] Ambient temperature 22°C (tested at 1kHz)
[2] Velocity (rpm) = f (Hz) x 60/N

Features

In this version, the DC-Micromotors have an optical encoder with two output channels. A code wheel on the shaft is optically captured and further processed. At the encoder outputs, two 90° phase-shifted rectangular signals are available with 16 impulses per motor revolution.

The encoder is suitable for the monitoring and regulation of the speed and direction of rotation and for positioning the drive shaft.

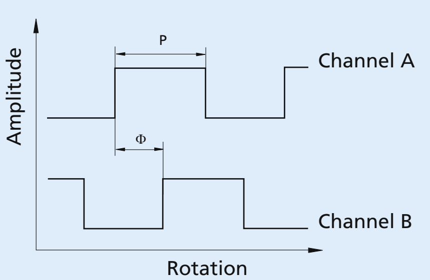
The supply voltage for the encoder and the DC-Micromotor as well as the two channel output signals are interfaced through a ribbon cable with connector.

Full product description

- Examples:
  2619S006SR 8:1 IE2-16
  2619S024SR 1257:1 IE2-16

Output signals / Circuit diagram / Connector information

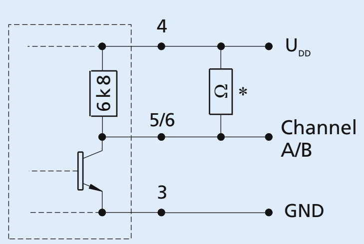
Output signals
with clockwise rotation as seen from the shaft end



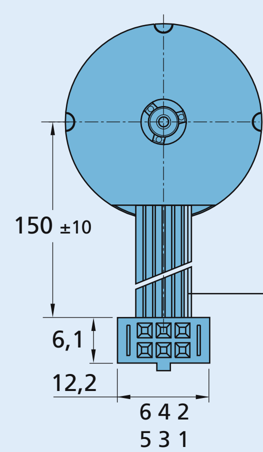
Admissible deviation of phase shift:

$$\Delta\Phi = \left| 90° - \frac{\Phi}{P} * 180° \right| \leq 45°$$

Output circuit



* An additional external pull-up resistor can be added to improve the rise time.
Caution: I_{OUT} max. 5 mA must not be exceeded!

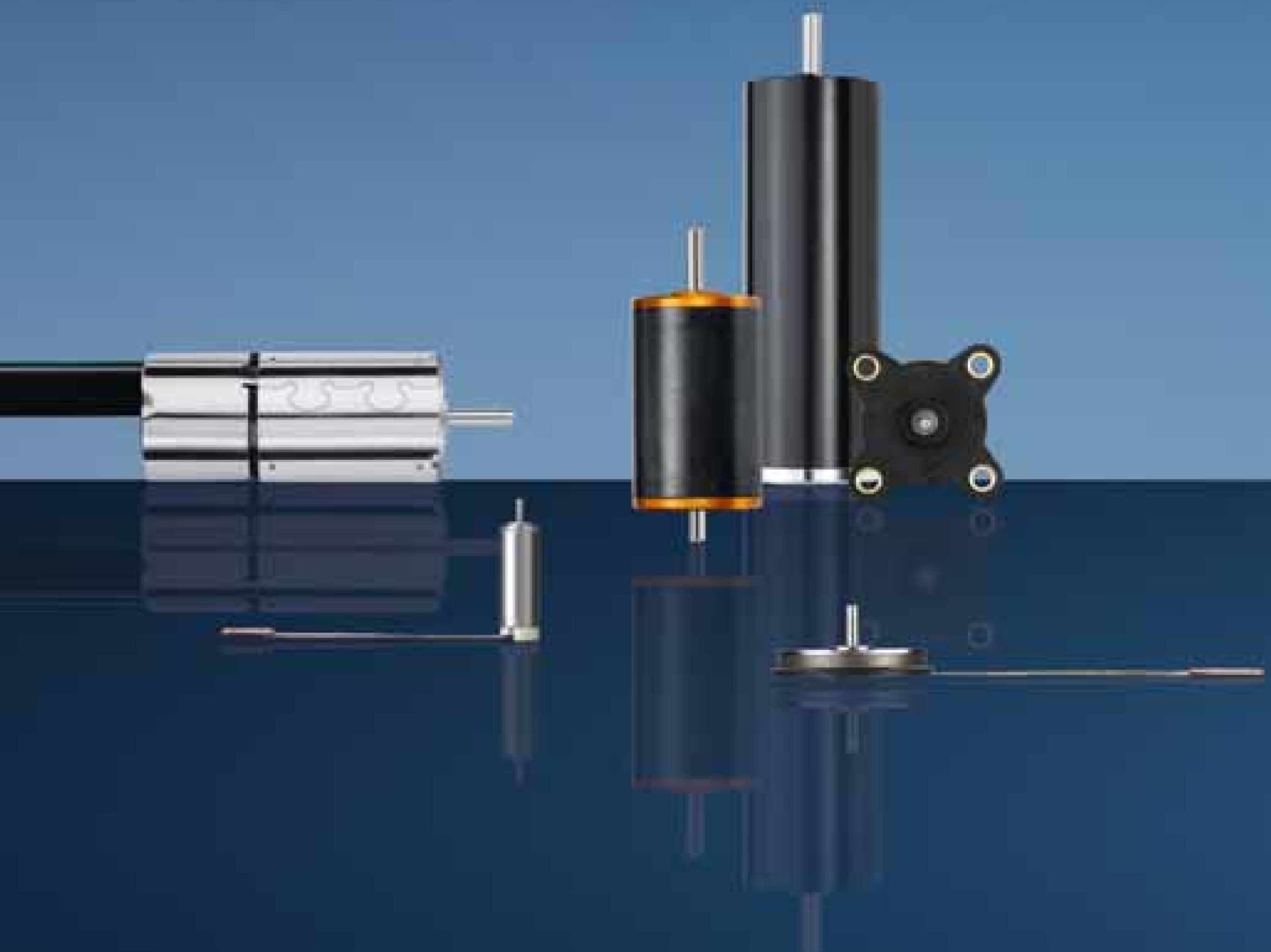


Pin Function
1 Motor –
2 Motor +
3 GND
4 U_{DD}
5 channel B
6 channel A

PVC ribbon cable
6-conductors – 0,09 mm²

Connector
DIN-41651
grid 2,54 mm

Brushless DC-Motors



WE CREATE MOTION

FAULHABER

Brushless DC-Motors

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Brushless DC-Micromotors – smoovy® Technology	0308 … B	sensorless	0,023 mNm	83
	03A	Micro Planetary Gearhead	0,88 mNm	84
	03A S3	Linear Actuator	2,8 N	85
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Brushless DC-Servomotors

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Brushless DC-Servomotors	0620 … B	with integrated Hall Sensors	0,36 mNm	90 – 91
	1226 … B	with integrated Hall Sensors	2,2 mNm	92 – 93
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Brushless DC-Servomotors – SMARTSHELL® Technology	1524 … BSL	sensorless, optional with Hall Sensors	2,1 mNm	112 – 113
	1536 … BSL	sensorless, optional with Hall Sensors	5,7 mNm	114 – 115
	2232 … BSL	sensorless, optional with Hall Sensors	6,5 mNm	116 – 117
	2248 … BSL	sensorless, optional with Hall Sensors	15,5 mNm	118 – 119
Brushless DC-Servomotors – 4 Pole Technology	2232 … BX4 S	with integrated Hall Sensors	10 mNm	122 – 123
	2232 … BX4	with integrated Hall Sensors	19 mNm	124 – 125
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	2250 … BX4	with integrated Hall Sensors	37 mNm	128 – 129
	3242 … BX4	with integrated Hall Sensors	56 mNm	130 – 131
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Brushless DC-Servomotors with integrated Encoder

				Page
Brushless DC-Servomotors – 4 Pole Technology	2232 … BX4 S + Encoder	with integrated Encoder	11 mNm	136 – 141
	2232 … BX4 + Encoder	with integrated Encoder	22 mNm	142 – 147
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	3242 … BX4 + Encoder	with integrated Encoder	55 mNm	160 – 165
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Brushless Flat DC-Micromotors & DC-Gearmotors

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Brushless Flat DC-Micromotors & DC-Gearmotors – penny-motor® Technology	1202 … BH	with integrated Hall Sensors	0,16 mNm	181
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Brushless DC-Motors with integrated Speed Controller

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Brushless DC-Servomotors – 4 Pole Technology	2232 … BX4 S SC	with integrated Speed Controller	7 mNm	192 – 194
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	3242 … BX4 SC	with integrated Speed Controller	54 mNm	204 – 206
	3242 … BX4 SCDC	with integrated Speed Controller, 2-wire	50 mNm	207 – 209
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Brushless Flat DC-Micromotors & DC-Gearmotors	2610 … B SC	with integrated Speed Controller	3,7 mNm	216 – 217
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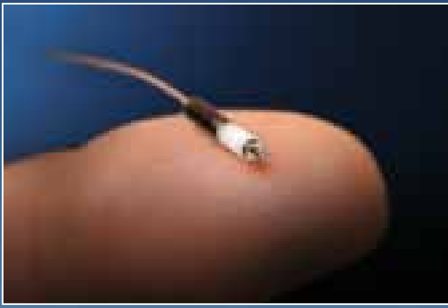
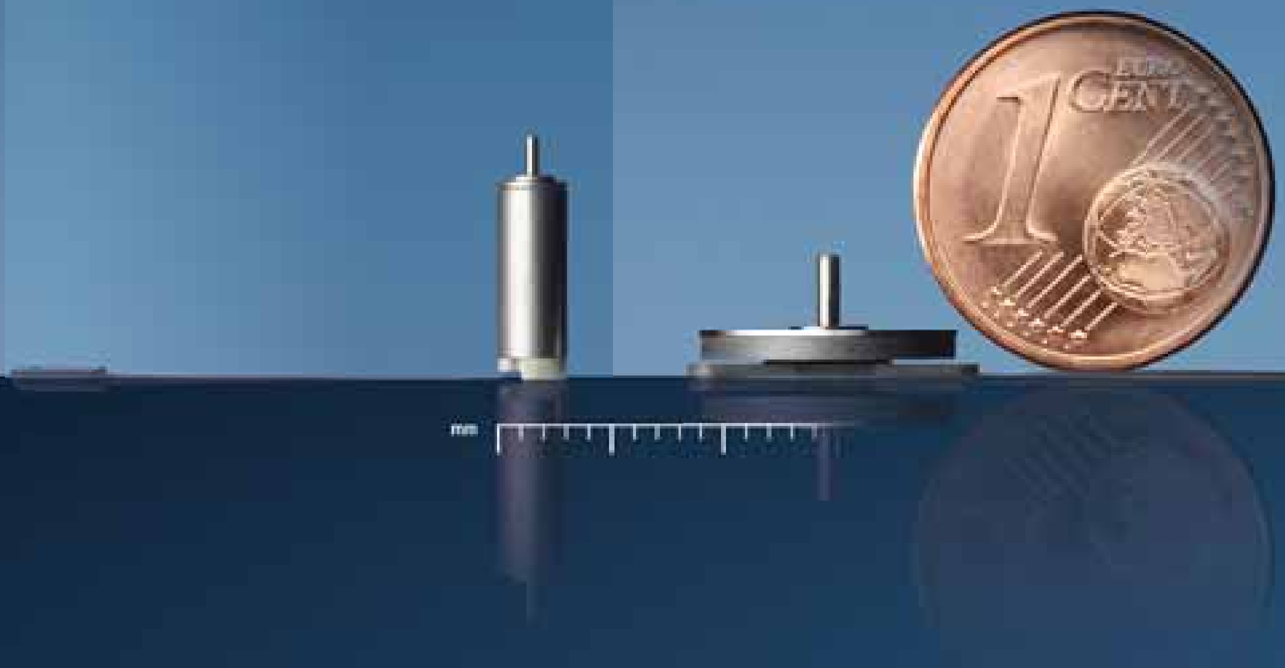
Micro Drive Systems

The outer diameter of the world's smallest brushless planetary gearmotor measures just 1.9 mm.

FAULHABER offers the most extensive portfolio of truly "micro" drive technology products in the industry today. Whether micro in diameter or ultra flat FAULHABER provides micro drive systems for innovative applications in the field of microtechnology ranging from highly reliable medical devices to precision optical assemblies.

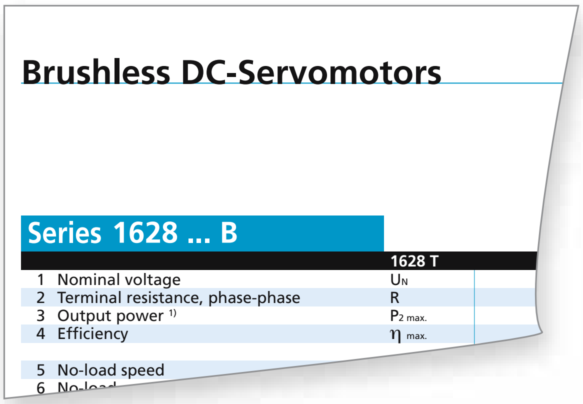




WE CREATE MOTION

Brushless DC-Servomotors

Technical Information


Brushless DC-Servomotors

Series 1628 ... B

		1628 T
1	Nominal voltage	U_N
2	Terminal resistance, phase-phase	R
3	Output power [1]	$P_{2\,max.}$
4	Efficiency	$\eta_{max.}$
5	No-load speed	
6	No-load...	

Notes on technical data

The perfomance lifetime of Brushless DC-Servomotors is mainly influenced by the ball bearings service life and the electronic components used. On average, the lifetime may exceed 10 000 hours if the motors are operated within the recommended values indicated on the data sheet.

All values at 22 °C.
All values at nominal voltage, motor only, without load.

Nominal voltage U_N [Volt]
The direct voltage applied on the motor phases correspond to a bipolar supply with a 120° square-wave commutation logic. Definition of motor parameters η, n_o and I_o are directly related to it. A higher or lower voltage may be applied according to the application requirement.

Terminal resistance, phase to phase R [Ω] ±12 %
The resistance measured between two motor phases. The value is directly affected by the coil temperature (temperature coefficient: $\alpha_{22} = 0{,}004\ K^{-1}$).

Output power $P_{2\,max.}$ [W]
The maximum obtainable mechanical power achieved by the motor at continuous operation and at the thermal limit. This power can only be obtained at high speeds.

$$P_{2\,max.} = \frac{\pi}{30\,000} \cdot n \cdot (k_m \cdot I_{e\,max.} - C_o - C_v \cdot n)$$

Efficiency $\eta_{max.}$ [%]
The max. ratio between the absorbed electrical power and the obtained mechanical power of the motor. It does not always correspond to the optimum working point of the motor.

No-load speed n_o [rpm] ±12 %
The maximum speed the motor attains under no-load conditions at the nominal voltage. This value varies according to the voltage applied to the motor.

$$n_o = (U_n - I_o \cdot R) \cdot \frac{1\,000}{k_E}$$

No-load current I_o [A] ± 50 %
The current consumption of the motor at nominal voltage and under no-load conditions. This value varies proportionally to speed and is influenced by temperature.

$$I_o = \frac{C_o + C_v \cdot n_o}{k_M}$$

Stall torque M_H [mNm]
The torque developed by the motor at zero speed and nominal voltage.

$$M_H = k_M \cdot \frac{U_N}{R} - C_o$$

Friction torque C_o [mNm]
The sum of torque losses not depending from speed. This torque is caused by static mechanical friction of the ball bearings and magnetic hysteresis of the stator.

Viscous damping factor C_v [$\cdot 10^{-5}$ mNm/rpm]
The multiplier factor defining the torque losses proportional to speed. This torque is due to the viscous friction of the ball bearings as well as to the Foucault currents in the stator, originated by the rotating magnetic field of the magnet.

Speed constant k_n [rpm/V]
The speed variation per Volt applied to the motor phases at constant load.

$$k_n = \frac{n_o}{U_N - I_o \cdot R} = \frac{1\,000}{k_E}$$

Back-EMF constant k_E [mV/rpm]
The constant corresponding to the relationship between the induced voltage in the motor phases and the rotation speed.

$$k_E = \frac{2\pi \cdot k_M}{60}$$

Torque constant k_M [mNm/A]
The constant corresponding to the relationship between the torque developed and the current drawn.

Current constant k_I [A/mNm]
The constant corresponding to the relationship between the current drawn and torque developed.

$$k_I = \frac{1}{k_M}$$

Slope of n-M curve $\Delta n/\Delta M$ [rpm/mNm]
The ratio of the speed to torque variations. The smaller this value, the more powerful the motor.

$$\frac{n}{M} = \frac{30\,000}{\pi} \cdot \frac{R}{k_M^2}$$

Terminal inductance, phase to phase L [μH]
The inductance measured between two phases at 1 kHz.

Mechanical time constant τ_m [ms]
The time required by the motor to reach a speed of 63% of its final no-load speed, from standstill.

$$\tau_m = \frac{100 \cdot R \cdot J}{k_M^2}$$

Rotor intertia J [gcm²]
Rotor's mass. dynamic inertia moment.

Angular acceleration $\alpha_{max.}$ [$\cdot 10^3$ rad/s²]
No-load rotor acceleration, from standstill and at nominal voltage.

$$\alpha_{max.} = \frac{(U_N/R) \cdot k_M - C_o}{J} \cdot 10$$

Thermal resistance $R_{th\,1}$ / $R_{th\,2}$ [K/W]
$R_{th\,1}$ corresponds to the value between the coil and housing. $R_{th\,2}$ corresponds to the value between the housing and the ambient air.

$R_{th\,2}$ can be reduced by enabling exchange of heat between the motor and the ambient air (for example using a heat sink or forced air cooling).
All parameters calculated at thermal limit are given with a $R_{th\,2}$ value reduced by 55%.

Thermal time constant τ_{w1} / τ_{w2} [s]
The thermal time constant specifies the time needed for the rotor and housing to reach a temperature equal to 63% of final value.

Operating temperature range [°C]
The min. and max. permissible operating temperature of the motor.

Shaft bearings
The standard bearings used for the Brushless DC-Servomotor.

Shaft load max. [N]
The max. load values allow a motor lifetime of 20 000 hours. This is in accordance with the values given by the bearing manufacturer. The radial load is defined for a force applied at the center of the standard shaft length. This value is speed dependent.

Shaft play [mm]
The shaft play on the bearings, measured at the bearing exit.

Housing material
The housing material and the surface protection.

Weight [g]
The average weight of the basic motor type.

Direction of rotation
The direction of rotation is given by the external servo amplifier. All motors are designed for clockwise (CW) and counter-clockwise (CCW) operation; the direction of rotation is reversible.

Recommended values

The maximum recommended values for continuous operation to obtain optimum life performance are listed below.

These values are independent each other.

The recommended torque ($M_{e\,max.}$) and current ($I_{e\,max.}$) are given with the $R_{th\,2}$ value reduced by 55%.

Speed $n_{e\,max.}$ [rpm]
The max. operation speed limited by Foucault currents is generated by the rotation of the magnet and the magnetic field in the stator. The values are calculated at 2/3 of the max. permissible motor temperature, rounded off.

$$n_{e\,max.} = \sqrt{\frac{C_o^2}{4 \cdot C_v^2} + \frac{30\,000 \cdot (T_{83} - T_{22})}{\pi \cdot 0{,}45 \cdot R_{th\,2} \cdot C_v}} - \frac{C_o}{2 \cdot C_v}$$

Torque $M_{e\,max.}$ [mNm]
The calculated torque for a motor at the thermal limit.

$$M_{e\,max.} = k_M \cdot I_{e\,max.} - C_o - C_v \cdot n$$

Current $I_{e\,max.}$ [A]
The calculated current for a motor at the thermal limit.

$$I_{e\,max.} = \sqrt{\frac{T_{125} - T_{22} - \frac{\pi}{30\,000} \cdot n \cdot 0{,}45 \cdot R_{th\,2} \cdot (C_o + C_v \cdot n)}{R \cdot (1 + \alpha_{22} \cdot (T_{125} - T_{22})) \cdot (R_{th\,1} + 0{,}45 \cdot R_{th\,2})}}$$

Brushless DC-Micromotors

sensorless
smoovy® Technology

0,023 mNm

For combination with
Gearheads:
03A
Linear Actuators:
03A S3
Drive Electronics:
Speed controller

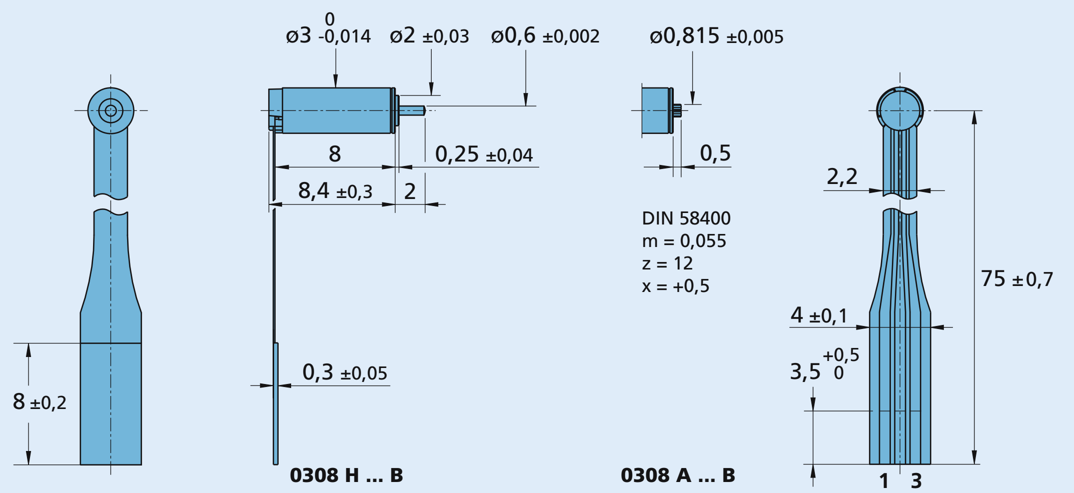
Series 0308 ... B

		0308 H	003 B	
1	Nominal voltage	U_N	3	Volt
2	Terminal resistance, phase-phase	R	33,5	Ω
3	Output power 1)	$P_{2\ max.}$	0,04	W
4	Efficiency	$\eta_{max.}$	16,94	%
5	No-load speed	n_o	60 500	rpm
6	No-load current (with shaft ø 0,6 mm)	I_o	0,029	A
7	Stall torque	M_H	0,024	mNm
8	Friction torque, static	C_o	$1{,}77 \cdot 10^{-3}$	mNm
9	Friction torque, dynamic	C_v	$1{,}09 \cdot 10^{-7}$	mNm/rpm
10	Speed constant	k_n	33 043	rpm/V
11	Back-EMF constant	k_E	0,03	mV/rpm
12	Torque constant	k_M	0,289	mNm/A
13	Current constant	k_I	3,46	A/mNm
14	Slope of n-M curve	$\Delta n/\Delta M$	$3{,}8 \cdot 10^{6}$	rpm/mNm
15	Terminal inductance, phase-phase	L	60	µH
16	Mechanical time constant	τ_m	8	ms
17	Rotor inertia	J	$2 \cdot 10^{-4}$	gcm^2
18	Angular acceleration	$\alpha_{max.}$	1 200	$\cdot 10^3 rad/s^2$
19	Thermal resistance	$R_{th\,1}$ / $R_{th\,2}$	29 / 188	K/W
20	Thermal time constant	τ_{w1} / τ_{w2}	0,4 / 8	s
21	Operating temperature range		– 30 ... + 60	°C
22	Shaft bearings		jewel bearings	
23	Shaft load max.:			
	– radial at 3 000 (1 mm from mounting flange)		0,2	N
	– axial at 3 000 rpm (push-on only)		0,2	N
	– axial at standstill (push-on only)		2	N
24	Shaft play:			
	– radial	≤	0,03	mm
	– axial	≤	0,15	mm
25	Housing material		Nickel alloy	
26	Weight		0,31	g
27	Direction of rotation		electronically reversible	

Recommended values - mathematically independent of each other				
28	Speed up to 2)	$n_{e\ max.}$	84 000	rpm
29	Torque up to 1) 2)	$M_{e\ max.}$	0,023	mNm
30	Current up to (thermal limits) 1) 2)	$I_{e\ max.}$	0,1	A

1) at 15 000 rpm
2) thermal resistance $R_{th\,2}$ not reduced

Scale enlarged M 2:1



Connection

No.	Function
1	Phase A
2	Phase B
3	Phase C

Flex Print connector
3-pole, 1 mm pitch, e.g.:
Molex: 52207-0390

FAULHABER

Micro Planetary Gearheads

smoovy® Technology

0,88 mNm

For combination with
Brushless DC-Motors

Brushless DC-Motors

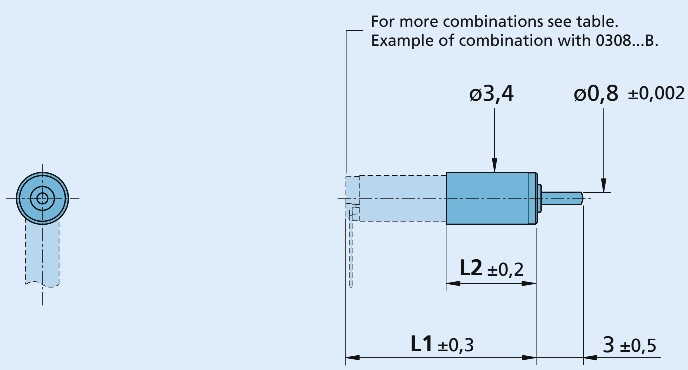
Series 03A

	03A
Housing material	plastic
Geartrain material	steel
Recommended max. input speed for:	
– continuous operation	15 000 rpm
Backlash, at no-load	≤ 4 °
Bearings on output shaft	bronze
Shaft load, max.:	
– radial (1,5 mm from mounting face)	≤ 0,1 N
– axial	≤ 0,2 N
Shaft press fit force, max.	≤ 1 N
Shaft play	
– radial (1,5 mm from mounting face)	≤ 0,03 mm
– axial	≤ 0,15 mm
Operating temperature range	- 20 ... + 60 °C

Specifications			
Number of gear stages		**2**	**3**
Continuous torque	mNm	0,28	0,88
Intermittent torque	mNm	0,42	1,32
Weight without motor, ca.	g	0,2	0,18
Efficiency, max.		-	-
Direction of rotation, drive to output		=	=
Reduction ratio (exact)		**25:1**	**125:1**
L2 [mm] = length without motor		6,0	6,0
L1 [mm] = length with motor 0308A...B		12,6	12,6

Note: These gearheads are available only with motors mounted.

Scale enlarged



03A

Linear Actuators

smoovy® Technology

2,8 N

For combination with
Brushless DC-Motors

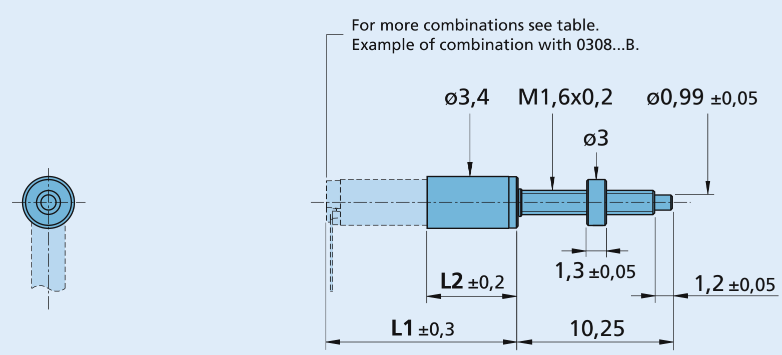
Series 03A S3

	03A S3
Housing material	plastic
Geartrain material	steel
Screw material	steel
Nut material	bronze
Recommended max. input speed for:	
– continuous operation	15 000 rpm
Max. linear travel	7 mm
Bearings on output shaft	bronze
Shaft play (on bearing output):	
– radial	≤ 0,03 mm
– axial	≤ 0,15 mm
Operating temperature range	- 20 ... + 60 °C

Specifications			
Number of gear stages		**2**	**3**
Push force, continuous	N	0,47	2,8
Push force, intermittent	N	0,7	4,2
Weight without motor, ca.	g	0,36	0,34
Max. speed	mm/min	120	24
Direction of rotation, drive to output		=	=
Reduction ratio (exact)		**25:1**	**125:1**
L2 [mm] = length without motor		6,0	6,0
L1 [mm] = length with motor 0308A...B		12,6	12,6

Note: These gearheads are available only with motors mounted.
Capability of pushing/pulling the nut with a bearing at the end of the shaft.

Scale enlarged



03A S3

Brushless DC-Micromotors

sensorless
smoovy® Technology

0,2 mNm

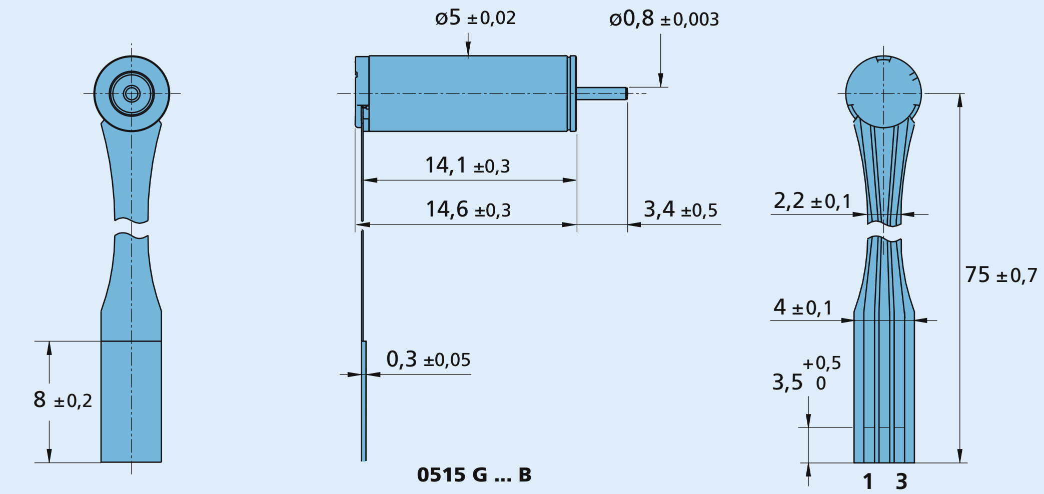
For combination with
Gearheads:
06A
Linear Actuators:
06A S2
Drive Electronics:
Speed Controller

Series 0515 ... B

		0515 G		006 B	
1	Nominal voltage	U_N		6	Volt
2	Terminal resistance, phase-phase	R		15,8	Ω
3	Output power [1]	$P_{2\,max.}$		0,43	W
4	Efficiency	$\eta_{max.}$		34,7	%
5	No-load speed	n_0		37 800	rpm
6	No-load current (with shaft ø 0,8 mm)	I_0		0,062	A
7	Stall torque	M_H		0,43	mNm
8	Friction torque, static	C_0		0,030	mNm
9	Friction torque, dynamic	C_v		$1,2 \cdot 10^{-6}$	mNm/rpm
10	Speed constant	k_n		7 847	rpm/V
11	Back-EMF constant	k_E		0,127	mV/rpm
12	Torque constant	k_M		1,217	mNm/A
13	Current constant	k_I		0,822	A/mNm
14	Slope of n-M curve	$\Delta n/\Delta M$		102 000	rpm/mNm
15	Terminal inductance, phase-phase	L		120	µH
16	Mechanical time constant	τ_m		2,2	ms
17	Rotor inertia	J		0,002	gcm^2
18	Angular acceleration	$\alpha_{max.}$		2 000	$\cdot 10^3 rad/s^2$
19	Thermal resistance	R_{th1} / R_{th2}	15 / 110		K/W
20	Thermal time constant	τ_{w1} / τ_{w2}	1,4 / 75		s
21	Operating temperature range		– 30 ... + 80		°C
22	Shaft bearings		sintered bronze sleeves		
23	Shaft load max.:				
	– radial at 3 000 (1 mm from mounting flange)		0,2		N
	– axial at 3 000 rpm (push-on only)		0,2		N
	– axial at standstill (push-on only)		2		N
24	Shaft play:				
	– radial	≤	0,03		mm
	– axial	≤	0,15		mm
25	Housing material		Nickel alloy		
26	Weight		1,5		g
27	Direction of rotation		electronically reversible		
Recommended values - mathematically independent of each other					
28	Speed up to [2]	$n_{e\,max.}$		15 000	rpm
29	Torque up to [1] [2]	$M_{e\,max.}$		0,2	mNm
30	Current up to (thermal limits) [1] [2]	$I_{e\,max.}$		0,23	A

1) at 15 000 rpm
2) thermal resistance $R_{th\,2}$ by 55% reduced

Scale enlarged M 2:1



0515 G ... B

Connection

No.	Function
1	Phase A
2	Phase B
3	Phase C

Flex Print connector
3-pole, 1 mm pitch, e.g.:
Molex: 52207-0390

Micro Planetary Gearheads

smoovy® Technology

25 mNm

For combination with
Brushless DC-Motors

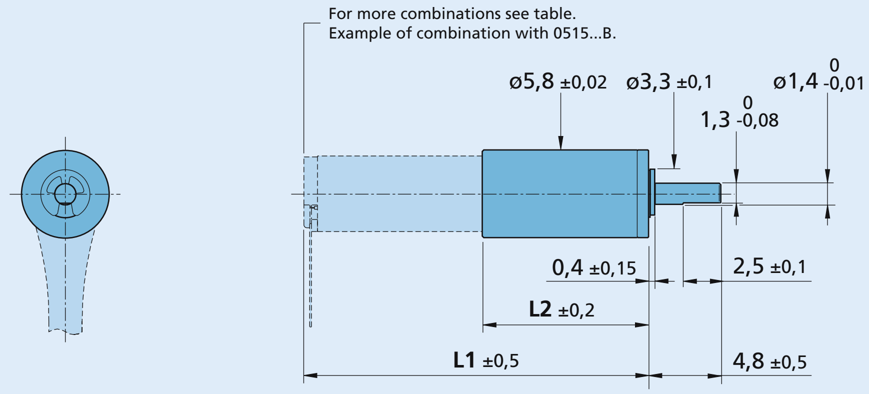
Series 06A

	06A
Housing material	plastic
Geartrain material	bronze
Recommended max. input speed for:	
– continuous operation	15 000 rpm
Backlash, at no-load	≤ 4 °
Bearings on output shaft	bronze
Shaft load, max.:	
– radial (2,5 mm from mounting face)	≤ 0,3 N
– axial	≤ 0,5 N
Shaft press fit force, max.	≤ 2 N
Shaft play	
– radial (2,5 mm from mounting face)	≤ 0,03 mm
– axial	≤ 0,1 mm
Operating temperature range	- 20 ... + 60 °C

Specifications				
Number of gear stages		**2**	**3**	**3**
Continuous torque	mNm	1,2	6	25
Intermittent torque	mNm	1,8	9	37,5
Weight without motor, ca.	g	1,24	1,32	1,4
Efficiency, max.		-	-	-
Direction of rotation, drive to output		=	=	=
Reduction ratio (exact)		**25:1**	**125:1**	**625:1**
L2 [mm] = length without motor		11,0	11,0	12,7
L1 [mm] = length with motor 0515A...B		22,8	22,8	24,5

Note: These gearheads are available only with motors mounted.

Scale enlarged



06A

Linear Actuators

smoovy® Technology

41 N

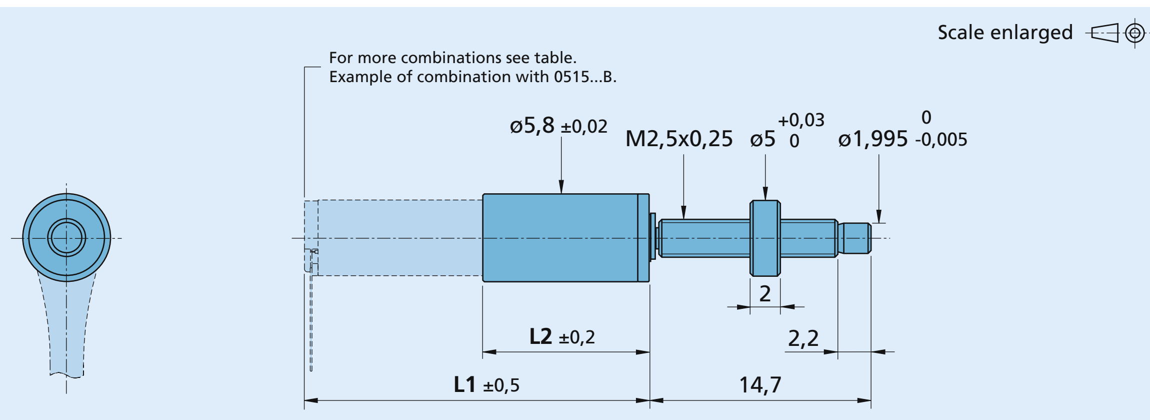
For combination with
Brushless DC-Motors

Series 06A S2

	06A S2
Housing material	plastic
Geartrain material	bronze
Screw material	steel
Nut material	bronze
Recommended max. input speed for:	
– continuous operation	15 000 rpm
Max. linear travel	12 mm
Bearings on output shaft	bronze
Shaft play (on bearing output):	
– radial	≤ 0,03 mm
– axial	≤ 0,1 mm
Operating temperature range	- 20 ... + 60 °C

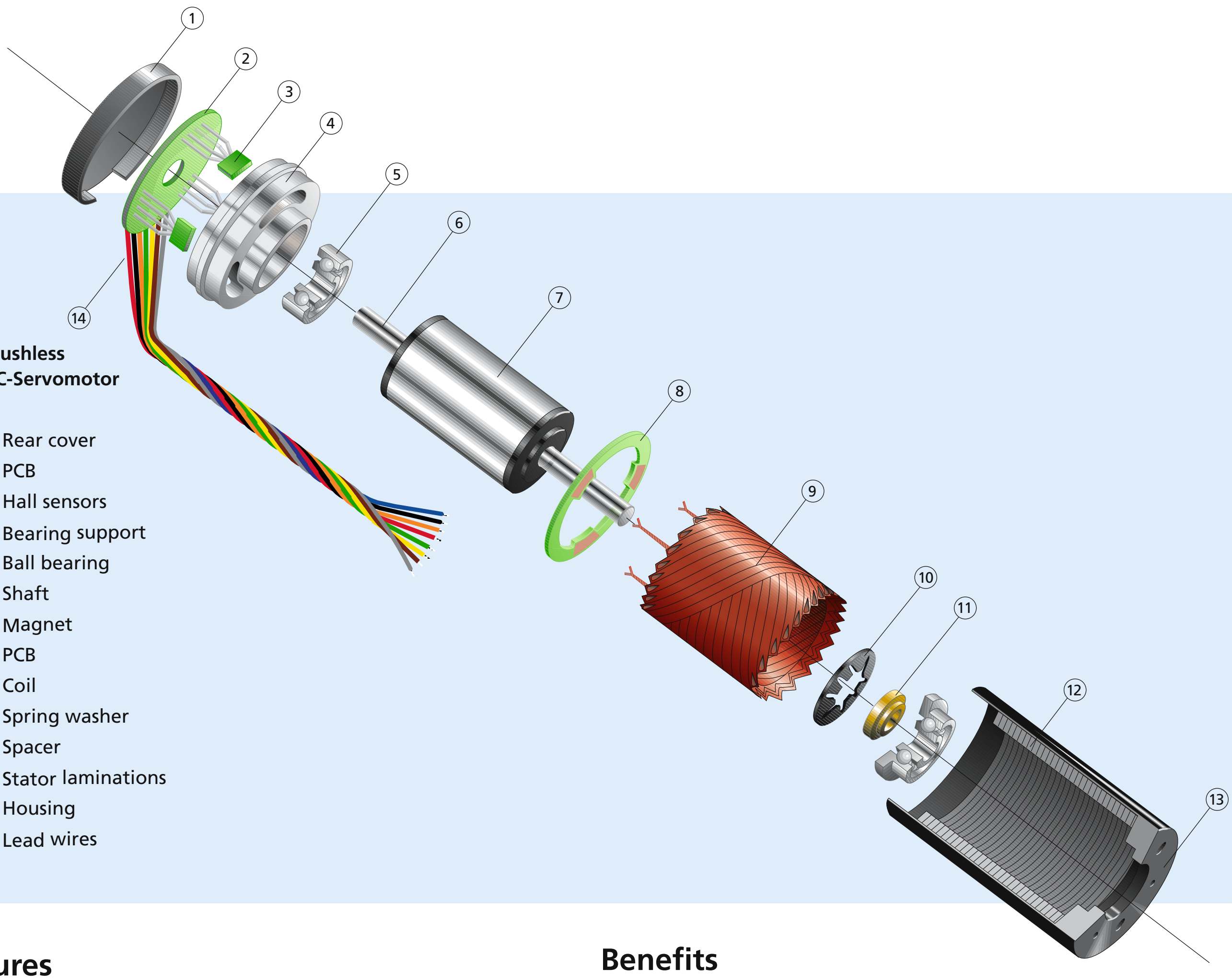
Specifications				
Number of gear stages		**2**	**3**	**4**
Push force, continuous	N	1,6	15,7	41,2
Push force, intermittent	N	2,4	23,6	61,8
Weight without motor, ca.	g	1,79	1,92	2,05
Max. speed	mm/min	150	30	6
Direction of rotation, drive to output		=	=	=
Reduction ratio (exact)		**25:1**	**125:1**	**625:1**
L2 [mm] = length without motor		11,0	11,0	12,7
L1 [mm] = length with motor 0515A...B		22,8	22,8	24,5

Note: These gearheads are available only with motors mounted.
Capability of pushing/pulling the nut with a bearing at the end of the shaft.



06A S2

Brushless DC-Servomotors



Brushless DC-Servomotor

① Rear cover
② PCB
③ Hall sensors
④ Bearing support
⑤ Ball bearing
⑥ Shaft
⑦ Magnet
⑧ PCB
⑨ Coil
⑩ Spring washer
⑪ Spacer
⑫ Stator laminations
⑬ Housing
⑭ Lead wires

Features

The FAULHABER Brushless DC-Servomotors are built for extreme operating conditions. They are precise, have extreme long lifetimes and are highly reliable. Exceptional qualities such as smooth running and especially low noise level are of particular note. The rare-earth magnet as rotor, and FAULHABER skew winding technology ensure that these motors deliver top performance dynamics within minimum overall dimensions.

This series is also available in an autoclavable version and is ideally suited for application in laboratory and medical equipment.

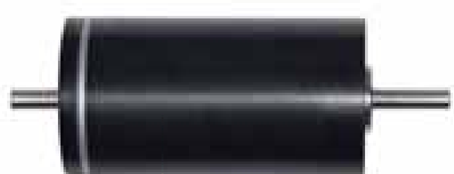
Sterilizing conditions

- Temperature 134 °C ± 2 °C
- Water vapour pressure 2,1 bar
- Relative humidity 100 %
- Duration of cycle 20 min.
- Rated for a minimum of 100 cycles

Benefits

- System FAULHABER®, ironless stator coil
- High reliability and operational lifetime
- Wide range of linear torque / speed performance
- No sparking
- No cogging
- Dynamically balanced rotor
- Simple design
- Standard with digital hall sensors with optional analog hall sensors

Product Code



2444 S 024 B

24	Motor diameter [mm]
44	Motor length [mm]
S	Shaft type
024	Nominal voltage [V]
B	Type of commutation (brushless)

Brushless DC-Servomotors

0,36 mNm

For combination with
Gearheads:
06/1
Encoder:
PA2-50, HXM3-64
Drive Electronics:
Speed Controller, Motion Controller

Series 0620 ... B

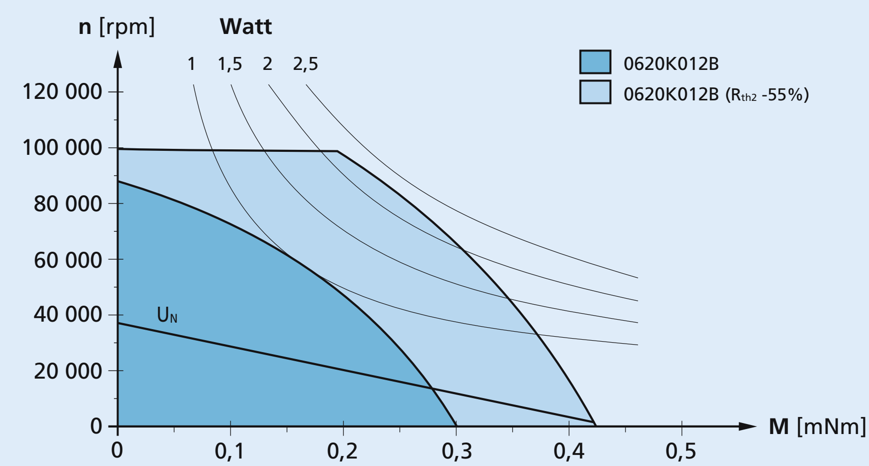
	0620 K			006 B	012 B	
1	Nominal voltage	U_N		6	12	Volt
2	Terminal resistance, phase-phase	R		9,1	59,0	Ω
3	Output power 1)	$P_{2\,max.}$		1,47	1,49	W
4	Efficiency	$\eta_{max.}$		52	50	%
5	No-load speed	n_o		46 500	35 600	rpm
6	No-load current (with shaft ø 1,0 mm)	I_o		0,062	0,020	A
7	Stall torque	M_H		0,73	0,57	mNm
8	Friction torque, static	C_o		0,023	0,023	mNm
9	Friction torque, dynamic	C_v		$1,0 \cdot 10^{-6}$	$1,0 \cdot 10^{-6}$	mNm/rpm
10	Speed constant	k_n		8 451	3 282	rpm/V
11	Back-EMF constant	k_E		0,118	0,305	mV/rpm
12	Torque constant	k_M		1,13	2,91	mNm/A
13	Current constant	k_I		0,885	0,344	A/mNm
14	Slope of n-M curve	$\Delta n/\Delta M$		68 054	66 533	rpm/mNm
15	Terminal inductance, phase-phase	L		26	187	µH
16	Mechanical time constant	τ_m		6	6	ms
17	Rotor inertia	J		0,0095	0,0095	gcm^2
18	Angular acceleration	$\alpha_{max.}$		768	601	$\cdot 10^3 rad/s^2$
19	Thermal resistance	$R_{th\,1} / R_{th\,2}$	14 / 88,0			K/W
20	Thermal time constant	τ_{w1} / τ_{w2}	1 / 149			s
21	Operating temperature range:					
	– motor		– 20 ... +100			°C
	– coil, max. permissible		+125			°C
22	Shaft bearings		ball bearings, preloaded			
23	Shaft load max.:					
	– radial at 10 000/50 000 rpm (3,7 mm from mounting flange)		2,0 / 1,5			N
	– axial at 10 000/50 000 rpm (push-on only)		0,6 / 0,2			N
	– axial at standstill (push-on only)		10			N
24	Shaft play:					
	– radial	≤	0,012			mm
	– axial	=	0			mm
25	Housing material		aluminium, black anodized			
26	Weight		2,5			g
27	Direction of rotation		electronically reversible			
	Recommended values - mathematically independent of each other					
28	Speed up to 2)	$n_{e\,max.}$		100 000	100 000	rpm
29	Torque up to 1) 2)	$M_{e\,max.}$		0,351	0,356	mNm
30	Current up to 1) 2)	$I_{e\,max.}$		0,367	0,144	A

1) at 40 000 rpm
2) thermal resistance $R_{th\,2}$ by 55% reduced

Note:
The diagram indicates the recommended speed in relation to the available torque at the output shaft for a given ambient temperature of 22°C.

The diagram shows the motor in a completely insulated as well as thermally coupled condition ($R_{th\,2}$ 55% reduced).

The nominal voltage (U_N) curve shows the operating point at nominal voltage in the insulated and thermally coupled condition. Any points of operation above the curve at nominal voltage will require a higher operating voltage. Any points below the nominal voltage curve will require less voltage.

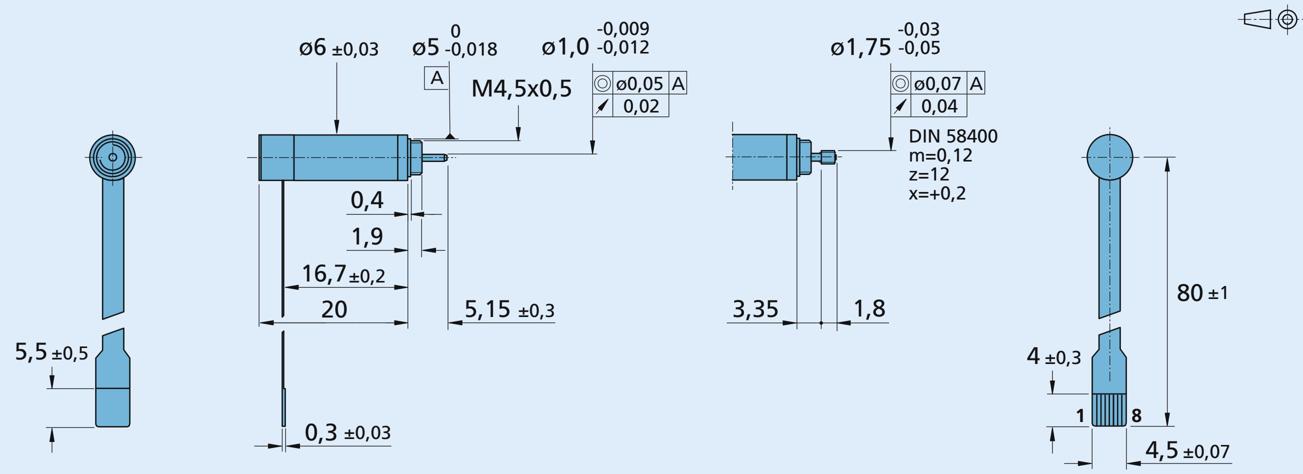


Recommended areas for continuous operation

Options
K1855:
Motors for operation with Motion Controllers

Brushless DC-Motors

0620 ... B



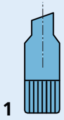
0620 K

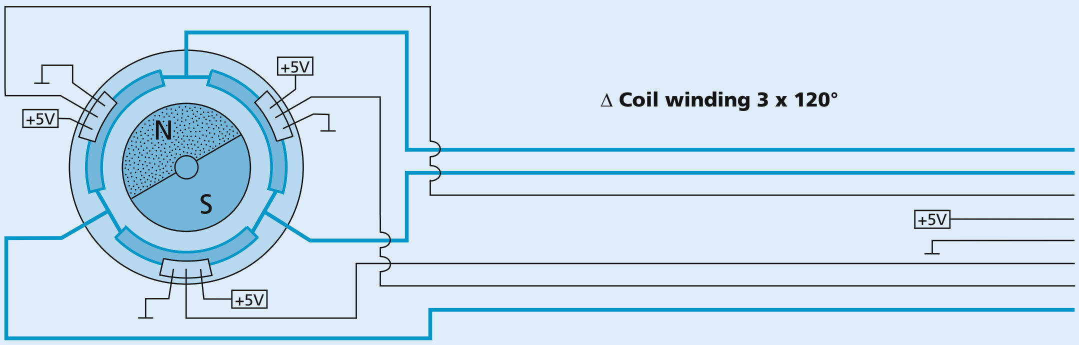
0620 C for Gearheads 06/1

Cable and connection information

Recommended connector
Molex - ZIF Connector,
No. 52745-0896.

Flexboard
8 circuits; 0,5mm pitch,
Top Contact Style.





Δ Coil winding 3 x 120°

Connection

No.	Function
1	Phase C
2	Phase B
3	Hall sensor C
4	+5V
5	GND
6	Hall sensor A
7	Hall sensor B
8	Phase A

Brushless DC-Servomotors

2,2 mNm

For combination with
Gearheads:
10/1, 12/3, 12/4, 12/5
Drive electronics:
Speed Controller, Motion Controller

Series 1226 ... B

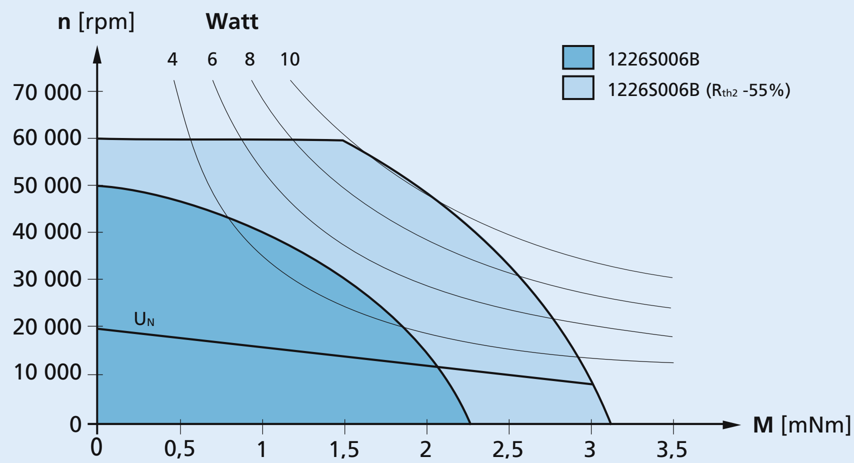
	1226 S			006 B	012 B	
1	Nominal voltage	U_N		6	12	Volt
2	Terminal resistance, phase-phase	R		2,30	5,30	Ω
3	Output power [1]	$P_{2\ max.}$		9,6	9,3	W
4	Efficiency	$\eta_{max.}$		68	69	%
5	No-load speed	n_o		20 100	27 200	rpm
6	No-load current (with shaft ø 1,2 mm)	I_o		0,088	0,074	A
7	Stall torque	M_H		7,19	9,21	mNm
8	Friction torque, static	C_o		0,079	0,079	mNm
9	Friction torque, dynamic	C_v		$8{,}2 \cdot 10^{-6}$	$8{,}2 \cdot 10^{-6}$	mNm/rpm
10	Speed constant	k_n		3 447	2 335	rpm/V
11	Back-EMF constant	k_E		0,290	0,428	mV/rpm
12	Torque constant	k_M		2,77	4,09	mNm/A
13	Current constant	k_I		0,361	0,244	A/mNm
14	Slope of n-M curve	$\Delta n/\Delta M$		2 862	3 026	rpm/mNm
15	Terminal inductance, phase-phase	L		35	80	µH
16	Mechanical time constant	τ_m		4	4	ms
17	Rotor inertia	J		0,145	0,145	gcm^2
18	Angular acceleration	$\alpha_{max.}$		496	635	$\cdot 10^3 rad/s^2$
19	Thermal resistance	$R_{th\ 1}$ / $R_{th\ 2}$	7 / 38,0			K/W
20	Thermal time constant	τ_{w1} / τ_{w2}	3 / 186			s
21	Operating temperature range:					
	– motor		– 20 ... +100			°C
	– coil, max. permissible		+125			°C
22	Shaft bearings		ball bearings, preloaded			
23	Shaft load max.:					
	– radial at 10 000/30 000 rpm (3,7 mm from mounting flange)		4,9 / 4,0			N
	– axial at 10 000/30 000 rpm (push-on only)		2,6 / 1,1			N
	– axial at standstill (push-on only)		11			N
24	Shaft play:					
	– radial	≤	0,012			mm
	– axial	=	0			mm
25	Housing material		aluminium, black anodized			
26	Weight		13			g
27	Direction of rotation		electronically reversible			
	Recommended values - mathematically independent of each other					
28	Speed up to [2]	$n_{e\ max.}$		60 000	60 000	rpm
29	Torque up to [1) 2)]	$M_{e\ max.}$		2,28	2,21	mNm
30	Current up to [1) 2)]	$I_{e\ max.}$		0,97	0,64	A

1) at 40 000 rpm
2) thermal resistance $R_{th\ 2}$ by 55% reduced

Note:
The diagram indicates the recommended speed in relation to the available torque at the output shaft for a given ambient temperature of 22°C.

The diagram shows the motor in a completely insulated as well as thermally coupled condition ($R_{th\ 2}$ 55% reduced).

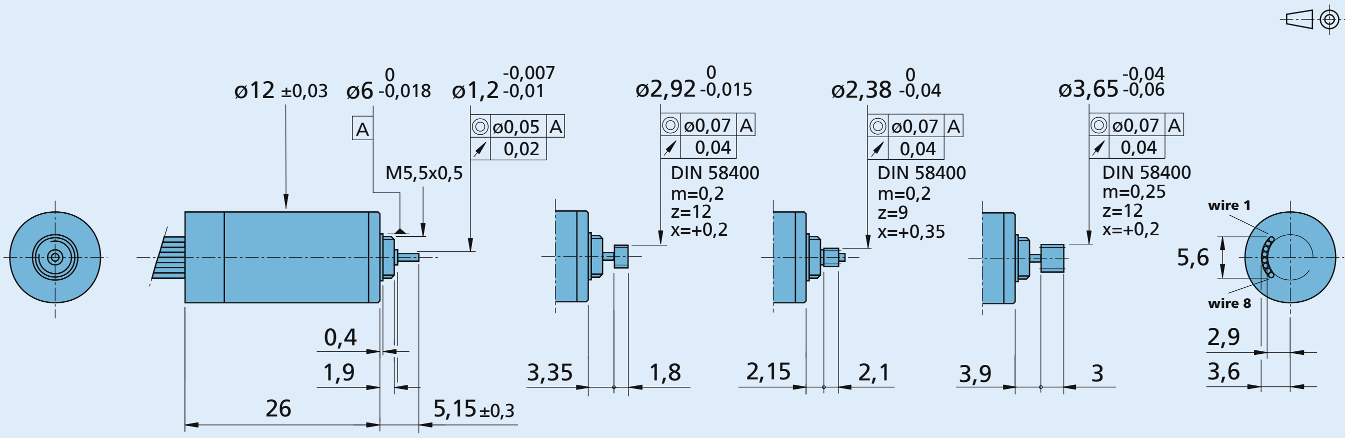
The nominal voltage (U_N) curve shows the operating point at nominal voltage in the insulated and thermally coupled condition. Any points of operation above the curve at nominal voltage will require a higher operating voltage. Any points below the nominal voltage curve will require less voltage.



Recommended areas for continuous operation

Options
K1855:
Motors for operation with Motion Controllers

1226 ... B



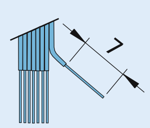
1226 S

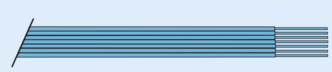
1226 M
for Gearhead 10/1

1226 E
for Gearheads 12/3, 12/5

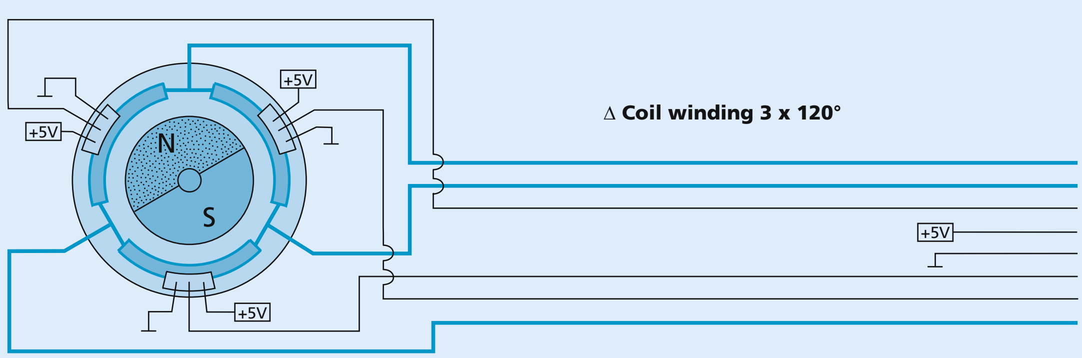
1226 A
for Gearhead 12/4

Cable and connection information





Cable
Single wires, material PTFE
Length 80 mm ± 3 mm
8 conductors, AWG 30



Connection

No.	Function	Colour
1	Phase C	yellow
2	Phase B	orange
3	Hall sensor C	grey
4	Logical supply +5V	red
5	Logical GND	black
6	Hall sensor A	green
7	Hall sensor B	blue
8	Phase A	brown

Brushless DC-Servomotors

2,6 mNm

For combination with
Gearheads:
16/7
Encoders:
IE2-1024
Drive Electronics:
Speed Controller, Motion Controller

Series 1628 ... B

	1628 T			012 B	024 B	
1	Nominal voltage	U_N		12	24	Volt
2	Terminal resistance, phase-phase	R		4,3	15,1	Ω
3	Output power [1]	$P_{2\,max.}$		10	11	W
4	Efficiency	$\eta_{max.}$		68	68	%
5	No-load speed	n_o		28 650	29 900	rpm
6	No-load current (with shaft ø 1,5 mm)	I_o		0,098	0,052	A
7	Stall torque	M_H		11	12	mNm
8	Friction torque, static	C_o		0,15	0,15	mNm
9	Friction torque, dynamic	C_v		$8{,}0 \cdot 10^{-6}$	$8{,}0 \cdot 10^{-6}$	mNm/rpm
10	Speed constant	k_n		2 474	1 287	rpm/V
11	Back-EMF constant	k_E		0,404	0,777	mV/rpm
12	Torque constant	k_M		3,86	7,42	mNm/A
13	Current constant	k_I		0,259	0,135	A/mNm
14	Slope of n-M curve	$\Delta n/\Delta M$		2 737	2 610	rpm/mNm
15	Terminal inductance, phase-phase	L		141	525	µH
16	Mechanical time constant	τ_m		15	14	ms
17	Rotor inertia	J		0,54	0,54	gcm^2
18	Angular acceleration	$\alpha_{max.}$		198	217	$\cdot 10^3 rad/s^2$
19	Thermal resistance	$R_{th\,1} / R_{th\,2}$	7,8 / 30,1			K/W
20	Thermal time constant	τ_{w1} / τ_{w2}	8 / 379			s
21	Operating temperature range		– 30 ... +125			°C
22	Shaft bearings		ball bearings, preloaded			
23	Shaft load max.:					
	– radial at 3 000/20 000 rpm (4,5 mm from mounting flange)		17 / 10			N
	– axial at 3 000/20 000 rpm (push-on only)		10 / 6			N
	– axial at standstill (push-on only)		20			N
24	Shaft play:					
	– radial	≤	0,015			mm
	– axial	=	0			mm
25	Housing material		aluminium, black anodized			
26	Weight		31			g
27	Direction of rotation		electronically reversible			

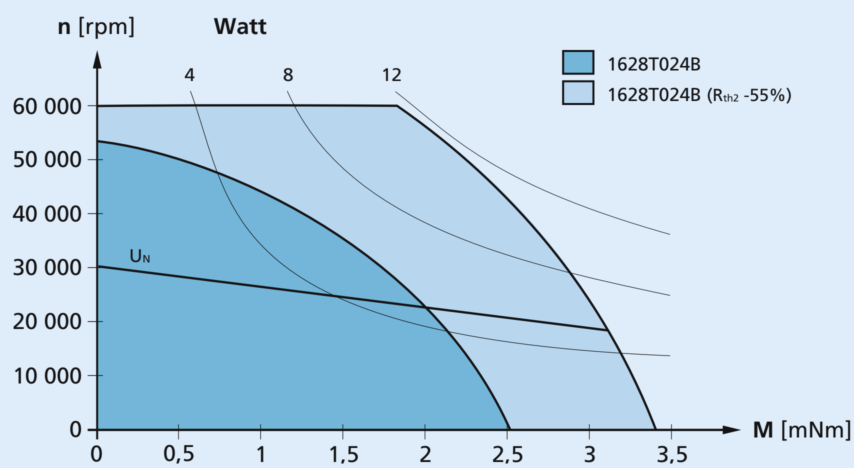
	Recommended values - mathematically independent of each other			012 B	024 B	
28	Speed up to [2]	$n_{e\,max.}$		60 000	60 000	rpm
29	Torque up to [1] [2]	$M_{e\,max.}$		2,5	2,6	mNm
30	Current up to [1] [2]	$I_{e\,max.}$		0,77	0,41	A

[1] at 40 000 rpm
[2] thermal resistance $R_{th\,2}$ by 55% reduced

Note:
The diagram indicates the recommended speed in relation to the available torque at the output shaft for a given ambient temperature of 22°C.

The diagram shows the motor in a completely insulated as well as thermally coupled condition ($R_{th\,2}$ 55% reduced).

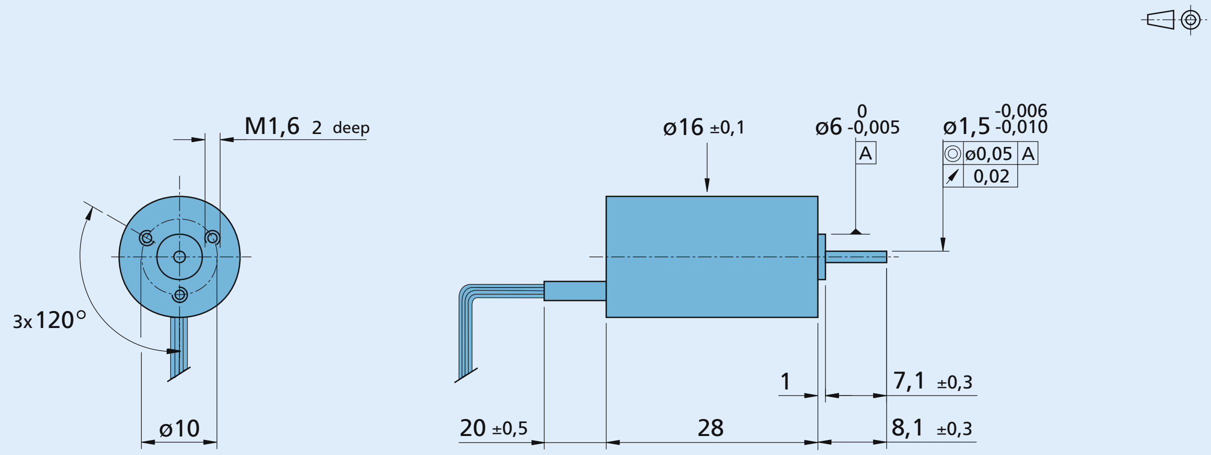
The nominal voltage (U_N) curve shows the operating point at nominal voltage in the insulated and thermally coupled condition. Any points of operation above the curve at nominal voltage will require a higher operating voltage. Any points below the nominal voltage curve will require less voltage.



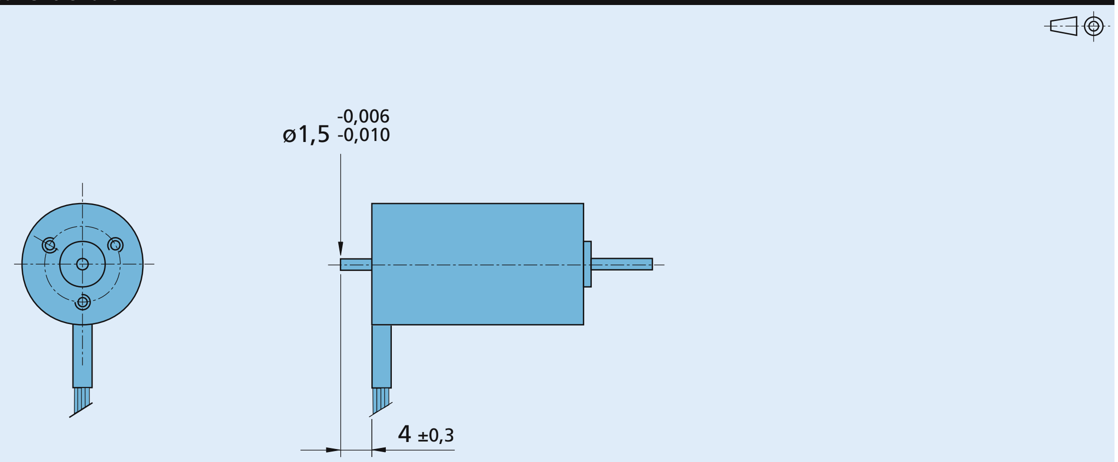
Recommended areas for continuous operation

Options
K1000:
Motors in autoclavable version.
K1155:
Motors for operation with Motion Controllers

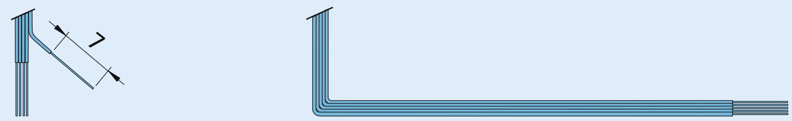
1628 T ... B



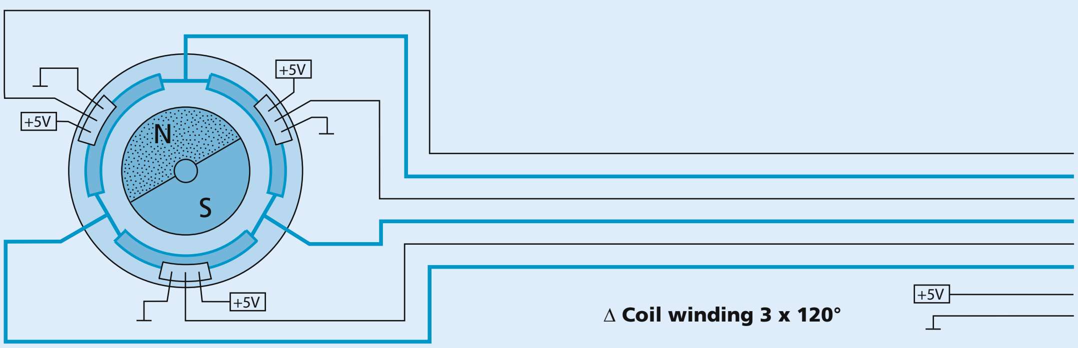
1628 T ... B - K312 with rear end shaft



Cable and connection information



Cable
Single wires, material PTFE
Length 300 mm ± 15 mm
8 conductors, AWG 26



Connection

	Function	Colour
A	Hall sensor	green
A	Phase	brown
B	Hall sensor	blue
B	Phase	orange
C	Hall sensor	grey
C	Phase	yellow
+5V	Logical supply	red
GND	Logical	black

Brushless DC-Servomotors

5,2 mNm

For combination with
Gearheads:
20/1
Encoders:
IE2-1024, 5500, 5540
Drive Electronics:
Speed Controller, Motion Controller

Series 2036 ... B

	2036 U			012 B	024 B	036 B	048 B	
1	Nominal voltage	U_N		12	24	36	48	Volt
2	Terminal resistance, phase-phase	R		3,4	14,0	27,9	62,2	Ω
3	Output power [1]	$P_{2\,max.}$		20	19	18	18	W
4	Efficiency	$\eta_{max.}$		70	69	69	69	%
5	No-load speed	n_o		17 600	18 000	19 500	17 400	rpm
6	No-load current (with shaft ø 2,0 mm)	I_o		0,102	0,053	0,040	0,025	A
7	Stall torque	M_H		22	21	22	20	mNm
8	Friction torque, static	C_o		0,27	0,27	0,27	0,27	mNm
9	Friction torque, dynamic	C_v		$2,14 \cdot 10^{-5}$	$2,14 \cdot 10^{-5}$	$2,14 \cdot 10^{-5}$	$2,14 \cdot 10^{-5}$	mNm/rpm
10	Speed constant	k_n		1 506	773	557	374	rpm/V
11	Back-EMF constant	k_E		0,664	1,294	1,796	2,677	mV/rpm
12	Torque constant	k_M		6,34	12,36	17,15	25,56	mNm/A
13	Current constant	k_I		0,158	0,081	0,058	0,039	A/mNm
14	Slope of n-M curve	$\Delta n/\Delta M$		808	875	906	909	rpm/mNm
15	Terminal inductance, phase-phase	L		148	600	1 160	2 500	µH
16	Mechanical time constant	τ_m		16	18	18	18	ms
17	Rotor inertia	J		1,95	1,95	1,95	1,95	gcm²
18	Angular acceleration	$\alpha_{max.}$		114	107	113	100	$\cdot 10^3$rad/s²
19	Thermal resistance	$R_{th\,1}$ / $R_{th\,2}$	5,7 / 19,9					K/W
20	Thermal time constant	τ_{w1} / τ_{w2}	9 / 577					s
21	Operating temperature range		– 30 ... +125					°C
22	Shaft bearings		ball bearings, preloaded					
23	Shaft load max.:							
	– radial at 3 000/20 000 rpm (4,5 mm from mounting flange)		14 / 7					N
	– axial at 3 000/20 000 rpm (push-on only)		8 / 4					N
	– axial at standstill (push-on only)		30					N
24	Shaft play:							
	– radial	≤	0,015					mm
	– axial	=	0					mm
25	Housing material		aluminium, black anodized					
26	Weight		50					g
27	Direction of rotation		electronically reversible					

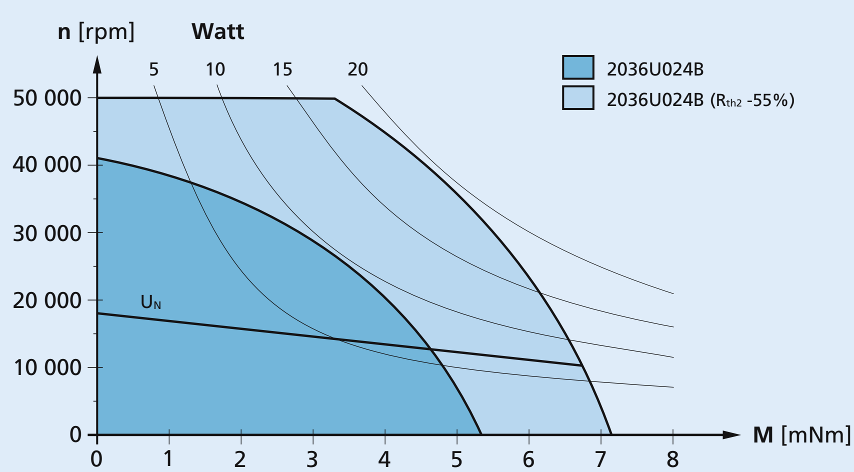
Recommended values - mathematically independent of each other								
28	Speed up to [2]	$n_{e\,max.}$		50 000	50 000	50 000	50 000	rpm
29	Torque up to [1] [2]	$M_{e\,max.}$		5,2	4,9	4,8	4,8	mNm
30	Current up to [1] [2]	$I_{e\,max.}$		0,98	0,48	0,34	0,23	A

[1] at 36 000 rpm
[2] thermal resistance $R_{th\,2}$ by 55% reduced

Note:
The diagram indicates the recommended speed in relation to the available torque at the output shaft for a given ambient temperature of 22°C.

The diagram shows the motor in a completely insulated as well as thermally coupled condition ($R_{th\,2}$ 55% reduced).

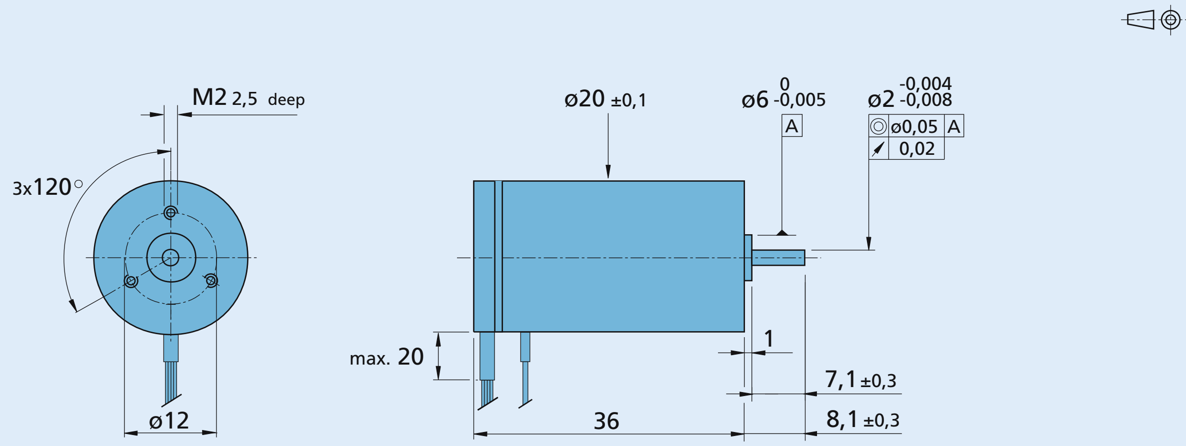
The nominal voltage (U_N) curve shows the operating point at nominal voltage in the insulated and thermally coupled condition. Any points of operation above the curve at nominal voltage will require a higher operating voltage. Any points below the nominal voltage curve will require less voltage.



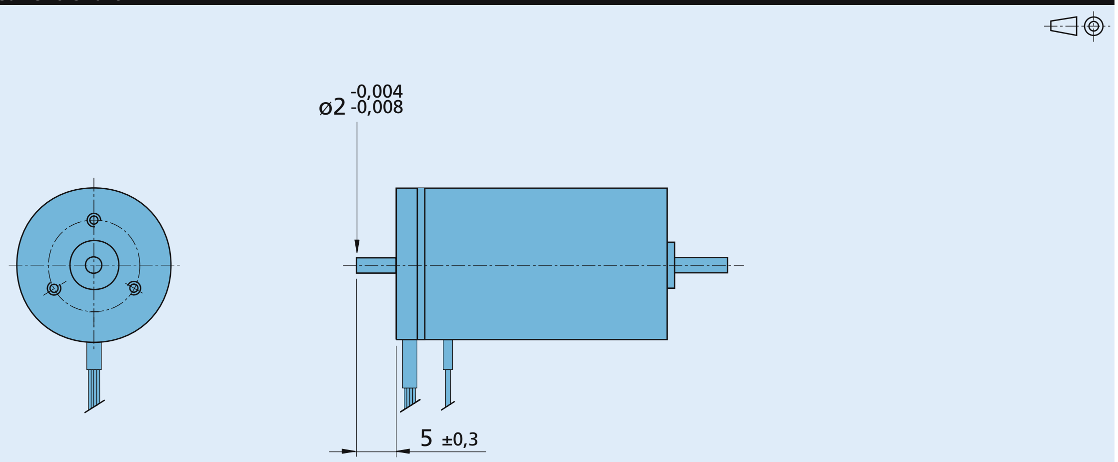
Recommended areas for continuous operation

Options
K1000:
Motors in autoclavable version.
K1155:
Motors for operation with Motion Controllers

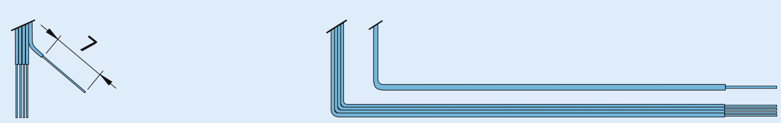
2036 U ... B



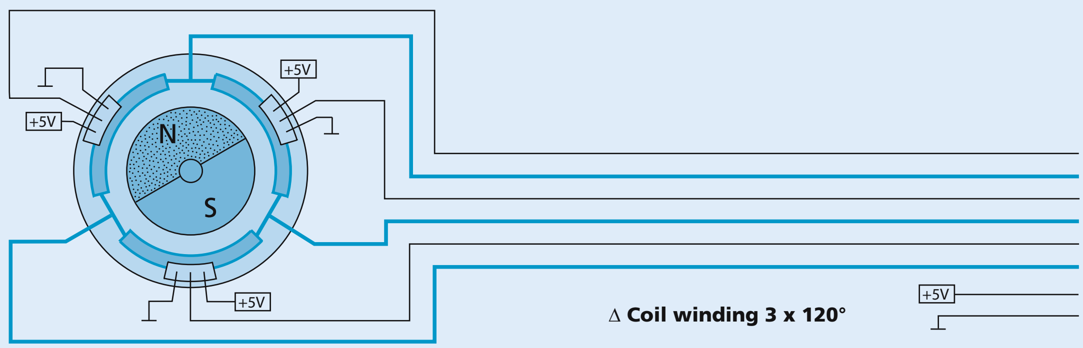
2036 U ... B - K312 with rear end shaft



Cable and connection information



Cable
Single wires, material PTFE
Length 300 mm ± 15 mm
3 conductors, AWG 24
5 conductors, AWG 26



Connection

	Function	Colour
A	Hall sensor	green
A	Phase	brown
B	Hall sensor	blue
B	Phase	orange
C	Hall sensor	grey
C	Phase	yellow
+5V	Logical supply	red
GND	Logical	black

Brushless DC-Servomotors

16,5 mNm

For combination with
Gearheads:
20/1, 23/1
Encoders:
IE2-1024, 5500, 5540
Drive Electronics:
Speed Controller, Motion Controller

Series 2057 ... B

	2057 S			012 B	024 B	
1	Nominal voltage	U_N		12	24	Volt
2	Terminal resistance, phase-phase	R		0,55	1,42	Ω
3	Output power [1]	$P_{2\ max.}$		61	62	W
4	Efficiency	$\eta_{max.}$		82	83	%
5	No-load speed	n_o		21 900	26 500	rpm
6	No-load current (with shaft ø 3,0 mm)	I_o		0,210	0,147	A
7	Stall torque	M_H		113	144	mNm
8	Friction torque, static	C_o		0,28	0,28	mNm
9	Friction torque, dynamic	C_v		$3,70 \cdot 10^{-5}$	$3,70 \cdot 10^{-5}$	mNm/rpm
10	Speed constant	k_n		1 840	1 116	rpm/V
11	Back-EMF constant	k_E		0,543	0,896	mV/rpm
12	Torque constant	k_M		5,19	8,56	mNm/A
13	Current constant	k_I		0,193	0,117	A/mNm
14	Slope of n-M curve	$\Delta n/\Delta M$		195	185	rpm/mNm
15	Terminal inductance, phase-phase	L		68	117	µH
16	Mechanical time constant	τ_m		8	8	ms
17	Rotor inertia	J		3,95	3,95	gcm^2
18	Angular acceleration	$\alpha_{max.}$		286	365	$\cdot 10^3 rad/s^2$
19	Thermal resistance	$R_{th 1}$ / $R_{th 2}$	2,8 / 11,5			K/W
20	Thermal time constant	τ_{w1} / τ_{w2}	10 / 590			s
21	Operating temperature range		– 30 ... +125			°C
22	Shaft bearings		ball bearings, preloaded			
23	Shaft load max.:					
	– radial at 3 000/20 000 rpm (4,5 mm from mounting flange)		28 / 14			N
	– axial at 3 000/20 000 rpm (push-on only)		17 / 11			N
	– axial at standstill (push-on only)		75			N
24	Shaft play:					
	– radial	≤	0,015			mm
	– axial	=	0			mm
25	Housing material		aluminium, black anodized			
26	Weight		95			g
27	Direction of rotation		electronically reversible			

Recommended values - mathematically independent of each other

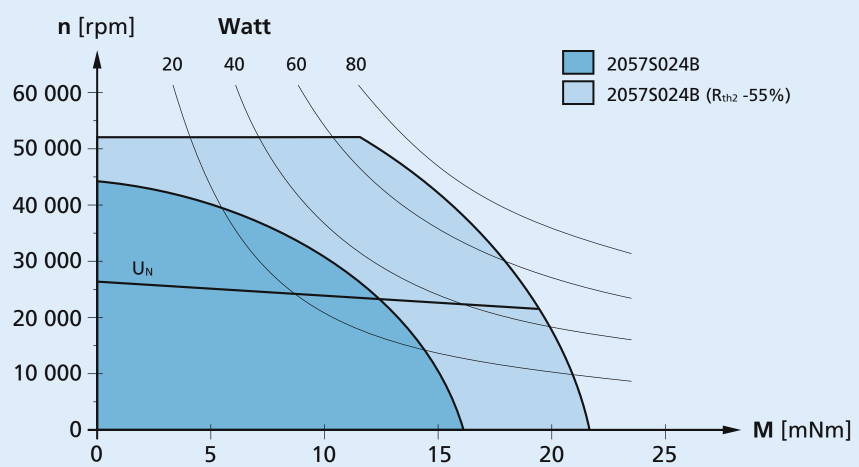
				012 B	024 B	
28	Speed up to [2]	$n_{e\ max.}$		52 000	52 000	rpm
29	Torque up to [1) 2)]	$M_{e\ max.}$		16,1	16,5	mNm
30	Current up to [1) 2)]	$I_{e\ max.}$		3,41	2,12	A

[1] at 36 000 rpm
[2] thermal resistance $R_{th 2}$ by 55% reduced

Note:
The diagram indicates the recommended speed in relation to the available torque at the output shaft for a given ambient temperature of 22°C.

The diagram shows the motor in a completely insulated as well as thermally coupled condition ($R_{th 2}$ 55% reduced).

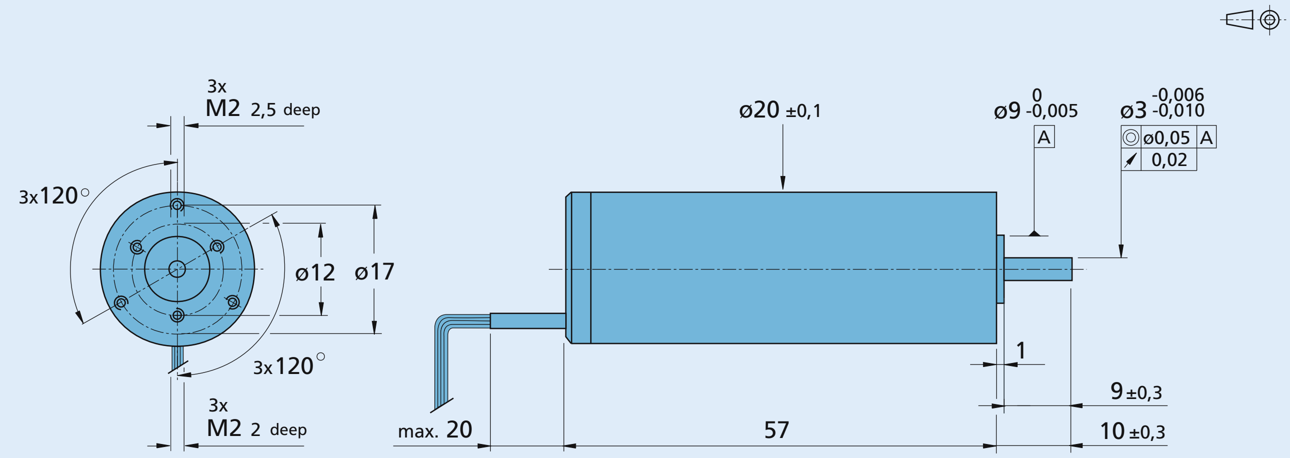
The nominal voltage (U_N) curve shows the operating point at nominal voltage in the insulated and thermally coupled condition. Any points of operation above the curve at nominal voltage will require a higher operating voltage. Any points below the nominal voltage curve will require less voltage.



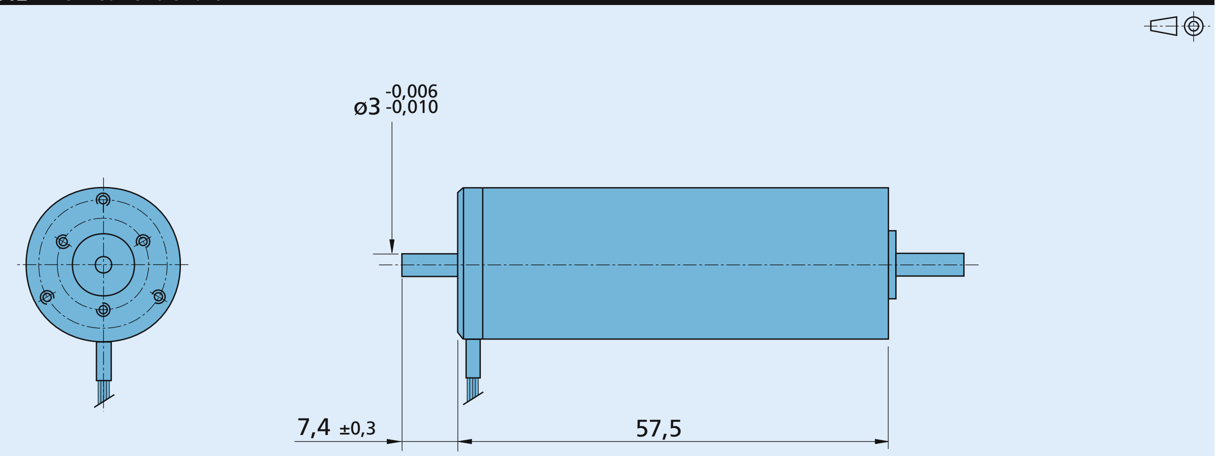
Recommended areas for continuous operation

Options
K1000:
Motors in autoclavable version.
K1155:
Motors for operation with Motion Controllers

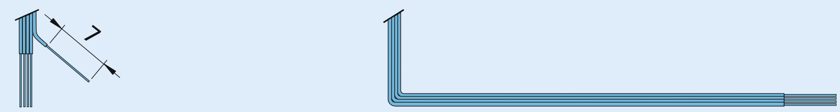
2057 S ... B



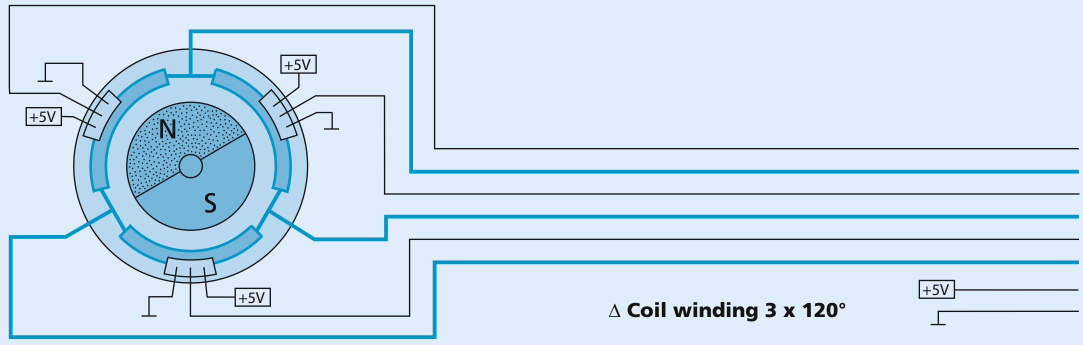
2057 S ... B - K312 with rear end shaft



Cable and connection information



Cable
Single wires, material PTFE
Length 300 mm ± 15 mm
5 conductors, AWG 26
3 conductors, AWG 24



Connection

	Function	Colour
A	Hall sensor	green
A	Phase	brown
B	Hall sensor	blue
B	Phase	orange
C	Hall sensor	grey
C	Phase	yellow
+5V	Logical supply	red
GND	Logical	black

Brushless DC-Servomotors

11,8 mNm

For combination with
Gearheads:
23/1, 26/1(S), 30/1(S), 38/3
Encoders:
IE2-1024, 5500, 5540
Drive Electronics:
Speed Controller, Motion Controller

Series 2444 ... B

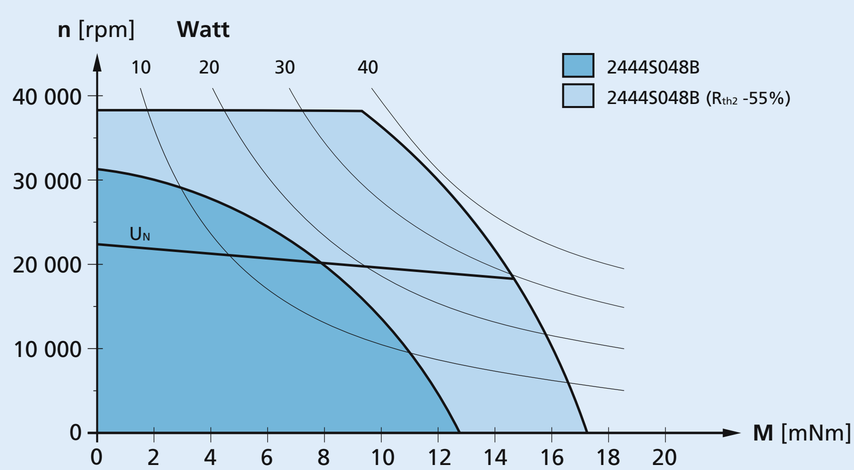
	2444 S			024 B	048 B	
1	Nominal voltage	U_N		24	48	Volt
2	Terminal resistance, phase-phase	R		2,1	8,4	Ω
3	Output power [1]	$P_{2\ max.}$		36	37	W
4	Efficiency	$\eta_{max.}$		77	77	%
5	No-load speed	n_o		23 000	22 500	rpm
6	No-load current (with shaft ø 3,0 mm)	I_o		0,184	0,088	A
7	Stall torque	M_H		111	115	mNm
8	Friction torque, static	C_o		1,00	1,00	mNm
9	Friction torque, dynamic	C_v		$3{,}5 \cdot 10^{-5}$	$3{,}5 \cdot 10^{-5}$	mNm/rpm
10	Speed constant	k_n		974	473	rpm/V
11	Back-EMF constant	k_E		1,026	2,115	mV/rpm
12	Torque constant	k_M		9,8	20,2	mNm/A
13	Current constant	k_I		0,102	0,050	A/mNm
14	Slope of n-M curve	$\Delta n/\Delta M$		209	197	rpm/mNm
15	Terminal inductance, phase-phase	L		180	760	µH
16	Mechanical time constant	τ_m		14	13	ms
17	Rotor inertia	J		6,5	6,5	gcm^2
18	Angular acceleration	$\alpha_{max.}$		171	177	$\cdot 10^3 rad/s^2$
19	Thermal resistance	$R_{th\ 1}$ / $R_{th\ 2}$	4,1 / 14,8			K/W
20	Thermal time constant	τ_{w1} / τ_{w2}	16 / 680			s
21	Operating temperature range		– 30 ... +125			°C
22	Shaft bearings		ball bearings, preloaded			
23	Shaft load max.:					
	– radial at 3 000/20 000 rpm (6 mm from mounting flange)		30 / 17			N
	– axial at 3 000/20 000 rpm (push-on only)		16 / 10			N
	– axial at standstill (push-on only)		57			N
24	Shaft play:					
	– radial	≤	0,015			mm
	– axial	=	0			mm
25	Housing material		aluminium, black anodized			
26	Weight		100			g
27	Direction of rotation		electronically reversible			
	Recommended values - mathematically independent of each other					
28	Speed up to [2]	$n_{e\ max.}$		38 000	38 000	rpm
29	Torque up to [1) 2)]	$M_{e\ max.}$		11,4	11,8	mNm
30	Current up to [1) 2)]	$I_{e\ max.}$		1,37	0,69	A

[1] at 30 000 rpm
[2] thermal resistance $R_{th\ 2}$ by 55% reduced

Note:
The diagram indicates the recommended speed in relation to the available torque at the output shaft for a given ambient temperature of 22°C.

The diagram shows the motor in a completely insulated as well as thermally coupled condition ($R_{th\ 2}$ 55% reduced).

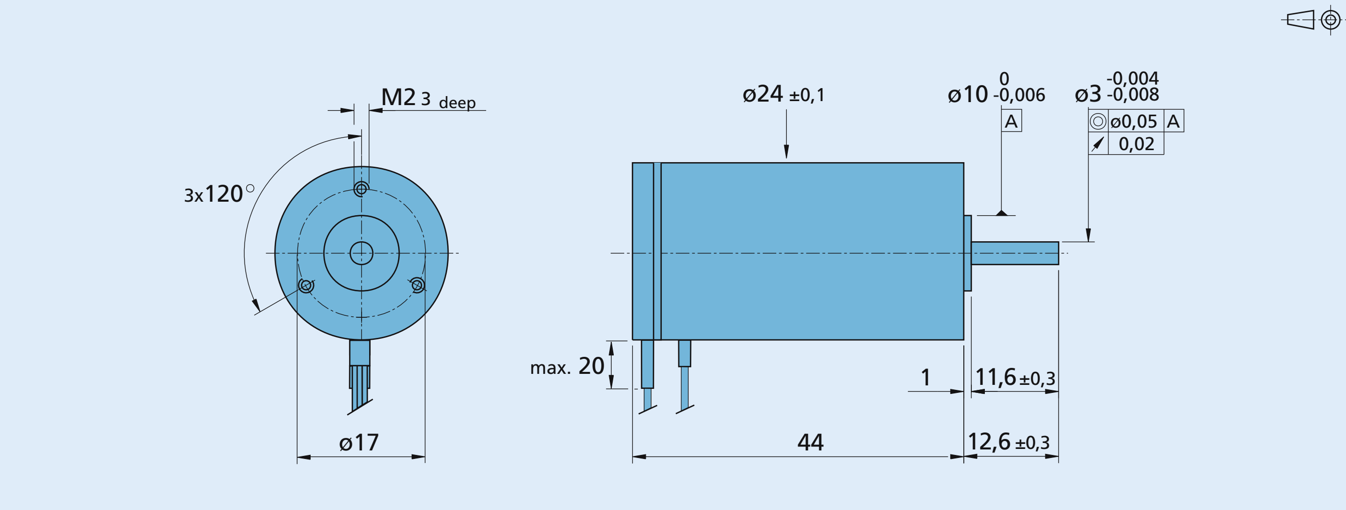
The nominal voltage (U_N) curve shows the operating point at nominal voltage in the insulated and thermally coupled condition. Any points of operation above the curve at nominal voltage will require a higher operating voltage. Any points below the nominal voltage curve will require less voltage.



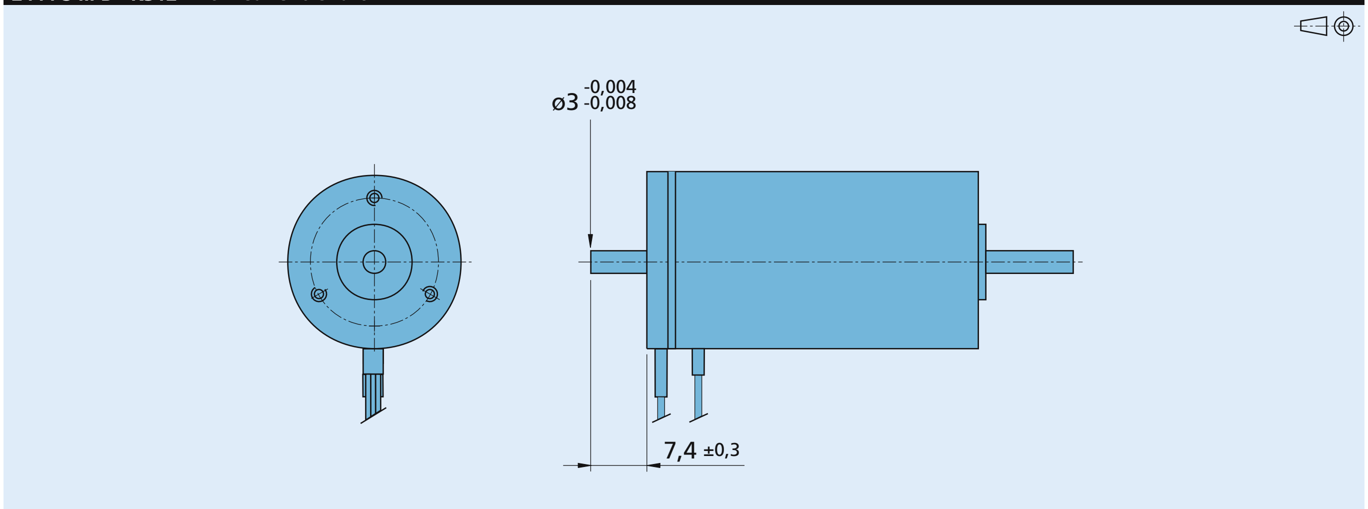
Recommended areas for continuous operation

Options
K1000:
Motors in autoclavable version.
K1155:
Motors for operation with Motion Controllers

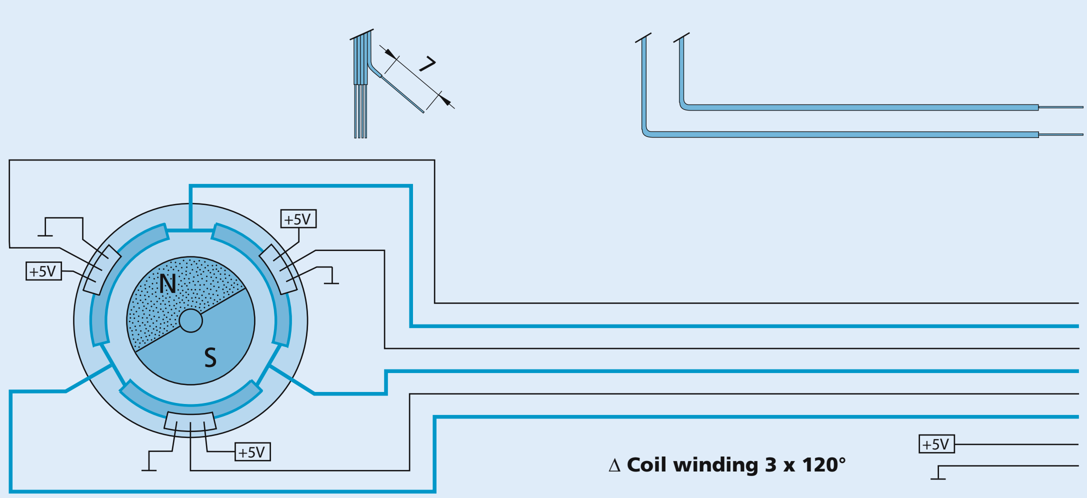
2444 S ... B



2444 S ... B - K312 with rear end shaft



Cable and connection information



Cable
Single wires, material PTFE
Length 300 mm ± 15 mm
3 conductors, AWG 24
5 conductors, AWG 26

Connection

	Function	Colour
A	Hall sensor	green
A	Phase	brown
B	Hall sensor	blue
B	Phase	orange
C	Hall sensor	grey
C	Phase	yellow
+5V	Logical supply	red
GND	Logical	black

Brushless DC-Servomotors

22,1 mNm

For combination with
Gearheads:
30/1(S), 38/1(S), 38/2(S)
Encoders:
IE3-1024(L), 5500, 5540
Drive Electronics:
Speed Controller, Motion Controller

Series 3056 ... B

	3056 K			012 B	024 B	036 B	048 B	
1	Nominal voltage	U_N		12	24	36	48	Volt
2	Terminal resistance, phase-phase	R		1,6	6,6	13,7	26,5	Ω
3	Output power [1]	$P_{2\ max.}$		48	51	49	49	W
4	Efficiency	$\eta_{max.}$		73	74	74	74	%
5	No-load speed	n_o		8 790	8 200	8 840	8 740	rpm
6	No-load current (with shaft ø 4,0 mm)	I_o		0,168	0,075	0,056	0,042	A
7	Stall torque	M_H		95	98	99	100	mNm
8	Friction torque, static	C_o		0,91	0,91	0,91	0,91	mNm
9	Friction torque, dynamic	C_v		$1,4 \cdot 10^{-4}$	$1,4 \cdot 10^{-4}$	$1,4 \cdot 10^{-4}$	$1,4 \cdot 10^{-4}$	mNm/rpm
10	Speed constant	k_n		750	350	251	186	rpm/V
11	Back-EMF constant	k_E		1,334	2,861	3,981	5,374	mV/rpm
12	Torque constant	k_M		12,74	27,32	38,02	51,32	mNm/A
13	Current constant	k_I		0,078	0,037	0,026	0,019	A/mNm
14	Slope of n-M curve	$\Delta n/\Delta M$		94	84	91	89	rpm/mNm
15	Terminal inductance, phase-phase	L		160	720	1 400	2 520	µH
16	Mechanical time constant	τ_m		13	12	13	12	ms
17	Rotor inertia	J		13,6	13,6	13,6	13,6	gcm^2
18	Angular acceleration	$\alpha_{max.}$		70	72	73	73	$\cdot 10^3 rad/s^2$
19	Thermal resistance	$R_{th 1}$ / $R_{th 2}$	3,3 / 9,4					K/W
20	Thermal time constant	τ_{w1} / τ_{w2}	19 / 1 034					s
21	Operating temperature range		– 30 ... +125					°C
22	Shaft bearings		ball bearings, preloaded					
23	Shaft load max.:							
	– radial at 3 000/20 000 rpm (7,4 mm from mounting flange)		72 / 51					N
	– axial at 3 000/20 000 rpm (axial push-on only)		18 / 12					N
	– axial at standstill (axial push-on only)		62					N
24	Shaft play:							
	– radial	≤	0,015					mm
	– axial	=	0					mm
25	Housing material		aluminium, black anodized					
26	Weight		190					g
27	Direction of rotation		electronically reversible					

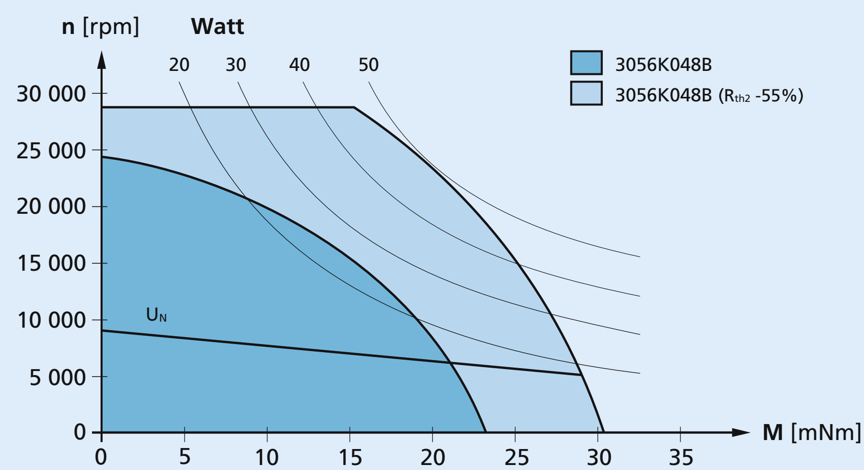
Recommended values - mathematically independent of each other								
28	Speed up to [2]	$n_{e\ max.}$		28 000	28 000	28 000	28 000	rpm
29	Torque up to [1] [2]	$M_{e\ max.}$		20,7	22,1	21,2	21,5	mNm
30	Current up to [1] [2]	$I_{e\ max.}$		1,94	0,96	0,66	0,50	A

[1] at 22 000 rpm
[2] thermal resistance $R_{th 2}$ by 55% reduced

Note:
The diagram indicates the recommended speed in relation to the available torque at the output shaft for a given ambient temperature of 22°C.

The diagram shows the motor in a completely insulated as well as thermally coupled condition ($R_{th 2}$ 55% reduced).

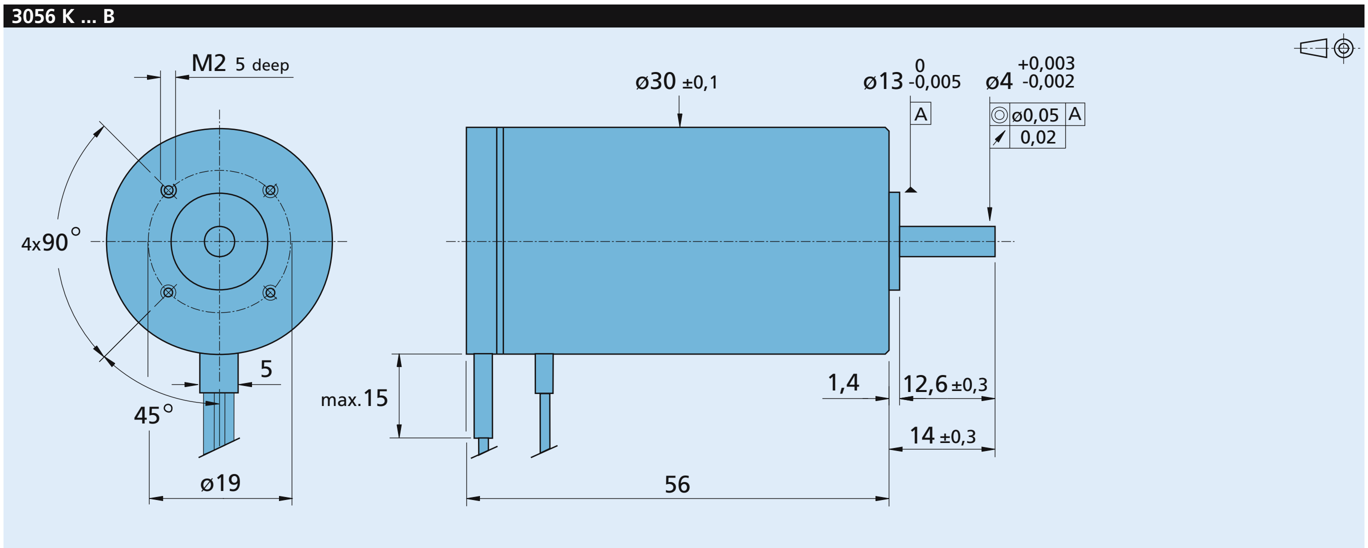
The nominal voltage (U_N) curve shows the operating point at nominal voltage in the insulated and thermally coupled condition. Any points of operation above the curve at nominal voltage will require a higher operating voltage. Any points below the nominal voltage curve will require less voltage.



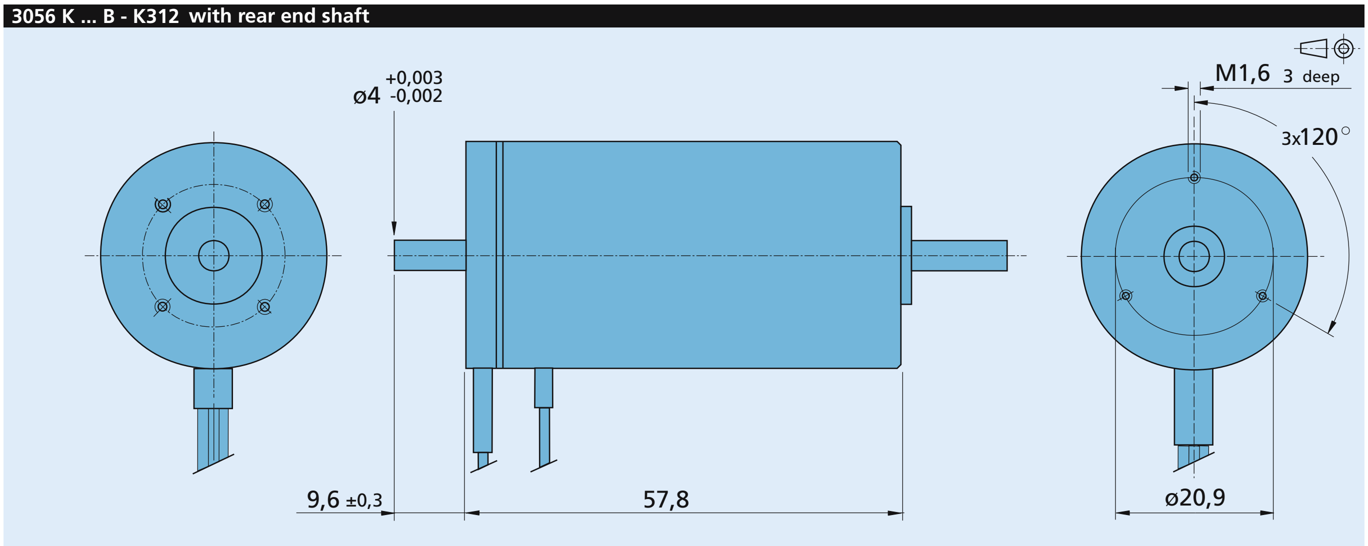
Recommended areas for continuous operation

Options
K1000:
Motors in autoclavable version.
K1155:
Motors for operation with Motion Controllers

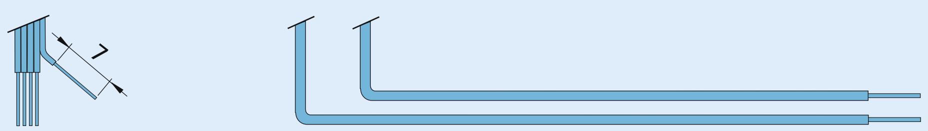
3056 K ... B



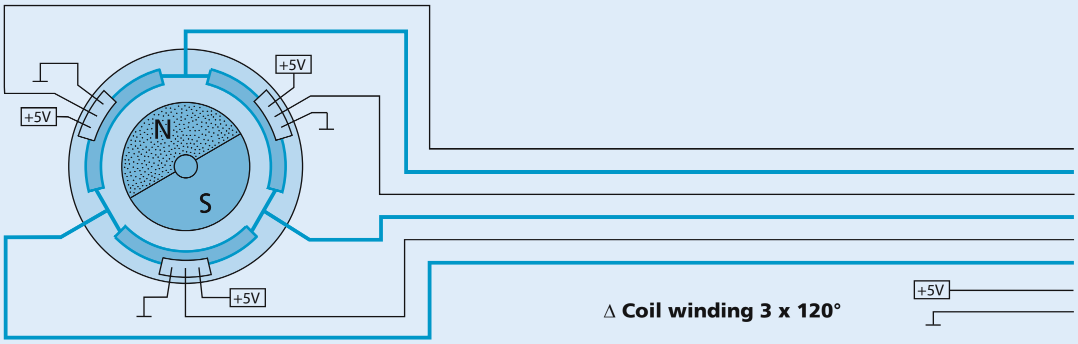
3056 K ... B - K312 with rear end shaft



Cable and connection information



Cable
Single wires, material PTFE
Length 300 mm ± 15 mm
3 conductors, AWG 20
5 conductors, AWG 26



Connection

	Function	Colour
A	Hall sensor	green
A	Phase	brown
B	Hall sensor	blue
B	Phase	orange
C	Hall sensor	grey
C	Phase	yellow
+5V	Logical supply	red
GND	Logical	black

Brushless DC-Servomotors

47,1 mNm

For combination with
Gearheads:
30/1(S), 32/3(S), 38A, 38/1(S), 38/2(S)
Encoders:
IE3-1024(L), 5500, 5540
Drive Electronics:
Speed Controller, Motion Controller

Series 3564 ... B

	3564 K			012 B	024 B	036 B	048 B	
1	Nominal voltage	U_N		12	24	36	48	Volt
2	Terminal resistance, phase-phase	R		0,6	1,2	2,8	4,4	Ω
3	Output power [1]	$P_{2\ max.}$		109	101	101	101	W
4	Efficiency	$\eta_{max.}$		81	81	81	82	%
5	No-load speed	n_o		7 850	11 300	11 550	12 200	rpm
6	No-load current (with shaft ø 4,0 mm)	I_o		0,206	0,189	0,131	0,109	A
7	Stall torque	M_H		291	371	379	401	mNm
8	Friction torque, static	C_o		1,10	1,10	1,10	1,10	mNm
9	Friction torque, dynamic	C_v		$2,4 \cdot 10^{-4}$	$2,4 \cdot 10^{-4}$	$2,4 \cdot 10^{-4}$	$2,4 \cdot 10^{-4}$	mNm/rpm
10	Speed constant	k_n		658	475	324	258	rpm/V
11	Back-EMF constant	k_E		1,521	2,107	3,089	3,877	mV/rpm
12	Torque constant	k_M		14,52	20,12	29,50	37,02	mNm/A
13	Current constant	k_I		0,069	0,050	0,034	0,027	A/mNm
14	Slope of n-M curve	$\Delta n/\Delta M$		27	31	31	31	rpm/mNm
15	Terminal inductance, phase-phase	L		96	194	427	678	µH
16	Mechanical time constant	τ_m		10	11	11	11	ms
17	Rotor inertia	J		34	34	34	34	gcm²
18	Angular acceleration	$\alpha_{max.}$		86	109	111	118	$\cdot 10^3$rad/s²
19	Thermal resistance	R_{th1} / R_{th2}	2,5 / 6,3					K/W
20	Thermal time constant	τ_{w1} / τ_{w2}	23 / 1 175					s
21	Operating temperature range		– 30 ... +125					°C
22	Shaft bearings		ball bearings, preloaded					
23	Shaft load max.:							
	– radial at 3 000/20 000 rpm (7,4 mm from mounting flange)		108 / 73					N
	– axial at 3 000/20 000 rpm (push-on only)		50 / 30					N
	– axial at standstill (push-on only)		131					N
24	Shaft play:							
	– radial	≤	0,015					mm
	– axial	=	0					mm
25	Housing material		aluminium, black anodized					
26	Weight		310					g
27	Direction of rotation		electronically reversible					

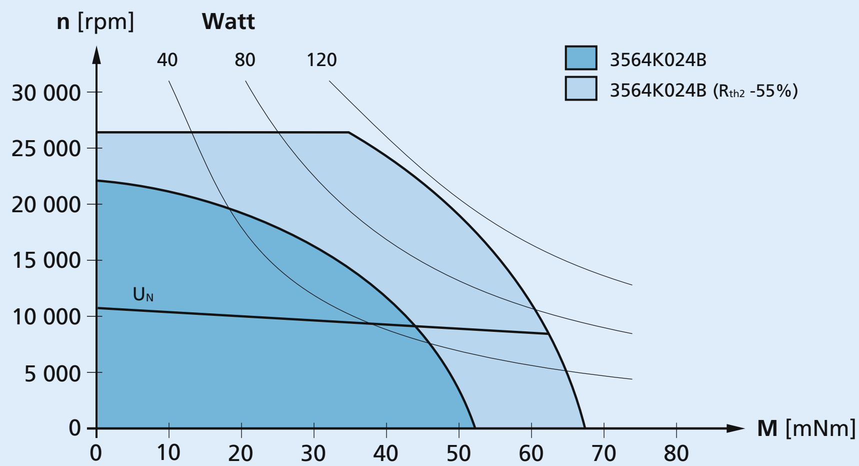
	Recommended values - mathematically independent of each other							
28	Speed up to [2]	$n_{e\ max.}$		27 000	27 000	27 000	27 000	rpm
29	Torque up to [1) 2)]	$M_{e\ max.}$		47,1	44,0	43,9	44,0	mNm
30	Current up to [1) 2)]	$I_{e\ max.}$		3,68	2,50	1,71	1,36	A

[1] at 22 000 rpm
[2] thermal resistance $R_{th\ 2}$ by 55% reduced

Note:
The diagram indicates the recommended speed in relation to the available torque at the output shaft for a given ambient temperature of 22°C.

The diagram shows the motor in a completely insulated as well as thermally coupled condition ($R_{th\ 2}$ 55% reduced).

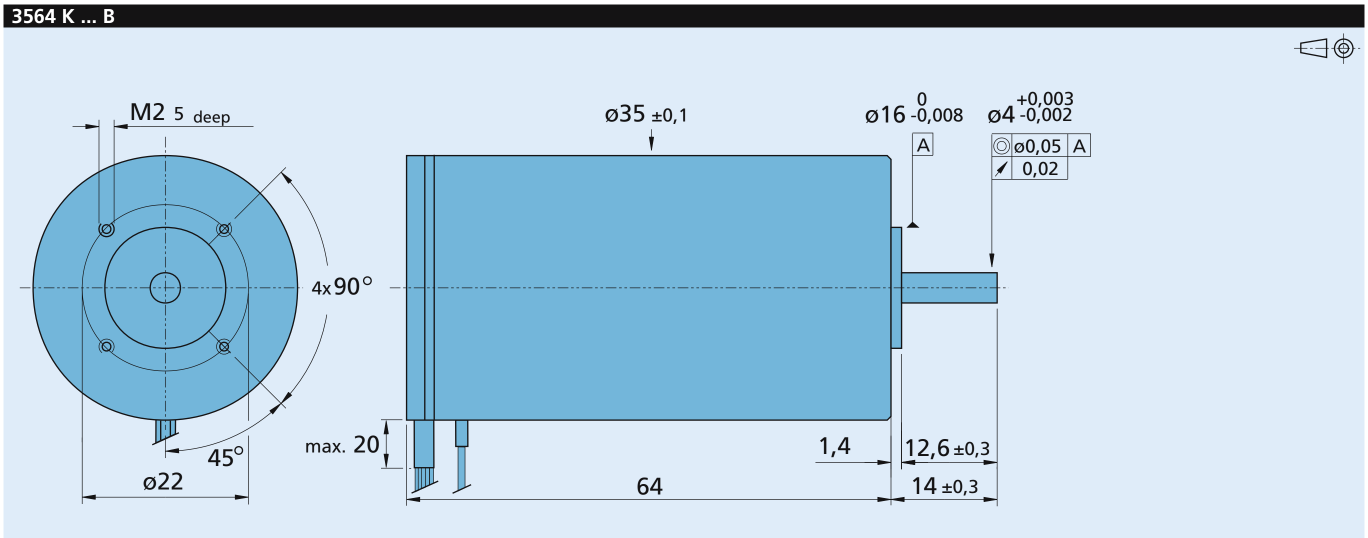
The nominal voltage (U_N) curve shows the operating point at nominal voltage in the insulated and thermally coupled condition. Any points of operation above the curve at nominal voltage will require a higher operating voltage. Any points below the nominal voltage curve will require less voltage.



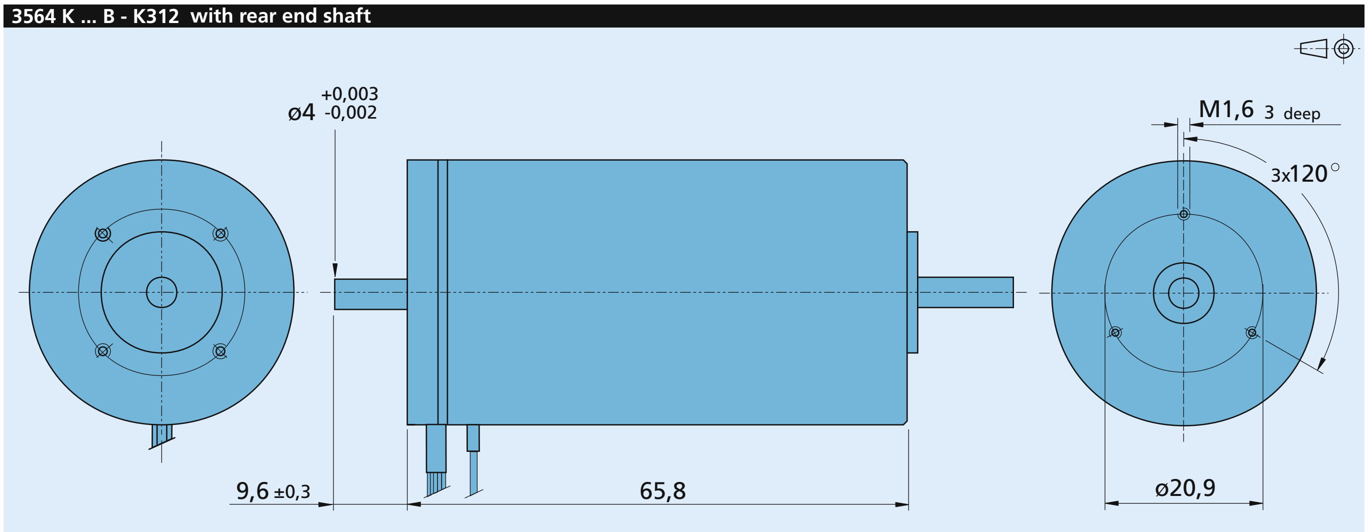
Recommended areas for continuous operation

Options
K1000:
Motors in autoclavable version.
K1155:
Motors for operation with Motion Controllers

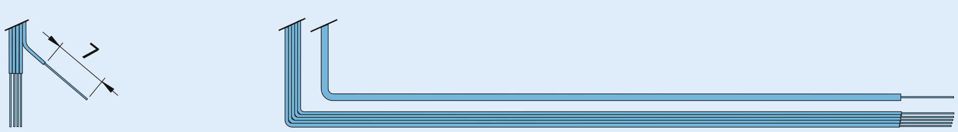
3564 K ... B



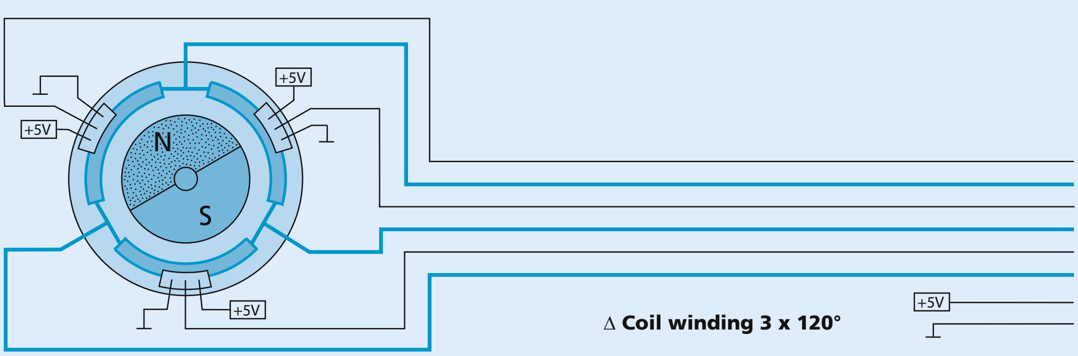
3564 K ... B - K312 with rear end shaft



Cable and connection information



Cable
Single wires, material PTFE
Length 300 mm ± 15 mm
3 conductors, AWG 20
5 conductors, AWG 26



Connection

	Function	Colour
A	Hall sensor	green
A	Phase	brown
B	Hall sensor	blue
B	Phase	orange
C	Hall sensor	grey
C	Phase	yellow
+5V	Logical supply	red
GND	Logical	black

Brushless DC-Servomotors

191 mNm

For combination with
Gearheads:
38A, 44/1
Encoders:
IE3-1024(L), 40B
Drive Electronics:
Speed Controller, Motion Controller

Series 4490 ... B

	4490 H			024 B	036 B	048 B	
1	Nominal voltage	U_N		24	36	48	Volt
2	Terminal resistance, phase-phase	R		0,237	0,445	0,720	Ω
3	Output power [1]	$P_{2\,max.}$		201	201	200	W
4	Efficiency	$\eta_{max.}$		86	86	86	%
5	No-load speed	n_o		9 550	10 450	11 000	rpm
6	No-load current (with shaft ø 6,0 mm)	I_o		0,554	0,432	0,354	A
7	Stall torque	M_H		2 406	2 637	2 758	mNm
8	Friction torque, static	C_o		3,65	3,65	3,65	mNm
9	Friction torque, dynamic	C_v		$1{,}0 \cdot 10^{-3}$	$1{,}0 \cdot 10^{-3}$	$1{,}0 \cdot 10^{-3}$	mNm/rpm
10	Speed constant	k_n		401	292	231	rpm/V
11	Back-EMF constant	k_E		2,495	3,422	4,335	mV/rpm
12	Torque constant	k_M		23,83	32,68	41,40	mNm/A
13	Current constant	k_I		0,042	0,031	0,024	A/mNm
14	Slope of n-M curve	$\Delta n/\Delta M$		4,0	4,0	4,0	rpm/mNm
15	Terminal inductance, phase-phase	L		76	143	236	µH
16	Mechanical time constant	τ_m		5	5	5	ms
17	Rotor inertia	J		130	130	130	gcm^2
18	Angular acceleration	$\alpha_{max.}$		185	203	212	$\cdot 10^3 rad/s^2$
19	Thermal resistance	$R_{th\,1}$ / $R_{th\,2}$	1,35 / 3,94				K/W
20	Thermal time constant	τ_{w1} / τ_{w2}	29 / 1 756				s
21	Operating temperature range		– 30 ... +125				°C
22	Shaft bearings		ball bearings, preloaded				
23	Shaft load max.:						
	– radial at 3 000/10 000 rpm (13,5 mm from mounting flange)		103 / 66				N
	– axial at 3 000/10 000 rpm (push-on only)		45 / 30				N
	– axial at standstill (push-on only)		135				N
24	Shaft play:						
	– radial	≤	0,015				mm
	– axial	=	0				mm
25	Housing material		aluminium, black anodized				
26	Weight		750				g
27	Direction of rotation		electronically reversible				
	Coil connection		Δ Delta-circuit				

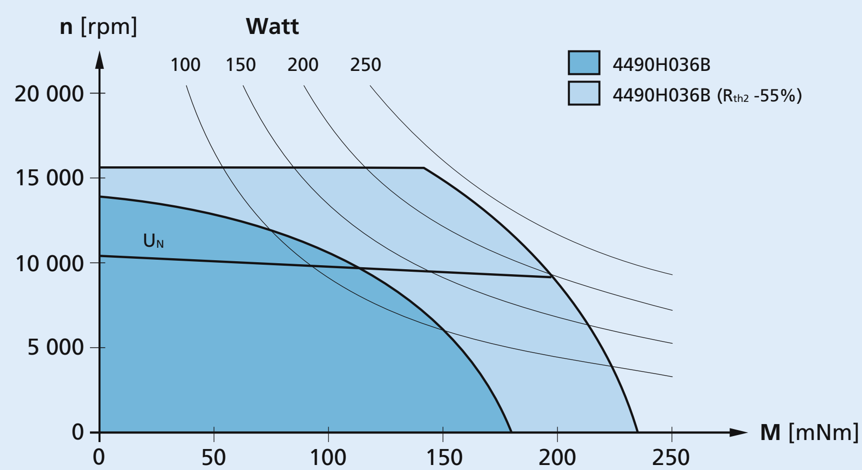
Recommended values - mathematically independent of each other							
28	Speed up to [2]	$n_{e\,max.}$		16 000	16 000	16 000	rpm
29	Torque up to [1] [2]	$M_{e\,max.}$		191,8	191,9	191,1	mNm
30	Current up to [1] [2]	$I_{e\,max.}$		8,62	6,29	4,95	A

[1] at 10 000 rpm
[2] thermal resistance $R_{th\,2}$ by 55% reduced

Note:
The diagram indicates the recommended speed in relation to the available torque at the output shaft for a given ambient temperature of 22°C.

The diagram shows the motor in a completely insulated as well as thermally coupled condition ($R_{th\,2}$ 55% reduced).

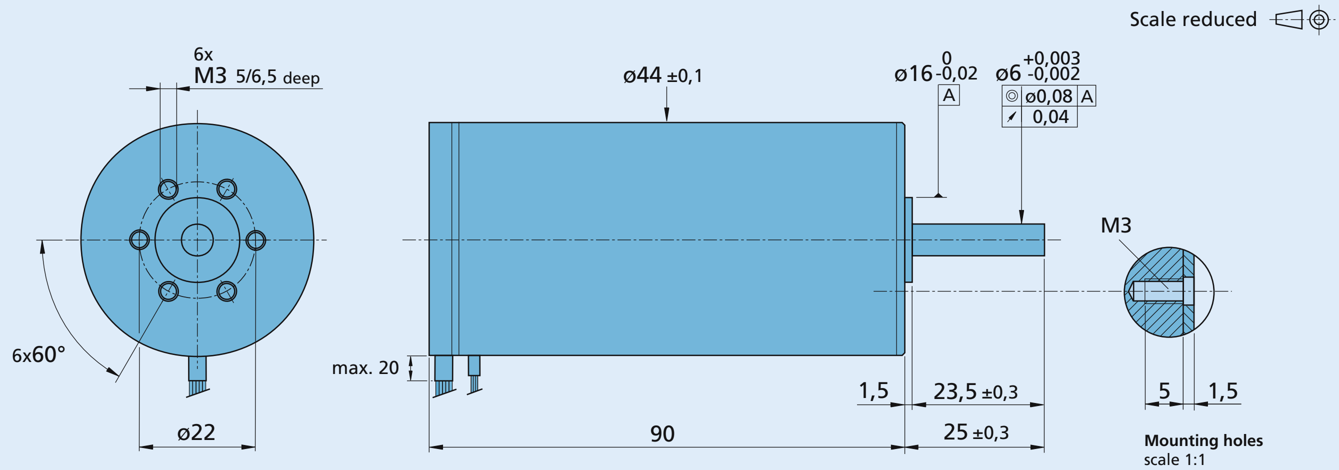
The nominal voltage (U_N) curve shows the operating point at nominal voltage in the insulated and thermally coupled condition. Any points of operation above the curve at nominal voltage will require a higher operating voltage. Any points below the nominal voltage curve will require less voltage.



Recommended areas for continuous operation

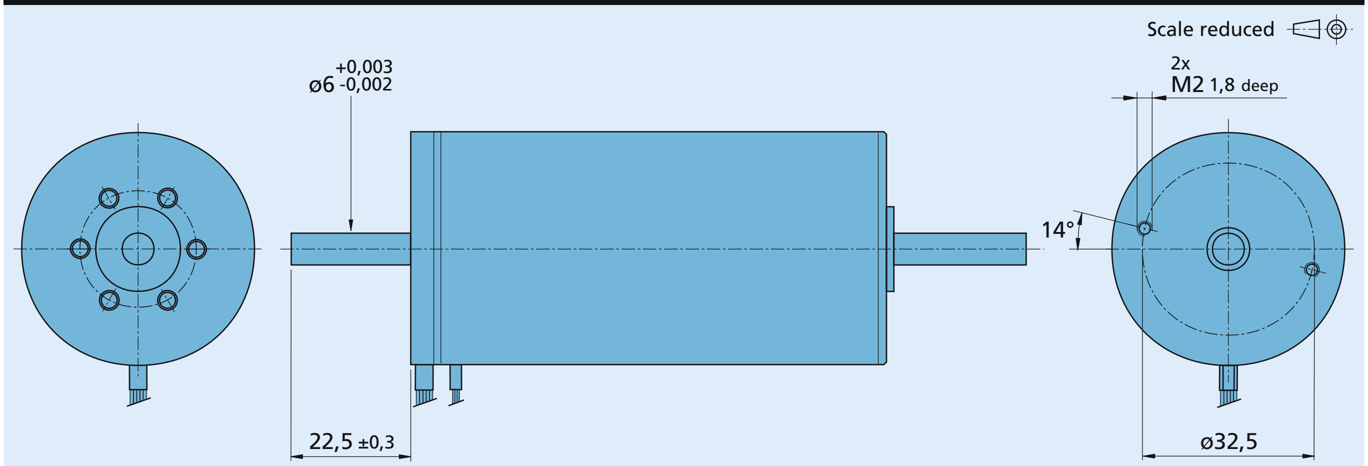
Options
K1155:
Motors for operation with Motion Controllers

4490 H ... B



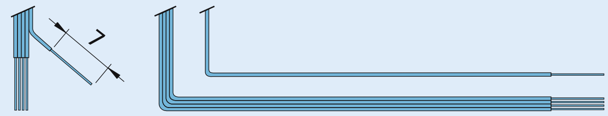
4490 H ... B

4490 H ... B - K312 with rear end shaft

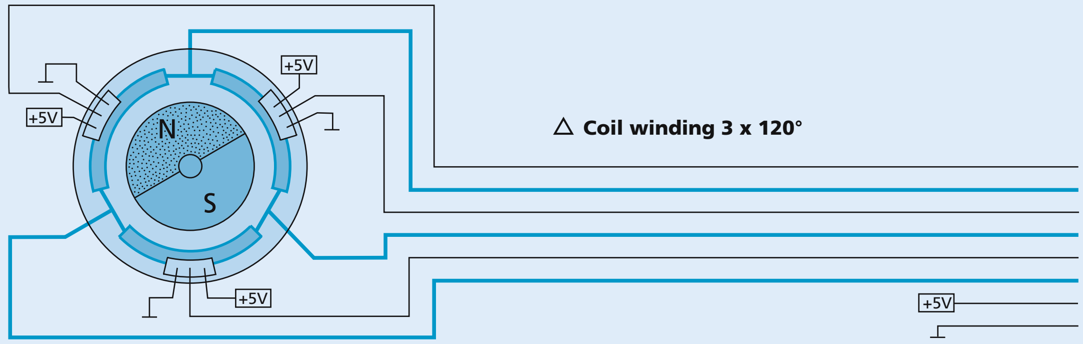


4490 H ... B - K312

Cable and connection information



Cable
Single wires, material PTFE
Length 300 mm ± 15 mm
3 conductors, AWG 16
5 conductors, AWG 26



△ **Coil winding 3 x 120°**

Connection

	Function	Colour
A	Hall sensor	green
A	Phase	brown
B	Hall sensor	blue
B	Phase	orange
C	Hall sensor	grey
C	Phase	yellow
+5V	Logical supply	red
GND	Logical	black

Brushless DC-Motors

Brushless DC-Servomotors

202 mNm

For combination with
Gearheads:
38A, 44/1
Encoders:
IE3-1024(L), 40B
Drive Electronics:
Speed Controller, Motion Controller

Series 4490 ... BS

	4490 H		024 BS	036 BS	048 BS	
1	Nominal voltage	U_N	24	36	48	Volt
2	Terminal resistance, phase-phase	R	0,690	1,340	2,130	Ω
3	Output power [1]	$P_{2\ max.}$	207	210	212	W
4	Efficiency	$\eta_{max.}$	85	85	86	%
5	No-load speed	n_o	5 450	5 790	6 060	rpm
6	No-load current (with shaft ø 6,0 mm)	I_o	0,217	0,160	0,129	A
7	Stall torque	M_H	1 455	1 584	1 689	mNm
8	Friction torque, static	C_o	3,65	3,65	3,65	mNm
9	Friction torque, dynamic	C_v	$1{,}0 \cdot 10^{-3}$	$1{,}0 \cdot 10^{-3}$	$1{,}0 \cdot 10^{-3}$	mNm/rpm
10	Speed constant	k_n	228	162	127	rpm/V
11	Back-EMF constant	k_E	4,384	6,185	7,871	mV/rpm
12	Torque constant	k_M	41,86	59,06	75,16	mNm/A
13	Current constant	k_I	0,024	0,017	0,013	A/mNm
14	Slope of n-M curve	$\Delta n/\Delta M$	3,8	3,7	3,6	rpm/mNm
15	Terminal inductance, phase-phase	L	220	435	720	µH
16	Mechanical time constant	τ_m	5	5	5	ms
17	Rotor inertia	J	130	130	130	gcm^2
18	Angular acceleration	$\alpha_{max.}$	112	122	130	$\cdot 10^3 rad/s^2$
19	Thermal resistance	R_{th1} / R_{th2}	1,35 / 3,94			K/W
20	Thermal time constant	τ_{w1} / τ_{w2}	29 / 1 756			s
21	Operating temperature range		– 30 ... +125			°C
22	Shaft bearings		ball bearings, preloaded			
23	Shaft load max.:					
	– radial at 3 000/10 000 rpm (13,5 mm from mounting flange)		103 / 66			N
	– axial at 3 000/10 000 rpm (push-on only)		45 / 30			N
	– axial at standstill (push-on only)		135			N
24	Shaft play:					
	– radial	≤	0,015			mm
	– axial	=	0			mm
25	Housing material		aluminium, black anodized			
26	Weight		750			g
27	Direction of rotation		electronically reversible			
	Coil connection		Y Star-circuit			

Recommended values - mathematically independent of each other

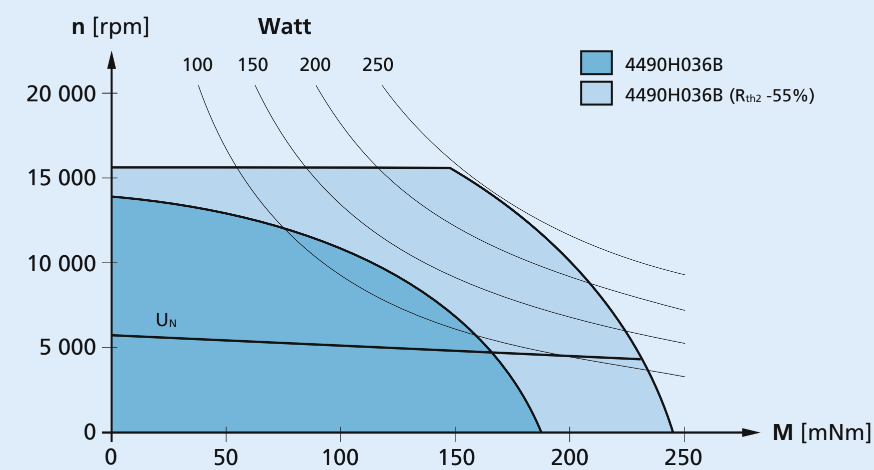
			024 BS	036 BS	048 BS	
28	Speed up to [2]	$n_{e\ max.}$	16 000	16 000	16 000	rpm
29	Torque up to [1] [2]	$M_{e\ max.}$	197,8	200,4	202,4	mNm
30	Current up to [1] [2]	$I_{e\ max.}$	5,05	3,63	2,88	A

[1] at 10 000 rpm
[2] thermal resistance $R_{th\ 2}$ by 55% reduced

Note:
The diagram indicates the recommended speed in relation to the available torque at the output shaft for a given ambient temperature of 22°C.

The diagram shows the motor in a completely insulated as well as thermally coupled condition ($R_{th\ 2}$ 55% reduced).

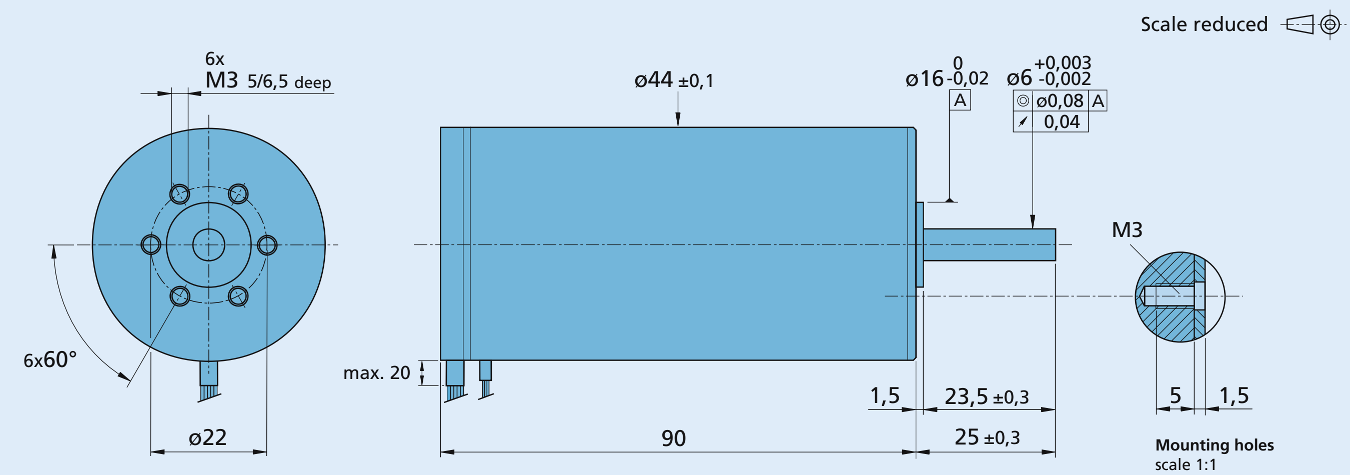
The nominal voltage (U_N) curve shows the operating point at nominal voltage in the insulated and thermally coupled condition. Any points of operation above the curve at nominal voltage will require a higher operating voltage. Any points below the nominal voltage curve will require less voltage.



Recommended areas for continuous operation

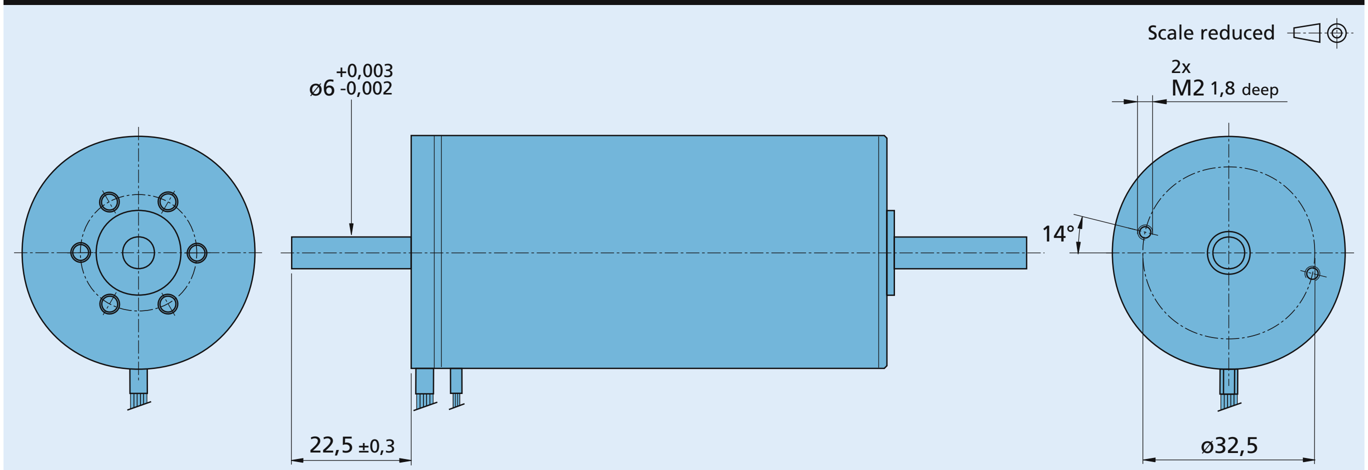
Options
K1155:
Motors for operation with Motion Controllers

4490 H ... BS



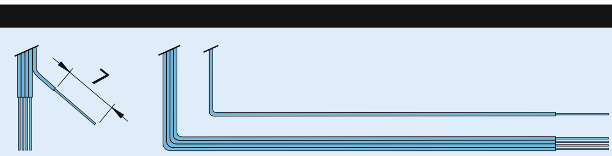
4490 H ... BS

4490 H ... BS - K312 with rear end shaft

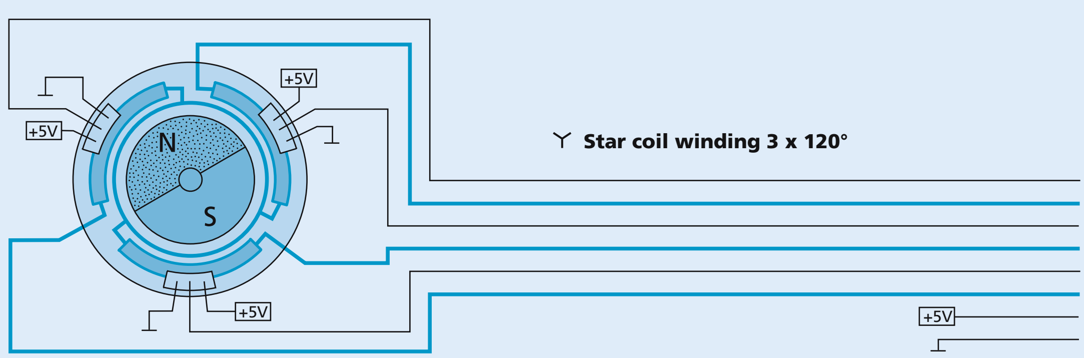


4490 H ... BS - K312

Cable and connection information



Cable
Single wires, material PTFE
Length 300 mm ± 15 mm
3 conductors, AWG 16
5 conductors, AWG 26



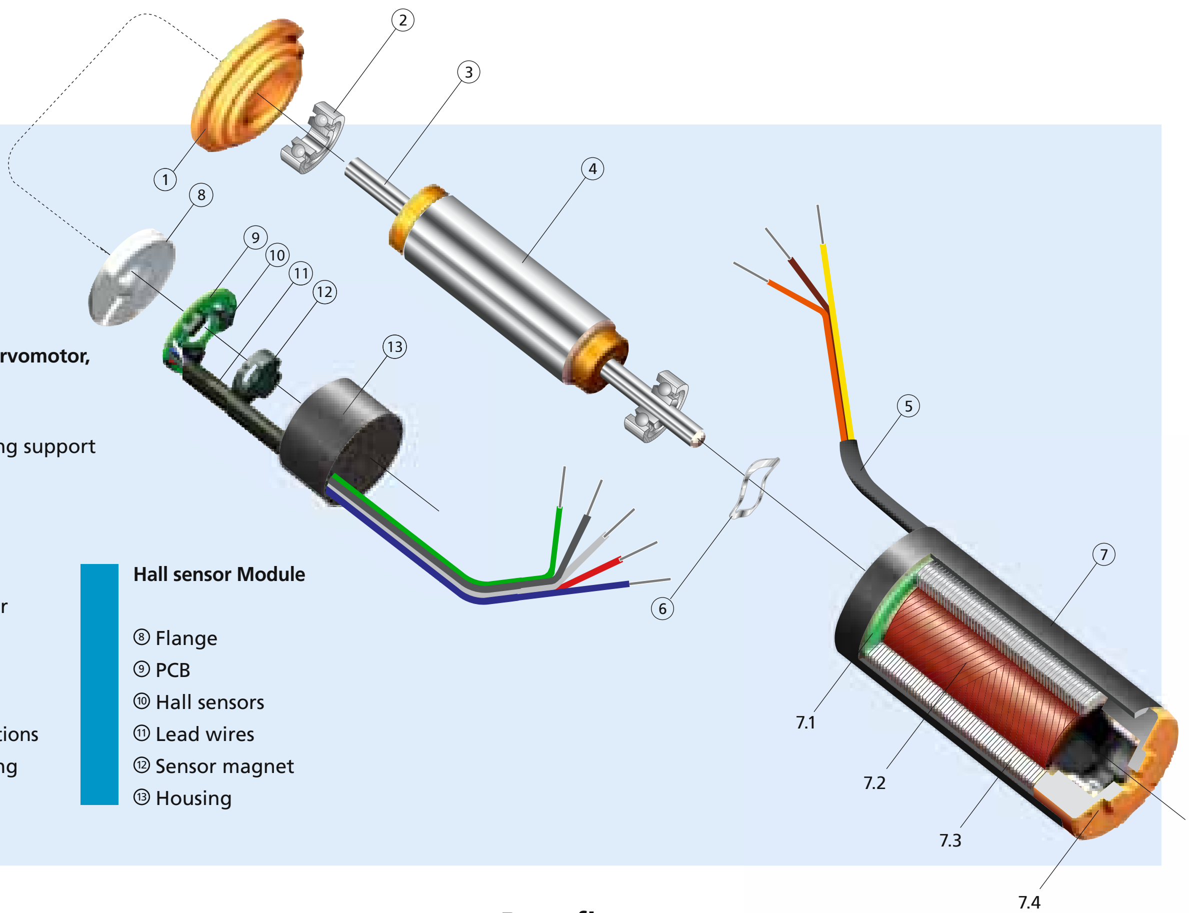
Connection

	Function	Colour
A	Hall sensor	green
A	Phase	brown
B	Hall sensor	blue
B	Phase	orange
C	Hall sensor	grey
C	Phase	yellow
+5V	Logical supply	red
GND	Logical	black

Notes

Brushless DC-Servomotors

Sensorless, SMARTSHELL® Technology



Brushless DC-Servomotor, sensorless

① Cover / Bearing support
② Ball bearing
③ Shaft
④ Magnet
⑤ Lead wires
⑥ Spring washer
⑦ Stator:
7.1 PCB
7.2 Coil
7.3 Stator laminations
7.4 Cover / Bearing support

Hall sensor Module

⑧ Flange
⑨ PCB
⑩ Hall sensors
⑪ Lead wires
⑫ Sensor magnet
⑬ Housing

Features

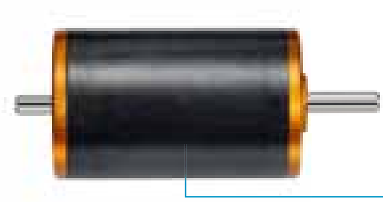
The skew-wound self-supporting coil, System FAULHABER®, the printed circuit board, the laminated stack and the front-end bearing cover are all encapsulated and meshed together with a mould-injected LCP (Liquid Crystal Polymer), exhibiting outstanding mechanical and thermal features.

The modular design concept of the SMARTSHELL® motors offers two Hall sensor modules for precise speed and position control. With these modules assembled to the rear end of the motors, the BDS (Brushless Digital Sensors) and BAS (Brushless Analog Sensors) options are available for use with the appropriate drive electronics.

Benefits

- System FAULHABER®, ironless stator coil
- High reliability and operational lifetime
- Wide range of linear torque / speed performance
- No sparking
- No cogging
- Dynamically balanced rotor
- Simple design
- Available with optional digital or analog hall sensors

Product Code



2232 S 048 BSL

22	Motor diameter [mm]
32	Motor length [mm]
S	Shaft type
048	Nominal voltage [V]
B	Type of commutation (brushless)
SL	Version (sensorless)

Brushless DC-Servomotors

sensorless, with optional Hall Sensors
SMARTSHELL® Technology

2,1 mNm

For combination with
Gearheads:
15/5(S), 15/8, 16/7
Drive Electronics:
Speed Controller

Series 1524 ... BSL

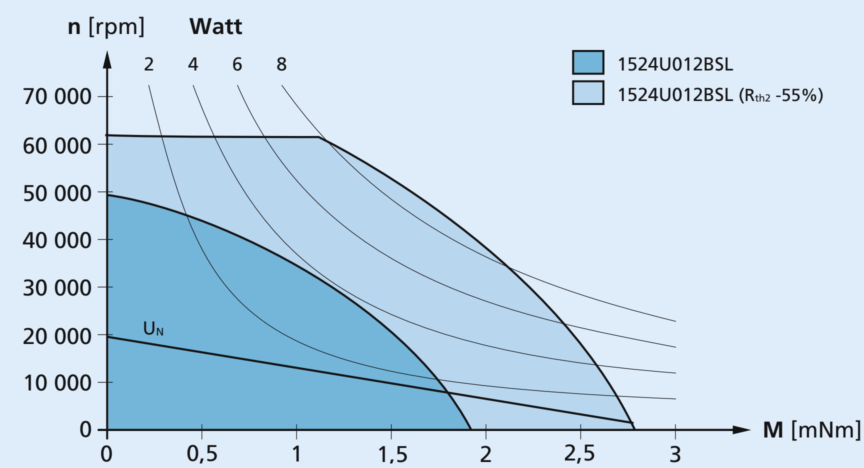
		1524 U		006 BSL	009 BSL	012 BSL	
1	Nominal voltage	U_N		6	9	12	Volt
2	Terminal resistance, phase-phase	R		4,30	9,7	15,3	Ω
3	Output power [1]	$P_{2\ max.}$		8	8	8	W
4	Efficiency	$\eta_{\ max.}$		54	53	54	%
5	No-load speed	n_o		18 500	19 200	19 900	rpm
6	No-load current (with shaft ø 2,0 mm)	I_o		0,110	0,078	0,062	A
7	Stall torque	M_H		4	4	4	mNm
8	Friction torque, static	C_o		0,140	0,140	0,140	mNm
9	Friction torque, dynamic	C_v		$9{,}5 \cdot 10^{-6}$	$9{,}5 \cdot 10^{-6}$	$9{,}5 \cdot 10^{-6}$	mNm/rpm
10	Speed constant	k_n		3 339	2 318	1 805	rpm/V
11	Back-EMF constant	k_E		0,299	0,431	0,554	mV/rpm
12	Torque constant	k_M		2,86	4,12	5,29	mNm/A
13	Current constant	k_I		0,350	0,243	0,189	A/mNm
14	Slope of n-M curve	$\Delta n/\Delta M$		5 020	5 457	5 221	rpm/mNm
15	Terminal inductance, phase-phase	L		82	169	273	µH
16	Mechanical time constant	τ_m		15	16	16	ms
17	Rotor inertia	J		0,30	0,30	0,30	gcm²
18	Angular acceleration	$\alpha_{\ max.}$		129	123	133	$\cdot 10^3$rad/s²
19	Thermal resistance	$R_{th\ 1}$ / $R_{th\ 2}$	2,6 / 29,0				K/W
20	Thermal time constant	τ_{w1} / τ_{w2}	1 / 326				s
21	Operating temperature range		– 30 ... +125				°C
22	Shaft bearings		ball bearings, preloaded				
23	Shaft load max.:						
	– radial at 3 000/20 000 rpm (4,5 mm from mounting flange)		5 / 4 for series 1524 U ... B ..				N
	– radial at 3 000/20 000 rpm (2,0 mm from mounting flange)		5,5 / 4,5 for series 1524 E ... B ..				N
	– axial at 3 000/20 000 rpm (push-on only)		4 / 3,5				N
	– axial at standstill (push-on only)		17				N
24	Shaft play:						
	– radial	≤	0,015				mm
	– axial	=	0				mm
25	Housing material		mounting face in aluminium, housing in plastic				
26	Weight		20				g
27	Direction of rotation		electronically reversible				
	Recommended values - mathematically independent of each other						
28	Speed up to [2]	$n_{e\ max.}$		62 000	62 000	62 000	rpm
29	Torque up to [1) 2)]	$M_{e\ max.}$		2,1	2,0	2,1	mNm
30	Current up to [1) 2)]	$I_{e\ max.}$		0,91	0,61	0,48	A

[1] at 36 000 rpm
[2] thermal resistance $R_{th\ 2}$ by 55% reduced

Note:
The diagram indicates the recommended speed in relation to the available torque at the output shaft for a given ambient temperature of 22°C.

The diagram shows the motor in a completely insulated as well as thermally coupled condition ($R_{th\ 2}$ 55% reduced).

The nominal voltage (U_N) curve shows the operating point at nominal voltage in the insulated and thermally coupled condition. Any points of operation above the curve at nominal voltage will require a higher operating voltage. Any points below the nominal voltage curve will require less voltage.

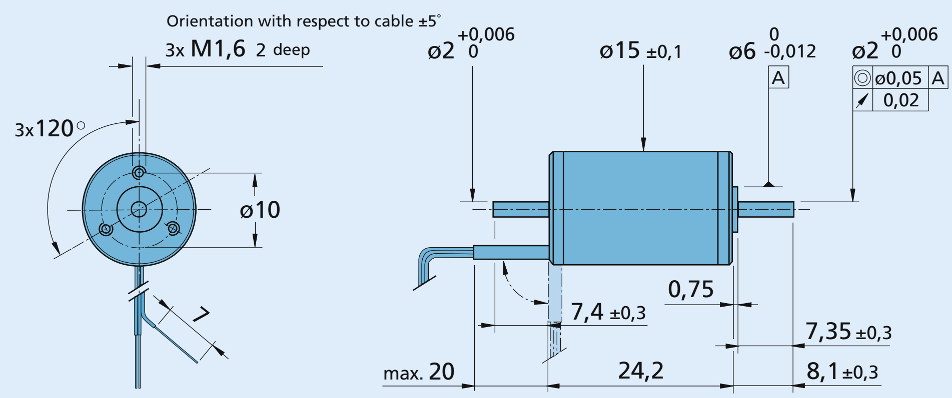


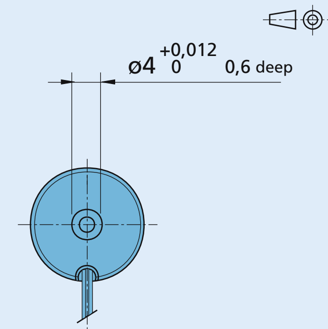
Recommended areas for continuous operation

Options
Motors with digital sensors:
1524 U ... BDS, 1524 E ... BDS

Motors with analog sensors:
1524 U ... BAS, 1524 E ... BAS

1524 U ... BSL sensorless





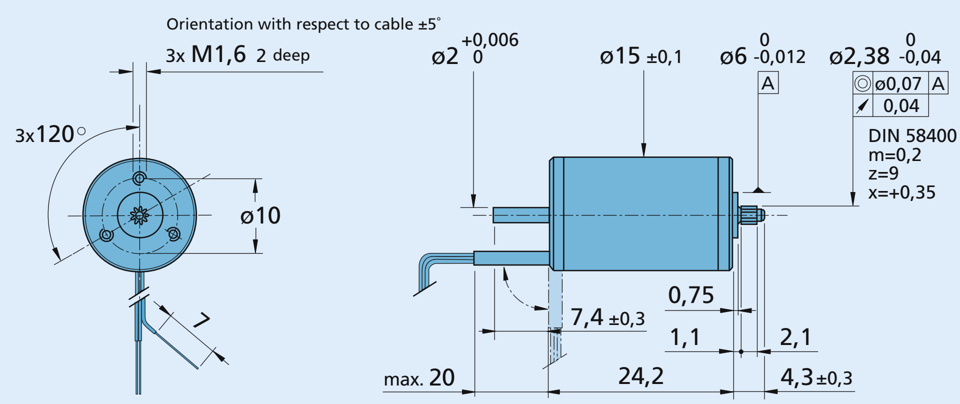
Cable
Single wires, material PTFE
Length 300 mm ± 15 mm
3 conductors, AWG 26

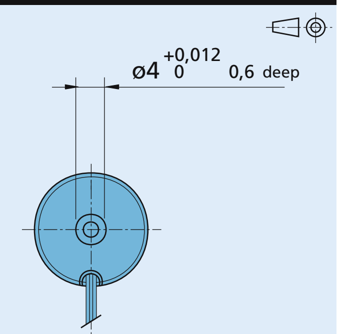
1524 U ... BSL
for combination with:
Gearheads 16/7
Drive Electronics Speed Controller

Connection

Function	Colour
Phase A	brown
Phase B	orange
Phase C	yellow

1524 E ... BSL sensorless





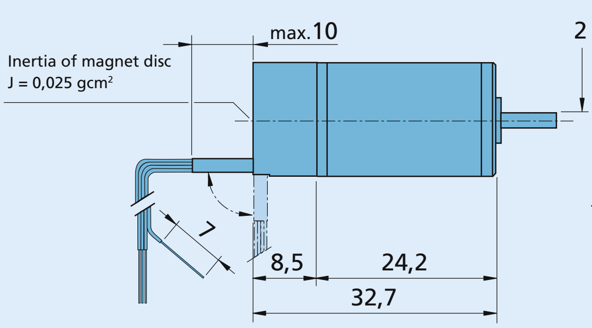
Cable
Single wires, material PTFE
Length 300 mm ± 15 mm
3 conductors, AWG 26

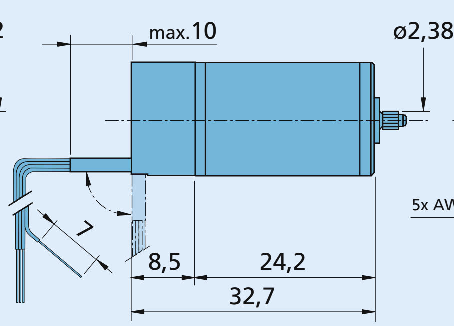
1524 E ... BSL
for combination with:
Getriebe 15/5(S), 15/8
Drive Electronics Speed Controller

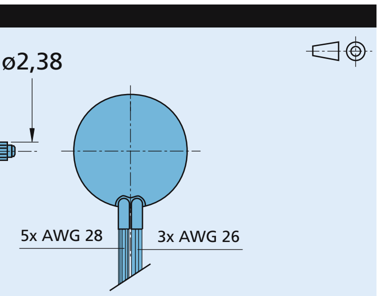
Connection

Function	Colour
Phase A	brown
Phase B	orange
Phase C	yellow

1524 U ... BAS, 1524 U ... BDS, 1524 E ... BAS, 1524 E ... BDS with Hall sensors







1524 U ... BDS
for combination with:
Drive Electronics Speed Controller

1524 U ... BAS
for combination with:
Drive Electronics Motion Controllers

1524 E ... BDS
for combination with:
Drive Electronics Speed Controller

1524 E ... BAS
for combination with:
Drive Electronics Motion Controllers

Cable
Single wires, material PTFE
Length 300 mm ± 15 mm
3 conductors, AWG 26
5 conductors, AWG 28

Connection

Function	Colour
Phase A	brown
Phase B	orange
Phase C	yellow
Hall sensor A	green
Hall sensor B	blue
Hall sensor C	grey
+5V - Logical supply	red
GND - Logical	black

Brushless DC-Servomotors

5,7 mNm

sensorless, with optional Hall Sensors
SMARTSHELL® Technology

For combination with
Gearheads:
15/5(S), 15/8, 16/7
Drive Electronics:
Speed Controller

Series 1536 ... BSL

	1536 U			009 BSL	012 BSL	024 BSL	
1	Nominal voltage	U_N		9	12	24	Volt
2	Terminal resistance, phase-phase	R		3,28	5,48	21,42	Ω
3	Output power [1]	$P_{2\ max.}$		22	21	21	W
4	Efficiency	$\eta_{max.}$		69	69	69	%
5	No-load speed	n_o		15 100	15 900	16 200	rpm
6	No-load current (with shaft ø 2,0 mm)	I_o		0,086	0,069	0,036	A
7	Stall torque	M_H		15	15	15	mNm
8	Friction torque, static	C_o		0,230	0,230	0,230	mNm
9	Friction torque, dynamic	C_v		$1,61 \cdot 10^{-5}$	$1,61 \cdot 10^{-5}$	$1,61 \cdot 10^{-5}$	mNm/rpm
10	Speed constant	k_n		1 739	1 364	698	rpm/V
11	Back-EMF constant	k_E		0,575	0,733	1,433	mV/rpm
12	Torque constant	k_M		5,49	7,00	13,68	mNm/A
13	Current constant	k_I		0,182	0,143	0,073	A/mNm
14	Slope of n-M curve	$\Delta n/\Delta M$		1 039	1 068	1 093	rpm/mNm
15	Terminal inductance, phase-phase	L		102	170	654	µH
16	Mechanical time constant	τ_m		6	6	6	ms
17	Rotor inertia	J		0,55	0,55	0,55	gcm²
18	Angular acceleration	$\alpha_{max.}$		269	275	274	$\cdot 10^3$rad/s²
19	Thermal resistance	$R_{th\ 1}$ / $R_{th\ 2}$	1,9 / 20,9				K/W
20	Thermal time constant	τ_{w1} / τ_{w2}	2 / 430				s
21	Operating temperature range		– 30 ... +125				°C
22	Shaft bearings		ball bearings, preloaded				
23	Shaft load max.:						
	– radial at 3 000/20 000 rpm (4,5 mm from mounting flange)		5,5 / 4,5 for series 1536 U ... B ..				N
	– radial at 3 000/20 000 rpm (2,0 mm from mounting flange)		6 / 5 for series 1536 E ... B ..				N
	– axial at 3 000/20 000 rpm (push-on only)		4 / 3,5				N
	– axial at standstill (push-on only)		17				N
24	Shaft play:						
	– radial	≤	0,015				mm
	– axial	=	0				mm
25	Housing material		mounting face in aluminium, housing in plastic				
26	Weight		33				g
27	Direction of rotation		electronically reversible				

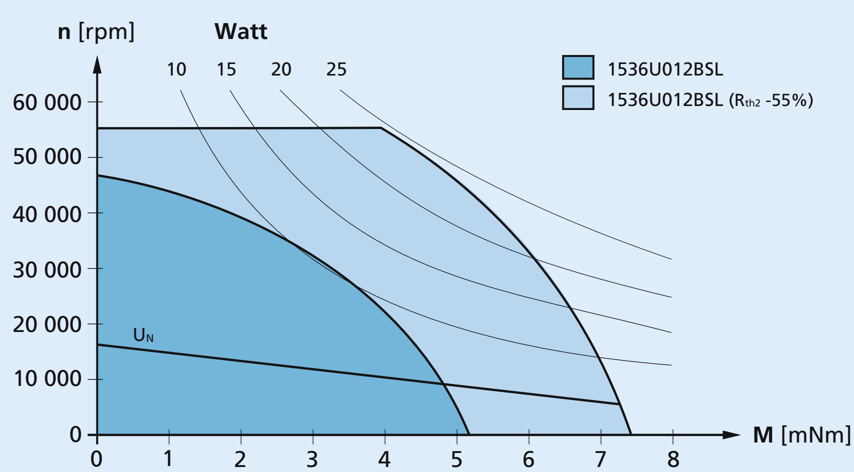
Recommended values - mathematically independent of each other							
28	Speed up to [2]	$n_{e\ max.}$		55 000	55 000	55 000	rpm
29	Torque up to [1] [2]	$M_{e\ max.}$		5,7	5,6	5,6	mNm
30	Current up to [1] [2]	$I_{e\ max.}$		1,19	0,92	0,47	A

[1] at 36 000 rpm
[2] thermal resistance $R_{th\ 2}$ by 55% reduced

Note:
The diagram indicates the recommended speed in relation to the available torque at the output shaft for a given ambient temperature of 22°C.

The diagram shows the motor in a completely insulated as well as thermally coupled condition ($R_{th\ 2}$ 55% reduced).

The nominal voltage (U_N) curve shows the operating point at nominal voltage in the insulated and thermally coupled condition. Any points of operation above the curve at nominal voltage will require a higher operating voltage. Any points below the nominal voltage curve will require less voltage.

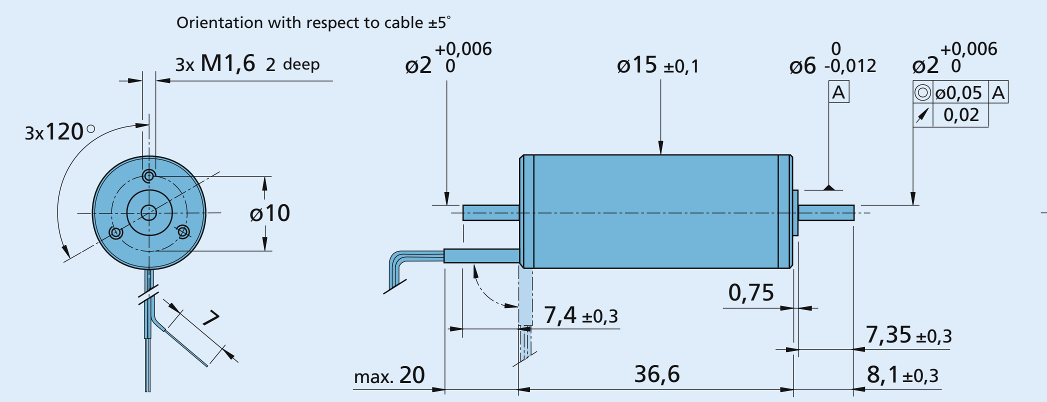


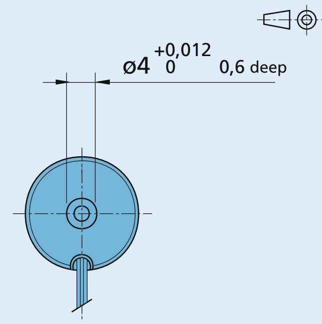
Recommended areas for continuous operation

Options
Motors with digital sensors:
1536 U ... BDS, 1536 E ... BDS

Motors with analog sensors:
1536 U ... BAS, 1536 E ... BAS

1536 U ... BSL sensorless





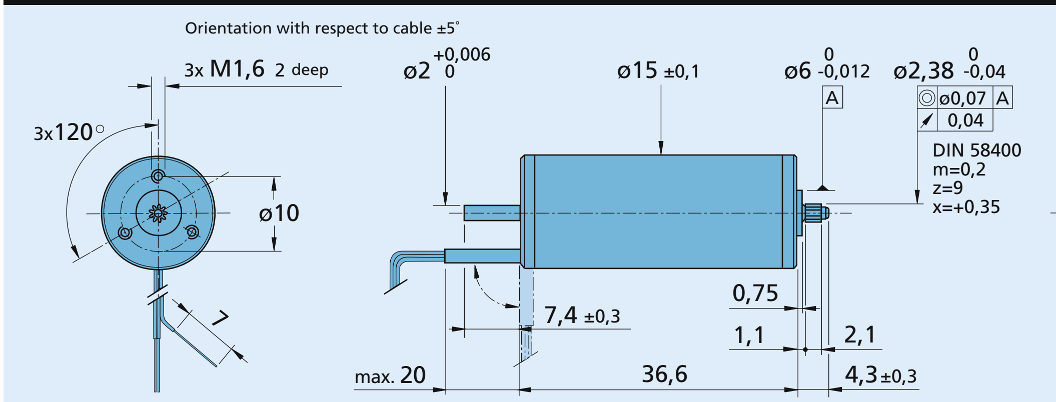
Cable
Single wires, material PTFE
Length 300 mm ± 15 mm
3 conductors, AWG 26

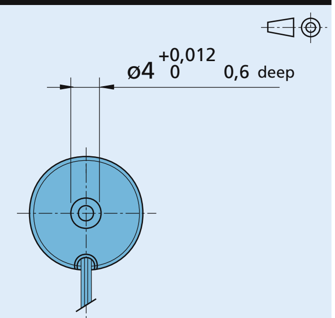
1536 U ... BSL
for combination with:
Gearheads 16/7
Drive Electronics Speed Controller

Connection

Function	Colour
Phase A	brown
Phase B	orange
Phase C	yellow

1536 E ... BSL sensorless





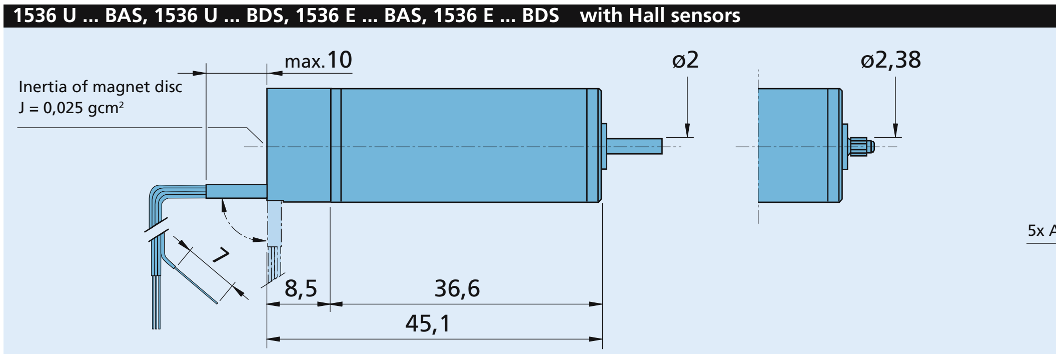
Cable
Single wires, material PTFE
Length 300 mm ± 15 mm
3 conductors, AWG 26

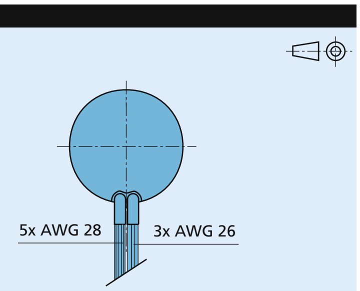
1536 E ... BSL
for combination with:
Getriebe 15/5(S), 15/8
Drive Electronics Speed Controller

Connection

Function	Colour
Phase A	brown
Phase B	orange
Phase C	yellow

1536 U ... BAS, 1536 U ... BDS, 1536 E ... BAS, 1536 E ... BDS with Hall sensors





Connection

Function	Colour
Phase A	brown
Phase B	orange
Phase C	yellow
Hall sensor A	green
Hall sensor B	blue
Hall sensor C	grey
+5V - Logical supply	red
GND - Logical	black

1536 U ... BDS
for combination with:
Drive Electronics Speed Controller

1536 U ... BAS
for combination with:
Drive Electronics Motion Controllers

1536 E ... BDS
for combination with:
Drive Electronics Speed Controller

1536 E ... BAS
for combination with:
Drive Electronics Motion Controllers

Cable
Single wires, material PTFE
Length 300 mm ± 15 mm
3 conductors, AWG 26
5 conductors, AWG 28

Brushless DC-Servomotors

6,5 mNm

sensorless, with optional Hall Sensors
SMARTSHELL® Technology

For combination with
Gearheads:
20/1, 22/2, 22/5, 22/7, 23/1, 26/1(S), 30/1(S), 38/3
Drive Electronics:
Speed Controller

Series 2232 ... BSL

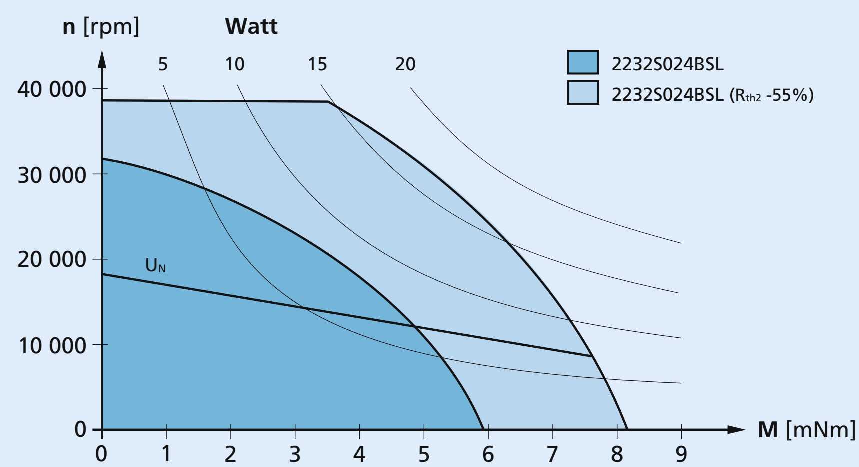
		2232 S		006 BSL	012 BSL	024 BSL	048 BSL	
1	Nominal voltage	U_N		6	12	24	48	Volt
2	Terminal resistance, phase-phase	R		1,11	4,33	14,46	41,20	Ω
3	Output power [1]	$P_{2\,max.}$		13	14	14	13	W
4	Efficiency	$\eta_{max.}$		61	61	62	62	%
5	No-load speed	n_o		15 600	15 600	17 100	20 950	rpm
6	No-load current (with shaft ø 3,0 mm)	I_o		0,294	0,146	0,085	0,060	A
7	Stall torque	M_H		18	19	21	24	mNm
8	Friction torque, static	C_o		0,389	0,389	0,389	0,389	mNm
9	Friction torque, dynamic	C_v		$4{,}05 \cdot 10^{-5}$	$4{,}05 \cdot 10^{-5}$	$4{,}05 \cdot 10^{-5}$	$4{,}05 \cdot 10^{-5}$	mNm/rpm
10	Speed constant	k_n		2 752	1 370	751	460	rpm/V
11	Back-EMF constant	k_E		0,363	0,730	1,331	2,175	mV/rpm
12	Torque constant	k_M		3,47	6,97	12,71	20,77	mNm/A
13	Current constant	k_I		0,288	0,143	0,079	0,048	A/mNm
14	Slope of n-M curve	$\Delta n/\Delta M$		880	851	855	912	rpm/mNm
15	Terminal inductance, phase-phase	L		38	153	509	1 337	µH
16	Mechanical time constant	τ_m		17	17	17	18	ms
17	Rotor inertia	J		1,92	1,92	1,92	1,92	gcm^2
18	Angular acceleration	$\alpha_{max.}$		96	99	108	124	$\cdot 10^3 rad/s^2$
19	Thermal resistance	$R_{th\,1}$ / $R_{th\,2}$	3,56 / 17,2					K/W
20	Thermal time constant	τ_{w1} / τ_{w2}	3 / 645					s
21	Operating temperature range		– 30 ... +125					°C
22	Shaft bearings		ball bearings, preloaded					
23	Shaft load max.:							
	– radial at 3 000/20 000 rpm (6 mm from mounting flange)		28 / 24 for series 2232 S ... B ..					N
	– radial at 3 000/20 000 rpm (4,5 mm from mounting flange)		29 / 25 for series 2232 U ... B ..					N
	– axial at 3 000/20 000 rpm (push-on only)		21 / 16					N
	– axial at standstill (push-on only)		45					N
24	Shaft play:							
	– radial	≤	0,015					mm
	– axial	=	0					mm
25	Housing material		mounting face in aluminium, housing in plastic					
26	Weight		60					g
27	Direction of rotation		electronically reversible					
	Recommended values - mathematically independent of each other							
28	Speed up to [2]	$n_{e\,max.}$		39 000	39 000	39 000	39 000	rpm
29	Torque up to [1] [2]	$M_{e\,max.}$		6,3	6,5	6,5	6,2	mNm
30	Current up to [1] [2]	$I_{e\,max.}$		2,17	1,10	0,60	0,36	A

[1] at 20 000 rpm
[2] thermal resistance $R_{th\,2}$ by 55% reduced

Note:
The diagram indicates the recommended speed in relation to the available torque at the output shaft for a given ambient temperature of 22°C.

The diagram shows the motor in a completely insulated as well as thermally coupled condition ($R_{th\,2}$ 55% reduced).

The nominal voltage (U_N) curve shows the operating point at nominal voltage in the insulated and thermally coupled condition. Any points of operation above the curve at nominal voltage will require a higher operating voltage. Any points below the nominal voltage curve will require less voltage.

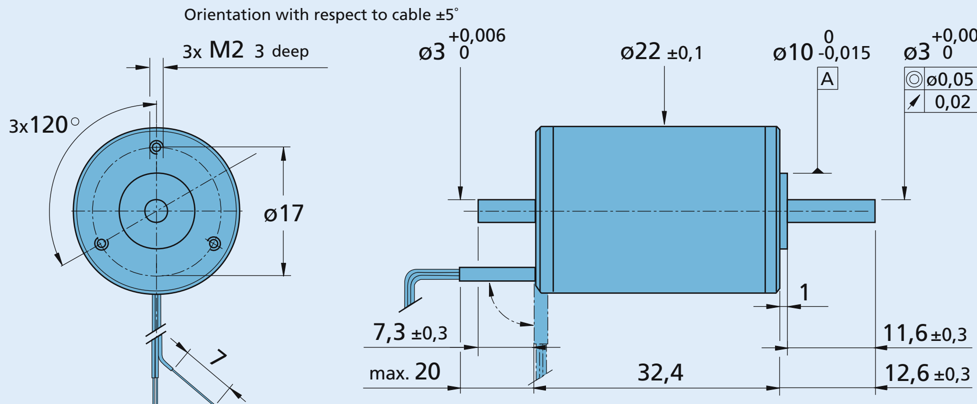


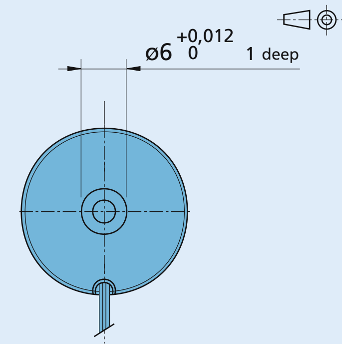
Recommended areas for continuous operation

FAULHABER

Options
Motors with digital sensors:
2232 S ... BDS, 2232 U ... BDS
Motors with analog sensors:
2232 S ... BAS, 2232 U ... BAS

2232 S ... BSL sensorless





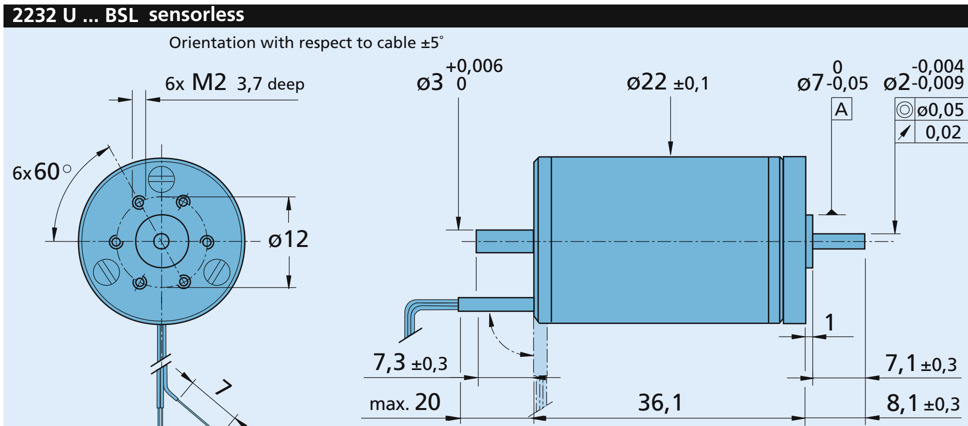
Cable
Single wires, material PTFE
Length 300 mm ± 15 mm
3 conductors, AWG 24

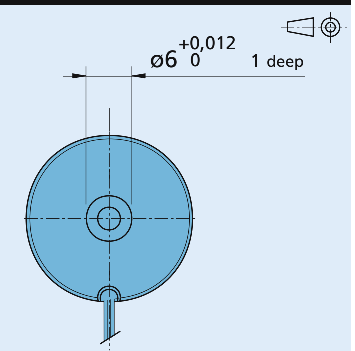
2232 S ... BSL
for combination with:
Gearheads 22/7, 23/1, 26/1(S), 30/1(S), 38/3
Drive Electronics Speed Controller

Connection

Function	Colour
Phase A	brown
Phase B	orange
Phase C	yellow

2232 U ... BSL sensorless





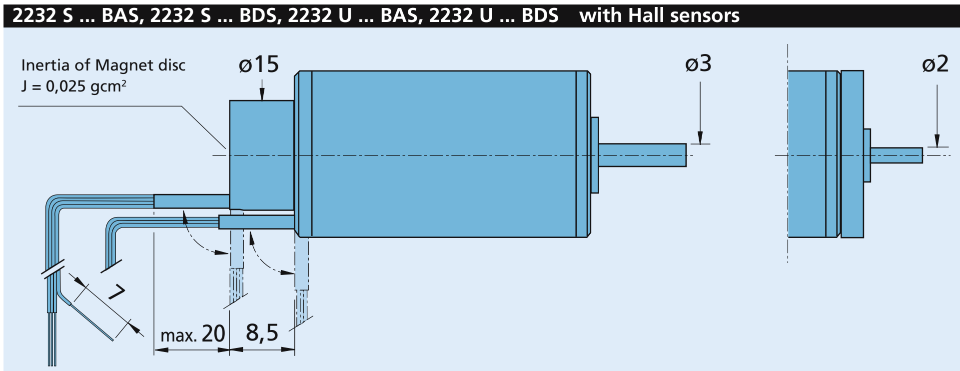
Cable
Single wires, material PTFE
Length 300 mm ± 15 mm
3 conductors, AWG 24

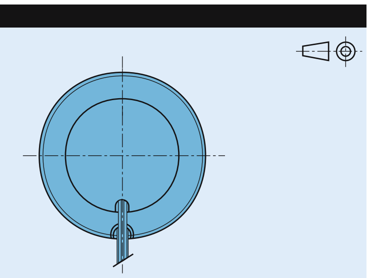
2232 U ... BSL
for combination with:
Gearheads 20/1, 22/2, 22/5
Drive Electronics Speed Controller

Connection

Function	Colour
Phase A	brown
Phase B	orange
Phase C	yellow

2232 S ... BAS, 2232 S ... BDS, 2232 U ... BAS, 2232 U ... BDS with Hall sensors





Connection

Function	Colour
Phase A	brown
Phase B	orange
Phase C	yellow
Hall sensor A	green
Hall sensor B	blue
Hall sensor C	grey
+5V - Logical supply	red
GND - Logical	black

2232 S ... BDS
for combination with:
Drive Electronics Speed Controller

2232 S ... BAS
for combination with:
Drive Electronics Motion Controllers

2232 U ... BDS
for combination with:
Drive Electronics Speed Controller

2232 U ... BAS
for combination with:
Drive Electronics Motion Controllers

Cable
Single wires, material PTFE
Length 300 mm ± 15 mm
3 conductors, AWG 24
5 conductors, AWG 26

Brushless DC-Motors

Brushless DC-Servomotors

sensorless, with optional Hall Sensors
SMARTSHELL® Technology

15,5 mNm

For combination with
Gearheads:
20/1, 22/2, 22/5, 22/7, 23/1, 26/1(S), 30/1(S), 38/3
Drive Electronics:
Speed Controller

Series 2248 ... BSL

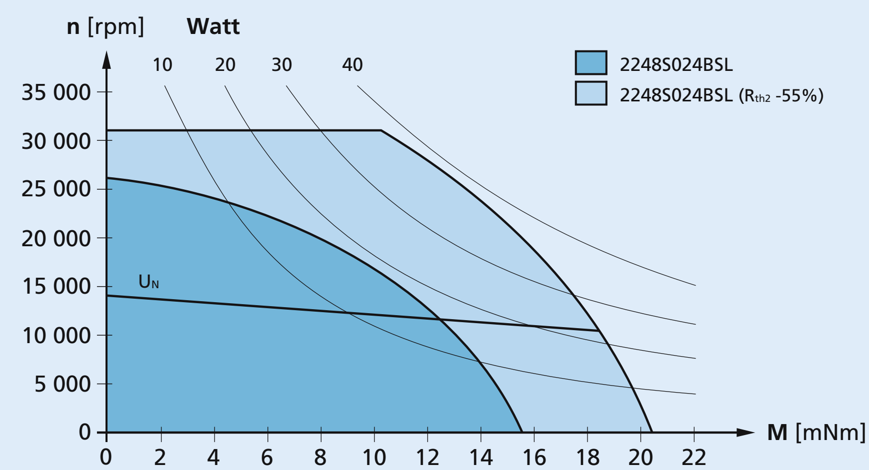
		2248 S		012 BSL	024 BSL	048 BSL	
1	Nominal voltage	U_N		12	24	48	Volt
2	Terminal resistance, phase-phase	R		1,15	4,20	17,00	Ω
3	Output power [1]	$P_{2\,max.}$		32	33	31	W
4	Efficiency	$\eta_{max.}$		74	75	74	%
5	No-load speed	n_o		13 700	14 100	14 600	rpm
6	No-load current (with shaft ø 3,0 mm)	I_o		0,217	0,114	0,060	A
7	Stall torque	M_H		85	90	86	mNm
8	Friction torque, static	C_o		0,640	0,640	0,640	mNm
9	Friction torque, dynamic	C_v		$8{,}31 \cdot 10^{-5}$	$8{,}31 \cdot 10^{-5}$	$8{,}31 \cdot 10^{-5}$	mNm/rpm
10	Speed constant	k_n		1 167	599	311	rpm/V
11	Back-EMF constant	k_E		0,857	1,668	3,215	mV/rpm
12	Torque constant	k_M		8,18	15,93	30,70	mNm/A
13	Current constant	k_I		0,122	0,063	0,033	A/mNm
14	Slope of n-M curve	$\Delta n/\Delta M$		164	158	172	rpm/mNm
15	Terminal inductance, phase-phase	L		71	276	1 048	µH
16	Mechanical time constant	τ_m		6	5	6	ms
17	Rotor inertia	J		3,36	3,36	3,36	gcm²
18	Angular acceleration	$\alpha_{max.}$		252	269	256	·10³rad/s²
19	Thermal resistance	$R_{th\,1}$ / $R_{th\,2}$	4,5 / 12,6				K/W
20	Thermal time constant	τ_{w1} / τ_{w2}	7 / 710				s
21	Operating temperature range		– 30 ... +125				°C
22	Shaft bearings		ball bearings, preloaded				
23	Shaft load max.:						
	– radial at 3 000/20 000 rpm (6 mm from mounting flange)		31 / 23 for series 2248 S ... B ..				N
	– radial at 3 000/20 000 rpm (4,5 mm from mounting flange)		32 / 24 for series 2248 U ... B ..				N
	– axial at 3 000/20 000 rpm (push-on only)		18 / 13				N
	– axial at standstill (push-on only)		45				N
24	Shaft play:						
	– radial	≤	0,015				mm
	– axial	=	0				mm
25	Housing material		mounting face in aluminium, housing in plastic				
26	Weight		95				g
27	Direction of rotation		electronically reversible				
	Recommended values - mathematically independent of each other						
28	Speed up to [2]	$n_{e\,max.}$		32 000	32 000	32 000	rpm
29	Torque up to [1) 2)]	$M_{e\,max.}$		15,2	15,5	14,8	mNm
30	Current up to [1) 2)]	$I_{e\,max.}$		2,14	1,12	0,56	A

[1] at 20 000 rpm
[2] thermal resistance $R_{th\,2}$ by 55% reduced

Note:
The diagram indicates the recommended speed in relation to the available torque at the output shaft for a given ambient temperature of 22°C.

The diagram shows the motor in a completely insulated as well as thermally coupled condition ($R_{th\,2}$ 55% reduced).

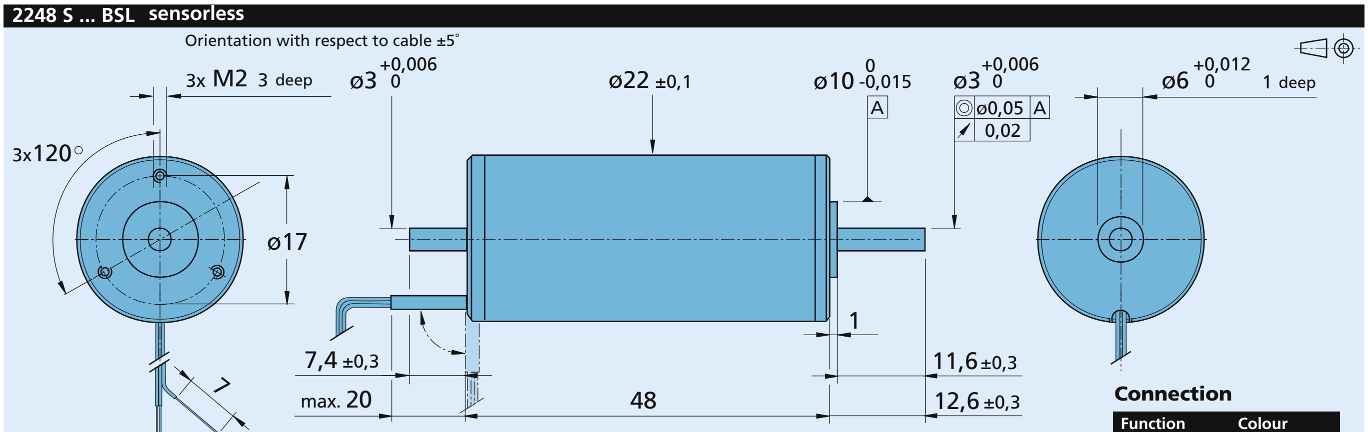
The nominal voltage (U_N) curve shows the operating point at nominal voltage in the insulated and thermally coupled condition. Any points of operation above the curve at nominal voltage will require a higher operating voltage. Any points below the nominal voltage curve will require less voltage.



Recommended areas for continuous operation

Options
Motors with digital sensors:
2248 S ... BDS, 2248 U ... BDS
Motors with analog sensors:
2248 S ... BAS, 2248 U ... BAS

2248 S ... BSL sensorless



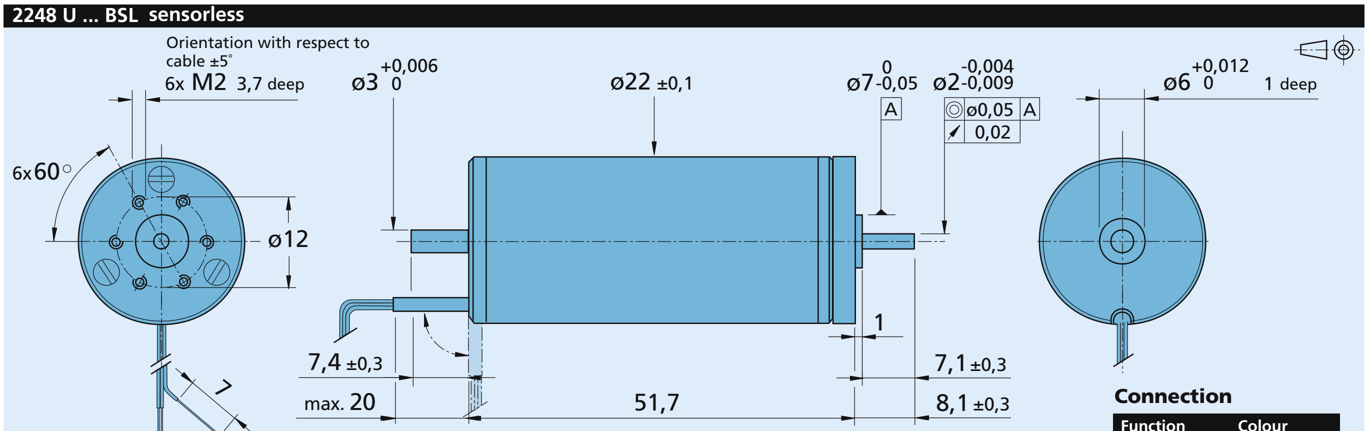
Cable
Single wires, material PTFE
Length 300 mm ± 15 mm
3 conductors, AWG 24

2248 S ... BSL
for combination with:
Gearheads 22/7, 23/1, 26/1(S), 30/1(S), 38/3
Drive Electronics Speed Controller

Connection

Function	Colour
Phase A	brown
Phase B	orange
Phase C	yellow

2248 U ... BSL sensorless



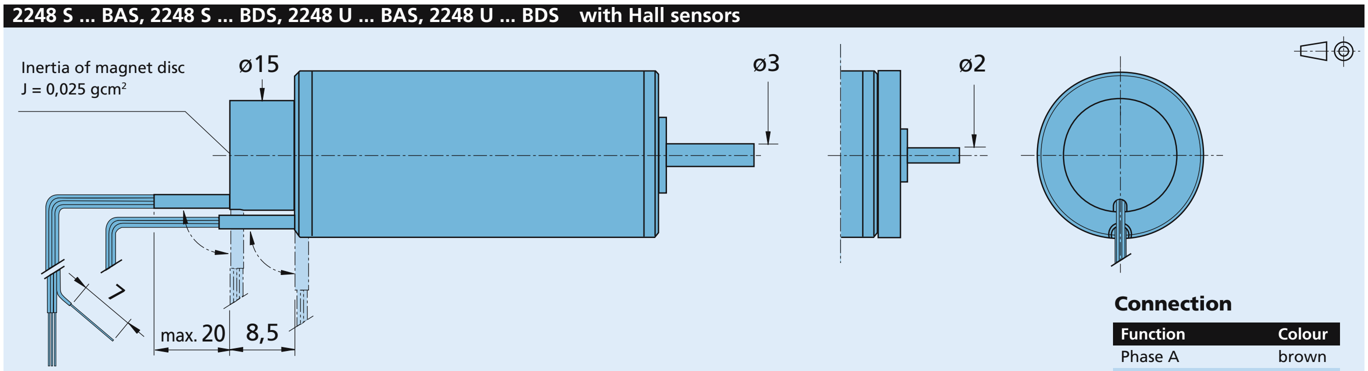
Cable
Single wires, material PTFE
Length 300 mm ± 15 mm
3 conductors, AWG 24

2248 U ... BSL
for combination with:
Gearheads 20/1, 22/2, 22/5
Drive Electronics Speed Controller

Connection

Function	Colour
Phase A	brown
Phase B	orange
Phase C	yellow

2248 S ... BAS, 2248 S ... BDS, 2248 U ... BAS, 2248 U ... BDS with Hall sensors



Cable
Single wires, material PTFE
Length 300 mm ± 15 mm
3 conductors, AWG 24
5 conductors, AWG 26

2248 S ... BDS
for combination with:
Drive Electronics Speed Controller

2248 S ... BAS
for combination with:
Drive Electronics Motion Controllers

2248 U ... BDS
for combination with:
Drive Electronics Speed Controller

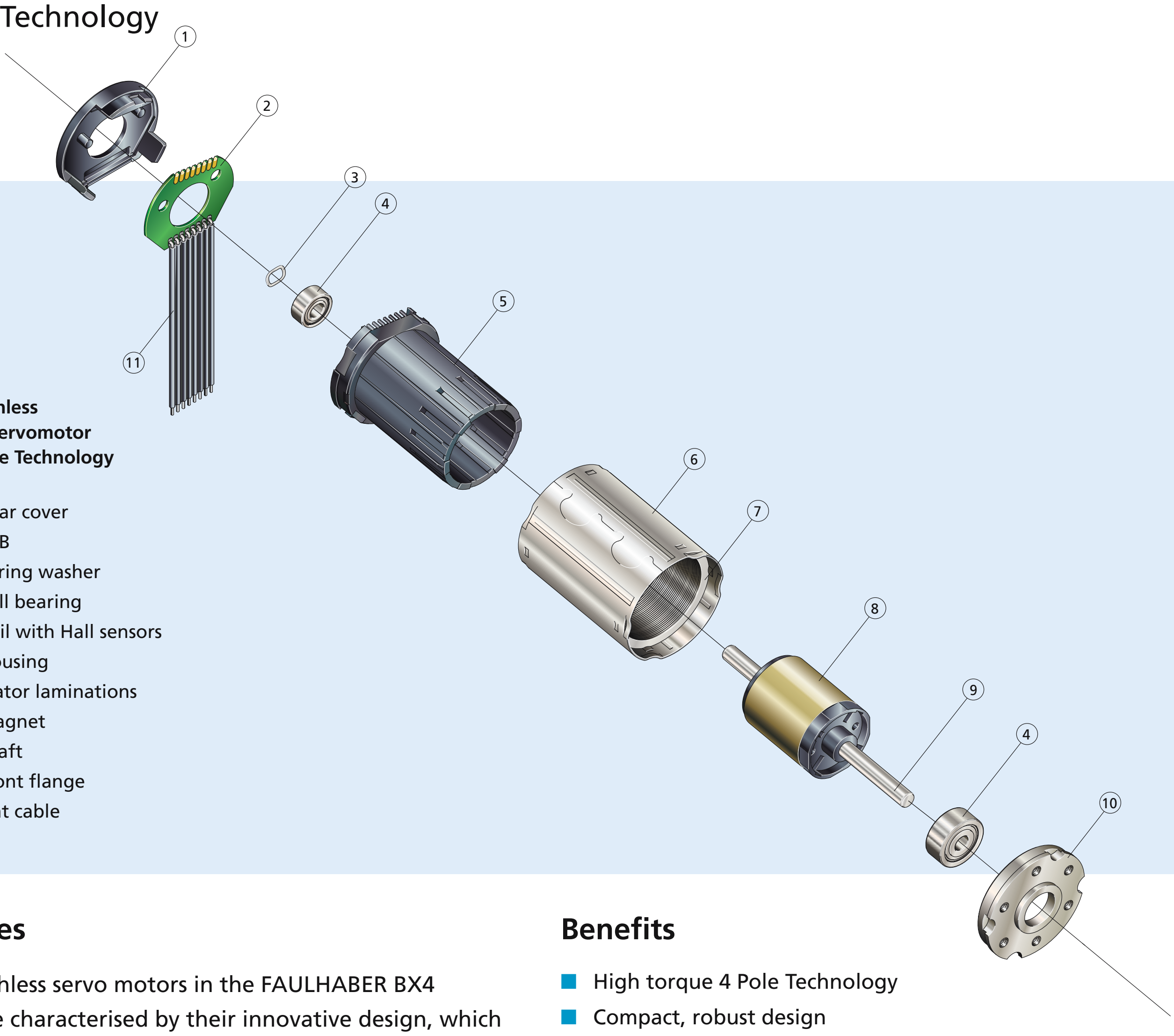
2248 U ... BAS
for combination with:
Drive Electronics Motion Controllers

Connection

Function	Colour
Phase A	brown
Phase B	orange
Phase C	yellow
Hall sensor A	green
Hall sensor B	blue
Hall sensor C	grey
+5V - Logical supply	red
GND - Logical	black

Brushless DC-Servomotors

4 Pole Technology



Brushless DC-Servomotor 4 Pole Technology

① Rear cover
② PCB
③ Spring washer
④ Ball bearing
⑤ Coil with Hall sensors
⑥ Housing
⑦ Stator laminations
⑧ Magnet
⑨ Shaft
⑩ Front flange
⑪ Flat cable

Features

The brushless servo motors in the FAULHABER BX4 series are characterised by their innovative design, which comprises just a few individual components.

Despite their compact dimensions, the 4 pole magnet technology gives these drives a high continuous torque with smooth running characteristics and a particularly low noise level. The modular rotor system makes it possible to tune the performance of the motor to the higher torque or higher speed needs of the application.

Thanks to the electronic commutation of the drives, the lifetime is much longer in comparison with mechanically commutated motors. Alongside the basic version in which the commutation is provided by an external control, the highly flexible BX4 series also includes advanced specifications with integrated speed controller or integrated encoder.

The motors come standard with digital Hall sensors.

Benefits

- High torque 4 Pole Technology
- Compact, robust design
- Modular concept
- Available with integrated encoders and speed controllers
- High reliability and operational lifetime
- No sparking
- No cogging
- Dynamically balanced rotor
- Simple design

Product Code

2232 S 012 BX4

22	Motor diameter [mm]
32	Motor length [mm]
S	Shaft type
012	Nominal voltage [V]
BX4	Type of commutation (brushless), 4 Pole Technology

Brushless DC-Servomotors

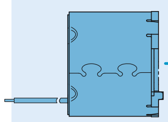
4 Pole Technology
overview of combinations

Series 22 ... BX4

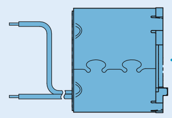
Controller

SC
Speed Controller
Ø 22 mm, integrated
400 – 50.000 rpm
Page 192 – 203

CSD/CCD
Motion Controller
Ø 22 mm, integrated
RS232 / CAN
Page 226 – 229



Encoders

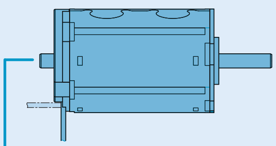


IE3(L)
Magnetic Encoder
3 Channel, Ø 22 mm
1024 Lines
Page 136 – 159

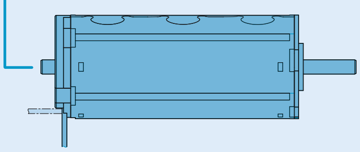
AES
Absolute Encoder
Ø 22 mm, 4096 Lines
Page 136 – 159

Motors

Series 2232 … BX4



Series 2250 … BX4



Gearheads

Series 22F, 22/7
Planetary Gearheads
Ø 22 mm
0,7 – 1,0 Nm
Page 316, 319

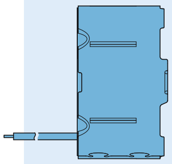
Series 26A
Planetary Gearheads
Ø 26 mm
1,0 Nm
Page 321

Series 32 ... BX4

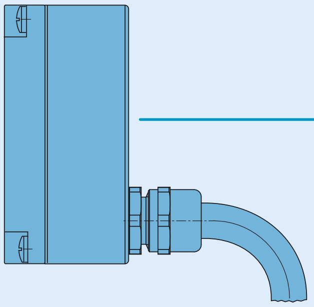
Controller

SC
Speed Controller
Ø 32 mm, integrated
400 – 50.000 rpm
Page 204, 210

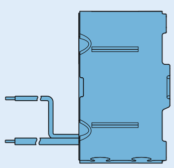
SCDC
Speed Controller
Ø 32 mm, 2-wire
400 – 50.000 rpm
Page 207, 213



CS/CC
Motion Controller
integrated
RS232 / CAN
Page 230 – 233



Encoders

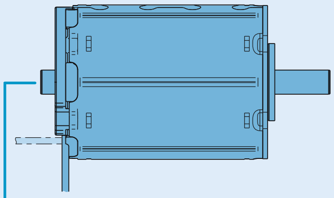


IE3(L)
Magnetic Encoder
3 Channel, Ø 32 mm
1024 Lines
Page 160 – 170

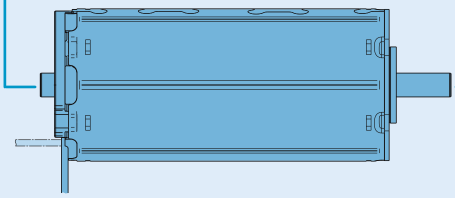
AES
Absolute Encoder
Ø 32 mm
4096 Lines
Page 160 – 170

Motors

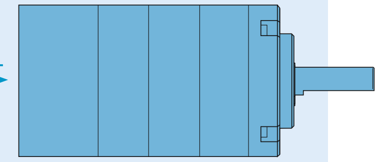
Series 3242 … BX4



Series 3268 … BX4



Gearheads



Series 30/1(S)
Planetary Gearheads
Ø 30 mm
4,5 Nm
Page 324 – 325

Series 32A, 32ALN, 32/3(S)
Planetary Gearheads
Ø 32 mm
4,5 - 7 Nm
Page 326 – 329

Series 38/1(S), 38/2(S)
Planetary Gearheads
Ø 38 mm
10 Nm
Page 331 – 334

Brushless DC-Servomotors

4 Pole Technology

10 mNm

For combination with
Gearheads:
22F, 22/7, 26A
Encoders:
2232...BX4S + Encoder
Drive Electronics:
Speed Controller

Series 2232 ... BX4 S

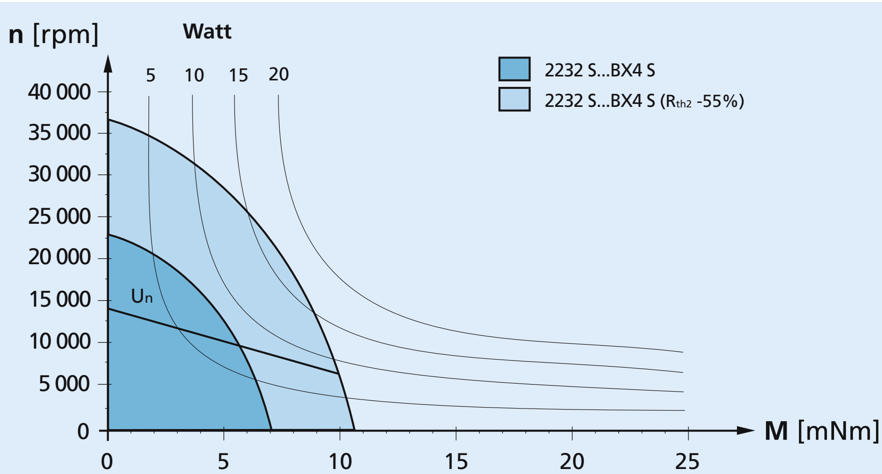
	2232 S			012 BX4 S	024 BX4 S	
1	Nominal voltage	U_N		12	24	Volt
2	Terminal resistance, phase-phase	R		3,5	12,4	Ω
3	Output power [1]	$P_{2\ max.}$		3,8	3,9	W
4	Efficiency	$\eta_{max.}$		60,9	61,7	%
5	No-load speed	n_o		13 200	14 000	rpm
6	No-load current (with shaft ø 3,0 mm)	I_o		0,163	0,088	A
7	Stall torque	M_H		27,3	29,4	mNm
8	Friction torque, static	C_o		0,6	0,6	mNm
9	Friction torque, dynamic	C_v		$5,5 \cdot 10^{-5}$	$5,5 \cdot 10^{-5}$	mNm/rpm
10	Speed constant	k_n		1 173	616	rpm/V
11	Back-EMF constant	k_E		0,852	1,623	mV/rpm
12	Torque constant	k_M		8,14	15,50	mNm/A
13	Current constant	k_I		0,123	0,065	A/mNm
14	Slope of n-M curve	$\Delta n/\Delta M$		504	493	rpm/mNm
15	Terminal inductance, phase-phase	L		130	470	µH
16	Mechanical time constant	τ_m		22	22	ms
17	Rotor inertia	J		4,2	4,2	gcm^2
18	Angular acceleration	$\alpha_{max.}$		65	70	$\cdot 10^3 rad/s^2$
19	Thermal resistance	$R_{th\ 1} / R_{th\ 2}$	2 / 17			K/W
20	Thermal time constant	τ_{w1} / τ_{w2}	4,1 / 360			s
21	Operating temperature range		– 40 ... + 100			°C
22	Shaft bearings		ball bearings, preloaded			
23	Shaft load max.:					
	– radial at 3 000 rpm (4 mm from mounting flange)		20			N
	– axial at 3 000 rpm		2			N
	– axial at standstill		20			N
24	Shaft play:					
	– radial	≤	0,015			mm
	– axial	=	0			mm
25	Housing material		stainless steel			
26	Weight		70			g
27	Direction of rotation		electronically reversible			
28	Number of pole pairs		2			
	Recommended values - mathematically independent of each other					
29	Speed up to	$n_{e\ max.}$		34 000	34 000	rpm
30	Torque up to [1] [2]	$M_{e\ max.}$		6 / 10	6 / 10	mNm
31	Current up to [1] [2]	$I_{e\ max.}$		0,94 / 1,42	0,50 / 0,75	A

[1] at 5 000 rpm
[2] thermal resistance $R_{th\ 2}$ not reduced / thermal resistance $R_{th\ 2}$ by 55% reduced

Note:
The diagram indicates the recommended speed in relation to the available torque at the output shaft for a given ambient temperature of 22°C.

The diagram shows the motor in a completely insulated as well as thermally coupled condition ($R_{th\ 2}$ 55% reduced).

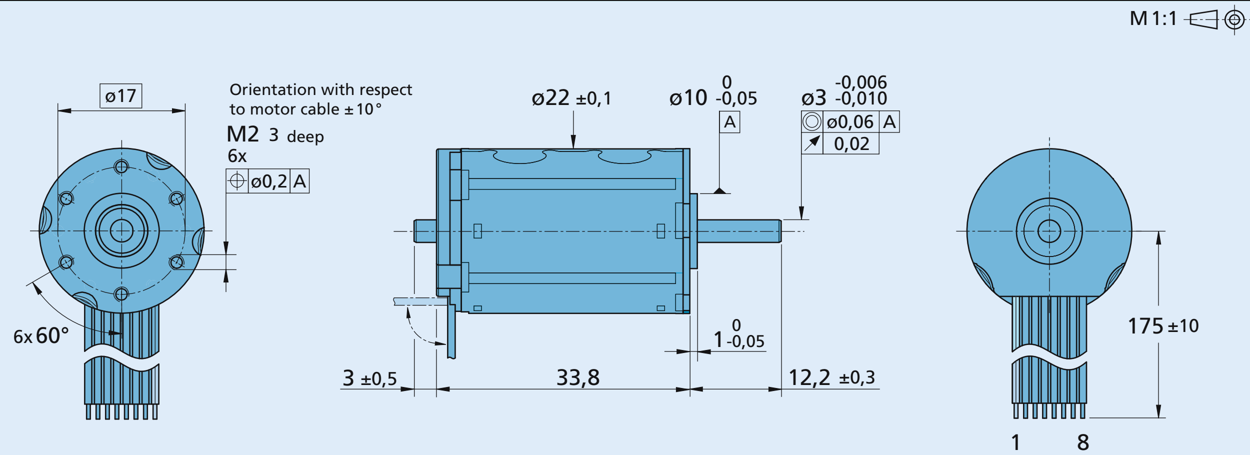
The nominal voltage (U_N) curve shows the operating point at nominal voltage in the insulated and thermally coupled condition. Any points of operation above the curve at nominal voltage will require a higher operating voltage. Any points below the nominal voltage curve will require less voltage.



Recommended areas for continuous operation

For notes on technical data and lifetime performance refer to „Technical Information".
Edition 2012 – 2013

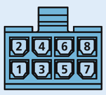
Dimensional drawing



2232 S ... BX4 S

Options

- Connector variant (Option no. 3830)
  Motor:
  AWG 26 / PVC ribbon cable
  with connector Micro-Fit

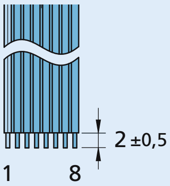


- Analog Hall sensors (Option no. 3692)

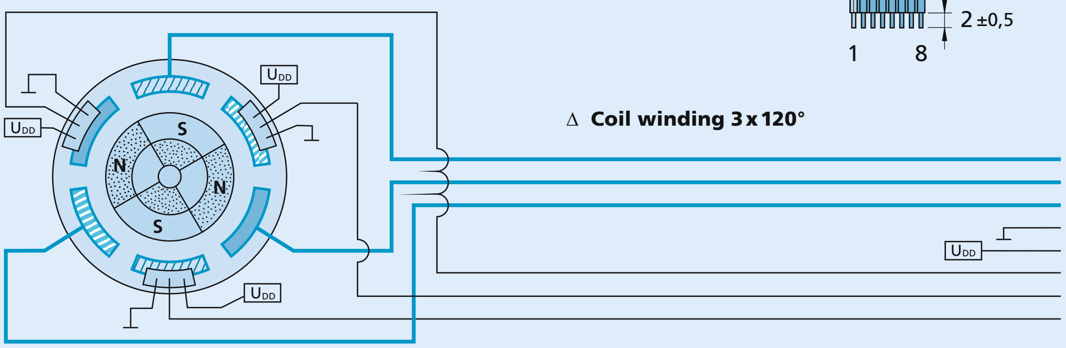
Full product description

- Examples:
  2232S012BX4S

Cable and connection information



Cable
Jacket Material: PVC
8 conductors, AWG 26
grid 1,27 mm
wires tinned



Connection

No.	Function
1	Phase C
2	Phase B
3	Phase A
4	GND
5	U_{DD} (2,2 ... 18V DC)
6	Hall sensor C
7	Hall sensor B
8	Hall sensor A

Brushless DC-Servomotors

4 Pole Technology

19 mNm

For combination with
Gearheads:
22F, 22/7, 26A
Encoders:
2232...BX4 + Encoder
Drive Electronics:
Speed Controller

Series 2232 ... BX4

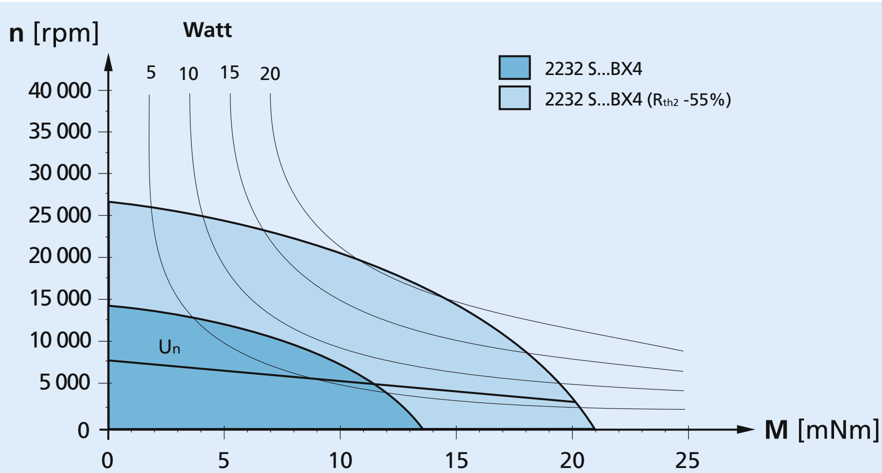
	2232 S			012 BX4	024 BX4	
1	Nominal voltage	U_N		12	24	Volt
2	Terminal resistance, phase-phase	R		3,5	12,4	Ω
3	Output power [1]	$P_{2\ max.}$		7,6	7,7	W
4	Efficiency	$\eta_{\ max.}$		66,9	67,6	%
5	No-load speed	n_o		6 600	7 000	rpm
6	No-load current (with shaft ø 3,0 mm)	I_o		0,112	0,061	A
7	Stall torque	M_H		55,7	59,9	mNm
8	Friction torque, static	C_o		0,85	0,85	mNm
9	Friction torque, dynamic	C_v		$1,5 \cdot 10^{-4}$	$1,5 \cdot 10^{-4}$	mNm/rpm
10	Speed constant	k_n		579	304	rpm/V
11	Back-EMF constant	k_E		1,728	3,288	mV/rpm
12	Torque constant	k_M		16,50	31,40	mNm/A
13	Current constant	k_I		0,061	0,032	A/mNm
14	Slope of n-M curve	$\Delta n/\Delta M$		123	120	rpm/mNm
15	Terminal inductance, phase-phase	L		120	440	µH
16	Mechanical time constant	τ_m		6,7	6,5	ms
17	Rotor inertia	J		5,2	5,2	gcm^2
18	Angular acceleration	$\alpha_{\ max.}$		107	115	$\cdot 10^3 rad/s^2$
19	Thermal resistance	$R_{th\ 1}$ / $R_{th\ 2}$	2 / 17			K/W
20	Thermal time constant	τ_{w1} / τ_{w2}	4,1 / 370			s
21	Operating temperature range		– 40 ... + 100			°C
22	Shaft bearings		ball bearings, preloaded			
23	Shaft load max.:					
	– radial at 3 000 rpm (4 mm from mounting flange)		20			N
	– axial at 3 000 rpm		2			N
	– axial at standstill		20			N
24	Shaft play:					
	– radial	≤	0,015			mm
	– axial	=	0			mm
25	Housing material		stainless steel			
26	Weight		70			g
27	Direction of rotation		electronically reversible			
28	Number of pole pairs		2			
	Recommended values - mathematically independent of each other					
29	Speed up to	$n_{e\ max.}$		22 000	22 000	rpm
30	Torque up to [1] [2]	$M_{e\ max.}$		12 / 19	12 / 19	mNm
31	Current up to [1] [2]	$I_{e\ max.}$		0,90 / 1,40	0,48 / 0,74	A

[1] at 5 000 rpm
[2] thermal resistance $R_{th\ 2}$ not reduced / thermal resistance $R_{th\ 2}$ by 55% reduced

Note:
The diagram indicates the recommended speed in relation to the available torque at the output shaft for a given ambient temperature of 22°C.

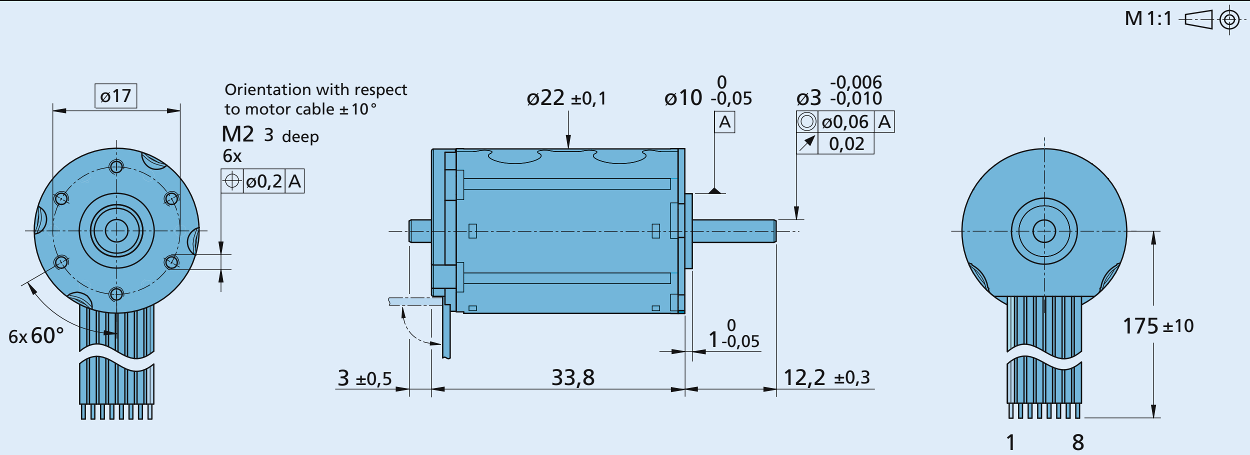
The diagram shows the motor in a completely insulated as well as thermally coupled condition ($R_{th\ 2}$ 55% reduced).

The nominal voltage (U_N) curve shows the operating point at nominal voltage in the insulated and thermally coupled condition. Any points of operation above the curve at nominal voltage will require a higher operating voltage. Any points below the nominal voltage curve will require less voltage.



Recommended areas for continuous operation

Dimensional drawing

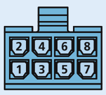


2232 S ... BX4

Options

- Connector variant (Option no. 3830)

  Motor:
  AWG 26 / PVC ribbon cable
  with connector Micro-Fit



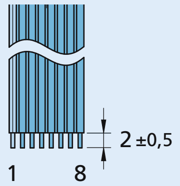
- Analog Hall sensors (Option no. 3692)

Full product description

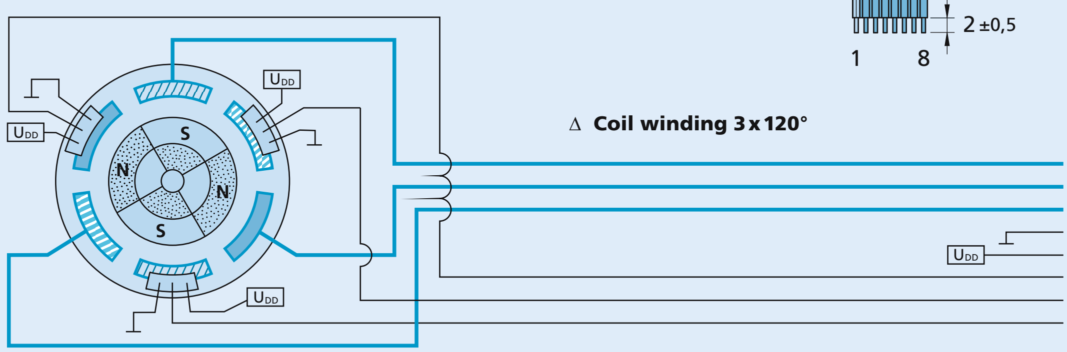
- Examples:

  2232S024BX4

Cable and connection information



Cable
Jacket Material: PVC
8 conductors, AWG 26
grid 1,27 mm
wires tinned



Connection

No.	Function
1	Phase C
2	Phase B
3	Phase A
4	GND
5	U_{DD} (2,2 ... 18V DC)
6	Hall sensor C
7	Hall sensor B
8	Hall sensor A

Brushless DC-Servomotors

4 Pole Technology

22 mNm

For combination with
Gearheads:
22F, 22/7, 26A
Encoders:
2250...BX4S + Encoder
Drive Electronics:
Speed Controller

Series 2250 ... BX4 S

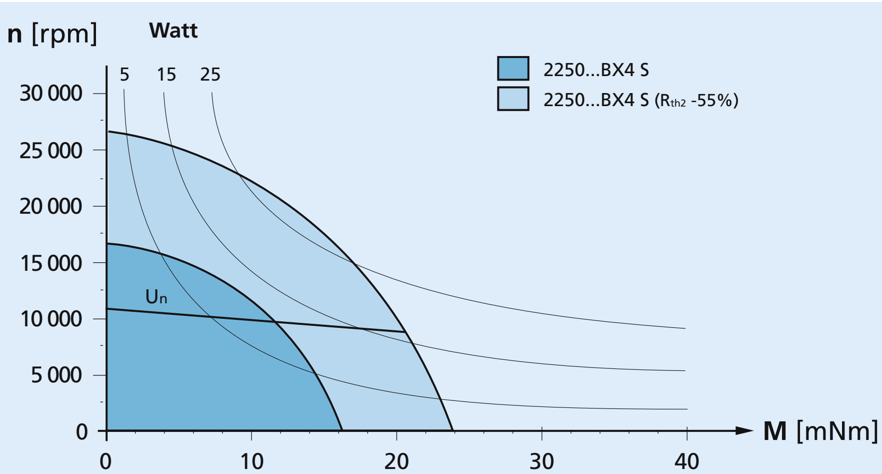
		2250 S		024 BX4 S	
1	Nominal voltage	U_N		24	Volt
2	Terminal resistance, phase-phase	R		5,9	Ω
3	Output power [1]	$P_{2\ max.}$		8,8	W
4	Efficiency	$\eta_{max.}$		70,4	%
5	No-load speed	n_o		10 500	rpm
6	No-load current (with shaft ø 3,0 mm)	I_o		0,105	A
7	Stall torque	M_H		84,7	mNm
8	Friction torque, static	C_o		0,75	mNm
9	Friction torque, dynamic	C_v		$1,4 \cdot 10^{-4}$	mNm/rpm
10	Speed constant	k_n		451	rpm/V
11	Back-EMF constant	k_E		2,218	mV/rpm
12	Torque constant	k_M		21,1	mNm/A
13	Current constant	k_I		0,047	A/mNm
14	Slope of n-M curve	$\Delta n/\Delta M$		125,6	rpm/mNm
15	Terminal inductance, phase-phase	L		250	µH
16	Mechanical time constant	τ_m		6,97	ms
17	Rotor inertia	J		5,3	gcm^2
18	Angular acceleration	$\alpha_{max.}$		160	$\cdot 10^3 rad/s^2$
19	Thermal resistance	$R_{th\ 1}$ / $R_{th\ 2}$	1,2 / 14		K/W
20	Thermal time constant	τ_{w1} / τ_{w2}	4,2 / 443		s
21	Operating temperature range		– 40 ... + 100		°C
22	Shaft bearings		ball bearings, preloaded		
23	Shaft load max.:				
	– radial at 3 000 rpm (4 mm from mounting flange)		20		N
	– axial at 3 000 rpm		2		N
	– axial at standstill		20		N
24	Shaft play:				
	– radial	≤	0,015		mm
	– axial	=	0		mm
25	Housing material		stainless steel		
26	Weight		90		g
27	Direction of rotation		electronically reversible		
28	Number of pole pairs		2		
	Recommended values - mathematically independent of each other				
29	Speed up to	$n_{e\ max.}$		25 000	rpm
30	Torque up to [1] [2]	$M_{e\ max.}$		14 / 22	mNm
31	Current up to [1] [2]	$I_{e\ max.}$		0,79 / 1,20	A

[1] at 5 000 rpm
[2] thermal resistance $R_{th\ 2}$ not reduced / thermal resistance $R_{th\ 2}$ by 55% reduced

Note:
The diagram indicates the recommended speed in relation to the available torque at the output shaft for a given ambient temperature of 22°C.

The diagram shows the motor in a completely insulated as well as thermally coupled condition ($R_{th\ 2}$ 55% reduced).

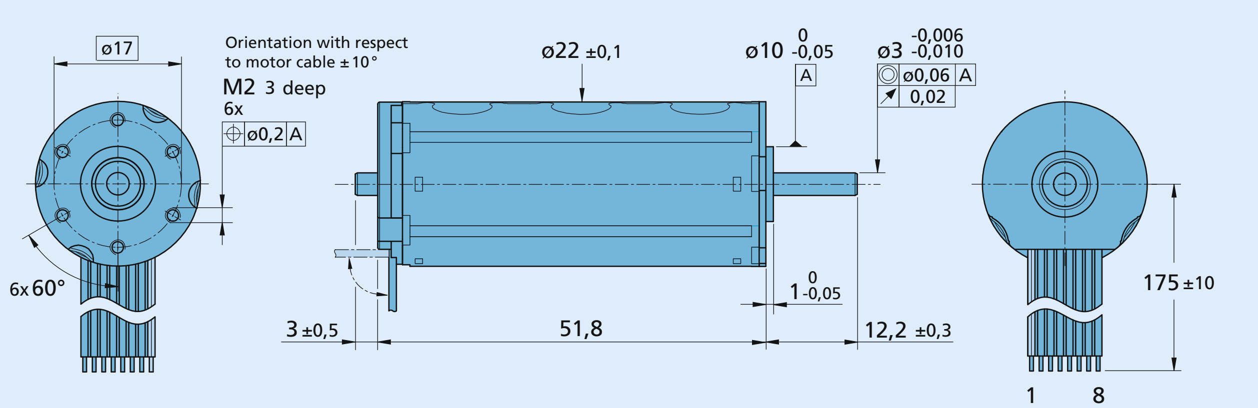
The nominal voltage (U_N) curve shows the operating point at nominal voltage in the insulated and thermally coupled condition. Any points of operation above the curve at nominal voltage will require a higher operating voltage. Any points below the nominal voltage curve will require less voltage.



Recommended areas for continuous operation

Dimensional drawing

M 1:1

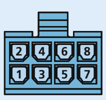


2250 S ... BX4 S

Options

- Connector variant (Option no. 3830)

Motor:
AWG 26 / PVC ribbon cable
with connector Micro-Fit

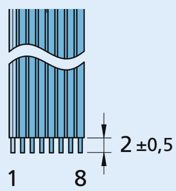


Full product description

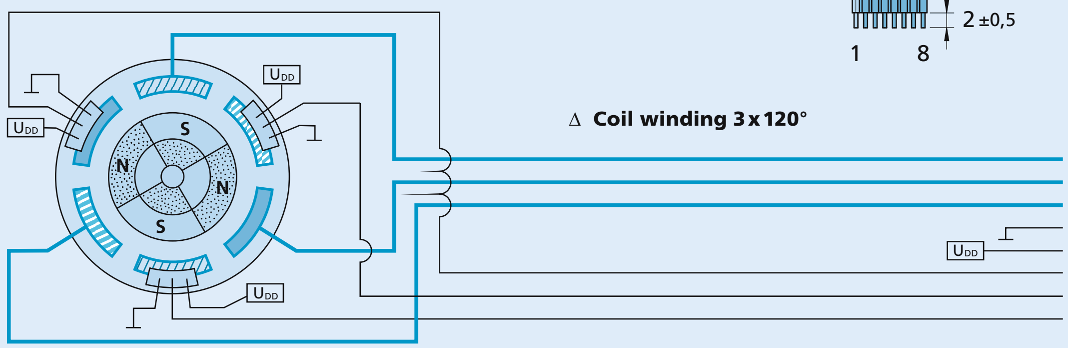
- Examples:

2250S024 BX4S

Cable and connection information



Cable
Jacket Material: PVC
8 conductors, AWG 26
grid 1,27 mm
wires tinned



Δ Coil winding 3 x 120°

Connection

No.	Function
1	Phase C
2	Phase B
3	Phase A
4	GND
5	U_{DD} (2,2 ... 18V DC)
6	Hall sensor C
7	Hall sensor B
8	Hall sensor A

Brushless DC-Servomotors

4 Pole Technology

37 mNm

For combination with
Gearheads:
22F, 22/7, 26A
Encoders:
2250...BX4 + Encoder
Drive Electronics:
Speed Controller

Series 2250 ... BX4

		2250 S		024 BX4	
1	Nominal voltage	U_N		24	Volt
2	Terminal resistance, phase-phase	R		5,9	Ω
3	Output power [1]	$P_{2\ max.}$		14,6	W
4	Efficiency	$\eta_{\ max.}$		75,0	%
5	No-load speed	n_o		6 000	rpm
6	No-load current (with shaft ø 3,0 mm)	I_o		0,072	A
7	Stall torque	M_H		149,0	mNm
8	Friction torque, static	C_o		1,20	mNm
9	Friction torque, dynamic	C_v		$2{,}4 \cdot 10^{-4}$	mNm/rpm
10	Speed constant	k_n		259	rpm/V
11	Back-EMF constant	k_E		3,860	mV/rpm
12	Torque constant	k_M		36,9	mNm/A
13	Current constant	k_I		0,027	A/mNm
14	Slope of n-M curve	$\Delta n/\Delta M$		41,4	rpm/mNm
15	Terminal inductance, phase-phase	L		240	µH
16	Mechanical time constant	τ_m		4,30	ms
17	Rotor inertia	J		10,0	gcm^2
18	Angular acceleration	$\alpha_{\ max.}$		149	$\cdot 10^3 rad/s^2$
19	Thermal resistance	$R_{th\ 1}$ / $R_{th\ 2}$	1,2 / 14		K/W
20	Thermal time constant	τ_{w1} / τ_{w2}	4,2 / 566		s
21	Operating temperature range		– 40 ... + 100		°C
22	Shaft bearings		ball bearings, preloaded		
23	Shaft load max.:				
	– radial at 3 000 rpm (4 mm from mounting flange)		20		N
	– axial at 3 000 rpm		2		N
	– axial at standstill		20		N
24	Shaft play:				
	– radial	≤	0,015		mm
	– axial	=	0		mm
25	Housing material		stainless steel		
26	Weight		106		g
27	Direction of rotation		electronically reversible		
28	Number of pole pairs		2		

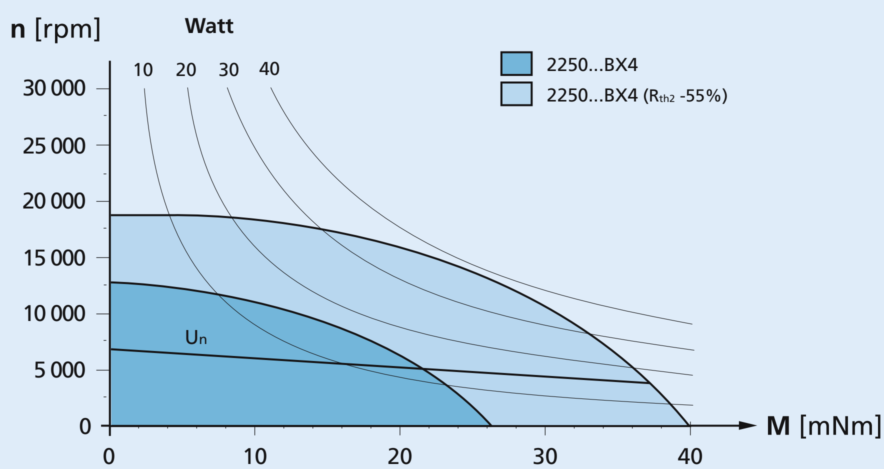
	Recommended values - mathematically independent of each other				
29	Speed up to	$n_{e\ max.}$		18 000	rpm
30	Torque up to [1,2]	$M_{e\ max.}$		23 / 37	mNm
31	Current up to [1,2]	$I_{e\ max.}$		0,74 / 1,18	A

[1] at 5 000 rpm
[2] thermal resistance $R_{th\ 2}$ not reduced / thermal resistance $R_{th\ 2}$ by 55% reduced

Note:
The diagram indicates the recommended speed in relation to the available torque at the output shaft for a given ambient temperature of 22°C.

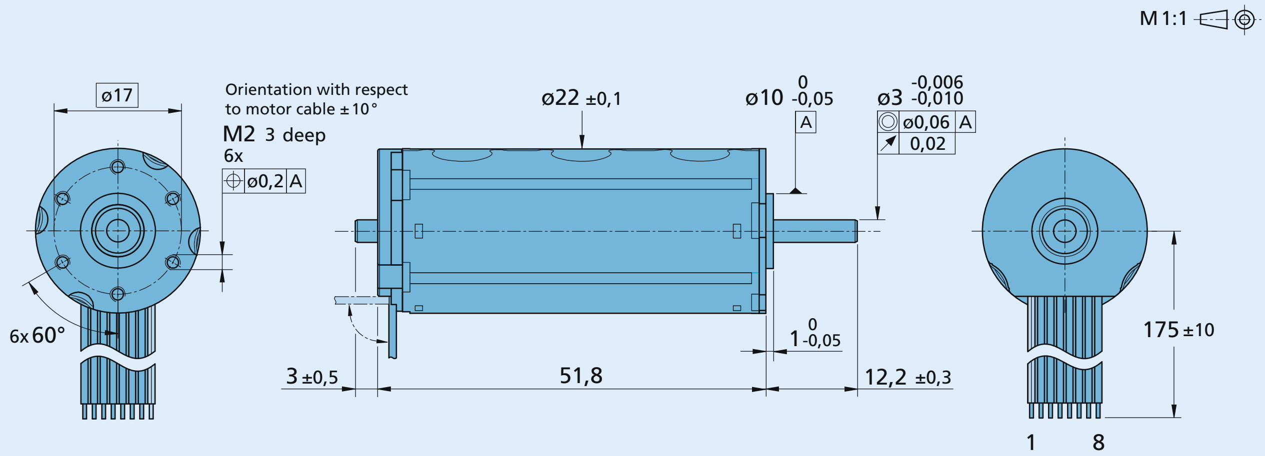
The diagram shows the motor in a completely insulated as well as thermally coupled condition ($R_{th\ 2}$ 55% reduced).

The nominal voltage (U_N) curve shows the operating point at nominal voltage in the insulated and thermally coupled condition. Any points of operation above the curve at nominal voltage will require a higher operating voltage. Any points below the nominal voltage curve will require less voltage.



Recommended areas for continuous operation

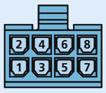
Dimensional drawing



2250 S ... BX4

Options

- Connector variant (Option no. 3830)
  Motor:
  AWG 26 / PVC ribbon cable
  with connector Micro-Fit

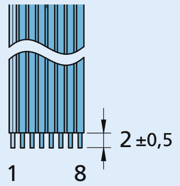


- Analog Hall sensors (Option no. 3692)

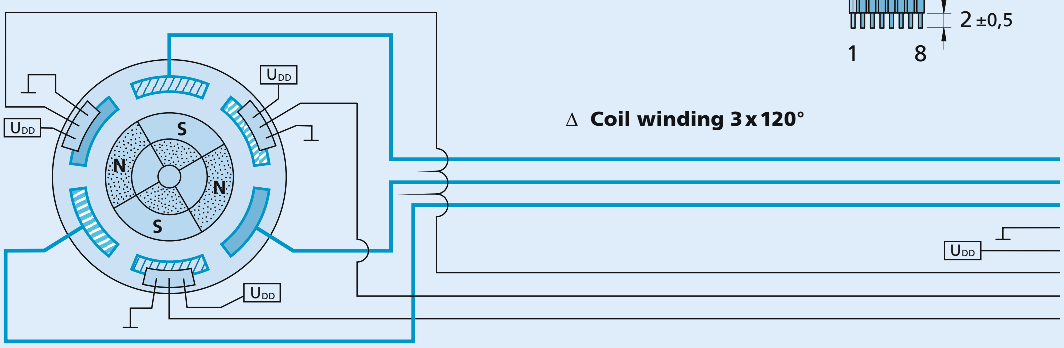
Full product description

- Examples:
  2250S024 BX4

Cable and connection information



Cable
Jacket Material: PVC
8 conductors, AWG 26
grid 1,27 mm
wires tinned



Connection

No.	Function
1	Phase C
2	Phase B
3	Phase A
4	GND
5	U_{DD} (2,2 ... 18V DC)
6	Hall sensor C
7	Hall sensor B
8	Hall sensor A

Brushless DC-Servomotors

56 mNm

4 Pole Technology

For combination with
Gearheads:
30/1(S), 32A, 32ALN, 32/3(S), 38/1(S), 38/2(S)
Encoders:
3242...BX4 + Encoder
Drive Electronics:
Speed Controller

Series 3242 ... BX4

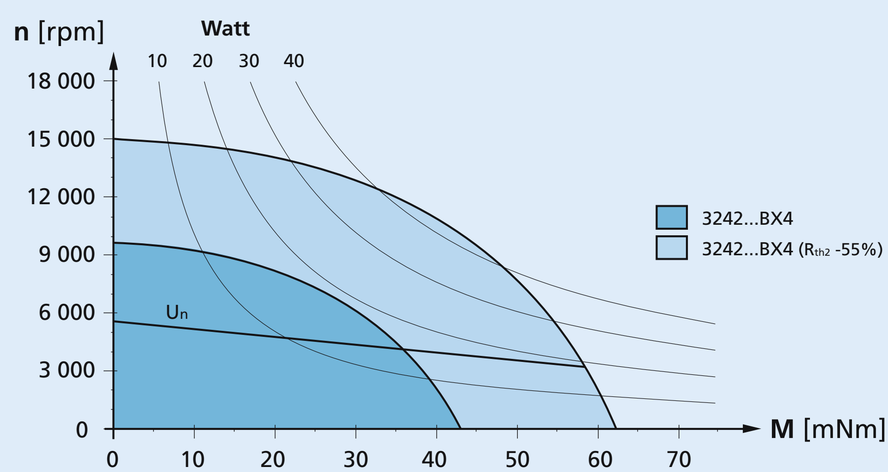
	3242 G			012 BX4	024 BX4	
1	Nominal voltage	U_N		12	24	Volt
2	Terminal resistance, phase-phase	R		0,89	3,6	Ω
3	Output power [1]	$P_{2\,max.}$		21,7	21,7	W
4	Efficiency	$\eta_{max.}$		77,4	77,3	%
5	No-load speed	n_o		5 500	5 500	rpm
6	No-load current	I_o		0,206	0,103	A
7	Stall torque	M_H		282	279	mNm
8	Friction torque, static	C_o		1,3	1,3	mNm
9	Friction torque, dynamic	C_v		$5,2 \cdot 10^{-4}$	$5,2 \cdot 10^{-4}$	mNm/rpm
10	Speed constant	k_n		455	227	rpm/V
11	Back-EMF constant	k_E		2,199	4,409	mV/rpm
12	Torque constant	k_M		21,0	42,1	mNm/A
13	Current constant	k_I		0,0476	0,0238	A/mNm
14	Slope of n-M curve	$\Delta n/\Delta M$		19,3	19,4	rpm/mNm
15	Terminal inductance, phase-phase	L		60	240	µH
16	Mechanical time constant	τ_m		6,1	6,1	ms
17	Rotor inertia	J		30	30	gcm^2
18	Angular acceleration	$\alpha_{max.}$		94	93	$\cdot 10^3 rad/s^2$
19	Thermal resistance	$R_{th\,1}$ / $R_{th\,2}$	1,6 / 11,9			K/W
20	Thermal time constant	τ_{w1} / τ_{w2}	9 / 780			s
21	Operating temperature range		– 40 ... + 100			°C
22	Shaft bearings		ball bearings, preloaded			
23	Shaft load max.:					
	– radial at 3 000 rpm (4,5 mm from mounting flange)		50			N
	– axial at 3 000 rpm		5			N
	– axial at standstill		50			N
24	Shaft play:					
	– radial	≤	0,015			mm
	– axial	=	0			mm
25	Housing material		stainless steel			
26	Weight		177			g
27	Direction of rotation		electronically reversible			
28	Number of pole pairs		2			
	Recommended values - mathematically independent of each other					
29	Speed up to	$n_{e\,max.}$		14 500	14 500	rpm
30	Torque up to [1] [2]	$M_{e\,max.}$		33 / 56	33 / 56	mNm
31	Current up to [1] [2]	$I_{e\,max.}$		1,95 / 3,19	0,97 / 1,59	A

[1] at 5 000 rpm
[2] thermal resistance $R_{th\,2}$ not reduced / thermal resistance $R_{th\,2}$ by 55% reduced

Note:
The diagram indicates the recommended speed in relation to the available torque at the output shaft for a given ambient temperature of 22°C.

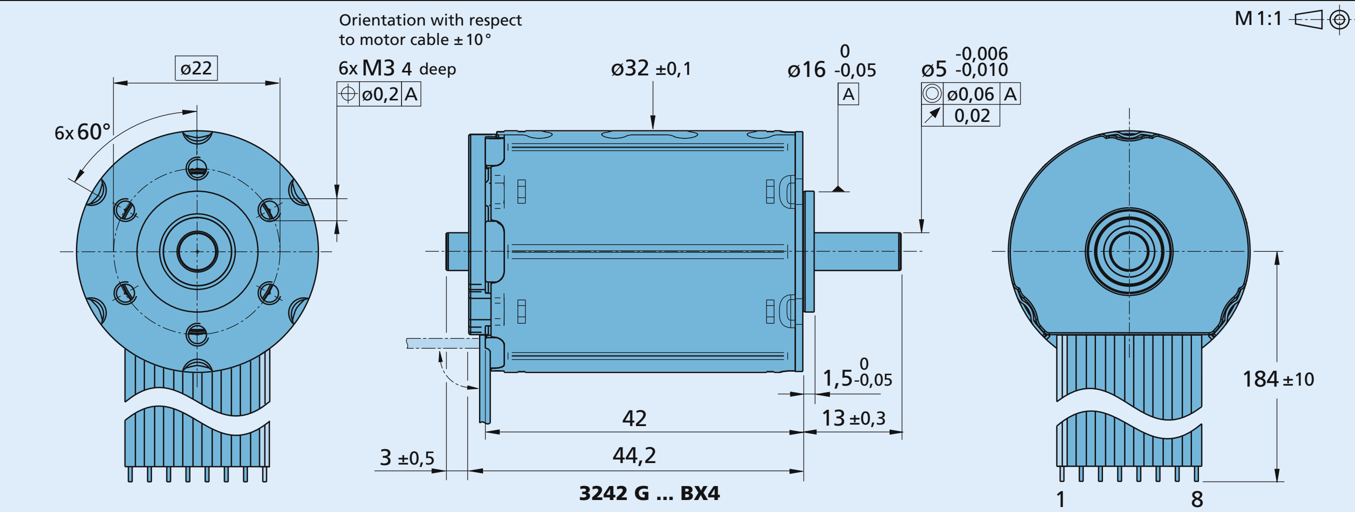
The diagram shows the motor in a completely insulated as well as thermally coupled condition ($R_{th\,2}$ 55% reduced).

The nominal voltage (U_N) curve shows the operating point at nominal voltage in the insulated and thermally coupled condition. Any points of operation above the curve at nominal voltage will require a higher operating voltage. Any points below the nominal voltage curve will require less voltage.



Recommended areas for continuous operation

Dimensional drawing

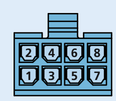


3242 G ... BX4

Options

- Connector variant (Option no. 3830)

  Motor:
  AWG 24 / PVC ribbon cable
  with connector Micro-Fit



- Analog Hall sensors (Option no. 3692)

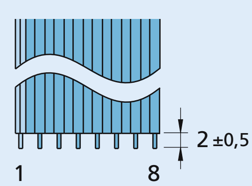
Full product description

- Examples:

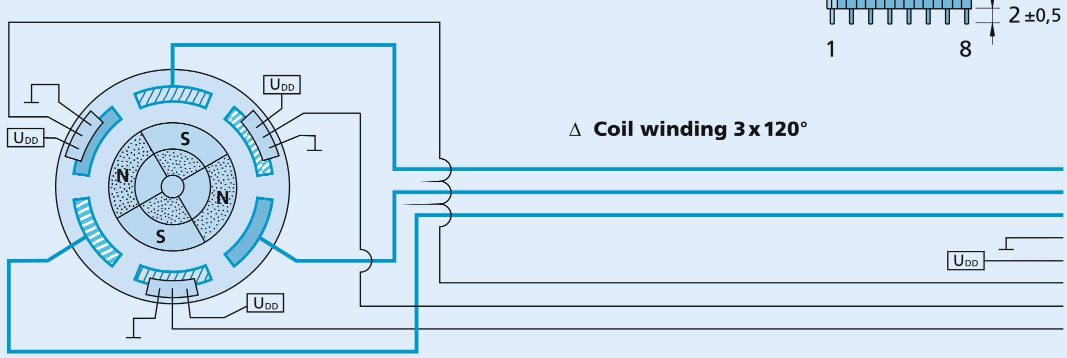
  3242G012BX4

  3242G024BX4

Cable and connection information



Cable
Insulation: PVC
8 conductors, AWG 24
pitch 2,54 mm
wires tinned



∆ Coil winding 3 x 120°

Connection

No.	Function
1	Phase C
2	Phase B
3	Phase A
4	GND
5	U_{DD} (2,2 ... 18V DC)
6	Hall sensor C
7	Hall sensor B
8	Hall sensor A

Brushless DC-Servomotors

4 Pole Technology

97 mNm

For combination with
Gearheads:
30/1(S), 32A, 32ALN, 32/3(S), 38/1(S), 38/2(S)
Encoders:
3268...BX4 + Encoder
Drive Electronics:
Speed Controller

Series 3268 ... BX4

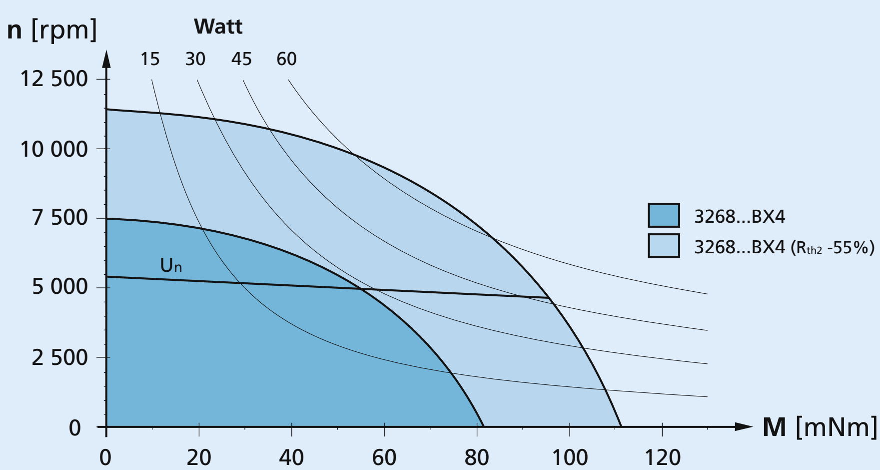
No.	Parameter	3268 G		024 BX4	Unit
1	Nominal voltage	U_N		24	Volt
2	Terminal resistance, phase-phase	R		1,45	Ω
3	Output power [1]	$P_{2\,max.}$		35,8	W
4	Efficiency	$\eta_{max.}$		79,5	%
5	No-load speed	n_o		5 500	rpm
6	No-load current	I_o		0,212	A
7	Stall torque	M_H		718	mNm
8	Friction torque, static	C_o		1,7	mNm
9	Friction torque, dynamic	C_v		$1,3 \cdot 10^{-3}$	mNm/rpm
10	Speed constant	k_n		220	rpm/V
11	Back-EMF constant	k_E		4,555	mV/rpm
12	Torque constant	k_M		43,5	mNm/A
13	Current constant	k_I		0,0230	A/mNm
14	Slope of n-M curve	$\Delta n/\Delta M$		7,3	rpm/mNm
15	Terminal inductance, phase-phase	L		110	µH
16	Mechanical time constant	τ_m		4,6	ms
17	Rotor inertia	J		60	gcm^2
18	Angular acceleration	$\alpha_{max.}$		120	$\cdot 10^3 rad/s^2$
19	Thermal resistance	$R_{th\,1} / R_{th\,2}$	1,9 / 8,6		K/W
20	Thermal time constant	τ_{w1} / τ_{w2}	17 / 950		s
21	Operating temperature range		– 40 ... + 100		°C
22	Shaft bearings		ball bearings, preloaded		
23	Shaft load max.:				
	– radial at 3 000 rpm (4,5 mm from mounting flange)		50		N
	– axial at 3 000 rpm		5		N
	– axial at standstill		50		N
24	Shaft play:				
	– radial	≤	0,015		mm
	– axial	=	0		mm
25	Housing material		stainless steel		
26	Weight		290		g
27	Direction of rotation		electronically reversible		
28	Number of pole pairs		2		
	Recommended values - mathematically independent of each other				
29	Speed up to	$n_{e\,max.}$		12 000	rpm
30	Torque up to [1) 2)]	$M_{e\,max.}$		54 / 97	mNm
31	Current up to [1) 2)]	$I_{e\,max.}$		1,57 / 2,72	A

1) at 5 000 rpm
2) thermal resistance $R_{th\,2}$ not reduced / thermal resistance $R_{th\,2}$ by 55% reduced

Note:
The diagram indicates the recommended speed in relation to the available torque at the output shaft for a given ambient temperature of 22°C.

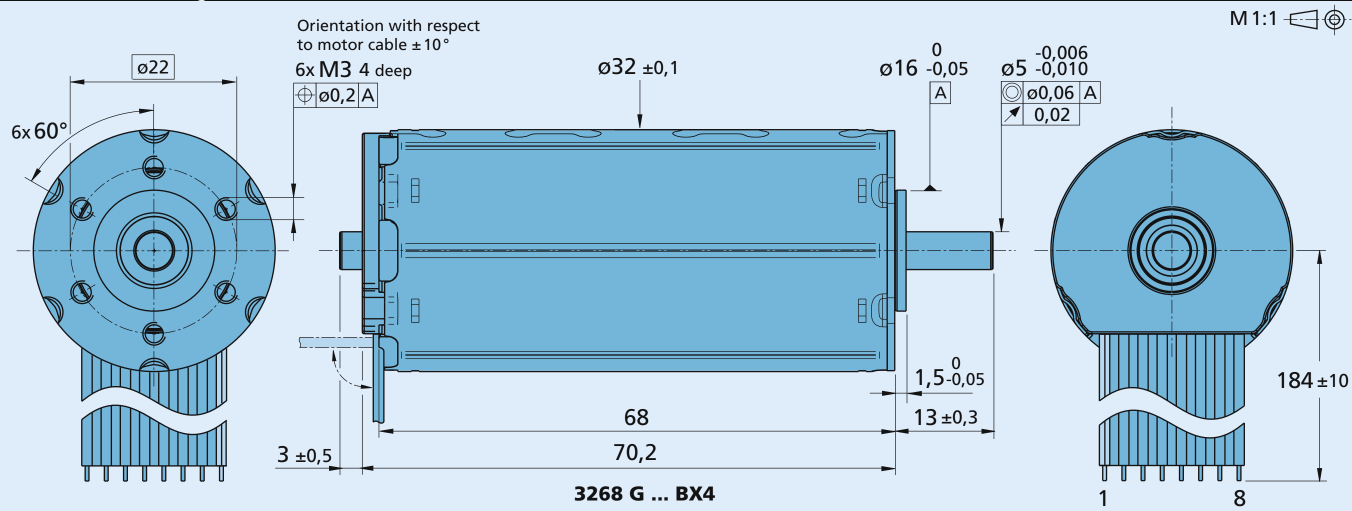
The diagram shows the motor in a completely insulated as well as thermally coupled condition ($R_{th\,2}$ 55% reduced).

The nominal voltage (U_N) curve shows the operating point at nominal voltage in the insulated and thermally coupled condition. Any points of operation above the curve at nominal voltage will require a higher operating voltage. Any points below the nominal voltage curve will require less voltage.



Recommended areas for continuous operation

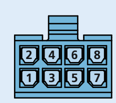
Dimensional drawing



3268 G ... BX4

Options

- Connector variant (Option no. 3830)
  Motor:
  AWG 24 / PVC ribbon cable
  with connector Micro-Fit

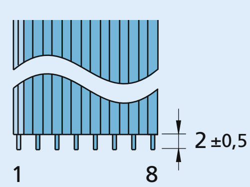


- Analog Hall sensors (Option no. 3692)

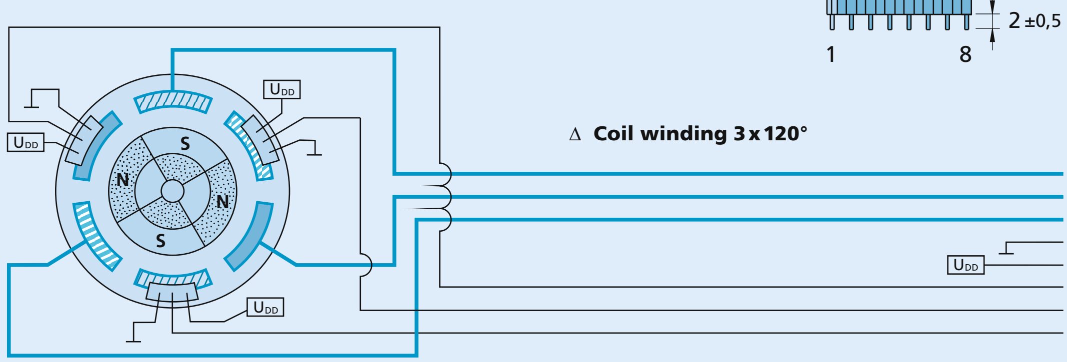
Full product description

- Examples:
  3268G024BX4

Cable and connection information



Cable
Insulation: PVC
8 conductors, AWG 24
pitch 2,54 mm
wires tinned



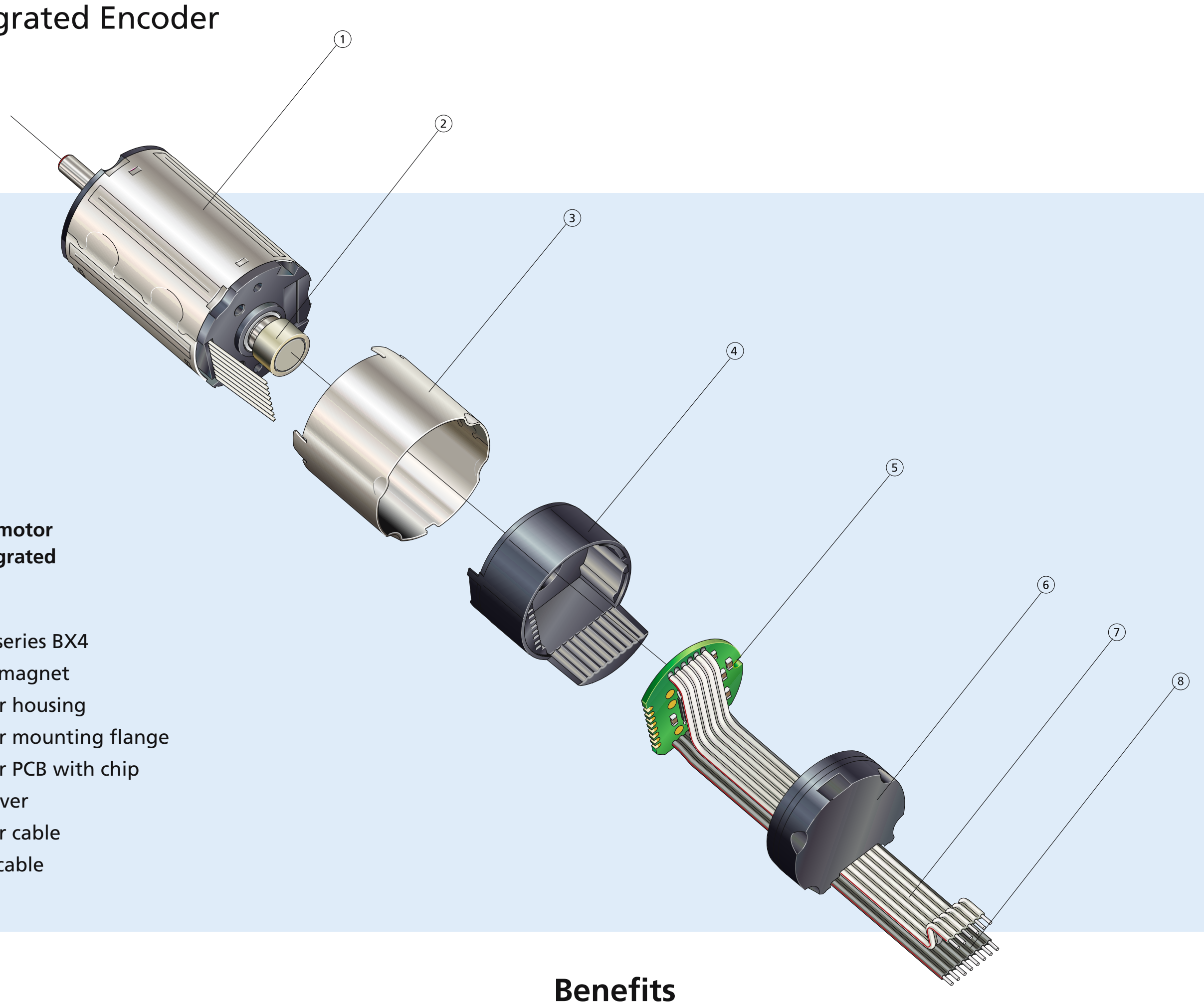
Connection

No.	Function
1	Phase C
2	Phase B
3	Phase A
4	GND
5	U_{DD} (2,2 ... 18V DC)
6	Hall sensor C
7	Hall sensor B
8	Hall sensor A

Notes

Brushless DC-Servomotors

with integrated Encoder



Brushless DC-Servomotor with integrated Encoder

① Motor series BX4
② Sensor magnet
③ Encoder housing
④ Encoder mounting flange
⑤ Encoder PCB with chip
⑥ Rear cover
⑦ Encoder cable
⑧ Motor cable

Features

Encoders of the series IE3/IE3L and AES are designed with a diametrically magnetized code wheel which is pressed onto the motor shaft and provides the axial magnetic field to the encoder electronics. The electronics contain all the necessary functions of an encoder including Hall sensors, interpolation, and driver. The Hall sensors senses the rotational position of the sensor magnet and the signal is interpolated to provide a high resolution position signal.

At the encoder outputs, two 90° phase-shifted rectangular signals are available with up to 1024 impulses and an index impulse per motor revolution.

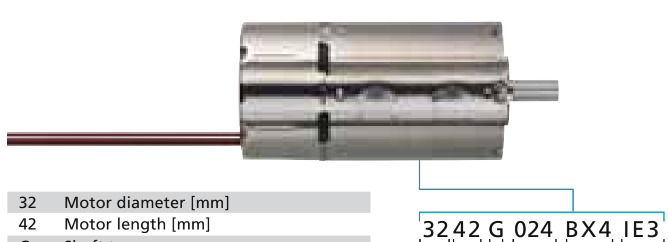
In the AES version, absolute position information is provided with a resolution of 4096 steps per revolution at the signal outputs and communicated via a serial (SSI) interface.

The absolute encoder is ideal for commutation, speed and position control of the motor.

Benefits

- Compact design in robust housing
- A wide range of resolutions are available
- Index channel
- Line Drivers are available
- Standardized encoder outputs
- Ideal for combination with FAULHABER Motion Controllers and FAULHABER Speed Controllers
- Custom modifications including custom resolution, index position and index pulse width are possible
- Available as absolute encoder with serial interface

Product Code



32	Motor diameter [mm]
42	Motor length [mm]
G	Shaft type
024	Nominal voltage [V]
BX4	Type of commutation (brushless), 4 Pole Technology
IE3	Integrated Encoder

Brushless DC-Servomotors

with integrated Encoder
4 Pole Technology

11 mNm

For combination with
Gearheads:
22F, 22/7, 26A

2232 ... BX4 S + Encoders

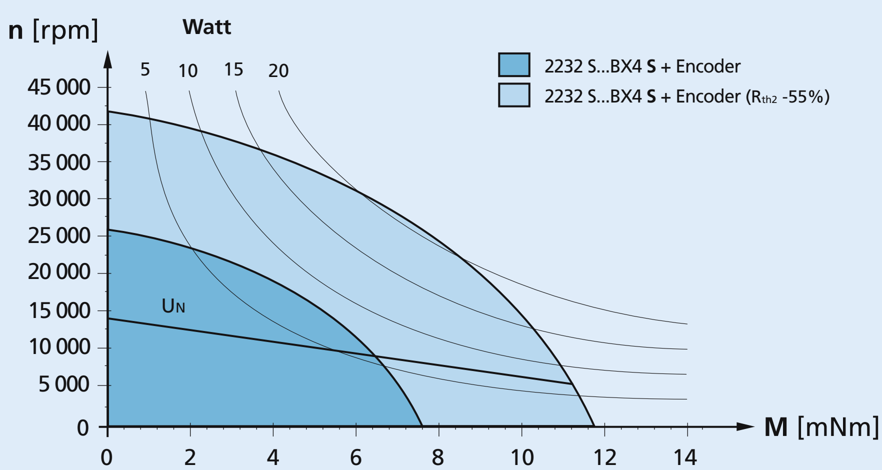
		2232 S		012 BX4 S	024 BX4 S	
1	Nominal voltage	U_N		12	24	Volt
2	Terminal resistance, phase-phase	R		3,5	12,4	Ω
3	Output power 1)	$P_{2\ max.}$		4,4	4,5	W
4	Efficiency	$\eta_{max.}$		60,9	61,7	%
5	No-load speed	n_o		13 200	14 000	rpm
6	No-load current (with shaft ø 3,0 mm)	I_o		0,163	0,088	A
7	Stall torque	M_H		27,3	29,4	mNm
8	Friction torque, static	C_o		0,6	0,6	mNm
9	Friction torque, dynamic	C_v		$5,5 \cdot 10^{-5}$	$5,5 \cdot 10^{-5}$	mNm/rpm
10	Speed constant	k_n		1 173	616	rpm/V
11	Back-EMF constant	k_E		0,852	1,623	mV/rpm
12	Torque constant	k_M		8,14	15,50	mNm/A
13	Current constant	k_I		0,123	0,065	A/mNm
14	Slope of n-M curve	$\Delta n/\Delta M$		504	493	rpm/mNm
15	Terminal inductance, phase-phase	L		130	470	µH
16	Mechanical time constant	τ_m		22	22	ms
17	Rotor inertia	J		4,2	4,2	gcm²
18	Angular acceleration	$\alpha_{max.}$		65	70	$\cdot 10^3 rad/s^2$
19	Thermal resistance	R_{th1} / R_{th2}	2 / 13			K/W
20	Thermal time constant	τ_{w1} / τ_{w2}	4,1 / 283			s
21	Operating temperature range		– 40 ... + 100			°C
22	Shaft bearings		ball bearings, preloaded			
23	Shaft load max.:					
	– radial at 3 000 rpm (4 mm from mounting flange)		20			N
	– axial at 3 000 rpm		2			N
	– axial at standstill		20			N
24	Shaft play:					
	– radial	≤	0,015			mm
	– axial	=	0			mm
25	Housing material		stainless steel			
26	Weight		81			g
27	Direction of rotation		electronically reversible			
28	Number of pole pairs		2			
	Recommended values - mathematically independent of each other					
29	Speed up to	$n_{e\ max.}$		40 000	40 000	rpm
30	Torque up to 1) 2)	$M_{e\ max.}$		7 / 11	7 / 11	mNm
31	Current up to 1) 2)	$I_{e\ max.}$		1,06 / 1,61	0,58 / 0,86	A

1) at 5 000 rpm
2) thermal resistance $R_{th\ 2}$ not reduced / thermal resistance $R_{th\ 2}$ by 55% reduced

Note:
The diagram indicates the recommended speed in relation to the available torque at the output shaft for a given ambient temperature of 22°C.

The diagram shows the motor in a completely insulated as well as thermally coupled condition ($R_{th\ 2}$ 55% reduced).

The nominal voltage (U_N) curve shows the operating point at nominal voltage in the insulated and thermally coupled condition. Any points of operation above the curve at nominal voltage will require a higher operating voltage. Any points below the nominal voltage curve will require less voltage.



Recommended areas for continuous operation

Features

The brushless DC-servomotors feature in this version an Encoder that is available with different interfaces. A permanent magnet on the shaft creates a moving magnetic field which is captured using a single-chip angular sensor and further processed.

In the **IE3** version, the brushless DC servomotors have an encoder with 3 output channels. At the encoder outputs, two 90° phase-shifted rectangular signals are available with up to 1 024 impulses and an index impulse per motor revolution. The encoder is available in a variety of different resolutions and is suitable for speed control and positioning applications.

The Line Driver **IE3L** version has differential signal outputs (TIA-422). Differential signals reduce ambient interference and are suitable for applications with high ambient interference. The line driver amplifies the encoder signal which means that long cables can be used without signal degradation. Differential signal outputs must be decoded by the appropriate receiver module. The motor and encoder cables are connected via separate ribbon cables.
Other resolutions of 1 - 127 impulses are available on request.

In the **AES** version (absolute encoder), absolute position information is provided with a resolution of 4096 steps per revolution at the signal outputs and communicated via a serial (SSI) interface.
Absolute means, that each shaft position is assigned to a unique angular value within one revolution. This value is already available directly after power-on.

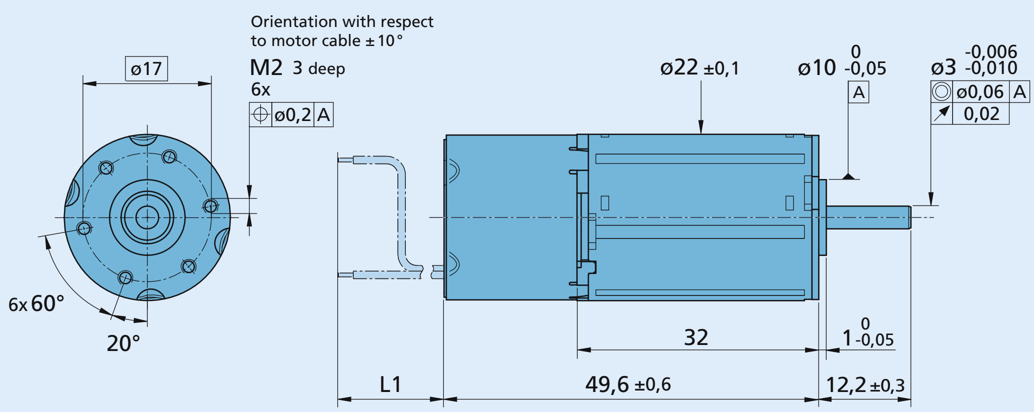
The absolute encoder is ideal for commutation, speed and position control of the motor. It can be used to create a sinusoidal commutation signal. The advantages are a reduced torque ripple, a higher efficiency, and reduced electrical noise generation.

Motor and encoder are connected via a common ribbon cable.

For more information about installation and setup a detailed instruction manual is included with the product or is available online at www.faulhaber.com

Dimensional drawing

M 1:1



Encoder		L1 mm
IE3	2 Cable	162 ±10
IE3 L	2 Cable	150 ±10
AES	1 Cable	162 ±10

2232 S ... BX4 S+ Encoder

Brushless DC-Servomotor 2232 ... BX4 S with Encoder		IE3-32	IE3-64	IE3-128	IE3-256	IE3 - 512	IE3 - 1024	
Lines per revolution	N	32	64	128	256	512	1024	
Frequency range [1], up to	f	15	30	60	120	240	430	kHz
Signal output, square wave		2+1 Index						channels
Supply voltage Encoder	$U_{DD\ Enc}$	4,5 ... 5,5						V DC
Current consumption, typical [2]	$I_{DD\ Enc}$	typ. 16, max. 23						mA
Output current, max. allowable [3]	I_{OUT}	4						mA
Index Pulse width [4]	P_0	90±45				90±75		°e
Phase shift, channel A to B [4]	Φ	90±45				90±75		°e
Signal rise/fall time, max. (C_{LOAD} = 50 pF)	tr/tf	0,1/0,1						µs
Inertia of encoder magnet	J	0,08						gcm^2

Connection information Motor		IE3-32	IE3-64	IE3-128	IE3-256	IE3 - 512	IE3 - 1024	
Supply voltage Hallsensors [5]	U_{DD}	2,2 ...18				4,5 ... 5,5		V DC

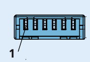
[1] speed (rpm) = f (Hz) x 60/N
[2] $U_{DD\ Enc}$ = 5 V: with unloaded outputs
[3] $U_{DD\ Enc}$ = 5 V: low logic level < 0,4 V, high logic level > 4,5 V: CMOS- and TTL compatible
[4] at 5 000 rpm
[5] IE3-32/64/128/256 $U_{DD} \neq U_{DD\ ENC}$ (galvanically isolated)
IE3-512 / 1 024 $U_{DD} = U_{DD\ ENC}$

Features / Connector information

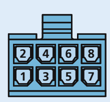
Options

- Connector variant (Option no. 3592)

Encoder:
AWG 28 / PVC ribbon cable
with connector PicoBlade (pitch 1,25 mm)



Motor:
AWG 26 / PVC ribbon cable
with connector Micro-Fit

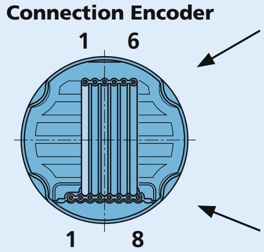


Full product description

- Examples:

2232S024BX4 S IE3-1024

Connection Encoder



Connection Motor

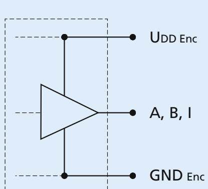
No.	Function
1	n.c.
2	Channel I (Index)
3	GND Enc
4	$U_{DD\ Enc}$
5	Channel B
6	Channel A

No.	Function
1	Phase C
2	Phase B
3	Phase A
4	GND
5	U_{DD}
6	Hall sensor C
7	Hall sensor B
8	Hall sensor A

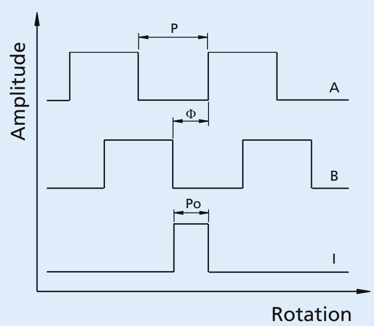
Caution:
Incorrect lead connection will damage the motor electronics!

Output signals / Circuit diagram

Output circuit



Output signals
with clockwise rotation as seen from the shaft end



Admissible deviation of phase shift/Index pulse:

$$\Delta\Phi = \left|90° - \frac{\Phi}{P} * 180°\right| \le 75° \qquad \Delta P_O = \left|90° - \frac{P_O}{P} * 180°\right| \le 75°$$

Brushless DC-Servomotor 2232 ... BX4 S with Encoder		IE3-32 L	IE3-64 L	IE3-128 L	IE3-256 L	IE3-512 L	IE3-1024 L	
Lines per revolution	N	32	64	128	256	512	1 024	
Frequency range [1], up to	f	15	30	60	120	240	430	kHz
Signal output, square wave		2 + 1 index and complementary outputs						channels
Supply voltage	$U_{DD\ Enc}$	4,5 ... 5,5						V DC
Current consumption, typical [2]	$I_{DD\ Enc}$	typ. 17, max. 25						mA
Index Pulse width [3]	P_0	90 ± 45				90 ± 75		°e
Phase shift, channel A to B [3]	Φ	90 ± 45				90 ± 75		°e
Inertia of encoder magnet	J	0,08						gcm^2

[1] speed (rpm) = f (Hz) x 60/N
[2] $U_{DD\ Enc}$ = 5 V: with unloaded outputs
[3] at 5 000 rpm

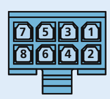
Notes: The output signals are TIA-422 compatible.
Examples of Line driver Receivers: ST26C32ABD (STM), ST26C32IP16 (EXAR), DS26C32AT (NSC).

Features / Connector information

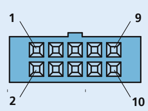
Options

- Connector variant (Option no.: 3589)

Motor:
AWG 26 / PVC ribbon cable
with connector Micro-Fit



Encoder:
AWG 28 / PVC ribbon cable
with connector DIN-41651 (pitch 2,54 mm)

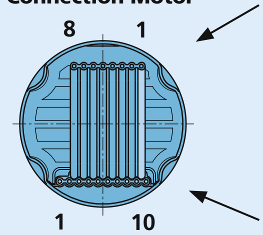


Full product description

- Examples:

2232S024BX4S IE3-1024 L

Connection Motor



Connection Encoder

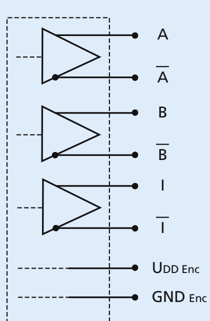
No.	Function
1	Phase C
2	Phase B
3	Phase A
4	GND
5	U_{DD} (2,2 ... 18V DC)
6	Hall sensor C
7	Hall sensor B
8	Hall sensor A

No.	Function
1	n.c.
2	$U_{DD\ Enc}$
3	GND_{Enc}
4	n.c.
5	Channel $\overline{A}$
6	Channel A
7	Channel $\overline{B}$
8	Channel B
9	Channel $\overline{I}$ (Index)
10	Channel I (Index)

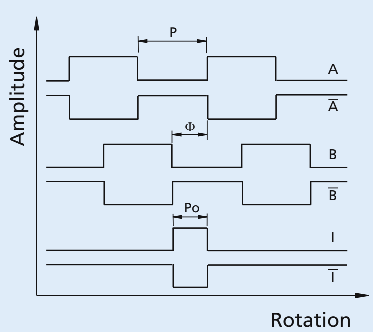
Caution:
Incorrect lead connection will damage the motor electronics!

Output signals / Circuit diagram

Output circuit



Output signals
with clockwise rotation as seen from the shaft end



Admissible deviation of phase shift / Index pulse:

$$\Delta\Phi = \left| 90° - \frac{\Phi}{P} * 180° \right| \leq 75° \qquad \Delta P_O = \left| 90° - \frac{P_O}{P} * 180° \right| \leq 75°$$

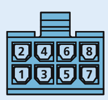
Brushless DC-Servomotor 2232 ... BX4 S with Encoder		AES-4096	
Lines per revolution (resolution)	N	4 096	
Signal output		Synchronous Serial Interface (SSI)	
Supply voltage	$U_{DD\ Enc}$	4,5 ... 5,5	V DC
Current consumption, typical [1]	$I_{DD\ Enc}$	typ. 16, max. 23	mA
Output current, max. (DATA) [2]		4	mA
Clock Frequency, max. (CLK)		2	MHz
Input low level (CLK)		0 ... 0,8	V
Input high level (CLK)		2 ... $U_{DD\ Enc}$	V
Setup time after power on, max.	t_{setup}	4	ms
Operating temperature range		– 40 ... +100	°C

[1] $U_{DD\ Enc}$ = 5 V: with unloaded outputs
[2] $U_{DD\ Enc}$ = 5 V: low logic level ≤ 0,4 V, high logic level ≥ 4,6 V

Features / Connector information

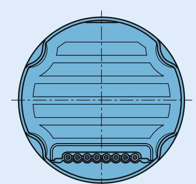
Options

- Connector variant (Option no. 3830)
  AWG 26 / PVC ribbon cable
  with connector Micro-Fit



Full product description

- Examples:
  2232S024BX4S AES-4096



1 8

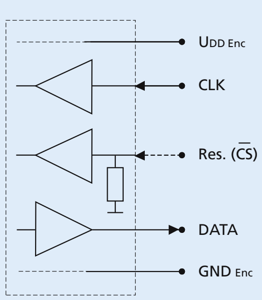
Connection Motor and Encoder

No.	Function
1	Phase C
2	Phase B
3	Phase A
4	GND Enc
5	$U_{DD\ Enc}$
6	CLK
7	Res. ($\overline{CS}$)
8	DATA

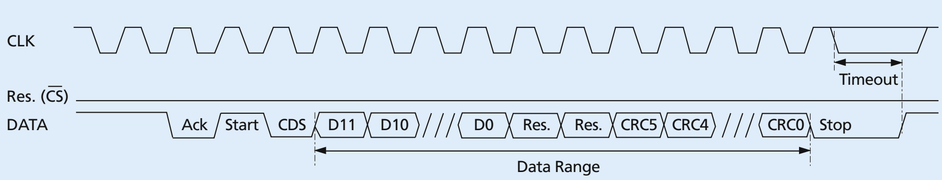
Caution:
Incorrect lead connection will damage the motor electronics!

Circuit diagram / Interface signals

Output circuit



Interface signals (SSI)



Angle position values are ascending for clockwise rotation.
Clockwise rotation as seen from the shaft end

Notes

Brushless DC-Servomotors

with integrated Encoder
4 Pole Technology

22 mNm

For combination with
Gearheads:
22F, 22/7, 26A

2232 ... BX4 + Encoders

		2232 S		012 BX4	024 BX4	
1	Nominal voltage	U_N		12	24	Volt
2	Terminal resistance, phase-phase	R		3,5	12,4	Ω
3	Output power [1]	$P_{2\,max.}$		8,8	8,9	W
4	Efficiency	$\eta_{max.}$		66,9	67,6	%
5	No-load speed	n_o		6 600	7 000	rpm
6	No-load current (with shaft ø 3,0 mm)	I_o		0,112	0,061	A
7	Stall torque	M_H		55,7	59,9	mNm
8	Friction torque, static	C_o		0,85	0,85	mNm
9	Friction torque, dynamic	C_v		$1,5 \cdot 10^{-4}$	$1,5 \cdot 10^{-4}$	mNm/rpm
10	Speed constant	k_n		579	304	rpm/V
11	Back-EMF constant	k_E		1,728	3,288	mV/rpm
12	Torque constant	k_M		16,50	31,40	mNm/A
13	Current constant	k_I		0,061	0,032	A/mNm
14	Slope of n-M curve	$\Delta n/\Delta M$		123	120	rpm/mNm
15	Terminal inductance, phase-phase	L		120	440	µH
16	Mechanical time constant	τ_m		6,7	6,5	ms
17	Rotor inertia	J		5,2	5,2	gcm^2
18	Angular acceleration	$\alpha_{max.}$		107	115	$\cdot 10^3 rad/s^2$
19	Thermal resistance	$R_{th\,1}$ / $R_{th\,2}$	2 / 13			K/W
20	Thermal time constant	τ_{w1} / τ_{w2}	4,1 / 283			s
21	Operating temperature range		– 40 ... + 100			°C
22	Shaft bearings		ball bearings, preloaded			
23	Shaft load max.:					
	– radial at 3 000 rpm (4 mm from mounting flange)		20			N
	– axial at 3 000 rpm		2			N
	– axial at standstill		20			N
24	Shaft play:					
	– radial	≤	0,015			mm
	– axial	=	0			mm
25	Housing material		stainless steel			
26	Weight		81			g
27	Direction of rotation		electronically reversible			
28	Number of pole pairs		2			

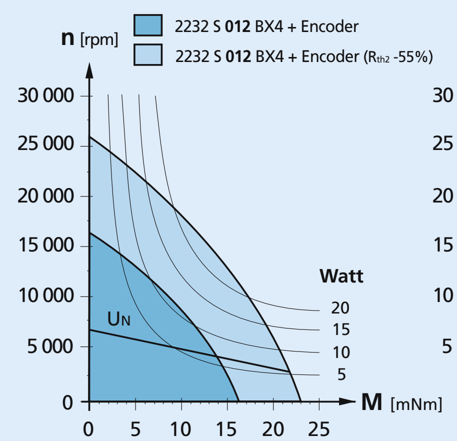
Recommended values - mathematically independent of each other						
29	Speed up to	$n_{e\,max.}$		25 000	20 000	rpm
30	Torque up to [1] [2]	$M_{e\,max.}$		14 / 22	14 / 22	mNm
31	Current up to [1] [2]	$I_{e\,max.}$		1,05 / 1,60	0,56 / 0,85	A

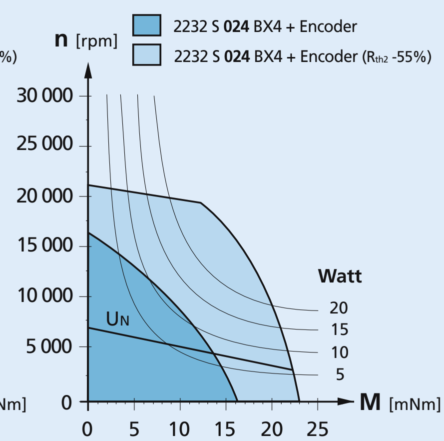
[1] at 5 000 rpm
[2] thermal resistance $R_{th\,2}$ not reduced / thermal resistance $R_{th\,2}$ by 55% reduced

Note:
The diagram indicates the recommended speed in relation to the available torque at the output shaft for a given ambient temperature of 22°C.

The diagram shows the motor in a completely insulated as well as thermally coupled condition ($R_{th\,2}$ 55% reduced).

The nominal voltage (U_N) curve shows the operating point at nominal voltage in the insulated and thermally coupled condition. Any points of operation above the curve at nominal voltage will require a higher operating voltage. Any points below the nominal voltage curve will require less voltage.





Recommended areas for continuous operation

Features

The brushless DC-servomotors feature in this version an Encoder that is available with different interfaces. A permanent magnet on the shaft creates a moving magnetic field which is captured using a single-chip angular sensor and further processed.

In the **IE3** version, the brushless DC servomotors have an encoder with 3 output channels. At the encoder outputs, two 90° phase-shifted rectangular signals are available with up to 1 024 impulses and an index impulse per motor revolution. The encoder is available in a variety of different resolutions and is suitable for speed control and positioning applications.

The Line Driver **IE3L** version has differential signal outputs (TIA-422). Differential signals reduce ambient interference and are suitable for applications with high ambient interference. The line driver amplifies the encoder signal which means that long cables can be used without signal degradation. Differential signal outputs must be decoded by the appropriate receiver module. The motor and encoder cables are connected via separate ribbon cables.
Other resolutions of 1 - 127 impulses are available on request.

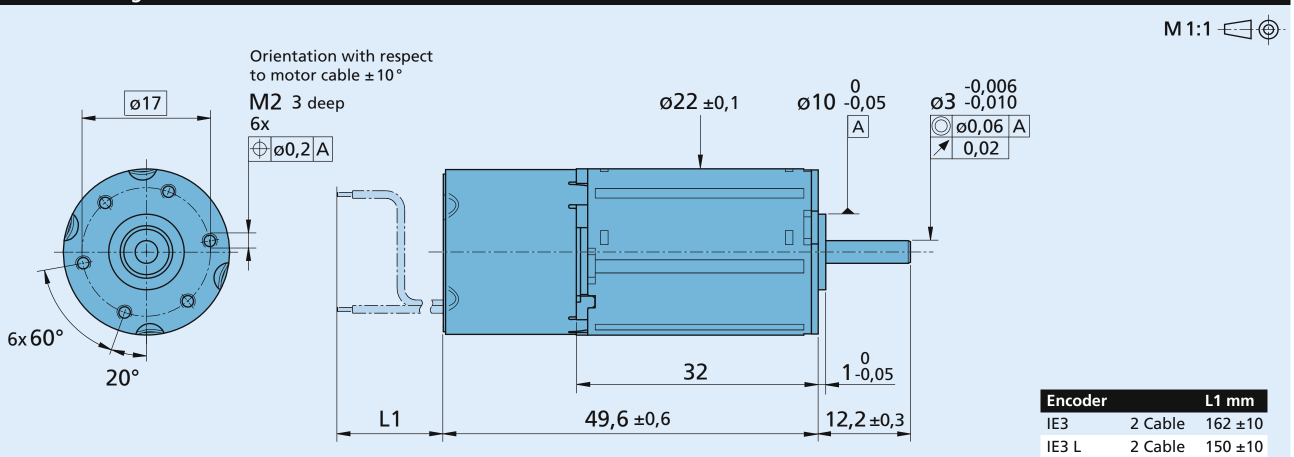
In the **AES** version (absolute encoder), absolute position information is provided with a resolution of 4096 steps per revolution at the signal outputs and communicated via a serial (SSI) interface. Absolute means, that each shaft position is assigned to a unique angular value within one revolution. This value is already available directly after power-on.

The absolute encoder is ideal for commutation, speed and position control of the motor. It can be used to create a sinusoidal commutation signal. The advantages are a reduced torque ripple, a higher efficiency, and reduced electrical noise generation.

Motor and encoder are connected via a common ribbon cable.

For more information about installation and setup a detailed instruction manual is included with the product or is available online at www.faulhaber.com

Dimensional drawing



Encoder		L1 mm
IE3	2 Cable	162 ±10
IE3 L	2 Cable	150 ±10
AES	1 Cable	162 ±10

2232 S ... BX4 + Encoder

Brushless DC-Servomotor 2232 ... BX4 with Encoder		IE3-32	IE3-64	IE3-128	IE3-256	IE3 - 512	IE3 - 1 024	
Lines per revolution	N	32	64	128	256	512	1 024	
Frequency range 1), up to	f	15	30	60	120	240	430	kHz
Signal output, square wave		2 + 1 Index						channels
Supply voltage Encoder	$U_{DD\ Enc}$	4,5 ... 5,5						V DC
Current consumption, typical 2)	$I_{DD\ Enc}$	typ. 16, max. 23						mA
Output current, max. allowable 3)	I_{OUT}	4						mA
Index Pulse width 4)	P_0	90 ± 45				90 ± 75		°e
Phase shift, channel A to B 4)	Φ	90 ± 45				90 ± 75		°e
Signal rise/fall time, max. (C_{LOAD} = 50 pF)	tr/tf	0,1 / 0,1						µs
Inertia of encoder magnet	J	0,08						gcm^2

Connection information Motor		IE3-32	IE3-64	IE3-128	IE3-256	IE3 - 512	IE3 - 1 024	
Supply voltage Hallsensors 5)	U_{DD}	2,2 ...18				4,5 ... 5,5		V DC

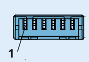
1) speed (rpm) = f (Hz) x 60/N
2) $U_{DD\ Enc}$ = 5 V: with unloaded outputs
3) $U_{DD\ Enc}$ = 5 V: low logic level < 0,4 V, high logic level > 4,5 V: CMOS- and TTL compatible
4) at 5 000 rpm
5) IE3-32/64/128/256 $U_{DD} \neq U_{DD\ ENC}$ (galvanically isolated)
IE3-512 / 1 024 $U_{DD} = U_{DD\ ENC}$

Features / Connector information

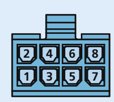
Options

- Connector variant (Option no. 3592)

Encoder:
AWG 28 / PVC ribbon cable
with connector PicoBlade (pitch 1,25 mm)



Motor:
AWG 26 / PVC ribbon cable
with connector Micro-Fit

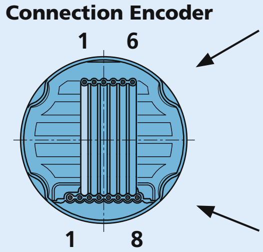


Full product description

- Examples:

2232S024BX4 IE3-1024

Connection Encoder



Connection Motor

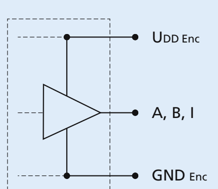
No.	Function
1	n.c.
2	Channel I (Index)
3	GND Enc
4	$U_{DD\ Enc}$
5	Channel B
6	Channel A

No.	Function
1	Phase C
2	Phase B
3	Phase A
4	GND
5	U_{DD}
6	Hall sensor C
7	Hall sensor B
8	Hall sensor A

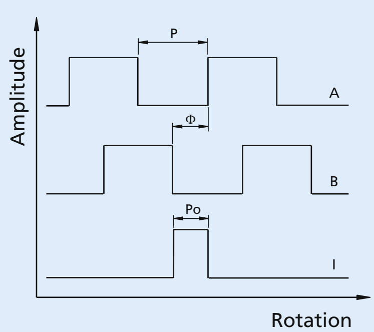
Caution:
Incorrect lead connection will damage the motor electronics!

Output signals / Circuit diagram

Output circuit



Output signals
with clockwise rotation as seen from the shaft end



Admissible deviation of phase shift / Index pulse:

$$\Delta\Phi = \left|90° - \frac{\Phi}{P} * 180°\right| \leq 75° \qquad \Delta P_0 = \left|90° - \frac{P_0}{P} * 180°\right| \leq 75°$$

Brushless DC-Servomotor 2232 ... BX4 with Encoder		IE3-32 L	IE3-64 L	IE3-128 L	IE3-256 L	IE3-512 L	IE3-1024 L	
Lines per revolution	N	32	64	128	256	512	1 024	
Frequency range [1], up to	f	15	30	60	120	240	430	kHz
Signal output, square wave		2 + 1 index and complementary outputs						channels
Supply voltage	$U_{DD\ Enc}$	4,5 ... 5,5						V DC
Current consumption, typical [2]	$I_{DD\ Enc}$	typ. 17, max. 25						mA
Index Pulse width [3]	P_0	90 ± 45				90 ± 75		°e
Phase shift, channel A to B [3]	Φ	90 ± 45				90 ± 75		°e
Inertia of encoder magnet	J	0,08						gcm²

[1] speed (rpm) = f (Hz) x 60/N
[2] $U_{DD\ Enc}$ = 5 V: with unloaded outputs
[3] at 5 000 rpm

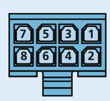
Notes: The output signals are TIA-422 compatible.
Examples of Line driver Receivers: ST26C32ABD (STM), ST26C32IP16 (EXAR), DS26C32AT (NSC).

Features / Connector information

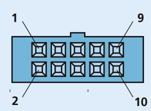
Options

- Connector variant (Option no.: 3589)

Motor:
AWG 26 / PVC ribbon cable
with connector Micro-Fit



Encoder:
AWG 28 / PVC ribbon cable
with connector DIN-41651 (pitch 2,54 mm)

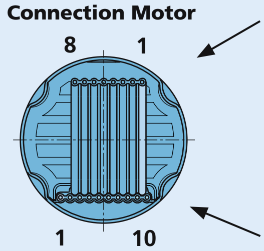


Full product description

- Examples:

2232S024BX4 IE3-1024 L

Connection Motor



Connection Encoder

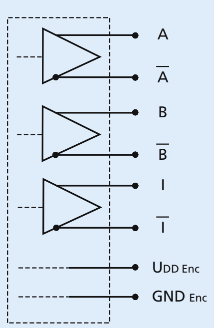
No.	Function
1	Phase C
2	Phase B
3	Phase A
4	GND
5	U_{DD} (2,2 ... 18V DC)
6	Hall sensor C
7	Hall sensor B
8	Hall sensor A

No.	Function
1	n.c.
2	$U_{DD\ Enc}$
3	GND Enc
4	n.c.
5	Channel $\overline{A}$
6	Channel A
7	Channel $\overline{B}$
8	Channel B
9	Channel $\overline{I}$ (Index)
10	Channel I (Index)

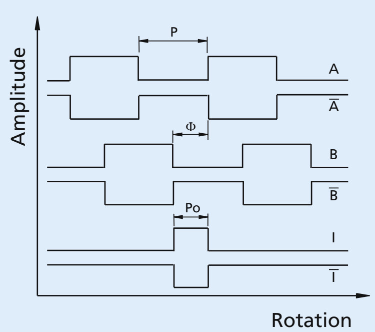
Caution:
Incorrect lead connection will damage the motor electronics!

Output signals / Circuit diagram

Output circuit



Output signals
with clockwise rotation as seen from the shaft end



Admissible deviation of phase shift / Index pulse:

$$\Delta\Phi = \left| 90° - \frac{\Phi}{P} * 180° \right| \leq 75° \qquad \Delta P_0 = \left| 90° - \frac{P_0}{P} * 180° \right| \leq 75°$$

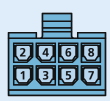
Brushless DC-Servomotor 2232 ... BX4 with Encoder		AES-4096	
Lines per revolution (resolution)	N	4 096	
Signal output		Synchronous Serial Interface (SSI)	
Supply voltage	$U_{DD\,Enc}$	4,5 ... 5,5	V DC
Current consumption, typical [1]	$I_{DD\,Enc}$	typ. 16, max. 23	mA
Output current, max. (DATA) [2]		4	mA
Clock Frequency, max. (CLK)		2	MHz
Input low level (CLK)		0 ... 0,8	V
Input high level (CLK)		2 ... $U_{DD\,Enc}$	V
Setup time after power on, max.	t_{setup}	4	ms
Operating temperature range		– 40 ... +100	°C

[1] $U_{DD\,Enc}$ = 5 V: with unloaded outputs
[2] $U_{DD\,Enc}$ = 5 V: low logic level ≤ 0,4 V, high logic level ≥ 4,6 V

Features / Connector information

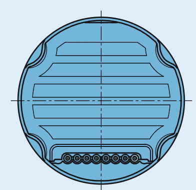
Options

- Connector variant (Option no. 3830)
  AWG 26 / PVC ribbon cable
  with connector Micro-Fit



Full product description

- Examples:
  2232S024BX4 AES-4096



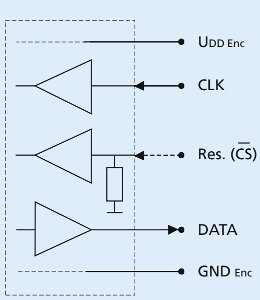
Connection Motor and Encoder

No.	Function
1	Phase C
2	Phase B
3	Phase A
4	GND Enc
5	$U_{DD\,Enc}$
6	CLK
7	Res. ($\overline{CS}$)
8	DATA

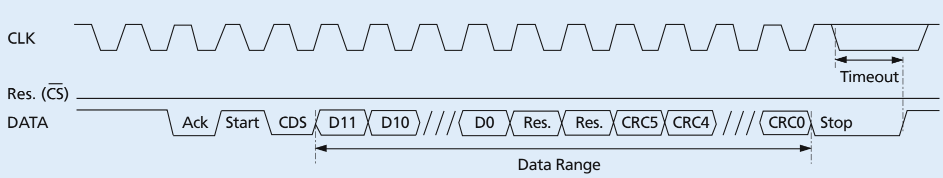
Caution:
Incorrect lead connection will damage the motor electronics!

Circuit diagram / Interface signals

Output circuit



Interface signals (SSI)



Angle position values are ascending for clockwise rotation.
Clockwise rotation as seen from the shaft end

Notes

Brushless DC-Servomotors

with integrated Encoder
4 Pole Technology

25 mNm

For combination with
Gearheads:
22F, 22/7, 26A

2250 ... BX4 S + Encoders

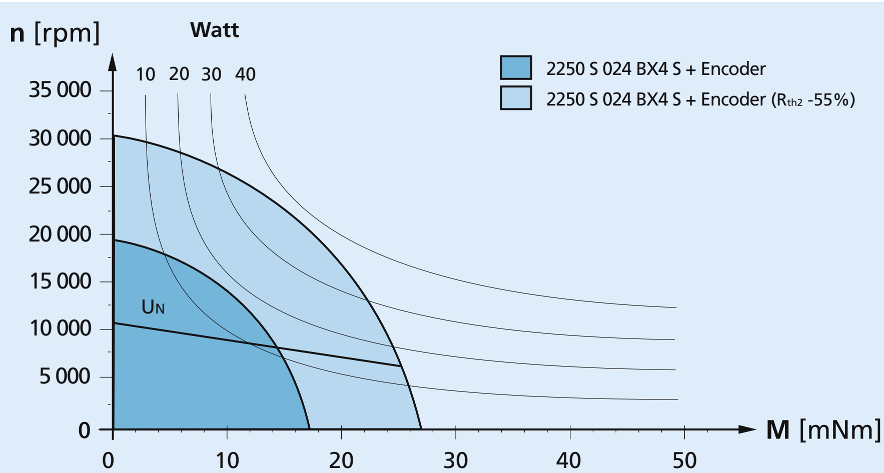
		2250 S		024 BX4 S	
1	Nominal voltage	U_N		24	Volt
2	Terminal resistance, phase-phase	R		5,9	Ω
3	Output power 1)	$P_{2\ max.}$		10,3	W
4	Efficiency	$\eta_{max.}$		70,4	%
5	No-load speed	n_o		10 500	rpm
6	No-load current (with shaft ø 3,0 mm)	I_o		0,105	A
7	Stall torque	M_H		84,7	mNm
8	Friction torque, static	C_o		0,75	mNm
9	Friction torque, dynamic	C_v		$1,4 \cdot 10^{-4}$	mNm/rpm
10	Speed constant	k_n		451	rpm/V
11	Back-EMF constant	k_E		2,218	mV/rpm
12	Torque constant	k_M		21,1	mNm/A
13	Current constant	k_I		0,047	A/mNm
14	Slope of n-M curve	$\Delta n/\Delta M$		125,6	rpm/mNm
15	Terminal inductance, phase-phase	L		250	µH
16	Mechanical time constant	τ_m		6,97	ms
17	Rotor inertia	J		5,3	gcm^2
18	Angular acceleration	$\alpha_{max.}$		160	$\cdot 10^3 rad/s^2$
19	Thermal resistance	$R_{th\ 1}$ / $R_{th\ 2}$	1,2 / 10,5		K/W
20	Thermal time constant	τ_{w1} / τ_{w2}	4,2 / 332		s
21	Operating temperature range		– 40 ... + 100		°C
22	Shaft bearings		ball bearings, preloaded		
23	Shaft load max.:				
	– radial at 3 000 rpm (4 mm from mounting flange)		20		N
	– axial at 3 000 rpm		2		N
	– axial at standstill		20		N
24	Shaft play:				
	– radial	≤	0,015		mm
	– axial	=	0		mm
25	Housing material		stainless steel		
26	Weight		101		g
27	Direction of rotation		electronically reversible		
28	Number of pole pairs		2		
Recommended values - mathematically independent of each other					
29	Speed up to	$n_{e\ max.}$		30 000	rpm
30	Torque up to 1) 2)	$M_{e\ max.}$		16 / 25	mNm
31	Current up to 1) 2)	$I_{e\ max.}$		0,92 / 1,40	A

1) at 5 000 rpm
2) thermal resistance $R_{th\ 2}$ not reduced / thermal resistance $R_{th\ 2}$ by 55% reduced

Note:
The diagram indicates the recommended speed in relation to the available torque at the output shaft for a given ambient temperature of 22°C.

The diagram shows the motor in a completely insulated as well as thermally coupled condition ($R_{th\ 2}$ 55% reduced).

The nominal voltage (U_N) curve shows the operating point at nominal voltage in the insulated and thermally coupled condition. Any points of operation above the curve at nominal voltage will require a higher operating voltage. Any points below the nominal voltage curve will require less voltage.



Recommended areas for continuous operation

Features

The brushless DC-servomotors feature in this version an Encoder that is available with different interfaces. A permanent magnet on the shaft creates a moving magnetic field which is captured using a single-chip angular sensor and further processed.

In the **IE3** version, the brushless DC servomotors have an encoder with 3 output channels. At the encoder outputs, two 90° phase-shifted rectangular signals are available with up to 1 024 impulses and an index impulse per motor revolution. The encoder is available in a variety of different resolutions and is suitable for speed control and positioning applications.

The Line Driver **IE3L** version has differential signal outputs (TIA-422). Differential signals reduce ambient interference and are suitable for applications with high ambient interference. The line driver amplifies the encoder signal which means that long cables can be used without signal degradation. Differential signal outputs must be decoded by the appropriate receiver module. The motor and encoder cables are connected via separate ribbon cables.
Other resolutions of 1 - 127 impulses are available on request.

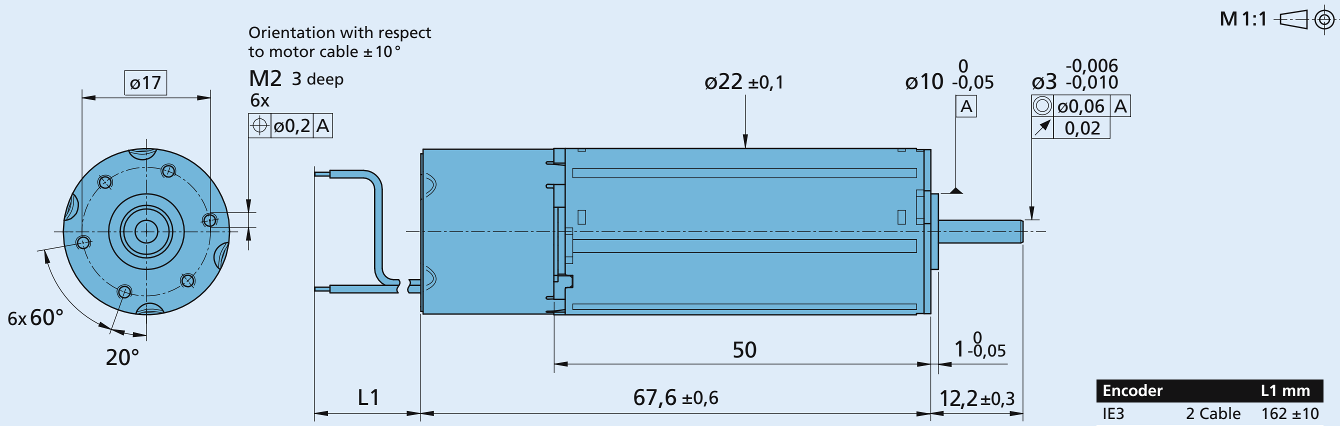
In the **AES** version (absolute encoder), absolute position information is provided with a resolution of 4096 steps per revolution at the signal outputs and communicated via a serial (SSI) interface. Absolute means, that each shaft position is assigned to a unique angular value within one revolution. This value is already available directly after power-on.

The absolute encoder is ideal for commutation, speed and position control of the motor. It can be used to create a sinusoidal commutation signal. The advantages are a reduced torque ripple, a higher efficiency, and reduced electrical noise generation.

Motor and encoder are connected via a common ribbon cable.

For more information about installation and setup a detailed instruction manual is included with the product or is available online at www.faulhaber.com

Dimensional drawing



Encoder		L1 mm
IE3	2 Cable	162 ±10
IE3 L	2 Cable	150 ±10
AES	1 Cable	162 ±10

2250 S ... BX4 S + Encoder

Brushless DC-Servomotor 2250 ... BX4 S with Encoder		IE3-32	IE3-64	IE3-128	IE3-256	IE3 - 512	IE3 - 1024	
Lines per revolution	N	32	64	128	256	512	1024	
Frequency range 1), up to	f	15	30	60	120	240	430	kHz
Signal output, square wave		2 + 1 Index						channels
Supply voltage Encoder	$U_{DD\ Enc}$	4,5 ... 5,5						V DC
Current consumption, typical 2)	$I_{DD\ Enc}$	typ. 16, max. 23						mA
Output current, max. allowable 3)	I_{OUT}	4						mA
Index Pulse width 4)	P_0	90 ± 45				90 ± 75		°e
Phase shift, channel A to B 4)	Φ	90 ± 45				90 ± 75		°e
Signal rise/fall time, max. (C_{LOAD} = 50 pF)	tr/tf	0,1 / 0,1						µs
Inertia of encoder magnet	J	0,08						gcm²

Connection information Motor				
Supply voltage Hallsensors 5)	U_{DD}	2,2 ...18	4,5 ... 5,5	V DC

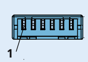
1) speed (rpm) = f (Hz) x 60/N
2) $U_{DD\ Enc}$ = 5 V: with unloaded outputs
3) $U_{DD\ Enc}$ = 5 V: low logic level < 0,4 V, high logic level > 4,5 V: CMOS- and TTL compatible
4) at 5 000 rpm
5) IE3-32/64/128/256 $U_{DD} \neq U_{DD\ ENC}$ (galvanically isolated)
IE3-512 / 1 024 $U_{DD} = U_{DD\ ENC}$

Features / Connector information

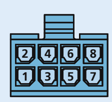
Options

- Connector variant (Option no. 3592)

Encoder:
AWG 28 / PVC ribbon cable
with connector PicoBlade (pitch 1,25 mm)



Motor:
AWG 26 / PVC ribbon cable
with connector Micro-Fit

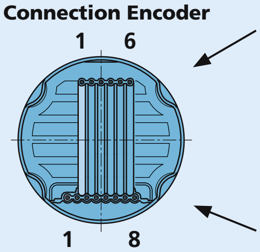


Full product description

- Examples:

2250S024BX4S IE3-1024

Connection Encoder



Connection Motor

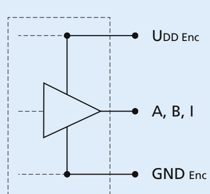
No.	Function
1	n.c.
2	Channel I (Index)
3	GND Enc
4	$U_{DD\ Enc}$
5	Channel B
6	Channel A

No.	Function
1	Phase C
2	Phase B
3	Phase A
4	GND
5	U_{DD}
6	Hall sensor C
7	Hall sensor B
8	Hall sensor A

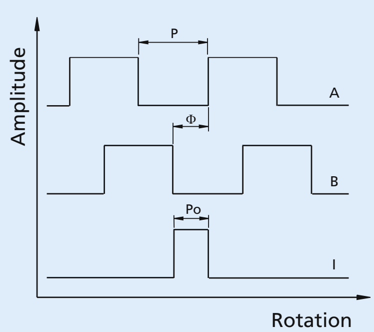
Caution:
Incorrect lead connection will damage the motor electronics!

Output signals / Circuit diagram

Output circuit



Output signals
with clockwise rotation as seen from the shaft end



Admissible deviation of phase shift / Index pulse:

$$\Delta\Phi = \left|90° - \frac{\Phi}{P} * 180°\right| \leq 75° \qquad \Delta P_O = \left|90° - \frac{P_O}{P} * 180°\right| \leq 75°$$

Brushless DC-Servomotor 2250 ... BX4 S with Encoder		IE3-32 L	IE3-64 L	IE3-128 L	IE3-256 L	IE3-512 L	IE3-1024 L	
Lines per revolution	N	32	64	128	256	512	1 024	
Frequency range 1), up to	f	15	30	60	120	240	430	kHz
Signal output, square wave		2 + 1 index and complementary outputs						channels
Supply voltage	$U_{DD\ Enc}$	4,5 ... 5,5						V DC
Current consumption, typical 2)	$I_{DD\ Enc}$	typ. 17, max. 25						mA
Index Pulse width 3)	P_0	90 ± 45				90 ± 75		°e
Phase shift, channel A to B 3)	Φ	90 ± 45				90 ± 75		°e
Inertia of encoder magnet	J	0,08						gcm²

1) speed (rpm) = f (Hz) x 60/N
2) $U_{DD\ Enc}$ = 5 V: with unloaded outputs
3) at 5 000 rpm

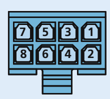
Notes: The output signals are TIA-422 compatible.
Examples of Line driver Receivers: ST26C32ABD (STM), ST26C32IP16 (EXAR), DS26C32AT (NSC).

Features / Connector information

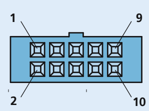
Options

- Connector variant (Option no.: 3589)

Motor:
AWG 26 / PVC ribbon cable
with connector Micro-Fit



Encoder:
AWG 28 / PVC ribbon cable
with connector DIN-41651 (pitch 2,54 mm)

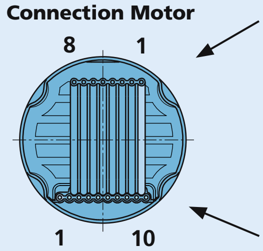


Full product description

- Examples:

2250S024BX4S IE3-1024 L

Connection Motor



Connection Encoder

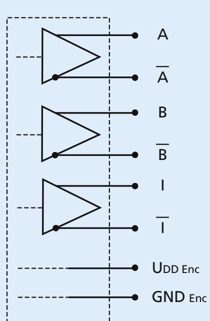
No.	Function
1	Phase C
2	Phase B
3	Phase A
4	GND
5	U_{DD} (2,2 ... 18V DC)
6	Hall sensor C
7	Hall sensor B
8	Hall sensor A

No.	Function
1	n.c.
2	$U_{DD\ Enc}$
3	GND_{Enc}
4	n.c.
5	Channel $\overline{A}$
6	Channel A
7	Channel $\overline{B}$
8	Channel B
9	Channel $\overline{I}$ (Index)
10	Channel I (Index)

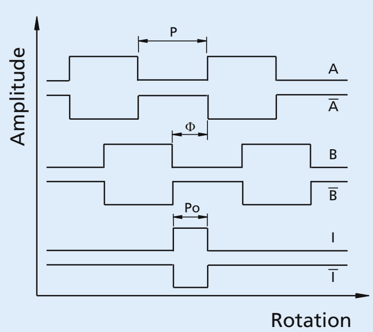
Caution:
Incorrect lead connection will damage the motor electronics!

Output signals / Circuit diagram

Output circuit



Output signals
with clockwise rotation as seen from the shaft end



Admissible deviation of phase shift / Index pulse:

$$\Delta\Phi = \left| 90° - \frac{\Phi}{P} * 180° \right| \le 75° \qquad \Delta P_0 = \left| 90° - \frac{P_0}{P} * 180° \right| \le 75°$$

FAULHABER

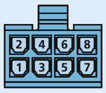
Brushless DC-Servomotor 2250 ... BX4 S with Encoder		AES-4096	
Lines per revolution (resolution)	N	4 096	
Signal output		Synchronous Serial Interface (SSI)	
Supply voltage	$U_{DD\ Enc}$	4,5 ... 5,5	V DC
Current consumption, typical [1]	$I_{DD\ Enc}$	typ. 16, max. 23	mA
Output current, max. (DATA) [2]		4	mA
Clock Frequency, max. (CLK)		2	MHz
Input low level (CLK)		0 ... 0,8	V
Input high level (CLK)		2 ... $U_{DD\ Enc}$	V
Setup time after power on, max.	t_{setup}	4	ms
Operating temperature range		– 40 ... +100	°C

1) $U_{DD\ Enc}$ = 5 V: with unloaded outputs
2) $U_{DD\ Enc}$ = 5 V: low logic level ≤ 0,4 V, high logic level ≥ 4,6 V

Features / Connector information

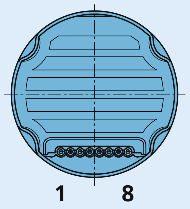
Options

- Connector variant (Option no. 3830)
  AWG 26 / PVC ribbon cable
  with connector Micro-Fit



Full product description

- Examples:
  2250S024BX4 S AES-4096



Connection Motor and Encoder

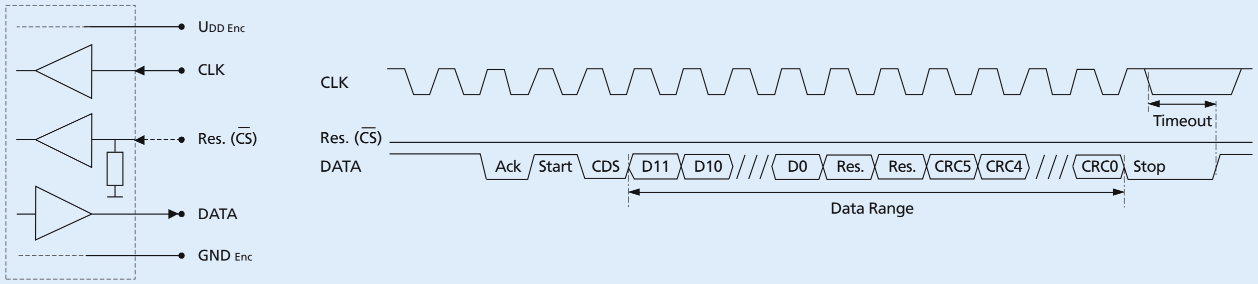
No.	Function
1	Phase C
2	Phase B
3	Phase A
4	GND Enc
5	$U_{DD\ Enc}$
6	CLK
7	Res. ($\overline{CS}$)
8	DATA

Caution:
Incorrect lead connection will damage the motor electronics!

Circuit diagram / Interface signals

Output circuit

Interface signals (SSI)



Angle position values are ascending for clockwise rotation.
Clockwise rotation as seen from the shaft end

Notes

Brushless DC-Servomotors

with integrated Encoder
4 Pole Technology

43 mNm

For combination with
Gearheads:
22F, 22/7, 26A

2250 ... BX4 + Encoder

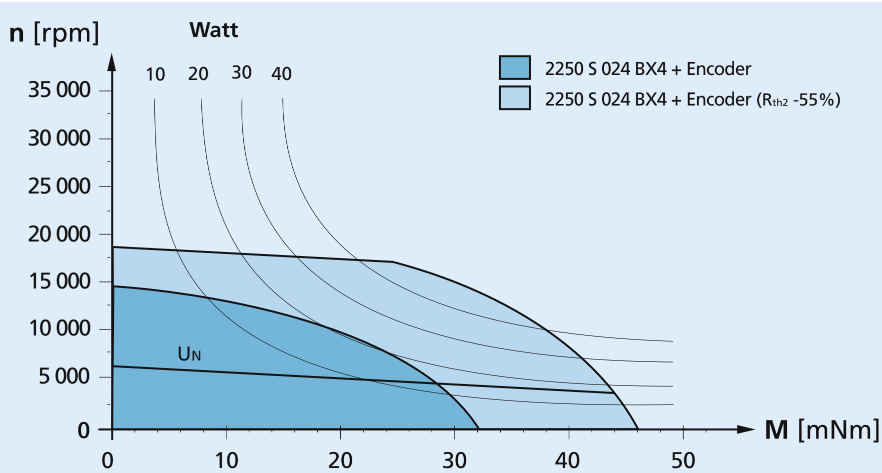
		2250 S		024 BX4	
1	Nominal voltage	U_N		24	Volt
2	Terminal resistance, phase-phase	R		5,9	Ω
3	Output power [1]	$P_{2\ max.}$		17,3	W
4	Efficiency	$\eta_{max.}$		75	%
5	No-load speed	n_o		6 000	rpm
6	No-load current (with shaft ø 3,0 mm)	I_o		0,072	A
7	Stall torque	M_H		149	mNm
8	Friction torque, static	C_o		1,2	mNm
9	Friction torque, dynamic	C_v		$2,4 \cdot 10^{-4}$	mNm/rpm
10	Speed constant	k_n		259	rpm/V
11	Back-EMF constant	k_E		3,860	mV/rpm
12	Torque constant	k_M		36,9	mNm/A
13	Current constant	k_I		0,027	A/mNm
14	Slope of n-M curve	$\Delta n/\Delta M$		41,4	rpm/mNm
15	Terminal inductance, phase-phase	L		240	µH
16	Mechanical time constant	τ_m		4,3	ms
17	Rotor inertia	J		10	gcm^2
18	Angular acceleration	$\alpha_{max.}$		149	$\cdot 10^3 rad/s^2$
19	Thermal resistance	R_{th1} / R_{th2}	1,2 / 10,5		K/W
20	Thermal time constant	τ_{w1} / τ_{w2}	4,2 / 424		s
21	Operating temperature range		– 40 ... + 100		°C
22	Shaft bearings		ball bearings, preloaded		
23	Shaft load max.:				
	– radial at 3 000 rpm (4 mm from mounting flange)		20		N
	– axial at 3 000 rpm		2		N
	– axial at standstill		20		N
24	Shaft play:				
	– radial	≤	0,015		mm
	– axial	=	0		mm
25	Housing material		stainless steel		
26	Weight		117		g
27	Direction of rotation		electronically reversible		
28	Number of pole pairs		2		
Recommended values - mathematically independent of each other					
29	Speed up to	$n_{e\ max.}$		18 000	rpm
30	Torque up to [1) 2)]	$M_{e\ max.}$		27 / 43	mNm
31	Current up to [1) 2)]	$I_{e\ max.}$		0,89 / 1,37	A

[1)] at 5 000 rpm
[2)] thermal resistance $R_{th\ 2}$ not reduced / thermal resistance $R_{th\ 2}$ by 55% reduced

Note:
The diagram indicates the recommended speed in relation to the available torque at the output shaft for a given ambient temperature of 22°C.

The diagram shows the motor in a completely insulated as well as thermally coupled condition ($R_{th\ 2}$ 55% reduced).

The nominal voltage (U_N) curve shows the operating point at nominal voltage in the insulated and thermally coupled condition. Any points of operation above the curve at nominal voltage will require a higher operating voltage. Any points below the nominal voltage curve will require less voltage.



Recommended areas for continuous operation

Features

The brushless DC-servomotors feature in this version an Encoder that is available with different interfaces. A permanent magnet on the shaft creates a moving magnetic field which is captured using a single-chip angular sensor and further processed.

In the **IE3** version, the brushless DC servomotors have an encoder with 3 output channels. At the encoder outputs, two 90° phase-shifted rectangular signals are available with up to 1 024 impulses and an index impulse per motor revolution. The encoder is available in a variety of different resolutions and is suitable for speed control and positioning applications.

The Line Driver **IE3L** version has differential signal outputs (TIA-422). Differential signals reduce ambient interference and are suitable for applications with high ambient interference. The line driver amplifies the encoder signal which means that long cables can be used without signal degradation. Differential signal outputs must be decoded by the appropriate receiver module. The motor and encoder cables are connected via separate ribbon cables.
Other resolutions of 1 - 127 impulses are available on request.

In the **AES** version (absolute encoder), absolute position information is provided with a resolution of 4096 steps per revolution at the signal outputs and communicated via a serial (SSI) interface.
Absolute means, that each shaft position is assigned to a unique angular value within one revolution. This value is already available directly after power-on.

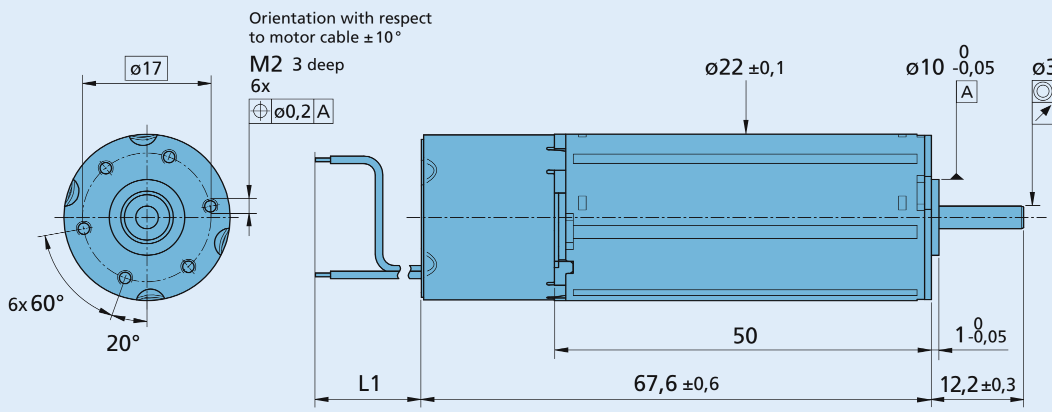
The absolute encoder is ideal for commutation, speed and position control of the motor. It can be used to create a sinusoidal commutation signal. The advantages are a reduced torque ripple, a higher efficiency, and reduced electrical noise generation.

Motor and encoder are connected via a common ribbon cable.

For more information about installation and setup a detailed instruction manual is included with the product or is available online at www.faulhaber.com

Dimensional drawing

M 1:1



Encoder		L1 mm
IE3	2 Cable	162 ±10
IE3 L	2 Cable	150 ±10
AES	1 Cable	162 ±10

2250 S ... BX4 + Encoder

Brushless DC-Servomotor 2250 ... BX4 with Encoder		IE3-32	IE3-64	IE3-128	IE3-256	IE3 - 512	IE3 - 1024	
Lines per revolution	N	32	64	128	256	512	1024	
Frequency range [1], up to	f	15	30	60	120	240	430	kHz
Signal output, square wave		2+1 Index						channels
Supply voltage Encoder	$U_{DD\,Enc}$	4,5 ... 5,5						V DC
Current consumption, typical [2]	$I_{DD\,Enc}$	typ. 16, max. 23						mA
Output current, max. allowable [3]	I_{OUT}	4						mA
Index Pulse width [4]	P_O	90±45				90±75		°e
Phase shift, channel A to B [4]	Φ	90±45				90±75		°e
Signal rise/fall time, max. (C_{LOAD} = 50 pF)	tr/tf	0,1/0,1						µs
Inertia of encoder magnet	J	0,08						gcm^2

Connection information Motor								
Supply voltage Hallsensors [5]	U_{DD}	2,2 ...18				4,5 ... 5,5		V DC

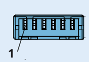
[1] speed (rpm) = f (Hz) x 60/N
[2] $U_{DD\,Enc}$ = 5 V: with unloaded outputs
[3] $U_{DD\,Enc}$ = 5 V: low logic level < 0,4 V, high logic level > 4,5 V: CMOS- and TTL compatible
[4] at 5 000 rpm
[5] IE3-32/64/128/256 $U_{DD} \neq U_{DD\,ENC}$ (galvanically isolated)
IE3-512 / 1 024 $U_{DD} = U_{DD\,ENC}$

Features / Connector information

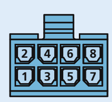
Options

- Connector variant (Option no. 3592)

Encoder:
AWG 28 / PVC ribbon cable
with connector PicoBlade (pitch 1,25 mm)



Motor:
AWG 26 / PVC ribbon cable
with connector Micro-Fit

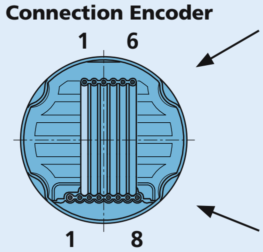


Full product description

- Examples:

2250S024BX4 IE3-1024

Connection Encoder



Connection Motor

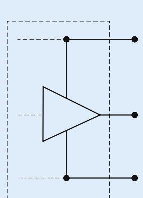
No.	Function
1	n.c.
2	Channel I (Index)
3	GND Enc
4	$U_{DD\,Enc}$
5	Channel B
6	Channel A

No.	Function
1	Phase C
2	Phase B
3	Phase A
4	GND
5	U_{DD}
6	Hall sensor C
7	Hall sensor B
8	Hall sensor A

Caution:
Incorrect lead connection will damage the motor electronics!

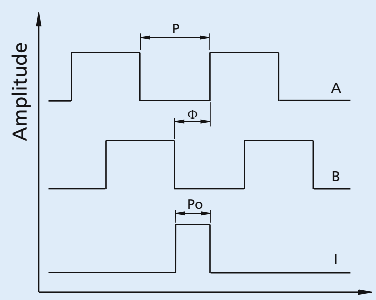
Output signals / Circuit diagram

Output circuit



Output signals

with clockwise rotation as seen from the shaft end



Admissible deviation of phase shift / Index pulse:

$$\Delta\Phi = \left| 90° - \frac{\Phi}{P} * 180° \right| \le 75° \qquad \Delta P_O = \left| 90° - \frac{P_O}{P} * 180° \right| \le 75°$$

Brushless DC-Servomotor 2250 ... BX4 with Encoder		IE3-32 L	IE3-64 L	IE3-128 L	IE3-256 L	IE3-512 L	IE3-1024 L	
Lines per revolution	N	32	64	128	256	512	1 024	
Frequency range [1], up to	f	15	30	60	120	240	430	kHz
Signal output, square wave		2 + 1 index and complementary outputs						channels
Supply voltage	$U_{DD\ Enc}$	4,5 ... 5,5						V DC
Current consumption, typical [2]	$I_{DD\ Enc}$	typ. 17, max. 25						mA
Index Pulse width [3]	P_0	90 ± 45				90 ± 75		°e
Phase shift, channel A to B [3]	Φ	90 ± 45				90 ± 75		°e
Inertia of encoder magnet	J	0,08						gcm²

[1] speed (rpm) = f (Hz) x 60/N
[2] $U_{DD\ Enc}$ = 5 V: with unloaded outputs
[3] at 5 000 rpm

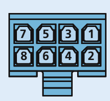
Notes: The output signals are TIA-422 compatible.
Examples of Line driver Receivers: ST26C32ABD (STM), ST26C32IP16 (EXAR), DS26C32AT (NSC).

Features / Connector information

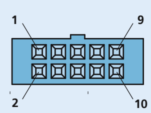
Options

- Connector variant (Option no.: 3589)

Motor:
AWG 26 / PVC ribbon cable
with connector Micro-Fit



Encoder:
AWG 28 / PVC ribbon cable
with connector DIN-41651 (pitch 2,54 mm)

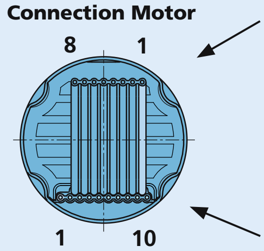


Full product description

- Examples:

2250S024BX4 IE3-1024 L

Connection Motor



Connection Encoder

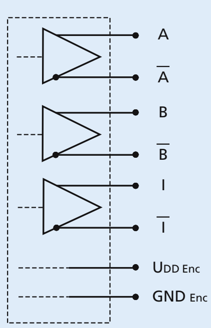
No.	Function
1	Phase C
2	Phase B
3	Phase A
4	GND
5	U_{DD} (2,2 ... 18V DC)
6	Hall sensor C
7	Hall sensor B
8	Hall sensor A

No.	Function
1	n.c.
2	$U_{DD\ Enc}$
3	GND Enc
4	n.c.
5	Channel $\overline{A}$
6	Channel A
7	Channel $\overline{B}$
8	Channel B
9	Channel $\overline{I}$ (Index)
10	Channel I (Index)

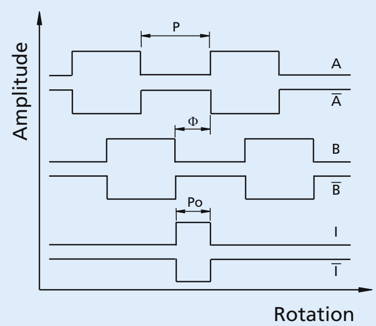
Caution:
Incorrect lead connection will damage the motor electronics!

Output signals / Circuit diagram

Output circuit



Output signals
with clockwise rotation as seen from the shaft end



Admissible deviation of phase shift / Index pulse:

$$\Delta\Phi = \left| 90° - \frac{\Phi}{P} * 180° \right| \leq 75° \qquad \Delta P_0 = \left| 90° - \frac{P_0}{P} * 180° \right| \leq 75°$$

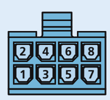
Brushless DC-Servomotor 2250 ... BX4 with Encoder		AES-4096	
Lines per revolution (resolution)	N	4 096	
Signal output		Synchronous Serial Interface (SSI)	
Supply voltage	$U_{DD\,Enc}$	4,5 ... 5,5	V DC
Current consumption, typical [1]	$I_{DD\,Enc}$	typ. 16, max. 23	mA
Output current, max. (DATA) [2]		4	mA
Clock Frequency, max. (CLK)		2	MHz
Input low level (CLK)		0 ... 0,8	V
Input high level (CLK)		2 ... $U_{DD\,Enc}$	V
Setup time after power on, max.	t_{setup}	4	ms
Operating temperature range		– 40 ... +100	°C

[1] $U_{DD\,Enc}$ = 5 V: with unloaded outputs
[2] $U_{DD\,Enc}$ = 5 V: low logic level ≤ 0,4 V, high logic level ≥ 4,6 V

Features / Connector information

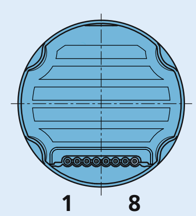
Options

- Connector variant (Option no. 3830)
  AWG 26 / PVC ribbon cable
  with connector Micro-Fit



Full product description

- Examples:
  2250S024BX4 AES-4096



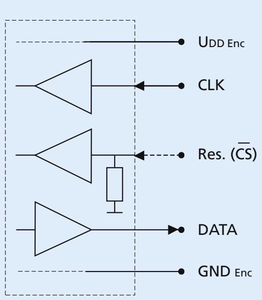
Connection Motor and Encoder

No.	Function
1	Phase C
2	Phase B
3	Phase A
4	GND Enc
5	$U_{DD\,Enc}$
6	CLK
7	Res. ($\overline{CS}$)
8	DATA

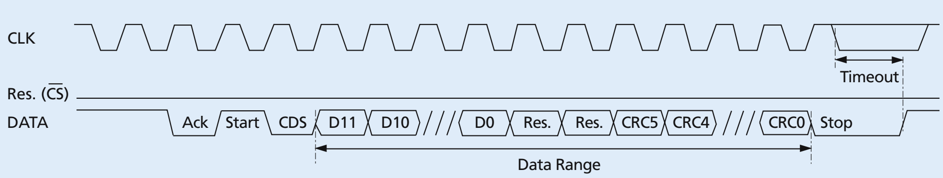
Caution:
Incorrect lead connection will damage the motor electronics!

Circuit diagram / Interface signals

Output circuit



Interface signals (SSI)



Angle position values are ascending for clockwise rotation.
Clockwise rotation as seen from the shaft end

Notes

Brushless DC-Servomotors

with integrated Encoder
4 Pole Technology

55 mNm

For combination with
Gearheads:
30/1(S), 32A, 32ALN, 32/3(S), 38/1(S), 38/2(S)

3242 ... BX4 + Encoders

	3242 G			012 BX4	024 BX4	
1	Nominal voltage	U_N		12	24	Volt
2	Terminal resistance, phase-phase	R		0,89	3,60	Ω
3	Output power [1]	$P_{2\ max.}$		21,2	21,1	W
4	Efficiency	$\eta_{\ max.}$		77,4	77,3	%
5	No-load speed	n_o		5 600	5 500	rpm
6	No-load current	I_o		0,206	0,103	A
7	Stall torque	M_H		282	279	mNm
8	Friction torque, static	C_o		1,3	1,3	mNm
9	Friction torque, dynamic	C_v		$5{,}2 \cdot 10^{-4}$	$5{,}2 \cdot 10^{-4}$	mNm/rpm
10	Speed constant	k_n		455	227	rpm/V
11	Back-EMF constant	k_E		2,199	4,409	mV/rpm
12	Torque constant	k_M		21,0	42,1	mNm/A
13	Current constant	k_I		0,0476	0,0238	A/mNm
14	Slope of n-M curve	$\Delta n/\Delta M$		19,3	19,4	rpm/mNm
15	Terminal inductance, phase-phase	L		60	240	µH
16	Mechanical time constant	τ_m		6,1	6,1	ms
17	Rotor inertia	J		30	30	gcm^2
18	Angular acceleration	$\alpha_{\ max.}$		94	93	$\cdot 10^3 rad/s^2$
19	Thermal resistance	$R_{th\ 1}$ / $R_{th\ 2}$	1,6 / 12,4			K/W
20	Thermal time constant	τ_{w1} / τ_{w2}	9 / 810			s
21	Operating temperature range		– 40 ... + 100			°C
22	Shaft bearings		ball bearings, preloaded			
23	Shaft load max.:					
	– radial at 3 000 rpm (4,5 mm from mounting flange)		50			N
	– axial at 3 000 rpm		5			N
	– axial at standstill		50			N
24	Shaft play:					
	– radial	≤	0,015			mm
	– axial	=	0			mm
25	Housing material		stainless steel			
26	Weight		194			g
27	Direction of rotation		electronically reversible			
28	Number of pole pairs		2			
	Recommended values - mathematically independent of each other					
29	Speed up to	$n_{e\ max.}$		14 000	14 000	rpm
30	Torque up to [1] [2]	$M_{e\ max.}$		32 / 55	32 / 54	mNm
31	Current up to [1] [2]	$I_{e\ max.}$		1,89 / 3,12	0,94 / 1,55	A

[1] at 5 000 rpm
[2] thermal resistance $R_{th\ 2}$ not reduced / thermal resistance $R_{th\ 2}$ by 55% reduced

Note:
The diagram indicates the recommended speed in relation to the available torque at the output shaft for a given ambient temperature of 22°C.

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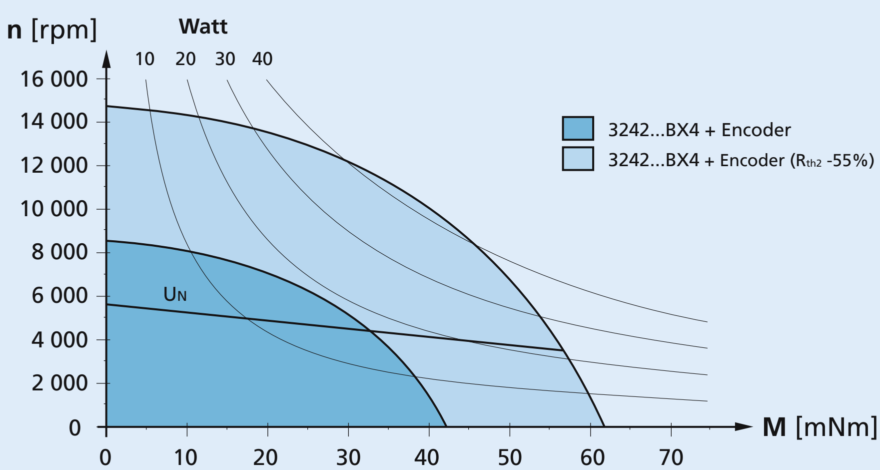

Recommended areas for continuous operation

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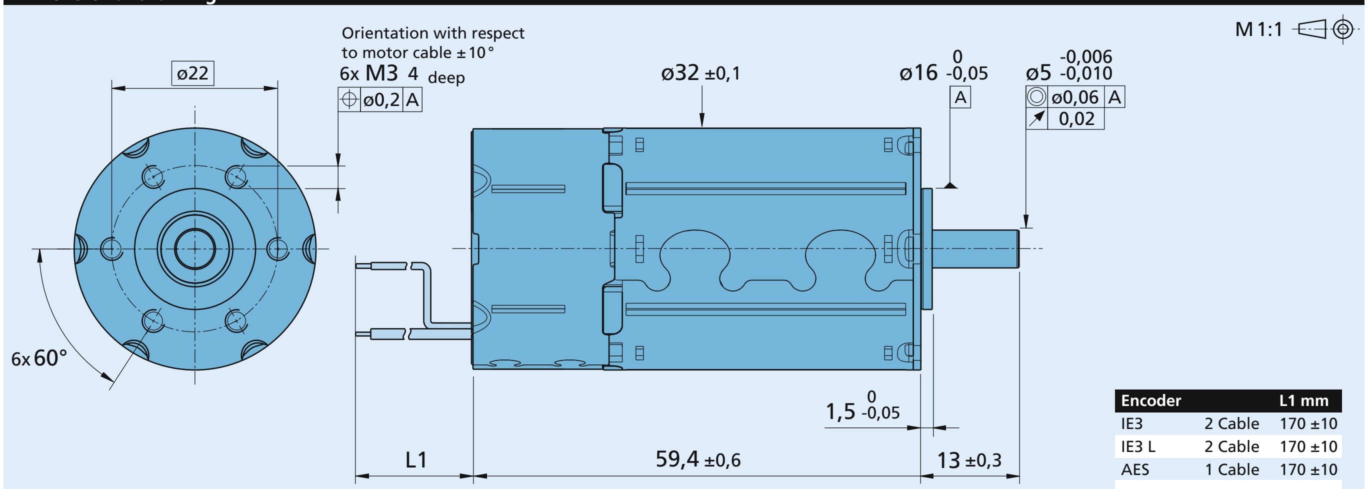
The absolute encoder is ideal for commutation, speed and position control of the motor. It can be used to create a sinusoidal commutation signal. The advantages are a reduced torque ripple, a higher efficiency, and reduced electrical noise generation.

Motor and encoder are connected via a common ribbon cable.

For more information about installation and setup a detailed instruction manual is included with the product or is available online at www.faulhaber.com

Dimensional drawing



3242 G ... BX4 + Encoder

Encoder		L1 mm
IE3	2 Cable	170 ±10
IE3 L	2 Cable	170 ±10
AES	1 Cable	170 ±10

Brushless DC-Servomotor 3242 ... BX4 with Encoder		IE3-32	IE3-64	IE3-128	IE3-256	IE3 - 512	IE3 - 1024	
Lines per revolution	N	32	64	128	256	512	1024	
Frequency range [1], up to	f	15	30	60	120	240	430	kHz
Signal output, square wave		2 + 1 Index						channels
Supply voltage Encoder	$U_{DD\,Enc}$	4,5 ... 5,5						V DC
Current consumption, typical [2]	$I_{DD\,Enc}$	typ. 16, max. 23						mA
Output current, max. allowable [3]	I_{OUT}	4						mA
Index Pulse width [4]	P_0	90 ± 45				90 ± 75		°e
Phase shift, channel A to B [4]	Φ	90 ± 45				90 ± 75		°e
Signal rise/fall time, max. (C_{LOAD} = 50 pF)	tr/tf	0,1 / 0,1						µs
Inertia of encoder magnet	J	0,08						gcm^2

Connection information Motor				
Supply voltage Hallsensors [5]	U_{DD}	2,2 ...18	4,5 ... 5,5	V DC

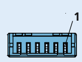
[1] speed (rpm) = f (Hz) x 60/N
[2] $U_{DD\,Enc}$ = 5 V: with unloaded outputs
[3] $U_{DD\,Enc}$ = 5 V: low logic level < 0,4 V, high logic level > 4,5 V: CMOS- and TTL compatible
[4] at 5 000 rpm
[5] IE3-32/64/128/256 $U_{DD} \neq U_{DD\,ENC}$ (galvanically isolated)
IE3-512 / 1 024 $U_{DD} = U_{DD\,ENC}$

Features / Connector information

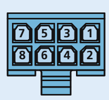
Options

- Connector variant (Option no. 3592)

Encoder:
AWG 28 / PVC ribbon cable
with connector PicoBlade (pitch 1,25 mm)



Motor:
AWG 24 / PVC ribbon cable
with connector Micro-Fit



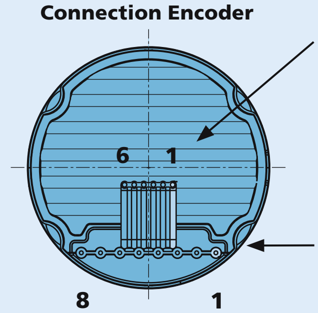
Full product description

- Examples:

3242G024BX4 IE3-1024

3242G012BX4 IE3-32

Connection Encoder



Connection Motor

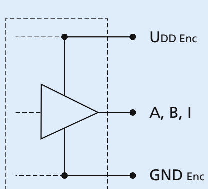
No.	Function
1	n.c.
2	Channel I (Index)
3	GND Enc
4	$U_{DD\,Enc}$
5	Channel B
6	Channel A

No.	Function
1	Phase C
2	Phase B
3	Phase A
4	GND
5	U_{DD}
6	Hall sensor C
7	Hall sensor B
8	Hall sensor A

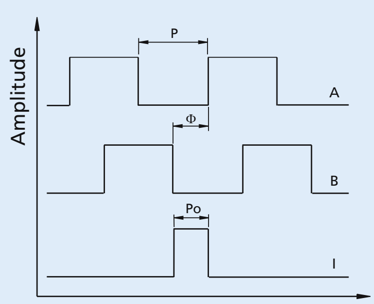
Caution:
Incorrect lead connection will damage the motor electronics!

Output signals / Circuit diagram

Output circuit



Output signals
with clockwise rotation as seen from the shaft end



Admissible deviation of phase shift / Index pulse:

$$\Delta\Phi = \left| 90° - \frac{\Phi}{P} * 180° \right| \leq 75° \qquad \Delta P_0 = \left| 90° - \frac{P_0}{P} * 180° \right| \leq 75°$$

Brushless DC-Servomotor 3242 ... BX4 with Encoder		IE3-32 L	IE3-64 L	IE3-128 L	IE3-256 L	IE3-512 L	IE3-1024 L	
Lines per revolution	N	32	64	128	256	512	1 024	
Frequency range [1], up to	f	15	30	60	120	240	430	kHz
Signal output, square wave		2 + 1 index and complementary outputs						channels
Supply voltage	$U_{DD\ Enc}$	4,5 ... 5,5						V DC
Current consumption, typical [2]	$I_{DD\ Enc}$	typ. 17, max. 25						mA
Index Pulse width [3]	P_0	90 ± 45				90 ± 75		°e
Phase shift, channel A to B [3]	Φ	90 ± 45				90 ± 75		°e
Inertia of encoder magnet	J	0,08						gcm^2

[1] speed (rpm) = f (Hz) x 60/N
[2] $U_{DD\ Enc}$ = 5 V: with unloaded outputs
[3] at 5 000 rpm

Notes: The output signals are TIA-422 compatible.
Examples of Line driver Receivers: ST26C32ABD (STM), ST26C32IP16 (EXAR), DS26C32AT (NSC).

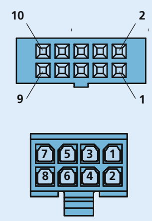
Features / Connector information

Options

- Connector variant (Option no.: 3589)

Encoder:
AWG 28 / PVC ribbon cable
with connector DIN-41651 (pitch 2,54 mm)

Motor:
AWG 24 / PVC ribbon cable
with connector Micro-Fit



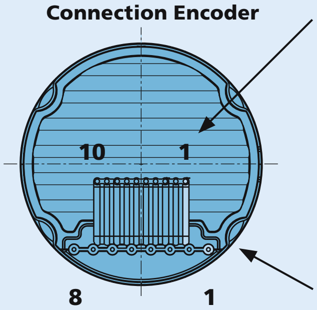
Full product description

- Examples:

3242G024BX4 IE3-1024 L

3242G012BX4 IE3-32 L

Connection Encoder



Connection Motor

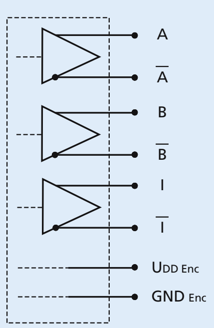
Caution:
Incorrect lead connection will damage the motor electronics!

No.	Function
1	n.c.
2	$U_{DD\ Enc}$
3	GND Enc
4	n.c.
5	Channel $\overline{A}$
6	Channel A
7	Channel $\overline{B}$
8	Channel B
9	Channel $\overline{I}$ (Index)
10	Channel I (Index)

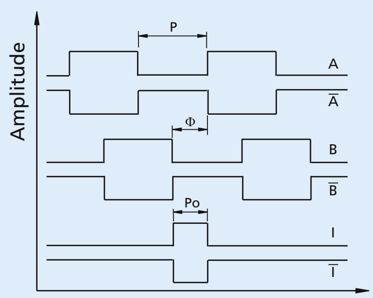
No.	Function
1	Phase C
2	Phase B
3	Phase A
4	GND
5	U_{DD} (2,2 ... 18V DC)
6	Hall sensor C
7	Hall sensor B
8	Hall sensor A

Output signals / Circuit diagram

Output circuit



Output signals
with clockwise rotation as seen from the shaft end



Admissible deviation of phase shift / Index pulse:

$$\Delta\Phi = \left|90° - \frac{\Phi}{P} * 180°\right| \leq 75° \qquad \Delta P_O = \left|90° - \frac{P_O}{P} * 180°\right| \leq 75°$$

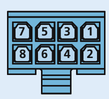
Brushless DC-Servomotor 3242 ... BX4 with Encoder		AES-4096	
Lines per revolution (resolution)	N	4 096	
Signal output		Synchronous Serial Interface (SSI)	
Supply voltage	$U_{DD\ Enc}$	4,5 ... 5,5	V DC
Current consumption, typical [1]	$I_{DD\ Enc}$	typ. 16, max. 23	mA
Output current, max. (DATA) [2]		4	mA
Clock Frequency, max. (CLK)		2	MHz
Input low level (CLK)		0 ... 0,8	V
Input high level (CLK)		2 ... $U_{DD\ Enc}$	V
Setup time after power on, max.	t_{setup}	4	ms
Operating temperature range		– 40 ... +100	°C

[1] $U_{DD\ Enc}$ = 5 V: with unloaded outputs
[2] $U_{DD\ Enc}$ = 5 V: low logic level ≤ 0,4 V, high logic level ≥ 4,6 V

Features / Connector information

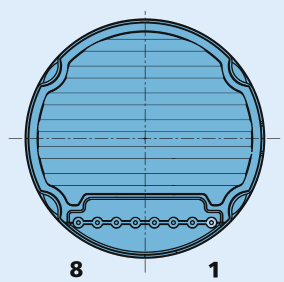
Options

- Connector variant (Option no. 3830)
  AWG 24 / PVC ribbon cable
  with connector Micro-Fit



Full product description

- Examples:
  3242G024BX4 AES-4096
  3242G012BX4 AES-4096



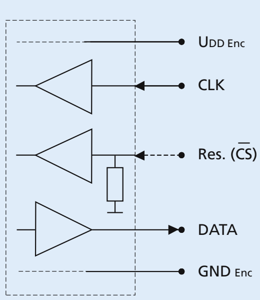
Connection Motor and Encoder

No.	Function
1	Phase C
2	Phase B
3	Phase A
4	GND Enc
5	$U_{DD\ Enc}$
6	CLK
7	Res. ($\overline{CS}$)
8	DATA

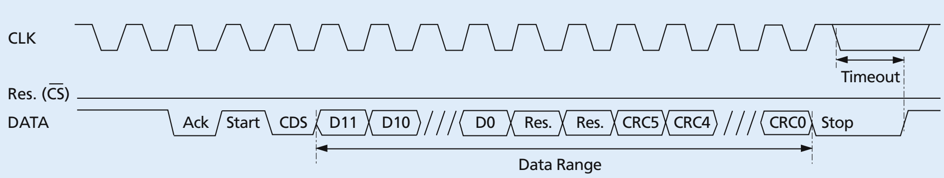
Caution:
Incorrect lead connection will damage the motor electronics!

Circuit diagram / Interface signals

Output circuit



Interface signals (SSI)



Angle position values are ascending for clockwise rotation.
Clockwise rotation as seen from the shaft end

Notes

Brushless DC-Servomotors

with integrated Encoder
4 Pole Technology

92 mNm

For combination with
Gearheads:
30/1(S), 32A, 32ALN, 32/3(S), 38/1(S), 38/2(S)

3268 ... BX4 + Encoders

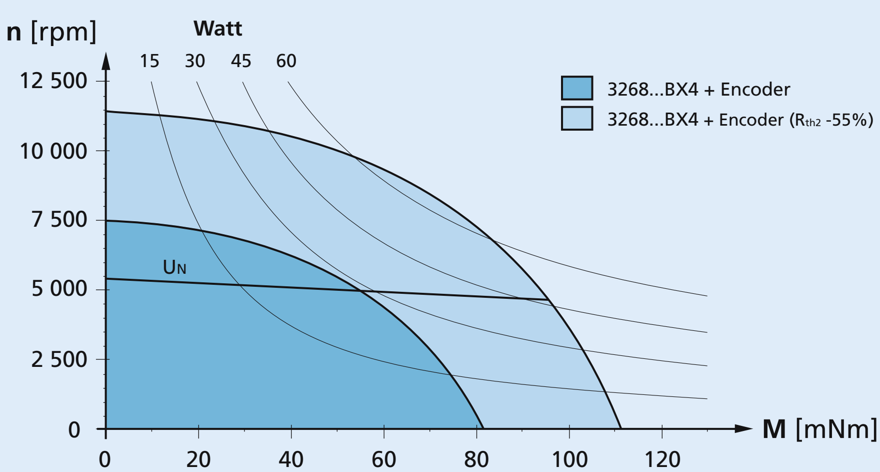
		3268 G		024 BX4	
1	Nominal voltage	U_N		24	Volt
2	Terminal resistance, phase-phase	R		1,45	Ω
3	Output power [1]	$P_{2\ max.}$		32,7	W
4	Efficiency	$\eta_{\ max.}$		79,5	%
5	No-load speed	n_o		5 500	rpm
6	No-load current	I_o		0,215	A
7	Stall torque	M_H		718	mNm
8	Friction torque, static	C_o		1,7	mNm
9	Friction torque, dynamic	C_v		$1,3 \cdot 10^{-3}$	mNm/rpm
10	Speed constant	k_n		220	rpm/V
11	Back-EMF constant	k_E		4,555	mV/rpm
12	Torque constant	k_M		43,5	mNm/A
13	Current constant	k_I		0,0230	A/mNm
14	Slope of n-M curve	$\Delta n/\Delta M$		7,3	rpm/mNm
15	Terminal inductance, phase-phase	L		110	µH
16	Mechanical time constant	τ_m		4,6	ms
17	Rotor inertia	J		60	gcm^2
18	Angular acceleration	$\alpha_{\ max.}$		120	$\cdot 10^3 rad/s^2$
19	Thermal resistance	$R_{th\ 1}$ / $R_{th\ 2}$	1,9 / 9,6		K/W
20	Thermal time constant	τ_{w1} / τ_{w2}	17 / 1 060		s
21	Operating temperature range		– 40 ... + 100		°C
22	Shaft bearings		ball bearings, preloaded		
23	Shaft load max.:				
	– radial at 3 000 rpm (4,5 mm from mounting flange)		50		N
	– axial at 3 000 rpm		5		N
	– axial at standstill		50		N
24	Shaft play:				
	– radial	≤	0,015		mm
	– axial	=	0		mm
25	Housing material		stainless steel		
26	Weight		307		g
27	Direction of rotation		electronically reversible		
28	Number of pole pairs		2		
Recommended values - mathematically independent of each other					
29	Speed up to	$n_{e\ max.}$		11 000	rpm
30	Torque up to [1] [2]	$M_{e\ max.}$		47 / 92	mNm
31	Current up to [1] [2]	$I_{e\ max.}$		1,41 / 2,59	A

[1] at 5 000 rpm
[2] thermal resistance $R_{th\ 2}$ not reduced / thermal resistance $R_{th\ 2}$ by 55% reduced

Note:
The diagram indicates the recommended speed in relation to the available torque at the output shaft for a given ambient temperature of 22°C.

The diagram shows the motor in a completely insulated as well as thermally coupled condition ($R_{th\ 2}$ 55% reduced).

The nominal voltage (U_N) curve shows the operating point at nominal voltage in the insulated and thermally coupled condition. Any points of operation above the curve at nominal voltage will require a higher operating voltage. Any points below the nominal voltage curve will require less voltage.



Recommended areas for continuous operation

Features

The brushless DC-servomotors feature in this version an Encoder that is available with different interfaces. A permanent magnet on the shaft creates a moving magnetic field which is captured using a single-chip angular sensor and further processed.

In the **IE3** version, the brushless DC servomotors have an encoder with 3 output channels. At the encoder outputs, two 90° phase-shifted rectangular signals are available with up to 1 024 impulses and an index impulse per motor revolution. The encoder is available in a variety of different resolutions and is suitable for speed control and positioning applications.

The Line Driver **IE3L** version has differential signal outputs (TIA-422). Differential signals reduce ambient interference and are suitable for applications with high ambient interference. The line driver amplifies the encoder signal which means that long cables can be used without signal degradation. Differential signal outputs must be decoded by the appropriate receiver module. The motor and encoder cables are connected via separate ribbon cables.
Other resolutions of 1 - 127 impulses are available on request.

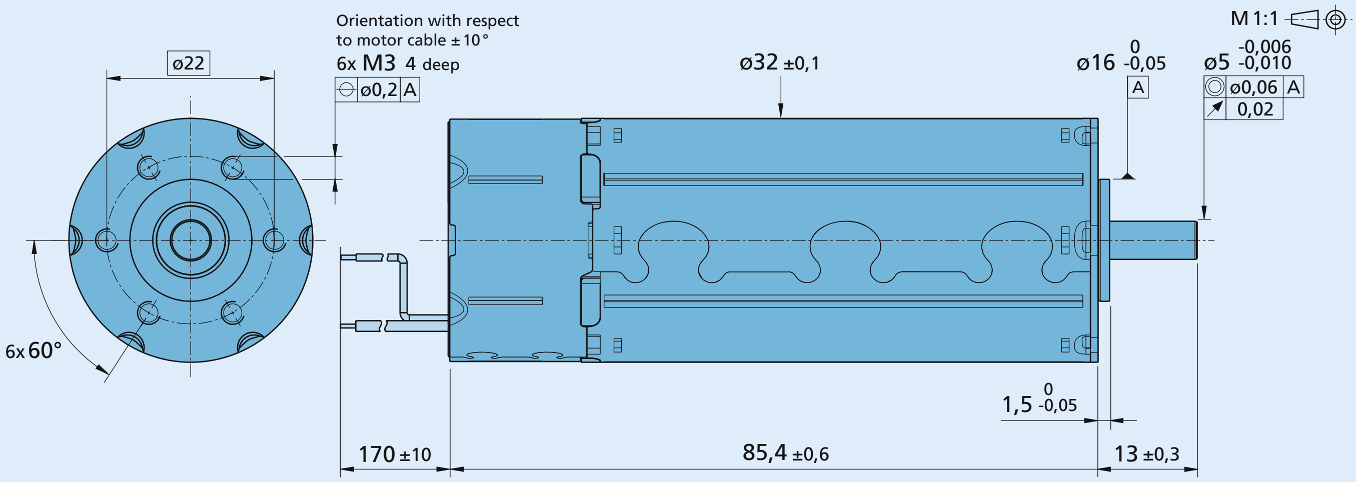
In the **AES** version (absolute encoder), absolute position information is provided with a resolution of 4096 steps per revolution at the signal outputs and communicated via a serial (SSI) interface. Absolute means, that each shaft position is assigned to a unique angular value within one revolution. This value is already available directly after power-on.

The absolute encoder is ideal for commutation, speed and position control of the motor. It can be used to create a sinusoidal commutation signal. The advantages are a reduced torque ripple, a higher efficiency, and reduced electrical noise generation.

Motor and encoder are connected via a common ribbon cable.

For more information about installation and setup a detailed instruction manual is included with the product or is available online at www.faulhaber.com

Dimensional drawing



3268 G ... BX4 + Encoder

Brushless DC-Servomotor 3268 ... BX4 with Encoder		IE3-32	IE3-64	IE3-128	IE3-256	IE3-512	IE3-1024	
Lines per revolution	N	32	64	128	256	512	1024	
Frequency range [1], up to	f	15	30	60	120	240	430	kHz
Signal output, square wave		2 + 1 Index						
Supply voltage Encoder	$U_{DD\,Enc}$	4,5 ... 5,5						V DC
Current consumption, typical [2]	$I_{DD\,Enc}$	typ. 16, max. 23						mA
Output current, max. allowable [3]	I_{OUT}	4						mA
Index Pulse width [4]	P_0	90 ± 45				90 ± 75		°e
Phase shift, channel A to B [4]	Φ	90 ± 45				90 ± 75		°e
Signal rise/fall time, max. (C_{LOAD} = 50 pF)	tr/tf	0,1 / 0,1						µs
Inertia of encoder magnet	J	0,08						gcm²

Connection information Motor								
Supply voltage Hallsensors [5]	U_{DD}	2,2 ...18				4,5 ... 5,5		V DC

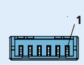
[1] speed (rpm) = f (Hz) x 60/N
[2] $U_{DD\,Enc}$ = 5 V: with unloaded outputs
[3] $U_{DD\,Enc}$ = 5 V: low logic level < 0,4 V, high logic level > 4,5 V: CMOS- and TTL compatible
[4] at 5 000 rpm
[5] IE3-32/64/128/256 $U_{DD} \neq U_{DD\,ENC}$ (galvanically isolated)
IE3-512 / 1 024 $U_{DD} = U_{DD\,ENC}$

Features / Connector information

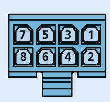
Options

- Connector variant (Option no. 3592)

Encoder:
AWG 28 / PVC ribbon cable
with connector PicoBlade (pitch 1,25 mm)



Motor:
AWG 24 / PVC ribbon cable
with connector Micro-Fit

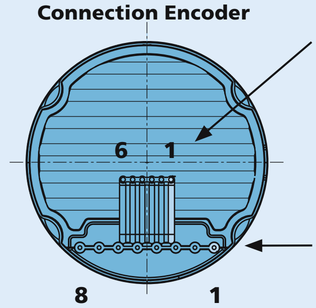


Full product description

- Examples:

3268G024BX4 IE3-1024

Connection Encoder



Connection Motor

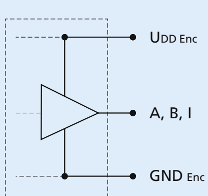
No.	Function
1	n.c.
2	Channel I (Index)
3	GND Enc
4	U_{DD} Enc
5	Channel B
6	Channel A

No.	Function
1	Phase C
2	Phase B
3	Phase A
4	GND
5	U_{DD}
6	Hall sensor C
7	Hall sensor B
8	Hall sensor A

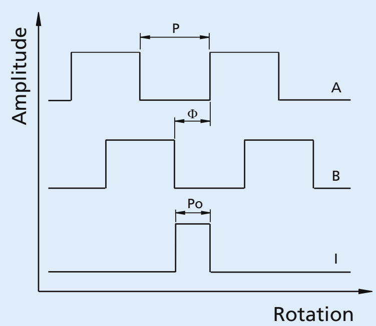
Caution:
Incorrect lead connection will damage the motor electronics!

Output signals / Circuit diagram

Output circuit



Output signals
with clockwise rotation as seen from the shaft end



Admissible deviation of phase shift / Index pulse:

$$\Delta\Phi = \left| 90° - \frac{\Phi}{P} * 180° \right| \leq 75° \qquad \Delta P_0 = \left| 90° - \frac{P_0}{P} * 180° \right| \leq 75°$$

Brushless DC-Servomotor 3268 ... BX4 with Encoder		IE3-32 L	IE3-64 L	IE3-128 L	IE3-256 L	IE3-512 L	IE3-1024 L	
Lines per revolution	N	32	64	128	256	512	1 024	
Frequency range [1], up to	f	15	30	60	120	240	430	kHz
Signal output, square wave		2 + 1 index and complementary outputs						channels
Supply voltage	$U_{DD\ Enc}$	4,5 ... 5,5						V DC
Current consumption, typical [2]	$I_{DD\ Enc}$	typ. 17, max. 25						mA
Index Pulse width [3]	P_0	90 ± 45				90 ± 75		°e
Phase shift, channel A to B [3]	Φ	90 ± 45				90 ± 75		°e
Inertia of encoder magnet	J	0,08						gcm^2

[1] speed (rpm) = f (Hz) x 60/N
[2] $U_{DD\ Enc}$ = 5 V: with unloaded outputs
[3] at 5 000 rpm

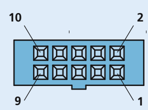
Notes: The output signals are TIA-422 compatible.
Examples of Line driver Receivers: ST26C32ABD (STM), ST26C32IP16 (EXAR), DS26C32AT (NSC).

Features / Connector information

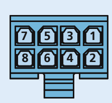
Options

- Connector variant (Option no.: 3589)

Encoder:
AWG 28 / PVC ribbon cable
with connector DIN-41651 (pitch 2,54 mm)



Motor:
AWG 24 / PVC ribbon cable
with connector Micro-Fit

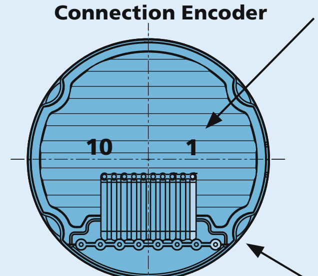


Full product description

- Examples:

3268G024BX4 IE3-1024 L

Connection Encoder



8 1

Connection Motor

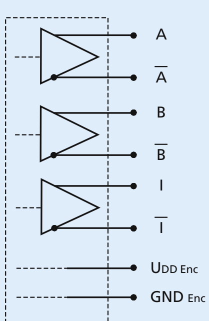
Caution:
Incorrect lead connection will damage the motor electronics!

No.	Function
1	n.c.
2	$U_{DD\ Enc}$
3	GND_{Enc}
4	n.c.
5	Channel $\overline{A}$
6	Channel A
7	Channel $\overline{B}$
8	Channel B
9	Channel $\overline{I}$ (Index)
10	Channel I (Index)

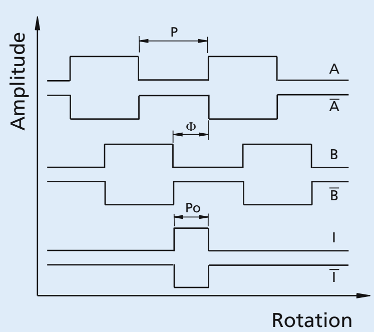
No.	Function
1	Phase C
2	Phase B
3	Phase A
4	GND
5	U_{DD} (2,2 ... 18V DC)
6	Hall sensor C
7	Hall sensor B
8	Hall sensor A

Output signals / Circuit diagram

Output circuit



Output signals
with clockwise rotation as seen from the shaft end



Admissible deviation of phase shift / Index pulse:

$$\Delta\Phi = \left| 90° - \frac{\Phi}{P} * 180° \right| \le 75° \qquad \Delta P_O = \left| 90° - \frac{P_O}{P} * 180° \right| \le 75°$$

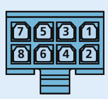
Brushless DC-Servomotor 3268 ... BX4 with Encoder		AES-4096	
Lines per revolution (resolution)	N	4 096	
Signal output		Synchronous Serial Interface (SSI)	
Supply voltage	$U_{DD\,Enc}$	4,5 ... 5,5	V DC
Current consumption, typical [1]	$I_{DD\,Enc}$	typ. 16, max. 23	mA
Output current, max. (DATA) [2]		4	mA
Clock Frequency, max. (CLK)		2	MHz
Input low level (CLK)		0 ... 0,8	V
Input high level (CLK)		2 ... $U_{DD\,Enc}$	V
Setup time after power on, max.	t_{setup}	4	ms
Operating temperature range		– 40 ... +100	°C

[1] $U_{DD\,Enc}$ = 5 V: with unloaded outputs
[2] $U_{DD\,Enc}$ = 5 V: low logic level ≤ 0,4 V, high logic level ≥ 4,6 V

Features / Connector information

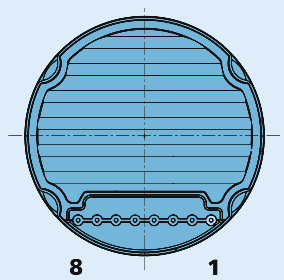
Options

- Connector variant (Option no. 3830)
  AWG 24 / PVC ribbon cable
  with connector Micro-Fit



Full product description

- Examples:
  3268G024BX4 AES-4 096



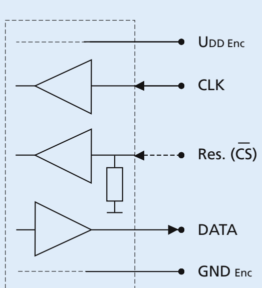
Connection Motor and Encoder

No.	Function
1	Phase C
2	Phase B
3	Phase A
4	GND Enc
5	$U_{DD\,Enc}$
6	CLK
7	Res. ($\overline{CS}$)
8	DATA

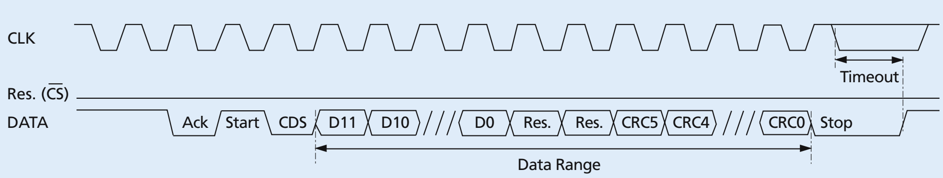
Caution:
Incorrect lead connection will damage the motor electronics!

Circuit diagram / Interface signals

Output circuit

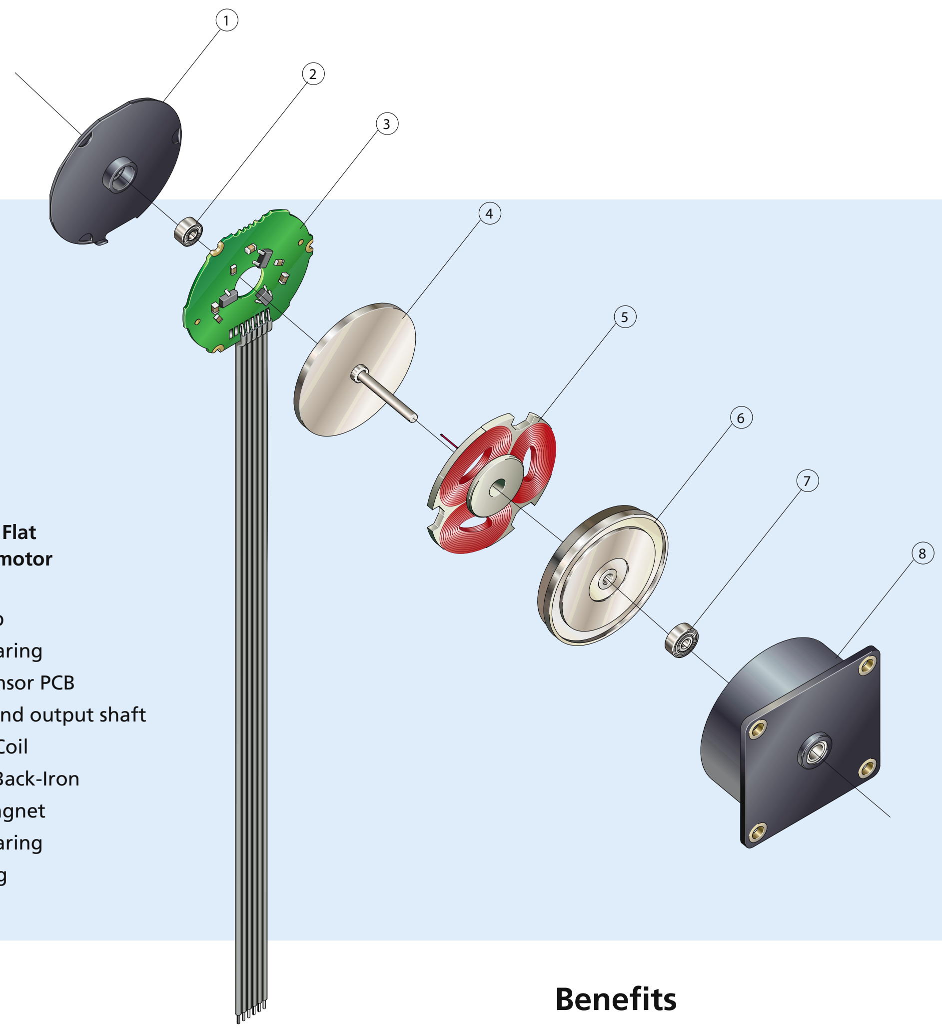


Interface signals (SSI)



Angle position values are ascending for clockwise rotation.
Clockwise rotation as seen from the shaft end

Brushless Flat DC-Micromotors



Brushless Flat DC-Micromotor

① End cap
② Ball bearing
③ Hall Sensor PCB
④ Rotor and output shaft
⑤ Stator Coil
⑥ Rotor, Back-Iron and Magnet
⑦ Ball bearing
⑧ Housing

Features

The heart of each brushless flat DC motor consists of the flat stator coils. The rotor is constructed of a high power rare earth magnet and two rotating discs which provide the back iron for an optimal use of the magnetic flux. The rotating back iron also serves to eliminate any cogging, or so-called detent torque which improves the inherent speed control properties of the motor drastically.

Thanks to the brushless commutation the motors can reach much higher operational lifetimes than conventional mechanically commutated DC motors.

Motor torque can be increased and motor speed reduced by the addition of an integrated reduction gearhead. The revolutionary integrated design provides for a wide variety of reduction ratios while maintaining a very flat profile.

Benefits

- No cogging torque
- Electronic commutation using three digital hall sensors
- Precise speed control
- Flat, light, and very compact

Product Code

26 10 T 012 B

26	Motor diameter [mm]
10	Motor length [mm]
T	Shaft type
012	Nominal voltage [V]
B	Type of commutation (electronic)

Brushless Flat DC-Micromotors

0,6 mNm

For combination with
Drive Electronics:
Speed Controller

Series 1509 ... B

		1509 T		006 B	012 B	
1	Nominal voltage	U_N		6	12	Volt
2	Terminal resistance, phase-phase	R		22,0	92,8	Ω
3	Output power 1)	$P_{2\ max.}$		0,31	0,30	W
4	Efficiency	$\eta_{\ max.}$		56	55	%
5	No-load speed	n_o		14 700	14 700	rpm
6	No-load current	I_o		0,0174	0,0087	A
7	Stall torque	M_H		0,97	0,92	mNm
8	Friction torque, static	C_o		0,025	0,025	mNm
9	Friction torque, dynamic	C_v		$2,6 \cdot 10^{-6}$	$2,6 \cdot 10^{-6}$	mNm/rpm
10	Speed constant	k_n		2 623	1 312	rpm/V
11	Back-EMF constant	k_E		0,381	0,762	mV/rpm
12	Torque constant	k_M		3,64	7,28	mNm/A
13	Current constant	k_I		0,275	0,137	A/mNm
14	Slope of n-M curve	$\Delta n/\Delta M$		15 856	16 721	rpm/mNm
15	Terminal inductance, phase-phase	L		590	2 350	µH
16	Mechanical time constant	τ_m		115	121	ms
17	Rotor inertia	J		0,69	0,69	gcm^2
18	Angular acceleration	$\alpha_{\ max.}$		14	13	$\cdot 10^3 rad/s^2$
19	Thermal resistance	$R_{th\ 1} / R_{th\ 2}$	65 / 45			K/W
20	Thermal time constant	τ_{w1} / τ_{w2}	10 / 130			s
21	Operating temperature range		-25 ... +80			°C
22	Shaft bearings		ball bearing, preloaded			
23	Shaft load max.:					
	– radial at 3 000/16 000 rpm (3 mm from mounting flange)		2,0 / 0,5			N
	– axial at 3 000/16 000 rpm (push-on only)		2,0 / 1,7			N
	– axial at standstill (push-on only)		15			N
24	Shaft play:					
	– radial	≤	0,015			mm
	– axial	=	0			mm
25	Housing material		plastic			
26	Weight		6,9			g
27	Direction of rotation		electronically reversible			

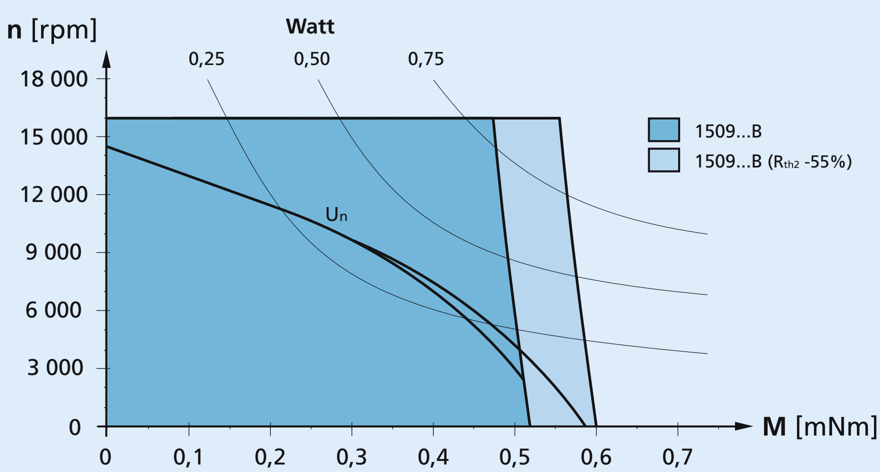
Recommended values - mathematically independent of each other						
28	Speed up to	$n_{e\ max.}$		16 000	16 000	rpm
29	Torque up to 1) 2)	$M_{e\ max.}$		0,52 / 0,60	0,51 / 0,58	mNm
30	Current up to 1) 2)	$I_{e\ max.}$		0,174/0,198	0,085/0,096	A

1) at 5 000 rpm
2) thermal resistance $R_{th\ 2}$ not reduced / thermal resistance $R_{th\ 2}$ by 55% reduced

Note:
The diagram indicates the recommended speed in relation to the available torque at the output shaft for a given ambient temperature of 22°C.

The diagram shows the motor in a completely insulated as well as thermally coupled condition ($R_{th\ 2}$ 55% reduced).

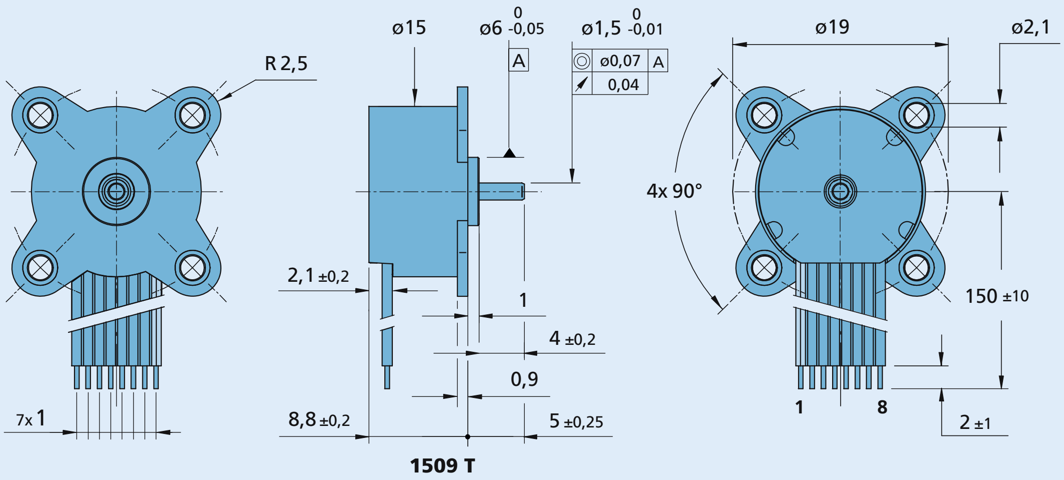
The nominal voltage curve shows the operating point at nominal voltage in the insulated and thermally coupled condition. Any points of operation above the curve at nominal voltage will require a higher operating voltage. Any points below the nominal voltage curve will require less voltage.



Recommended areas for continuous operation

1509 T ... B

Scale enlarged



Connection

No.	Function
1	Phase C
2	Phase B
3	Phase A
4	GND
5	+ 5V
6	Hall sensor C
7	Hall sensor B
8	Hall sensor A

Brushless DC-Gearmotors

30 mNm

For combination with
Drive Electronics:
Speed Controller

Series 1515 ... B

1515 U			006 B	012 B	
1 Nominal voltage	U_N		6	12	Volt
2 Terminal resistance, phase-phase	R		22,0	92,8	Ω
3 Output power	$P_{2\ max.}$		0,31	0,30	W
4 Efficiency	$\eta_{max.}$		56	55	%
5 No-load speed	n_o		14 700	14 700	rpm
6 No-load current	I_o		0,0174	0,0087	A
7 Stall torque	M_H		0,97	0,92	mNm
8 Friction torque, static	C_o		0,025	0,025	mNm
9 Friction torque, dynamic	C_v		$2,6 \cdot 10^{-6}$	$2,6 \cdot 10^{-6}$	mNm/rpm
10 Speed constant	k_n		2 623	1 312	rpm/V
11 Back-EMF constant	k_E		0,381	0,762	mV/rpm
12 Torque constant	k_M		3,64	7,28	mNm/A
13 Current constant	k_I		0,275	0,137	A/mNm
14 Slope of n-M curve	$\Delta n/\Delta M$		15 856	16 721	rpm/mNm
15 Terminal inductance, phase-phase	L		590	2 350	µH
16 Mechanical time constant	τ_m		115	121	ms
17 Rotor inertia	J		0,69	0,69	gcm^2
18 Angular acceleration	$\alpha_{max.}$		14	13	$\cdot 10^3 rad/s^2$
19 Thermal resistance	R_{th1} / R_{th2}	65 / 45			K/W
20 Thermal time constant	τ_{w1} / τ_{w2}	10 / 130			s

Integrated Gearhead			
Housing material		plastic	
Geartrain material		metal	
Backlash, at no-load	≤	4	°
Bearings on output shaft		plastic / brass bearing	
Shaft load max.:			
– radial (5 mm from mounting face)	≤	1,4	N
– axial	≤	0,3	N
Shaft press fit force, max.	≤	5	N
Shaft play:			
– radial (5 mm from mounting face)	≤	0,08	mm
– axial	≤	0,25	mm
Operating temperature range		– 25 ... + 80	°C

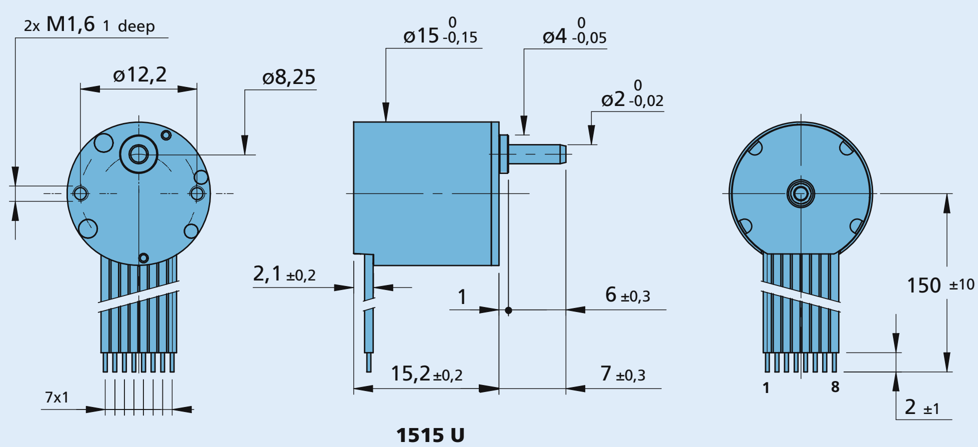
Specifications

reduction ratio (rounded)	output speed up to n_{max} rpm	weight with motor g	output torque continuous operation M_{max} mNm	output torque intermittent operation M_{max} mNm	direction of rotation (reversible)	efficiency %
6 : 1	779	6,9	1,4	3	=	81
13 : 1	372	7,0	2,8	5	≠	73
39 : 1	129	7,2	7,0	10	=	60
112 : 1	45	7,4	19,8	30	≠	59
324 : 1	15	7,7	30,0	50	=	53

Note: output speed at 5000 rpm input speed. Based on motor 1509 ... B.

1515 U ... B

Scale enlarged



Connection

No.	Function
1	Phase C
2	Phase B
3	Phase A
4	GND
5	+ 5V
6	Hall sensor C
7	Hall sensor B
8	Hall sensor A

Brushless Flat DC-Micromotors

3,8 mNm

For combination with
Drive Electronics:
Speed Controller

Series 2610 ... B

	2610 T			006 B	012 B	
1	Nominal voltage	U_N		6	12	Volt
2	Terminal resistance, phase-phase	R		7,0	28,2	Ω
3	Output power [1]	$P_{2\ max.}$		1,92	1,91	W
4	Efficiency	$\eta_{max.}$		78	78	%
5	No-load speed	n_o		6 200	6 200	rpm
6	No-load current	I_o		0,012	0,006	A
7	Stall torque	M_H		7,73	7,68	mNm
8	Friction torque, static	C_o		0,025	0,025	mNm
9	Friction torque, dynamic	C_v		$1{,}35 \cdot 10^{-5}$	$1{,}35 \cdot 10^{-5}$	mNm/rpm
10	Speed constant	k_n		1 055	528	rpm/V
11	Back-EMF constant	k_E		0,948	1,895	mV/rpm
12	Torque constant	k_M		9,05	18,1	mNm/A
13	Current constant	k_I		0,111	0,055	A/mNm
14	Slope of n-M curve	$\Delta n/\Delta M$		816	822	rpm/mNm
15	Terminal inductance, phase-phase	L		480	1 940	µH
16	Mechanical time constant	τ_m		69	70	ms
17	Rotor inertia	J		8,1	8,1	gcm^2
18	Angular acceleration	$\alpha_{max.}$		9,5	9,5	$\cdot 10^3 rad/s^2$
19	Thermal resistance	$R_{th\ 1}$ / $R_{th\ 2}$	33 / 27			K/W
20	Thermal time constant	τ_{w1} / τ_{w2}	20 / 230			s
21	Operating temperature range		-25 ... +80			°C
22	Shaft bearings		ball bearing, preloaded			
23	Shaft load max.:					
	– radial at 3 000/7 000 rpm (3 mm from mounting flange)		4,0 / 3,5			N
	– axial at 3 000/7 000 rpm (push-on only)		3,5 / 3,4			N
	– axial at standstill (push-on only)		17,5			N
24	Shaft play:					
	– radial	≤	0,015			mm
	– axial	=	0			mm
25	Housing material		plastic			
26	Weight		20,1			g
27	Direction of rotation		electronically reversible			

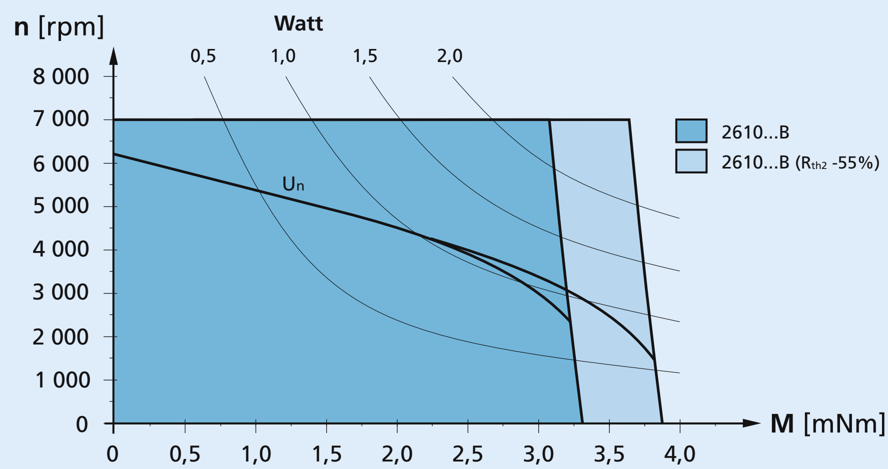
Recommended values - mathematically independent of each other						
28	Speed up to	$n_{e\ max.}$		7 000	7 000	rpm
29	Torque up to [1] [2]	$M_{e\ max.}$		3,24 / 3,77	3,23 / 3,75	mNm
30	Current up to [1] [2]	$I_{e\ max.}$		0,416 / 0,481	0,207 / 0,240	A

[1] at 5 000 rpm
[2] thermal resistance $R_{th\ 2}$ not reduced / thermal resistance $R_{th\ 2}$ by 55% reduced

Note:
The diagram indicates the recommended speed in relation to the available torque at the output shaft for a given ambient temperature of 22°C.

The diagram shows the motor in a completely insulated as well as thermally coupled condition ($R_{th\ 2}$ 55% reduced).

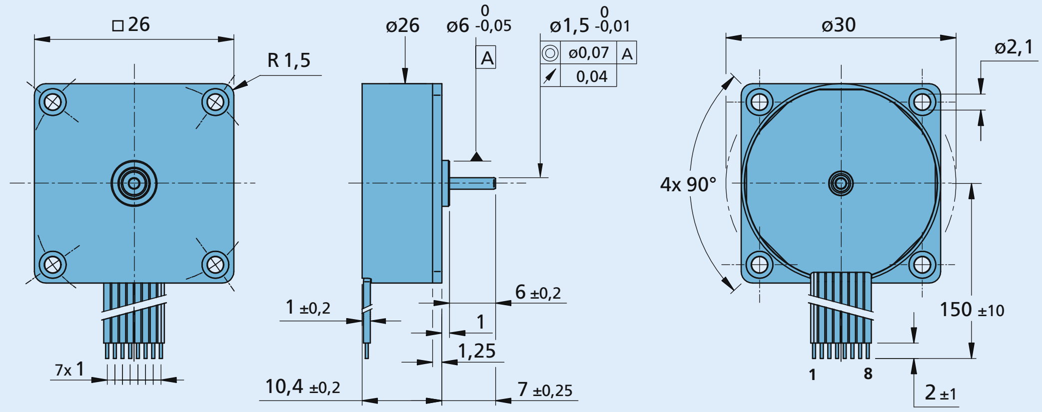
The nominal voltage curve shows the operating point at nominal voltage in the insulated and thermally coupled condition. Any points of operation above the curve at nominal voltage will require a higher operating voltage. Any points below the nominal voltage curve will require less voltage.



Recommended areas for continuous operation

2610 T ... B

M 1:1



2610 T

Connection

No.	Function
1	Phase C
2	Phase B
3	Phase A
4	GND
5	+ 5V
6	Hall sensor C
7	Hall sensor B
8	Hall sensor A

Brushless DC-Gearmotors

100 mNm

For combination with
Drive Electronics:
Speed Controller

Series 2622 ... B

	2622 S		006 B	012 B	
1 Nominal voltage	U_N		6	12	Volt
2 Terminal resistance, phase-phase	R		7,0	28,2	Ω
3 Output power	$P_{2\ max.}$		1,92	1,91	W
4 Efficiency	$\eta_{max.}$		78	78	%
5 No-load speed	n_o		6 200	6 200	rpm
6 No-load current	I_o		0,012	0,006	A
7 Stall torque	M_H		7,73	7,68	mNm
8 Friction torque, static	C_o		0,025	0,025	mNm
9 Friction torque, dynamic	C_v		$1,35 \cdot 10^{-5}$	$1,35 \cdot 10^{-5}$	mNm/rpm
10 Speed constant	k_n		1 055	528	rpm/V
11 Back-EMF constant	k_E		0,948	1,895	mV/rpm
12 Torque constant	k_M		9,05	18,1	mNm/A
13 Current constant	k_I		0,111	0,055	A/mNm
14 Slope of n-M curve	$\Delta n/\Delta M$		816	822	rpm/mNm
15 Terminal inductance, phase-phase	L		480	1 940	µH
16 Mechanical time constant	τ_m		69	70	ms
17 Rotor inertia	J		8,1	8,1	gcm^2
18 Angular acceleration	$\alpha_{max.}$		9,5	9,5	$\cdot 10^3 rad/s^2$
19 Thermal resistance	R_{th1} / R_{th2}	33 / 27			K/W
20 Thermal time constant	τ_{w1} / τ_{w2}	20 / 230			s

Integrated Gearhead			
Housing material		plastic	
Geartrain material		metal	
Backlash, at no-load	≤	4	°
Bearings on output shaft		ball bearing	
Shaft load max.:			
– radial (5 mm from mounting face)	≤	15	N
– axial	≤	5	N
Shaft press fit force, max.	≤	10	N
Shaft play:			
– radial (5 mm from mounting face)	≤	0,03	mm
– axial	≤	0,25	mm
Operating temperature range		– 25 ... + 80	°C

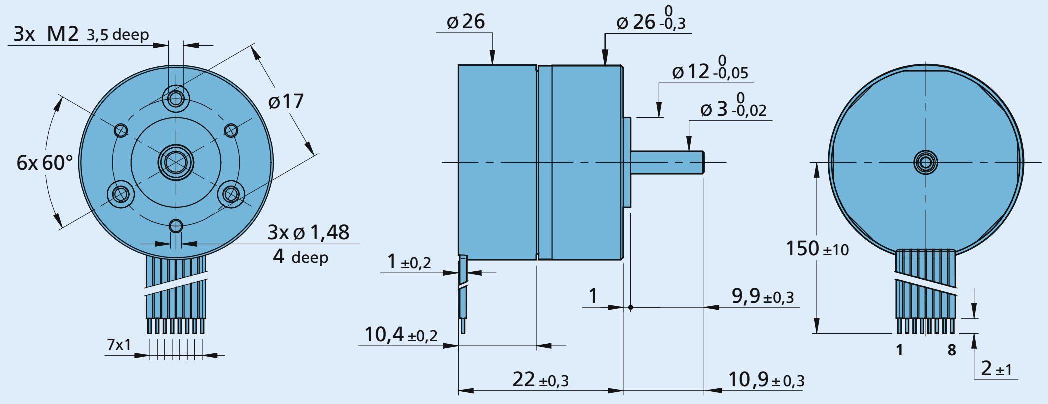
Specifications

reduction ratio (rounded)	output speed up to n_{max} rpm	weight with motor g	output torque continuous operation M_{max} mNm	output torque intermittent operation M_{max} mNm	direction of rotation (reversible)	efficiency %
8 : 1	635	25	9	30	=	81
22 : 1	223	26	23	75	≠	73
33 : 1	151	26	30	100	=	60
112 : 1	44	27	93	180	≠	59
207 : 1	24	27	100	180	=	53
361 : 1	14	27	100	180	=	53
814 : 1	6	28	100	180	=	43
1 257 : 1	4	29	100	180	=	43

Note: output speed at 5000 rpm input speed. Based on motor 2610 ... B.

2622 S ... B

M1:1



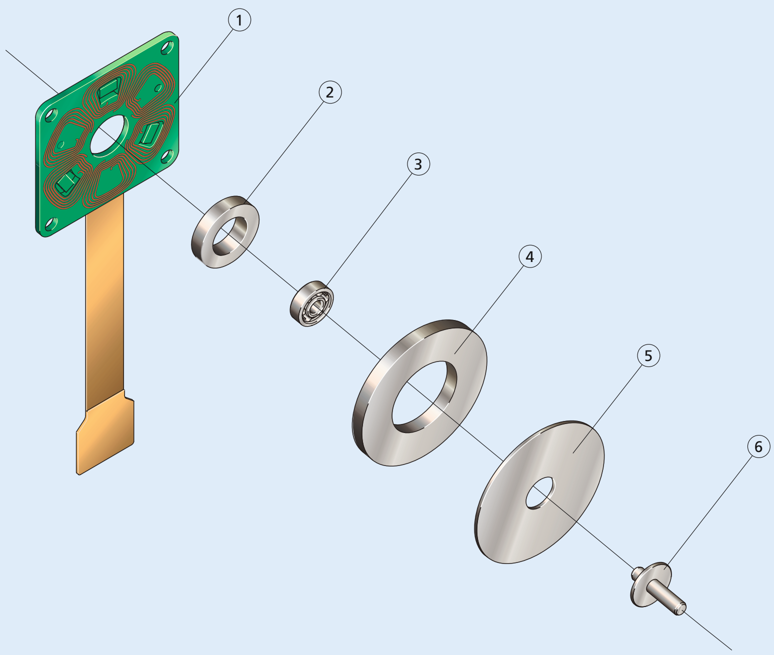
2622 S

Connection

No.	Function
1	Phase C
2	Phase B
3	Phase A
4	GND
5	+ 5V
6	Hall sensor C
7	Hall sensor B
8	Hall sensor A

Brushless Flat DC-Micromotors

penny-motor® Technology



Brushless Flat DC-Micromotor

① PCB with coil
② Bearing support
③ Ball bearing
④ Magnet
⑤ Rotor disc
⑥ Shaft

Features

The extremely flat design of the brushless penny-motor® is made possible by innovative coil design. Instead of being mechanically wound, it is fabricated by means of photo-lithographic processes. High power neodymium magnets (NdFeB) and a precise bearing system complete the motors for exceptional torque and smooth performance despite their extremely flat dimensions.

Motors with integrated spur gears are available with coaxial or eccentric shafts for higher torque in a compact form. The motors are electronically commutated for extremely long operational lifetime. They are particularly suited for applications where precise speed control and continuous duty operation are a must; for example in high precision optical filters, choppers or scanning devices.

Benefits

- Ultra flat design
- No cogging and precise speed control
- Exceptional power to volume ratio
- Very low current consumption
- High operational lifetime

Product Code

1202 H 004 BH

12	Motor diameter [mm]
02	Motor height [mm]
H	Shaft type
004	Nominal voltage [V]
B	Type of commutation (brushless)
H	Hall sensors

Brushless Flat DC-Micromotors

penny-motor® Technology

0,16 mNm

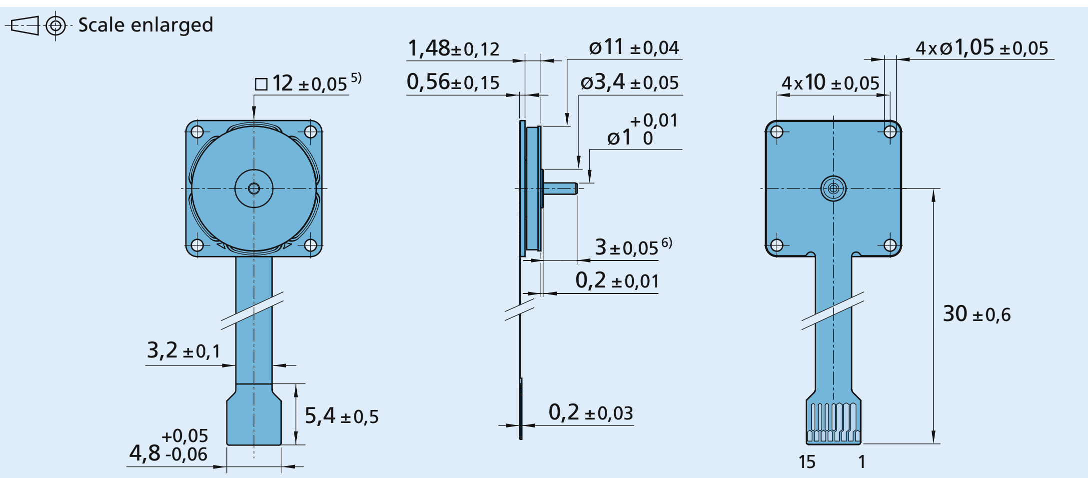
For combination with
Drive Electronics:
Speed controller with adapter board

Series 1202 ... BH

	1202 H		004 BH	006 BH	
Nominal voltage	U_N		4	6	V
Terminal resistance, phase-phase	R		16	70	Ω
Output power [1]	$P_{2\ max.}$		0,652	0,492	W
Efficiency	$\eta_{max.}$		51	42	%
No-load speed	n_o		41 740	37 600	rpm
No-load current	I_o		0,028	0,015	A
Stall torque	M_H		0,222	0,124	mNm
Friction torque, static	C_o		0,003	0,003	mNm
Friction torque, dynamic	C_v		$0{,}52 \cdot 10^{-6}$	$0{,}52 \cdot 10^{-6}$	mNm/rpm
Speed constant	k_n		10 587	6 431	rpm/V
Back-EMF constant	k_E		0,094	0,156	mV/rpm
Torque constant	k_M		0,902	1,485	mNm/A
Current constant	k_I		1,109	0,673	A/mNm
Slope of n-M curve	$\Delta n/\Delta M$		187 793	303 121	rpm/mNm
Terminal inductance, phase-phase	L		26	58	µH
Mechanical time constant	τ_m		246	397	ms
Rotor inertia	J		0,125	0,125	gcm^2
Angular acceleration	$\alpha_{max.}$		$18 \cdot 10^3$	$10 \cdot 10^3$	rad/s^2
Thermal resistance	$R_{th\ 1}$ / $R_{th\ 2}$	0 / 94			K/W
Operating temperature range		-30 ... +85			°C
Shaft bearing		ball bearing			
Shaft load max.:					
– radial at 10 000 rpm (at shaft step ø3,4 mm)		0,6			N
– axial at 10 000 rpm (axial push-on only)		1			N
– axial at standstill (axial push-on only)		1			N
Shaft play:					
– radial	≤	0,011			mm
– axial	≤	0,060			mm
Number of pole pairs		4			
Weight		1,1			g
Direction of rotation		electronically reversible			

Recommended values - mathematically independent of each other					
Speed up to	$n_{e\ max.}$		40 000	40 000	rpm
Torque up to [2] [3]	$M_{e\ max.}$		0,16	0,12	mNm
Thermal current up to [3] [4]	$I_{e\ max.}$		0,199	0,095	A

[1] at 40 000 rpm [2] at 10 000 rpm [3] thermal resistance $R_{th\ 2}$ not reduced [4] at standstill



[5] also available with round stator ø12±0,05
[6] also available with 1 mm output shaft length

1202 H

Connection

No.	Function
1	Star point
2	Phase A
3	Phase A
4	Phase B
5	Phase B
6	Phase C
7	Phase C
8	Hall sensor In +
9	Hall sensor In -
10	analog Hall A Out +
11	analog Hall A Out -
12	analog Hall B Out +
13	analog Hall B Out -
14	analog Hall C Out +
15	analog Hall C Out -

Connectors
15-pole; 0,3 mm pitch; e.g.:
Hirose: FH23-15S-0.3SHAW (05)

Brushless DC-Gearmotors

penny-motor® Technology

5 mNm

For combination with
Drive Electronics:
Speed controller with adapter board

Series 1307 ... BH

Integrated Motor	1307 C	004 BH	006 BH	
Nominal voltage	U_N	4	6	V
Terminal resistance, phase-phase	R	16	70	Ω
Output power [1]	$P_{2\ max.}$	0,206	0,157	W
Efficiency	$\eta_{max.}$	52	43	%
No-load speed	n_o	37 630	34 770	rpm
No-load current	I_o	0,026	0,015	A
Stall torque	M_H	0,249	0,136	mNm
Speed constant	k_n	9 502	5 902	rpm/V
Back-EMF constant	k_E	0,105	0,169	mV/rpm
Torque constant	k_M	1,005	1,618	mNm/A
Current constant	k_I	0,995	0,618	A/mNm
Slope of n-M curve	$\Delta n/\Delta M$	151 272	255 336	rpm/mNm
Rotor inertia	J	0,16	0,16	gcm^2

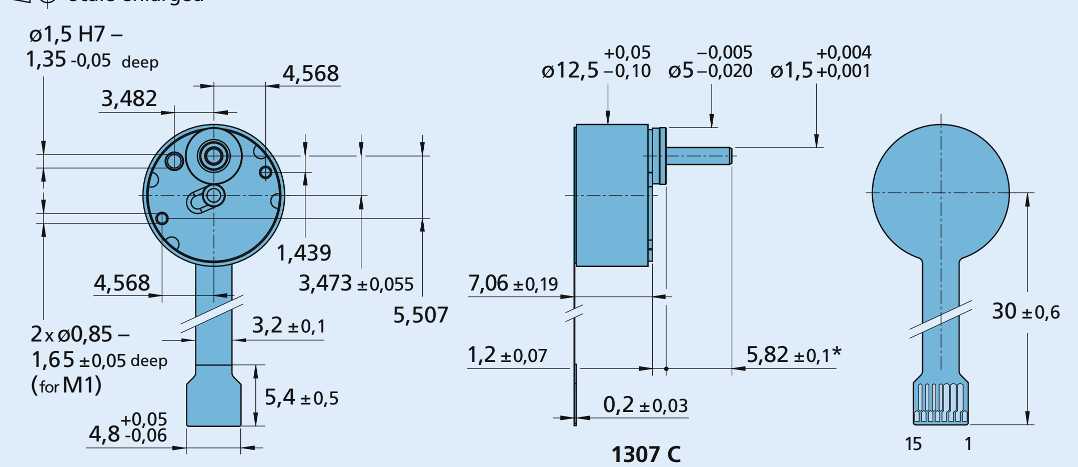
Drive system			
Housing material / Geartrain material		plastic / metal	
Shaft bearing		combination ball bearings + sleeve bearings	
Shaft load max.:			
– radial at 10 000 rpm (1,5 mm from bearing)	≤	0,5	N
– axial at 10 000 rpm	≤	0,1	N
– axial at standstill	≤	5	N
Shaft play:			
– radial (3 mm from bearing face)	≤	0,12	mm
– axial	≤	0,2	mm
Operating temperature range		0 ... + 85	°C

Recommended values - mathematically independent of each other				
Speed up to	$n_{e\ max}$	10 000	10 000	min^{-1}
Current up to (thermal limits) [2) 3)]	$I_{e\ max}$	0,205	0,098	A

1) at 10 000 min^{-1} 2) thermal resistance R_{th2} not reduced 3) at standstill

Integrated Gearhead			004 BH		006 BH			
reduction ratio (rounded)	output speed up to n_{max} rpm	weight with motor g	output torque continuous operation $M_{max.}$ mNm	output torque intermittent operation $M_{max.}$ mNm	output torque continuous operation $M_{max.}$ mNm	output torque intermittent operation $M_{max.}$ mNm	direction of rotation (reversible)	efficiency %
6 : 1	1 639	2,1	1,0	1,9	0,8	1,5	=	88
11 : 1	893	2,2	1,6	3,3	1,3	2,6	≠	82
32 : 1	310	2,3	4,4	8,9	3,5	7,1	=	77
93 : 1	107	2,4	5,0	15,0	5,0	15,0	≠	72
270 : 1	37	2,5	5,0	15,0	5,0	15,0	=	68
659 : 1	15	3,5	5,0	15,0	5,0	15,0	≠	64

Scale enlarged



* also available with 2,82 mm output shaft length

Connection

No.	Function
1	Star point
2	Phase A
3	Phase A
4	Phase B
5	Phase B
6	Phase C
7	Phase C
8	Hall sensor In+
9	Hall sensor In-
10	analog Hall A Out+
11	analog Hall A Out-
12	analog Hall B Out+
13	analog Hall B Out-
14	analog Hall C Out+
15	analog Hall C Out-

Connectors
15-pole; 0,3 mm pitch; e.g.:
Hirose: FH23-15S-0.3SHAW (05)

Brushless DC-Gearmotors

penny-motor® Technology

5 mNm

For combination with
Drive Electronics:
Speed controller with adapter board

Series 1309 ... BH

Integrated Motor	1309 C		004 BH	006 BH	
Nominal voltage	U_N		4	6	V
Terminal resistance, phase-phase	R		16	70	Ω
Output power [1]	$P_{2\ max.}$		0,206	0,157	W
Efficiency	$\eta_{max.}$		52	43	%
No-load speed	n_o		37 630	34 770	rpm
No-load current	I_o		0,026	0,015	A
Stall torque	M_H		0,249	0,136	mNm
Speed constant	k_n		9 502	5 902	rpm/V
Back-EMF constant	k_E		0,105	0,169	mV/rpm
Torque constant	k_M		1,005	1,618	mNm/A
Current constant	k_I		0,995	0,618	A/mNm
Slope of n-M curve	$\Delta n/\Delta M$		151 272	255 336	rpm/mNm
Rotor inertia	J		0,16	0,16	gcm^2

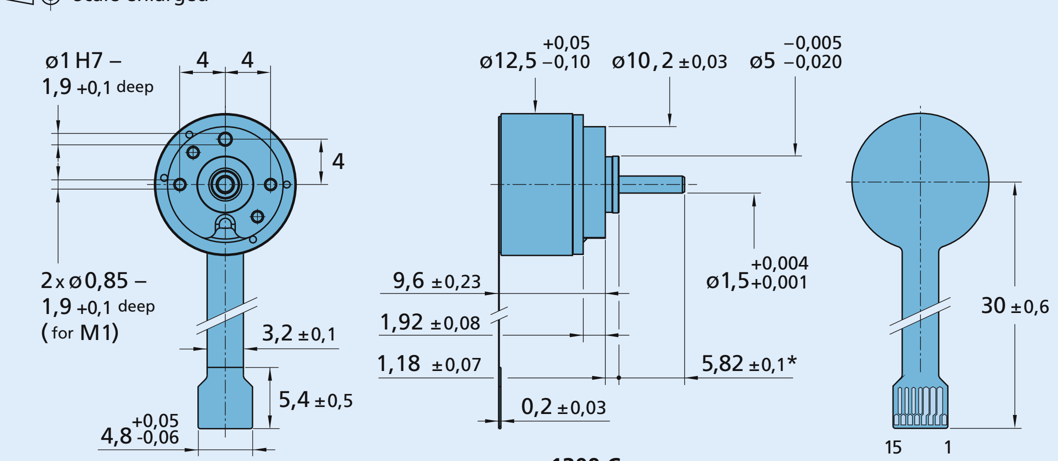
Drive system			
Housing material / Geartrain material		plastic / metal	
Shaft bearing		combination ball bearings + sleeve bearings	
Shaft load max.:			
– radial at 10 000 rpm (1,5 mm from bearing)	≤	0,5	N
– axial at 10 000 rpm	≤	0,1	N
– axial at standstill	≤	5	N
Shaft play:			
– radial (3 mm from bearing face)	≤	0,12	mm
– axial	≤	0,2	mm
Operating temperature range		0 ... + 85	°C

Recommended values - mathematically independent of each other					
Speed up to	$n_{e\ max}$		10 000	10 000	min^{-1}
Current up to (thermal limits) [2] [3]	$I_{e\ max}$		0,205	0,098	A

[1] at 10 000 min^{-1} [2] thermal resistance R_{th2} not reduced [3] at standstill

Integrated Gearhead reduction ratio (rounded)	output speed up to n_{max} rpm	weight with motor g	004 BH output torque continuous operation $M_{max.}$ mNm	004 BH output torque intermittent operation $M_{max.}$ mNm	006 BH output torque continuous operation $M_{max.}$ mNm	006 BH output torque intermittent operation $M_{max.}$ mNm	direction of rotation (reversible)	efficiency %
17 : 1	592	2,6	2,5	5,0	2,0	3,9	≠	82
31 : 1	323	2,7	4,3	8,5	3,4	6,8	=	77
90 : 1	111	2,8	5,0	15,0	5,0	15,0	≠	72
259 : 1	39	2,9	5,0	15,0	5,0	15,0	=	68
749 : 1	13	2,9	5,0	15,0	5,0	15,0	≠	64
1 830 : 1	5	3,0	5,0	15,0	5,0	15,0	=	60

Scale enlarged



1309 C

* also available with 2,82 mm output shaft length

Connection

No.	Function
1	Star point
2	Phase A
3	Phase A
4	Phase B
5	Phase B
6	Phase C
7	Phase C
8	Hall sensor In+
9	Hall sensor In-
10	analog Hall A Out+
11	analog Hall A Out-
12	analog Hall B Out+
13	analog Hall B Out-
14	analog Hall C Out+
15	analog Hall C Out-

Connectors
15-pole; 0,3 mm pitch; e.g.:
Hirose: FH23-15S-0.3SHAW (05)

Brushless Flat DC-Micromotors

penny-motor® Technology

0,2 mNm

For combination with
Gearheads:
16A
Drive Electronics:
Speed controller

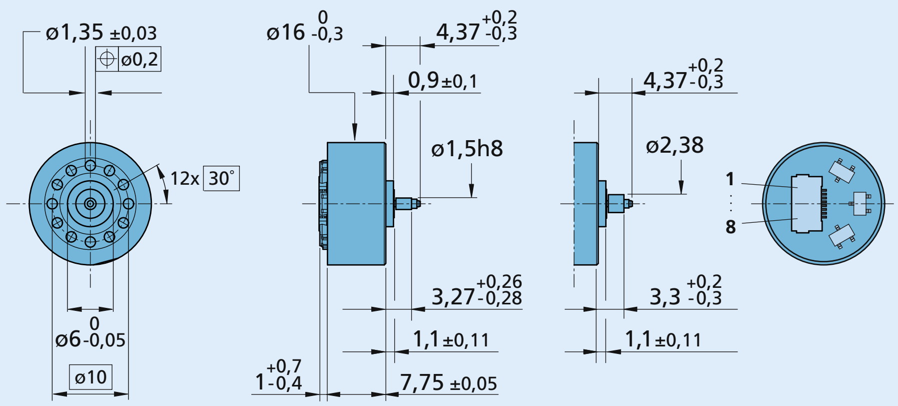
Series 1608 ... BH

1608 N			003 BH	
Nominal voltage	U_N		3	V
Terminal resistance, phase-phase	R		18,6	Ω
Output power [1]	$P_{2\ max.}$		0,116	W
Efficiency	$\eta_{\ max.}$		38	%
No-load speed	n_o		17 872	rpm
No-load current	I_o		0,032	A
Stall torque	M_H		0,203	mNm
Friction torque, static	C_o		0,005	mNm
Friction torque, dynamic	C_v		$2 \cdot 10^{-6}$	mNm/rpm
Speed constant	k_n		7 407	rpm/V
Back-EMF constant	k_E		0,135	mV/rpm
Torque constant	k_M		1,289	mNm/A
Current constant	k_I		0,776	A/mNm
Slope of n-M curve	$\Delta n/\Delta M$		106 746	rpm/mNm
Terminal inductance, phase-phase	L		21	µH
Mechanical time constant	τ_m		702	ms
Rotor inertia	J		0,628	gcm²
Angular acceleration	$\alpha_{\ max.}$		$3 \cdot 10^3$	rad/s²
Thermal resistance	$R_{th\ 1}$ / $R_{th\ 2}$	0 / 80		K/W
Operating temperature range		-30 ... +85		°C
Shaft bearing		sintered sleeve bearings		
Shaft load max.:				
– radial at 10 000 rpm (at shaft step ø 3,4 mm)		0,5		N
– axial at 10 000 rpm (axial push-on only)		0,1		N
– axial at standstill (axial push-on only)		20		N
Shaft play:				
– radial	≤	0,05		mm
– axial	≤	0,12		mm
Number of pole pairs		4		
Weight		4,1		g
Direction of rotation		electronically reversible		

Recommended values - mathematically independent of each other				
Speed up to	$n_{e\ max.}$		12 000	rpm
Torque up to [1) 2)]	$M_{e\ max.}$		0,205	mNm
Thermal current up to [1) 2)]	$I_{e\ max.}$		0,184	A

[1] at 5000 rpm [2] thermal resistance $R_{th\ 2}$ not reduced

Scale enlarged



1608 N ... BH **1608 E ... BH**

Connection

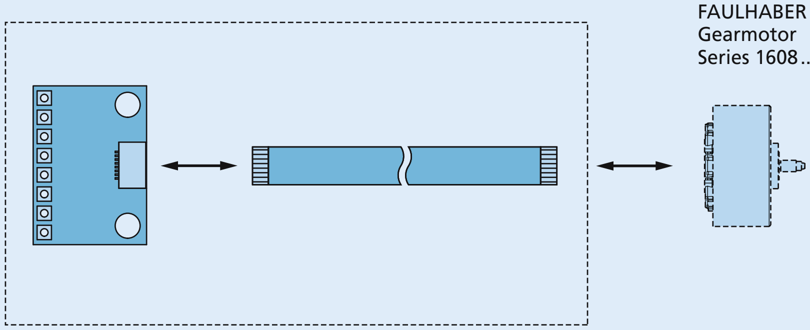
No.	Function
1	Hall sensor A
2	Hall sensor B
3	Hall sensor C
4	UDD (2.2 ... 18V DC)
5	GND
6	Phase A
7	Phase B
8	Phase C

Connectors
8-pole; 0,5 mm pitch;
thickness 0,3 mm

Accessory - optional

Adapter board with ribbon cable
Part number: 6611.00017

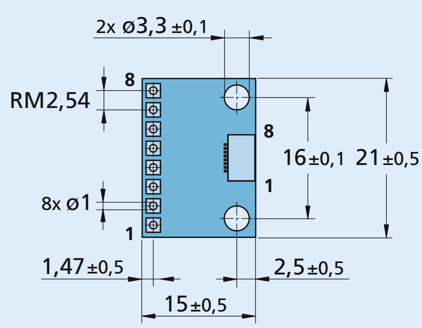
FAULHABER Brushless
Gearmotor
Series 1608...BH



Note: The conector on the adapter board has contacts on both sides. The pin out of the adapter board depends on the orientation of the ribbon cable and motor conector.

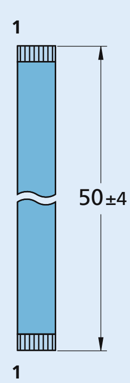
Accessory - Dimensional drawing

M 1:1



Adapter board

Connector Information
FFC/FPC Connector; 8-pole;
0,5 mm pitch; thickness: 0,3 mm
Connector has contacts on both sides

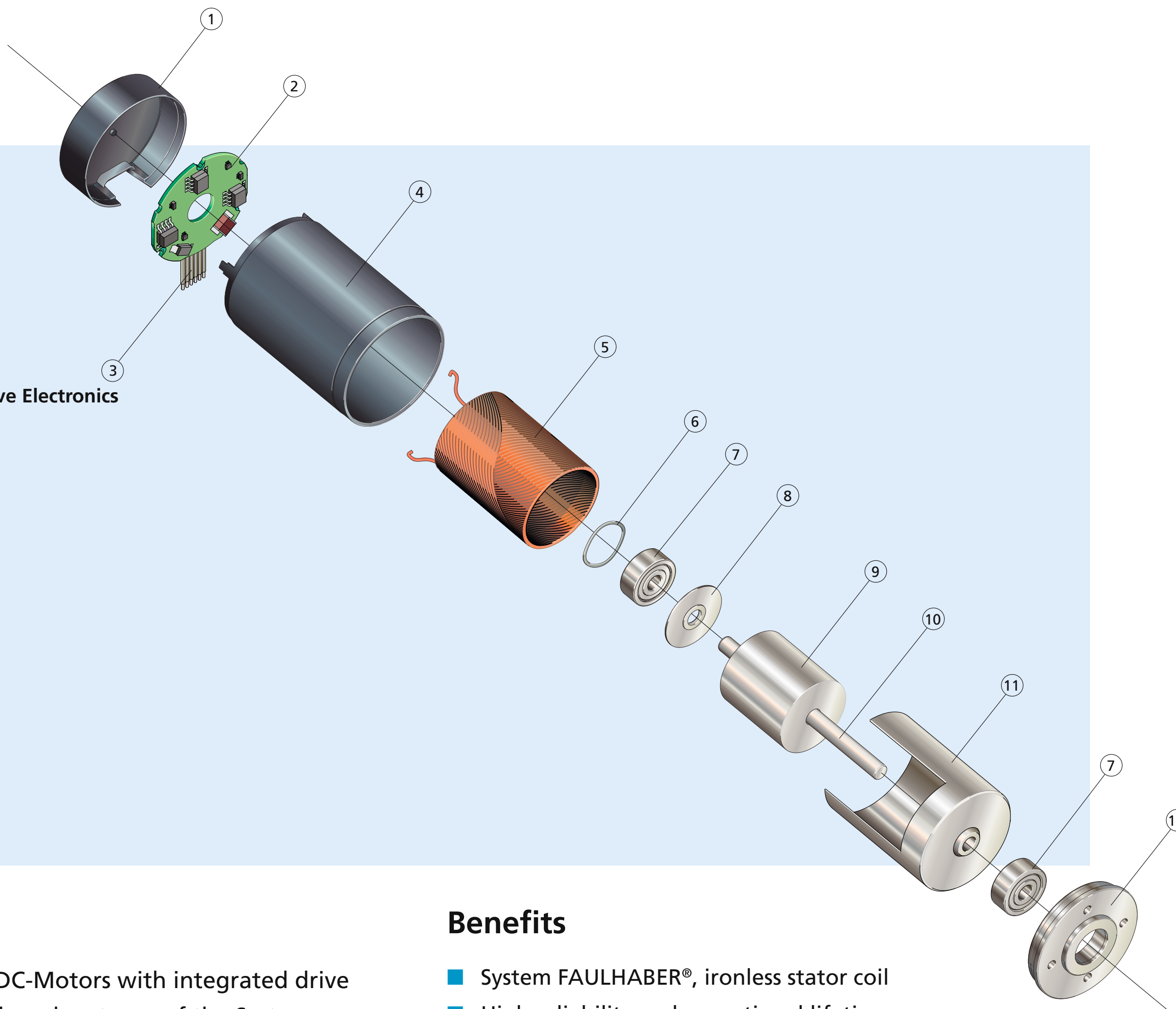


Ribbon cable

FAULHABER

Brushless DC-Motors

with integrated Drive Electronics



Brushless DC-Motor
with integrated Drive Electronics

① Rear cover
② Drive Electronics
③ Flat cable
④ Housing
⑤ Coil
⑥ Spring washer
⑦ Ball bearing
⑧ Washer
⑨ Magnet
⑩ Shaft
⑪ Rotor back-iron
⑫ Front flange

Features

These new brushless DC-Motors with integrated drive electronics combine the advantages of the System FAULHABER® skew wound coil technology with the lifetime benefits of electronic commutation. The motors are based on a three-phase ironless coil, a bipolar rare-earth permanent magnet and sensorless electronic commutation.

To define the position of the rotor in relation to the rotating field of the coil, the back-EMF is measured and processed. The position detection of the rotor is sensorless. The design features the basic linear characteristics over a wide speed range and the absence of cogging torque just like the traditional brush commutated DC-Motors in the FAULHABER program. The rotating magnet and iron flux path avoid iron losses and results in higher efficiency.

Benefits

- System FAULHABER®, ironless stator coil
- High reliability and operational lifetime
- Wide range of linear torque / speed performance
- Programmable motor characteristics
- No sparking
- No cogging
- Dynamically balanced rotor
- Integrated electronics
- Simple design

Product Code

3153 K 012 BRC

31	Motor diameter [mm]
53	Motor length [mm]
K	Shaft type
012	Nominal voltage [V]
BRC	Type of commutation (brushless), with integrated electronics

Brushless DC-Motors
with integrated Drive Electronics

1,8 mNm

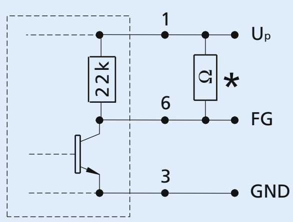
Series 1525 ... BRC

	1525 U		009 BRC	012 BRC	015 BRC	
Nominal voltage	U_N		9	12	15	Volt
No-load speed	n_0		16 300	15 800	15 500	rpm
No-load current (with shaft ø 2,0 mm)	I_0		0,047	0,037	0,033	A
Starting torque	M_A		3,9	4,1	4,1	mNm
Torque constant	k_M		5,12	7,06	8,95	mNm/A
Slope of n-M curve	$\Delta n/\Delta M$		2 540	2 260	2 270	rpm/mNm
Rotor inertia	J		2,2	2,2	2,2	gcm²
Operating temperature range		– 25 ... + 85				°C
Shaft bearings		ball bearings, preloaded				
Shaft load max.:						
– shaft diameter		2,0				mm
– radial at 3 000 rpm (3 mm from mounting face)		8				N
– axial at 3 000 rpm		0,8				N
– axial at standstill		10				N
Shaft play:						
– radial	≤	0,015				mm
– axial	=	0				mm
Housing material		mounting face in aluminium, housing in plastic				
Weight		16				g
Direction of rotation		reversible				

Recommended values - mathematically independent of each other						
Speed range	n_e			1 000 – 16 000		rpm
Torque up to [1]	$M_{e\,max.}$		1,7	1,8	1,8	mNm
Current up to (thermal limits) [1]	$I_{e\,max.}$		0,40	0,31	0,25	A

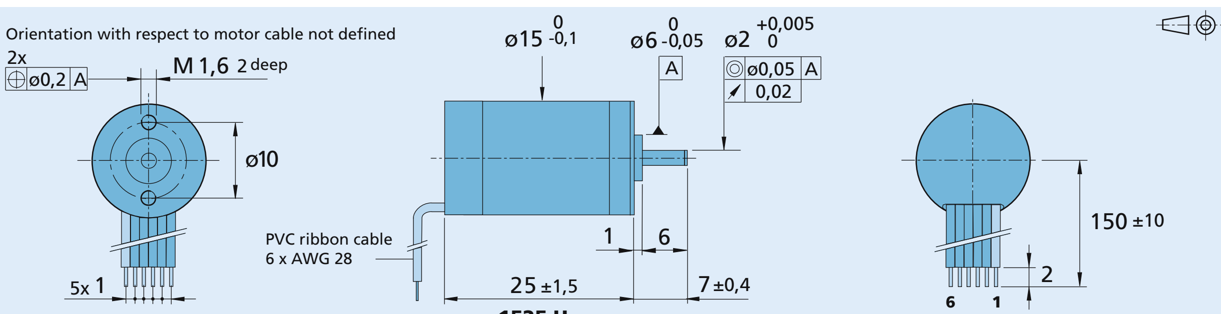
[1] Specification applies to U_{nsoll} = 10 V

Electronic			
Supply voltage	U_p	min. 4 ... max. 18	V DC
Current	$I_{max.}$	15	mA



Circuit diagram
* An additional external pull-up resistor can be added to improve the rise time.

Caution:
I_{OUT} max. 15 mA must not be exceeded!



1525 U

Cable connection

No.	Function		
1 (red)	U_p	: electronic supply	4 V DC - 18 V DC
2	U_{mot}	: coil supply	1,7 V DC - 18 V DC
3	GND	: ground	
4	U_{nsoll}	: Speed command	0 - 10 V DC | > 10 V DC - max. U_P not defined
5	DIR	: direction of rotation	on ground or U < 0,5 V = CCW, U > 3 V = CW
6	FG	: frequency output	(max. U_p, $I_{max.}$ 15 mA) 3 lines per revolution

Caution:
Incorrect lead connection will damage the motor electronics!

Brushless DC-Motors

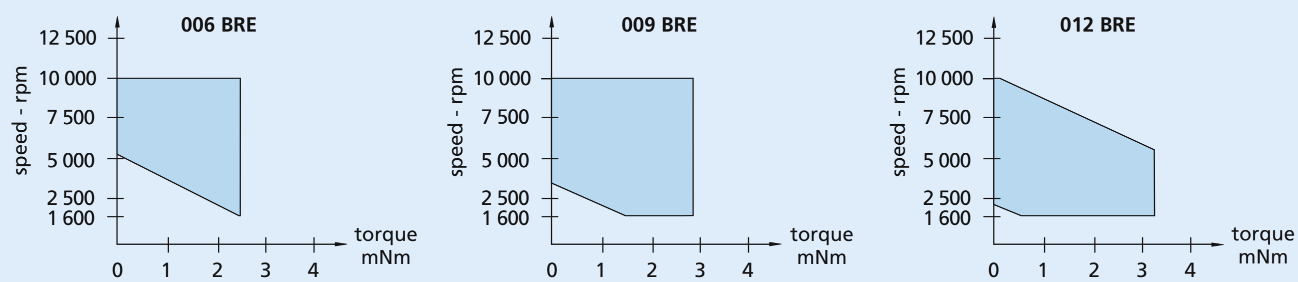
3,2 mNm

with integrated Drive Electronics

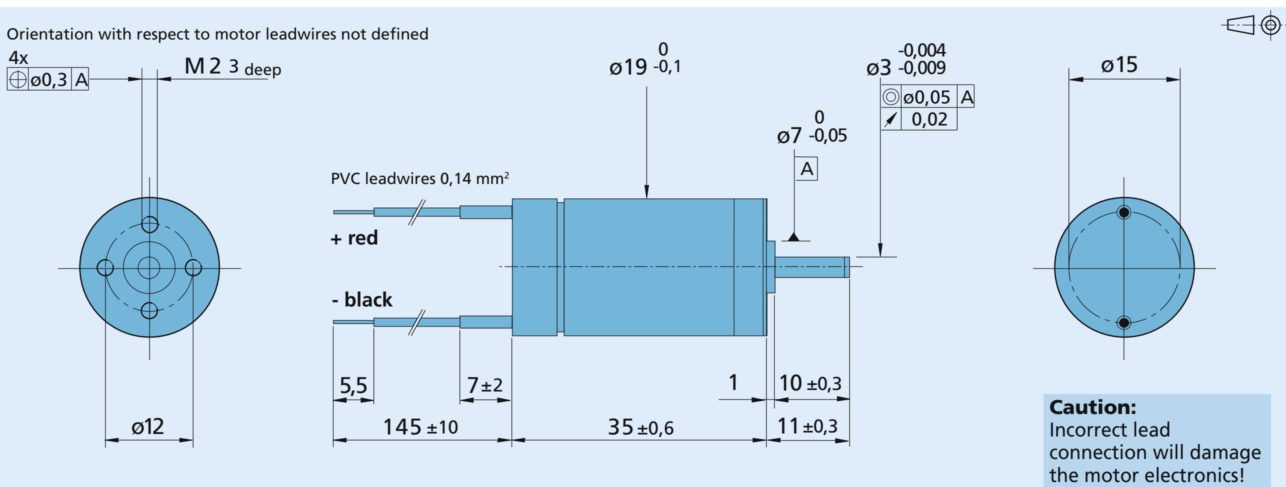
Series 1935 ... BRE

	1935 S		006 BRE	009 BRE	012 BRE	
Nominal voltage [1]	U_N		6	9	12	Volt
No-load speed	n_o		7 400	7 650	7 400	rpm
No-load current (with shaft ø 3,0 mm)	I_o		0,050	0,035	0,027	A
Starting torque	M_A		2,9	4,0	4,4	mNm
Torque constant	k_M		6,32	9,74	13,70	mNm/A
Slope of n-M curve	$\Delta n/\Delta M$		1 470	1 140	1 110	rpm/mNm
Rotor inertia	J		8,1	8,1	8,1	gcm²
Operating temperature range		0 ... + 70				°C
Shaft bearings		ball bearings, preloaded				
Shaft load max.:						
– shaft diameter		3				mm
– radial at 3 000 rpm (3 mm from mounting face)		10				N
– axial at 3 000 rpm		1				N
– axial at standstill		150				N
Shaft play:						
– radial	≤	0,015				mm
– axial	=	0				mm
Housing material		mounting face in aluminium, housing in plastic				
Weight		33				g
Direction of rotation		not reversible - clockwise rotation, viewed from the front face				
[1] The supply voltage range for the integrated electronics is:		min. 4,5 ... max. 16				V DC

Recommended values - mathematically independent of each other						
Speed range	n_e		1 600 – 10 000			rpm
Torque up to	$M_{e\,max.}$		2,4	2,9	3,2	mNm
Current up to (thermal limits)	$I_{e\,max.}$		0,50	0,40	0,33	A



Recommended speed - torque range



Caution: Incorrect lead connection will damage the motor electronics!

1935 S

Brushless DC-Motors

28 mNm

with integrated Drive Electronics

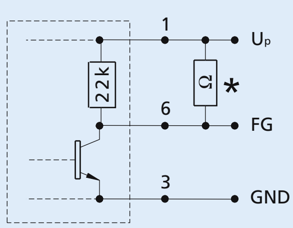
Series 3153 ... BRC

3153 K			009 BRC	012 BRC	024 BRC	
Nominal voltage	U_N		9	12	24	Volt
No-load speed	n_0		5 200	5 200	5 200	rpm
No-load current (with shaft ø 4,0 mm)	I_0		0,142	0,107	0,057	A
Starting torque	M_A		42	50	50	mNm
Torque constant	k_M		16,22	21,80	43,59	mNm/A
Slope of n-M curve	$\Delta n/\Delta M$		45,8	42,9	41,4	rpm/mNm
Rotor inertia	J		118	118	118	gcm²
Operating temperature range		– 25 ... + 85				°C
Shaft bearings		ball bearings, preloaded				
Shaft load max.:						
– shaft diameter		4,0				mm
– radial at 3 000 rpm (3 mm from mounting face)		30				N
– axial at 3 000 rpm		5				N
– axial at standstill		50				N
Shaft play:						
– radial	≤	0,015				mm
– axial	=	0				mm
Housing material		mounting face in aluminium, housing in plastic				
Weight		155				g
Direction of rotation		reversible				

Recommended values - mathematically independent of each other						
Speed range	n_e			1 000 – 6 500		rpm
Torque up to [1]	$M_{e\ max.}$		27	28	28	mNm
Current up to (thermal limits) [1]	$I_{e\ max.}$		1,90	1,46	0,75	A

[1] Specification applies to U_{nsoll} = 10 V

Electronic			
Supply voltage	U_p	min. 5 ... max. 30	V DC
Current	$I_{max.}$	25	mA

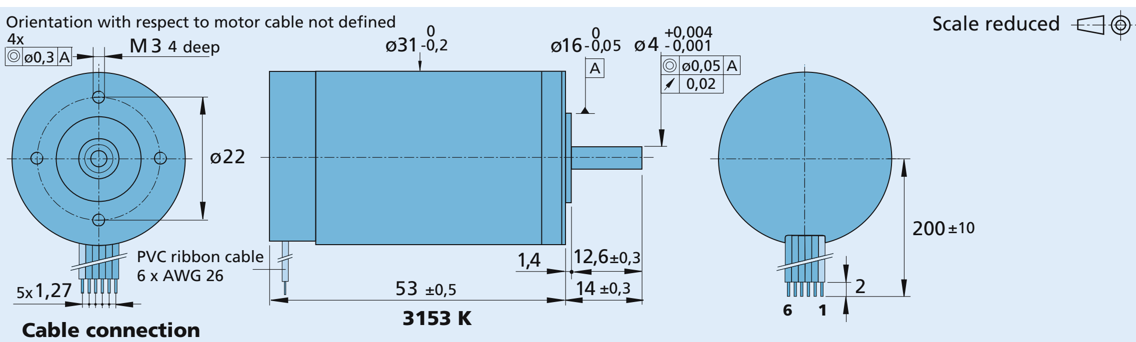


Circuit diagram

* An additional external pull-up resistor can be added to improve the rise time.

Caution:

I_{OUT} max. 15 mA must not be exceeded!



3153 K

Cable connection

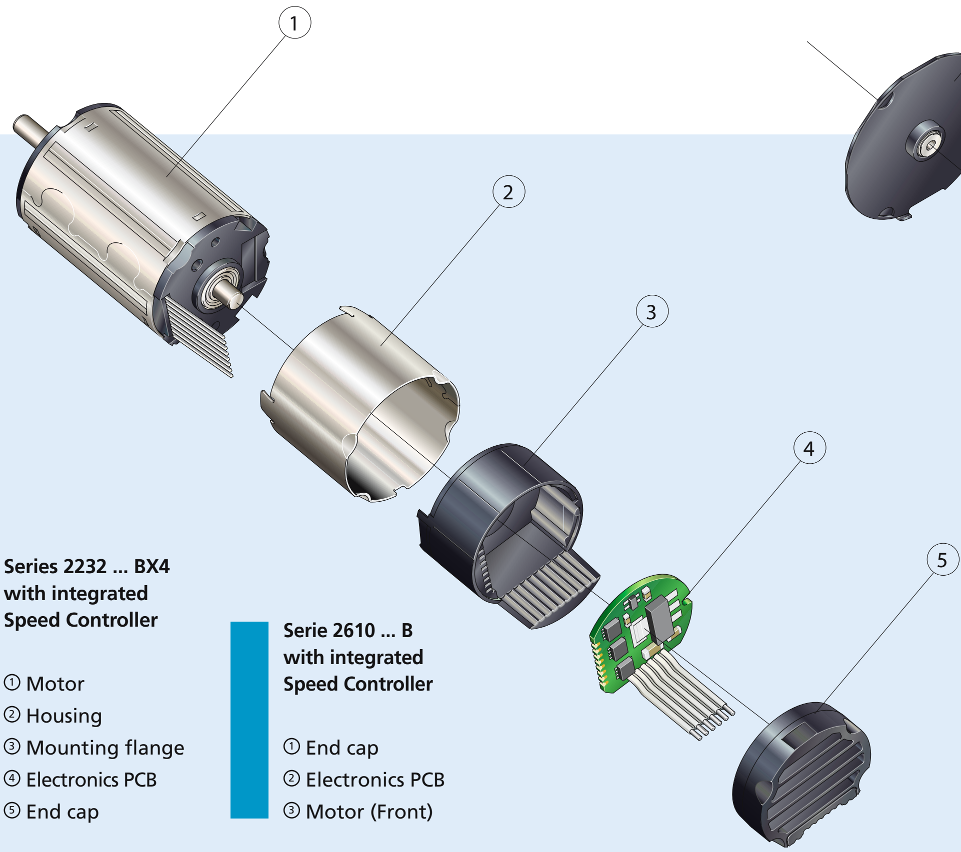
No.	Function		
1 (red)	U_p	: electronic supply	5 V DC - 30 V DC
2	U_{mot}	: coil supply	0 V DC up to 2 · U_N (max. 30 V DC)
3	GND	: ground	
4	U_{nsoll}	: Speed command	0 - 10 V DC | > 10 V DC - max. U_P not defined
5	DIR	: direction of rotation	on ground or U < 0,5 V = CCW, U > 3 V = CW
6	FG	: frequency output	(max. U_p, $I_{max.}$ 15 mA) 3 lines per revolution

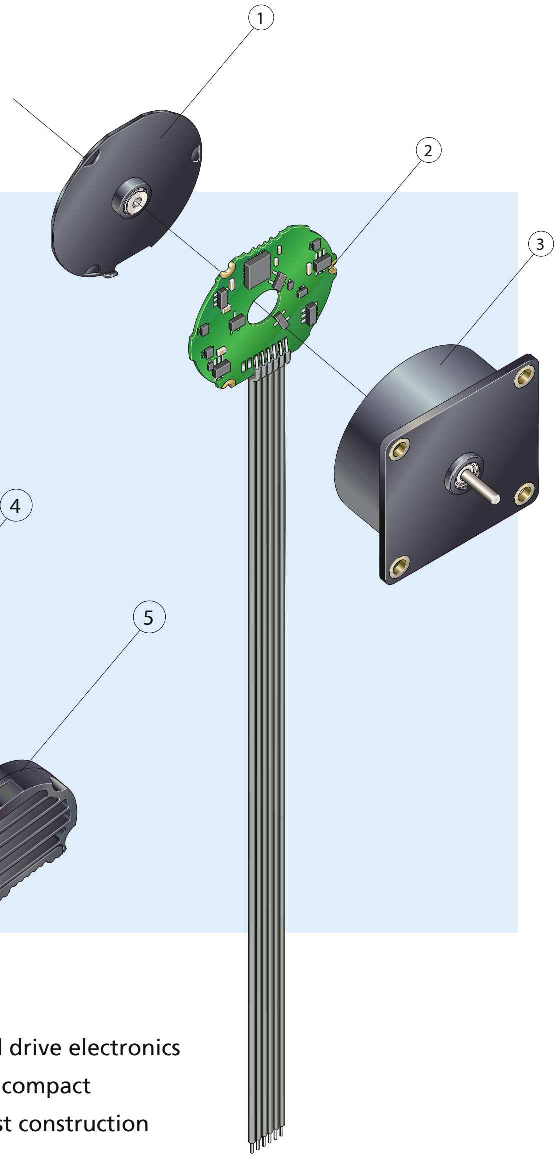
Caution:
Incorrect lead connection will damage the motor electronics!

Notes

Brushless DC-Motors

with integrated Speed Controller





Series 2232 ... BX4 with integrated Speed Controller

① Motor
② Housing
③ Mounting flange
④ Electronics PCB
⑤ End cap

Serie 2610 ... B with integrated Speed Controller

① End cap
② Electronics PCB
③ Motor (Front)

Features

These new brushless DC motors combine the advantages of a slotless brushless motor with dedicated, high precision, speed control electronics.

Speed control is achieved using the on board PI controller with an external command voltage. The drives are protected from overload with the integrated current limiting.

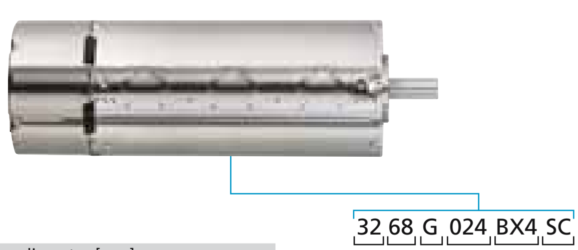
The control parameters of the drive electronics can be modified to fit the application using our optional programming adapter and the easy to use FAULHABER Motion Manager software.

Many drives are also available in a simple 2 wire configuration for ease of integration or replacement of standard DC motors in some applications.

Benefits

- Integrated drive electronics
- Extremely compact
- Very robust construction
- Easy to use
- Integrated current limiting
- Control parameters can be tuned to the application

Product Code



32	Motor diameter [mm]
68	Motor length [mm]
G	Shaft type
024	Nominal Voltage [V]
BX4	Type of commutation (electronic)
SC	Integrated Speed Controller

Brushless DC-Servomotors

with integrated Speed Controller
4 Pole Technology

7 mNm

For combination with
Gearheads:
22F, 22/7, 26A

Series 2232 ... BX4 S SC

	2232 S		012 BX4 S	024 BX4 S	SC
1	Nominal voltage	U_N	12	24	Volt
2	Terminal resistance, phase-phase	R	3,5	12,4	Ω
3	Output power [1]	$P_{2\ max.}$	4,4	4,5	W
4	Efficiency	$\eta_{\ max.}$	60,9	61,7	%
5	No-load speed	n_o	13 200	14 000	rpm
6	No-load current (with shaft ø 3,0 mm)	I_o	0,163	0,088	A
7	Stall torque	M_H	27,3	29,4	mNm
8	Friction torque, static	C_o	0,6	0,6	mNm
9	Friction torque, dynamic	C_v	$5,5 \cdot 10^{-5}$	$5,5 \cdot 10^{-5}$	mNm/rpm
10	Speed constant	k_n	1 173	616	rpm/V
11	Back-EMF constant	k_E	0,852	1,623	mV/rpm
12	Torque constant	k_M	8,14	15,50	mNm/A
13	Current constant	k_I	0,123	0,065	A/mNm
14	Slope of n-M curve	$\Delta n/\Delta M$	504	493	rpm/mNm
15	Terminal inductance, phase-phase	L	130	470	µH
16	Mechanical time constant	τ_m	22	22	ms
17	Rotor inertia	J	4,2	4,2	gcm^2
18	Angular acceleration	$\alpha_{\ max.}$	65	70	$\cdot 10^3 rad/s^2$
19	Thermal resistance	$R_{th\ 1}$ / $R_{th\ 2}$	2 / 13		K/W
20	Thermal time constant	τ_{w1} / τ_{w2}	4,1 / 274		s
21	Operating temperature range		– 40 ... + 85		°C
22	Shaft bearings		ball bearings, preloaded		
23	Shaft load max.:				
	– radial at 3 000 rpm (4 mm from mounting flange)		20		N
	– axial at 3 000 rpm		2		N
	– axial at standstill		20		N
24	Shaft play:				
	– radial	≤	0,015		mm
	– axial	=	0		mm
25	Housing material		stainless steel		
26	Weight		77		g
27	Direction of rotation		electronically reversible		
28	Number of pole pairs		2		
	Recommended values - mathematically independent of each other				
29	Speed up to	$n_{e\ max.}$	22 500	17 000	rpm
30	Torque up to [1] [2]	$M_{e\ max.}$	7	7	mNm
31	Current up to [1] [2]	$I_{e\ max.}$	0,99	0,52	A

[1] at 5 000 rpm
[2] thermal resistance $R_{th\ 2}$ not reduced

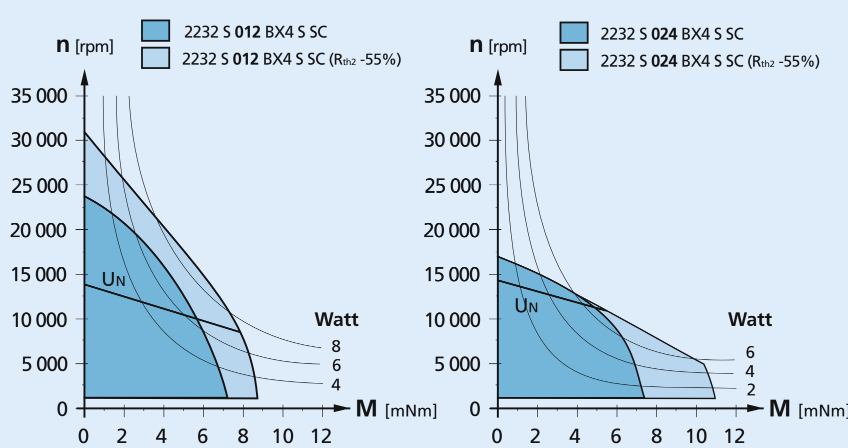
Note:

The diagram indicates the recommended speed in relation to the available torque at the output shaft for a given ambient temperature of 22°C.

The diagram shows the motor in a completely insulated condition.

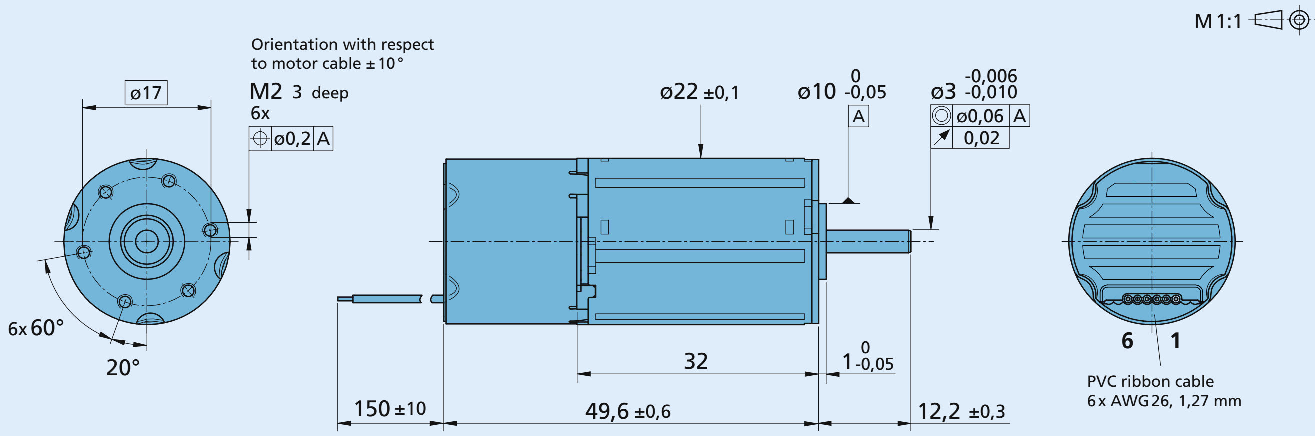
The motor is factory pre-configured to a continuous current for the thermally insulated condition. The controller must be reconfigured with the easy to use Motion Manager Software for use with other parameter settings.

The nominal voltage (U_N) curve shows the operating point at nominal voltage in the insulated condition. Any points of operation above the curve at nominal voltage will require a higher operating voltage. Any points below the nominal voltage curve will require less voltage.



Recommended areas for continuous operation

Dimensional drawing



2232 S ... BX4 S SC

Speed Controller			012 BX4 S	024 BX4 S	SC
Power supply electronic	U_P	5 ... 28			V DC
Power supply motor	U_{mot}	6 ... 28			V DC
PWM switching frequency	f_{PWM}	96			kHz
Efficiency	η	95			%
Max. continuous output current [1]	I_{dauer}		1	0,5	A
Max. peak output current	I_{max}		2	1	A
Total standby current at U_N	I_{el}	0,020			A
Speed range:					
– standard » Hall sensors (digital)		400 ... 50 000 [2]			rpm
– optional » Hall sensors (analog)		50 ... 50 000 [2]			rpm
Scanning range		500			µs

[1] at 22°C ambient temperature and max. 60°C motor temperature respectively
[2] speed depend on motor operating voltage

Connection information			012 BX4 S	024 BX4 S	SC
Connection 1 "U_P":	power supply electronic	U_P			
Connection 2 "U_{mot}":	power supply electronic coil	U_{mot}			
Connection 3 "GND":	ground	ground			
Connection 4 "U_{nsoll}":					
– analog input	input voltage	U_{in} = 0 ... 10 V | > 10 V ... U_P » set speed value not defined			
	input resistance	$R_{in} \geq 5\,k\Omega$			
	set speed value	per 1 V	2 000	2 000	rpm
		U_{in} < 0,15 V » motor stops			
		U_{in} > 0,3 V » motor starts			
Connection 5 "DIR":					
– digital input	direction of rotation	to ground or level < 0,5 V » counterclockwise			
		open or level > 3 V » clockwise			
	input resistance	$R_{in} \geq 10\,k\Omega$			
Connection 6 "FG":		max. U_P; I_{max} = 15 mA; open collector with 22 kΩ pull-up resistor			
– digital output	frequency output	6 lines per revolution			

Features

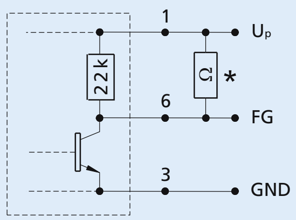
In this variant, the brushless DC servomotors have an integrated Speed Controller. The motor is commutated using Hall sensors integrated into the motor. Speed control is via a PI regulator.

The Speed Controller has a current limiting device which limits the maximum motor current if the thermal load is too high. Twice the continuous current is possible over a short time.

Using the **"FAULHABER Motion Manager"** software, the customer can modify the Speed Controller to special conditions of use. The following parameters can be changed: current limit and regulator parameters.

Circuit diagram / Connection information

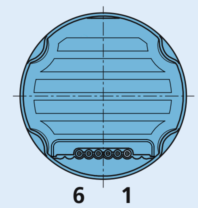
Output circuit



* An additional external pull-up resistor can be added to improve the rise time.

Caution: I_{OUT} max. 15 mA must not be exceeded!

Cable connection

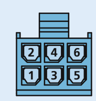


Connection

No.	Function
1	U_P
2	U_{mot}
3	GND
4	U_{nsoll}
5	DIR
6	FG

Caution:
Incorrect lead connection will damage the motor electronics!

Options



- Connector variant (Option no.: 3809)
  AWG 26 / PVC ribbon cable
  with connector Micro-Fit
- Analog Hall sensors (Option no.: 3692)

Accessories

- Programming board (Part No.: 6501.00088)

Full product description

- Example:
  2232S024BX4S SC

Brushless DC-Servomotors

with integrated Speed Controller
4 Pole Technology

13 mNm

For combination with
Gearheads:
22F, 22/7, 26A

Series 2232 ... BX4 SC

	2232 S		012 BX4	024 BX4	SC
1 Nominal voltage	U_N		12	24	Volt
2 Terminal resistance, phase-phase	R		3,5	12,4	Ω
3 Output power 1)	$P_{2\ max.}$		8,8	8,9	W
4 Efficiency	$\eta_{max.}$		66,9	67,6	%
5 No-load speed	n_o		6 600	7 000	rpm
6 No-load current (with shaft ø 3,0 mm)	I_o		0,112	0,061	A
7 Stall torque	M_H		55,7	59,9	mNm
8 Friction torque, static	C_o		0,85	0,85	mNm
9 Friction torque, dynamic	C_v		$1,5 \cdot 10^{-4}$	$1,5 \cdot 10^{-4}$	mNm/rpm
10 Speed constant	k_n		579	304	rpm/V
11 Back-EMF constant	k_E		1,728	3,288	mV/rpm
12 Torque constant	k_M		16,50	31,40	mNm/A
13 Current constant	k_I		0,061	0,032	A/mNm
14 Slope of n-M curve	$\Delta n/\Delta M$		123	120	rpm/mNm
15 Terminal inductance, phase-phase	L		120	440	µH
16 Mechanical time constant	τ_m		6,7	6,5	ms
17 Rotor inertia	J		5,2	5,2	gcm^2
18 Angular acceleration	$\alpha_{max.}$		107	115	$\cdot 10^3 rad/s^2$
19 Thermal resistance	$R_{th\,1}$ / $R_{th\,2}$	2 / 13			K/W
20 Thermal time constant	τ_{w1} / τ_{w2}	4,1 / 283			s
21 Operating temperature range		– 40 ... +85			°C
22 Shaft bearings		ball bearings, preloaded			
23 Shaft load max.:					
– radial at 3 000 rpm (4 mm from mounting flange)		20			N
– axial at 3 000 rpm		2			N
– axial at standstill		20			N
24 Shaft play:					
– radial	≤	0,015			mm
– axial	=	0			mm
25 Housing material		stainless steel			
26 Weight		77			g
27 Direction of rotation		electronically reversible			
28 Number of pole pairs		2			
Recommended values - mathematically independent of each other					
29 Speed up to	$n_{e\ max.}$		14 500	8 500	rpm
30 Torque up to 1) 2)	$M_{e\ max.}$		13	13	mNm
31 Current up to 1) 2)	$I_{e\ max.}$		0,95	0,50	A

1) at 5 000 rpm
2) thermal resistance $R_{th\,2}$ not reduced

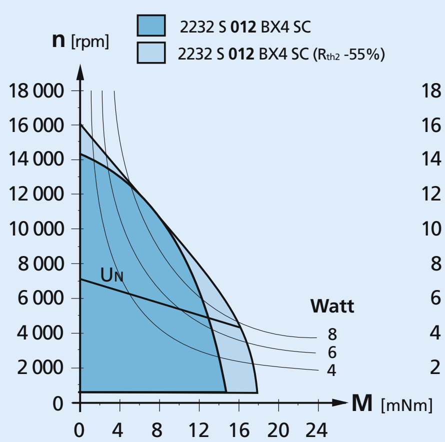
Note:

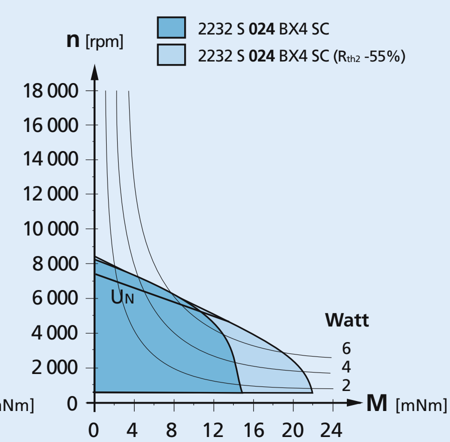
The diagram indicates the recommended speed in relation to the available torque at the output shaft for a given ambient temperature of 22°C.

The diagram shows the motor in a completely insulated condition.

The motor is factory pre-configured to a continuous current for the thermally insulated condition. The controller must be reconfigured with the easy to use Motion Manager Software for use with other parameter settings.

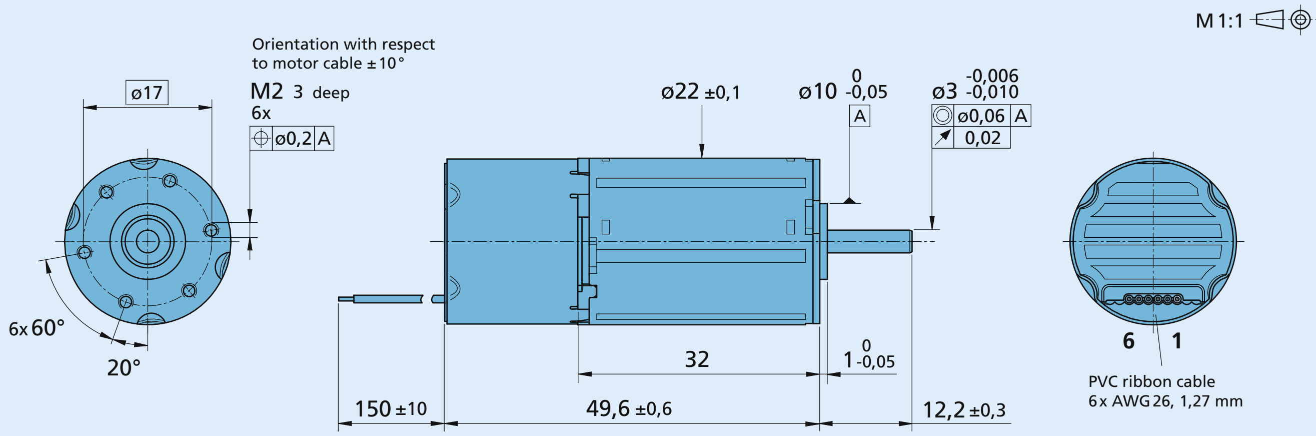
The nominal voltage (U_N) curve shows the operating point at nominal voltage in the insulated condition. Any points of operation above the curve at nominal voltage will require a higher operating voltage. Any points below the nominal voltage curve will require less voltage.





Recommended areas for continuous operation

Dimensional drawing



2232 S ... BX4 SC

Speed Controller			012 BX4	024 BX4	SC
Power supply electronic	U_P	5 ... 28			V DC
Power supply motor	U_{mot}	6 ... 28			V DC
PWM switching frequency	f_{PWM}	96			kHz
Efficiency	η	95			%
Max. continuous output current [1]	I_{dauer}		1	0,5	A
Max. peak output current	I_{max}		2	1	A
Total standby current at U_N	I_{el}	0,020			A
Speed range:					
– standard » Hall sensors (digital)		400 ... 50 000 [2]			rpm
– optional » Hall sensors (analog)		50 ... 50 000 [2]			rpm
Scanning range		500			µs

[1] at 22°C ambient temperature and max. 60°C motor temperature respectively
[2] speed depend on motor operating voltage

Connection information			012 BX4	024 BX4	SC
Connection 1 "U_P":	power supply electronic	U_P			
Connection 2 "U_{mot}":	power supply electronic coil	U_{mot}			
Connection 3 "GND":	ground	ground			
Connection 4 "U_{nsoll}":					
– analog input	input voltage	U_{in} = 0 ... 10 V | > 10 V ... U_P » set speed value not defined			
	input resistance	R_{in} ≥ 5 kΩ			
	set speed value	per 1 V	1 000	1 000	rpm
		U_{in} < 0,15 V » motor stops			
		U_{in} > 0,3 V » motor starts			
Connection 5 "DIR":					
– digital input	direction of rotation	to ground or level < 0,5 V » counterclockwise			
		open or level > 3 V » clockwise			
	input resistance	R_{in} ≥ 10 kΩ			
Connection 6 "FG":		max. U_P; I_{max} = 15 mA; open collector with 22 kΩ pull-up resistor			
– digital output	frequency output	6 lines per revolution			

Features

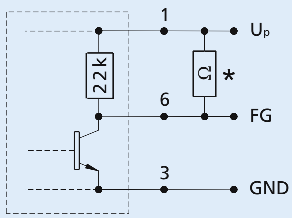
In this variant, the brushless DC servomotors have an integrated Speed Controller. The motor is commutated using Hall sensors integrated into the motor. Speed control is via a PI regulator.

The Speed Controller has a current limiting device which limits the maximum motor current if the thermal load is too high. Twice the continuous current is possible over a short time.

Using the **"FAULHABER Motion Manager"** software, the customer can modify the Speed Controller to special conditions of use. The following parameters can be changed: current limit and regulator parameters.

Circuit diagram / Connection information

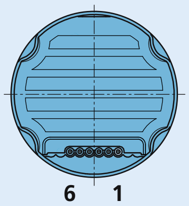
Output circuit



* An additional external pull-up resistor can be added to improve the rise time.

Caution: I_{OUT} max. 15 mA must not be exceeded!

Cable connection



Connection

No.	Function
1	U_P
2	U_{mot}
3	GND
4	U_{nsoll}
5	DIR
6	FG

Caution:
Incorrect lead connection will damage the motor electronics!

Options

- Connector variant (Option no.: 3809)
  AWG 26 / PVC ribbon cable
  with connector Micro-Fit
- Analog Hall sensors (Option no.: 3692)

Accessories

- Programming board (Part No.: 6501.00088)

Full product description

- Example:
  2232S024BX4 SC

Brushless DC-Motors

Brushless DC-Servomotors

with integrated Speed Controller
4 Pole Technology

15 mNm

For combination with
Gearheads:
22F, 22/7, 26A

Series 2250 ... BX4 S SC

		2250 S		024 BX4 S	SC
1	Nominal voltage	U_N		24	Volt
2	Terminal resistance, phase-phase	R		5,9	Ω
3	Output power 1)	$P_{2\ max.}$		10,3	W
4	Efficiency	$\eta_{max.}$		70,4	%
5	No-load speed	n_o		10 500	rpm
6	No-load current (with shaft ø 3,0 mm)	I_o		0,105	A
7	Stall torque	M_H		84,7	mNm
8	Friction torque, static	C_o		0,75	mNm
9	Friction torque, dynamic	C_v		$1,4 \cdot 10^{-4}$	mNm/rpm
10	Speed constant	k_n		451	rpm/V
11	Back-EMF constant	k_E		2,218	mV/rpm
12	Torque constant	k_M		21,1	mNm/A
13	Current constant	k_I		0,047	A/mNm
14	Slope of n-M curve	$\Delta n/\Delta M$		125,6	rpm/mNm
15	Terminal inductance, phase-phase	L		250	µH
16	Mechanical time constant	τ_m		6,97	ms
17	Rotor inertia	J		5,3	gcm^2
18	Angular acceleration	$\alpha_{max.}$		160	$\cdot 10^3 rad/s^2$
19	Thermal resistance	R_{th1} / R_{th2}	1,2 / 10,5		K/W
20	Thermal time constant	τ_{w1} / τ_{w2}	4,2 / 332		s
21	Operating temperature range		– 40 ... +85		°C
22	Shaft bearings		ball bearings, preloaded		
23	Shaft load max.:				
	– radial at 3 000 rpm (4 mm from mounting flange)		20		N
	– axial at 3 000 rpm		2		N
	– axial at standstill		20		N
24	Shaft play:				
	– radial	≤	0,015		mm
	– axial	=	0		mm
25	Housing material		stainless steel		
26	Weight		97		g
27	Direction of rotation		electronically reversible		
28	Number of pole pairs		2		
Recommended values - mathematically independent of each other					
29	Speed up to	$n_{e\ max.}$		12 500	rpm
30	Torque up to 1) 2)	$M_{e\ max.}$		15	mNm
31	Current up to 1) 2)	$I_{e\ max.}$		0,84	A

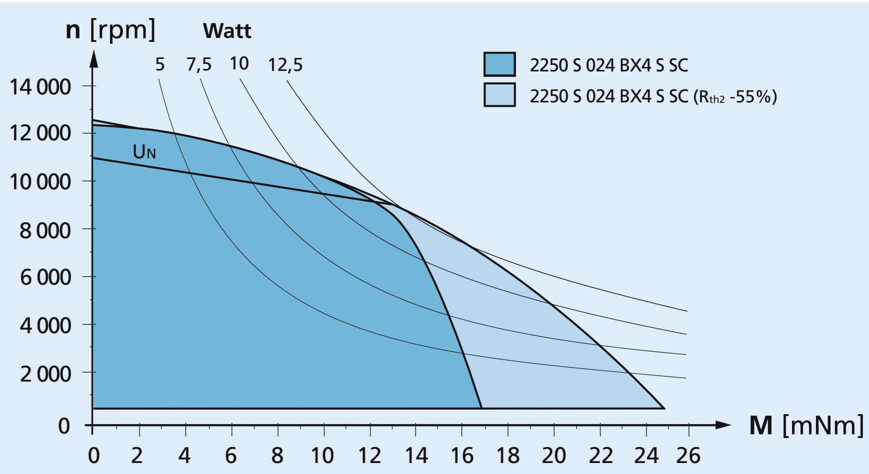
1) at 5 000 rpm
2) thermal resistance $R_{th\ 2}$ not reduced

Note:
The diagram indicates the recommended speed in relation to the available torque at the output shaft for a given ambient temperature of 22°C.

The diagram shows the motor in a completely insulated condition.

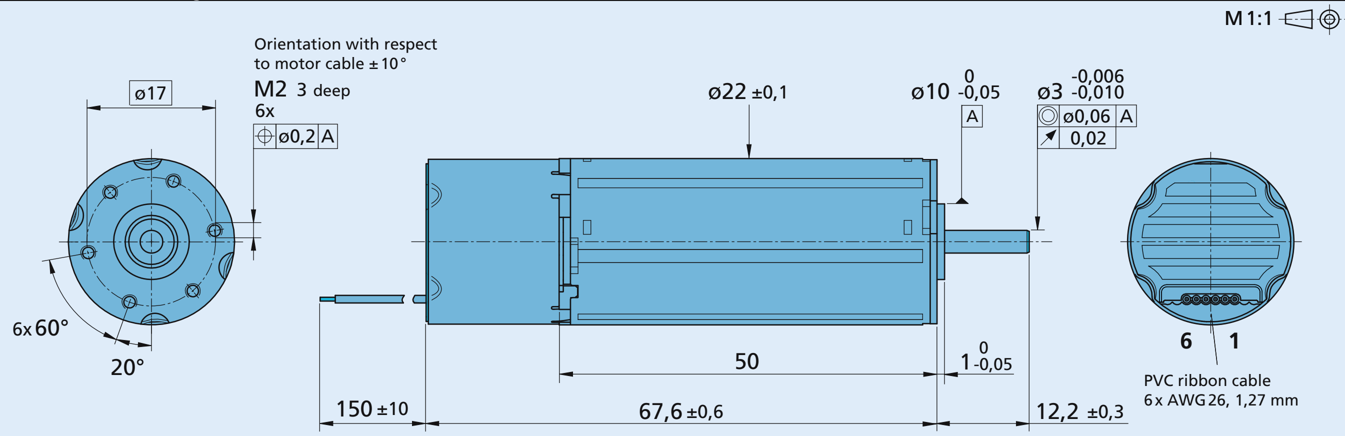
The motor is factory pre-configured to a continuous current for the thermally insulated condition. The controller must be reconfigured with the easy to use Motion Manager Software for use with other parameter settings.

The nominal voltage (U_N) curve shows the operating point at nominal voltage in the insulated condition. Any points of operation above the curve at nominal voltage will require a higher operating voltage. Any points below the nominal voltage curve will require less voltage.



Recommended areas for continuous operation

Dimensional drawing



2250 S ... BX4S SC

Speed Controller		024 BX4 S	SC
Power supply electronic	U_P	5 ... 28	V DC
Power supply motor	U_{mot}	6 ... 28	V DC
PWM switching frequency	f_{PWM}	96	kHz
Efficiency	η	95	%
Max. continuous output current [1]	I_{dauer}	0,8	A
Max. peak output current	I_{max}	1,6	A
Total standby current at U_N	I_{el}	0,020	A
Speed range:			
– standard » Hall sensors (digital)		400 ... 50 000 [2]	rpm
– optional » Hall sensors (analog)		50 ... 50 000 [2]	rpm
Scanning range		500	µs

[1] at 22°C ambient temperature and max. 60°C motor temperature respectively
[2] speed depend on motor operating voltage

Connection information		024 BX4 S	SC
Connection 1 "U_P":	power supply electronic	U_P	
Connection 2 "U_{mot}":	power supply electronic coil	U_{mot}	
Connection 3 "GND":	ground	ground	
Connection 4 "U_{nsoll}":			
– analog input	input voltage	U_{in} = 0 ... 10 V | > 10 V ... U_P » set speed value not defined	
	input resistance	R_{in} ≥ 5 kΩ	
	set speed value	per 1 V, 2 000	rpm
		U_{in} < 0,15 V » motor stops	
		U_{in} > 0,3 V » motor starts	
Connection 5 "DIR":			
– digital input	direction of rotation	to ground or level < 0,5 V » counterclockwise	
		open or level > 3 V » clockwise	
	input resistance	R_{in} ≥ 10 kΩ	
Connection 6 "FG":		max. U_P; Imax = 15 mA; open collector with 22 kΩ pull-up resistor	
– digital output	frequency output	6 lines per revolution	

Features

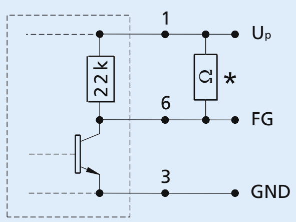
In this variant, the brushless DC servomotors have an integrated Speed Controller. The motor is commutated using Hall sensors integrated into the motor. Speed control is via a PI regulator.

The Speed Controller has a current limiting device which limits the maximum motor current if the thermal load is too high. Twice the continuous current is possible over a short time.

Using the **"FAULHABER Motion Manager"** software, the customer can modify the Speed Controller to special conditions of use. The following parameters can be changed: current limit and regulator parameters.

Circuit diagram / Connection information

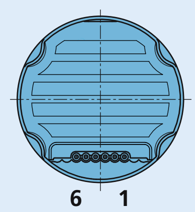
Output circuit



* An additional external pull-up resistor can be added to improve the rise time.

Caution: I_{OUT} max. 15 mA must not be exceeded!

Cable connection



Connection

No.	Function
1	U_P
2	U_{mot}
3	GND
4	U_{nsoll}
5	DIR
6	FG

Caution:
Incorrect lead connection will damage the motor electronics!

Options

- Connector variant (Option no.: 3809)
  AWG 26 / PVC ribbon cable
  with connector Micro-Fit

Accessories

- Programming board (Part No.: 6501.00088)

Full product description

- Example:
  2250S024BX4S SC

Brushless DC-Servomotors

with integrated Speed Controller
4 Pole Technology

25 mNm

For combination with
Gearheads:
22F, 22/7, 26A

Series 2250 ... BX4 SC

		2250 S		024 BX4	SC
1	Nominal voltage	U_N		24	Volt
2	Terminal resistance, phase-phase	R		5,9	Ω
3	Output power [1]	$P_{2\,max.}$		17,3	W
4	Efficiency	$\eta_{max.}$		75,0	%
5	No-load speed	n_o		6 000	rpm
6	No-load current (with shaft ø 3,0 mm)	I_o		0,072	A
7	Stall torque	M_H		149,0	mNm
8	Friction torque, static	C_o		1,2	mNm
9	Friction torque, dynamic	C_v		$2,4 \cdot 10^{-4}$	mNm/rpm
10	Speed constant	k_n		259	rpm/V
11	Back-EMF constant	k_E		3,860	mV/rpm
12	Torque constant	k_M		36,9	mNm/A
13	Current constant	k_I		0,027	A/mNm
14	Slope of n-M curve	$\Delta n/\Delta M$		41,4	rpm/mNm
15	Terminal inductance, phase-phase	L		240	µH
16	Mechanical time constant	τ_m		4,30	ms
17	Rotor inertia	J		10	gcm^2
18	Angular acceleration	$\alpha_{max.}$		149	$\cdot 10^3 rad/s^2$
19	Thermal resistance	$R_{th\,1}$ / $R_{th\,2}$	1,2 / 10,5		K/W
20	Thermal time constant	τ_{w1} / τ_{w2}	4,2 / 424		s
21	Operating temperature range		– 40 ... +85		°C
22	Shaft bearings		ball bearings, preloaded		
23	Shaft load max.:				
	– radial at 3 000 rpm (4 mm from mounting flange)		20		N
	– axial at 3 000 rpm		2		N
	– axial at standstill		20		N
24	Shaft play:				
	– radial	≤	0,015		mm
	– axial	=	0		mm
25	Housing material		stainless steel		
26	Weight		117		g
27	Direction of rotation		electronically reversible		
28	Number of pole pairs		2		
	Recommended values - mathematically independent of each other				
29	Speed up to	$n_{e\,max.}$		7 200	rpm
30	Torque up to [1] [2]	$M_{e\,max.}$		25	mNm
31	Current up to [1] [2]	$I_{e\,max.}$		0,79	A

[1] at 5 000 rpm
[2] thermal resistance $R_{th\,2}$ not reduced

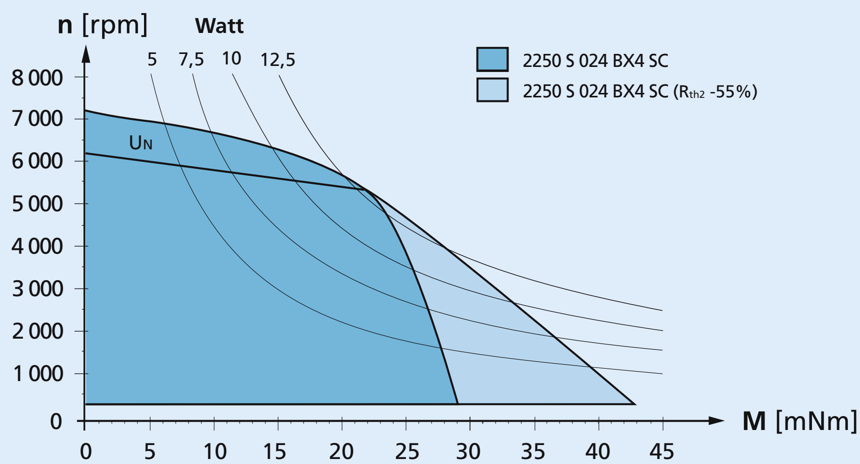
Note:

The diagram indicates the recommended speed in relation to the available torque at the output shaft for a given ambient temperature of 22°C.

The diagram shows the motor in a completely insulated condition.

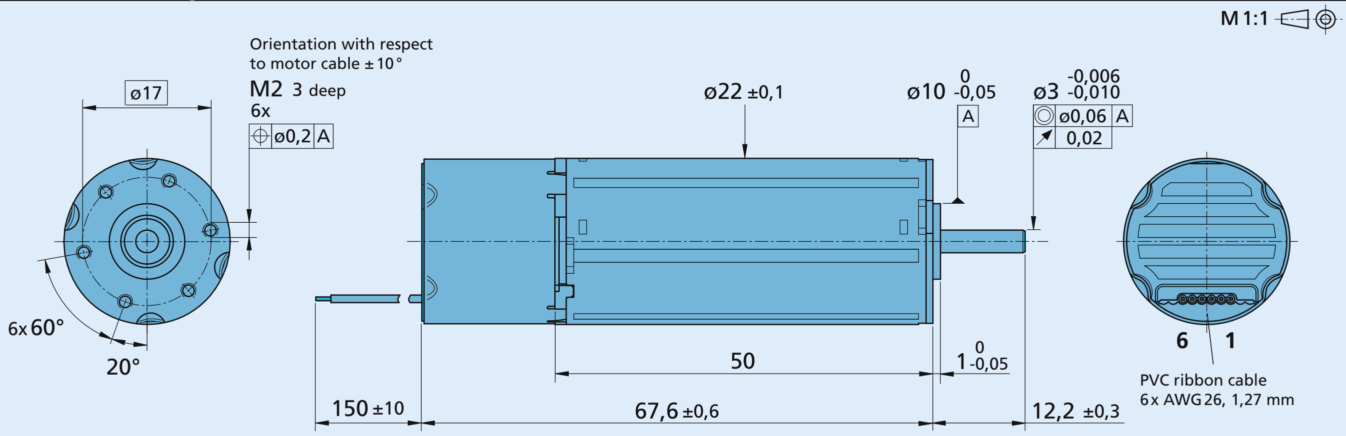
The motor is factory pre-configured to a continuous current for the thermally insulated condition. The controller must be reconfigured with the easy to use Motion Manager Software for use with other parameter settings.

The nominal voltage (U_N) curve shows the operating point at nominal voltage in the insulated condition. Any points of operation above the curve at nominal voltage will require a higher operating voltage. Any points below the nominal voltage curve will require less voltage.



Recommended areas for continuous operation

Dimensional drawing



2250 S ... BX4 SC

Speed Controller		024 BX4	SC
Power supply electronic	U_p	5 ... 28	V DC
Power supply motor	U_{mot}	6 ... 28	V DC
PWM switching frequency	f_{PWM}	96	kHz
Efficiency	η	95	%
Max. continuous output current [1]	I_{dauer}	0,8	A
Max. peak output current	I_{max}	1,6	A
Total standby current at U_N	I_{el}	0,020	A
Speed range:			
– standard » Hall sensors (digital)		400 ... 50 000 [2]	rpm
– optional » Hall sensors (analog)		50 ... 50 000 [2]	rpm
Scanning range		500	µs

[1] at 22°C ambient temperature and max. 60°C motor temperature respectively
[2] speed depend on motor operating voltage

Connection information		024 BX4	SC
Connection 1 “U_P”:	power supply electronic	U_P	
Connection 2 “U_{mot}”:	power supply electronic coil	U_{mot}	
Connection 3 “GND”:	ground	ground	
Connection 4 “U_{nsoll}”:			
– analog input	input voltage	U_{in} = 0 ... 10 V | > 10 V ... U_P » set speed value not defined	
	input resistance	R_{in} ≥ 5 kΩ	
	set speed value	per 1 V, 1 000	rpm
		U_{in} < 0,15 V » motor stops	
		U_{in} > 0,3 V » motor starts	
Connection 5 “DIR”:			
– digital input	direction of rotation	to ground or level < 0,5 V » counterclockwise	
		open or level > 3 V » clockwise	
	input resistance	R_{in} ≥ 10 kΩ	
Connection 6 “FG”:		max. U_P; Imax = 15 mA; open collector with 22 kΩ pull-up resistor	
– digital output	frequency output	6 lines per revolution	

Features

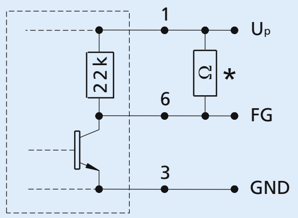
In this variant, the brushless DC servomotors have an integrated Speed Controller. The motor is commutated using Hall sensors integrated into the motor. Speed control is via a PI regulator.

The Speed Controller has a current limiting device which limits the maximum motor current if the thermal load is too high. Twice the continuous current is possible over a short time.

Using the **“FAULHABER Motion Manager”** software, the customer can modify the Speed Controller to special conditions of use. The following parameters can be changed: current limit and regulator parameters.

Circuit diagram / Connection information

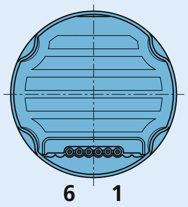
Output circuit



* An additional external pull-up resistor can be added to improve the rise time.

Caution: I_{OUT} max. 15 mA must not be exceeded!

Cable connection



Connection

No.	Function
1	U_P
2	U_{mot}
3	GND
4	U_{nsoll}
5	DIR
6	FG

Caution:
Incorrect lead connection will damage the motor electronics!

Options

- Connector variant (Option no.: 3809)
  AWG 26 / PVC ribbon cable
  with connector Micro-Fit
- Analog Hall sensors (Option no.: 3692)

Accessories

- Programming board (Part No.: 6501.00088)

Full product description

- Example:
  2250S024BX4 SC

Brushless DC-Servomotors

with integrated Speed Controller
4 Pole Technology

54 mNm

For combination with
Gearheads:
30/1, 32A, 32ALN, 32/3 (S), 38/1(S), 38/2(S)

Series 3242 ... BX4 SC

	3242 G			012 BX4	024 BX4	SC
1	Nominal voltage	U_N		12	24	Volt
2	Terminal resistance, phase-phase	R		0,89	3,6	Ω
3	Output power 1)	$P_{2\ max.}$		21,2	21,1	W
4	Efficiency	$\eta_{max.}$		77,4	77,3	%
5	No-load speed	n_o		5 500	5 500	rpm
6	No-load current	I_o		0,206	0,103	A
7	Stall torque	M_H		83	83	mNm
8	Friction torque, static	C_o		1,3	1,3	mNm
9	Friction torque, dynamic	C_v		$5{,}2 \cdot 10^{-4}$	$5{,}2 \cdot 10^{-4}$	mNm/rpm
10	Speed constant	k_n		455	227	rpm/V
11	Back-EMF constant	k_E		2,199	4,409	mV/rpm
12	Torque constant	k_M		21,0	42,1	mNm/A
13	Current constant	k_I		0,0476	0,0238	A/mNm
14	Slope of n-M curve	$\Delta n/\Delta M$		19,3	19,4	rpm/mNm
15	Terminal inductance, phase-phase	L		60	240	µH
16	Mechanical time constant	τ_m		6,1	6,1	ms
17	Rotor inertia	J		30	30	gcm^2
18	Angular acceleration	$\alpha_{max.}$		28	28	$\cdot 10^3 rad/s^2$
19	Thermal resistance	$R_{th\ 1}$ / $R_{th\ 2}$	1,6 / 12,4			K/W
20	Thermal time constant	τ_{w1} / τ_{w2}	9 / 810			s
21	Operating temperature range		– 40 ... + 100			°C
22	Shaft bearings		ball bearings, preloaded			
23	Shaft load max.:					
	– radial at 3 000 rpm (4,5 mm from mounting flange)		50			N
	– axial at 3 000 rpm		5			N
	– axial at standstill		50			N
24	Shaft play:					
	– radial	≤	0,015			mm
	– axial	=	0			mm
25	Housing material		stainless steel			
26	Weight		192			g
27	Direction of rotation		electronically reversible			
28	Number of pole pairs		2			
	Recommended values - mathematically independent of each other					
29	Speed up to	$n_{e\ max.}$		14 000	6 000	rpm
30	Torque up to 1) 2)	$M_{e\ max.}$		32 / 36	32 / 54	mNm
31	Current up to 1) 2)	$I_{e\ max.}$		1,90 / 2,00	0,95 / 1,55	A

1) at 5 000 rpm
2) thermal resistance $R_{th\ 2}$ not reduced / thermal resistance $R_{th\ 2}$ by 55% reduced

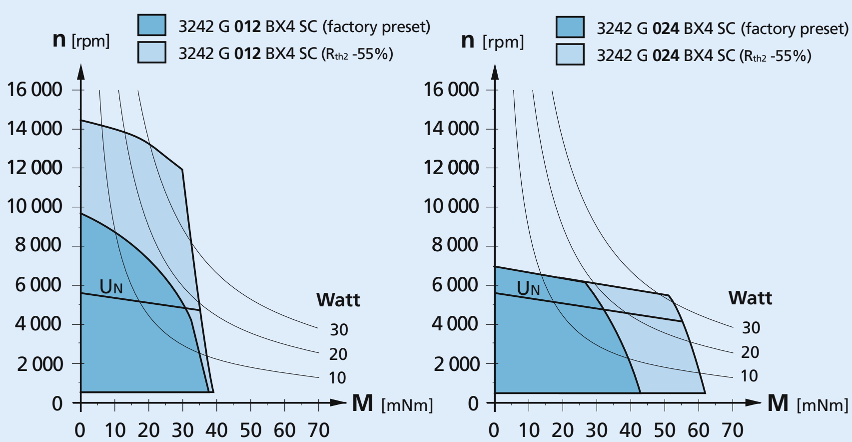
Note:

The diagram indicates the recommended speed in relation to the available torque at the output shaft for a given ambient temperature of 22°C.

The diagram shows the motor in a completely insulated as well as thermally coupled condition ($R_{th\ 2}$ 55% reduced).

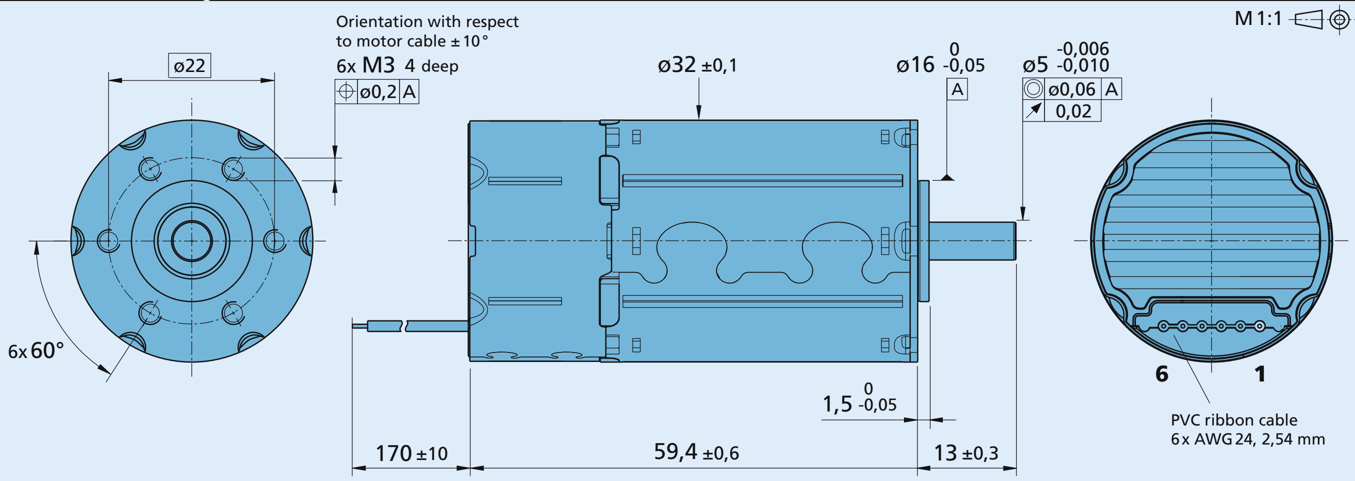
The motor is factory pre-configured to a continuous current for the thermally insulated condition. The controller must be reconfigured with the easy to use Motion Manager Software for use at higher continuous current.

The nominal voltage (U_N) curve shows the operating point at nominal voltage in the insulated and thermally coupled condition. Any points of operation above the curve at nominal voltage will require a higher operating voltage. Any points below the nominal voltage curve will require less voltage.



Recommended areas for continuous operation

Dimensional drawing



3242 G ... BX4 SC

Speed Controller		012 BX4	024 BX4	SC
Power supply electronic	U_P	6,5 ... 30		V DC
Power supply motor	U_{mot}	6,5 ... 30		V DC
PWM switching frequency	f_{PWM}	96		kHz
Efficiency	η	95		%
Max. continuous output current [1]	I_{dauer}	2		A
Max. peak output current	I_{max}	4		A
Total standby current at U_N	I_{el}	17	10	mA
Speed range:				
– standard » Hall sensors (digital)		400 ... 50 000 [2]		rpm
– optional » Hall sensors (analog)		50 ... 50 000 [2]		rpm
Scanning range		500		µs

[1] at 22°C ambient temperature
[2] speed is dependent on the motor operating voltage

Connection information

Connection 1 "U_P":	power supply electronic	U_P	
Connection 2 "U_{mot}":	power supply electronic coil	U_{mot}	
Connection 3 "GND":	ground	ground	
Connection 4 "U_{nsoll}":			
– analog input	input voltage	U_{in} = 0 ... 10 V | > 10 V ... U_P » set speed value not defined	
	input resistance	R_{in} ≥ 8,9 kΩ	
	set speed value	per 1 V, 1 000	rpm
		U_{in} < 0,15 V » motor stops	
		U_{in} > 0,3 V » motor starts	
Connection 5 "DIR":			
– digital input	direction of rotation	to ground or level < 0,5 V » counterclockwise	
		open or level > 3 V » clockwise	
	input resistance	R_{in} ≥ 10 kΩ	
Connection 6 "FG":		max. U_P; I_{max} = 15 mA; open collector with 22 kΩ pull-up resistor	
– digital output	frequency output	6 lines per revolution	

Features

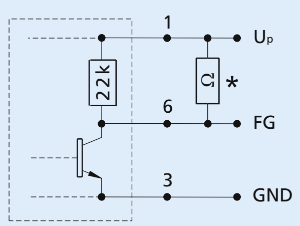
In this variant, the brushless DC servomotors have an integrated Speed Controller. The motor is commutated using Hall sensors integrated into the motor. Speed control is via a PI regulator.

The Speed Controller has a current limiting device which limits the maximum motor current if the thermal load is too high. Twice the continuous current is possible over a short time.

Using the **"FAULHABER Motion Manager"** software, the customer can modify the Speed Controller to special conditions of use. The following parameters can be changed: current limit and regulator parameters.

Circuit diagram / Connection information

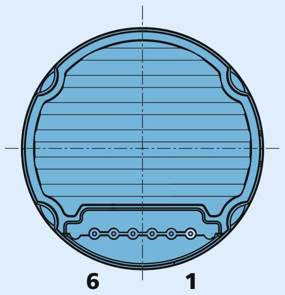
Output circuit



* An additional external pull-up resistor can be added to improve the rise time.

Caution: I_{OUT} max. 15 mA must not be exceeded!

Cable connection



Connection

No.	Function
1	U_P
2	U_{mot}
3	GND
4	U_{nsoll}
5	DIR
6	FG

Caution:
Incorrect lead connection will damage the motor electronics!

Options

- Connector variant (Option no.: 3809)
  AWG 24 / PVC ribbon cable
  with connector Micro-Fit
- Analog Hall sensors (Option no.: 3692)

Accessories

- Programming board (Part No.: 6501.00088)

Full product description

- Examples:
  3242G012BX4 SC
  3242G024BX4 SC

Brushless DC-Servomotors

with integrated Speed Controller
4 Pole Technology

50 mNm

For combination with
Gearheads:
30/1, 32A, 32ALN, 32/3 (S), 38/1(S), 38/2(S)

Series 3242 ... BX4 SCDC

		3242 G		012 BX4	024 BX4	SCDC
1	Nominal voltage	U_N		12	24	Volt
2	Terminal resistance, phase-phase	R		0,89	3,6	Ω
3	Output power [1]	$P_{2\,max.}$		21,2	21,1	W
4	Efficiency	$\eta_{max.}$		77,4	77,3	%
5	No-load speed	n_0		5 300	5 400	rpm
6	No-load current	I_0		0,199	0,101	A
7	Stall torque	M_H		83	83	mNm
8	Friction torque, static	C_0		1,3	1,3	mNm
9	Friction torque, dynamic	C_v		$5,2 \cdot 10^{-4}$	$5,2 \cdot 10^{-4}$	mNm/rpm
10	Speed constant	k_n		455	227	rpm/V
11	Back-EMF constant	k_E		2,199	4,409	mV/rpm
12	Torque constant	k_M		21,0	42,1	mNm/A
13	Current constant	k_I		0,0476	0,0238	A/mNm
14	Slope of n-M curve	$\Delta n/\Delta M$		19,3	19,4	rpm/mNm
15	Terminal inductance, phase-phase	L		60	240	µH
16	Mechanical time constant	τ_m		6,1	6,1	ms
17	Rotor inertia	J		30	30	gcm^2
18	Angular acceleration	$\alpha_{max.}$		28	28	$\cdot 10^3 rad/s^2$
19	Thermal resistance	$R_{th\,1}$ / $R_{th\,2}$	1,6 / 12,4			K/W
20	Thermal time constant	τ_{w1} / τ_{w2}	9 / 810			s
21	Operating temperature range		– 40 ... +85			°C
22	Shaft bearings		ball bearings, preloaded			
23	Shaft load max.:					
	– radial at 3 000 rpm (4,5 mm from mounting flange)		50			N
	– axial at 3 000 rpm		5			N
	– axial at standstill		50			N
24	Shaft play:					
	– radial	≤	0,015			mm
	– axial	=	0			mm
25	Housing material		stainless steel			
26	Weight		189			g
27	Direction of rotation		electronically reversible			
28	Number of pole pairs		2			
Recommended values - mathematically independent of each other						
29	Speed up to	$n_{e\,max.}$		12 000	6 000	rpm
30	Torque up to [1] [2]	$M_{e\,max.}$		27 / 29	28 / 50	mNm
31	Current up to [1] [2]	$I_{e\,max.}$		1,60 / 1,60	0,82 / 1,40	A

[1] at 5000 rpm
[2] thermal resistance $R_{th\,2}$ not reduced / thermal resistance $R_{th\,2}$ by 55% reduced

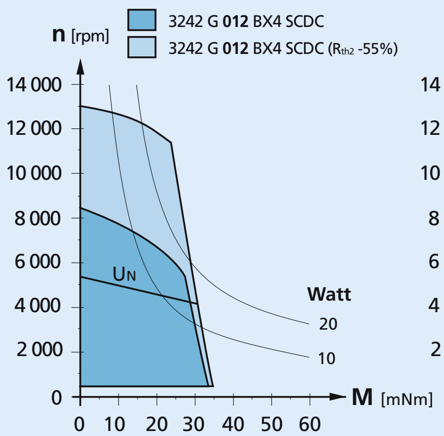
Note:

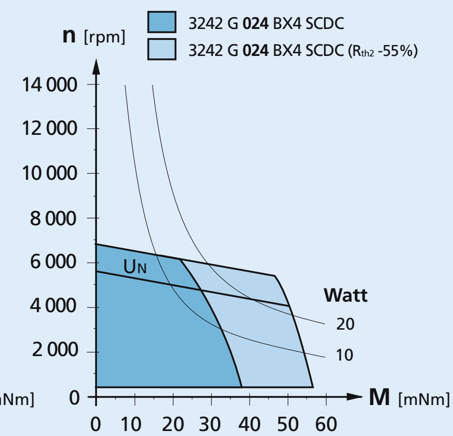
The diagram indicates the recommended speed in relation to the available torque at the output shaft for a given ambient temperature of 22°C.

The diagram shows the motor in a completely insulated as well as thermally coupled condition ($R_{th\,2}$ 55% reduced).

The motor is factory pre-configured to perform at the recommended continuous current. Non-standard configurations are only possible upon request from the manufacturer.

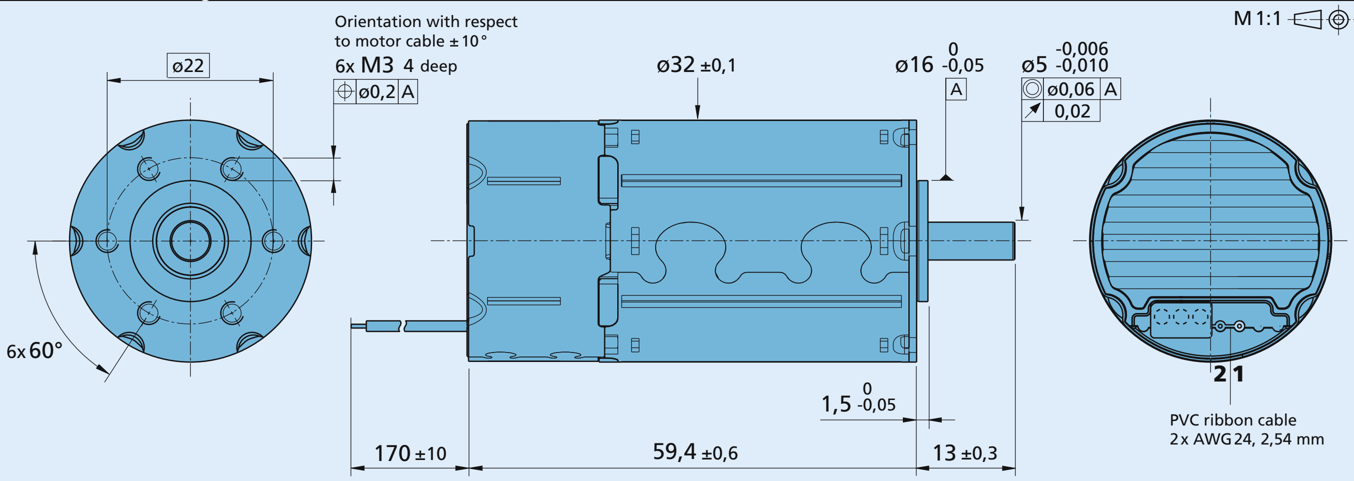
The nominal voltage (U_N) curve shows the operating point at nominal voltage in the insulated and thermally coupled condition. Any points of operation above the curve at nominal voltage will require a higher operating voltage. Any points below the nominal voltage curve will require less voltage.





Recommended areas for continuous operation

Dimensional drawing



3242 G ... BX4 SCDC

Speed Controller		012 BX4	024 BX4	SCDC
Power supply electronic	U_p	6,5 ... 30		V DC
Power supply motor	U_{mot}	6,5 ... 30		V DC
PWM switching frequency	f_{PWM}	96		kHz
Efficiency	η	95		%
Max. continuous output current [1]	I_{dauer}	1,6		A
Max. peak output current	I_{max}	4		A
Total standby current at U_N	I_{el}	17	10	mA
Speed range, electronics		400 ... 50 000 [2]		rpm
Scanning rate		500		µs

[1] at 22°C ambient temperature
[2] speed is dependent on the motor operating voltage

Connection information

Connection 1 "Mot +": positive power supply

Connection 2 "Mot –": negative power supply

Features

In this version, the brushless DC servomotors have an integrated Speed Controller. The motor is commutated using the integrated digital hall sensors. Speed control is via a PI regulator.

The Speed Controller has a current limiting device which limits the maximum motor current if the thermal load is too high.
Twice the continuous current is possible over a short time.

The direction of rotation is dependent on the polarity of the voltage.

Full product description

- Examples:

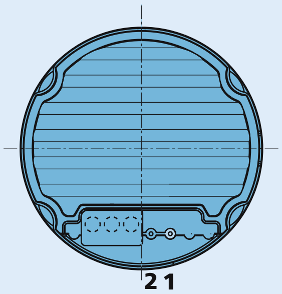
  3242G012BX4 SCDC
  3242G024BX4 SCDC

Connection information

Options

- Connector variants (Option no. 4140)
  AWG 24 / PVC ribbon cable
  with connector Micro-Fit
  connector pin assignment:

Cable connection



Connection

No.	Function
1	Mot +
2	Mot –

Brushless DC-Servomotors

with integrated Speed Controller
4 Pole Technology

73 mNm

For combination with
Gearheads:
30/1, 32A, 32ALN, 32/3 (S), 38/1(S), 38/2(S)

Brushless
DC-Motors

Series 3268 ... BX4 SC

		3268 G	024 BX4	SC
1	Nominal voltage	U_N	24	Volt
2	Terminal resistance, phase-phase	R	1,45	Ω
3	Output power [1]	$P_{2\,max.}$	32,7	W
4	Efficiency	$\eta_{max.}$	79,5	%
5	No-load speed	n_o	5 500	rpm
6	No-load current	I_o	0,215	A
7	Stall torque	M_H	137	mNm
8	Friction torque, static	C_o	1,7	mNm
9	Friction torque, dynamic	C_v	$1{,}3 \cdot 10^{-3}$	mNm/rpm
10	Speed constant	k_n	220	rpm/V
11	Back-EMF constant	k_E	4,555	mV/rpm
12	Torque constant	k_M	43,5	mNm/A
13	Current constant	k_I	0,0230	A/mNm
14	Slope of n-M curve	$\Delta n/\Delta M$	7,3	rpm/mNm
15	Terminal inductance, phase-phase	L	110	µH
16	Mechanical time constant	τ_m	4,6	ms
17	Rotor inertia	J	60	gcm^2
18	Angular acceleration	$\alpha_{max.}$	23	$\cdot 10^3 rad/s^2$
19	Thermal resistance	$R_{th\,1}$ / $R_{th\,2}$	1,9 / 9,6	K/W
20	Thermal time constant	τ_{w1} / τ_{w2}	17 / 1 060	s
21	Operating temperature range		– 40 ... + 100	°C
22	Shaft bearings		ball bearings, preloaded	
23	Shaft load max.:			
	– radial at 3 000 rpm (4,5 mm from mounting flange)		50	N
	– axial at 3 000 rpm		5	N
	– axial at standstill		50	N
24	Shaft play:			
	– radial	≤	0,015	mm
	– axial	=	0	mm
25	Housing material		stainless steel	
26	Weight		305	g
27	Direction of rotation		electronically reversible	
28	Number of pole pairs		2	
Recommended values - mathematically independent of each other				
29	Speed up to	$n_{e\,max.}$	7 000	rpm
30	Torque up to [1] [2]	$M_{e\,max.}$	47 / 73	mNm
31	Current up to [1] [2]	$I_{e\,max.}$	1,41 / 2,00	A

[1] at U_{soll} = 10V
[2] thermal resistance $R_{th\,2}$ not reduced / thermal resistance $R_{th\,2}$ by 55% reduced

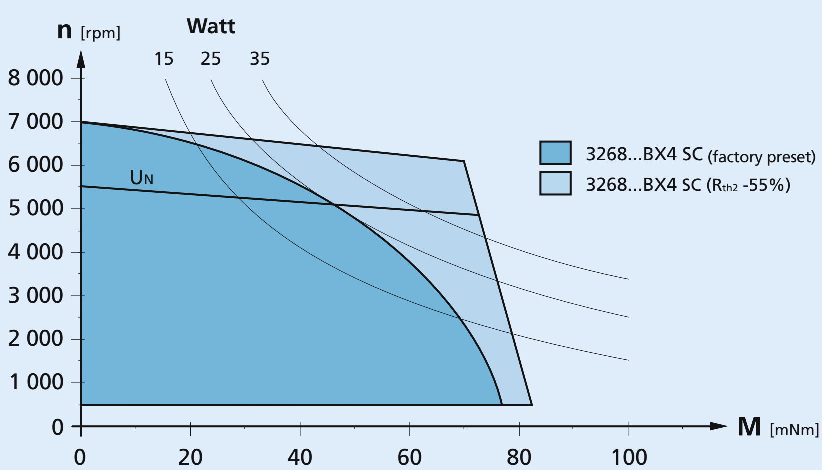
Note:

The diagram indicates the recommended speed in relation to the available torque at the output shaft for a given ambient temperature of 22°C.

The diagram shows the motor in a completely insulated as well as thermally coupled condition ($R_{th\,2}$ 55% reduced).

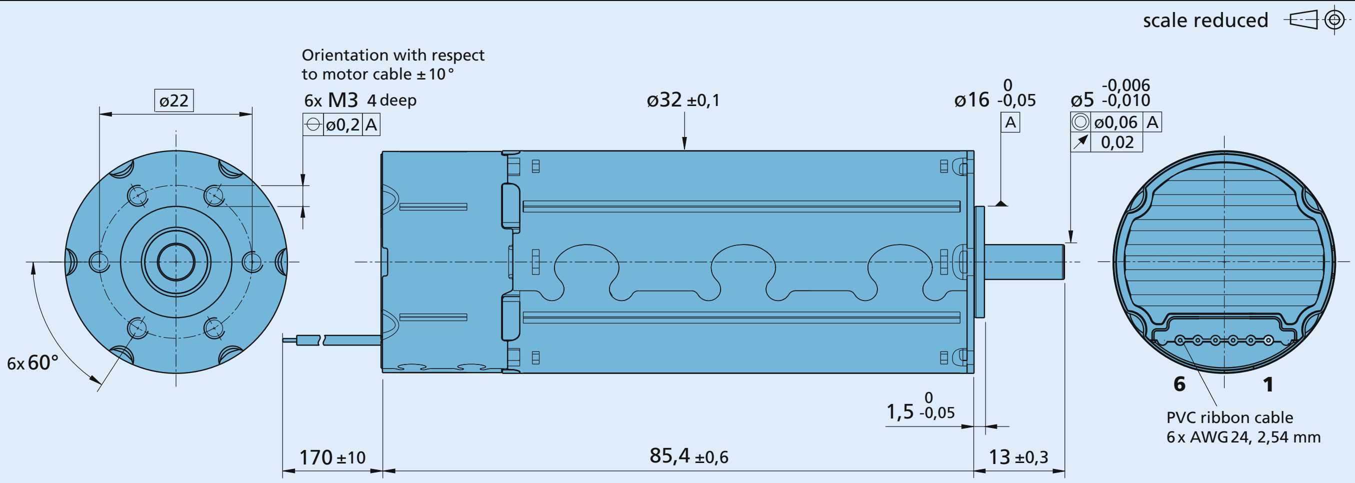
The motor is factory pre-configured to a continuous current for the thermally insulated condition. The controller must be reconfigured with the easy to use Motion Manager Software for use at higher continuous current.

The nominal voltage (U_N) curve shows the operating point at nominal voltage in the insulated and thermally coupled condition. Any points of operation above the curve at nominal voltage will require a higher operating voltage. Any points below the nominal voltage curve will require less voltage.



Recommended areas for continuous operation

Dimensional drawing



3268 G ... BX4 SC

Speed Controller		024 BX4	SC
Power supply electronic	U_P	6,5 ... 30	V DC
Power supply motor	U_{mot}	6,5 ... 30	V DC
PWM switching frequency	f_{PWM}	96	kHz
Efficiency	η	95	%
Max. continuous output current [1]	I_{dauer}	2	A
Max. peak output current	I_{max}	4	A
Total standby current at U_N	I_{el}	10	mA
Speed range:			
– standard » Hall sensors (digital)		400 ... 50 000 [2]	rpm
– optional » Hall sensors (analog)		50 ... 50 00 [2]	rpm
Scanning range		500	µs

[1] at 22°C ambient temperature
[2] speed is dependent on the motor operating voltage

Connection 1 "U_P":	power supply electronic	U_P	
Connection 2 "U_{mot}":	power supply electronic coil	U_{mot}	
Connection 3 "GND":	ground	ground	
Connection 4 "U_{nsoll}":			
– analog input	input voltage	U_{in} = 0 ... 10 V | > 10 V ... U_P » set speed value not defined	
	input resistance	R_{in} ≥ 8,9 kΩ	
	set speed value	per 1 V, 1 000	rpm
		U_{in} < 0,15 V » motor stops	
		U_{in} > 0,3 V » motor starts	
Connection 5 "DIR":			
– digital input	direction of rotation	to ground or level < 0,5 V » counterclockwise	
		open or level > 3 V » clockwise	
	input resistance	R_{in} ≥ 10 kΩ	
Connection 6 "FG":		max. U_P; I_{max} = 15 mA; open collector with 22 kΩ pull-up resistor	
– digital output	frequency output	6 lines per revolution	

Features

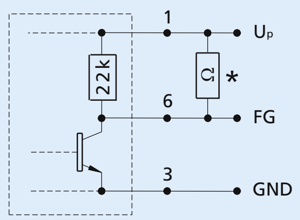
In this variant, the brushless DC servomotors have an integrated Speed Controller. The motor is commutated using Hall sensors integrated into the motor. Speed control is via a PI regulator.

The Speed Controller has a current limiting device which limits the maximum motor current if the thermal load is too high. Twice the continuous current is possible over a short time.

Using the **"FAULHABER Motion Manager"** software, the customer can modify the Speed Controller to special conditions of use. The following parameters can be changed: current limit and regulator parameters.

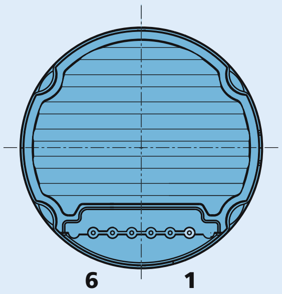
Circuit diagram / Connection information

Output circuit



* An additional external pull-up resistor can be added to improve the rise time.
Caution: I_{OUT} max. 15 mA must not be exceeded!

Cable connection



Connection

No.	Function
1	U_P
2	U_{mot}
3	GND
4	U_{nsoll}
5	DIR
6	FG

Caution:
Incorrect lead connection will damage the motor electronics!

Options

- Connector variant (Option no.: 3809)
  AWG 24 / PVC ribbon cable
  with connector Micro-Fit

- Analog Hall sensors (Option no.: 3692)

Accessories
- Programming board (Part No.: 6501.00088)

Full product description
- Example:
  3268G024BX4 SC

Brushless DC-Servomotors

with integrated Speed Controller
4 Pole Technology

58 mNm

For combination with
Gearheads:
30/1, 32A, 32ALN, 32/3 (S), 38/1(S), 38/2(S)

Series 3268 ... BX4 SCDC

		3268 G	024 BX4	SCDC
1	Nominal voltage	U_N	24	Volt
2	Terminal resistance, phase-phase	R	1,45	Ω
3	Output power [1]	$P_{2\,max.}$	32,7	W
4	Efficiency	$\eta_{\,max.}$	79,5	%
5	No-load speed	n_o	5 300	rpm
6	No-load current	I_o	0,210	A
7	Stall torque	M_H	137	mNm
8	Friction torque, static	C_o	1,7	mNm
9	Friction torque, dynamic	C_v	$1{,}3 \cdot 10^{-3}$	mNm/rpm
10	Speed constant	k_n	220	rpm/V
11	Back-EMF constant	k_E	4,555	mV/rpm
12	Torque constant	k_M	43,5	mNm/A
13	Current constant	k_I	0,0230	A/mNm
14	Slope of n-M curve	$\Delta n/\Delta M$	7,3	rpm/mNm
15	Terminal inductance, phase-phase	L	110	µH
16	Mechanical time constant	$\tau_{\,m}$	4,6	ms
17	Rotor inertia	J	60	gcm^2
18	Angular acceleration	$\alpha_{\,max.}$	23	$\cdot 10^3 rad/s^2$
19	Thermal resistance	$R_{th\,1}$ / $R_{th\,2}$	1,9 / 9,6	K/W
20	Thermal time constant	$\tau_{\,w1}$ / $\tau_{\,w2}$	17 / 1 060	s
21	Operating temperature range		– 40 ... +85	°C
22	Shaft bearings		ball bearings, preloaded	
23	Shaft load max.:			
	– radial at 3 000 rpm (4,5 mm from mounting flange)		50	N
	– axial at 3 000 rpm		5	N
	– axial at standstill		50	N
24	Shaft play:			
	– radial	≤	0,015	mm
	– axial	=	0	mm
25	Housing material		stainless steel	
26	Weight		305	g
27	Direction of rotation		electronically reversible	
28	Number of pole pairs		2	
	Recommended values - mathematically independent of each other			
29	Speed up to	$n_{e\,max.}$	6 500	rpm
30	Torque up to [1] [2]	$M_{e\,max.}$	37 / 58	mNm
31	Current up to [1] [2]	$I_{e\,max.}$	1,11 / 1,60	A

[1] at 5000 rpm
[2] thermal resistance $R_{th\,2}$ not reduced / thermal resistance $R_{th\,2}$ by 55% reduced

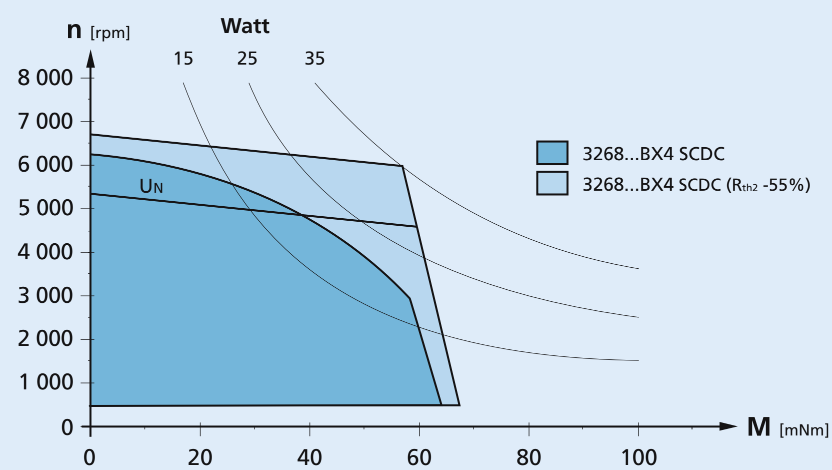
Note:

The diagram indicates the recommended speed in relation to the available torque at the output shaft for a given ambient temperature of 22°C.

The diagram shows the motor in a completely insulated as well as thermally coupled condition ($R_{th\,2}$ 55% reduced).

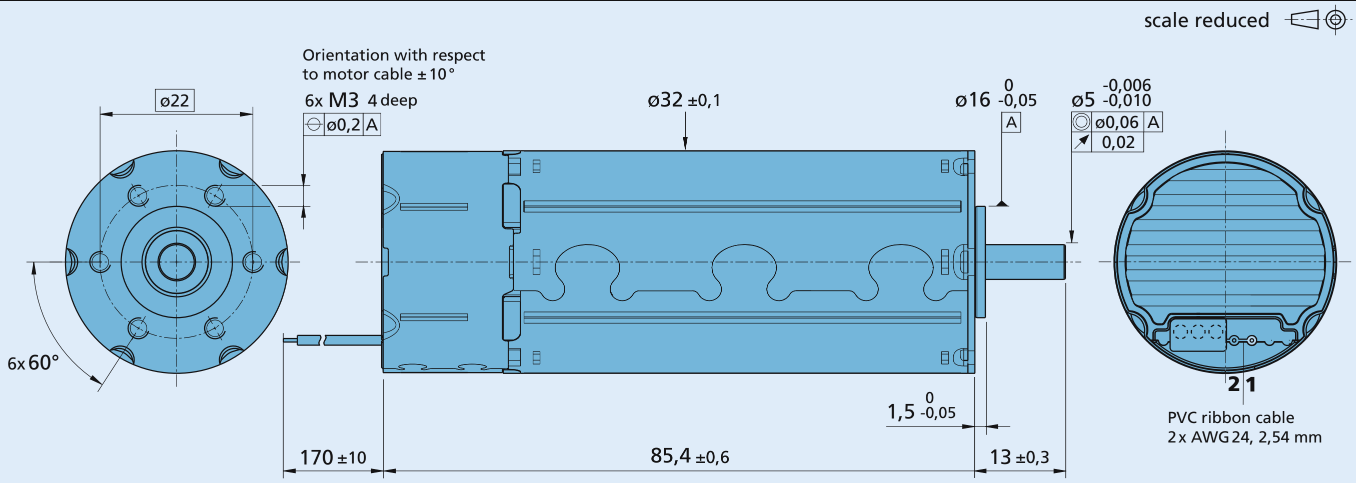
The motor is factory pre-configured to perform at the recommended continuous current. Non-standard configurations are only possible upon request from the manufacturer.

The nominal voltage (U_N) curve shows the operating point at nominal voltage in the insulated and thermally coupled condition. Any points of operation above the curve at nominal voltage will require a higher operating voltage. Any points below the nominal voltage curve will require less voltage.



Recommended areas for continuous operation

Dimensional drawing



3268 G ... BX4 SCDC

Speed Controller		024 BX4	SCDC
Power supply electronic	U_p	6,5 ... 30	V DC
Power supply motor	U_{mot}	6,5 ... 30	V DC
PWM switching frequency	f_{PWM}	96	kHz
Efficiency	η	95	%
Max. continuous output current [1]	I_{dauer}	1,6	A
Max. peak output current	I_{max}	4	A
Total standby current at U_N	I_{el}	10	mA
Speed range, electronics		400 ... 50 000 [2]	rpm
Scanning rate		500	µs

[1] at 22°C ambient temperature
[2] speed is dependent on the motor operating voltage

Connection information

Connection 1 "Mot +": positive power supply

Connection 2 "Mot –": negative power supply

Features

In this version, the brushless DC servomotors have an integrated Speed Controller. The motor is commutated using the integrated digital hall sensors. Speed control is via a PI regulator.

The Speed Controller has a current limiting device which limits the maximum motor current if the thermal load is too high.
Twice the continuous current is possible over a short time.

The direction of rotation is dependent on the polarity of the voltage.

Full product description

- Examples:

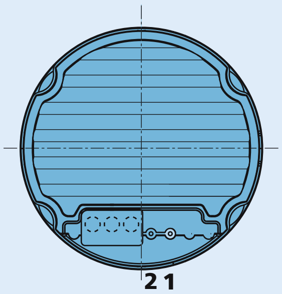
  3268G024BX4 SCDC

Connection information

Options

- Connector variants (Option no. 4140)
  AWG 24 / PVC ribbon cable
  with connector Micro-Fit
  connector pin assignment:

Cable connection



Connection

No.	Function
1	Mot +
2	Mot –

Brushless Flat DC-Micromotors

with integrated Speed Controller

3,7 mNm

Series 2610 ... B SC

		2610 T		006 B	012 B	SC
1	Nominal voltage	U_N		6	12	Volt
2	Terminal resistance, phase-phase	R		7,0	28,2	Ω
3	Output power [1]	$P_{2\ max.}$		1,92	1,91	W
4	Efficiency	$\eta_{max.}$		78	78	%
5	No-load speed	n_o		6 200	6 200	rpm
6	No-load current	I_o		0,012	0,006	A
7	Stall torque	M_H		7,73	7,68	mNm
8	Friction torque, static	C_o		0,025	0,025	mNm
9	Friction torque, dynamic	C_v		$1{,}35 \cdot 10^{-5}$	$1{,}35 \cdot 10^{-5}$	mNm/rpm
10	Speed constant	k_n		1 055	528	rpm/V
11	Back-EMF constant	k_E		0,948	1,895	mV/rpm
12	Torque constant	k_M		9,05	18,1	mNm/A
13	Current constant	k_I		0,111	0,055	A/mNm
14	Slope of n-M curve	$\Delta n/\Delta M$		816	822	rpm/mNm
15	Terminal inductance, phase-phase	L		480	1 940	µH
16	Mechanical time constant	τ_m		69	70	ms
17	Rotor inertia	J		8,1	8,1	gcm^2
18	Angular acceleration	$\alpha_{max.}$		9,5	9,5	$\cdot 10^3 rad/s^2$
19	Thermal resistance	$R_{th\ 1}$ / $R_{th\ 2}$	33 / 27			K/W
20	Thermal time constant	τ_{w1} / τ_{w2}	20 / 230			s
21	Operating temperature range		-25 ... +80			°C
22	Shaft bearings		ball bearing, preloaded			
23	Shaft load max.:					
	– radial at 3 000/7 000 rpm (3 mm from mounting flange)		4,0 / 3,5			N
	– axial at 3 000/7 000 rpm (push-on only)		3,5 / 3,4			N
	– axial at standstill (push-on only)		17,5			N
24	Shaft play:					
	– radial	≤	0,015			mm
	– axial	=	0			mm
25	Housing material		plastic			
26	Weight		20,1			g
27	Direction of rotation		electronically reversible			
	Recommended values - mathematically independent of each other					
28	Speed up to	$n_{e\ max.}$		7 000	7 000	rpm
29	Torque up to [1) 2)]	$M_{e\ max.}$		3,14 / 3,72	3,13 / 3,70	mNm
30	Current up to [1) 2)]	$I_{e\ max.}$		0,403 / 0,475	0,201 / 0,236	A

[1)] at 5 000 rpm

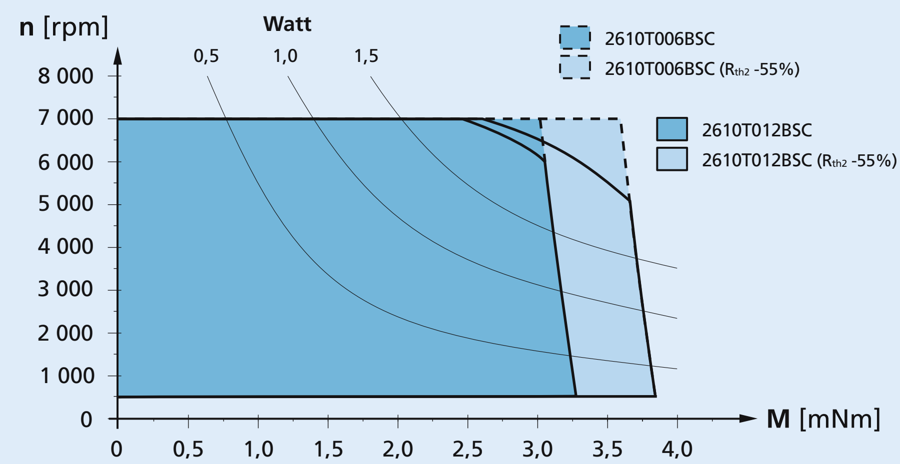
[2)] thermal resistance $R_{th\ 2}$ not reduced / thermal resistance $R_{th\ 2}$ by 55% reduced

Note:

The diagram indicates the recommended speed in relation to the available torque at the output shaft for a given ambient temperature of 22°C.

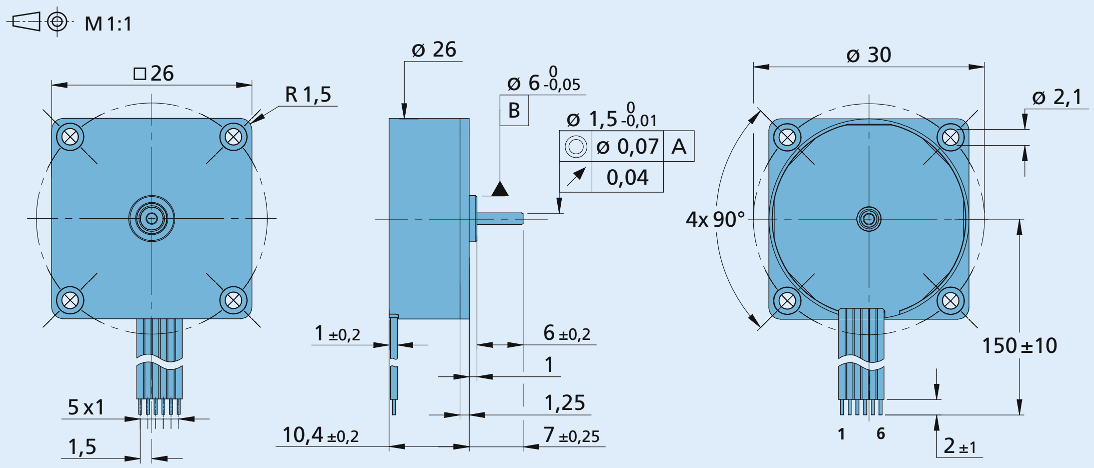
The diagram shows the motor in a completely insulated as well as thermally coupled condition ($R_{th\ 2}$ 55% reduced).

The area of the curve is defined by the maximum allowable supply voltage of the integrated speed controller as well as the control performance characteristics.



Recommended areas for continuous operation

2610 T ... B SC

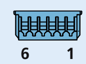


2610 B SC

Option

- connector variants AWG 28 / PVC ribbon cable with connector Picoblade

  connector pin assignment:



Connection

No.	Function
1	Up
2	Umot
3	GND
4	Unsoll
5	DIR
6	FG

Speed Controller		006 B	012 B	SC
PWM switching frequency		96	96	kHz
Efficiency		95	95	%
Max. continuous output current 1)		0,8	0,8	A
Max. peak output current		1,6	1,6	A
Total standby current	0,020			A
Speed range electronic	500 ... 60 000 2)			rpm
Scanning range	500			µs

1) at 22°C ambient temperature and max. 60°C motor temperature respectively
2) speed depend on motor operating voltage

Connection information			006 B	012 B	SC
Connection 1 “U_P”:	power supply electronic	U_P = 4 ... 18 V			
Connection 2 “U_{mot}”:	power supply electronic coil	U_{mot} = 1,7 ... 18 V			
Connection 3 “GND”:	ground	ground			
Connection 4 “U_{nsoll}”:					
– analog input	input voltage	U_{in} = 0 ... 10 V (max. Up)			
	input resistance	R_{in} ≥ 8 kΩ			
	set speed value	per 1 V	1 000	1 000	rpm
		U_{in} < 0,15 V » motor stops			
		U_{in} > 0,3 V » motor starts			
Connection 5 “DIR”:					
– digital input	direction of rotation	to ground or level < 0,5 V » counterclockwise			
		open or level > 3 V » clockwise (max. Up)			
	input resistance	R_{in} ≥ 10 kΩ			
Connection 6 “FG”:		with max. U_P » I_{max} = 15 mA; open collector with 22 kΩ pull-up resistor			
– digital output	frequency output	6 lines per revolution			

Features

In this variant, the brushless DC-Micromotors have an integrated Speed Controller. The motor is commutated using Hall sensors integrated into the motor. Speed control is via a PI regulator. The Speed Controller has a current limiting device which limits the maximum motor current if the thermal load is too high. Twice the continuous current is possible over a short time.

Using the **“FAULHABER Motion Manager”** software, the customer can modify the Speed Controller to special conditions of use.

The following parameters can be changed: current limit and regulator parameters.

Full product description

- Examples:

  2610T006B SC

  2610T012B SC

Brushless DC-Gearmotors
with integrated Speed Controller

100 mNm

Series 2622 ... B SC

	2622 S		006 B	012 B	SC
1 Nominal voltage	U_N		6	12	Volt
2 Terminal resistance, phase-phase	R		7,0	28,2	Ω
3 Output power	$P_{2\ max.}$		1,92	1,91	W
4 Efficiency	$\eta_{max.}$		78	78	%
5 No-load speed	n_o		6 200	6 200	rpm
6 No-load current	I_o		0,012	0,006	A
7 Stall torque	M_H		7,73	7,68	mNm
8 Friction torque, static	C_o		0,025	0,025	mNm
9 Friction torque, dynamic	C_v		$1,35 \cdot 10^{-5}$	$1,35 \cdot 10^{-5}$	mNm/rpm
10 Speed constant	k_n		1 055	528	rpm/V
11 Back-EMF constant	k_E		0,948	1,895	mV/rpm
12 Torque constant	k_M		9,05	18,1	mNm/A
13 Current constant	k_I		0,111	0,055	A/mNm
14 Slope of n-M curve	$\Delta n/\Delta M$		816	822	rpm/mNm
15 Terminal inductance, phase-phase	L		480	1 940	µH
16 Mechanical time constant	τ_m		69	70	ms
17 Rotor inertia	J		8,1	8,1	gcm^2
18 Angular acceleration	$\alpha_{max.}$		9,5	9,5	$\cdot 10^3 rad/s^2$
19 Thermal resistance	R_{th1} / R_{th2}	33 / 27			K/W
20 Thermal time constant	τ_{w1} / τ_{w2}	20 / 230			s

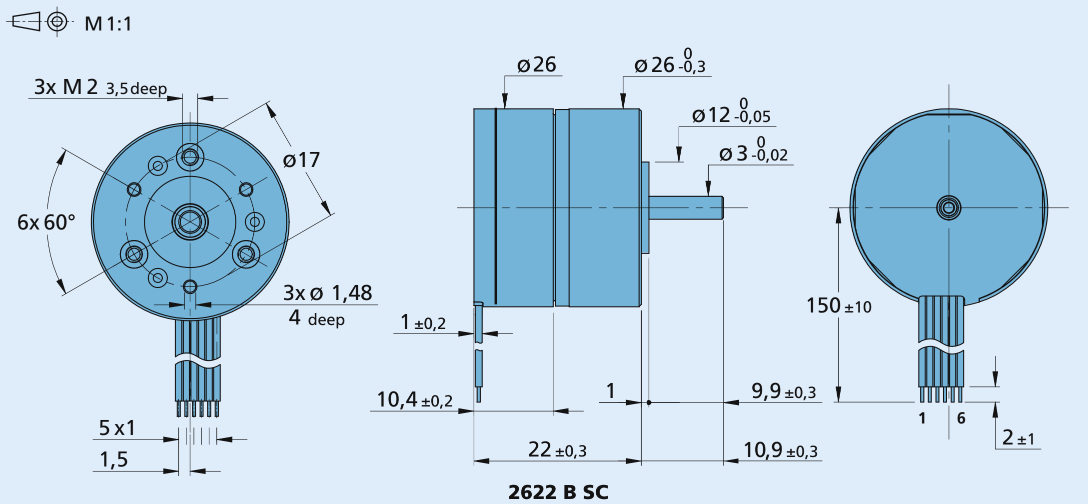
Integrated Gearhead			
Housing material		plastic	
Geartrain material		metal	
Backlash, at no-load	≤	4	°
Bearings on output shaft		ball bearing	
Shaft load max.:			
– radial (5 mm from mounting face)	≤	15	N
– axial	≤	5	N
Shaft press fit force, max.	≤	10	N
Shaft play:			
– radial (5 mm from mounting face)	≤	0,03	mm
– axial	≤	0,25	mm
Operating temperature range		– 25 ... + 80	°C

Specifications

reduction ratio (rounded)	output speed up to n_{max} rpm	weight with motor g	output torque continuous operation M_{max} mNm	output torque intermittent operation M_{max} mNm	direction of rotation (reversible)	efficiency %
8 : 1	635	25	9	30	=	81
22 : 1	223	26	23	75	≠	73
33 : 1	151	26	30	100	=	60
112 : 1	44	27	93	180	≠	59
207 : 1	24	27	100	180	=	53
361 : 1	14	27	100	180	=	53
814 : 1	6	28	100	180	=	43
1 257 : 1	4	29	100	180	=	43

Note: output speed at 5000 rpm input speed. Based on motor 2610 ... B.

2622 S ... B SC

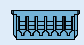


2622 B SC

Option

- connector variants AWG 28 / PVC ribbon cable with connector Picoblade

connector pin assignment:



Connection

No.	Function
1	Up
2	Umot
3	GND
4	Unsoll
5	DIR
6	FG

Speed Controller		006 B	012 B	SC
PWM switching frequency		96	96	kHz
Efficiency		95	95	%
Max. continuous output current [1]		0,8	0,8	A
Max. peak output current		1,6	1,6	A
Total standby current	0,020			A
Speed range electronic	500 ... 60 000 [2]			rpm
Scanning range	500			µs

[1] at 22°C ambient temperature and max. 60°C motor temperature respectively
[2] speed depend on motor operating voltage

Connection information			006 B	012 B	SC
Connection 1 "U_P":	power supply electronic	U_P = 4 ... 18 V			
Connection 2 "U_{mot}":	power supply electronic coil	U_{mot} = 1,7 ... 18 V			
Connection 3 "GND":	ground	ground			
Connection 4 "U_{nsoll}":					
– analog input	input voltage	U_{in} = 0 ... 10 V (max. Up)			
	input resistance	$R_{in} \geq$ 8 kΩ			
	set speed value	per 1 V	1 000	1 000	rpm
		U_{in} < 0,15 V » motor stops			
		U_{in} > 0,3 V » motor starts			
Connection 5 "DIR":					
– digital input	direction of rotation	to ground or level < 0,5 V » counterclockwise			
		open or level > 3 V » clockwise (max. Up)			
	input resistance	$R_{in} \geq$ 10 kΩ			
Connection 6 "FG":		with max. U_P » I_{max} = 15 mA; open collector with 22 kΩ pull-up resistor			
– digital output	frequency output	6 lines per revolution			

Features

In this variant, the brushless DC-Micromotors have an integrated Speed Controller. The motor is commutated using Hall sensors integrated into the motor. Speed control is via a PI regulator. The Speed Controller has a current limiting device which limits the maximum motor current if the thermal load is too high. Twice the continuous current is possible over a short time.

Using the **"FAULHABER Motion Manager"** software, the customer can modify the Speed Controller to special conditions of use.

The following parameters can be changed: current limit and regulator parameters.

Full product description

- Examples:

2622S006B SC 22:1

2622S012B SC 33:1

Motion Control Systems

WE CREATE MOTION

FAULHABER

Brushless DC-Servomotors with integrated Motion Controller

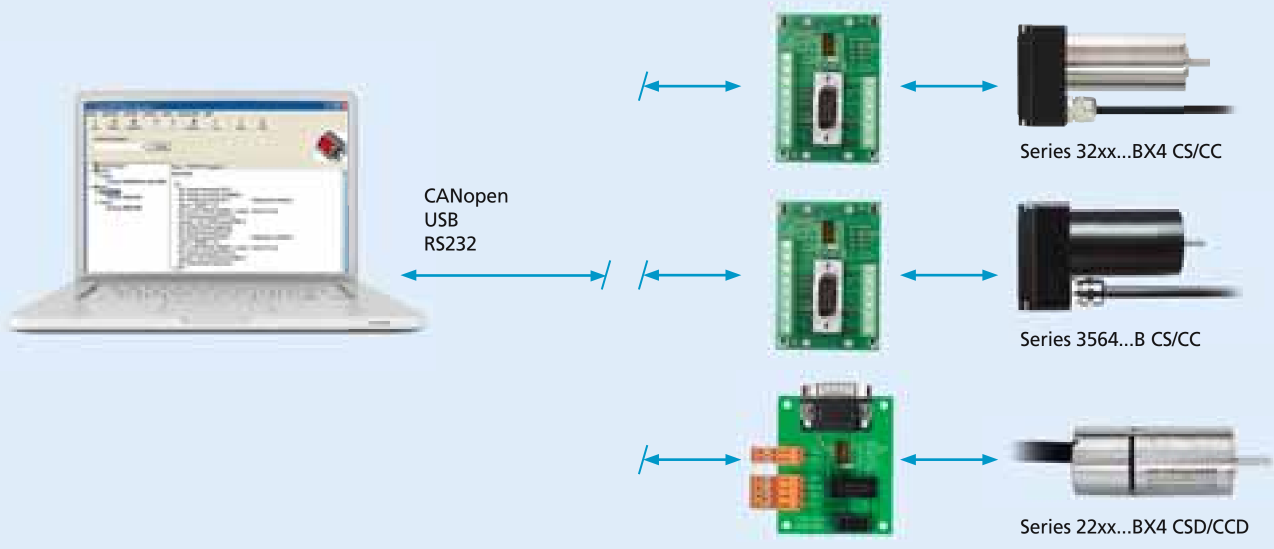
			Page
2232 ... BX4 CSD/CCD	with integrated Motion Controller	18 mNm	226 – 227
2250 ... BX4 CSD/CCD	with integrated Motion Controller	35 mNm	228 – 229
3242 ... BX4 CS/CC	with integrated Motion Controller	56 mNm	230 – 231
3268 ... BX4 CS/CC	with integrated Motion Controller	96 mNm	232 – 233
3564 ... B CS/CC	with integrated Motion Controller	53 mNm	234 – 235

Motion Control Systems

Technical Information

Terminal Variations

Brushless DC-Servomotors with integrated Motion Controller and RS232 or CAN interface



Features

FAULHABER Motion Controllers are highly dynamic positioning systems tailored specifically to the requirements of micromotor operations.

In addition to being deployed as a positioning system, they can also operate as speed or current controllers.

The drives can be supplied with an RS232 interface or with a CAN interface and CANopen protocol.

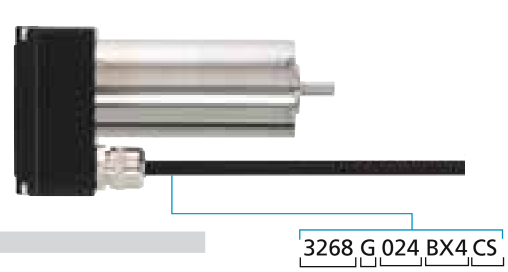
Using this technology, up to 127 drives can be interconnected and controlled with maximum efficiency.

Motion Control Systems – highly dynamic, low-maintenance BLDC servomotors with integrated motion control functionality – deliver the ultimate in slimline design. The integrated systems require less space, as well as making installation much simpler thanks to their reduced wiring.

Benefits

- Compact construction
- Modular design, various performance ratings
- Minimal wiring
- Parametrization via „FAULHABER MotionManager" software
- Extensive accessories
- Adapter for connection to USB interface

Product Code



3268	motor series
G	shaft type
024	nominal voltage
BX4	electronic commutation brushless
CS	Serial interface RS232

Motion Control Systems

Configuration, Networking, Interfaces

Operating Modes

Speed control
PI speed controls, even for demanding synchronization requirements.

Positioning
For moving to defined positions with a high level of resolution. Using a PD Controller, the dynamic response can be adjusted to suit the application. Reference and limit switches are evaluated by means of various homing modes.

Speed profiles
Acceleration ramps, deceleration ramps and maximum velocity can also be defined for each section. As a result, even complex profiles can be implemented quickly and effectively.

Current control
Protects the drive by limiting the motor current to the set peak current. The current is limited to the continuous current by means of integrated I^2t monitoring if required.

Protective features

- Protection against ESD
- Overload protection for electronics and motor
- Self-protection from overheating
- Overvoltage protection in generator mode

Extended operating modes

- Stepper motor mode
- Gearing mode
- Position control to analog set point
- Operation as servo amplifier in voltage adjuster mode
- Torque/force controller using variable set current input

Options

Separate supply of power to the motor and electronic actuator is optional (important for safety-critical applications). No third input is required in such cases. Depending on the drive, additional programming adapters and connection aids are available. The modes and parameters can be specially pre-configured on request.

Interfaces - Discrete I/O

Setpoint input
Depending on the operating mode, setpoints can be input via the command interface, via an analog voltage value, a PWM signal or a quadrature signal.

Error output (Open Collector)
Configured as error output (factory setting). Also usable as digital input, free switch output, for speed control or signaling an achieved position.

Additional digital input
For evaluating reference switches.

Motion Control Systems

Configuration, Networking, Interfaces

Networking

Integration in higher level control systems
The ASCII commands and CAN telegrams make it possible to integrate the drive into a higher level control system as well as the inclusion of the Motion Control Systems in field bus-based control environments.

Visual Basic Script can be written and tested directly in the Motion Manager.

Furthermore, any high-level language (Basic, C/C++, Delphi, LabView, ...) can be used to develop applications on the PC which send commands via RS232 or a CAN adapter directly to the drive or read messages sent from there. Commands can also be used within a PLC program for data exchange with the drive unit.

Interfaces – Bus Connection

Version with RS232 interface
For coupling to a PC with a transfer rate of up to 115 kbaud. Multiple drives can be connected to a single controller using the RS232 interface. As regards the control computer, no special arrangements are necessary. The interface also offers the possibility of retrieving online operational data and values.

A comprehensive ASCII command set is available for programming and operation. This can be preset from the PC using the „FAULHABER Motion Manager" software or from another control computer.

Additionally, there is the possibility of creating complex processes from these commands and storing them on the drive. Once programmed as a speed or positioning controller via the analog input, as step motor or electronic gear unit, the drive can operate independently of the RS232 interface.

Version with CAN interface
Multiple drives can be connected to and operated by a single higher level controller. For integration in a CAN network, transfer rates up to 1 Mbit/s are available.

In addition to the CANopen standard profiles, the CAN version supports a special FAULHABER mode that allows the drive to be operated as if it were running the RS232 version. With the help of the „FAULHABER Motion Manager"-Software and the implemented command interpreter, CAN drives can be configured and operated with standard ASCII commands.

In addition, all functions and parameters of the drive unit can be activated very easily using a special FAULHABER PDO channel.

Motion Control Systems with FAULHABER CANopen support the standard protocols CiA DS301 / DSP402 / DSP305. Motion Control Systems support the CANopen communication profile under DS301 V4.02 in accordance with the CiA specification for slave devices with the following services:

- 1 server SDO
- 3 transmit PDOs, 3 receive PDOs
- Static PDO mapping
- NMT with node guarding
- Emergency object

The following features are also supported from the CiA device profile for Motion Controllers (DSP 402):

- Profile position mode and position control function
- Homing mode
- Profile velocity mode

Transfer rates and node number are set via the network in accordance with the LSS protocol as per DSP305 V1.11; automatic baud rate detection has also been implemented.

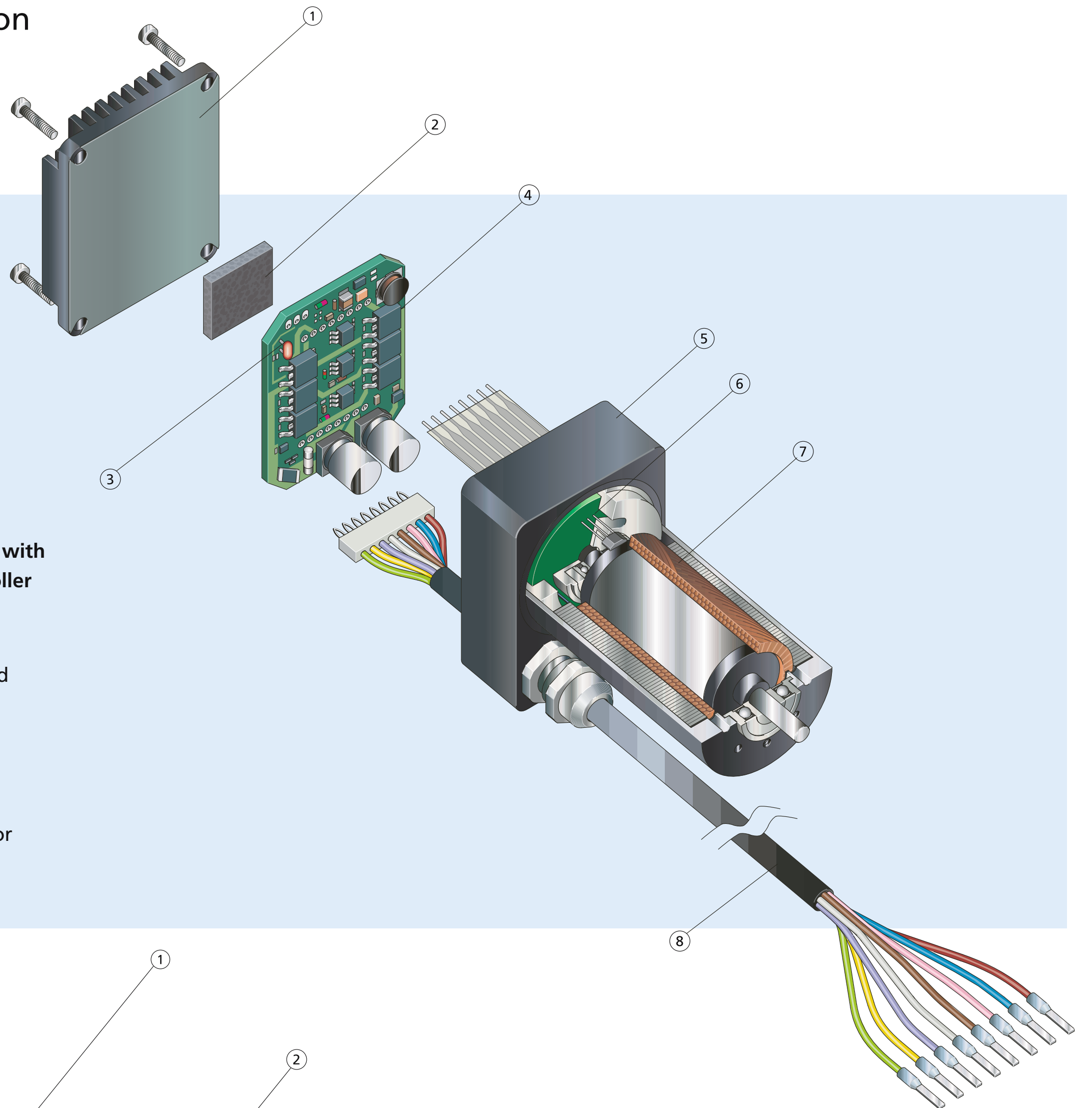
The CAN interface offers a wide range of other features. Details on use and configuration can be found in the corresponding manuals.

Notes

Motion Controllers and Motion Control Systems are accompanied by a device manual for installation and operation. Communication and function manuals as well as the „FAULHABER Motion Manager" software are available on request and on the Internet at www.faulhaber.com.

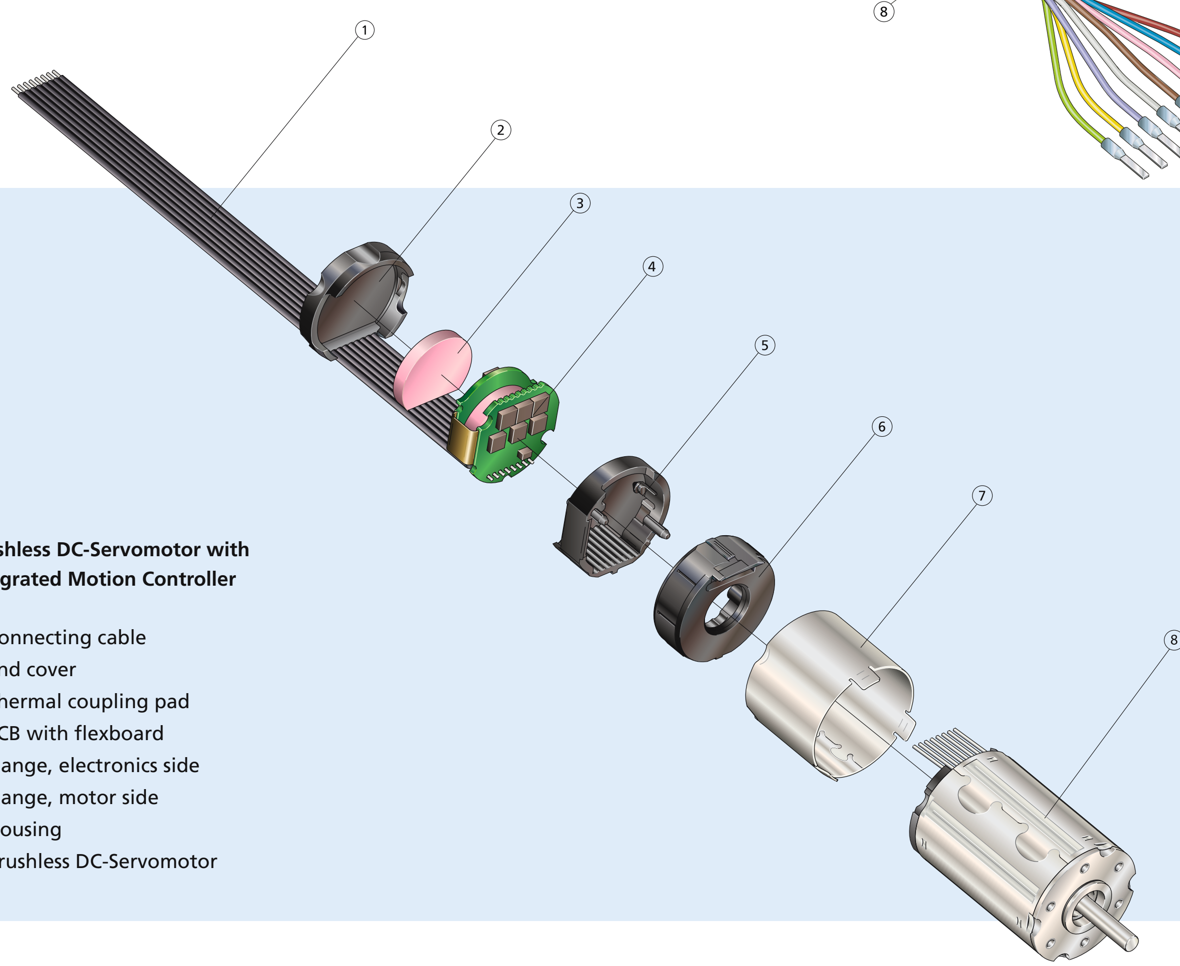
Motion Control Systems

Technical Information



Brushless DC-Servomotor with integrated Motion Controller

① Heat sink/cover
② Thermal conduction pad
③ Thermal protection
④ Motion Controller
⑤ Housing
⑥ Analog Hall sensors
⑦ Brushless DC-Servomotor
⑧ Interface cable



Brushless DC-Servomotor with integrated Motion Controller

① Connecting cable
② End cover
③ Thermal coupling pad
④ PCB with flexboard
⑤ Flange, electronics side
⑥ Flange, motor side
⑦ Housing
⑧ Brushless DC-Servomotor

Brushless DC-Servomotors

with integrated Motion Controller
and RS232 or CAN interface

18 mNm

For combination with
Gearheads:
22F, 22/7, 26A

2232 ... BX4 CSD/CCD

	2232 S		024 BX4 CSD/CCD	
1 Nominal voltage	U_N		24	Volt
2 Terminal resistance, phase-phase	R		12,4	Ω
3 Output power [1]	$P_{2\ max.}$		6,4	W
4 Efficiency	$\eta_{\ max.}$		67,7	%
5 No-load speed	n_o		6 800	rpm
6 No-load current	I_o		$6,1 \cdot 10^{-2}$	A
7 Stall torque at 1,8A	M_H		57	mNm
8 Friction torque, static	C_o		0,85	mNm
9 Friction torque, dynamic	C_v		$1,5 \cdot 10^{-4}$	mNm/rpm
10 Speed constant	k_n		304	rpm/V
11 Back-EMF constant	k_E		3,288	mV/rpm
12 Torque constant	k_M		31,40	mNm/A
13 Current constant	k_I		$3,18 \cdot 10^{-2}$	A/mNm
14 Slope of n-M curve	$\Delta n/\Delta M$		120	rpm/mNm
15 Terminal inductance, phase-phase	L		440	µH
16 Mechanical time constant	τ_m		6,5	ms
17 Rotor inertia	J		5,2	gcm²
18 Angular acceleration	$\alpha_{max.}$		109	$\cdot 10^3 rad/s^2$
19 Thermal resistance	$R_{th\ 1}$ / $R_{th\ 2}$	2 / 17		K/W
20 Thermal time constant	τ_{w1} / τ_{w2}	4,1 / 360		s
21 Operating temperature range		– 25 ... + 85		°C
22 Shaft bearings		ball bearings, preloaded		
23 Shaft load max.:				
– radial at 3 000 rpm (4 mm from mounting flange)		20		N
– axial at 3 000 rpm		2		N
– axial at standstill		20		N
24 Shaft play:				
– radial	≤	0,015		mm
– axial	=	0		mm
25 Housing material		stainless steel		
26 Weight		77		g
27 Direction of rotation		electronically reversible		
Recommended values - mathematically independent of each other				
28 Speed up to	$n_{e\ max.}$		5 - 8 000	rpm
29 Torque up to [1) 2)]	$M_{e\ max.}$		11 / 18	mNm
30 Current up to [1) 2)]	$I_{e\ max.}$		0,44 / 0,69	A

1) at 4 000 rpm
2) thermal resistance $R_{th\ 2}$ not reduced / thermal resistance $R_{th\ 2}$ by 55% reduced

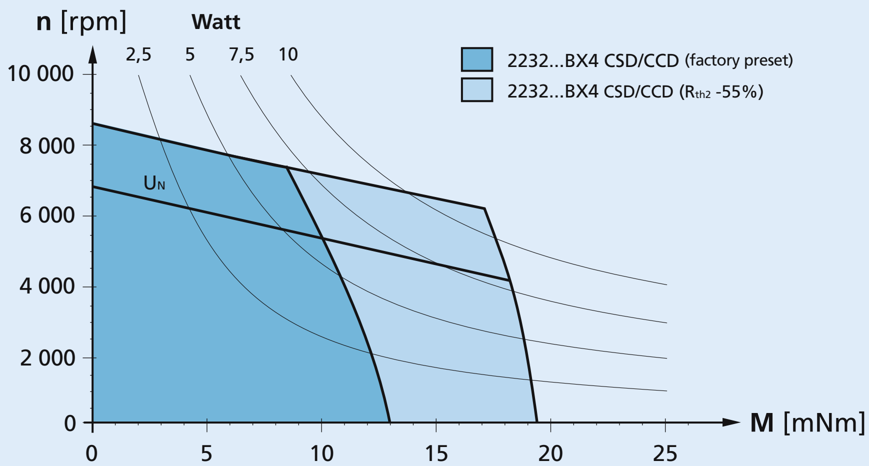
Note:

The diagram indicates the recommended speed in relation to the available torque at the output shaft for a given ambient temperature of 22°C.

The diagram shows the motor in a completely insulated as well as thermally coupled condition ($R_{th\ 2}$ 55% reduced).

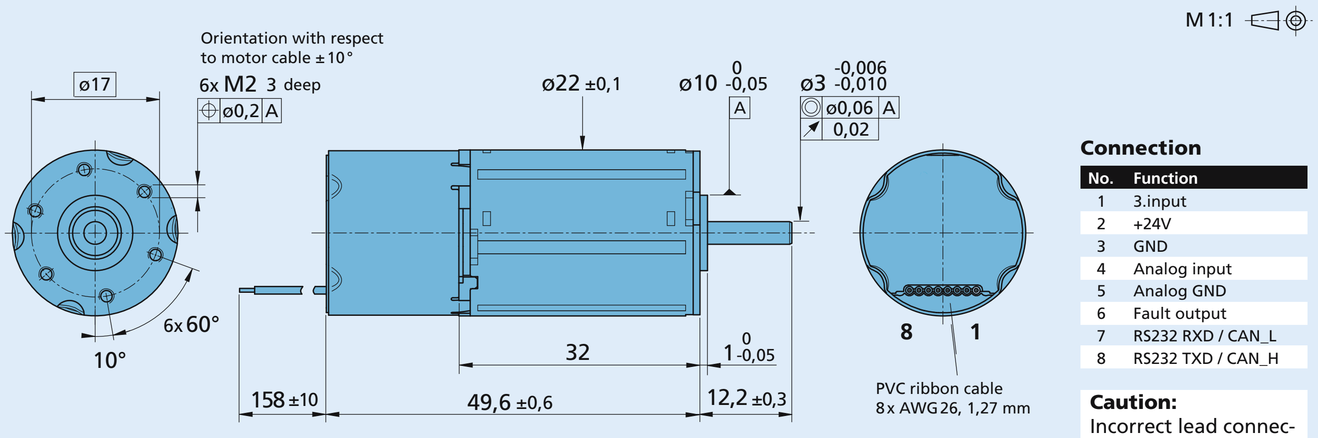
The motor is factory pre-configured to a continuous current for the thermally insulated condition. The controller must be reconfigured with the easy to use Motion Manager Software for use at higher continuous current.

The nominal voltage (U_N) curve shows the operating point at nominal voltage in the insulated and thermally coupled condition. Any points of operation above the curve at nominal voltage will require a higher operating voltage. Any points below the nominal voltage curve will require less voltage.



Recommended areas for continuous operation

Dimensional drawing



2232 S 024 BX4 CSD/CCD

Connection

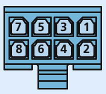
No.	Function
1	3.input
2	+24V
3	GND
4	Analog input
5	Analog GND
6	Fault output
7	RS232 RXD / CAN_L
8	RS232 TXD / CAN_H

Caution:
Incorrect lead connection will damage the motor electronics!

Options

Options

- Connector variant (Option no. 3830)
  AWG 26 / PVC ribbon cable
  with connector Micro-Fit



Accessories

- Adapter board BX4 CxD (Part No.: 6501.00113)

Full product description

- Example:
  2232S024 BX4 CSD

Motion Controller

Supply voltage [1]	U_B		5 ... 30	V DC
Peak current [2]	$I_{max.}$		3	A
Connection "Analog input":				
– Speed command analog input		voltage range	±10	V
– Speed command PWM input		frequency range	100 ... 2 000	Hz
		pulse duty factor 50%	0	rpm
– Digital input		input resistance (at 24V)	5	kΩ
– External encoder	$f_{max.}$		400	kHz
– Step frequency input	$f_{max.}$		400	kHz
Connection "Fault output":				
– Fault output		no error	switched to GND	
– Digital output		open collector	max. U_B / 30 mA	
– Digital input		input resistance	100	kΩ
Connection "3.input":				
– Digital input		input resistance	22	kΩ
– Electronic supply voltage [1]	U_B		5 ... 30	V DC
Encoder:				
– Scanning rate			200	µs
– Resolution internal encoder			3 000	Inc./turn

The signal level of the digital inputs can be set using the above commands:
Standard (PLC): Low 0...4,5V / High 12,5V...U_B, TTL: Low 0...0,5V / High 2,5V...U_B

[1] Separate supply of motor and control electronics for safetyrelevant applications is optionally available (Option no. 2993). In this case the 3rd input is not available for digital signals.
[2] Preset value. Can be changed over the interface.

Motion Control Systems

Brushless DC-Servomotors

with integrated Motion Controller
and RS232 or CAN interface

35 mNm

For combination with
Gearheads:
22F, 22/7, 26A

2250 ... BX4 CSD/CCD

		2250 S		024 BX4 CSD/CCD	
1	Nominal voltage	U_N		24	Volt
2	Terminal resistance, phase-phase	R		5,9	Ω
3	Output power [1]	$P_{2\ max.}$		12,2	W
4	Efficiency	$\eta_{max.}$		75,1	%
5	No-load speed	n_o		5 900	rpm
6	No-load current	I_o		$7{,}20 \cdot 10^{-2}$	A
7	Stall torque at 3A	M_H		110	mNm
8	Friction torque, static	C_o		1,20	mNm
9	Friction torque, dynamic	C_v		$2{,}4 \cdot 10^{-4}$	mNm/rpm
10	Speed constant	k_n		259	rpm/V
11	Back-EMF constant	k_E		3,864	mV/rpm
12	Torque constant	k_M		36,90	mNm/A
13	Current constant	k_I		$2{,}71 \cdot 10^{-2}$	A/mNm
14	Slope of n-M curve	$\Delta n/\Delta M$		41,4	rpm/mNm
15	Terminal inductance, phase-phase	L		240	µH
16	Mechanical time constant	τ_m		4,3	ms
17	Rotor inertia	J		10	gcm^2
18	Angular acceleration	$\alpha_{max.}$		110	$\cdot 10^3 rad/s^2$
19	Thermal resistance	R_{th1} / R_{th2}	1,2 / 14		K/W
20	Thermal time constant	τ_{w1} / τ_{w2}	4,2 / 566		s
21	Operating temperature range		– 25 ... + 85		°C
22	Shaft bearings		ball bearings, preloaded		
23	Shaft load max.:				
	– radial at 3 000 rpm (4 mm from mounting flange)		20		N
	– axial at 3 000 rpm		2		N
	– axial at standstill		20		N
24	Shaft play:				
	– radial	≤	0,015		mm
	– axial	=	0		mm
25	Housing material		stainless steel		
26	Weight		117		g
27	Direction of rotation		electronically reversible		

Recommended values - mathematically independent of each other					
28	Speed up to	$n_{e\ max.}$		5 - 7 000	rpm
29	Torque up to [1) 2)]	$M_{e\ max.}$		22 / 35	mNm
30	Current up to [1) 2)]	$I_{e\ max.}$		0,7 / 1,1	A

[1)] at 4 000 rpm
[2)] thermal resistance $R_{th\,2}$ not reduced / thermal resistance $R_{th\,2}$ by 55% reduced

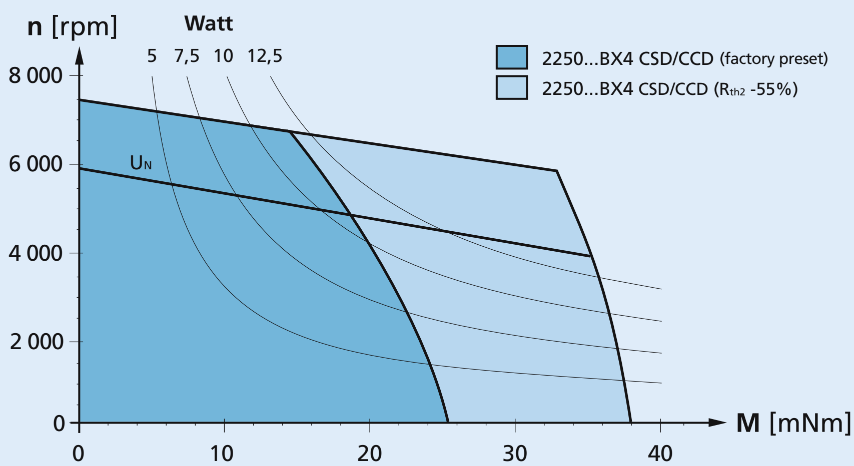
Note:

The diagram indicates the recommended speed in relation to the available torque at the output shaft for a given ambient temperature of 22°C.

The diagram shows the motor in a completely insulated as well as thermally coupled condition ($R_{th\,2}$ 55% reduced).

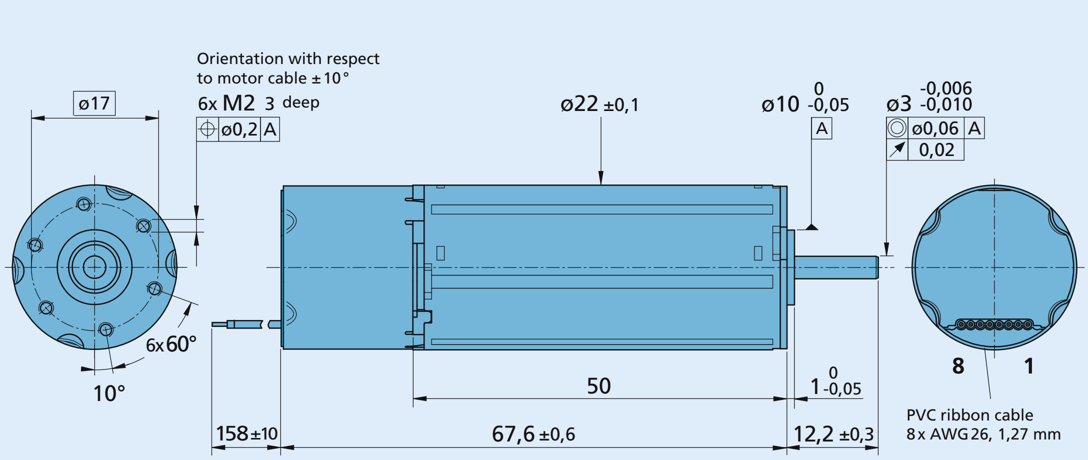
The motor is factory pre-configured to a continuous current for the thermally insulated condition. The controller must be reconfigured with the easy to use Motion Manager Software for use at higher continuous current.

The nominal voltage (U_N) curve shows the operating point at nominal voltage in the insulated and thermally coupled condition. Any points of operation above the curve at nominal voltage will require a higher operating voltage. Any points below the nominal voltage curve will require less voltage.



Recommended areas for continuous operation

Dimensional drawing



2250 ... BX4 CSD/CCD

Connection

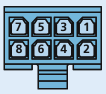
No.	Function
1	3.input
2	+24V
3	GND
4	Analog input
5	Analog GND
6	Fault output
7	RS232 RXD / CAN_L
8	RS232 TXD / CAN_H

Caution:
Incorrect lead connection will damage the motor electronics!

Options

Options

- Connector variant (Option no. 3830)
  AWG 26 / PVC ribbon cable
  with connector Micro-Fit



Accessories

- Adapter board BX4 CxD (Part No.: 6501.00113)

Full product description

- Example:
  2250S024 BX4 CSD

Motion Controller

Supply voltage [1]	U_B		5 ... 30	V DC
Peak current [2]	$I_{max.}$		3	A
Connection "Analog input":				
– Speed command analog input		voltage range	±10	V
– Speed command PWM input		frequency range	100 ... 2 000	Hz
		pulse duty factor 50%	0	rpm
– Digital input		input resistance (at 24V)	5	kΩ
– External encoder	$f_{max.}$		400	kHz
– Step frequency input	$f_{max.}$		400	kHz
Connection "Fault output":				
– Fault output		no error	switched to GND	
– Digital output		open collector	max. U_B / 30 mA	
– Digital input		input resistance	100	kΩ
Connection "3.input":				
– Digital input		input resistance	22	kΩ
– Electronic supply voltage [1]	U_B		5 ... 30	V DC
Encoder:				
– Scanning rate			200	µs
– Resolution internal encoder			3 000	Inc./turn

The signal level of the digital inputs can be set using the above commands:
Standard (PLC): Low 0...4,5V / High 12,5V...U_B, TTL: Low 0...0,5V / High 2,5V...U_B

[1] Separate supply of motor and control electronics for safetyrelevant applications is optionally available (Option no. 2993). In this case the 3rd input is not available for digital signals.
[2] Preset value. Can be changed over the interface.

Brushless DC-Servomotors

with integrated Motion Controller
and RS232 or CAN interface

56 mNm

For combination with
Gearheads:
30/1, 32A, 32ALN, 32/3 (S), 38/1 (S), 38/2 (S)

3242 ... BX4 CS/CC

		3242 G	024 BX4 CS/CC	
1	Nominal voltage	U_N	24	Volt
2	Terminal resistance, phase-phase	R	3,6	Ω
3	Output power [1]	$P_{2\ max.}$	18,2	W
4	Efficiency	$\eta_{\ max.}$	77,3	%
5	No-load speed	n_o	5 200	rpm
6	No-load current [3]	I_o	0,098	A
7	Stall torque at 5A	M_H	209	mNm
8	Friction torque, static	C_o	1,3	mNm
9	Friction torque, dynamic	C_v	$5,2 \cdot 10^{-4}$	mNm/rpm
10	Speed constant	k_n	227	rpm/V
11	Back-EMF constant	k_E	4,409	mV/rpm
12	Torque constant	k_M	42,1	mNm/A
13	Current constant	k_I	0,0238	A/mNm
14	Slope of n-M curve	$\Delta n/\Delta M$	19,4	rpm/mNm
15	Terminal inductance, phase-phase	L	240	µH
16	Mechanical time constant	τ_m	6,1	ms
17	Rotor inertia	J	30	gcm^2
18	Angular acceleration	$\alpha_{max.}$	66	$\cdot 10^3 rad/s^2$
19	Thermal resistance	R_{th1} / R_{th2}	1,6 / 12,4	K/W
20	Thermal time constant	τ_{w1} / τ_{w2}	9 / 810	s
21	Operating temperature range		– 40 ... +85	°C
22	Shaft bearings		ball bearings, preloaded	
23	Shaft load max.:			
	– radial at 3 000 rpm (4,5 mm from mounting flange)		50	N
	– axial at 3 000 rpm		5	N
	– axial at standstill		50	N
24	Shaft play:			
	– radial	≤	0,015	mm
	– axial	=	0	mm
25	Housing material		motor: stainless steel; controller housing: zinc, black anodized	
26	Weight		370	g
27	Direction of rotation		electronically reversible	

Recommended values - mathematically independent of each other				
28	Speed up to	$n_{e\ max.}$	5 - 6 500	rpm
29	Torque up to [1] [2]	$M_{e\ max.}$	35 / 56	mNm
30	Current up to [1] [2] [3]	$I_{e\ max.}$	1,00 / 1,58	A

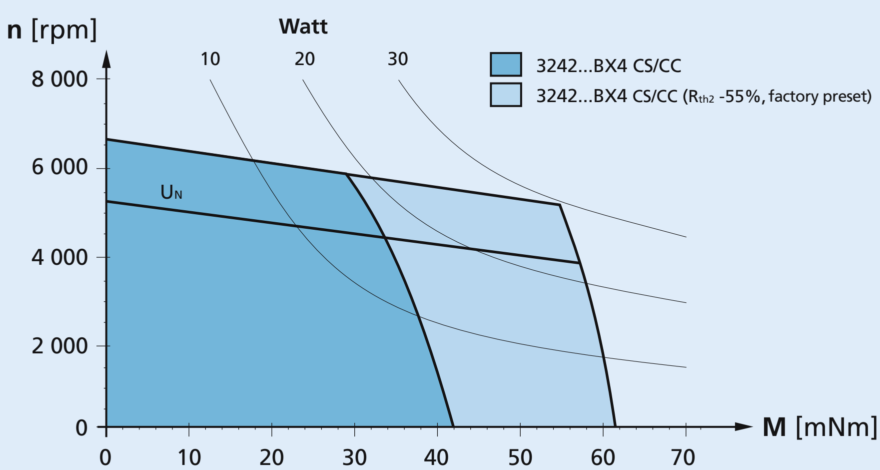
[1] at 4 000 rpm [2] thermal resistance $R_{th\,2}$ not reduced / thermal resistance $R_{th\,2}$ by 55% reduced
[3] total standby current 0,055 A at U_B = 24V

Note:
The diagram indicates the maximum speed in relation to the available torque at the output shaft for a given ambient temperature of 22°C.

The motor can provide more power with adequate cooling (for ex. R_{th2} reduction of –55%).

The maximum available torque and speed will be reduced if the ambient temperature is higher than 22°C and/or the motor is thermally insulated to the ambient environment.

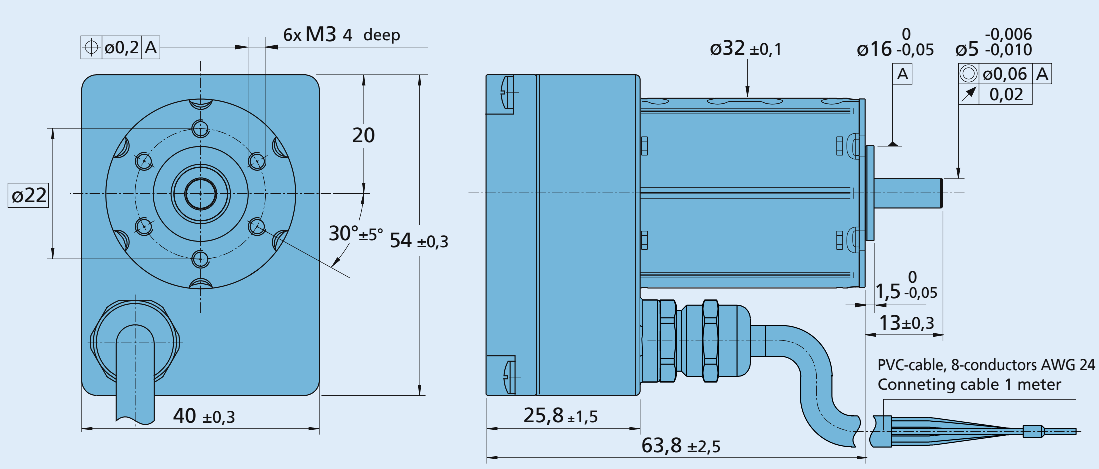
The characteristics of the curve diagram is determined by U_B and the control characteristics of the integrated Motion Controller.



Recommended areas for continuous operation

Dimensional drawing

scale reduced



3242 ... BX4 CS/CC

Connection

Wires	Function
blue	GND
pink	U_B
brown	Analog input
white	Fault output
grey	Analog GND
yellow	RS232 RXD / CAN_L
green	RS232 TXD / CAN_H
red	Connection No. 3

Caution:
be sure to connect motor supply terminals to the correct polarity. Motor electronics are protected against polarity reversal by an internal fuse. In case of damage due to polarity reversal, this internal fuse can only be replaced at the factory.

Options

Accessories

- Adapter board (Part No.: 6501.00065)

Full product description

- Example:
  3242G024 BX4 CS (RS232 interface)
  3242G024 BX4 CC (CAN interface)

Motion Controller

Supply voltage [1]	U_B		12 ... 30	V DC
Peak current [2]	$I_{max.}$		5	A
Input/output			3	
Connection "Analog input":				
– Speed command analog input		voltage range	±10	V
– Speed command PWM input		frequency range	100 ... 2 000	Hz
		pulse duty factor 50%	0	rpm
– Digital input		input resistance (at 24V)	5	kΩ
– External encoder	$f_{max.}$		400	kHz
– Step frequency input	$f_{max.}$		400	kHz
Connection "Fault output":				
– Fault output		no error	switched to GND	
– Digital output		open collector	max. U_B / 30 mA	
– Digital input		input resistance	100	kΩ
Connection "3.input":				
– Digital input		input resistance	22	kΩ
– Electronic supply voltage [1]	U_{EL}		12 ... 30	V DC
Encoder:				
– Scanning rate			200	µs
– Resolution internal encoder			3 000	Inc./turn

The signal level of the digital inputs can be set using the above commands:
Standard (PLC): Low 0...7,0V / High 12,5V...U_B, TTL: Low 0...0,5V / High 3,5V...U_B

[1] Separate supply of motor and control electronics for safetyrelevant applications is optionally available (Option no. 2993). In this case the 3rd input is not available for digital signals; connection 3.
[2] Preset value. Can be changed over the interface.

FAULHABER

Brushless DC-Servomotors

with integrated Motion Controller
and RS232 or CAN interface

96 mNm

For combination with
Gearheads:
30/1, 32A, 32ALN, 32/3 (S), 38/1 (S), 38/2 (S)

3268 ... BX4 CS/CC

		3268 G	024 BX4 CS/CC	
1	Nominal voltage	U_N	24	Volt
2	Terminal resistance, phase-phase	R	1,45	Ω
3	Output power [1]	$P_{2\,max.}$	29,8	W
4	Efficiency	$\eta_{max.}$	77,3	%
5	No-load speed	n_0	5 200	rpm
6	No-load current [3]	I_0	0,203	A
7	Stall torque at 8A	M_H	346	mNm
8	Friction torque, static	C_0	1,7	mNm
9	Friction torque, dynamic	C_v	$1,3 \cdot 10^{-3}$	mNm/rpm
10	Speed constant	k_n	220	rpm/V
11	Back-EMF constant	k_E	4,555	mV/rpm
12	Torque constant	k_M	43,5	mNm/A
13	Current constant	k_I	0,0230	A/mNm
14	Slope of n-M curve	$\Delta n/\Delta M$	7,3	rpm/mNm
15	Terminal inductance, phase-phase	L	110	µH
16	Mechanical time constant	τ_m	4,6	ms
17	Rotor inertia	J	60	gcm^2
18	Angular acceleration	$\alpha_{max.}$	58	$\cdot 10^3 rad/s^2$
19	Thermal resistance	$R_{th\,1} / R_{th\,2}$	1,9 / 9,6	K/W
20	Thermal time constant	τ_{w1} / τ_{w2}	17 / 1 060	s
21	Operating temperature range		– 40 ... +85	°C
22	Shaft bearings		ball bearings, preloaded	
23	Shaft load max.:			
	– radial at 3 000 rpm (4,5 mm from mounting flange)		50	N
	– axial at 3 000 rpm		5	N
	– axial at standstill		50	N
24	Shaft play:			
	– radial	≤	0,015	mm
	– axial	=	0	mm
25	Housing material		motor: stainless steel; controller housing: zinc, black anodized	
26	Weight		460	g
27	Direction of rotation		electronically reversible	
Recommended values - mathematically independent of each other				
28	Speed up to	$n_{e\,max.}$	5 - 6 500	rpm
29	Torque up to [1) 2)]	$M_{e\,max.}$	58 / 96	mNm
30	Current up to [1) 2) 3)]	$I_{e\,max.}$	1,60 / 2,65	A

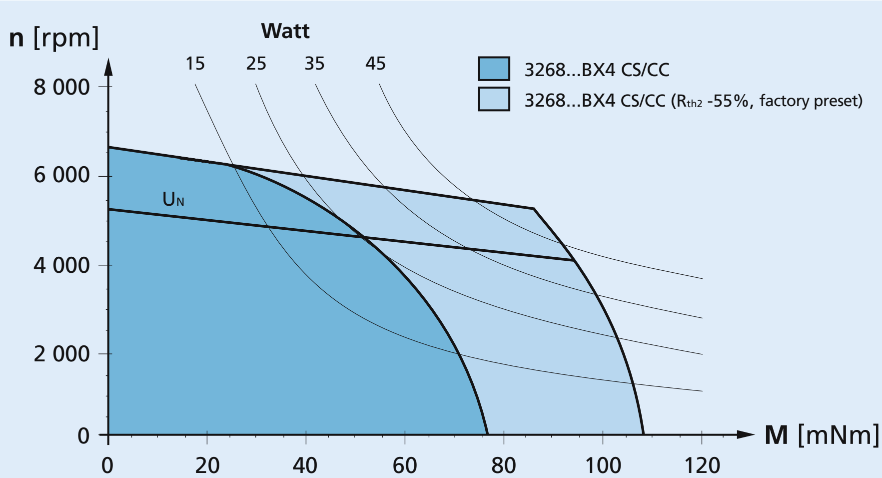
[1] at 4 000 rpm [2] thermal resistance $R_{th\,2}$ not reduced / thermal resistance $R_{th\,2}$ by 55% reduced
[3] total standby current 0,055 A at U_B = 24V

Note:
The diagram indicates the maximum speed in relation to the available torque at the output shaft for a given ambient temperature of 22°C.

The motor can provide more power with adequate cooling (for ex. R_{th2} reduction of –55%).

The maximum available torque and speed will be reduced if the ambient temperature is higher than 22°C and/or the motor is thermally insulated to the ambient environment.

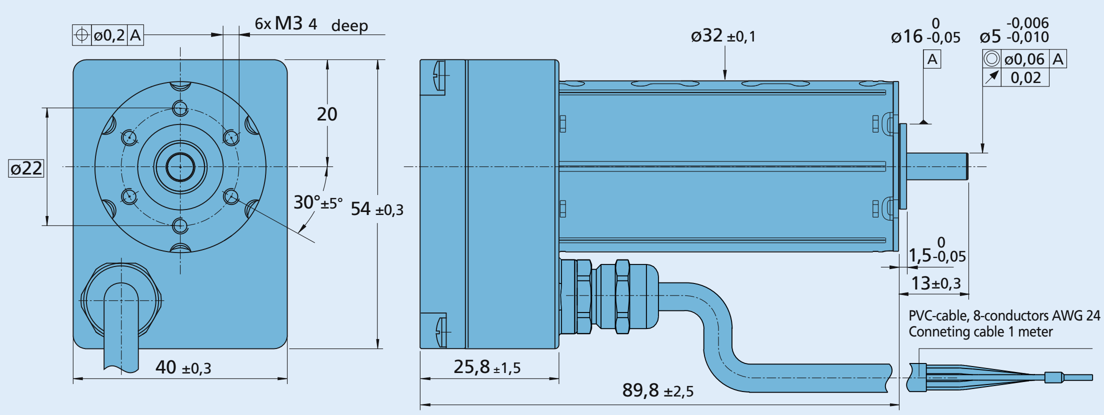
The characteristics of the curve diagram is determined by U_b and the control characteristics of the integrated Motion Controller.



Recommended areas for continuous operation

Dimensional drawing

scale reduced



3268 ... BX4 CS/CC

Connection

Wires	Function
blue	GND
pink	U_B
brown	Analog input
white	Fault output
grey	Analog GND
yellow	RS232 RXD / CAN_L
green	RS232 TXD / CAN_H
red	Connection No. 3

Caution:
be sure to connect motor supply terminals to the correct polarity. Motor electronics are protected against polarity reversal by an internal fuse. In case of damage due to polarity reversal, this internal fuse can only be replaced at the factory.

Options

Accessories

- Adapter board (Part No.: 6501.00065)

Full product description

- Example:
  3268G024 BX4 CS (RS232 interface)
  3268G024 BX4 CC (CAN interface)

Motion Controller

Supply voltage [1]	U_B		12 ... 30	V DC
Peak current [2]	$I_{max.}$		8	A
Input/output			3	
Connection "Analog input":				
– Speed command analog input		voltage range	±10	V
– Speed command PWM input		frequency range	100 ... 2 000	Hz
		pulse duty factor 50%	0	rpm
– Digital input		input resistance (at 24V)	5	kΩ
– External encoder	$f_{max.}$		400	kHz
– Step frequency input	$f_{max.}$		400	kHz
Connection "Fault output":				
– Fault output		no error	switched to GND	
– Digital output		open collector	max. U_B / 30 mA	
– Digital input		input resistance	100	kΩ
Connection "3.input":				
– Digital input		input resistance	22	kΩ
– Electronic supply voltage [1]	U_{EL}		12 ... 30	V DC
Encoder:				
– Scanning rate			200	µs
– Resolution internal encoder			3 000	Inc./turn

The signal level of the digital inputs can be set using the above commands:
Standard (PLC): Low 0...7,0V / High 12,5V...U_B, TTL: Low 0...0,5V / High 3,5V...U_B

[1] Separate supply of motor and control electronics for safetyrelevant applications is optionally available (Option no. 2993). In this case the 3rd input is not available for digital signals; connection 3.
[2] Preset value. Can be changed over the interface.

Brushless DC-Servomotors

with integrated Motion Controller and RS232 or CAN interface

53 mNm

For combination with
Gearheads:
30/1, 32A, 32ALN, 32/3 (S), 38/1 (S), 38/2 (S)

3564 ... B CS/CC

		3564 K	024 B CS/CC	
1	Nominal voltage	U_N	24	Volt
2	Terminal resistance, phase-phase	R	1,12	Ω
3	Output power [1]	$P_{2\ max.}$	51	W
4	Efficiency	$\eta_{\ max.}$	82	%
5	No-load speed	n_o	10 500	rpm
6	No-load current [3]	I_o	0,225	A
7	Stall torque at 8A	M_H	160	mNm
8	Friction torque, static	C_o	1,10	mNm
9	Friction torque, dynamic	C_v	$2{,}4 \cdot 10^{-4}$	mNm/rpm
10	Speed constant	k_n	473	rpm/V
11	Back-EMF constant	k_E	2,114	mV/rpm
12	Torque constant	k_M	20,2	mNm/A
13	Current constant	k_I	0,05	A/mNm
14	Slope of n-M curve	$\Delta n/\Delta M$	26,2	rpm/mNm
15	Terminal inductance, phase-phase	L	194	µH
16	Mechanical time constant	τ_m	9,3	ms
17	Rotor inertia	J	34	gcm^2
18	Angular acceleration	$\alpha_{\ max.}$	47	$\cdot 10^3 rad/s^2$
19	Thermal resistance	$R_{th\ 1}$ / $R_{th\ 2}$	2,5 / 6,3	K/W
20	Thermal time constant	τ_{w1} / τ_{w2}	23 / 1 175	s
21	Operating temperature range		– 30 ... +85	°C
22	Shaft bearings		ball bearings, preloaded	
23	Shaft load max.:			
	– radial at 3 000 rpm (4,5 mm from mounting flange)		108	N
	– axial at 3 000 rpm		50	N
	– axial at standstill		131	N
24	Shaft play:			
	– radial	≤	0,015	mm
	– axial	=	0	mm
25	Housing material		motor: aluminium, black anodized; controller housing: zinc	
26	Weight		510	g
27	Direction of rotation		electronically reversible	

Recommended values - mathematically independent of each other				
28	Speed up to	$n_{e\ max.}$	5 - 12 000	rpm
29	Torque up to [1) 2)]	$M_{e\ max.}$	39 / 53	mNm
30	Current up to [1) 2) 3)]	$I_{e\ max.}$	2,1 / 2,8	A

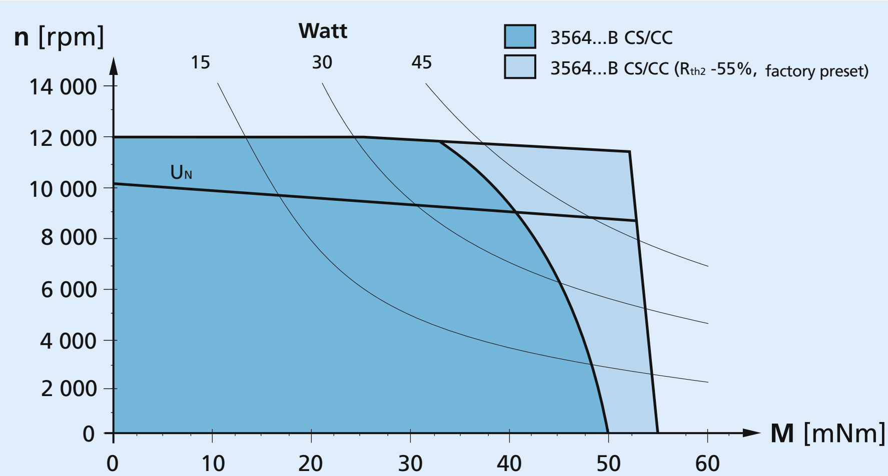
1) at 8 400 rpm 2) thermal resistance $R_{th\ 2}$ not reduced / thermal resistance $R_{th\ 2}$ by 55% reduced
3) current for electronic plus 0,055 A at U_B = 24V

Note:
The diagram indicates the maximum speed in relation to the available torque at the output shaft for a given ambient temperature of 22°C.

The motor can provide more power with adequate cooling (for ex. R_{th2} reduction of –55%).

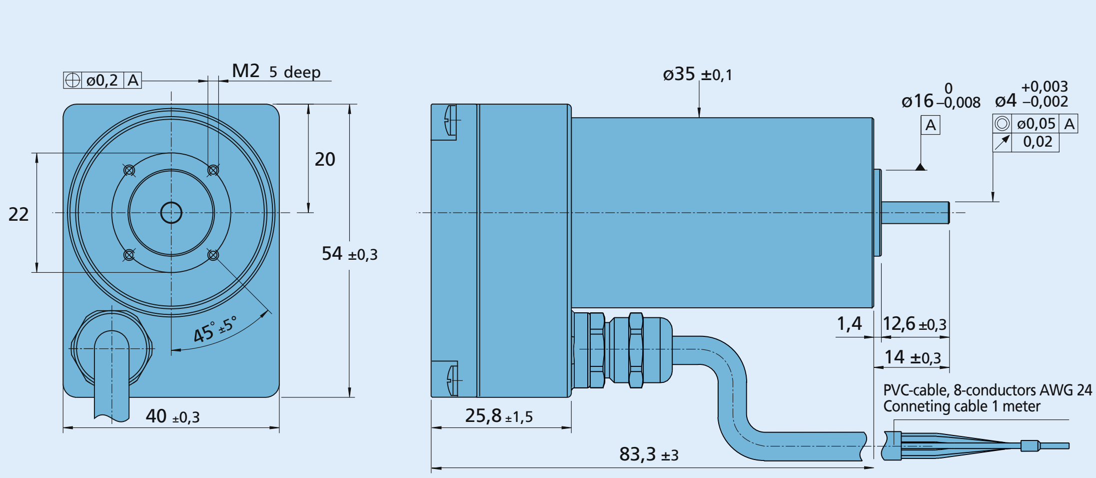
The maximum available torque and speed will be reduced if the ambient temperature is higher than 22°C and/or the motor is thermally insulated to the ambient environment.

The characteristics of the curve diagram is determined by U_B and the control characteristics of the integrated Motion Controller.



Recommended areas for continuous operation

Dimensional drawing



3564 ... B CS/CC

Connection

Wires	Function
blue	GND
pink	U_B
brown	Analog input
white	Fault output
grey	Analog GND
yellow	RS232 RXD / CAN_L
green	RS232 TXD / CAN_H
red	Connection No. 3

Caution:
be sure to connect motor supply terminals to the correct polarity. Motor electronics are protected against polarity reversal by an internal fuse. In case of damage due to polarity reversal, this internal fuse can only be replaced at the factory.

Options

Accessories

- Adapter board (Part No.: 6501.00065)

Full product description

- Example:
  3564K024B CS (RS232 interface)
  3564K024B CC (CAN interface)

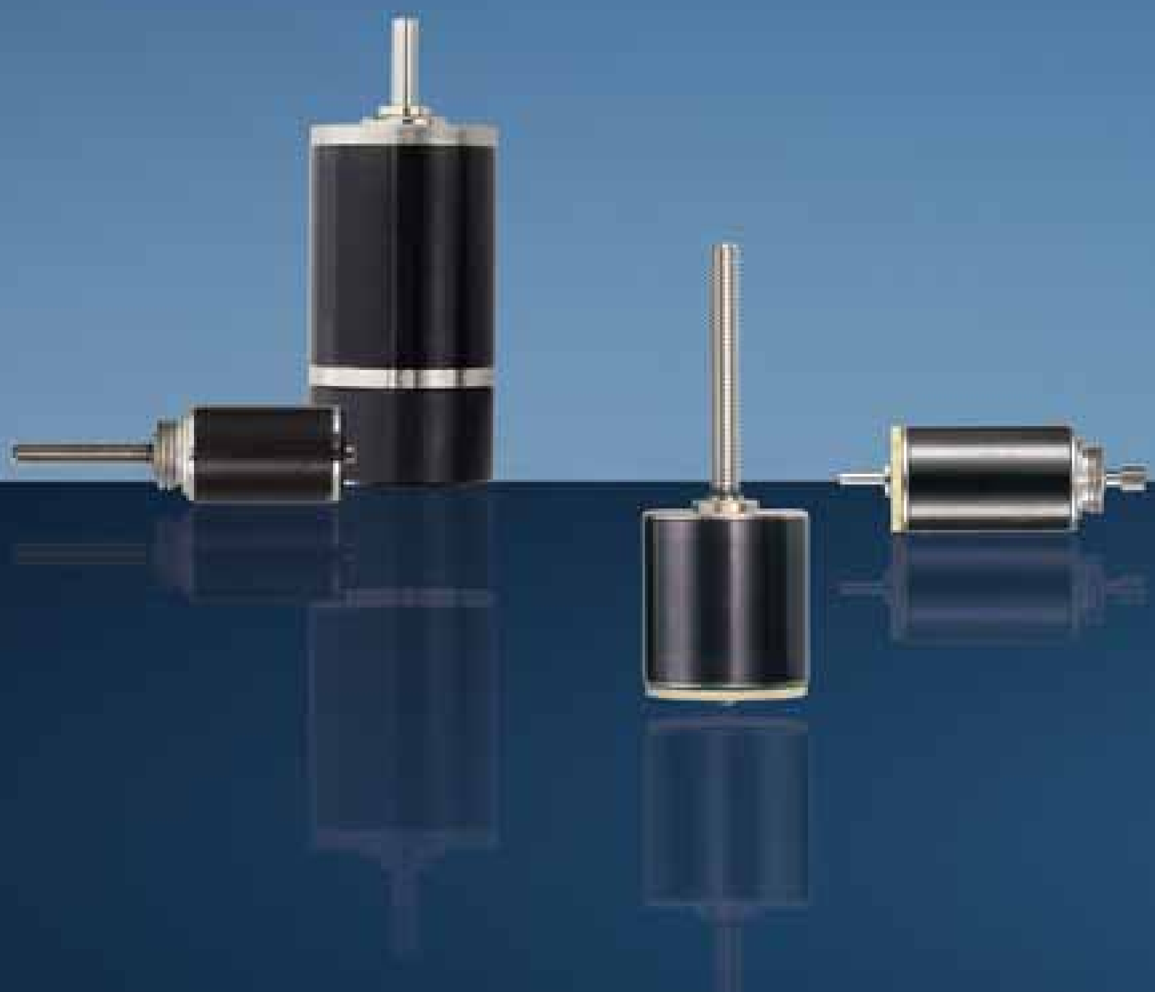
Motion Controller

Supply voltage [1]	U_B		12 ... 30	V DC
Peak current [2]	$I_{max.}$		8	A
Input/output			3	
Connection "Analog input":				
– Speed command analog input		voltage range	±10	V
– Speed command PWM input		frequency range	100 ... 2 000	Hz
		pulse duty factor 50%	0	rpm
– Digital input		input resistance (at 24V)	5	kΩ
– External encoder	$f_{max.}$		400	kHz
– Step frequency input	$f_{max.}$		400	kHz
Connection "Fault output":				
– Fault output		no error	switched to GND	
– Digital output		open collector	max. U_B / 30 mA	
– Digital input		input resistance	100	kΩ
Connection "3.input":				
– Digital input		input resistance	22	kΩ
– Electronic supply voltage [1]	U_{EL}		12 ... 30	V DC
Encoder:				
– Scanning rate			100	µs
– Resolution internal encoder			3 000	Inc./turn

The signal level of the digital inputs can be set using the above commands:
Standard (PLC): Low 0...7,0V / High 12,5V...U_B, TTL: Low 0...0,5V / High 3,5V...U_B

[1] Separate supply of motor and control electronics for safetyrelevant applications is optionally available (Option no. 2993). In this case the 3rd input is not available for digital signals; connection 3.
[2] Preset value. Can be changed over the interface.

Stepper Motors



WE CREATE MOTION

FAULHABER

Stepper Motors – PRECIstep® Technology

			Page
ADM 0620-2R	Two Phase with Disc Magnet	0,2 mNm	244 – 245
AM 0820	Two Phase	0,65 mNm	246 – 247
AM 1020	Two Phase	1,6 mNm	248 – 249
ADM 1220	Two Phase with Disc Magnet	2,4 mNm	250 – 251
ADM 1220 S	Two Phase with Disc Magnet	2,4 mNm	252 – 253
AM 1524	Two Phase	6 mNm	254 – 255
AM 2224	Two Phase	22 mNm	256 – 257
AM 2224-R3	Two Phase	22 mNm	258 – 259

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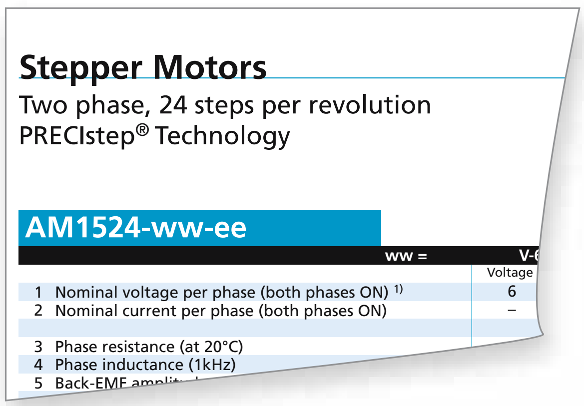
WE CREATE MOTION

Stepper Motors

Technical Information



Notes on technical data

Nominal voltage per phase (both phases ON) [Volts]
Is the voltage applied to both phase windings that will not overheat the motor (at 20 °C, continuous operation). The motor develops nominal holding torque using this voltage.

Nominal current per phase (both phases ON) [A]
Is the current level supplied to both phase windings that will not overheat the motor (at 20 °C, continuous operation). The motor develops the nominal holding torque when energized this way.

Phase resistance [1)] [Ω]
Phase winding resistance at 20 °C; tolerance is ±12%.

Phase inductance [mH]
Inductance of the phase windings, measured at 1 kHz.

Back-EMF amplitude [1)] [V/k step/s]
Amplitude of the back-EMF at 1000 steps/s. It is one of the factors which reduce the provided torque at higher speed.

Holding torque (at nominal current in both phases) [mNm]
Is the amplitude of the torque the motor generates with both phases energized in voltage or current mode with nominal voltage or nominal current respectively.

Holding torque (at twice the nominal current) [mNm]
Is the amplitude of the torque the motor generates with with either both phases energized with 2 x nominal current (current mode) or 2 x nominal voltage (voltage mode).

There is no risk of motor damage due to their magnetic design. However, to limit heat development the boost current should be applied only for short periods during critical sections of the motion cycle.

Step angle (full step) [degree]
Number of angular degrees the motor moves per full-step.

Angular accuracy [% of full step]
Percentage of a full step by which the unloaded motor with identical currents in both phases will be off from any calculated fullstep position. This error does not cumulate.

Residual torque, max.[1)] [mNm]
Maximal torque needed to rotate rotor by outside torque when no phase winding is energized. Residual torque is useful to hold a position without any current to save battery life or to reduce heat.

Rotor inertia [kgm²]
This value represents the inertia of the complete rotor.

Resonance frequency (at no load) [Hz]
Is the step rate at which the unload motor will show rotor resonance. It is recommended to start with a frequency above this frequency or to use half-, micro-step to operate outside this frequency. The resonance frequency changes with the addition of inertial loads.

Electrical time constant [ms]
Is the time needed to establish 67% of the max. possible phase current under a given operation point. It is one of the factors which reduce the provided torque at higher speed.

Ambient temperature range [°C]
Temperatures at which the motor can operate.

Winding temperature tolerated max. [°C]
Maximum temperature supported by the winding and the magnets.

Thermal resistance winding-ambient air [°C/W]
The gradient at which the motor winding temperature increases per Watt of power losses generated in the motor. Additional cooling surface is reducing it.

Thermal time constant [s]
Time needed to reach 67% of the final winding temperature. Adding cooling surfaces reduces the thermal resistance but will increase the thermal time constant.

Shaft bearings
Offered are either self lubricating sintered bronze bearings or 2 preloaded ball bearings. The ball bearing preload is assured by a spring washer assembled at the rear bearing.

Shaft load, max. radial [N]
The figure is representing for all bearing types the recommended maximally supported radial load.

Shaft load, max. axial [N]
This value is representing the recommended maximally supported axial load for all bearing types. For ball bearings, this value corresponds to the set preload. Note that overtaking the preload may cause an irreversible displacement of the shaft. The rotor can be pulled without risk of damage to the motor by approximately 0,2 mm.

Shaft play max., radial [μm]
The maximum clearance between shaft and bearing tested with the indicated force to move the shaft.

Shaft play max., axial [μm]
Represents the maximum axial play tested with the indicated force.

Isolation test voltage [1] [VDC]
Is the test voltage for isolation test between housing and phase windings.

Weight [g]
Is the motor weight in grams.

[1] these parameters are measured during final inspection on 100 % of the products delivered.

Stepper Motor Selection

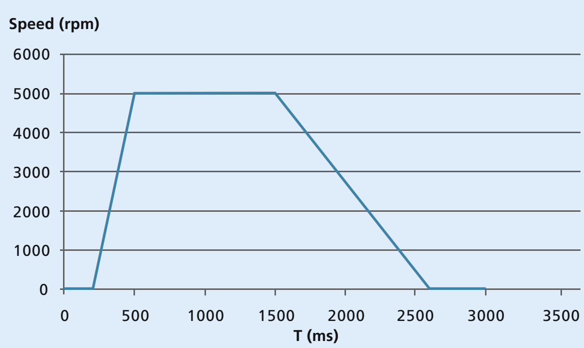
The selection of a stepper motor requires the use of published torque speed curves based on the load parameters.

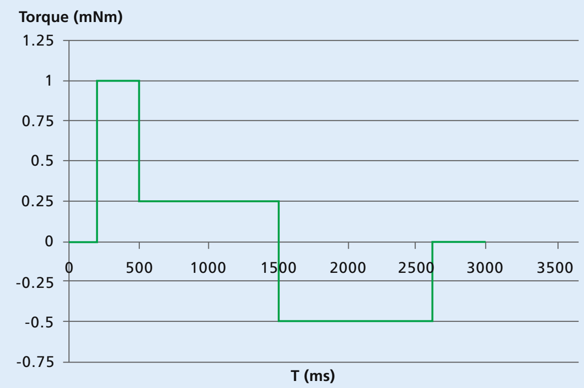
It is not possible to verify the motor selection mathematically without the use of the curves.

To select a motor the following parameters must be known:

- Motion profile
- Load friction and inertia
- Required resolution
- Available space
- Available power supply voltage

1. Definition of the load parameters at the motor shaft
The target of this step is to determine a motion profile needed to move the motion angle in the given time frame and to calculate the motor torque over the entire cycle using the application load parameters such as friction and load inertia.
The motion and torque profiles of the movement used in this example are shown below:





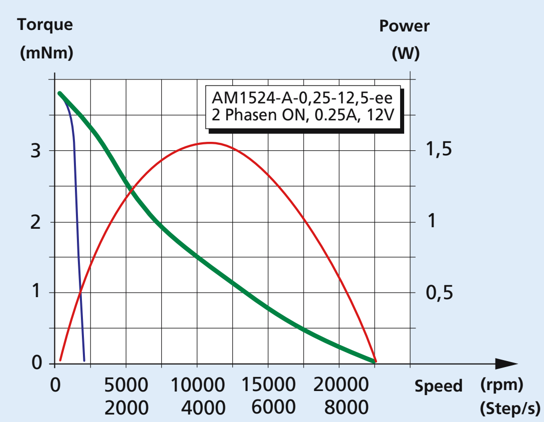
Depending on the motor size suitable for the application it is required to recompute the torque parameters with the motor inertia as well.

In the present case it is assumed that a motor with an outside diameter of maximum 15 mm is suitable and the data has been computed with the inertia of the AM1524.

2. Verification of the motor operation.
The highest torque/speed point for this application is found at the end of the acceleration phase. The top speed is then n = 5000 rpm, the torque is M = 1 mNm.

Using these parameters you can transfer the point into the torque speed curves of the motor as shown here with the AM1524 curves for a current mode drive.

It is not possible to use the full torque of the motor: a safety factor of 30% is requested. The shown example assures that the motor will correctly fulfil the requested application conditions.



In case that no solution is found, it is possible to adapt the load parameters seen by the motor by the use of a reduction gearhead.

The demonstrated method does not specify the differences between the two published torque speed curves, one for voltage mode and one for current mode (which was used as the solution for the application example).

The difference is mainly linked to the performance one may get from the motor. Whereas the voltage mode is offering good performance at low speed the torque will decrease rapidly, the current mode allows higher speed performance as the constant current mode drive (the current is controlled by a chip related control loop) which allows to apply a higher voltage to the motor phases.

Voltage mode is the best choice for application with supply voltage below 10 V mainly due to the availability of suitable driver chips. In voltage mode, the motor winding must have a nominal voltage equal to the power supply to get the best performances.

The moment the voltage is higher than 10 V a current mode driver will be the better choice. It is recommended to apply a supply voltage at least U = 5 x R x I of the selected motor winding.

3. Verification of the resolution
It is assumed that the application requires a resolution of 9° angular.

The selected motor AM1524 has a step angle of 15° which means that the motor is not suitable directly. It can be operated either in half-step, which reduces the step angle to 7,5°, or in micro stepping. With micro stepping, the resolution can be increased even higher whereas the precision is reduced because the error angle without load of the motor (expressed in % of a full-step) remains the same independently from the number of micro-steps the motor is operated.

For that reason the most common solution for adapting the motor resolution to the application requirements is the use of a gearhead or a lead-screw where linear motion is required.

General application notes

In principle each stepper motor can be operated in three modes: full step (one or two phases on), half step or microstep.

Holding torque is the same for each mode as long as dissipated power (I^2R losses) is the same. The theory is best presented on a basic motor model with two phases and one pair of poles where mechanical and electrical angle are equal.

- In full step mode (1 phase on) the phases are successively energised in the following way:
  1. A+ 2. B+ 3. A– 4. B–.
- Half step mode is obtained by alternating between 1-phase-on and 2-phases-on, resulting in 8 half steps per electrical cycle: 1. A+ 2. A+B+ 3. B+ 4. A–B+ 5. A– 6. A–B– 7. B– 8. A+B–.
- If every half step should generate the same holding torque, the current per phase is multiplied by √2 each time only 1 phase is energised.

The two major advantages provided by microstep operation are lower running noise and higher resolution, both depending on the number of microsteps per full step which can in fact be any number but is limited by the system cost.

As explained above, one electrical cycle or revolution of the field vector (4 full steps) requires the driver to provide a number of distinct current values proportional to the number of microsteps per full step.

For example, 8 microsteps require 8 different values which in phase A would drop from full current to zero following the cosine function from 0° to 90°, and in phase B would rise from zero to full following the sine function.

These values are stored and called up by the program controlling the chopper driver. The rotor target position is determined by the vector sum of the torques generated in phase A and B:

$$M_A = k \cdot I_A = k \cdot I_o \cdot \cos \varphi$$

$$M_B = k \cdot I_B = k \cdot I_o \cdot \sin \varphi$$

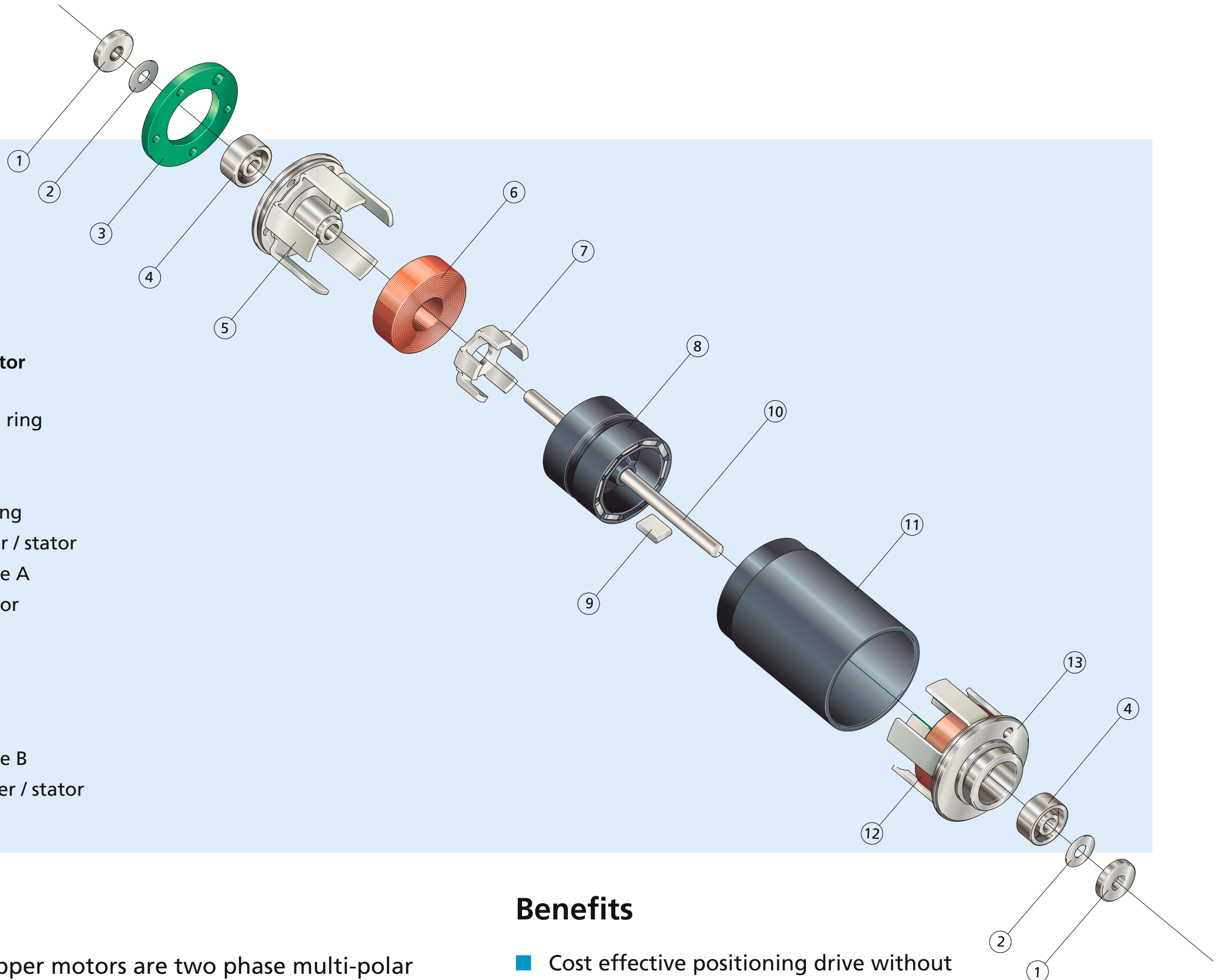
where M is the motor torque, k is the torque constant and Io the nominal phase current.

For the motor without load the position error is the same in full, half or microstep mode and depends on distortions of the sinusoidal motor torque function due to detent torque, saturation or construction details (hence on the actual rotor position), as well as on the accuracy of the phase current values.

4. Verification in the application
Any layout based on such considerations has to be verified in the final application under real conditions.
Please make sure that all load parameters are taken into account during this test.

Stepper Motors

Two phase



Stepper Motor

① Retaining ring
② Washer
③ PCB
④ Ball bearing
⑤ Rear cover / stator
⑥ Coil, Phase A
⑦ Inner stator
⑧ Rotor
⑨ Magnets
⑩ Shaft
⑪ Housing
⑫ Coil, Phase B
⑬ Front cover / stator

Features

PRECIstep® stepper motors are two phase multi-polar motors with permanent magnets. The use of rare-earth magnets provides an exceptionally high power to volume ratio. Precise, open-loop, speed control can be achieved with the application of full step, half step, or micro-stepping electronics.

The rotor consists of an injection moulded plastic support and magnets which are assembled in a 10 or 12 pole configuration depending on the motor type. The large magnet volume helps to achieve a very high torque density. The use of high power rare-earth magnets also enhances the available temperature range of the motors from extremely low temperatures up to 180 °C as a special configuration. The stator consists of two discrete phase coils which are positioned on either side of the rotor. The inner and outer stator assemblies provide the necessary radial magnetic field.

Benefits

- Cost effective positioning drive without an encoder
- High power density
- Long operational lifetimes
- Wide operational temperature range
- Speed range up to 16 000 rpm using a current mode chopper driver
- Possibility of full step, half step and microstep operation

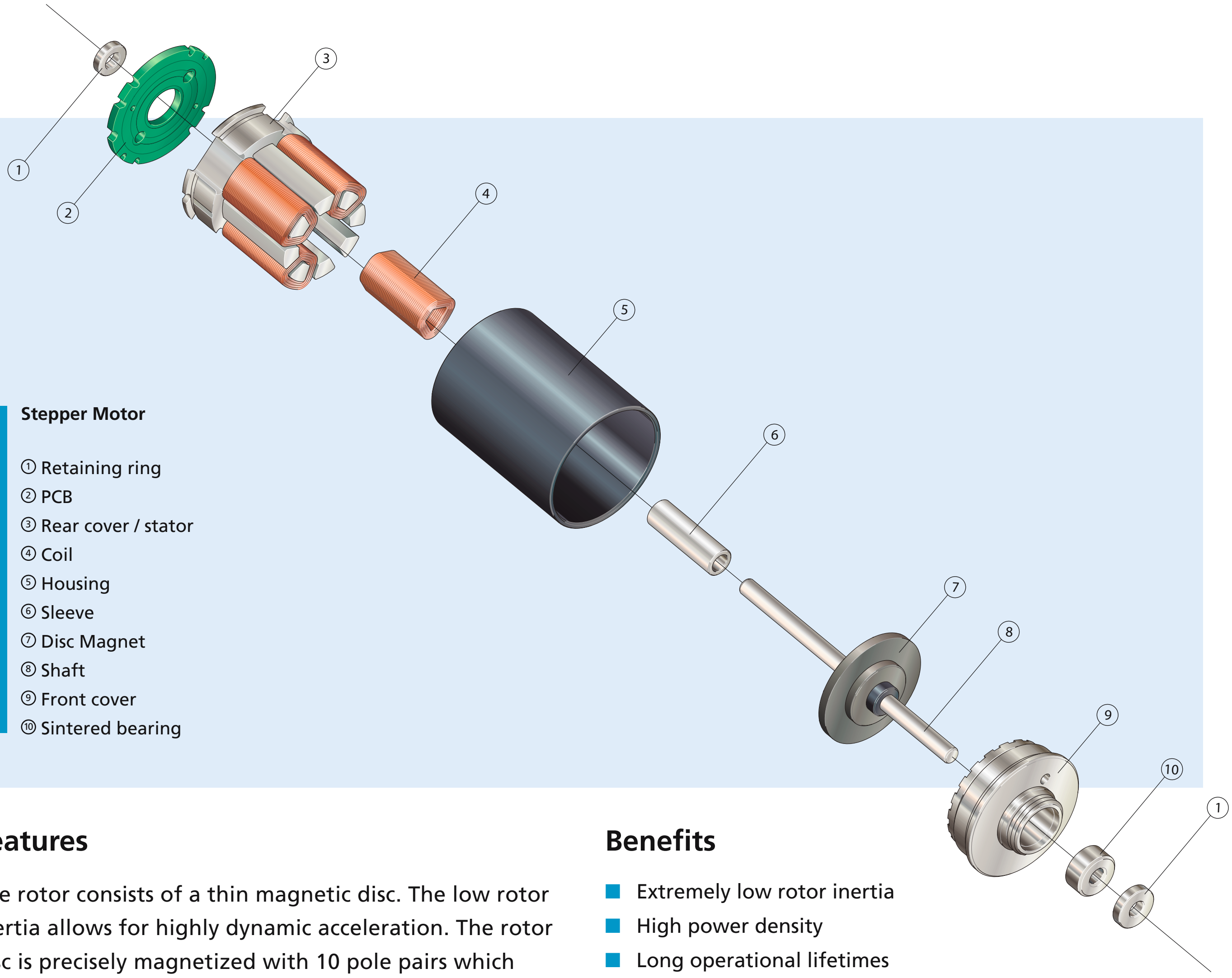
Product Code

AM1524	Motor series
2R	Bearing type
V-12-150	Coil type
57	Motor version

AM1524-2R-V-12-150-57

Stepper Motors

Two phase with Disc Magnet



Stepper Motor

① Retaining ring
② PCB
③ Rear cover / stator
④ Coil
⑤ Housing
⑥ Sleeve
⑦ Disc Magnet
⑧ Shaft
⑨ Front cover
⑩ Sintered bearing

Features

The rotor consists of a thin magnetic disc. The low rotor inertia allows for highly dynamic acceleration. The rotor disc is precisely magnetized with 10 pole pairs which helps the motor achieve a very high angular accuracy. The stator consists of four coils, two per phase, which are located on one side of the rotor disc and provide the axial magnetic field.

Special executions with additional rotating back-iron are available for exceptionally precise micro-stepping performance.

Benefits

- Extremely low rotor inertia
- High power density
- Long operational lifetimes
- Wide operational temperature range
- Ideally suited for micro-stepping applications

Product Code

ADM1220-2R-V2-01

ADM1220	Motor series
2R	Bearing type
V2	Coil type
01	Motor version

Stepper Motors

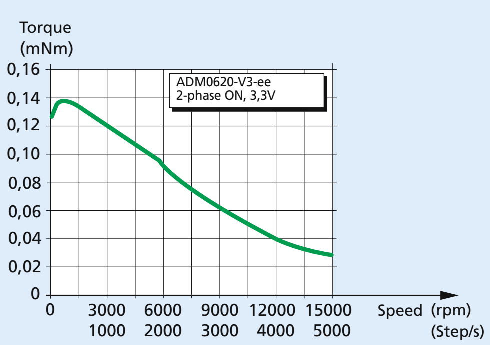
0,2 mNm

Two phase, 20 steps per revolution
PRECIstep® Technology

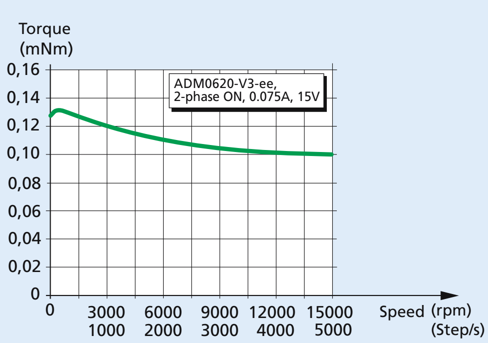
ADM0620-2R-ww-ee

	ww =		V2		V3		V6		
			Voltage	Current	Voltage	Current	Voltage	Current	Drive mode
1	Nominal voltage per phase (both phases ON) [1]		2	–	3	–	6	–	V DC
2	Nominal current per phase (both phases ON)		–	0,13	–	0,075	–	0,04	A
3	Phase resistance (at 20°C)		12,4		30,6		114		Ω
4	Phase inductance (1kHz)		1,2		3,0		10,5		mH
5	Back-EMF amplitude		0,33		0,6		1,1		V/k step/s
6	Holding torque (at nominal current in both phases)	0,2							mNm
7	Holding torque (at twice the nominal current)	0,28							mNm
8	Step angle (full step)	18							degree
9	Angular accuracy [2]	± 5							% of full step
10	Residual torque, max.	0,06							mNm
11	Rotor inertia	0,7							$\cdot 10^{-9}$ kgm²
12	Resonance frequency (at no load)	170							Hz
13	Electrical time constant	0,09							ms
14	Ambient temperature range	–35 ... +70							°C
15	Winding temperature tolerated, max.	130							°C
16	Thermal resistance winding-ambient air	165							°C/W
17	Thermal time constant	120							s
18	Shaft bearings	ball bearings, preloaded (standard)							
19	Shaft load, max.:								
	– radial (3 mm from bearing)	0,3							N
	– axial	0,5							N
20	Shaft play, max.:								
	– radial (0,2N)	20							µm
	– axial (0,2N)	50							µm
21	Isolation test voltage	200							V DC
22	Weight	1,4							g

1) Nominal voltage specified for voltage mode operation only
2) 2 phases ON, balanced phase currents
3) Curves measured with a load inertia of 8 $\cdot 10^{-9}$ kgm²
4) Testing the motor at lower supply voltages in current mode will result in a decrease in torque at higher speed, even with the same current setting

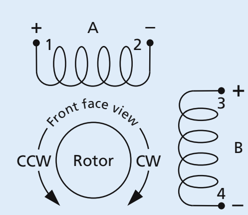


Voltage mode (V) [3]
Driver AD VL M1S

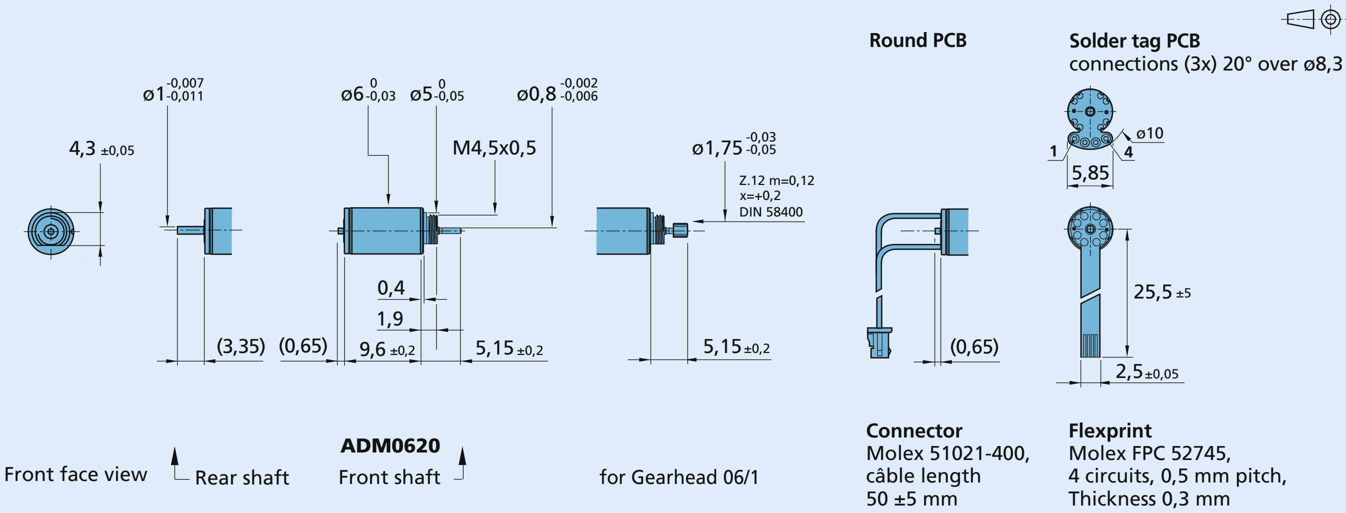


Current mode (A) [3] [4]
Driver AD CM M1S

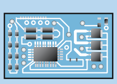
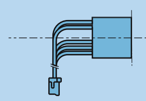
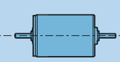
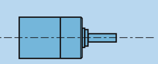
	← CW		CCW →	
	1	2	3	4
Phase **A**	+	–	–	+
Phase **B**	+	+	–	–



Dimensional drawing



Combinations

Drive Electronics	Encoders	Stepper Motors	Gearheads / Lead screws
			
AD VL M_S		**ADM0620**	**06/1**
AD CM M_S			**Lead screws M1,2 - M1,6**

Ordering information

Example: **ADM0620-2R-V2-01**

Motor type ADM = Motor design 06 = Motor diameter (mm) 20 = Steps per revolution	**Bearings** (rr) Special lubricant options available	**Winding** (ww)	**Motor execution** (ee) Only front output shaft	With double output shaft	Front output shaft
ADM0620	**-2R** (2 ball bearings)	**-V2**	**-11** (Solder tag PCB)	**-10** (Solder tag PCB)	Plain shaft
		-V3	**-15** (Solder tag PCB)	**-16** (Solder tag PCB)	Pinion 06/1
		-V6	**-26** (Solder tag PCB)	**-25** (Solder tag PCB)	Shaft for lead screw M1,2
			-28 (Solder tag PCB)	**-27** (Solder tag PCB)	Shaft for lead screw M1,6
			-43 (Flexprint)	**-42** (Flexprint)	Plain Shaft
			-47 (Flexprint)	**-48** (Flexprint)	Pinion 06/1
			-67 (Flexprint)	**-66** (Flexprint)	Shaft for lead screw M1,2
			-69 (Flexprint)	**-68** (Flexprint)	Shaft for lead screw M1,6
			-01 (Round PCB)		Plain Shaft
			-05 (Round PCB)		Pinion 06/1
			-21 (Round PCB)		Shaft for lead screw M1,2
			-23 (Round PCB)		Shaft for lead screw M1,6

Stepper Motors

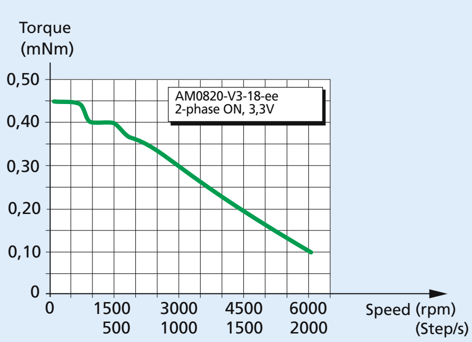
0,65 mNm

Two phase, 20 steps per revolution
PRECIstep® Technology

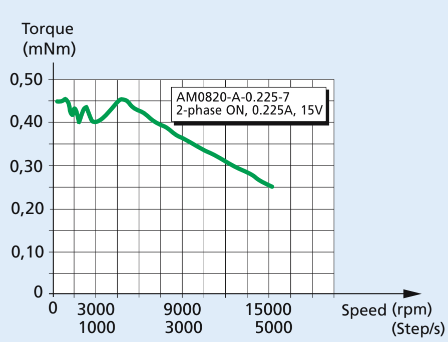
AM0820-ww-ee

No.	ww =		V-3-18 Voltage	V-3-18 Current	V-5-56 Voltage	V-5-56 Current	A-0,225-7 Voltage	A-0,225-7 Current	Drive mode
1	Nominal voltage per phase (both phases ON) [1]		3	–	5	–	2	–	V DC
2	Nominal current per phase (both phases ON)		–	0,15	–	0,08	–	0,225	A
3	Phase resistance (at 20°C)		18		56		7,3		Ω
4	Phase inductance (1kHz)		3,9		12,6		1,4		mH
5	Back-EMF amplitude		1,3		2,4		0,8		V/k step/s
6	Holding torque (at nominal current in both phases)	0,65							mNm
7	Holding torque (at twice the nominal current)	1							mNm
8	Step angle (full step)	18							degree
9	Angular accuracy [2]	± 10							% of full step
10	Residual torque, max.	0,17							mNm
11	Rotor inertia	2,75							$\cdot 10^{-9}$ kgm²
12	Resonance frequency (at no load)	170							Hz
13	Electrical time constant	0,21							ms
14	Ambient temperature range	–30 ... +70							°C
15	Winding temperature tolerated, max.	130							°C
16	Thermal resistance winding-ambient air	76							°C/W
17	Thermal time constant	180							s
18	Shaft bearings	sintered bronze sleeves (standard)			ball bearings, preloaded (optional)				
19	Shaft load, max.:								
	– radial (3 mm from bearing)	0,3			3,0				N
	– axial	0,2			1,5				N
20	Shaft play, max.:								
	– radial (0,2N)	15			12				µm
	– axial (0,2N)	140			~0				µm
21	Isolation test voltage	200							V DC
22	Weight	3,3							g

[1] Nominal voltage specified for voltage mode operation only
[2] 2 phases ON, balanced phase currents
[3] Curves measured with a load inertia of 10 $\cdot 10^{-9}$ kgm²
[4] Testing the motor at lower supply voltages in current mode will result in a decrease in torque at higher speed, even with the same current setting



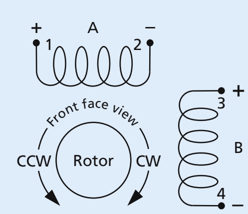
Voltage mode (V) [3]
Driver AD VL M1S



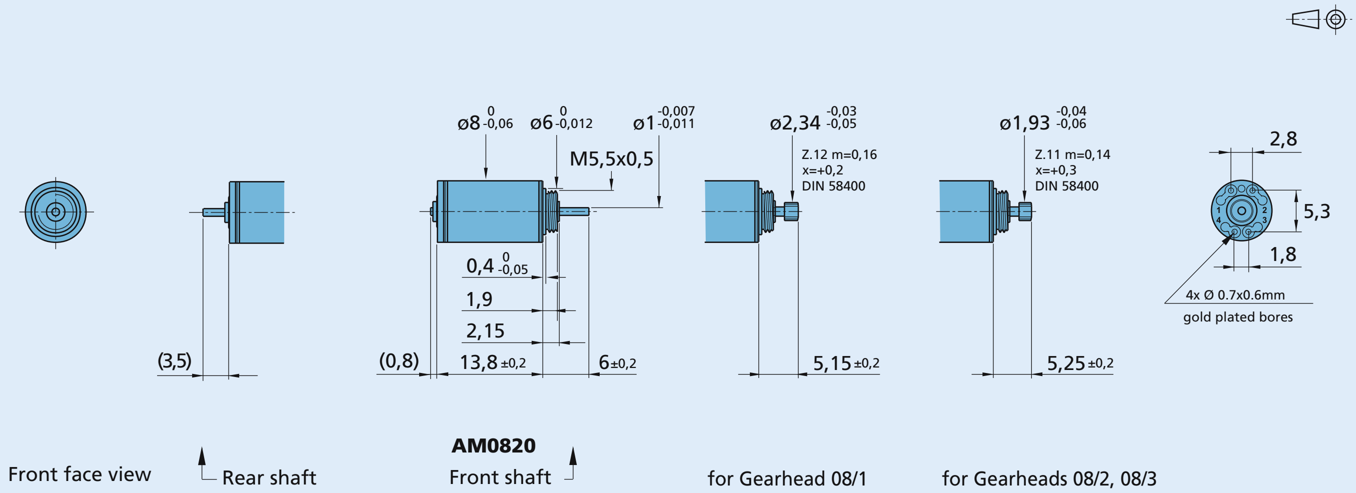
Current mode (A) [3] [4]
Driver AD CM M1S

← CW
CCW →

	1	2	3	4
Phase **A**	+	–	–	+
Phase **B**	+	+	–	–



Dimensional drawing



Combinations

Drive Electronics	Encoders	Stepper Motors	Gearheads / Lead screws
AD VL M_S		**AM0820**	**08/1**
AD CM M_S			**08/2**
			08/3*
			10/1
			Lead screws M1,2 - M1,6
			Lead screws M2 - M2,5 - M3

* Zero Backlash Gearheads

Ordering information

Example: **AM0820-2R-V-3-18-08**

Motor type	**Bearings** (rr)	**Winding** (ww)	**Motor execution** (ee)		
AM = Motor design 08 = Motor diameter (mm) 20 = Steps per revolution	Special lubricant options available		Only front output shaft	With double output shaft	Front output shaft
AM0820	**-** (sleeve bearings)	**-V-3-18**	**-01**	**-00**	Plain shaft
	-2R (2 ball bearings)	**-V-5-56**	**-08**	**-09**	Pinion 08/1
		-A-0,225-7	**-10**	**-11**	Pinion 10/1
			-12	**-13**	Pinion 08/2, 08/3
			-21	**-20**	Shaft for lead screw M1,2
			-23	**-22**	Shaft for lead screw M2 - M2,5 - M3
			-25	**-24**	Shaft for lead screw M1,6

Stepper Motors

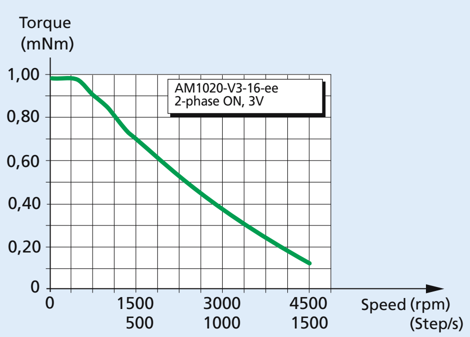
1,6 mNm

Two phase, 20 steps per revolution
PRECIstep® Technology

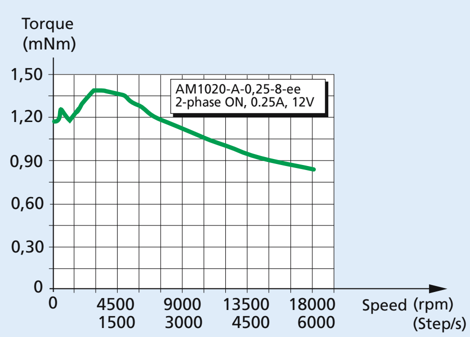
AM1020-ww-ee

ww =	V-3-16		V-6-65		V-12-250		A-0,25-8		
	Voltage	Current	Voltage	Current	Voltage	Current	Voltage	Current	Drive mode
1 Nominal voltage per phase (both phases ON) [1]	3	–	6	–	12	–	2	–	V DC
2 Nominal current per phase (both phases ON)	–	0,18	–	0,09	–	0,045	–	0,25	A
3 Phase resistance (at 20°C)	16		65		250		8		Ω
4 Phase inductance (1kHz)	5,2		21,4		80,1		2,4		mH
5 Back-EMF amplitude	2,6		5,3		10,5		1,8		V/k step/s
6 Holding torque (at nominal current in both phases)	1,6								mNm
7 Holding torque (at twice the nominal current)	2,4								mNm
8 Step angle (full step)	18								degree
9 Angular accuracy [2]	± 10								% of full step
10 Residual torque, max.	0,20								mNm
11 Rotor inertia	9								$\cdot 10^{-9}$ kgm²
12 Resonance frequency (at no load)	140								Hz
13 Electrical time constant	0,32								ms
14 Ambient temperature range	–35 ... +70								°C
15 Winding temperature tolerated, max.	130								°C
16 Thermal resistance winding-ambient air	73								°C/W
17 Thermal time constant	90								s
18 Shaft bearings	sintered sleeve bearings (standard)				ball bearings, preloaded (optional)				
19 Shaft load, max.:									
– radial (3 mm from bearing)	0,3				4,0				N
– axial	0,3				3,0				N
20 Shaft play, max.:									
– radial (0,2N)	15				12				µm
– axial (0,2N)	150				~0				µm
21 Isolation test voltage	200								V DC
22 Weight	5,5								g

[1] Nominal voltage specified for voltage mode operation only
[2] 2 phases ON, balanced phase currents
[3] Curves measured with a load inertia of $10 \cdot 10^{-9}$ kgm²
[4] Testing the motor at lower supply voltages in current mode will result in a decrease in torque at higher speed, even with the same current setting

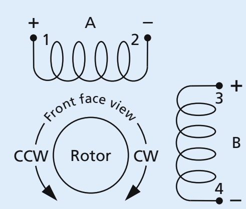


Voltage mode (V) [3]
Driver AD VL M1S



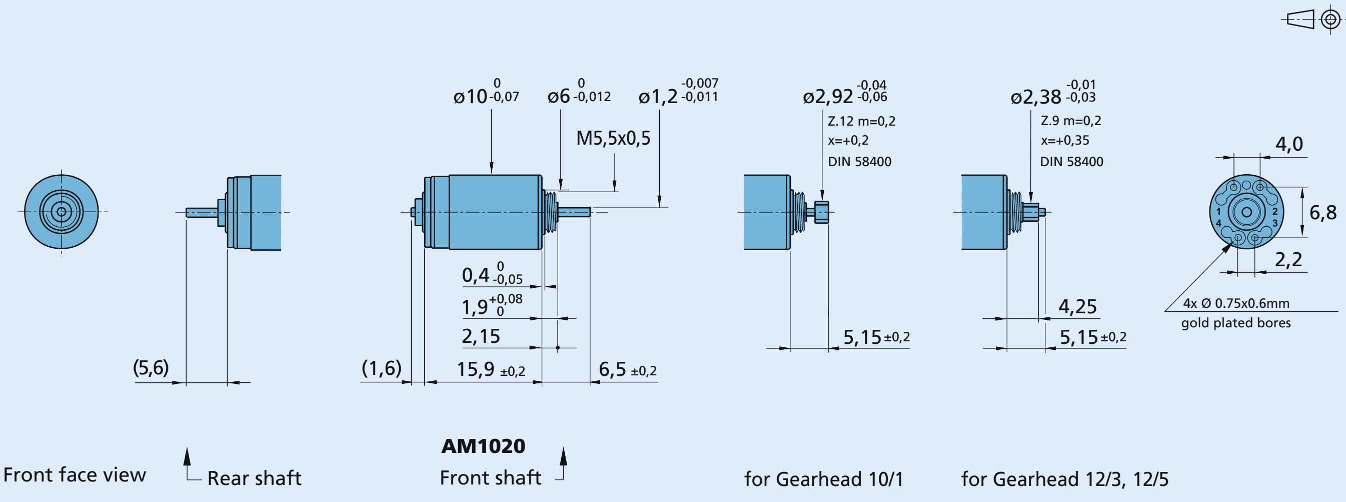
Current mode (A) [3] [4]
Driver AD CM M1S

	CW / CCW			
	1	2	3	4
Phase **A**	+	–	–	+
Phase **B**	+	+	–	–

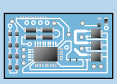
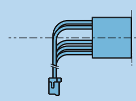
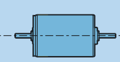
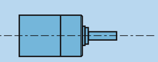


For notes on technical data and lifetime performance refer to „Technical Information“.
Edition 2012 – 2013

Dimensional drawing



Combinations

Drive Electronics	Encoders	Stepper Motors	Gearheads / Lead screws
			
AD VL M_S	**AE 30B19**	**AM1020**	**10/1**
AD CM M_S			**12/3**
			12/5*
			Lead screws M1,2 M1,6
			Lead screws M2 - M2,5 - M3

* Zero Backlash Gearheads

Ordering information

Example: **AM1020-2R-V-3-16-08**

Motor type AM = Motor design 10 = Motor diameter (mm) 20 = Steps per revolution	**Bearings** (rr) Special lubricant options available	**Winding** (ww)	**Motor execution** (ee) Only front output shaft	With double output shaft	Front output shaft
AM1020	**-** (sleeve bearings)	**-V-3-16**	**-01**	**-00**	Plain shaft
	-2R (2 ball bearings)	**-V-6-65**	**-08**	**-09**	Pinion 10/1
		-V-12-250	**-10**	**-11**	Pinion 12/5
		-A-0,25-8		**-12**	Plain shaft, Rear = 3,7mm for AE 30B19
				-13	Pinion 10/1, Rear = 3,7mm for AE 30B19
				-14	Pinion 12/5, Rear = 3,7mm for AE 30B19
			-21	**-20**	Plain shaft for lead screw M1,2
			-23	**-22**	Plain shaft for lead screw M2 - M2,5 - M3
			-25	**-24**	Plain shaft for lead screw M1,6

Stepper Motors

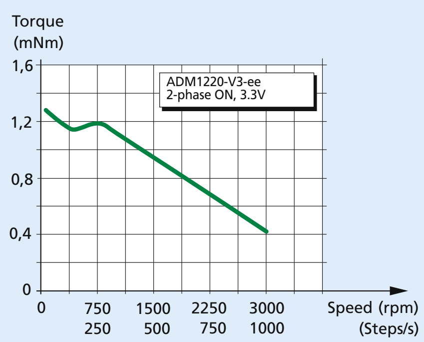
2,4 mNm

Two phase, 20 steps per revolution
PRECIstep® Technology

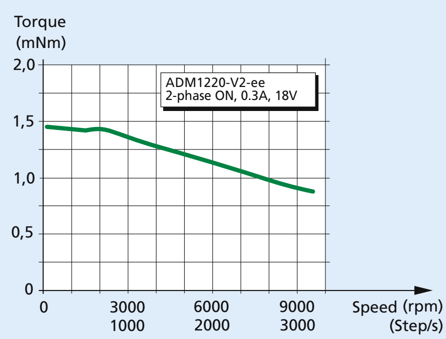
ADM1220-ww-ee

	ww =	V2		V3		V6		V12		
		Voltage	Current	Voltage	Current	Voltage	Current	Voltage	Current	Drive mode
1	Nominal voltage per phase (both phases ON) [1]	2	–	3	–	6	–	12	–	V DC
2	Nominal current per phase (both phases ON)	–	0,3	–	0,2	–	0,09	–	0,055	A
3	Phase resistance (at 20°C)	5,4		13		48		164		Ω
4	Phase inductance (1kHz)	1,4		4,1		11,8		49,1		mH
5	Back-EMF amplitude	1,5		2,5		4,5		9,1		V/k step/s
6	Holding torque (at nominal current in both phases)	2,4								mNm
7	Holding torque (at twice the nominal current)	4,1								mNm
8	Step angle (full step)	18								degree
9	Angular accuracy [2]	± 5								% of full step
10	Residual torque, max.	0,5								mNm
11	Rotor inertia	7,6								$\cdot 10^{-9}$ kgm²
12	Resonance frequency (at no load)	187								Hz
13	Electrical time constant	0,28								ms
14	Ambient temperature range	–35 ... +70								°C
15	Winding temperature tolerated, max.	130								°C
16	Thermal resistance winding-ambient air	62								°C/W
17	Thermal time constant	205								s
18	Shaft bearings	sintered bronze sleeves (standard)				ball bearings, preloaded (optional)				
19	Shaft load, max.:									
	– radial (3 mm from bearing)	0,5				6,0				N
	– axial	3,0				3,0				N
20	Shaft play, max.:									
	– radial (0,2N)	15				12				µm
	– axial (0,2N)	~0				~0				µm
21	Isolation test voltage	200								V DC
22	Weight	9								g

1) Nominal voltage specified for voltage mode operation only
2) 2 phases ON, balanced phase currents
3) Curves measured with a load inertia of 10 $\cdot 10^{-9}$ kgm²
4) Testing the motor at lower supply voltages in current mode will result in a decrease in torque at higher speed, even with the same current setting

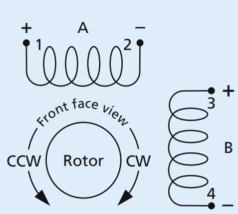


Voltage mode (V) [3]
Driver AD VL M1S

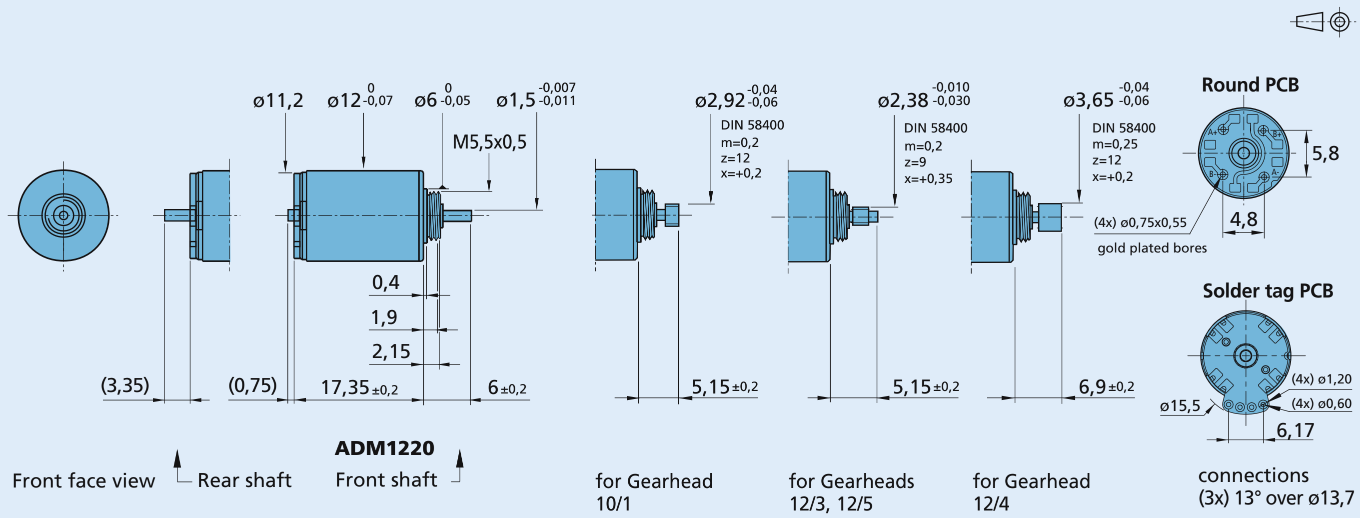


Current mode (A) [3] [4]
Driver AD CM M1S

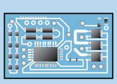
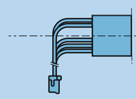
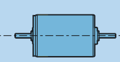
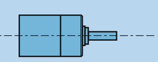
← CW / CCW →	1	2	3	4
Phase **A**	+	–	–	+
Phase **B**	+	+	–	–



Dimensional drawing



Combinations

Drive Electronics	Encoders	Stepper Motors	Gearheads / Lead screws
			
AD VL M_S		**ADM1220**	**10/1**
AD VM M_S			**12/3**
AD CM M_S			**12/4**
			12/5*
			Lead screws M2 - M2,5 - M3

* Zero Backlash Gearheads

Ordering information

Example: **ADM1220-2R-V2-01**

Motor type	Bearings (rr)	Winding (ww)	Motor execution (ee)		
ADM = Motor design 12 = Motor diameter (mm) 20 = Steps per revolution	Special lubricant options available		Only front output shaft	With double output shaft	Front output shaft
ADM1220	**-** (sleeve bearings)	**-V2**	**-01** (Round PCB)	**-00** (Round PCB)	Plain shaft, plain shaft for lead screw M3
	-2R (2 ball bearings)	**-V3**	**-05** (Round PCB)	**-06** (Round PCB)	Pinion 10/1
		-V6	**-07** (Round PCB)	**-08** (Round PCB)	Pinion 12/3, 12/5
		-V12	**-09** (Round PCB)	**-10** (Round PCB)	Pinion 12/4
			-23 (Round PCB)	**-22** (Round PCB)	Plain shaft for lead screw M2 - M2,5
			-21 (Solder tag PCB)	**-20** (Solder tag PCB)	Plain shaft, plain shaft for lead screw M3
			-25 (Solder tag PCB)	**-24** (Solder tag PCB)	Pinion 10/1
			-27 (Solder tag PCB)	**-26** (Solder tag PCB)	Pinion 12/3, 12/5
			-29 (Solder tag PCB)	**-28** (Solder tag PCB)	Pinion 12/4
			-43 (Solder tag PCB)	**-42** (Solder tag PCB)	Plain shaft for lead screw M2 - M2,5

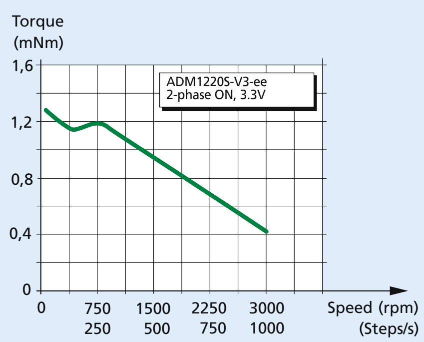
Stepper Motors — 2,4 mNm

Two phase, 20 steps per revolution
microstepping motor (low residual torque), PRECIstep® Technology

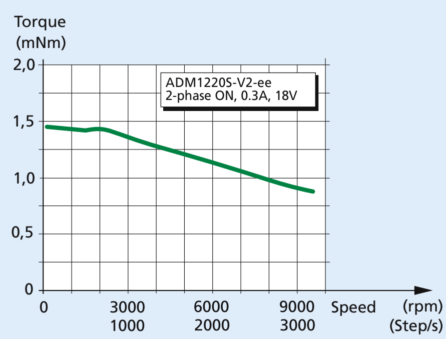
ADM1220S-ww-ee

	ww =	V2		V3		V6		V12		
		Voltage	Current	Voltage	Current	Voltage	Current	Voltage	Current	Drive mode
1	Nominal voltage per phase (both phases ON) [1]	2	–	3	–	6	–	12	–	V DC
2	Nominal current per phase (both phases ON)	–	0,3	–	0,2	–	0,09	–	0,055	A
3	Phase resistance (at 20°C)	5,4		13		48		164		Ω
4	Phase inductance (1kHz)	1,3		3,5		13		57		mH
5	Back-EMF amplitude	1,7		2,6		5,0		10,0		V/k step/s
6	Holding torque (at nominal current in both phases)	2,4								mNm
7	Holding torque (at twice the nominal current)	4,1								mNm
8	Step angle (full step)	18								degree
9	Angular accuracy [2]	± 3								% of full step
10	Residual torque, max.	0,15								mNm
11	Rotor inertia	18,5								$\cdot 10^{-9}$ kgm²
12	Resonance frequency (at no load)	128								Hz
13	Electrical time constant	0,28								ms
14	Ambient temperature range	–35 ... +70								°C
15	Winding temperature tolerated, max.	130								°C
16	Thermal resistance winding-ambient air	62								°C/W
17	Thermal time constant	205								s
18	Shaft bearings	sintered bronze sleeves (standard)				ball bearings, preloaded (optional)				
19	Shaft load, max.:									
	– radial (3 mm from bearing)	0,5				6,0				N
	– axial	3,0				3,0				N
20	Shaft play, max.:									
	– radial (0,2N)	15				12				µm
	– axial (0,2N)	~0				~0				µm
21	Isolation test voltage	200								V DC
22	Weight	9								g

[1] Nominal voltage specified for voltage mode operation only
[2] 2 phases ON, balanced phase currents
[3] Curves measured with a load inertia of 10 $\cdot 10^{-9}$ kgm²
[4] Testing the motor at lower supply voltages in current mode will result in a decrease in torque at higher speed, even with the same current setting

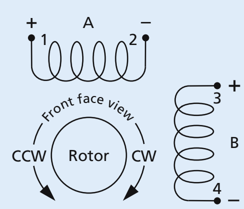


Voltage mode (V) [3]
Driver AD VL M1S

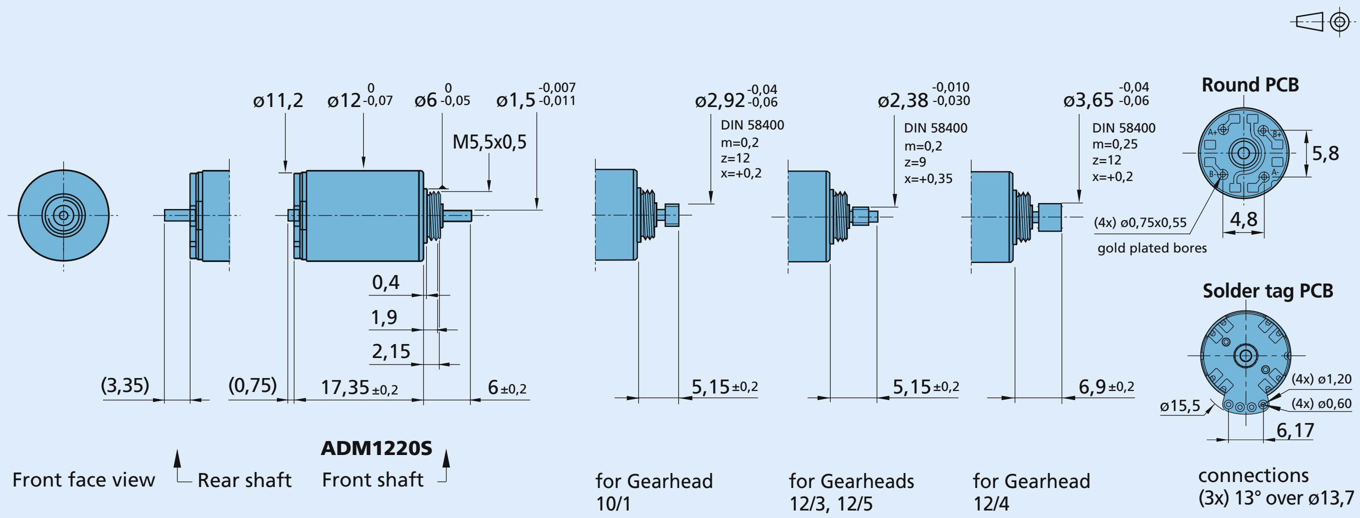


Current mode (A) [3] [4]
Driver AD CM M1S

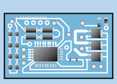
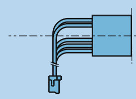
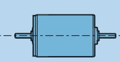
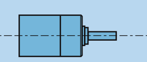
	1	2	3	4
← CW / CCW →				
Phase **A**	+	–	–	+
Phase **B**	+	+	–	–



Dimensional drawing



Combinations

Drive Electronics	Encoders	Stepper Motors	Gearheads / Lead screws
			
AD VL M_S		**ADM1220S**	**10/1**
AD VM M_S			**12/3**
AD CM M_S			**12/4**
			12/5*
			Lead screws M2 - M2,5 - M3

* Zero Backlash Gearheads

Ordering information

Example: **ADM1220S-2R-V2-51**

Motor type ADM = Motor design 12 = Motor diameter (mm) 20 = Steps per revolution	**Bearings** (rr) Special lubricant options available	**Winding** (ww)	**Motor execution** (ee) Only front output shaft	With double output shaft	Front output shaft
ADM1220S	**-** (sleeve bearings)	**-V2**	**-51** (Round PCB)	**-50** (Round PCB)	Plain shaft, plain shaft for lead screw M3
	-2R (2 ball bearings)	**-V3**	**-55** (Round PCB)	**-56** (Round PCB)	Pinion 10/1
		-V6	**-57** (Round PCB)	**-58** (Round PCB)	Pinion 12/3, 12/5
		-V12	**-59** (Round PCB)	**-60** (Round PCB)	Pinion 12/4
			-83 (Round PCB)	**-82** (Round PCB)	Plain shaft for lead screw M2 - M2,5
			-31 (Solder tag PCB)	**-30** (Solder tag PCB)	Plain shaft, plain shaft for lead screw M3
			-35 (Solder tag PCB)	**-34** (Solder tag PCB)	Pinion 10/1
			-37 (Solder tag PCB)	**-36** (Solder tag PCB)	Pinion 12/3, 12/5
			-39 (Solder tag PCB)	**-38** (Solder tag PCB)	Pinion 12/4
			-53 (Solder tag PCB)	**-52** (Solder tag PCB)	Plain shaft for lead screw M2 - M2,5

Stepper Motors

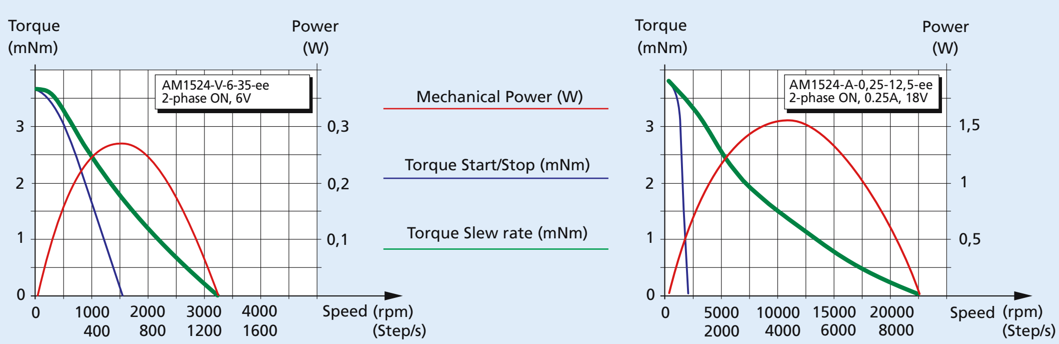
6,0 mNm

Two phase, 24 steps per revolution
PRECIstep® Technology

AM1524-ww-ee

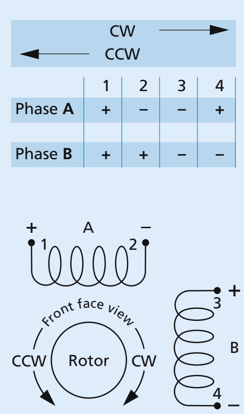
	ww =	V-6-35		V-12-150		A-0,25-12,5		A-0,45-3,6		
		Voltage	Current	Voltage	Current	Voltage	Current	Voltage	Current	Drive mode
1	Nominal voltage per phase (both phases ON) [1]	6	–	12	–	3,5	–	2	–	V DC
2	Nominal current per phase (both phases ON)	–	0,15	–	0,075	–	0,25	–	0,45	A
3	Phase resistance (at 20°C)	35		138		12,5		3,6		Ω
4	Phase inductance (1kHz)	16,5		70,6		6,3		1,9		mH
5	Back-EMF amplitude	7,2		14,7		4,4		2,4		V/k step/s
6	Holding torque (at nominal current in both phases)	6,0								mNm
7	Holding torque (at twice the nominal current)	10								mNm
8	Step angle (full step)	15								degree
9	Angular accuracy [2]	± 10								% of full step
10	Residual torque, max.	0,9								mNm
11	Rotor inertia	45								$\cdot 10^{-9}$ kgm^2
12	Resonance frequency (at no load)	120								Hz
13	Electrical time constant	0,5								ms
14	Ambient temperature range	–35 ... +70								°C
15	Winding temperature tolerated, max.	130								°C
16	Thermal resistance winding-ambient air	37								°C/W
17	Thermal time constant	220								s
18	Shaft bearings	sintered bronze sleeves (standard)				ball bearings, preloaded (optional)				
19	Shaft load, max.:									
	– radial (3 mm from bearing)	0,5				6,0				N
	– axial	0,5				2,0				N
20	Shaft play, max.:									
	– radial (0,2N)	15				12				µm
	– axial (0,2N)	150				~0				µm
21	Isolation test voltage	200								V DC
22	Weight	12								g

1) Nominal voltage specified for voltage mode operation only
2) 2 phases ON, balanced phase currents
3) Curves measured with a load inertia of 10 $\cdot 10^{-9}$ kgm^2
4) Testing the motor at lower supply voltages in current mode will result in a decrease in torque at higher speed, even with the same current setting

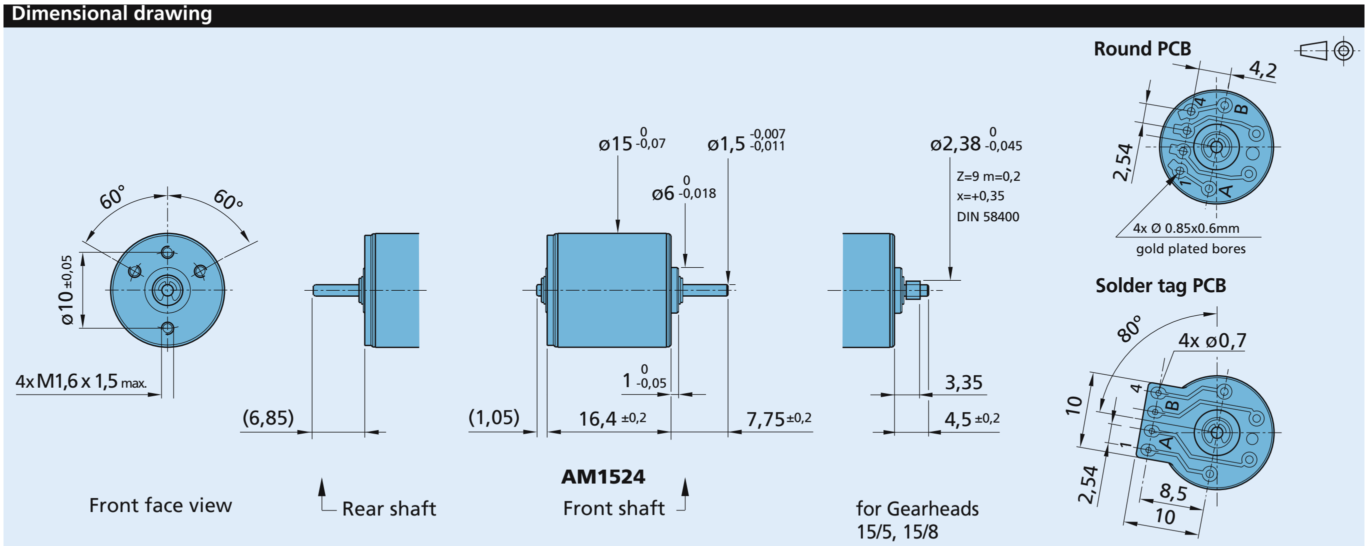


Voltage mode (V) 3)
Driver AD VM M1S

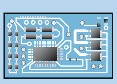
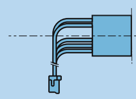
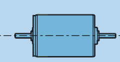
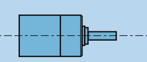
Current mode (A) 3) 4)
Driver AD CM M1S



Dimensional drawing



Combinations

Drive Electronics	Encoders	Stepper Motors	Gearheads / Lead screws
			
AD VL M_S	**AE 23B8**	**AM1524**	**15A**
AD VM M_S			**15/5**
AD CM M_S			**15/8***
			16/7
			Lead screws M2 - M2,5 - M3

* Zero Backlash Gearheads

Ordering information

Example: **AM1524-2R-V-6-35-57**

Motor type	**Bearings** (rr)	**Winding** (ww)	**Motor execution** (ee)		
AM = Motor design 15 = Motor diameter (mm) 24 = Steps per revolution	Special lubricant options available		Only front output shaft	With double output shaft	Front output shaft
AM1524	**-** (sleeve bearings)	**-V-3-10** *	**-55** (Round PCB)	**-54** (Round PCB)	Plain shaft, L=7,75 mm for 16/7, M3
	-2R (2 ball bearings)	**-V-6-35**	**-57** (Round PCB)	**-56** (Round PCB)	Pinion 15/5, 15/8
		-V-12-150	**-70** (Round PCB)	**-71** (Round PCB)	Plain shaft, L=4,5 mm for gearhead 15A
		-V-24-590 *	**-83** (Round PCB)	**-82** (Round PCB)	Plain shaft for lead screw M2 - M2,5
		-A-0,25-12,5	**-05** (Solder tag PCB)	**-04** (Solder tag PCB)	Plain shaft, L=7,75 mm for 16/7, M3
		-A-0,45-3,6	**-07** (Solder tag PCB)	**-06** (Solder tag PCB)	Pinion 15/5, 15/8
			-72 (Solder tag PCB)	**-73** (Solder tag PCB)	Plain shaft, L=4,5 mm for gearhead 15A
			-23 (Solder tag PCB)	**-22** (Solder tag PCB)	Plain shaft for lead screw M2 - M2,5
				-04-0904	Idem -04 & for encoder AE23B8
				-06-0904	Idem -06 & for encoder AE23B8
				-73-0904	Idem -73 & for encoder AE23B8

* Non-standard windings, for data please inquire with your point of sales

Stepper Motors

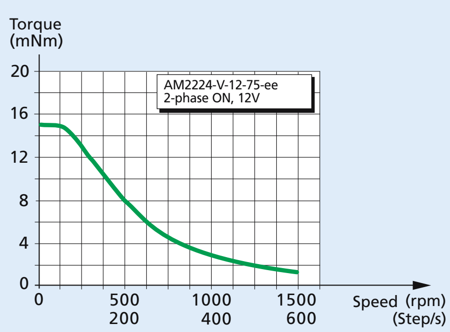
22 mNm

Two phase, 24 steps per revolution
PRECIstep® Technology

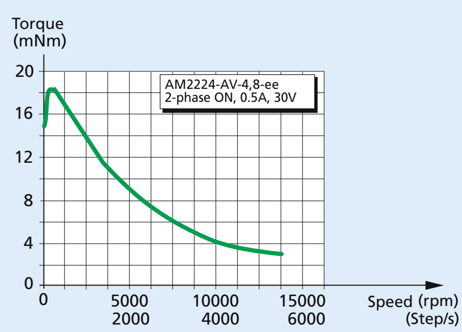
AM2224-ww-ee

	ww =	AV-0,9		AV-4,8		AV-18		V-12-75		
		Voltage	Current	Voltage	Current	Voltage	Current	Voltage	Current	Drive mode
1	Nominal voltage per phase (both phases ON) [1]	1,4	–	3	–	6	–	12	–	V DC
2	Nominal current per phase (both phases ON)	–	1,0	–	0,5	–	0,25	–	0,125	A
3	Phase resistance (at 20°C)	0,9		4,8		18		75		Ω
4	Phase inductance (1kHz)	0,9		4,3		16,3		65,6		mH
5	Back-EMF amplitude	3,8		8,3		16,3		32,7		V/k step/s
6	Holding torque (at nominal current in both phases)	22								mNm
7	Holding torque (at twice the nominal current)	37								mNm
8	Step angle (full step)	15								degree
9	Angular accuracy [2]	± 10								% of full step
10	Residual torque, max.	2								mNm
11	Rotor inertia	253								$\cdot 10^{-9}$ kgm²
12	Resonance frequency (at no load)	100								Hz
13	Electrical time constant	1,7								ms
14	Ambient temperature range	–35 ... +70								°C
15	Winding temperature tolerated, max.	130								°C
16	Thermal resistance winding-ambient air	28								°C/W
17	Thermal time constant	600								s
18	Shaft bearings	sintered bronze sleeves (standard with 2 mm shaft)				ball bearings, preloaded (optional)				
19	Shaft load, max.:									
	– radial (3 mm from bearing)	1,5				8,0				N
	– axial	0,5				4,0				N
20	Shaft play, max.:									
	– radial (0,2N)	30				15				µm
	– axial (0,2N)	200				~0				µm
21	Isolation test voltage	200								V DC
22	Weight	43								g

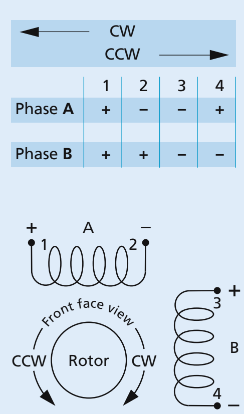
[1] Nominal voltage specified for voltage mode operation only
[2] 2 phases ON, balanced phase currents
[3] Curves measured with a load inertia of 8 $\cdot 10^{-9}$ kgm²
[4] Testing the motor at lower supply voltages in current mode will result in a decrease in torque at higher speed, even with the same current setting



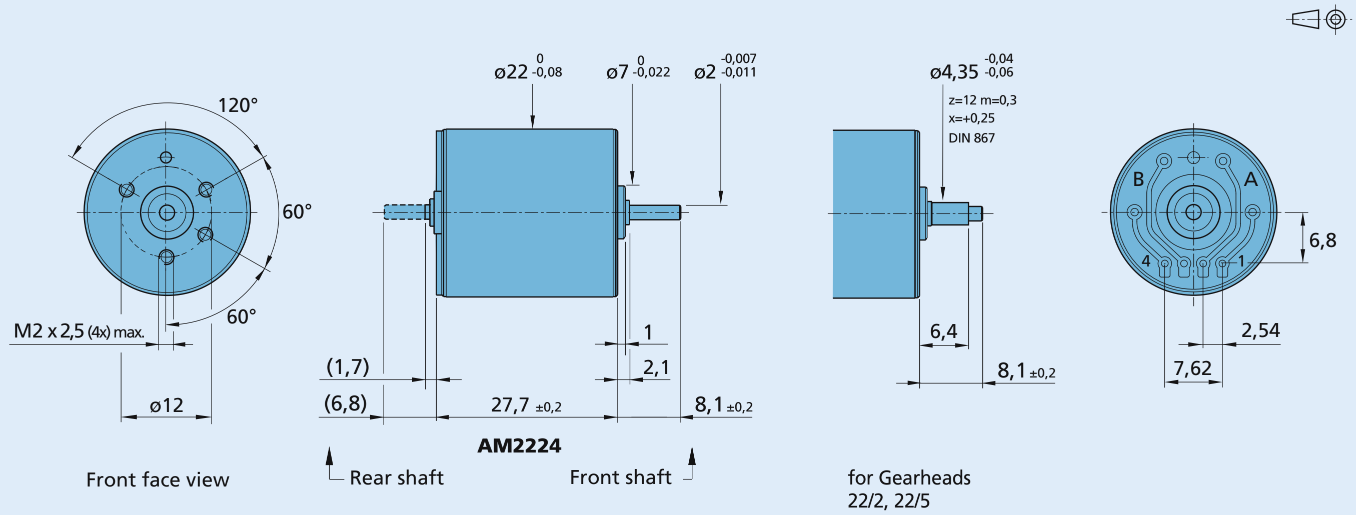
Voltage mode (V) [3]
Driver AD VM M1S



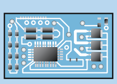
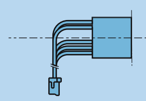
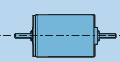
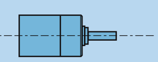
Current mode (A) [3] [4]
Driver AD CM M1S



Dimensional drawing



Combinations

Drive Electronics	Encoders	Stepper Motors	Gearheads / Lead screws
			
AD VM M_S	**PE 22-120**	**AM2224**	**22E**
AD CM M_S			**22EKV**
			22/2
			22/5*
			23/1

* Zero Backlash Gearheads

Ordering information

Example: **AM2224-2R-AV-18-10**

Motor type	**Bearings** (rr)	**Winding** (ww)	**Motor execution** (ee)		
AM = Motor design 22 = Motor diameter (mm) 24 = Steps per revolution	Special lubricant options available		Only front output shaft	With double output shaft	Front output shaft
AM2224	**-** (sleeve bearings)	**-AV-0,9**	**-10**	**-11**	Plain shaft, L=8,1 mm ø2 mm for 23/1
	-2R (2 ball bearings)	**-AV-4,8**	**-12**	**-13**	Plain shaft, L=6,6 mm ø1,5 for 22E, 22EKV
		-AV-18	**-14**	**-15**	Pinion 22/2, 22/5
		-V-12-75		**-16**	Plain shaft for 23/1, encoder PE22-120
		-V-24-290 *		**-17**	Plain shaft for 22E, encoder PE22-120
				-18	Pinion 22/2, 22/5, encoder PE22-120

* Non-standard windings, for data please inquire with your point of sales

Stepper Motors

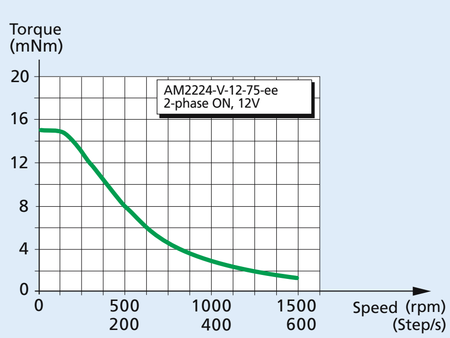
22 mNm

Two phase, 24 steps per revolution
PRECIstep® Technology

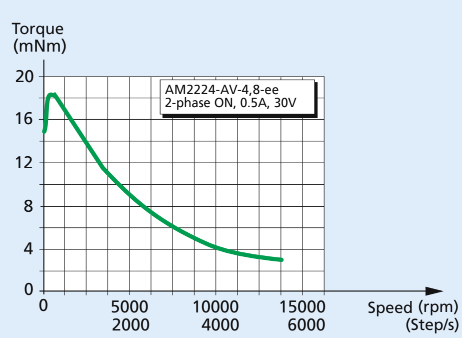
AM2224-R3-ww-ee

	ww =	AV-0,9		AV-4,8		AV-18		V-12-75		
		Voltage	Current	Voltage	Current	Voltage	Current	Voltage	Current	Drive mode
1	Nominal voltage per phase (both phases ON) [1]	1,4	–	3	–	6	–	12	–	V DC
2	Nominal current per phase (both phases ON)	–	1,0	–	0,5	–	0,25	–	0,125	A
3	Phase resistance (at 20°C)	0,9		4,8		18		75		Ω
4	Phase inductance (1kHz)	0,9		4,3		16,3		65,6		mH
5	Back-EMF amplitude	3,8		8,3		16,3		32,7		V/k step/s
6	Holding torque (at nominal current in both phases)	22								mNm
7	Holding torque (at twice the nominal current)	37								mNm
8	Step angle (full step)	15								degree
9	Angular accuracy [2]	± 10								% of full step
10	Residual torque, max.	2								mNm
11	Rotor inertia	253								$\cdot 10^{-9}$ kgm²
12	Resonance frequency (at no load)	100								Hz
13	Electrical time constant	0,92								ms
14	Ambient temperature range	–35 ... +70								°C
15	Winding temperature tolerated, max.	130								°C
16	Thermal resistance winding-ambient air	28								°C/W
17	Thermal time constant	600								s
18	Shaft bearings	ball bearings, preloaded (standard with 3 mm shaft)								
19	Shaft load, max.:									
	– radial (3 mm from bearing)	20,0								N
	– axial	4,0								N
20	Shaft play, max.:									
	– radial (0,2N)	15								µm
	– axial (0,2N)	~0								µm
21	Isolation test voltage	200								V DC
22	Weight	50,5								g

[1] Nominal voltage specified for voltage mode operation only
[2] 2 phases ON, balanced phase currents
[3] Curves measured with a load inertia of 8 $\cdot 10^{-9}$ kgm²
[4] Testing the motor at lower supply voltages in current mode will result in a decrease in torque at higher speed, even with the same current setting

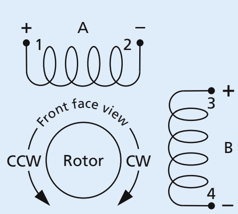


Voltage mode (V) [3]
Driver AD VM M1S

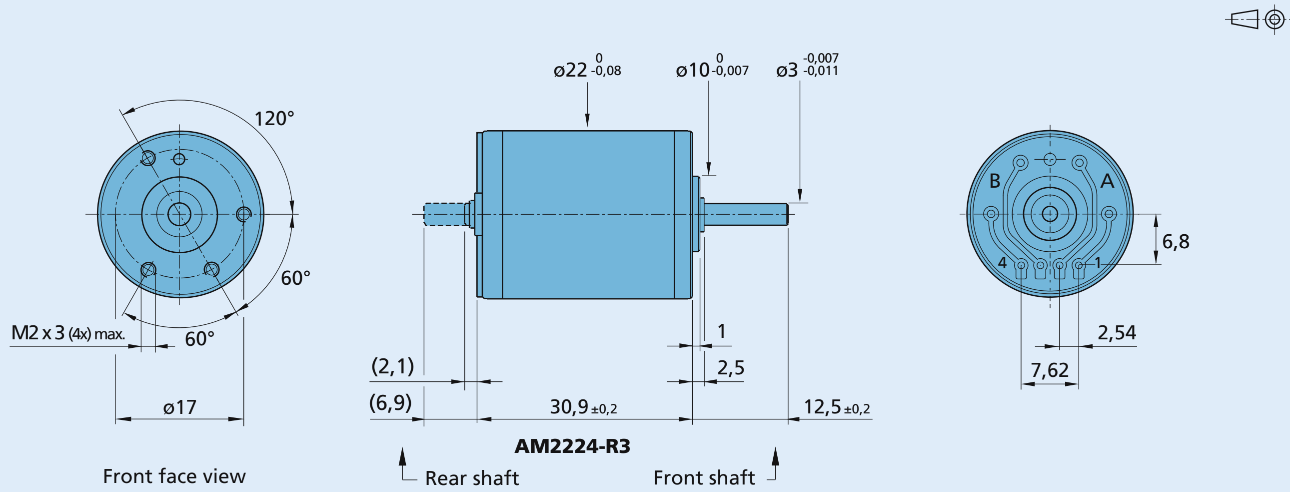


Current mode (A) [3] [4]
Driver AD CM M1S

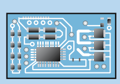
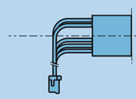
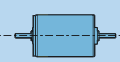
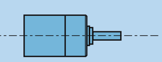
← CW				
CCW →				
	1	2	3	4
Phase **A**	+	–	–	+
Phase **B**	+	+	–	–



Dimensional drawing



Combinations

Drive Electronics	Encoders	Stepper Motors	Gearheads / Lead screws
			
AD VM M_S	**PE22-120**	**AM2224-R3**	**Lead screws M3**
AD CM M_S			

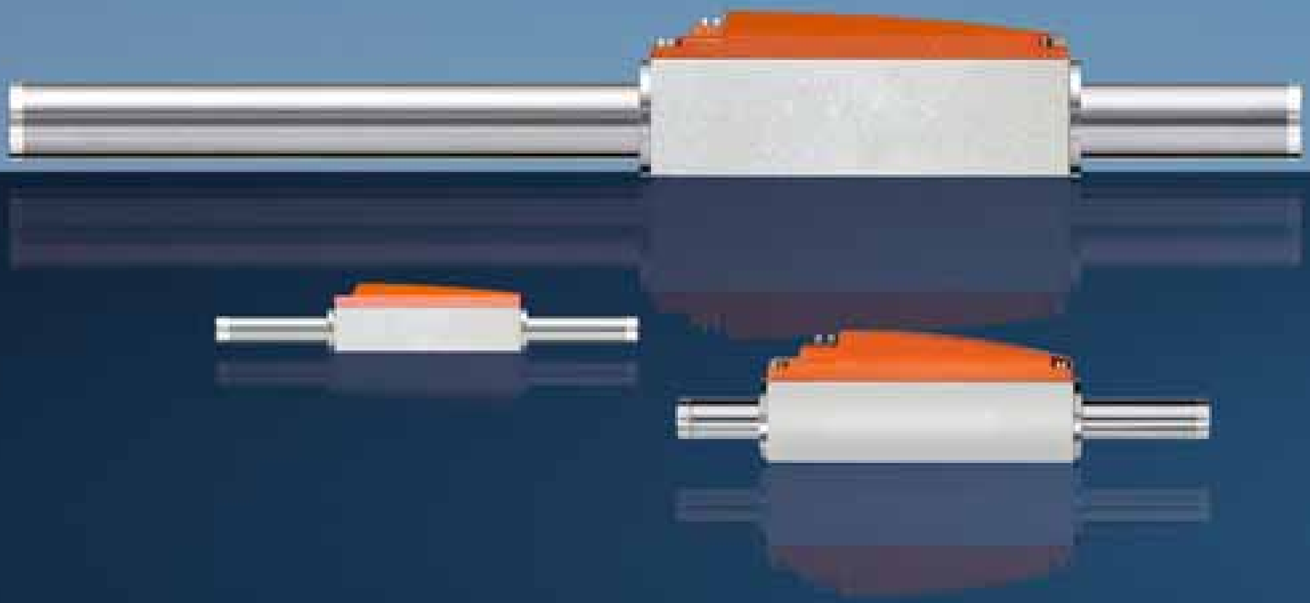
Ordering information

Example: **AM2224-R3-AV-18-31**

Motor type	Bearings (rr)	Winding (ww)	Motor execution (ee)		
AM = Motor design 22 = Motor diameter (mm) 24 = Steps per revolution	Special lubricant options available		Only front output shaft	With double output shaft	Front output shaft
AM2224	**-R3** (2 ball bearings)	**-AV-0,9**	**-30**	**-31**	Plain shaft
		-AV-4,8	**-85**	**-84**	Plain shaft for lead screw M3
		-AV-18		**-36**	Plain shaft for encoder PE22-120
		-V-12-75		**-86**	Plain shaft for lead screw M3, PE22-120
		-V-24-290 *			

* Non-standard windings, for data please inquire with your point of sales

Linear DC-Servomotors



WE CREATE MOTION

FAULHABER

Linear DC-Servomotors – QUICKSHAFT® Technology

			Page
LM 0830 ... 01	with analog Hall Sensors	1,03 N	268 – 269
LM 1247 ... 01	with analog Hall Sensors	3,6 N	270 – 273
LM 1247 ... 02	for sin/cos control	3,6 N	274 – 277
LM 2070 ... 01	with analog Hall Sensors	9,2 N	278 – 281
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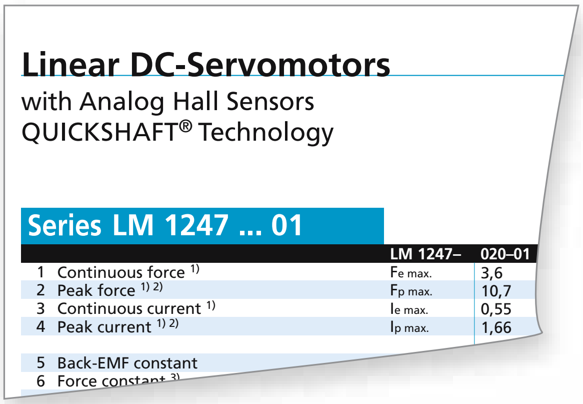
FAULHABER

WE CREATE MOTION

Linear DC-Servomotors

Technical Information



Linear DC-Servomotors
with Analog Hall Sensors
QUICKSHAFT® Technology

Series LM 1247 ... 01

			LM 1247–	020–01
1	Continuous force [1]	$F_{e\,max.}$	3,6
2	Peak force [1) 2)]	$F_{p\,max.}$	10,7
3	Continuous current [1]	$I_{e\,max.}$	0,55
4	Peak current [1) 2)]	$I_{p\,max.}$	1,66
5	Back-EMF constant		
6	Force constant [3]		

Notes on technical data

All values at 22 °C.

Continuous force $F_{e\,max.}$ [N]
The maximum force delivered by the motor at the thermal limit in continuous duty operation.

$$F_{e\,max.} = k_F \cdot I_{e\,max.}$$

Peak force $F_{p\,max.}$ [N]
The maximum force delivered by the motor at the thermal limit in intermittent duty operation (max. 1 s, 10% duty cycle).

$$F_{p\,max.} = k_F \cdot I_{p\,max.}$$

Continuous current $I_{e\,max.}$ [A]
The maximum motor current consumption at the thermal limit in continuous duty operation.

$$I_{e\,max.} = \sqrt{\frac{T_{125} - T_{22}}{R \cdot (1 + \alpha_{22} \cdot (T_{125} - T_{22})) \cdot (R_{th\,1} + 0{,}45 \cdot R_{th\,2})}} \cdot \frac{\sqrt{2}}{\sqrt{3}}$$

Peak current $I_{p\,max.}$ [A]
The maximum motor current consumption at the thermal limit in intermittent duty operation (max. 1 s, 10% duty cycle).

Back-EMF constant k_E [V/m/s]
The constant corresponding to the relationship between the induced voltage in the motor phases and the linear motion speed.

$$k_E = \frac{2 \cdot k_F}{\sqrt{6}}$$

Force constant k_F [N/A]
The constant corresponding to the relationship between the motor force delivered and current consumption.

Terminal resistance, phase-phase R [Ω] ±12%
The resistance measured between two motor phases. This value is directly influenced by the coil temperature (temperature coefficient: $\alpha_{22} = 0{,}004\ K^{-1}$).

Terminal inductance, phase-phase L [µH]
The inductance measured between two phases at 1 kHz.

Stroke length $s_{max.}$ [mm]
The maximum stroke length of the moving cylinder rod.

Repeatability [µm]
The maximum measured difference when repeating several times the same movement under the same conditions.

Precision [µm]
The maximum positioning error. This value corresponds to the maximum difference between the set position and the exact measured position of the system.

Acceleration $a_{e\,max.}$ [m/s²]
The maximum no-load acceleration from standstill.

$$a_{e\,max.} = \frac{F_{e\,max.}}{m_m}$$

Speed $v_{e\,max.}$ [m/s]
The maximum no-load speed from standstill, considering a triangular speed profile and maximum stroke length.

$$v_{e\,max.} = \sqrt{a_{e\,max.} \cdot s_{max.}}$$

Thermal resistance $R_{th\,1}$ / $R_{th\,2}$ [K/W]
R_{th1} corresponds to the value between coil and housing.
R_{th2} corresponds to the value between housing and ambient air.
The listed values refer to a motor totally surrounded by air.
R_{th2} can be reduced with a heat sink and/or forced air cooling.

Thermal time constant τ_{w1} / τ_{w2} [s]
The thermal time constant of the coil and housing, respectively.

Operating temperature range [°C]
The minimum and maximum permissible operating temperature values of the motors.

Rod weight m_m [g]
The weight of the rod (cylinder with magnets).

Total weight m_t [g]
The total weight of the linear DC-Servomotor.

Linear DC-Servomotors

Technical Information

Magnetic pitch τ_m [mm]
The distance between two equal poles.

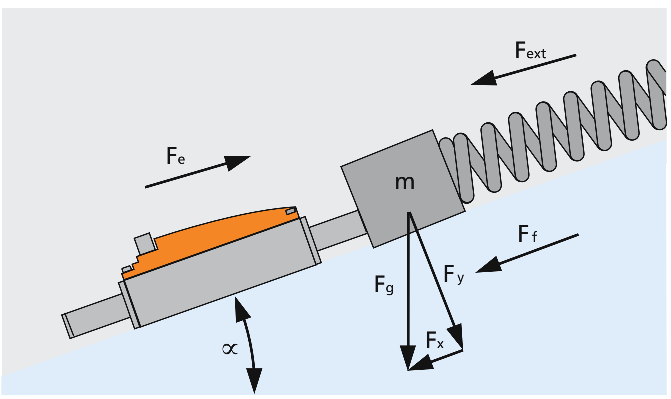
Rod bearings
The material and type of bearings.

Housing material
The material of the motor housing.

Direction of movement
The direction of movement is reversible, determined by the control electronics.

Force calculation

To move a mass on a slope, the motor needs to deliver a force to accelerate the load and overcome all forces opposing the movement.



The sum of forces shown in above figure has to be equal to:

$$\sum F = m \cdot a \qquad [N]$$

Entering the various forces in this equation it follows that:

$$F_e - F_{ext} - F_f - F_x = m \cdot a \qquad [N]$$

where:

F_e :	Continuous force delivered by motor		[N]
F_{ext} :	External force		[N]
F_f :	Friction force	$F_f = m \cdot g \cdot \mu \cdot \cos(\propto)$	[N]
F_x :	Parallel force	$F_x = m \cdot g \cdot \sin(\propto)$	[N]
m :	Total mass		[kg]
g :	Gravity acceleration		[m/s²]
a :	Acceleration		[m/s²]

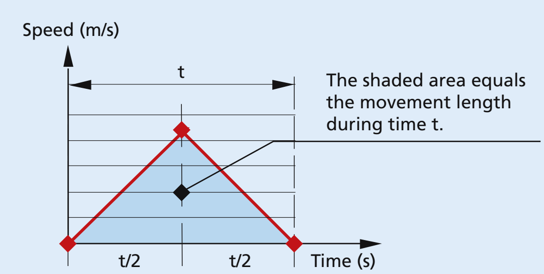
Speed profiles

Shifting any load from point A to point B is subject to the laws of kinematics.

Equations of a uniform straight-line movement and uniformly accelerated movement allow definition of the various speed vs. time profiles.

Prior to calculating the continuous duty force delivered by the motor, a speed profile representing the various load movements needs to be defined.

Triangular speed profile
The triangular speed profile simply consists of an acceleration and a deceleration time.

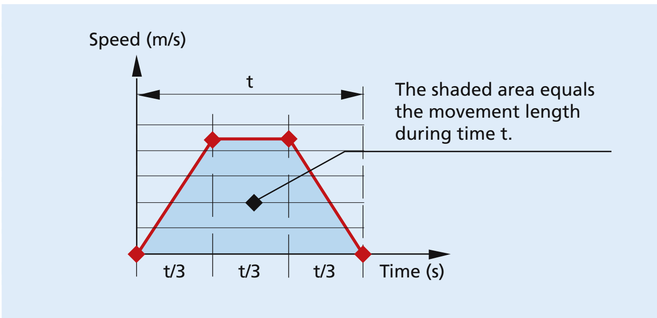


Displacement: $$s = \frac{1}{2} \cdot v \cdot t = \frac{1}{4} \cdot a \cdot t^2 = \frac{v^2}{a} \qquad [m]$$

Speed: $$v = 2 \cdot \frac{s}{t} = \frac{a \cdot t}{2} = \sqrt{a \cdot s} \qquad [m/s]$$

Acceleration: $$a = 4 \cdot \frac{s}{t^2} = 2 \cdot \frac{v}{t} = \frac{v^2}{s} \qquad [m/s^2]$$

Trapezoidal speed profile
The trapezoidal speed profile, acceleration, speed and deceleration, allow simple calculation and represent typical real application cases.



Displacement:	$s = \frac{2}{3} \cdot v \cdot t = \frac{1}{4,5} \cdot a \cdot t^2 = 2 \cdot \frac{v^2}{a}$	[m]
Speed:	$v = 1,5 \cdot \frac{s}{t} = \frac{a \cdot t}{3} = \sqrt{\frac{a \cdot s}{2}}$	[m/s]
Acceleration:	$a = 4,5 \cdot \frac{s}{t^2} = 3 \cdot \frac{v}{t} = 2 \cdot \frac{v^2}{s}$	[m/s²]

How to select a linear DC-Servomotor

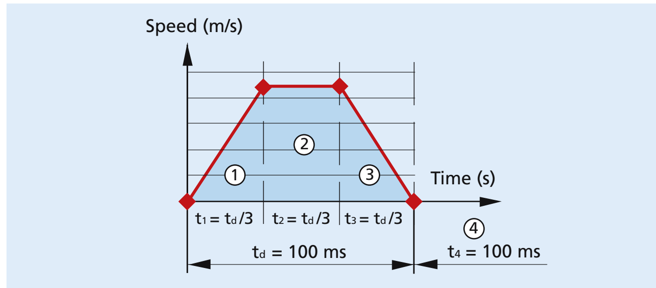
This section describes a step-by-step procedure to select a linear DC-Servomotor.

Speed profile definition
To start, it is necessary to define the speed profile of the load movements.

Movement characteristics are the first issues to be considered. Which is the maximum speed? How fast should the mass be accelerated? Which is the length of movement the mass needs to achieve? How long is the rest time?

Should the movement parameters not be clearly defined, it is recommended to use a triangular or trapezoidal profile.

Lets assume a load of 500 g that needs to be moved 20 mm in 100 ms on a slope having a rising angle of 20° considering a trapezoidal speed profile.



	Unit	①	②	③	④
s (displacement)	m	0,005	0,01	0,005	0
v (speed)	m/s	0 ... 0,3	0,3	0,3 ... 0	0
a (acceleration)	m/s²	9,0	0	–9,0	0
t (time)	s	0,033	0,033	0,033	0,100

Calculation example
Speed and acceleration of part ①

$$v_{max.} = 1,5 \cdot \frac{s}{t} = 1,5 \cdot \frac{20 \cdot 10^{-3}}{100 \cdot 10^{-3}} = 0,3 \text{ m/s}$$

$$a = 4,5 \cdot \frac{s}{t^2} = 4,5 \cdot \frac{20 \cdot 10^{-3}}{(100 \cdot 10^{-3})^2} = 9 \text{ m/s}^2$$

Force definition
Assuming a load of 500 g and a friction coefficient of 0,2, the following forces result:

			Forward				Backward			
Force	Unit	Symbol	①	②	③	④	①	②	③	④
Friction	N	F_f	0,94	0,94	0,94	-0,94	0,94	0,94	0,94	0,94
Parallel	N	F_x	1,71	1,71	1,71	1,71	-1,71	-1,71	-1,71	-1,71
Acceleration	N	F_a	4,5	0	-4,5	0	4,5	0	-4,5	0
Total	N	F_t	7,15	2,65	-1,85	0,77	3,73	-0,77	-5,27	-0,77

Calculation example
Friction and acceleration forces of part ①

$$F_f = m \cdot g \cdot \cdot \cos(\propto) = 0,5 \cdot 10 \cdot 0,2 \cdot \cos(20°) = 0,94 \text{ N}$$

$$F_a = m \cdot a = 0,5 \cdot 9 = 4,5 \text{ N} \qquad = 4,5 \text{ N}$$

Motor selection
Now that the forces of the three parts of the profile are known, requested peak and continuous forces can be calculated in function of the time of each part.

The peak force is the highest one achieved during the motion cycle.

$$F_p = _{max.}(|\mathbf{7,15}|, |2,65|, |-1,85|, |0,77|, |3,73|, |-0,77|, |-5,27|, |-0,77|) = 7,15 \text{ N}$$

Linear DC-Servomotors

Technical Information

The continuous force is represented by the expression:

$$F_e = \sqrt{\frac{\Sigma\,(t \cdot F_t^2)}{2 \cdot \Sigma t}} = \ldots$$

$$F_e = \sqrt{\frac{0{,}033 \cdot 7{,}15^2 + 0{,}033 \cdot 2{,}65^2 + 0{,}033 \cdot (-1{,}85)^2 + 0{,}1 \cdot 0{,}77^2 + 0{,}033 \cdot 3{,}73^2 + 0{,}033 \cdot (-0{,}77)^2 + 0{,}033 \cdot (-5{,}27)^2 + 0{,}1 \cdot (-0{,}77)^2}{2 \cdot (0{,}033 + 0{,}033 + 0{,}033 + 0{,}1)}} = 2{,}98\ \text{N}$$

With these two values it is now possible to select the suitable motor for the application.

Linearer DC-Servomotor **LM 1247–020–01**

$s_{max.} = 20$ mm ; $F_{e\,max} = 3{,}09$ N ; $F_{p\,max.} = 9{,}26$ N

Coil winding temperature calculation
To obtain the coil winding temperature, the continuous motor current needs to be calculated.
For this example, considering a force constant k_F equal to 6,43 N/A, gives the result:

$$I_e = \frac{F_e}{k_f} = \frac{2{,}98}{6{,}43} = 0{,}46\ \text{A}$$

With an electrical resistance of 13,17 Ω, a total thermal resistance of 26,2 °C/W ($R_{th1} + R_{th2}$) and a reduced thermal resistance Rth2 by 55% ($0{,}45 \cdot R_{th2}$), the resulting coil temperature is:

$$T_c\,(I) = \frac{R \cdot (R_{th1} + 0{,}45 \cdot R_{th2}) \cdot \left(I_e \cdot \frac{\sqrt{3}}{\sqrt{2}}\right)^2 \cdot (1 - \alpha_{22} \cdot T_{22}) + T_{22}}{1 - \alpha_{22} \cdot R \cdot (R_{th1} + 0{,}45 \cdot R_{th2}) \cdot \left(I_e \cdot \frac{\sqrt{3}}{\sqrt{2}}\right)^2} = \ldots$$

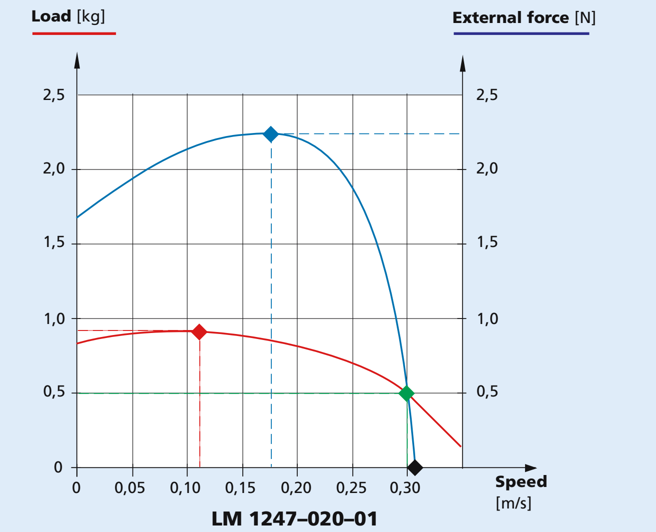
$$T_c\,(I) = \frac{13{,}17 \cdot (8{,}1 + 0{,}45 \cdot 18{,}1) \cdot \left(0{,}46 \cdot \frac{\sqrt{3}}{\sqrt{2}}\right)^2 \cdot (1 - 0{,}0038 \cdot 22) + 22}{1 - 0{,}0038 \cdot 13{,}17\,(8{,}1 + 0{,}45 \cdot 18{,}1) \cdot \left(0{,}46 \cdot \frac{\sqrt{3}}{\sqrt{2}}\right)^2} = 113{,}5\ °\text{C}$$

Motor characteristic curves

Motion profile:
Trapezoidal (t1 = t2 = t3), back and forth

Motor characteristic curves of the linear DC-Servomotor with the following parameters:

Displacement distance:	20 mm
Friction coefficient:	0,2
Slope angle:	20°
Rest time:	0,1 s



Load curve

Allows knowing the maximum applicable load for a given speed with 0 N external force.

The graph shows that a maximum load (◆) of 0,87 kg can be applied at a speed of 0,11 m/s.

External force curve

Allows knowing the maximum applicable external force for a given speed with a load of 0,5 kg.

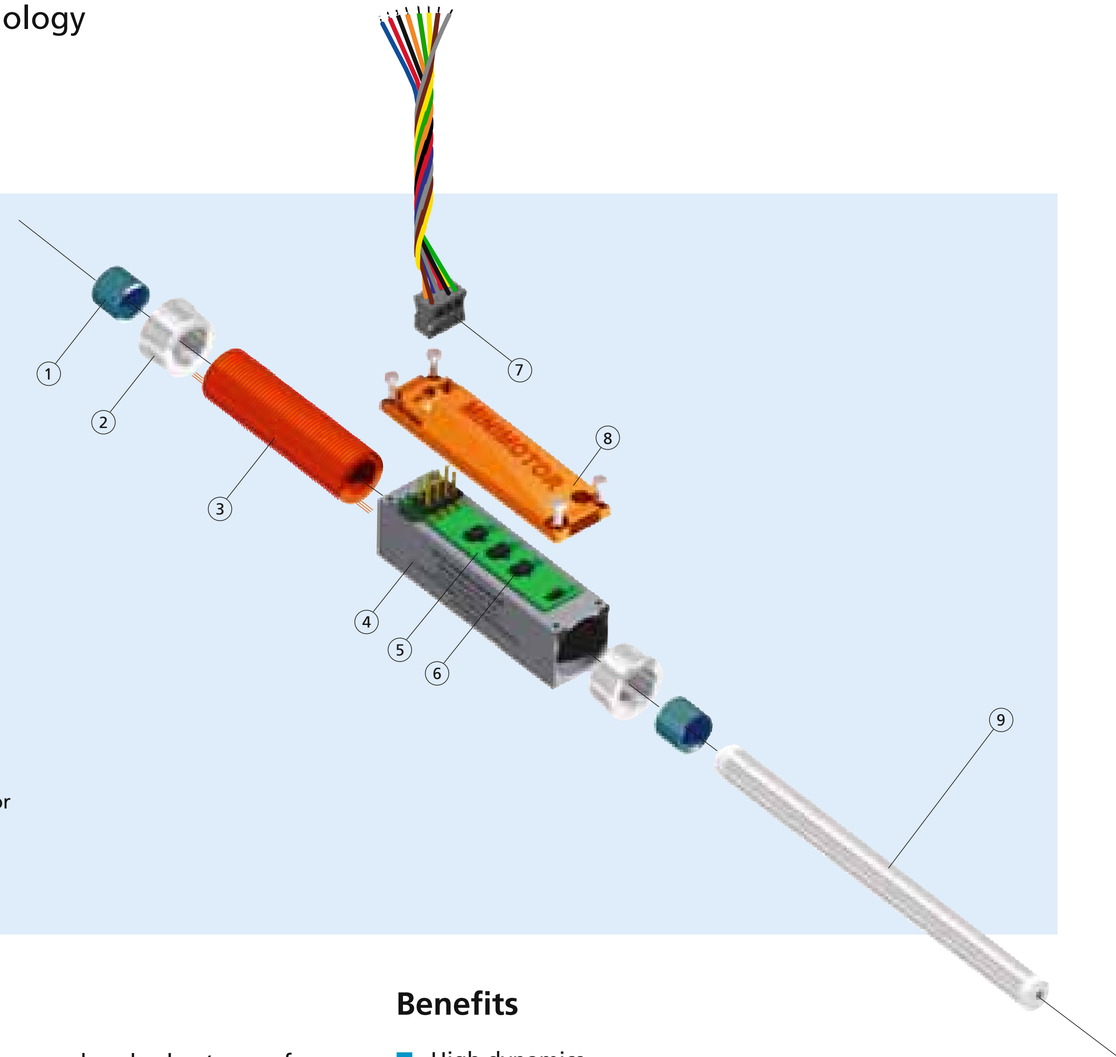
The graph shows that the max. achievable speed (◆) without external forces, but with a load of 0,5 kg is 0,31 m/s.

Therefore, the maximum applicable external force (◆) at a speed of 0,3 m/s is 0,5 N.

The external peak force (◆) is achieved at a speed of 0,17 m/s, corresponding to a maximum applicable external force of 2,27 N.

Linear DC-Servomotors

QUICKSHAFT© Technology



Linear DC-Servomotor

① Sleeve bearings
② Bearing support
③ Coil
④ Housing
⑤ PCB
⑥ Hall sensors
⑦ Lead wires and connector
⑧ Cover
⑨ Forcer rod

Features

QUICKSHAFT® combines the speed and robustness of a pneumatic system with the flexibility and reliability features of an electro-mechanical linear motor. The innovative design with a 3-phase self-supporting coil and non-magnetic steel housing offers outstanding performance.

The absence of residual static force and the excellent relationship between the linear force and current make these motors ideal for use in micro-positioning applications. Position control of the QUICKSHAFT® Linear DC-Servomotor is made possible by the built-in Hall sensors.

Performance lifetime of the QUICKSHAFT® Linear DC-Servomotors is mainly influenced by the wear of the sleeve bearings, which depends on operating speed and applied load of the cylinder rod.

Benefits

- High dynamics
- Excellent force to volume ratio
- No residual force present
- Non-magnetic steel housing
- Compact and robust construction
- No lubrication required
- Simple installation and configuration

Product Code

LM	Linear Motor
12	Motor width □ [mm]
47	Motor length [mm]
020	Stroke length [mm]
01	Sensors type: linear

LM1247–020–01

Linear DC-Servomotors

1,03 N

with Analog Hall Sensors
QUICKSHAFT® Technology

For combination with
Drive Electronics:
Motion Controller

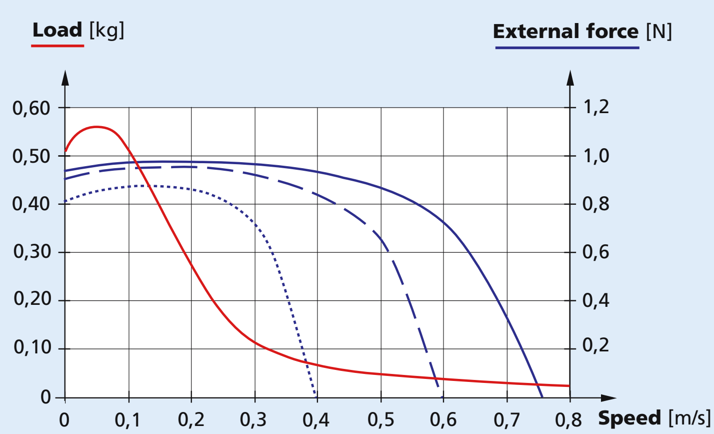
Series LM 0830 ... 01

	LM 0830–		015–01	040–01	
1 Continuous force [1]	$F_{e\ max.}$	1,03			N
2 Peak force [1] [2]	$F_{p\ max.}$	2,74			N
3 Continuous current [1]	$I_{e\ max.}$	0,53			A
4 Peak current [1] [2]	$I_{p\ max.}$	1,41			A
5 Back-EMF constant	k_E	1,58			V/m/s
6 Force constant [3]	k_F	1,94			N/A
7 Terminal resistance, phase-phase	R	7,37			Ω
8 Terminal inductance, phase-phase	L	117			µH
9 Stroke length	$s_{max.}$		15	40	mm
10 Repeatability [4]			40	40	µm
11 Precision [4]			120	140	µm
12 Acceleration [5]	$a_{e\ max.}$		206,9	147,8	m/s^2
13 Speed [5] [6]	$v_{e\ max.}$		1,8	2,4	m/s
14 Thermal resistance	$R_{th\ 1}$ / $R_{th\ 2}$	6,6 / 37,4			K/W
15 Thermal time constant	τ_{w1} / τ_{w2}	4 / 291			s
16 Operating temperature range		– 20 ... +125			°C
17 Rod weight [7]	m_m		5	7	g
18 Total weight [7]	m_t		15	17	g
19 Magnetic pitch	τ_m	12			mm
20 Rod bearings		polymer sleeves			
21 Housing material		metal, non-magnetic			
22 Direction of movement		electronically reversible			

[1] thermal resistance $R_{th\ 2}$ by 55% reduced
[2] for max. 1 second with a duty cycle of 10%
[3] with sine wave commutation
[4] typical values with integrated linear Hall sensors and Motion Controller.
The values depend on conditions of use
[5] theorical value, referring only to the motor
[6] with a triangular speed profile and the max. stroke
[7] rounded value, for reference only

Notes: These motors are for operation with DC-voltage < 50 V DC.
The given values are for free standing motors.
The mounting with magnetic conductive metal can influence the characteristics of the motor.

Caution: Presence of strong magnetic fields. Static sensitive device.



LM 0830–015–01

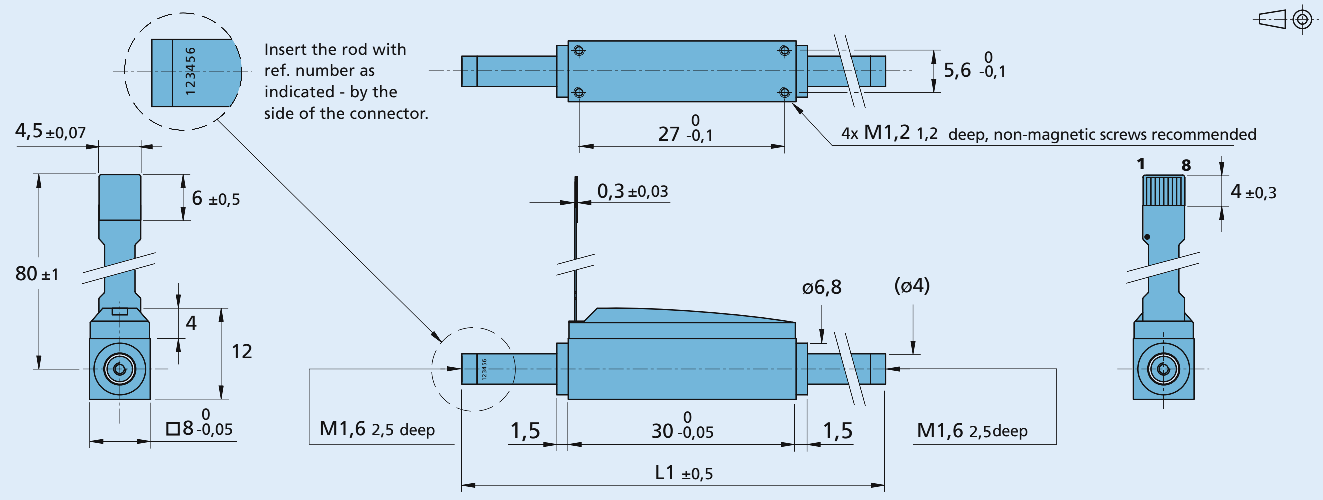
Trapezoidal motion profile (t1 = t2 = t3)

Displacement distance:	15 mm
Friction coefficient:	0,2
Slope angle:	0°
Rest time:	0,1 s

Load: The max. permissible load at a given speed with an external force of 0 N

External force: The max. permissible external force at a given speed with a load of:
- 0,035 Kg
- 0,05 Kg
- 0,1 Kg

Linear DC-Servomotor LM 0830



Ordering information

Linear DC-Servomotors Series	**Stroke** mm	**Rod length** L1 ±0,5 mm
LM 0830–015–01	–7,5 … 0 … +7,5	58
LM 0830–040–01	–20 … 0 … +20	82

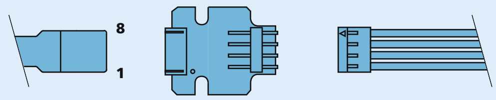
Note: Single rod available on request.

Options

- Flexboard adapter (part no. L08.90.02), size 18 x 23 x 6 mm
- Cable with connector (part no. L12.09.01), 200 mm length ± 10 mm, 8 conductors

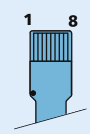
Cable and connection information

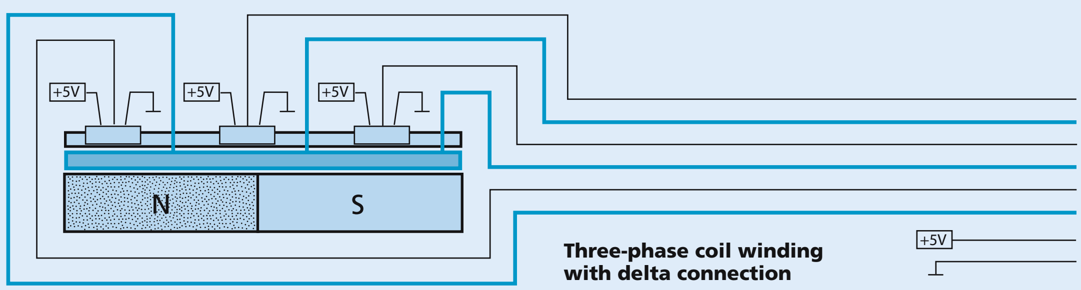
Motor flexboard | **Flexboard adapter** | **Cable for connection with Motion Controller**



Recommended connector
Molex - ZIF connector, Nr. 52746

Flexboard
8 circuits; 0,5mm pitch





Connection

No.	Function
6	Hall sensor C
1	Phase C
7	Hall sensor B
2	Phase B
8	Hall sensor A
3	Phase A
5	+5V
4	GND

Linear DC-Servomotors

with Analog Hall Sensors
QUICKSHAFT® Technology

3,6 N

For combination with
Drive Electronics:
Motion Controller

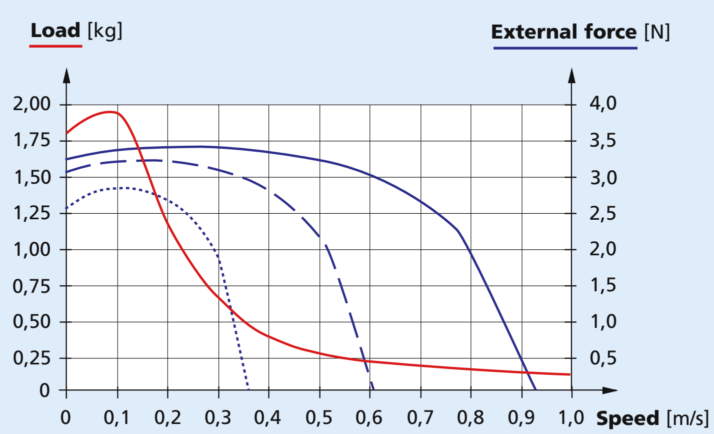
Series LM 1247 ... 01

	LM 1247–	020–01	040–01	060–01	080–01	100–01	120–01	
1 Continuous force [1]	$F_{e\,max.}$	3,6						N
2 Peak force [1] [2]	$F_{p\,max.}$	10,7						N
3 Continuous current [1]	$I_{e\,max.}$	0,55						A
4 Peak current [1] [2]	$I_{p\,max.}$	1,66						A
5 Back-EMF constant	k_E	5,25						V/m/s
6 Force constant [3]	k_F	6,43						N/A
7 Terminal resistance, phase-phase	R	13,17						Ω
8 Terminal inductance, phase-phase	L	820						µH
9 Stroke length	$s_{max.}$	20	40	60	80	100	120	mm
10 Repeatability [4]		40	40	40	40	40	40	µm
11 Precision [4]		120	140	160	180	200	220	µm
12 Acceleration [5]	$a_{e\,max.}$	198,0	148,5	127,3	101,8	91,4	82,9	m/s²
13 Speed [5] [6]	$v_{e\,max.}$	2,0	2,4	2,8	2,9	3,0	3,2	m/s
14 Thermal resistance	$R_{th\,1}$ / $R_{th\,2}$	3,2 / 20,0						K/W
15 Thermal time constant	τ_{w1} / τ_{w2}	11 / 624						s
16 Operating temperature range		– 20 ... +125						°C
17 Rod weight [7]	m_m	18	24	28	35	39	43	g
18 Total weight [7] [8]	m_t	57	63	67	74	78	82	g
19 Magnetic pitch	τ_m	18						mm
20 Rod bearings		polymer sleeves						
21 Housing material		metal, non-magnetic						
22 Direction of movement		electronically reversible						

[1] thermal resistance $R_{th\,2}$ by 55% reduced
[2] for max. 1 second with a duty cycle of 10%
[3] with sine wave commutation
[4] typical values with integrated linear Hall sensors and Motion Controller. The values depend on conditions of use
[5] theorical value, referring only to the motor
[6] with a triangular speed profile and the max. stroke
[7] rounded value, for reference only
[8] LM 1247 ... 11-C with axial connection has an additional weight of 6 g.

Notes: These motors are for operation with DC-voltage < 75 V DC.
The given values are for free standing motors.
The mounting with magnetic conductive metal can influence the characteristics of the motor.

Caution: Presence of strong magnetic fields. Static sensitive device.



LM 1247–020–01

Trapezoidal motion profile (t1 = t2 = t3)

Displacement distance:	20 mm
Friction coefficient:	0,2
Slope angle:	0°
Rest time:	0,1 s

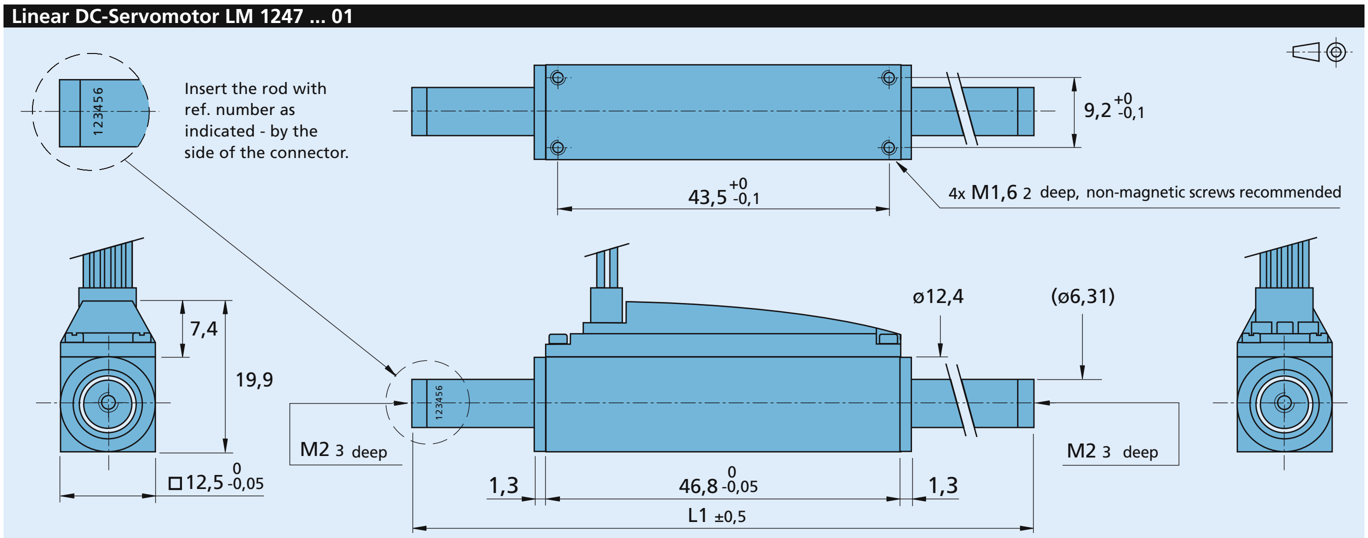
Load: The max. permissible load at a given speed with an external force of 0 N

External force: The max. permissible external force at a given speed with a load of:

- 0,1 Kg
- 0,2 Kg
- 0,5 Kg

Linear DC-Servomotors

Linear DC-Servomotor LM 1247 ... 01

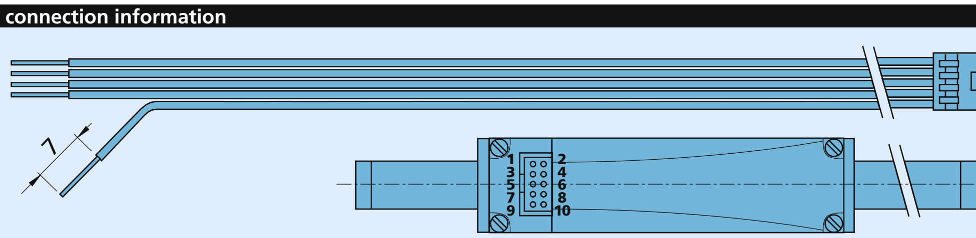


Ordering information

Linear DC-Servomotors Series	Stroke mm	Rod length L1 ±0,5 mm
LM 1247–020–01	– 10 … +10	82
LM 1247–040–01	– 20 … +20	109
LM 1247–060–01	– 30 … +30	127
LM 1247–080–01	– 40 … +40	154
LM 1247–100–01	– 50 … +50	172
LM 1247–120–01	– 60 … +60	190

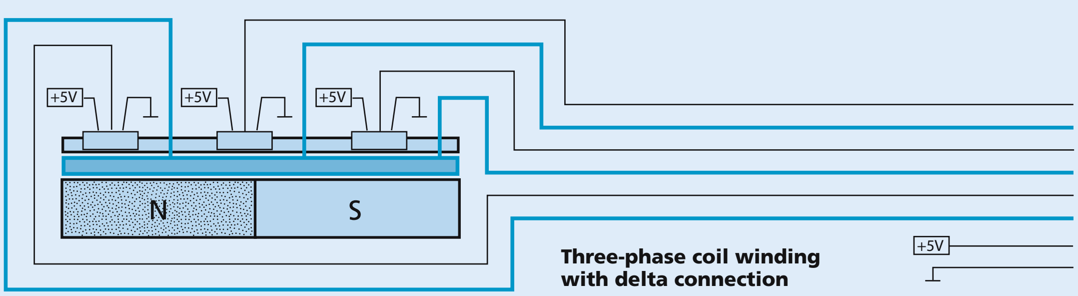
Note: Single rod available on request.

Cable and connection information



Cable
Single wires, material PVC
Length 200 mm ± 10 mm
10 conductors, AWG 28

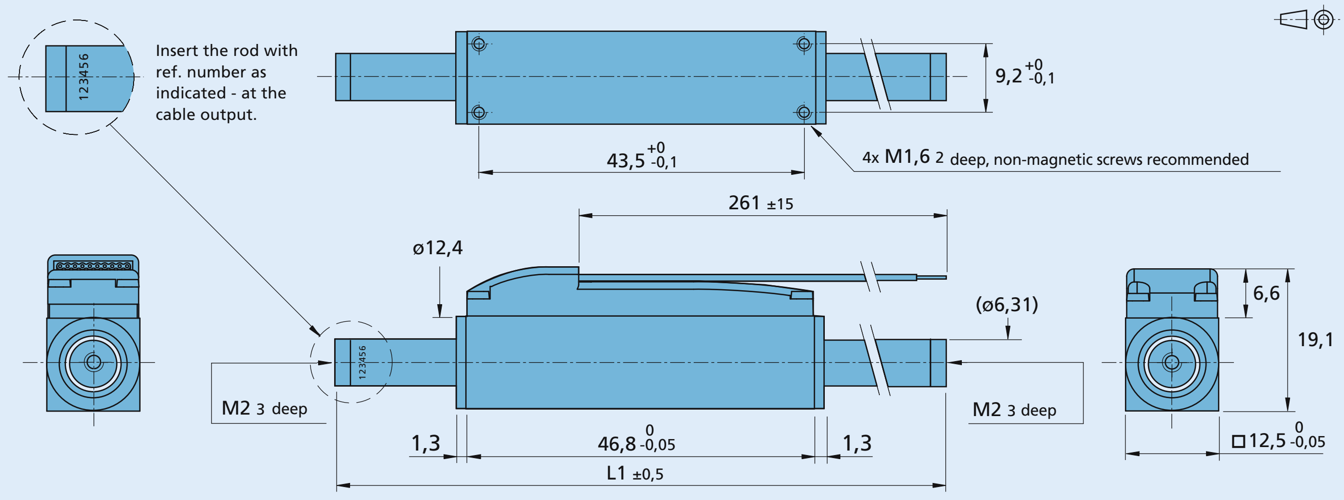
Recommended connector
Molex - Nr. 51110-1060



Connection

PIN	Function	Colour
10	N.C.	purple
9	N.C.	white
6	Hall sensor C	grey
1	Phase C	yellow
5	Hall sensor B	blue
7	Phase B	orange
2	Hall sensor A	green
8	Phase A	brown
3	+5V	red
4	GND	black

Linear DC-Servomotor LM 1247 ... 11 with axial connection



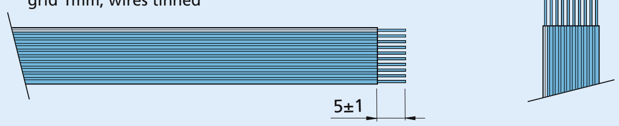
Ordering information

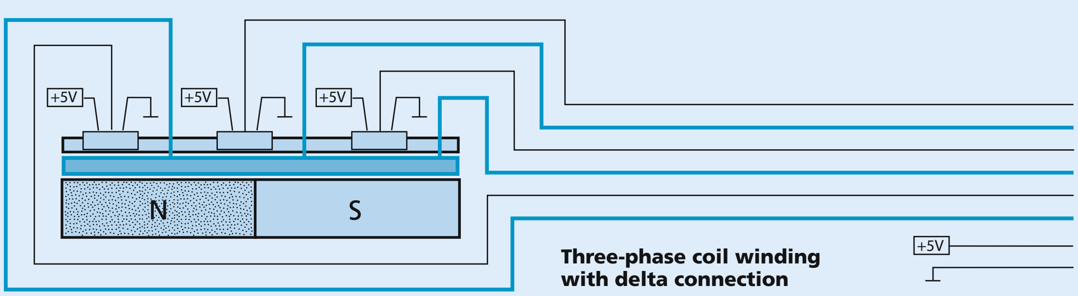
Linear DC-Servomotors Series	Stroke mm	Rod length L1 ±0,5 mm
LM 1247–020–11	– 10 … +10	82
LM 1247–040–11	– 20 … +20	109
LM 1247–060–11	– 30 … +30	127
LM 1247–080–11	– 40 … +40	154
LM 1247–100–11	– 50 … +50	172
LM 1247–120–11	– 60 … +60	190

Note: Single rod available on request.

Cable and connection information

Cable
Material PVC, 10 conductors, AWG 28, grid 1mm, wires tinned

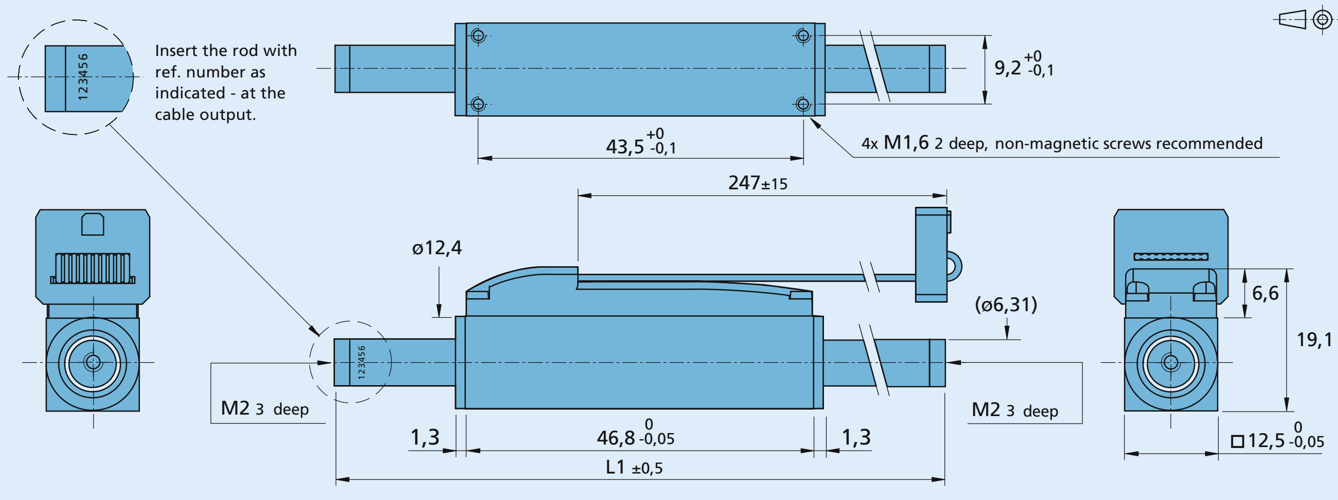




Connection

PIN	Function
10	N.C.
9	N.C.
6	Hall sensor C
1	Phase C
7	Hall sensor B
2	Phase B
8	Hall sensor A
3	Phase A
5	+5V
4	GND

Linear DC-Servomotor LM 1247 ... 11-C with axial connection and connector



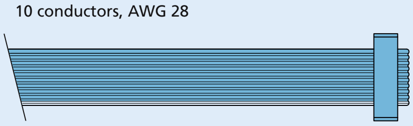
Ordering information

Linear DC-Servomotors Series	Stroke mm	Rod length L1 ±0,5 mm
LM 1247-020-11-C	–10 … +10	82
LM 1247-040-11-C	–20 … +20	109
LM 1247-060-11-C	–30 … +30	127
LM 1247-080-11-C	–40 … +40	154
LM 1247-100-11-C	–50 … +50	172
LM 1247-120-11-C	–60 … +60	190

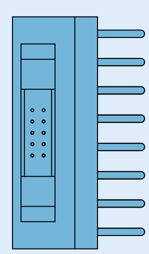
Note: Single rod available on request.

Cable and connection information

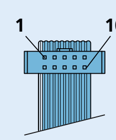
Cable
Material PVC
10 conductors, AWG 28



Adapter
size 41x15x22 mm,
for connection with
Motion Controllers:
- **MCLM 3006 S RS/CF** (part no. L12.90.02).

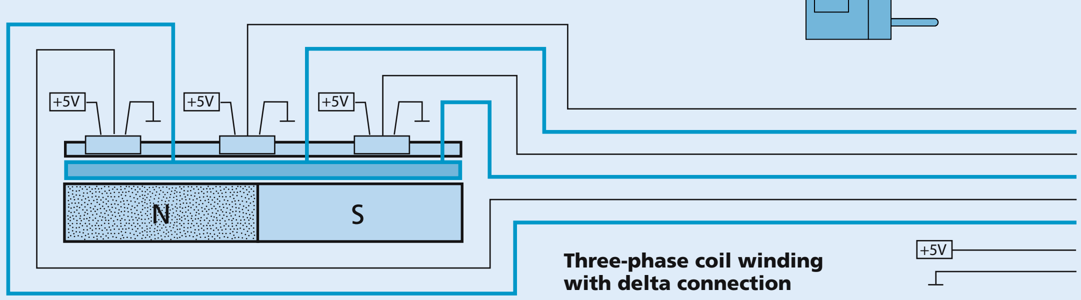


Connector
A05a - TCO, pitch 2 mm



Connection

PIN	Function
10	N.C.
9	N.C.
6	Hall sensor C
1	Phase C
7	Hall sensor B
2	Phase B
8	Hall sensor A
3	Phase A
5	+5V
4	GND



Three-phase coil winding with delta connection

Linear DC-Servomotors

3,6 N

for sin/cos control
QUICKSHAFT® Technology

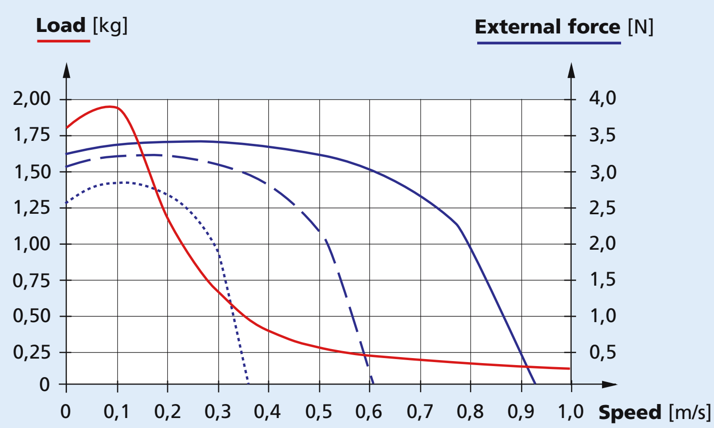
Series LM 1247 ... 02

		LM 1247–	020–02	040–02	060–02	080–02	100–02	120–02	
1	Continuous force [1]	$F_{e\ max.}$	3,6						N
2	Peak force [1,2]	$F_{p\ max.}$	10,7						N
3	Continuous current [1]	$I_{e\ max.}$	0,55						A
4	Peak current [1,2]	$I_{p\ max.}$	1,66						A
5	Back-EMF constant	k_E	5,25						V/m/s
6	Force constant [3]	k_F	6,43						N/A
7	Terminal resistance, phase-phase	R	13,17						Ω
8	Terminal inductance, phase-phase	L	820						µH
9	Stroke length	$s_{max.}$	20	40	60	80	100	120	mm
10	Repeatability [4]		80	80	80	80	80	80	µm
11	Precision [4]		200	220	240	260	280	300	µm
12	Acceleration [5]	$a_{e\ max.}$	198,0	148,5	127,3	101,8	91,4	82,9	m/s²
13	Speed [5,6]	$v_{e\ max.}$	2,0	2,4	2,8	2,9	3,0	3,2	m/s
14	Thermal resistance	$R_{th\ 1}$ / $R_{th\ 2}$	3,2 / 20,0						K/W
15	Thermal time constant	τ_{w1} / τ_{w2}	11 / 624						s
16	Operating temperature range		– 20 ... +125						°C
17	Rod weight [7]	m_m	18	24	28	35	39	43	g
18	Total weight [7,8]	m_t	57	63	67	74	78	82	g
19	Magnetic pitch	τ_m	18						mm
20	Rod bearings		polymer sleeves						
21	Housing material		metal, non-magnetic						
22	Direction of movement		electronically reversible						

1) thermal resistance $R_{th\ 2}$ by 55% reduced
2) for max. 1 second with a duty cycle of 10%
3) with sine wave commutation
4) typical values with integrated linear Hall sensors (sin/cos) and Motion Controller Elmo "Whistle" SOL-WHI2.5/60I01. The values depend on conditions of use
5) theorical value, referring only to the motor
6) with a triangular speed profile and the max. stroke
7) rounded value, for reference only
8) LM 1247 ... 12 with axial connection has an additional weight of 5 g.

Notes: These motors are for operation with DC-voltage < 75 V DC.
The given values are for free standing motors.
The mounting with magnetic conductive metal can influence the characteristics of the motor.
For more information about drive electronics, please contact your local sales representative.

Caution: Presence of strong magnetic fields. Static sensitive device.



LM 1247–020–02

Trapezoidal motion profile (t1 = t2 = t3)

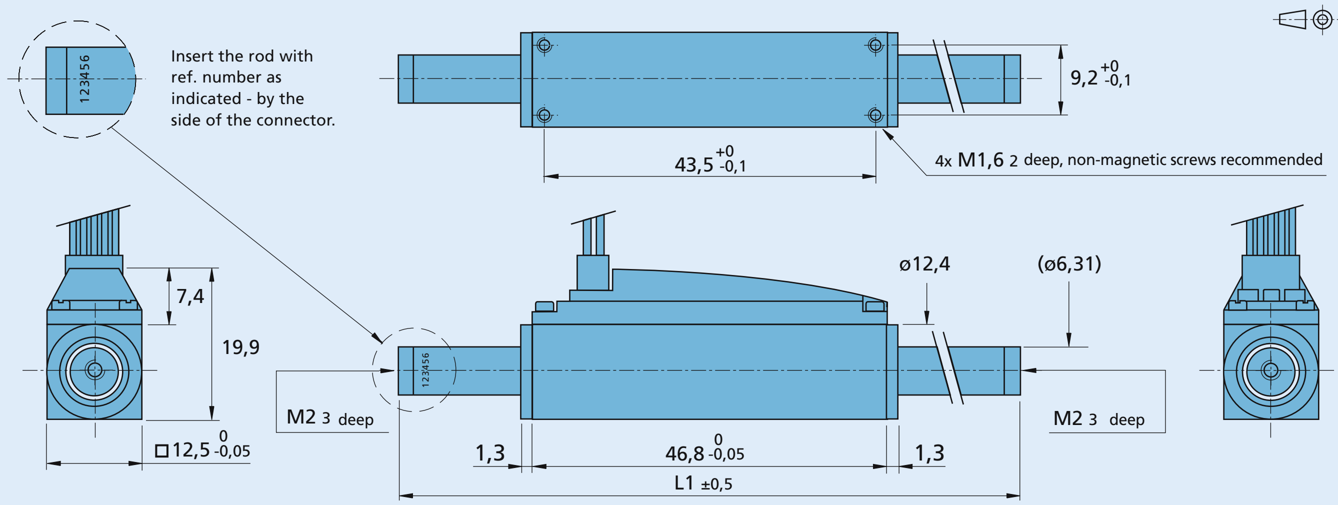
Displacement distance:	20 mm
Friction coefficient:	0,2
Slope angle:	0°
Rest time:	0,1 s

Load: The max. permissible load at a given speed with an external force of 0 N

External force: The max. permissible external force at a given speed with a load of:

- 0,1 Kg
- 0,2 Kg
- 0,5 Kg

Linear DC-Servomotor LM 1247 ... 02

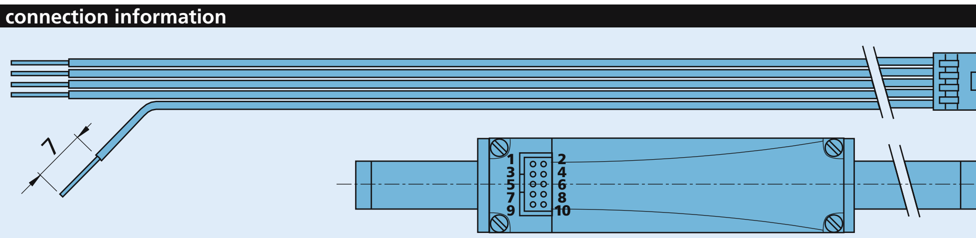


Ordering information

Linear DC-Servomotors Series	Stroke mm	Rod length L1 ±0,5 mm
LM 1247–020–02	–10 … +10	82
LM 1247–040–02	–20 … +20	109
LM 1247–060–02	–30 … +30	127
LM 1247–080–02	–40 … +40	154
LM 1247–100–02	–50 … +50	172
LM 1247–120–02	–60 … +60	190

Note: Single rod available on request.

Cable and connection information

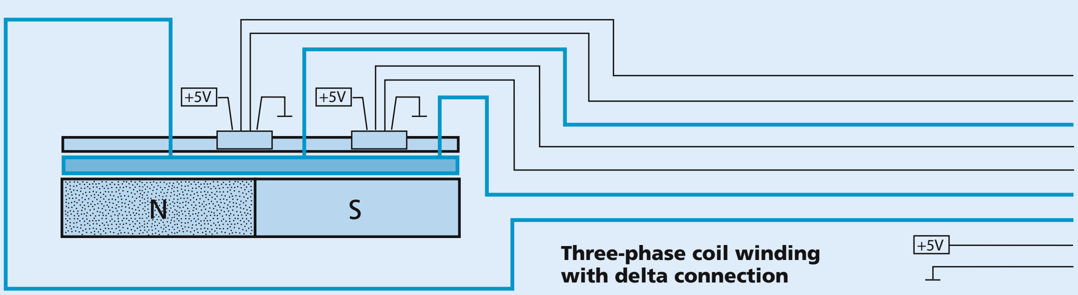


Cable
Single wires, material PVC
Length 200 mm ± 10 mm
10 conductors, AWG 28

Recommended connector
Molex - Nr. 51110-1060

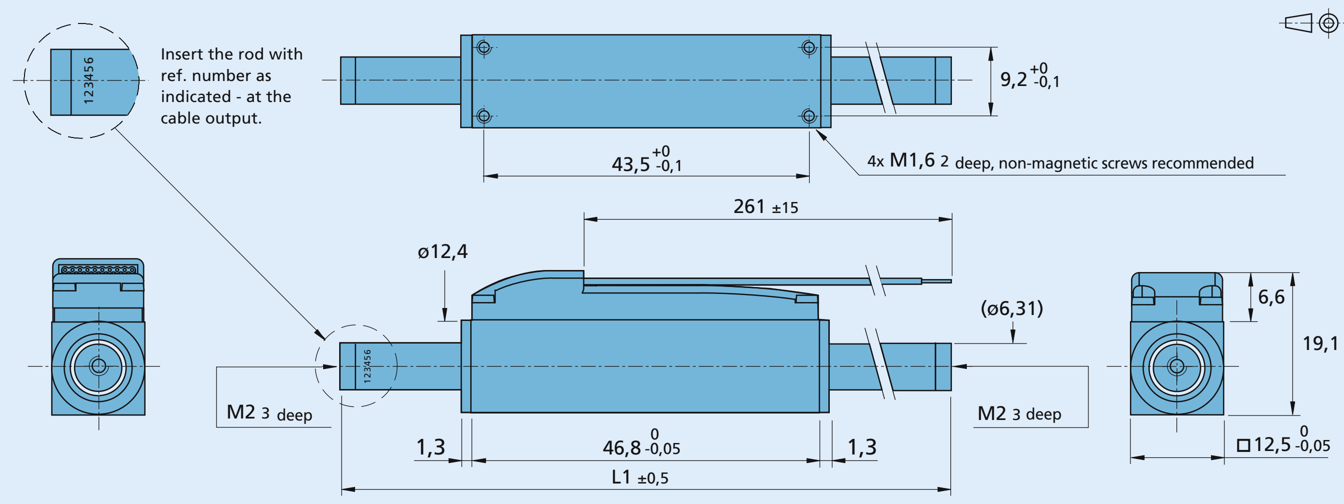
Connection

PIN	Function	Colour
10	N.C.	purple
2	Sin +	green
5	Sin -	blue
8	Phase A	brown
6	Cos +	grey
9	Cos -	white
7	Phase B	orange
1	Phase C	yellow
3	+5V	red
4	GND	black



Three-phase coil winding with delta connection

Linear DC-Servomotor LM 1247 ... 12 with axial connection



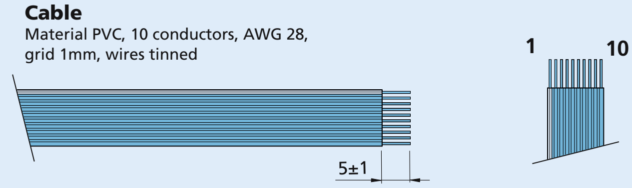
Ordering information

Linear DC-Servomotors Series	Stroke mm	Rod length L1 ±0,5 mm
LM 1247–020–12	–10 … +10	82
LM 1247–040–12	–20 … +20	109
LM 1247–060–12	–30 … +30	127
LM 1247–080–12	–40 … +40	154
LM 1247–100–12	–50 … +50	172
LM 1247–120–12	–60 … +60	190

Note: Single rod available on request.

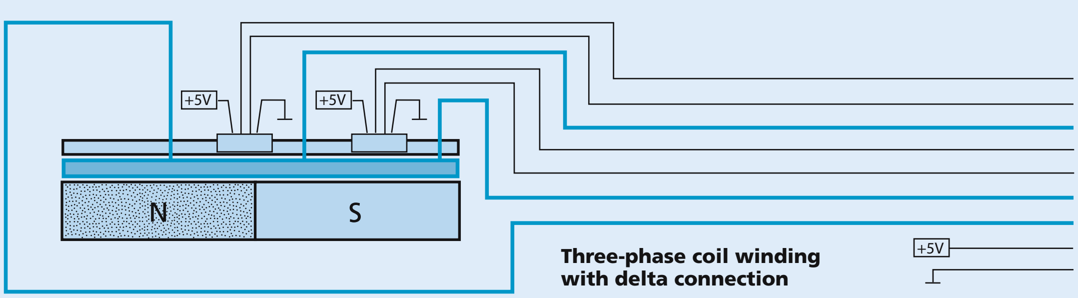
Cable and connection information

Cable
Material PVC, 10 conductors, AWG 28,
grid 1mm, wires tinned

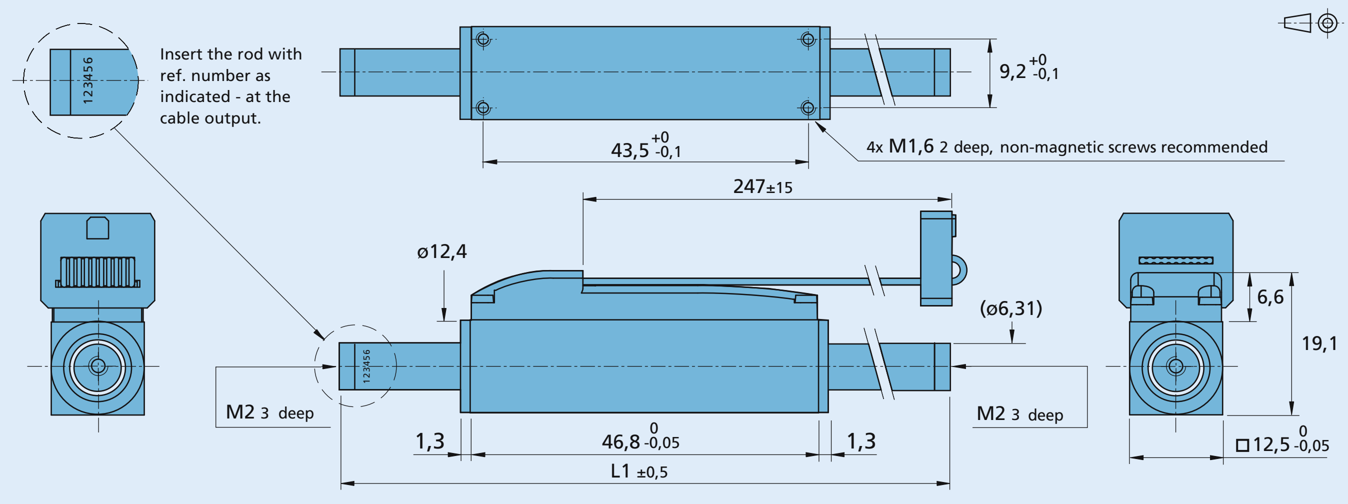


Connection

PIN	Function
10	N.C.
6	Sin +
7	Sin -
3	Phase A
8	Cos +
9	Cos -
2	Phase B
1	Phase C
5	+5V
4	GND



Linear DC-Servomotor LM 1247 ... 12-C with axial connection and connector



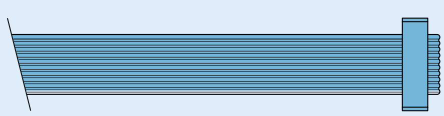
Ordering information

Linear DC-Servomotors Series	Stroke mm	Rod length L1 ±0,5 mm
LM 1247-020-12-C	–10 … +10	82
LM 1247-040-12-C	–20 … +20	109
LM 1247-060-12-C	–30 … +30	127
LM 1247-080-12-C	–40 … +40	154
LM 1247-100-12-C	–50 … +50	172
LM 1247-120-12-C	–60 … +60	190

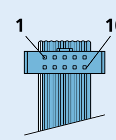
Note: Single rod available on request.

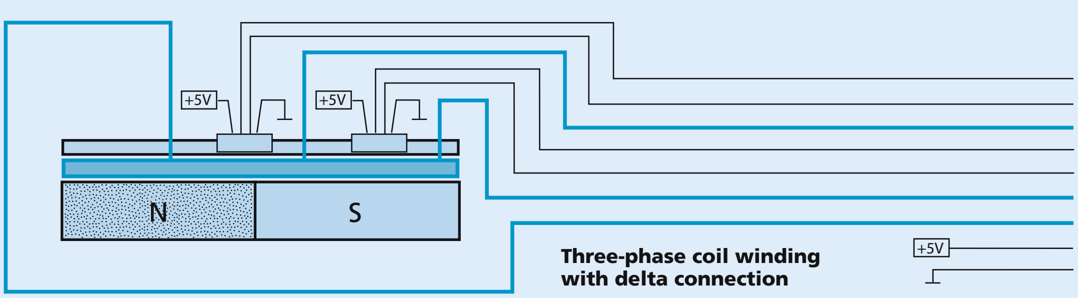
Cable and connection information

Cable
Material PVC
10 conductors, AWG 28



Connector
A05a - TCO, pitch 2 mm





Three-phase coil winding with delta connection

Connection

PIN	Function
10	N.C.
6	Sin +
7	Sin -
3	Phase A
8	Cos +
9	Cos -
2	Phase B
1	Phase C
5	+5V
4	GND

Linear DC-Servomotors

with Analog Hall Sensors
QUICKSHAFT® Technology

9,2 N

For combination with
Drive Electronics:
Motion Controller

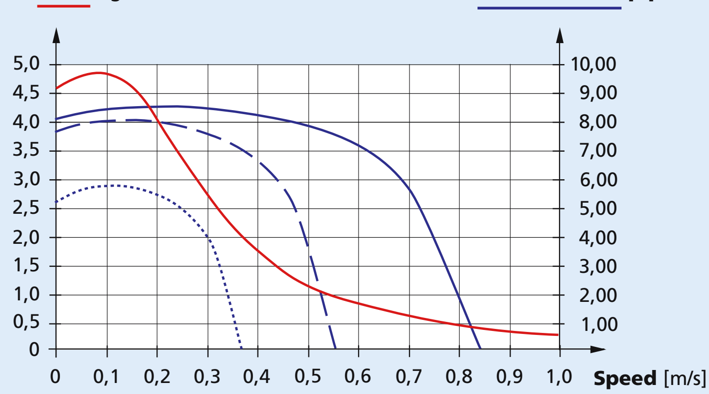
Series LM 2070 ... 01

		LM 2070–	040–01	080–01	120–01	160–01	220–01	
1	Continuous force [1]	$F_{e\ max.}$	9,2					N
2	Peak force [1] [2]	$F_{p\ max.}$	27,6					N
3	Continuous current [1]	$I_{e\ max.}$	0,79					A
4	Peak current [1] [2]	$I_{p\ max.}$	2,37					A
5	Back-EMF constant	k_E	9,5					V/m/s
6	Force constant [3]	k_F	11,64					N/A
7	Terminal resistance, phase-phase	R	10,83					Ω
8	Terminal inductance, phase-phase	L	1 125					µH
9	Stroke length	$s_{max.}$	40	80	120	160	220	mm
10	Repeatability [4]		60	60	60	60	80	µm
11	Precision [4]		200	300	400	500	600	µm
12	Acceleration [5]	$a_{e\ max.}$	93,9	65,7	54,8	46,0	36,8	m/s^2
13	Speed [5] [6]	$v_{e\ max.}$	1,9	2,3	2,6	2,7	2,8	m/s
14	Thermal resistance	$R_{th\ 1}$ / $R_{th\ 2}$	3,1 / 9,3					K/W
15	Thermal time constant	τ_{w1} / τ_{w2}	30 / 1 200					s
16	Operating temperature range		– 20 ... +125					°C
17	Rod weight [7]	m_m	98	140	168	200	250	g
18	Total weight [7] [8]	m_t	236	278	306	338	388	g
19	Magnetic pitch	τ_m	24					mm
20	Rod bearings		polymer sleeves					
21	Housing material		metal, non-magnetic					
22	Direction of movement		electronically reversible					

[1] thermal resistance $R_{th\ 2}$ by 55% reduced
[2] for max. 1 second with a duty cycle of 10%
[3] with sine wave commutation
[4] typical values with integrated linear Hall sensors and Motion Controller. The values depend on conditions of use
[5] theorical value, referring only to the motor
[6] with a triangular speed profile and the max. stroke
[7] rounded value, for reference only
[8] LM 2070 ... 11-C with axial connection has an additional weight of 4 g.

Notes: These motors are for operation with DC-voltage < 75 V DC.
The given values are for free standing motors.
The mounting with magnetic conductive metal can influence the characteristics of the motor.

Caution: Presence of strong magnetic fields. Static sensitive device.



LM 2070–040–01

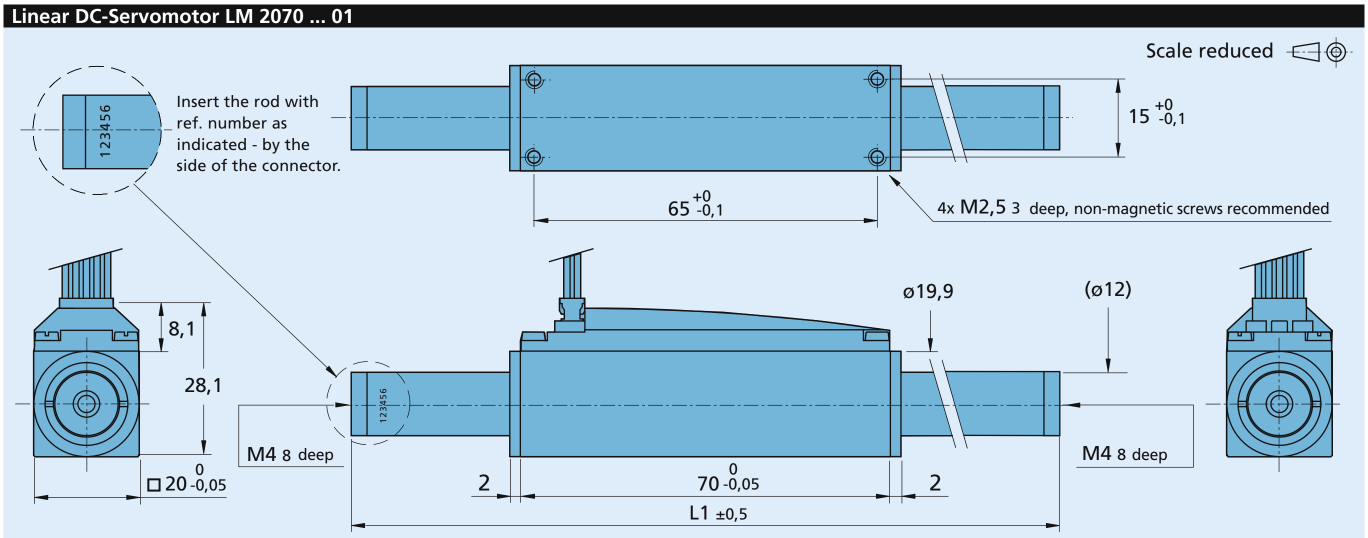
Trapezoidal motion profile (t1 = t2 = t3)

Displacement distance:	40 mm
Friction coefficient:	0,2
Slope angle:	0°
Rest time:	0,1 s

Load: The max. permissible load at a given speed with an external force of 0 N

External force: The max. permissible external force at a given speed with a load of:
- 0,5 Kg
- 1,0 Kg
- 2,0 Kg

Linear DC-Servomotor LM 2070 ... 01

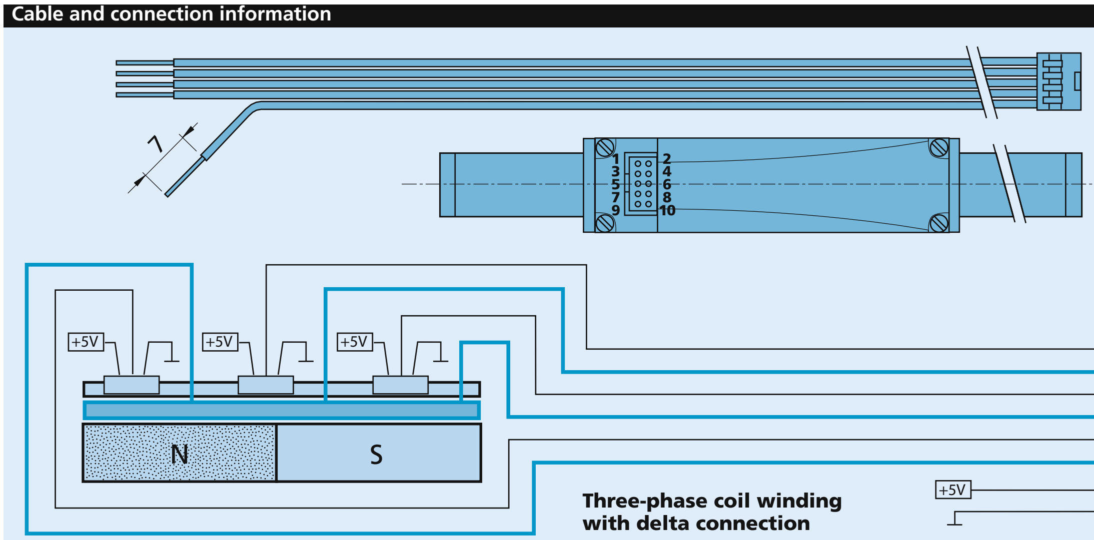


Ordering information

Linear DC-Servomotors Series	Stroke mm		Rod length L1 ±0,5 mm
LM 2070-040-01	- 20	+ 20	134
LM 2070-080-01	- 40	+ 40	182
LM 2070-120-01	- 60	+ 60	218
LM 2070-160-01	- 80	+ 80	254
LM 2070-220-01	- 110	+ 110	314

Note: Single rod available on request.

Cable and connection information



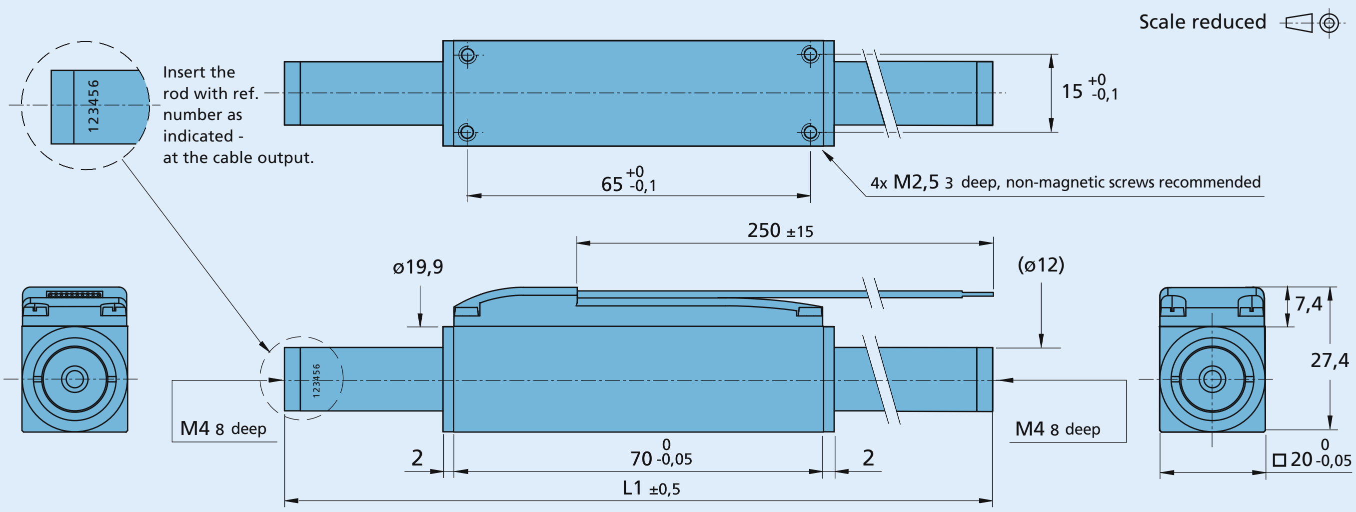
Cable
Single wires, material PVC
Length 200 mm ± 10 mm
10 conductors, AWG 28

Recommended connector
Molex - Nr. 51110-1060

Connection

PIN	Function	Colour
10	N.C.	purple
9	N.C.	white
6	Hall sensor C	grey
1	Phase C	yellow
5	Hall sensor B	blue
7	Phase B	orange
2	Hall sensor A	green
8	Phase A	brown
3	+5V	red
4	GND	black

Linear DC-Servomotor LM 2070 ... 11 with axial connection



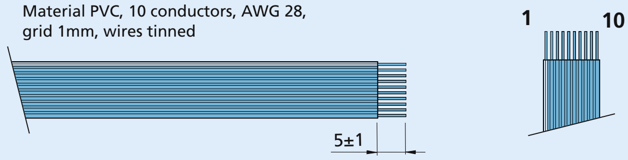
Ordering information

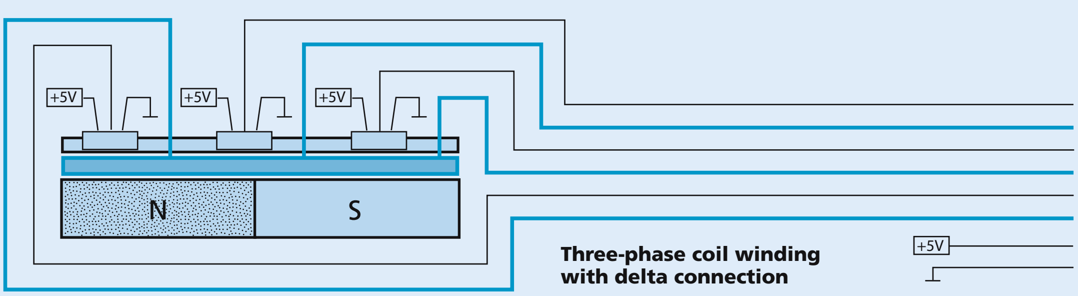
Linear DC-Servomotors Series	**Stroke** mm	**Rod length** L1 ±0,5 mm
LM 2070-040-11	- 20 … + 20	134
LM 2070-080-11	- 40 … + 40	182
LM 2070-120-11	- 60 … + 60	218
LM 2070-160-11	- 80 … + 80	254
LM 2070-220-11	- 110 … + 110	314

Note: Single rod available on request.

Cable and connection information

Cable
Material PVC, 10 conductors, AWG 28, grid 1mm, wires tinned



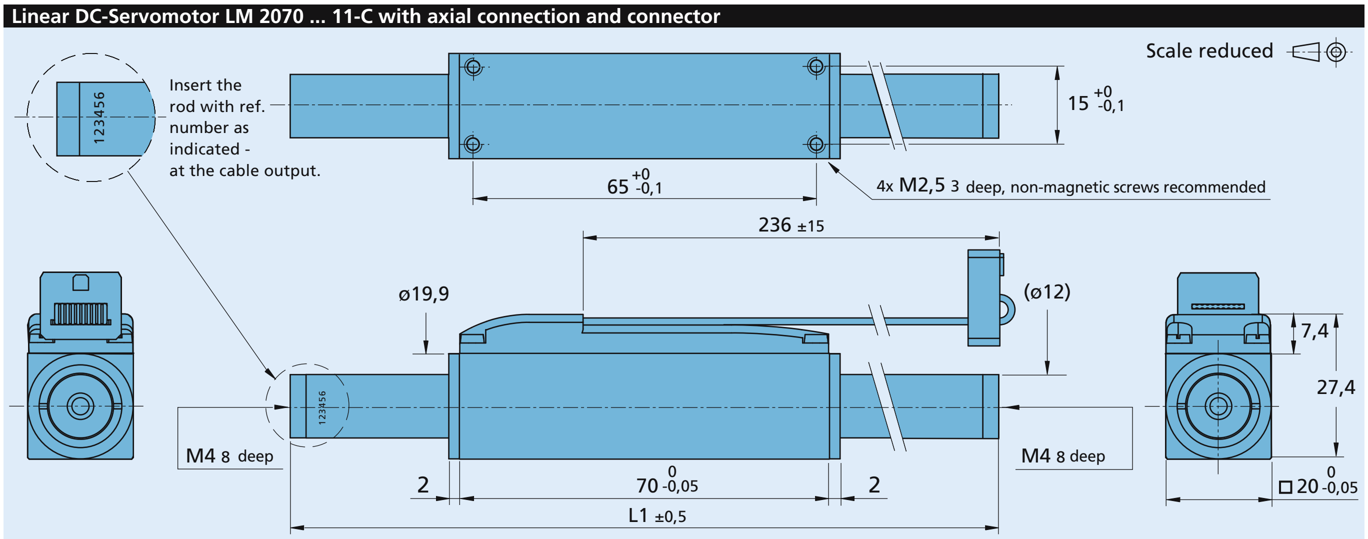


Connection

PIN	Function
10	N.C.
9	N.C.
6	Hall sensor C
1	Phase C
7	Hall sensor B
2	Phase B
8	Hall sensor A
3	Phase A
5	+5V
4	GND

For notes on technical data and lifetime performance refer to „Technical Information“.
Edition 2012 – 2013

Linear DC-Servomotor LM 2070 ... 11-C with axial connection and connector



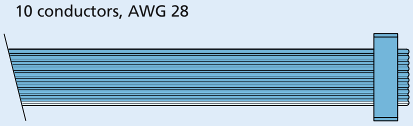
Ordering information

Linear DC-Servomotors Series	Stroke mm	Rod length L1 ±0,5 mm
LM 2070-040-11-C	- 20 … + 20	134
LM 2070-080-11-C	- 40 … + 40	182
LM 2070-120-11-C	- 60 … + 60	218
LM 2070-160-11-C	- 80 … + 80	254
LM 2070-220-11-C	- 110 … + 110	314

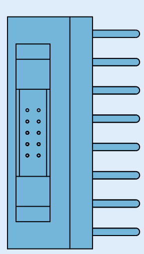
Note: Single rod available on request.

Cable and connection information

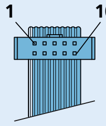
Cable
Material PVC
10 conductors, AWG 28

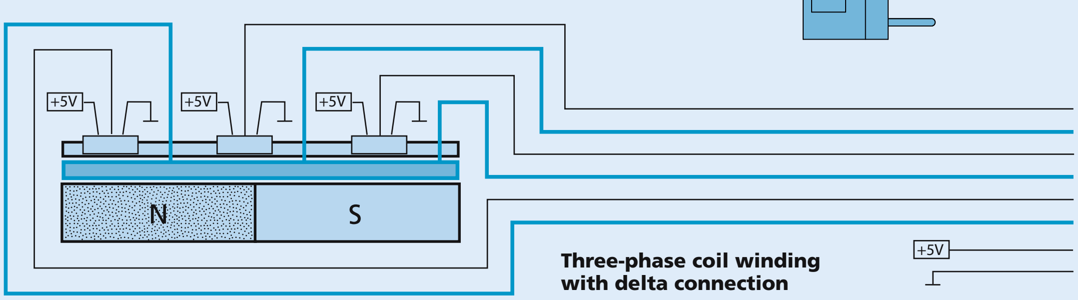


Adapter
size 41x15x22 mm,
for connection with
Motion Controllers:
- **MCLM 3006 S RS/CF** (part no. L12.90.02).



Connector
A05a - TCO, pitch 2 mm





Three-phase coil winding with delta connection

Connection

PIN	Function
10	N.C.
9	N.C.
6	Hall sensor C
1	Phase C
7	Hall sensor B
2	Phase B
8	Hall sensor A
3	Phase A
5	+5V
4	GND

Linear DC-Servomotors 9,2 N

for sin/cos control
QUICKSHAFT® Technology

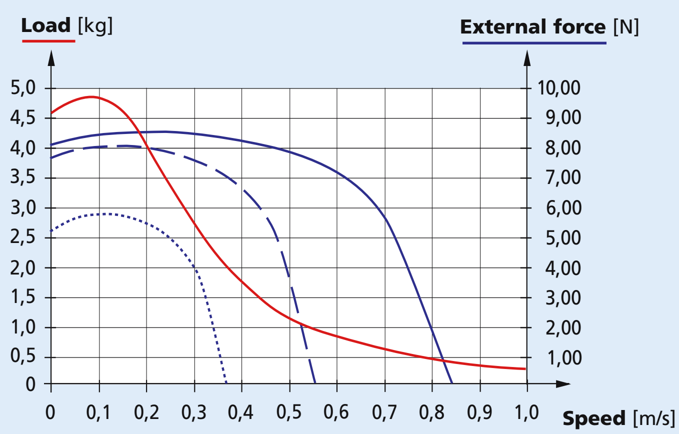
Series LM 2070 ... 02

		LM 2070–	040–02	080–02	120–02	160–02	220–02	
1	Continuous force [1]	$F_{e\ max.}$	9,2					N
2	Peak force [1) 2)]	$F_{p\ max.}$	27,6					N
3	Continuous current [1]	$I_{e\ max.}$	0,79					A
4	Peak current [1) 2)]	$I_{p\ max.}$	2,37					A
5	Back-EMF constant	k_E	9,5					V/m/s
6	Force constant [3]	k_F	11,64					N/A
7	Terminal resistance, phase-phase	R	10,83					Ω
8	Terminal inductance, phase-phase	L	1 125					µH
9	Stroke length	$s_{max.}$	40	80	120	160	220	mm
10	Repeatability [4]		100	100	100	100	120	µm
11	Precision [4]		500	600	700	800	900	µm
12	Acceleration [5]	$a_{e\ max.}$	93,9	65,7	54,8	46,0	36,8	m/s²
13	Speed [5) 6)]	$v_{e\ max.}$	1,9	2,3	2,6	2,7	2,8	m/s
14	Thermal resistance	$R_{th\ 1}$ / $R_{th\ 2}$	3,1 / 9,3					K/W
15	Thermal time constant	τ_{w1} / τ_{w2}	30 / 1 200					s
16	Operating temperature range		– 20 ... +125					°C
17	Rod weight [7]	m_m	98	140	168	200	250	g
18	Total weight [7) 8)]	m_t	236	278	306	338	388	g
19	Magnetic pitch	τ_m	24					mm
20	Rod bearings		polymer sleeves					
21	Housing material		metal, non-magnetic					
22	Direction of movement		electronically reversible					

1) thermal resistance $R_{th\ 2}$ by 55% reduced
2) for max. 1 second with a duty cycle of 10%
3) with sine wave commutation
4) typical values with integrated linear Hall sensors (sin/cos) and Motion Controller Elmo "Whistle" SOL-WHI2.5/60I01. The values depend on conditions of use
5) theorical value, referring only to the motor
6) with a triangular speed profile and the max. stroke
7) rounded value, for reference only
8) LM 2070 ... 12 with axial connection has an additional weight of 3 g.

Notes: These motors are for operation with DC-voltage < 75 V DC.
The given values are for free standing motors.
The mounting with magnetic conductive metal can influence the characteristics of the motor.
For more information about drive electronics, please contact your local sales representative.

Caution: Presence of strong magnetic fields. Static sensitive device.



LM 2070–040–02

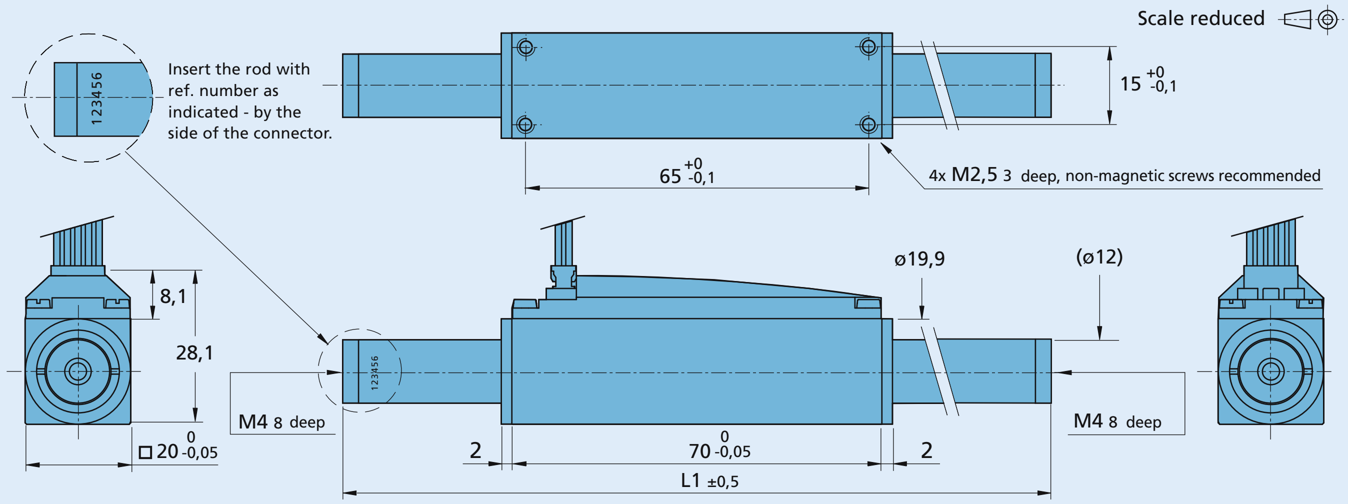
Trapezoidal motion profile (t1 = t2 = t3)

Displacement distance:	40 mm
Friction coefficient:	0,2
Slope angle:	0°
Rest time:	0,1 s

Load: The max. permissible load at a given speed with an external force of 0 N

External force: The max. permissible external force at a given speed with a load of:
- 0,5 Kg
- 1,0 Kg
- 2,0 Kg

Linear DC-Servomotor LM 2070 ... 02

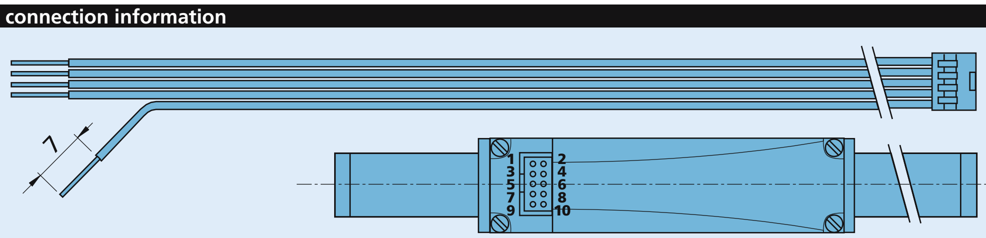


Ordering information

Linear DC-Servomotors Series	Stroke mm	Rod length L1 ±0,5 mm
LM 2070-040-02	- 20 … + 20	134
LM 2070-080-02	- 40 … + 40	182
LM 2070-120-02	- 60 … + 60	218
LM 2070-160-02	- 80 … + 80	254
LM 2070-220-02	- 110 … + 110	314

Note: Single rod available on request.

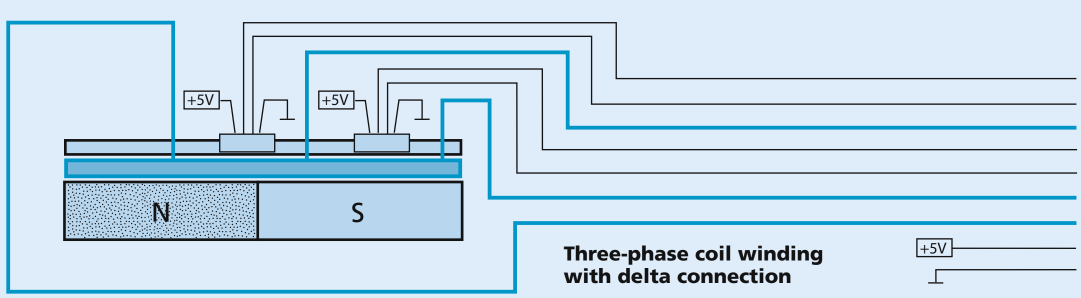
Cable and connection information



Cable
Single wires, material PVC
Length 200 mm ± 10 mm
10 conductors, AWG 28

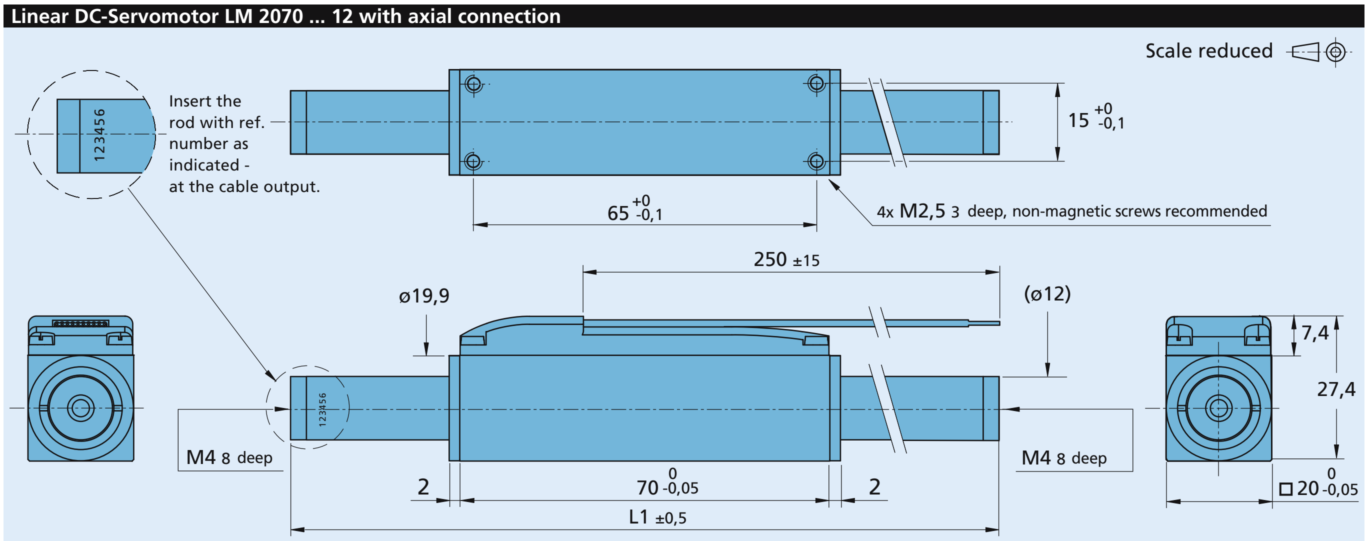
Recommended connector
Molex - Nr. 51110-1060

Connection



PIN	Function	Colour
10	N.C.	purple
2	Sin +	green
5	Sin -	blue
8	Phase A	brown
6	Cos +	grey
9	Cos -	white
7	Phase B	orange
1	Phase C	yellow
3	+5V	red
4	GND	black

Linear DC-Servomotor LM 2070 ... 12 with axial connection



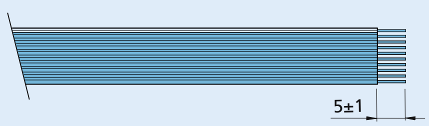
Ordering information

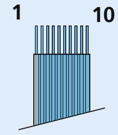
Linear DC-Servomotors Series	Stroke mm	Rod length L1 ±0,5 mm
LM 2070-040-12	- 20 … + 20	134
LM 2070-080-12	- 40 … + 40	182
LM 2070-120-12	- 60 … + 60	218
LM 2070-160-12	- 80 … + 80	254
LM 2070-220-12	- 110 … + 110	314

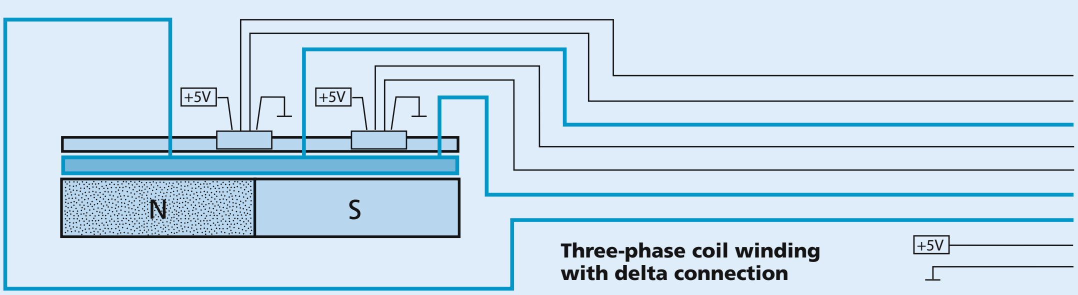
Note: Single rod available on request.

Cable and connection information

Cable
Material PVC, 10 conductors, AWG 28,
grid 1mm, wires tinned



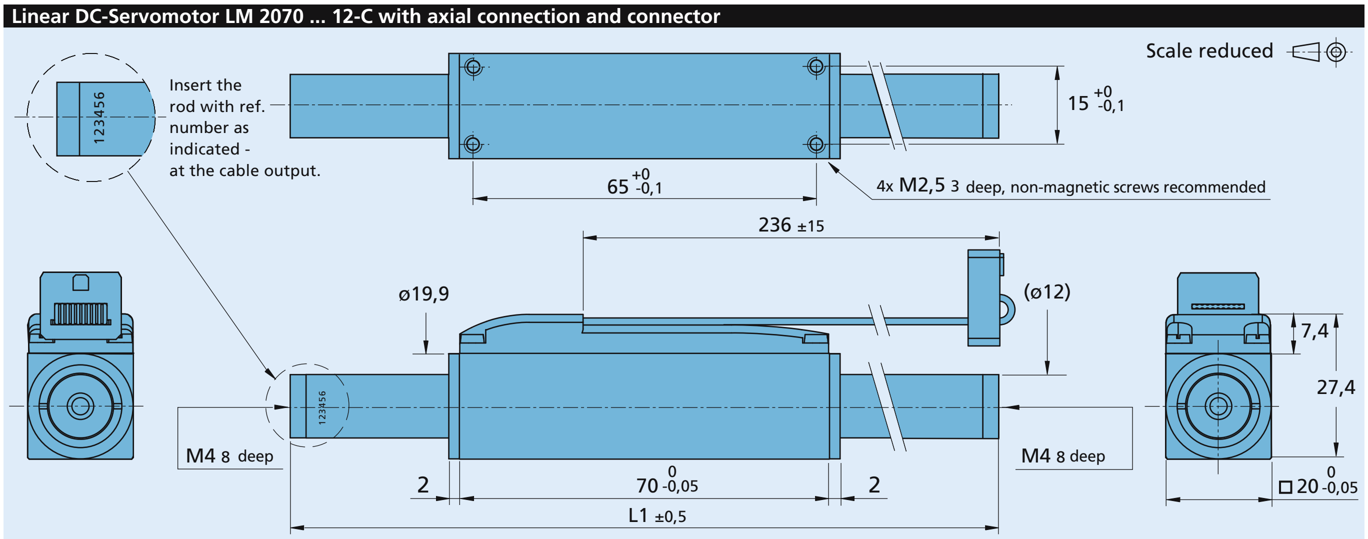




Connection

PIN	Function
10	N.C.
6	Sin +
7	Sin -
3	Phase A
8	Cos +
9	Cos -
2	Phase B
1	Phase C
5	+5V
4	GND

Linear DC-Servomotor LM 2070 ... 12-C with axial connection and connector



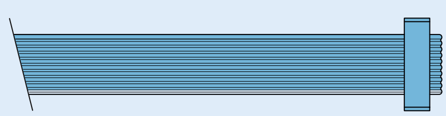
Ordering information

Linear DC-Servomotors Series	Stroke mm	Rod length L1 ±0,5 mm
LM 2070-040-12-C	- 20 … + 20	134
LM 2070-080-12-C	- 40 … + 40	182
LM 2070-120-12-C	- 60 … + 60	218
LM 2070-160-12-C	- 80 … + 80	254
LM 2070-220-12-C	- 110 … + 110	314

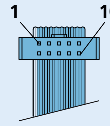
Note: Single rod available on request.

Cable and connection information

Cable
Material PVC
10 conductors, AWG 28

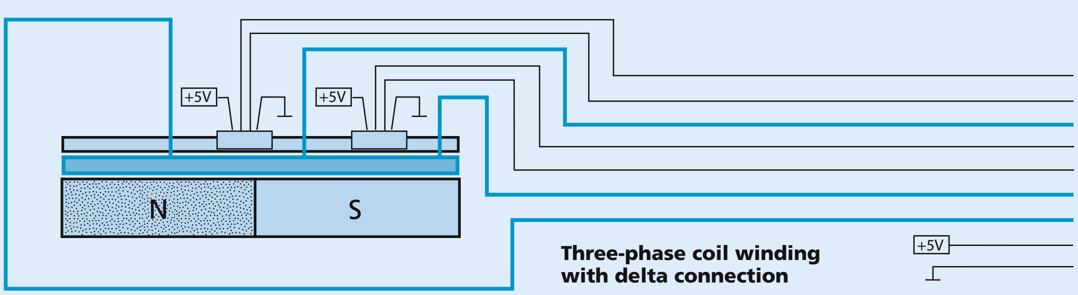


Connector
A05a - TCO, pitch 2 mm



Connection

PIN	Function
10	N.C.
6	Sin +
7	Sin -
3	Phase A
8	Cos +
9	Cos -
2	Phase B
1	Phase C
5	+5V
4	GND



Three-phase coil winding with delta connection

Precision Gearheads

WE CREATE MOTION

FAULHABER

Precision Gearheads

				Page
	06/1	Planetary Gearheads	25 mNm	294
	08/1	Planetary Gearheads	60 mNm	295
	08/2	Spur Gearheads	15 mNm	296
	08/3	Spur Gearheads, zero backlash	15 mNm	297
	10/1	Planetary Gearheads	0,1 Nm	298
	12/3	Spur Gearheads	0,03 Nm	299
	12/4	Planetary Gearheads	0,3 Nm	300
	12/5	Spur Gearheads, zero backlash	0,03 Nm	301
	13A	Planetary Gearheads	0,18 Nm	302
	14/1	Planetary Gearheads	0,3 Nm	303
	15A	Planetary Gearheads	0,25 Nm	304
	15/5	Spur Gearheads	0,1 Nm	305
	15/5 S	Spur Gearheads	0,1 Nm	306
	15/8	Spur Gearheads, zero backlash	0,1 Nm	307
	16A	Spur Gearheads	0,03 Nm	308
	16/5	Spur Gearheads	0,1 Nm	309
	16/5 S	Spur Gearheads	0,1 Nm	310
	16/7	Planetary Gearheads	0,3 Nm	311
	16/8	Spur Gearheads, zero backlash	0,1 Nm	312
	20/1	Planetary Gearheads	0,5 Nm	313
	22E	Planetary Gearheads	0,6 Nm	314
	22EKV	Planetary Gearheads	1,2 Nm	315
	22F	Planetary Gearheads	1,0 Nm	316
	22/2	Spur Gearheads	0,1 Nm	317
	22/5	Spur Gearheads, zero backlash	0,1 Nm	318
	22/7	Planetary Gearheads	0,7 Nm	319
	23/1	Planetary Gearheads	0,7 Nm	320
	26A	Planetary Gearheads	1,0 Nm	321
	26/1	Planetary Gearheads	3,5 Nm	322
	26/1 S	Planetary Gearheads	3,5 Nm	323
	30/1	Planetary Gearheads	4,5 Nm	324
	30/1 S	Planetary Gearheads	4,5 Nm	325
	32A	Planetary Gearheads	4,5 Nm	326
NEW	32ALN	Planetary Gearheads, low noise	4,5 Nm	327
	32/3	Planetary Gearheads	7,0 Nm	328
	32/3 S	Planetary Gearheads	7,0 Nm	329
	38A	Planetary Gearheads	20 Nm	330
	38/1	Planetary Gearheads	10 Nm	331
	38/1 S	Planetary Gearheads	10 Nm	332
	38/2	Planetary Gearheads	10 Nm	333
	38/2 S	Planetary Gearheads	10 Nm	334
	38/3	Spur Gearheads	1,2 Nm	335
	44/1	Planetary Gearheads	16 Nm	336

FAULHABER

WE CREATE MOTION

Precision Gearheads

Technical Information

General information

Life performance
The operational lifetime of a reduction gearhead and motor combination is determined by:

- Input speed
- Output torque
- Operating conditions
- Environment and Integration into other systems

Since a multitude of parameters prevail in any application, it is nearly impossible to state the actual lifetime that can be expected from a specific type of gearhead or motor-gearhead combination. A number of options to the standard reduction gearheads are available to increase life performance: ball bearings, all metal gears, reinforced lubrication etc.

Bearings – Lubrication
Gearheads are available with a range of bearings to meet various shaft loading requirements: sintered sleeve bearings, ball bearings and ceramic bearings. Where indicated, ball bearings are preloaded with spring washers of limited force to avoid excessive current consumption.

A higher axial shaft load or shaft pressfit force than specified in the data sheets will neutralise the preload on the ball bearings.

The satellite gears in the 38/1-2 Series Planetary Gearheads are individually supported on sintered sleeve bearings.
In the 44/1 Series, the satellite gears are individually supported on needle or ball bearings.

All bearings are lubricated for life. Relubrication is not necessary and not recommended. The use of non-approved lubricants on or around the gearheads or motors can negatively influence the function and life expectancy.

The standard lubrication of the reduction gears is such as to provide optimum life performance at minimum current consumption at no-load conditions. For extended life performance, all metal gears and heavy duty lubrication are available. Specially lubricated gearheads are available for operation at extended temperature environments and under vacuum.

Notes on technical data

Unspecified tolerances
Tolerances in accordance with ISO 2768 medium.

≤	6	=	± 0,1 mm
≤	30	=	± 0,2 mm
≤	120	=	± 0,3 mm

Input speed
The recommended maximum input speed for continuous operation serves as a guideline. It is possible to operate the gearhead at higher speeds. However, to obtain optimum life performance in applications that require continuous operation and long life, the recommended speed should be considered.

Ball bearings
Ratings on load and lifetime, if not stated, are according to the information from the ball bearing manufacturers.

Operating temperature range
Standard range as listed on the data sheets.
Special executions for extended temperature range available on request.

Reduction ratio
The listed ratios are nominal values only, the exact ratio for each reduction gearhead can be calculated by means of the stage ratio applicable for each type.

Output torque
Continuous operation.
The continuous torque provides the maximum load possible applied to the output shaft; exceeding this value will reduce the service life.

Intermittent operation.
The intermittent torque value may be applied for a short period. It should be for short intervals only and not exceed 5% of the continuous duty cycle.

Direction of rotation, reversible
All gearheads are designed for clockwise and counter-clockwise rotation. The indication refers to the direction of rotation as seen from the shaft end, with the motor running in a clockwise direction.

Backlash
Backlash is defined by the amount by which the width of a tooth space exceeds the width of the engaging tooth on the pitch circle. Backlash is not to be confused with elasticity or torsional stiffness of the system.
The general purpose of backlash is to prevent gears from jamming when making contact on both sides of their teeth simultaneously. A small amount of backlash is desirable to provide for lubricant space and differential expansion between gear components. The backlash is measured on the output shaft, at the last geartrain stage.

Precision Gearheads

Technical Information

Zero Backlash Gearheads

The spur gearheads, series 08/3, 12/5, 15/8, 16/8 and 22/5, with dual pass geartrains feature zero backlash when pre-loaded with a FAULHABER DC-Micromotor.

Preloaded gearheads result in a slight reduction in overall efficiency and load capability.

Due to manufacturing tolerances, the preloaded gear-heads could present higher and irregular internal friction torque resulting in higher and variable current consumption in the motor.

However, the unusual design of the FAULHABER zero backlash gearheads offers, with some compromise, an excellent and unique product for many low torque, high precision postioning applications.

The preloading, especially with a small reduction ratios, is very sensitive. This operation is achieved after a defined burn-in in both directions of rotation. For this reason, gearheads with pre-loaded zero backlash are only available when factory assembled to the motor.

The true zero backlash properties are maintained with new gearheads only. Depending on the application, a slight backlash could appear with usage when the gears start wearing. If the wearing is not excessive, a new preload could be considered to return to the original zero backlash properties.

Assembly instructions

It is strongly recommended to have the motors and gearheads factory assembled and tested. This will assure perfect matching and lowest current consumption.

The assembly of spur and hybrid gearheads with motors requires running the motor at very low speed to ensure the correct engagement of the gears without damage.

The planetary gearheads must not be assembled with the motor running. The motor pinion must be matched with the planetary input-stage gears to avoid misalignment before the motor is secured to the gearhead.

When face mounting any gearhead, care must be taken not to exceed the specified screw depth. Driving screws beyond this point will damage the gearhead. Gearheads with metal housing can be mounted using a radial set screw.

How to select a reduction gearhead

This section gives an example of a step-by-step procedure on how to select a reduction gearhead.

Application data

The basic data required for any given application are:

Required torque	M	[mNm]
Required speed	n	[rpm]
Duty cycle	δ	[%]
Available space, max.	diameter/length	[mm]
Shaft load	radial/axial	[N]

The assumed application data for the selected example are:

Output torque	M	=	120 mNm
Speed	n	=	30 rpm
Duty cycle	δ	=	100%
Space dimensions, max.	diameter	=	18 mm
	length	=	60 mm
Shaft load	radial	=	20 N
	axial	=	4 N

To simplify the calculation in this example, the duty cycle is assumed to be continuous operation.

Preselection

A reduction gearhead which has a continuous output torque larger than the one required in the application is selected from the catalogue.
If the required torque load is for intermittent use, the selection is based on the output torque for intermittent operation.
The shaft load, frame size and overall length with the motor must also meet the minimum requirements.
The product selected for this application is the planetary gearhead, type 16/7.

Output torque, continuous operation	$M_{max.}$	= 300 mNm
Recommended max. input speed for		
– Continuous operation	n	$\leq$ 5 000 rpm
– Shaft load, max.	radial	$\leq$ 30 N
	axial	$\leq$ 5 N

Calculation of the reduction ratio

To calculate the theoretical reduction ratio, the recommended input speed for continuous operation is divided by the required output speed.

$$i_N = \frac{\text{Recommended max. input speed}}{\text{required output speed}}$$

From the gearhead data sheet, a reduction ratio is selected which is equal to or less than the calculated one.

For this example, the reduction ratio selected is 159 : 1.

Precision Gearheads

Calculation of the input speed n_{input}

$$n_{input} = n \cdot i \qquad [rpm]$$

$$n_{input} = 30 \cdot 159 = 4\,770 \quad rpm$$

Calculation of the input torque M_{input}

$$M_{input} = \frac{M \cdot 100}{i \cdot \eta} \qquad [mNm]$$

The efficiency of this gearhead is 60%, consequently:

$$M_{input} = \frac{120 \cdot 100}{159 \cdot 60} = 1{,}26 \quad mNm$$

The values of

Input speed	n_{input}	= 4 770	rpm
and			
Input torque	M_{input}	= 1,26	mNm

are related to the motor calculation.

The motor suitable for the gearhead selected must be capable of producing at least two times the input torque needed.

For this example, the DC-Micromotor type 1624 E 024 S supplied with 14 V DC will produce the required speed and torque.

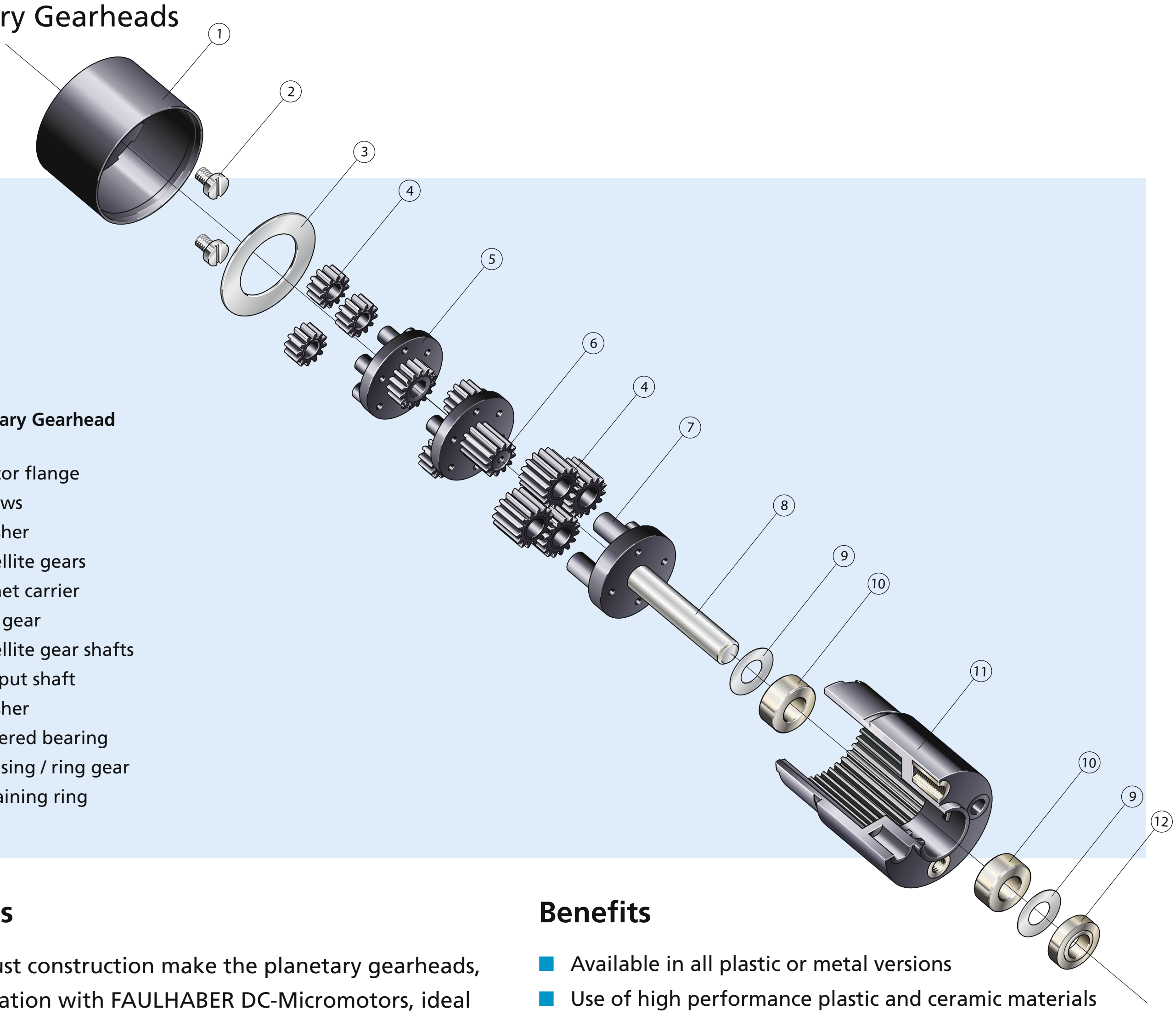
For practical applications, the calculation of the ideal motor-gearhead drive is not always possible.
Detailed values on torque and speed are usually not clearly defined.

It is recommended to select suitable components based on a first estimation, and then test the units in the application by varying the supply voltage until the required speed and torque are obtained.
Recording the applied voltage and current at the point of operation, along with the type numbers of the test assembly, we can help you to select the ideal motor-gearhead.

The success of your product will depend on the best possible selection being made!
For confirmation of your selection and peace of mind, please contact our sales engineers.

Precision Gearheads

Planetary Gearheads



Planetary Gearhead

① Motor flange
② Screws
③ Washer
④ Satellite gears
⑤ Planet carrier
⑥ Sun gear
⑦ Satellite gear shafts
⑧ Output shaft
⑨ Washer
⑩ Sintered bearing
⑪ Housing / ring gear
⑫ Retaining ring

Features

Their robust construction make the planetary gearheads, in combination with FAULHABER DC-Micromotors, ideal for high torque, high performance applications.
In most cases, the geartrain of the input stage is made of plastic to keep noise levels as low as possible at higher RPM's. All steel input gears as well as a modified lubrication are available for applications requiring very high torque, vacuum, or higher temperature compatability.

For applications requiring medium to high torque FAULHABER offers planetary gearheads constructed of high performance plastics. They are ideal solutions for applications where low weight and high torque density play a decisive role. The gearhead is mounted to the motor with a threaded flange to ensure a solid fit.

All metal planetary gearhead series 12/4

Benefits

- Available in all plastic or metal versions
- Use of high performance plastic and ceramic materials
- Available with a variety of shaft bearings including sintered, ceramic, and ball bearings
- Modified versions for extended temperature and special environmental conditions are available
- Custom modifications available

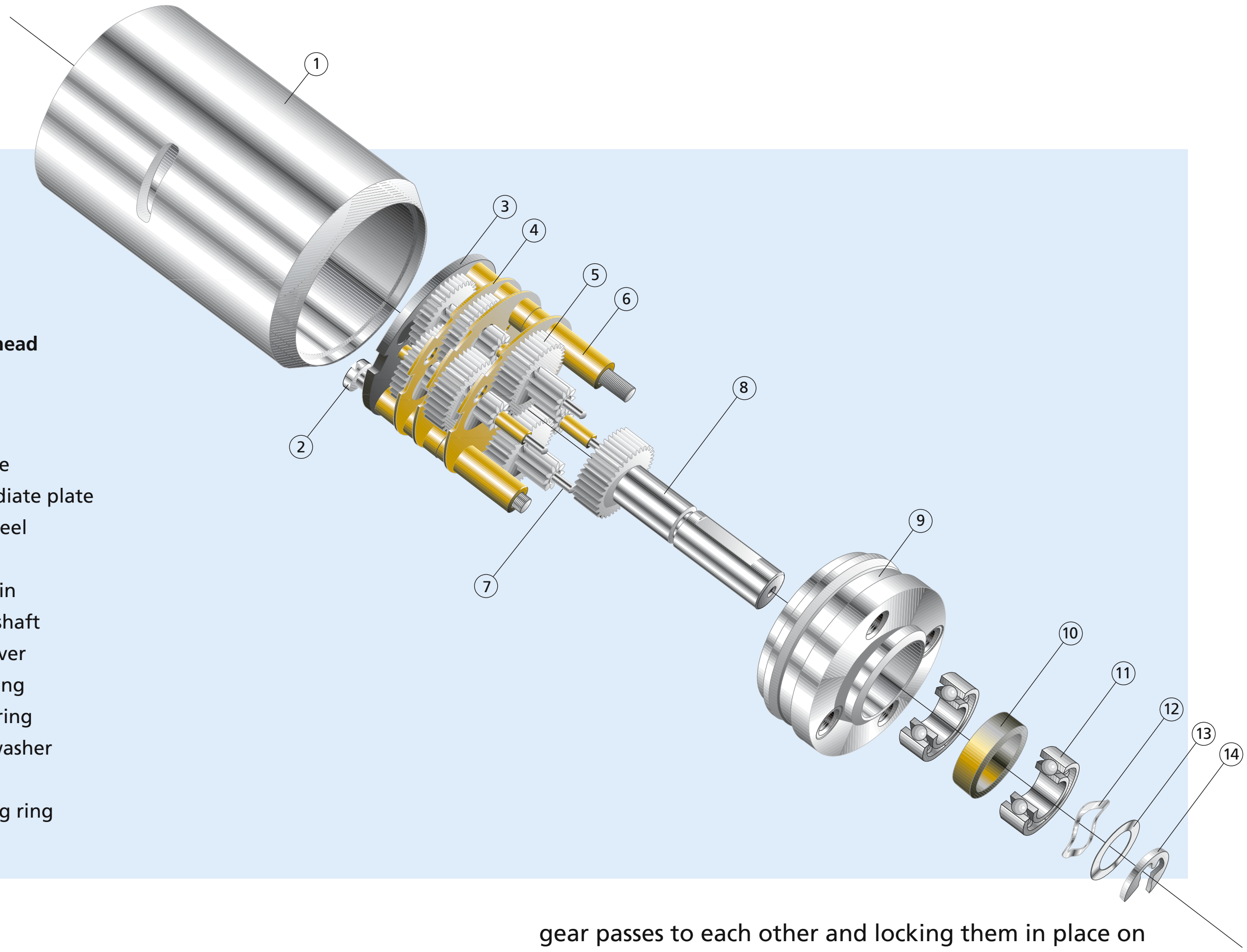
Product Code

26	Outer diameter [mm]
A	Version
64:1	Reduction ratio

26A 64:1

Precision Gearheads

Spur Gearheads

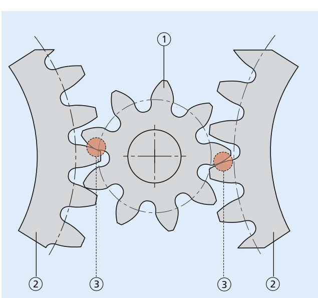


Spur Gearhead

① Housing
② Screws
③ End plate
④ Intermediate plate
⑤ Gear wheel
⑥ Sleeve
⑦ Dowel pin
⑧ Output shaft
⑨ Front cover
⑩ Spacer ring
⑪ Ball bearing
⑫ Spring washer
⑬ Washer
⑭ Retaining ring

Features

A wide range of high quality spur gearheads are available to compliment FAULHABER DC-Micromotors.
The all metal or plastic input-stage geartrain assures extremely quiet running. The precise construction of the gearhead causes very low current consumption in the motor, giving greater efficiency. The gearhead is sleeve mounted on the motor, providing a seamless in-line fit.
The FAULHABER Spur Gearheads are ideal for high precision, low torque and low noise applications.



Zero Backlash Spur Gearhead

① Motor pinion
② Dual-pass geartrain input stage
③ Zero backlash preloaded engagement

FAULHABER offers a special version of a spur gearhead with zero backlash. These gearheads consist of a dual pass spur geartrain with all metal gears. The backlash is reduced to a minimum by counter-rotating the two individual gear passes to each other and locking them in place on the motor pinion gear. They are ideal for positioning applications with a very high resolution and moderate torque. Zero backlash gearheads can only be delivered preloaded from the factory.

Benefits

- Available in a wide variety of reduction ratios including very high ratios
- Zero backlash versions are available
- Available with a variety of shaft bearings including sintered, ceramic, and ball bearings

Product Code

22	Outer diameter [mm]
/5	Version
377:1	Reduction ratio

22/5 377:1

FAUHABER

Planetary Gearheads

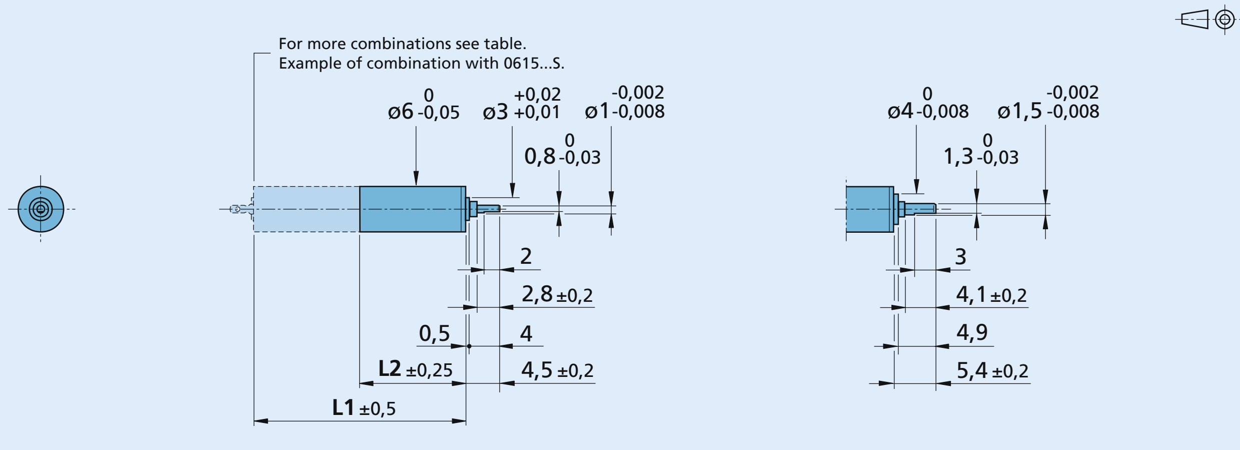
25 mNm

For combination with
DC-Micromotors
Brushless DC-Motors
Stepper Motors

Series 06/1

	06/1	06/1K
Housing material	steel	steel
Geartrain material	steel	steel
Recommended max. input speed for:		
– continuous operation	8 000 rpm	8 000 rpm
Backlash, at no-load	≤ 3 °	≤ 3 °
Bearings on output shaft	sintered bearings	ball bearings
Shaft load, max.:		
– radial (3,5 mm from mounting face)	≤ 0,5 N	≤ 5 N
– axial	≤ 0,5 N	≤ 3 N
Shaft press fit force, max.	≤ 3,5 N	≤ 5 N
Shaft play		
– radial (3,5 mm from mounting face)	≤ 0,04 mm	≤ 0,05 mm
– axial	≤ 0,1 mm	≤ 0,05 mm
Operating temperature range	- 30 ... + 100 °C	- 30 ... + 100 °C

Specifications							
Number of gear stages		**1**	**2**	**3**	**4**	**5**	**6**
Continuous torque	mNm	25	25	25	25	25	25
Intermittent torque	mNm	35	35	35	35	35	35
Weight without motor, ca.	g	2	2,8	3,4	4	4,4	5
Efficiency, max.	%	90	80	70	60	55	48
Direction of rotation, drive to output		=	=	=	=	=	=
Reduction ratio (exact)		**4:1**	**16:1**	**64:1**	**256:1**	**1 024:1**	**4 096:1**
L2 [mm] = length without motor		9,2	11,9	14,6	17,3	20,0	22,7
L1 [mm] = length with motor	0615C...S	24,2	26,9	29,6	32,3	35,0	37,7
	0620C...B	29,2	31,9	34,6	37,3	40,0	42,7
	ADM0620...-05	18,8	21,5	24,2	26,9	29,6	32,3



06/1

06/1 K
(L1, L2 = +1)

Planetary Gearheads

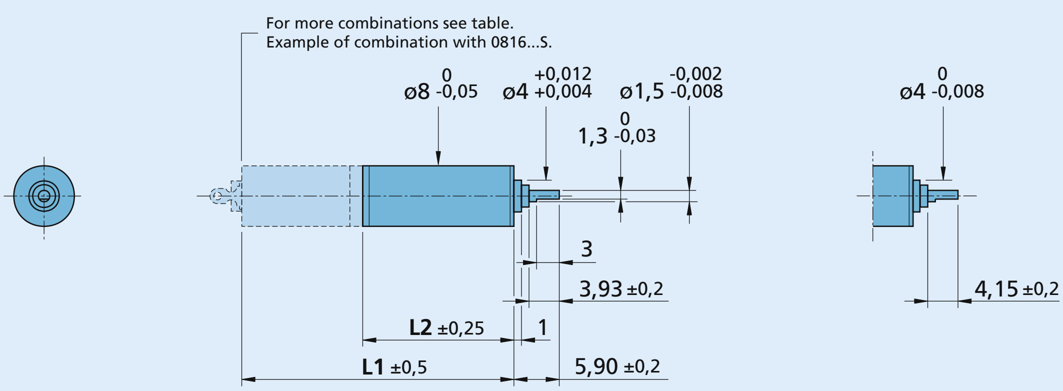
60 mNm

For combination with
DC-Micromotors
Stepper Motors

Series 08/1

	08/1	08/1K
Housing material	metal	metal
Geartrain material	steel	steel
Recommended max. input speed for:		
– continuous operation	8 000 rpm	8 000 rpm
Backlash, at no-load	≤ 3 °	≤ 3 °
Bearings on output shaft	sintered bearings	ball bearings
Shaft load, max.:		
– radial (4,5 mm from mounting face)	≤ 0,8 N	≤ 5 N
– axial	≤ 1 N	≤ 3 N
Shaft press fit force, max.	≤ 5 N	≤ 5 N
Shaft play		
– radial (4,5 mm from mounting face)	≤ 0,04 mm	≤ 0,06 mm
– axial	≤ 0,1 mm	≤ 0,05 mm
Operating temperature range	- 30 ... + 100 °C	- 30 ... + 100 °C

Specifications							
Number of gear stages		1	2	3	4	5	6
Continuous torque	mNm	60	60	60	60	60	60
Intermittent torque	mNm	120	120	120	120	120	120
Weight without motor, ca.	g	2,9	3,8	4,6	5,4	6,3	7,1
Efficiency, max.	%	90	80	70	60	55	48
Direction of rotation, drive to output		=	=	=	=	=	=
Reduction ratio (exact)		**4:1**	**16:1**	**64:1**	**256:1**	**1 024:1**	**4 096:1**
L2 [mm] = length without motor		9,6	12,3	15,0	17,7	20,4	23,1
L1 [mm] = length with motor 0816P...S		25,6	28,3	31,0	33,7	36,4	39,1
AM0820...-08		23,4	26,1	28,8	31,5	34,2	36,9



08/1 **08/1 K**

FAULHABER

Spur Gearheads

15 mNm

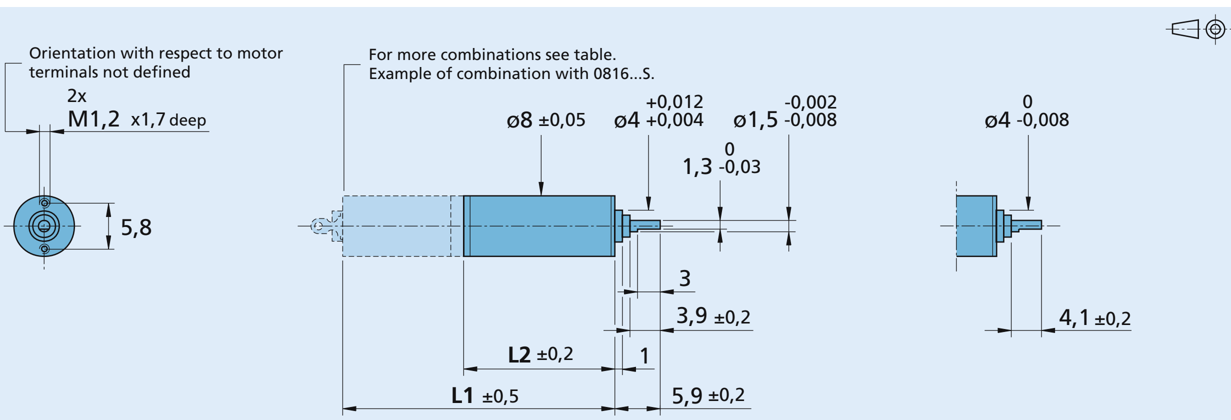
For combination with
DC-Micromotors
Stepper Motors

Series 08/2

	08/2	08/2K
Housing material	metal	metal
Geartrain material	metal	metal
Recommended max. input speed for:		
– continuous operation	8 000 rpm	8 000 rpm
Backlash, at no-load	≤ 5 °	≤ 5 °
Bearings on output shaft	sintered bearings	ball bearings
Shaft load, max.:		
– radial (4,5 mm from mounting face)	≤ 0,8 N	≤ 5 N
– axial	≤ 1 N	≤ 3 N
Shaft press fit force, max.	≤ 5 N	≤ 5 N
Shaft play		
– radial (4,5 mm from mounting face)	≤ 0,04 mm	≤ 0,06 mm
– axial	≤ 0,1 mm	≤ 0,05 mm
Operating temperature range	- 30 ... + 100 °C	- 30 ... + 100 °C

Specifications									
Number of gear stages		2	3	4	5	6	7	8	9
Continuous torque	mNm	15	15	15	15	15	15	15	15
Intermittent torque	mNm	25	25	25	25	25	25	25	25
Weight without motor, ca.	g	3,2	3,4	3,6	3,8	4	4,2	4,4	4,6
Efficiency, max.	%	94	90	86	81	77	74	70	66
Direction of rotation, drive to output		=	≠	=	≠	=	≠	=	≠
Reduction ratio [1] (rounded)		**4:1**	**9,4:1**	**21,9:1**	**51,2:1**	**120:1**	**279:1**	**650:1**	**1 518:1**
L2 [mm] = length without motor		12,0	13,4	15,2	17,0	18,8	20,6	22,4	24,2
L1 [mm] = length with motor	0816D...S	28,0	29,4	31,2	33,0	34,8	36,6	38,4	40,2
	AM0820...-12	25,8	27,2	29,0	30,8	32,6	34,4	36,2	38,0

[1] The reduction ratios are rounded, the exact values are available on request or at www.faulhaber.com.



08/2 **08/2 K**

Spur Gearheads

Zero Backlash

15 mNm

For combination with
DC-Micromotors
Stepper Motors

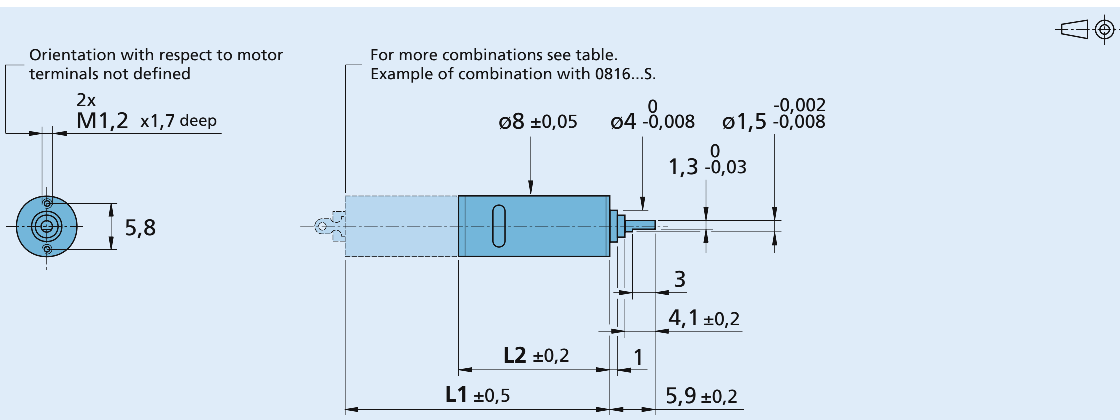
Series 08/3

	08/3
Housing material	metal
Geartrain material	metal
Recommended max. input speed for:	
– continuous operation	8 000 rpm
Backlash, at no-load	0 °
Bearings on output shaft	ball bearings
Shaft load, max.:	
– radial (4,5 mm from mounting face)	≤ 5 N
– axial	≤ 3 N
Shaft press fit force, max.	≤ 5 N
Shaft play	
– radial (4,5 mm from mounting face)	≤ 0,06 mm
– axial	≤ 0,05 mm
Operating temperature range	- 30 ... + 100 °C

Specifications					
Number of gear stages		**6**	**7**	**8**	**9**
Continuous torque	mNm	15	15	15	15
Intermittent torque	mNm	25	25	25	25
Weight without motor, ca.	g	4,5	4,9	5,3	5,7
Efficiency, max.		-	-	-	-
Direction of rotation, drive to output		=	≠	=	≠
Reduction ratio [1] (rounded)		**120:1**	**279:1**	**650:1**	**1 518:1**
L2 [mm] = length without motor		18,8	20,6	22,4	24,2
L1 [mm] = length with motor	0816D...S	34,8	36,6	38,4	40,2
	AM0820...-12	32,6	34,4	36,2	38,0

[1] The reduction ratios are rounded, the exact values are available on request or at www.faulhaber.com.

Note: These gearheads are available only with motors mounted.



08/3

Planetary Gearheads

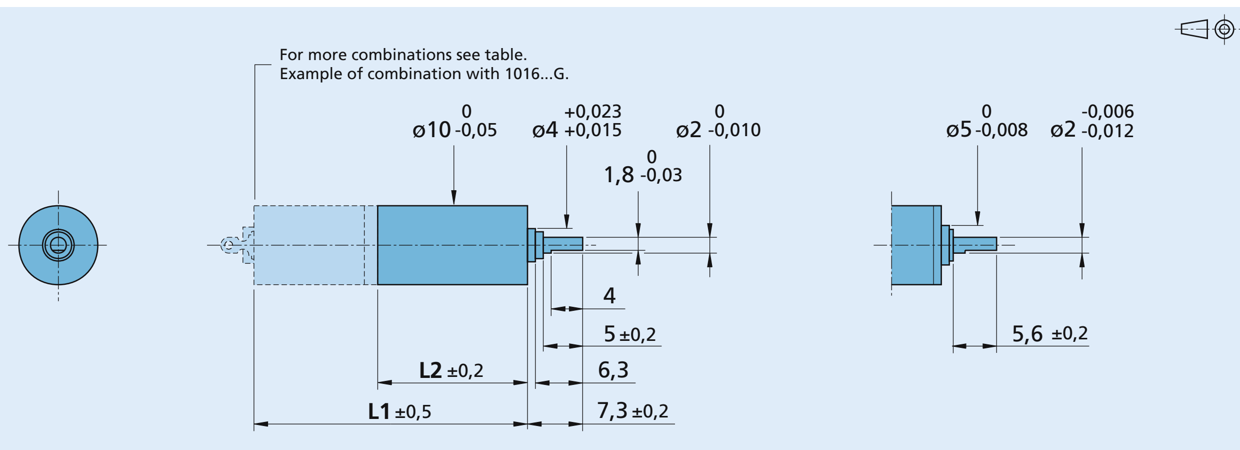
0,1 Nm

For combination with
DC-Micromotors
Brushless DC-Motors
Stepper Motors

Series 10/1

	10/1	10/1K
Housing material	metal	metal
Geartrain material	steel	steel
Recommended max. input speed for:		
– continuous operation	5 000 rpm	5 000 rpm
Backlash, at no-load	≤ 3 °	≤ 3 °
Bearings on output shaft	sintered bearings	ball bearings, preloaded
Shaft load, max.:		
– radial (5 mm from mounting face)	≤ 1 N	≤ 7 N
– axial	≤ 2 N	≤ 5 N
Shaft press fit force, max.	≤ 10 N	≤ 5 N
Shaft play		
– radial (5 mm from mounting face)	≤ 0,04 mm	≤ 0,02 mm
– axial	≤ 0,1 mm	= 0 mm
Operating temperature range	- 30 ... + 100 °C	- 30 ... + 100 °C

Specifications							
Number of gear stages		1	2	3	4	5	6
Continuous torque	mNm	5	15	54	100	100	100
Intermittent torque	mNm	200	200	200	200	200	200
Weight without motor, ca.	g	6	7	8	10	11	13
Efficiency, max.	%	90	80	70	60	55	48
Direction of rotation, drive to output		=	=	=	=	=	=
Reduction ratio (exact)		**4:1**	**16:1**	**64:1**	**256:1**	**1 024:1**	**4 096:1**
L2 [mm] = length without motor		9,7	12,8	15,9	19,0	22,1	25,2
L1 [mm] = length with motor	1016M...G	25,4	28,5	31,6	34,7	37,8	40,9
	1024M...S	33,4	36,5	39,6	42,7	45,8	48,9
	1219M...G	28,4	31,5	34,6	37,7	40,8	43,9
	1224M...S	33,9	37,0	40,1	43,2	46,3	49,4
	1224M...SR	33,9	37,0	40,1	43,2	46,3	49,4
	1226M...B	35,7	38,8	41,9	45,0	48,1	51,2
	ADM1220...-05	27,1	30,2	33,3	36,4	39,5	42,6
	ADM1220S...-55	27,1	30,2	33,3	36,4	39,5	42,6
	AM0820...-10	23,5	26,6	29,7	32,8	35,9	39,0
	AM1020...-08	25,6	28,7	31,8	34,9	38,0	41,1



10/1

10/1 K
(L1, L2 = +1)

For notes on technical data and lifetime performance refer to „Technical Information“.
Edition 2012 – 2013

Spur Gearheads

0,03 Nm

For combination with
DC-Micromotors
Brushless DC-Motors
Stepper Motors

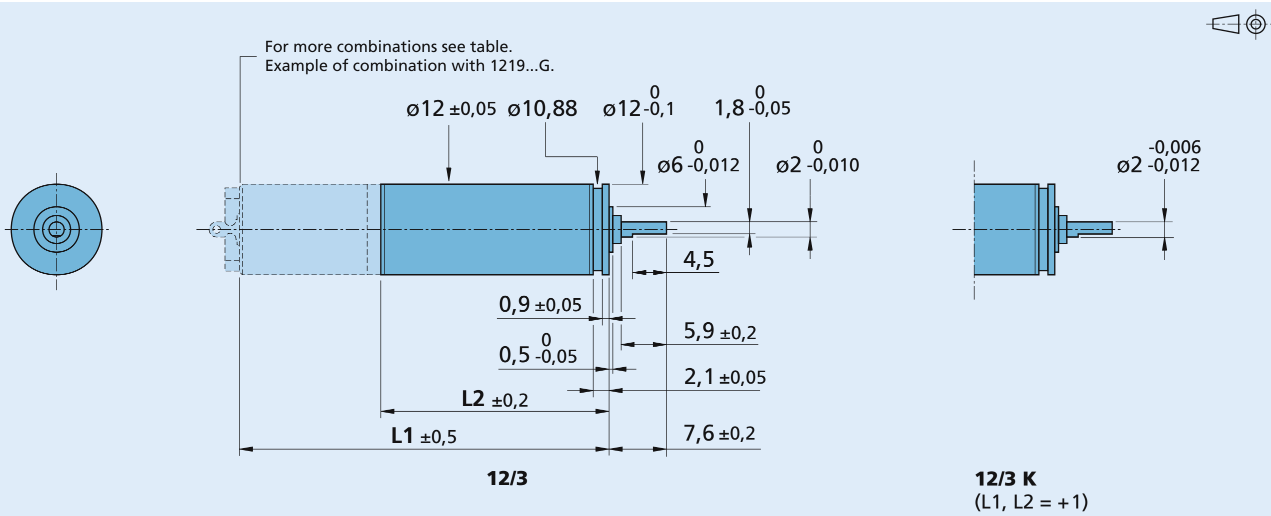
Series 12/3

	12/3	12/3K
Housing material	metal	metal
Geartrain material	metal	metal
Recommended max. input speed for:		
– continuous operation	5 000 rpm	5 000 rpm
Backlash, at no-load	≤ 3 °	≤ 3 °
Bearings on output shaft	sintered bearings	ball bearings
Shaft load, max.:		
– radial (4,5 mm from mounting face)	≤ 3 N	≤ 5 N
– axial	≤ 2 N	≤ 10 N
Shaft press fit force, max.	≤ 10 N	≤ 10 N
Shaft play		
– radial (4,5 mm from mounting face)	≤ 0,04 mm	≤ 0,07 mm
– axial	≤ 0,1 mm	≤ 0,05 mm
Operating temperature range	- 30 ... + 100 °C	- 30 ... + 100 °C

Specifications										
Number of gear stages		3	4	5	6	7	8	9	10	11
Continuous torque	mNm	6	8	10	20	30	30	30	30	30
Intermittent torque	mNm	100	100	100	100	100	100	100	100	100
Weight without motor, ca.	g	9	10	11	12	13	14	15	16	17
Efficiency, max.	%	90	86	81	77	74	70	66	63	60
Direction of rotation, drive to output		≠	=	≠	=	≠	=	≠	=	≠
Reduction ratio [1] (rounded)		**9,17:1**	**20,6:1**	**46,4:1**	**104,4:1**	**235:1**	**529:1**	**1 190:1**	**2 677:1**	**6 023:1**
L2 [mm] = length without motor		15,4	17,5	19,6	21,7	23,8	25,9	28,0	30,1	32,2
L1 [mm] = length with motor	1016E...G	31,1	33,2	35,3	37,4	39,5	41,6	43,7	45,8	47,9
	1024E...S	39,1	41,2	43,3	45,4	47,5	49,6	51,7	53,8	55,9
	1219E...G	34,1	36,2	38,3	40,4	42,5	44,6	46,7	48,8	50,9
	1224E...S	39,6	41,7	43,8	45,9	48,0	50,1	52,2	54,3	56,4
	1224E...SR	39,6	41,7	43,8	45,9	48,0	50,1	52,2	54,3	56,4
	1226E...B	41,4	43,5	45,6	47,7	49,8	51,9	54,0	56,1	58,2
	ADM1220...-07	32,8	34,9	37,0	39,1	41,2	43,3	45,4	47,5	49,6
	ADM1220S...-57	32,8	34,9	37,0	39,1	41,2	43,3	45,4	47,5	49,6

[1] The reduction ratios are rounded, the exact values are available on request or at www.faulhaber.com.

Note: Reduction ratios from 13 552:1 to 154 368:1 are available on request.



Planetary Gearheads

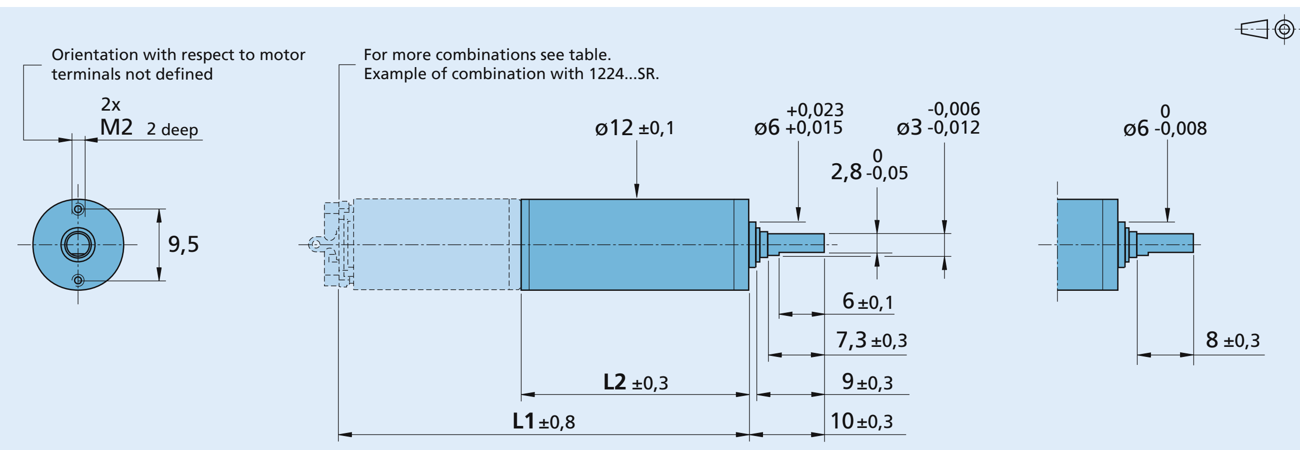
0,3 Nm

For combination with
DC-Micromotors
Brushless DC-Motors
Stepper Motors

Series 12/4

	12/4	12/4K
Housing material	metal	metal
Geartrain material	metal	metal
Recommended max. input speed for:		
– continuous operation	5 000 rpm	5 000 rpm
Backlash, at no-load	≤ 3 °	≤ 3 °
Bearings on output shaft	sintered bearings	ball bearings, preloaded
Shaft load, max.:		
– radial (6 mm from mounting face)	≤ 4 N	≤ 20 N
– axial	≤ 3 N	≤ 5 N
Shaft press fit force, max.	≤ 15 N	≤ 5 N
Shaft play		
– radial (6 mm from mounting face)	≤ 0,04 mm	≤ 0,02 mm
– axial	≤ 0,1 mm	= 0 mm
Operating temperature range	- 30 ... + 100 °C	- 30 ... + 100 °C

Specifications						
Number of gear stages		**1**	**2**	**3**	**4**	**5**
Continuous torque	mNm	300	300	300	300	300
Intermittent torque	mNm	450	450	450	450	450
Weight without motor, ca.	g	12	15	18	21	24
Efficiency, max.	%	90	80	70	60	55
Direction of rotation, drive to output		=	=	=	=	=
Reduction ratio (exact)		**4:1**	**16:1**	**64:1**	**256:1**	**1 024:1**
L2 [mm] = length without motor		15,1	19,7	24,3	28,9	33,5
L1 [mm] = length with motor	1024A...S	38,8	43,4	48,0	52,6	57,2
	1224A...S	39,3	43,9	48,5	53,1	57,7
	1224A...SR	39,3	43,9	48,5	53,1	57,7
	1226A...B	41,1	45,7	50,3	54,9	59,5
	ADM1220...-09	32,5	37,1	41,7	46,3	50,9
	ADM1220S...-59	32,5	37,1	41,7	46,3	50,9



12/4 **12/4 K**

Spur Gearheads

Zero Backlash

0,03 Nm

For combination with
DC-Micromotors
Brushless DC-Motors
Stepper Motors

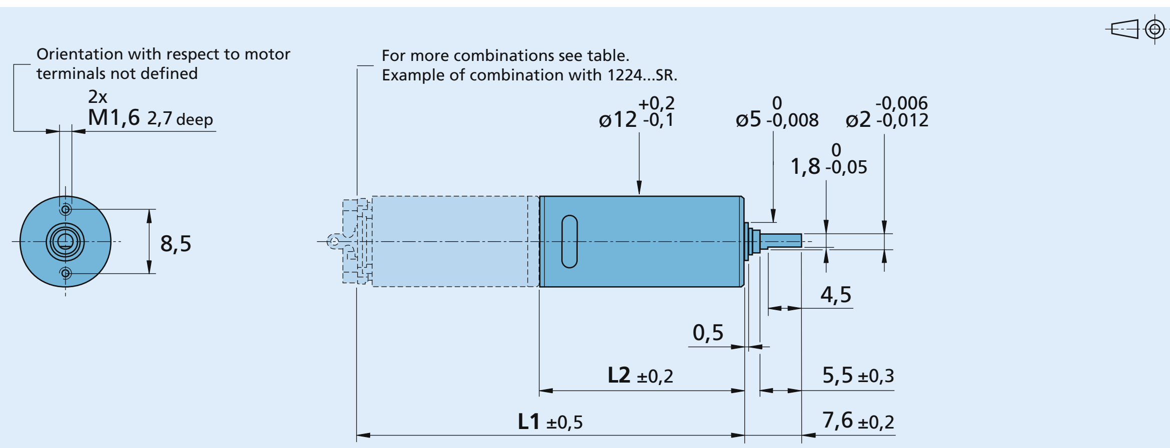
Series 12/5

	12/5
Housing material	metal
Geartrain material	metal
Recommended max. input speed for:	
– continuous operation	5 000 rpm
Backlash, at no-load	0 °
Bearings on output shaft	ball bearings, preloaded
Shaft load, max.:	
– radial (4,5 mm from mounting face)	≤ 5 N
– axial	≤ 5 N
Shaft press fit force, max.	≤ 10 N
Shaft play	
– radial (4,5 mm from mounting face)	≤ 0,02 mm
– axial	= 0 mm
Operating temperature range	- 30 ... + 100 °C

Specifications						
Number of gear stages		**5**	**6**	**7**	**8**	**9**
Continuous torque	mNm	30	30	30	30	30
Intermittent torque	mNm	100	100	100	100	100
Weight without motor, ca.	g	11	12	13	14	15
Efficiency, max.		-	-	-	-	-
Direction of rotation, drive to output		≠	=	≠	=	≠
Reduction ratio [1] (rounded)		**69,2:1**	**161:1**	**377:1**	**879:1**	**2 050:1**
L2 [mm] = length without motor		18,7	20,8	22,9	25,0	27,1
L1 [mm] = length with motor	1024E...S	42,4	44,5	46,6	48,7	50,8
	1224E...S	42,9	45,0	47,1	49,2	51,3
	1224E...SR	42,9	45,0	47,1	49,2	51,3
	1226E...B	44,7	46,8	48,9	51,0	53,1
	ADM1220...-07	36,1	38,2	40,3	42,4	44,5
	ADM1220S...-57	36,1	38,2	40,3	42,4	44,5
	AM1020...-10	34,6	36,7	38,8	40,9	43,0

[1] The reduction ratios are rounded, the exact values are available on request or at www.faulhaber.com.

Note: These gearheads are available only with motors mounted.



12/5

Planetary Gearheads

0,18 Nm

For combination with
DC-Micromotors

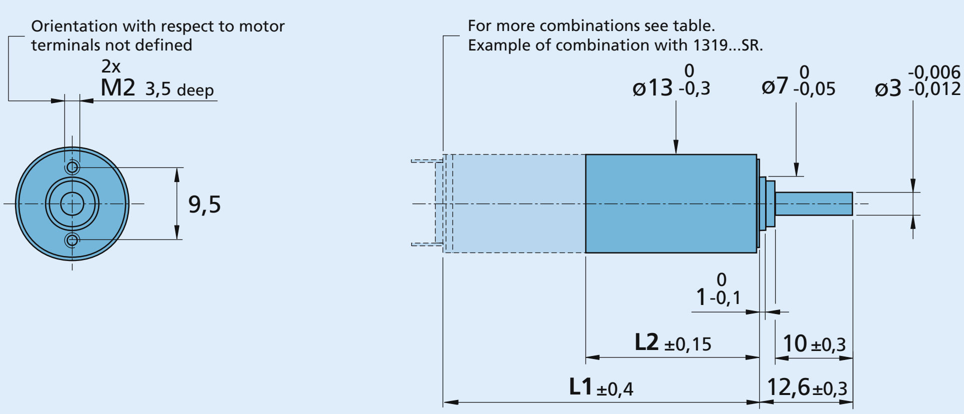
Series 13A

	13A	13AC	13AK
Housing material	plastic/aluminium	plastic/aluminium	plastic/aluminium
Geartrain material	plastic	plastic	plastic
Recommended max. input speed for:			
– continuous operation	5 000 rpm	5 000 rpm	5 000 rpm
Backlash, at no-load	≤ 4 °	≤ 4 °	≤ 4 °
Bearings on output shaft	sintered bearings	ceramic bearings	ball bearings
Shaft load, max.:			
– radial (5 mm from mounting face)	≤ 3 N	≤ 10 N	≤ 15 N
– axial	≤ 1 N	≤ 2 N	≤ 5 N
Shaft press fit force, max.	≤ 10 N	≤ 10 N	≤ 10 N
Shaft play			
– radial (5 mm from mounting face)	≤ 0,06 mm	≤ 0,08 mm	≤ 0,09 mm
– axial	≤ 0,25 mm	≤ 0,25 mm	≤ 0,25 mm
Operating temperature range	- 30 ... + 65 °C	- 20 ... + 85 °C	- 30 ... + 85 °C

Specifications					
Number of gear stages		**2**	**3**	**4**	**5**
Continuous torque	mNm	100	100	150	180
Intermittent torque	mNm	150	150	180	220
Weight without motor, ca.	g	5	5	5	6
Efficiency, max.	%	80	72	64	55
Direction of rotation, drive to output		=	=	=	=
Reduction ratio [1] (rounded)		**16:1**	**50:1** **64:1**	**158:1** **201:1** **256:1**	**497:1** **632:1** **805:1** **1 024:1**
L2 [mm] = length without motor		18,8	22,0	25,2	28,4
L1 [mm] = length with motor	1319C...SR	38,0	41,2	44,4	47,6
	1331C...SR	50,0	53,2	56,4	59,6
	1336C...CXR	53,8	57,0	60,2	63,4

[1] The reduction ratios are rounded, the exact values are available on request or at www.faulhaber.com.

Note: These gearheads are available only with motors mounted.
Vibrational load of up to 5 g at frequencies up to 500 Hz will not limit the function of the motor-gearhead combinations.



13A, 13AC, 13AK

Planetary Gearheads

0,3 Nm

For combination with
DC-Micromotors

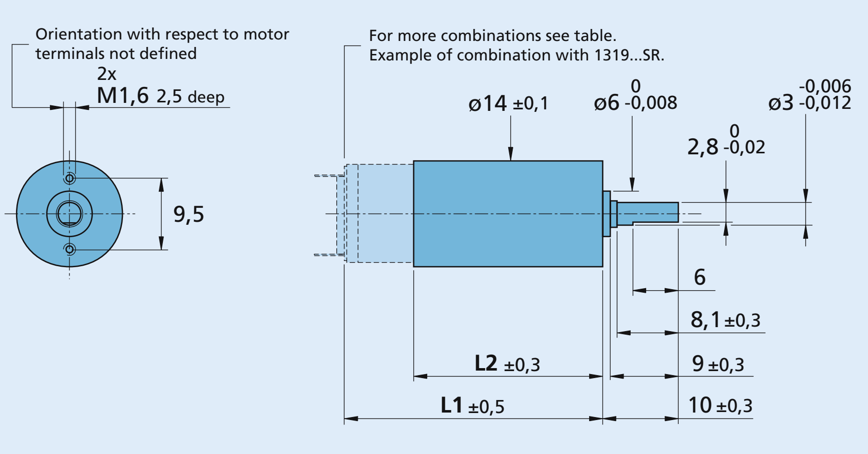
Series 14/1

	14/1
Housing material	metal
Geartrain material	steel
Recommended max. input speed for:	
– continuous operation	5 000 rpm
Backlash, at no-load	≤ 1 °
Bearings on output shaft	ball bearings, preloaded
Shaft load, max.:	
– radial (6,5 mm from mounting face)	≤ 20 N
– axial	≤ 5 N
Shaft press fit force, max.	≤ 5 N
Shaft play	
– radial (6,5 mm from mounting face)	≤ 0,02 mm
– axial	= 0 mm
Operating temperature range	- 30 ... + 100 °C

Specifications

Number of gear stages		**1**	**2**	**3**	**4**	**5**	**6**
Continuous torque	mNm	200	300	300	300	300	300
Intermittent torque	mNm	300	450	450	450	450	450
Weight without motor, ca.	g	17	20	24	27	30	34
Efficiency, max.	%	90	80	70	60	55	50
Direction of rotation, drive to output		=	=	=	=	=	=
Reduction ratio [1] (rounded)		**3,71:1**	**9,7:1** **14:1**	**43:1** **66:1**	**94:1** **112:1** **134:1** **159:1** **190:1** **246:1**	**415:1** **592:1** **989:1** **1 526:1**	**2 608:1** **4 365:1** **5 647:1**
L2 [mm] = length without motor		20,9	25,0	29,2	33,3	37,4	41,5
L1 [mm] = length with motor	1319T...SR	34,1	38,2	42,4	46,5	50,6	54,7
	1331T...SR	45,9	50,0	54,2	58,3	62,4	66,5
	1336U...CXR	50,9	55,0	59,2	63,3	67,4	71,5

[1] The reduction ratios are rounded, the exact values are available on request or at www.faulhaber.com.



14/1

Planetary Gearheads

0,25 Nm

For combination with
DC-Micromotors
Stepper Motors

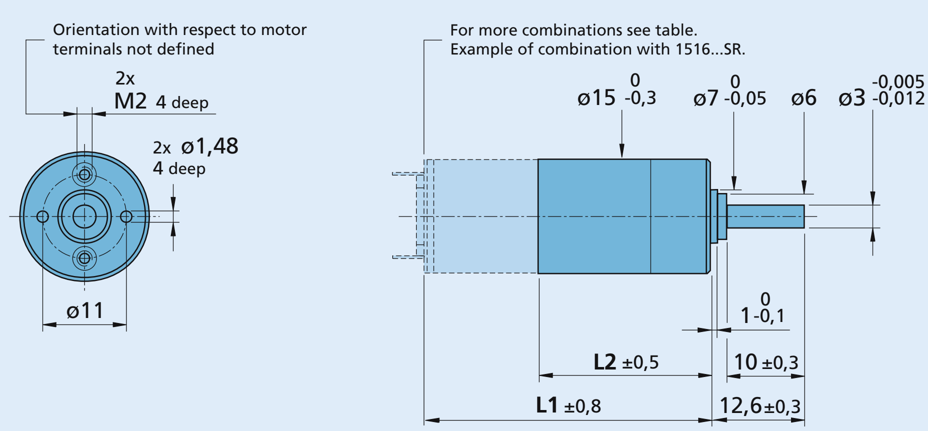
Series 15A

	15A	15AC	15AK
Housing material	plastic	plastic	plastic
Geartrain material	plastic	plastic	plastic
Recommended max. input speed for:			
– continuous operation	5 000 rpm	5 000 rpm	5 000 rpm
Backlash, at no-load	≤ 4 °	≤ 4 °	≤ 4 °
Bearings on output shaft	sintered bearings	ceramic bearings	ball bearings
Shaft load, max.:			
– radial (5 mm from mounting face)	≤ 3 N	≤ 10 N	≤ 15 N
– axial	≤ 1 N	≤ 2 N	≤ 5 N
Shaft press fit force, max.	≤ 10 N	≤ 10 N	≤ 10 N
Shaft play			
– radial (5 mm from mounting face)	≤ 0,06 mm	≤ 0,08 mm	≤ 0,09 mm
– axial	≤ 0,25 mm	≤ 0,25 mm	≤ 0,25 mm
Operating temperature range	- 30 ... + 65 °C	- 20 ... + 85 °C	- 30 ... + 85 °C

Specifications										
Number of gear stages			**1**	**2**	**3**	**3**	**4**	**5**	**5**	**6**
Continuous torque		mNm	50	100	100	150	200	200	250	250
Intermittent torque		mNm	100	200	200	300	400	400	400	400
Weight without motor, ca.		g	4	5	5	5	6	6	6	7
Efficiency, max.		%	87	78	68	67	62	55	52	49
Direction of rotation, drive to output			=	=	=	=	=	=	=	=
Reduction ratio [1] (rounded)	Code B [2]			**14:1** **19:1**	**52:1** **69:1**		**249:1**	**896:1**		**3 225:1**
	Code A [2]		**5,33:1**	**28:1**	**102:1**	**152:1**	**369:1** **546:1** **809:1**	**1 327:1** **1 966:1**	**2 913:1** **4 315:1**	**4 778:1** **7 078:1** **10 486:1** **15 534:1** **23 014:1**
L2 [mm] = length without motor [3]			14,1	17,7	21,3	21,3	24,9	28,5	28,5	32,1
L1 [mm] = length with motor	1516A/B...SR		29,9	33,5	37,1	37,1	40,7	44,3	44,3	47,9
	1524A/B...SR		37,9	41,5	45,1	45,1	48,7	52,3	52,3	55,9
	1624A/B...S		37,9	41,5	45,1	45,1	48,7	52,3	52,3	55,9
	1717A/B...SR		31,1	34,7	38,3	38,3	41,9	45,5	45,5	49,1
	1724A/B...SR		38,1	41,7	45,3	45,3	48,9	52,5	52,5	56,1
	AM1524...-70		30,5	34,1	37,7	37,7	41,3	44,9	44,9	48,5

[1] The reduction ratios are rounded, the exact values are available on request or at www.faulhaber.com.
[2] Example of ordering information: 1516 **B** 012 SR + 15A 19:1, not for AM1524.
[3] L2 + 0,7 mm, in combination with 1516A/B...SR and 1524A/B...SR.

Note: These gearheads are available only with motors mounted.



15A, 15AC, 15AK

FAULHABER

Spur Gearheads

0,1 Nm

For combination with
DC-Micromotors
Brushless DC-Motors
Stepper Motors

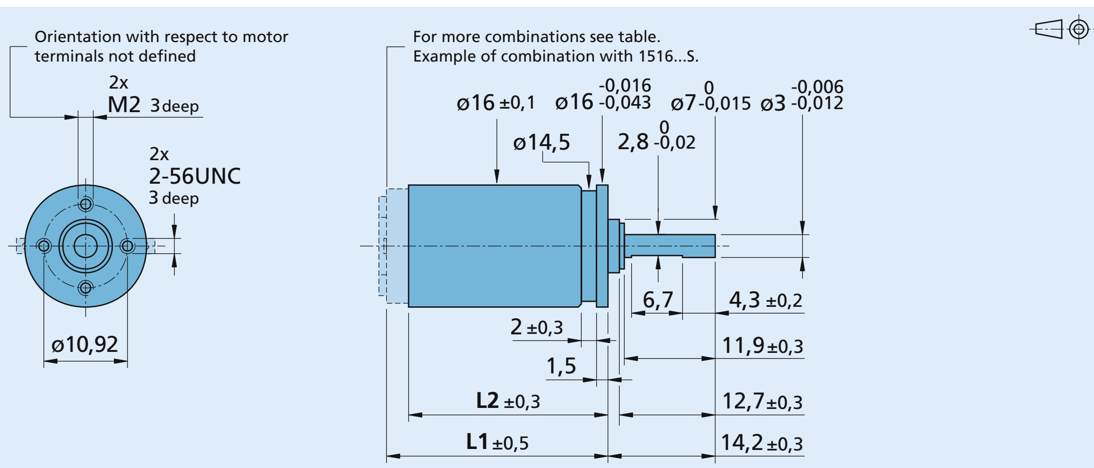
Series 15/5

	15/5
Housing material	metal
Geartrain material [1]	plastic/steel
Recommended max. input speed for:	
– continuous operation	5 000 rpm
Backlash, at no-load	≤ 3 °
Bearings on output shaft	ball bearings, preloaded
Shaft load, max.:	
– radial (6,5 mm from mounting face)	≤ 25 N
– axial	≤ 5 N
Shaft press fit force, max.	≤ 5 N
Shaft play	
– radial (6,5 mm from mounting face)	≤ 0,02 mm
– axial	= 0 mm
Operating temperature range	- 30 ... + 100 °C

Specifications									
Number of gear stages	2	3	4	4	5	5	6	6	7
Continuous torque mNm	60	60	100	100	100	100	100	100	100
Intermittent torque mNm	150	150	300	150	300	150	300	150	300
Weight without motor, ca. g	17	19	21	21	22	22	24	24	25
Efficiency, max. %	81	73	66	66	59	59	53	53	48
Direction of rotation, drive to output	=	≠	=	=	≠	≠	=	=	≠
Reduction ratio [2] (rounded)	**6,3:1** **11,8:1**	**22:1** **41:1**	**76:1**	**141:1**	**262:1**	**485:1**	**900:1**	**1 670:1**	**3 101:1**
L2 [mm] = length without motor	26,2	29,9	32,0	32,0	34,1	34,1	36,2	36,2	38,3
L1 [mm] = length with motor 1319E...SR	32,5	36,2	38,3	38,3	40,4	40,4	42,5	42,5	44,6
1331E...SR	44,5	48,2	50,3	50,3	52,4	52,4	54,5	54,5	56,6
1516E...S	29,1	32,8	34,9	34,9	37,0	37,0	39,1	39,1	41,2
1516E...SR	29,1	32,8	34,9	34,9	37,0	37,0	39,1	39,1	41,2
1524E...SR	37,1	40,8	42,9	42,9	45,0	45,0	47,1	47,1	49,2
1524E...BSL	37,5	41,2	43,3	43,3	45,4	45,4	47,5	47,5	49,6
1536E...BSL	49,9	53,6	55,7	55,7	57,8	57,8	59,9	59,9	62,0
AM1524...-57	30,0	33,7	35,8	35,8	37,9	37,9	40,0	40,0	42,1

[1] Gearheads with ratios < 3 101:1 have all steel gears.
[2] The reduction ratios are rounded, the exact values are available on request or at www.faulhaber.com.

Note: Reduction ratios from 5 752:1 to 235 067:1 are available on request.



Precision Gearheads

For notes on technical data and lifetime performance refer to „Technical Information“.
Edition 2012 – 2013

Spur Gearheads

0,1 Nm

For combination with
DC-Micromotors
Brushless DC-Motors
Stepper Motors

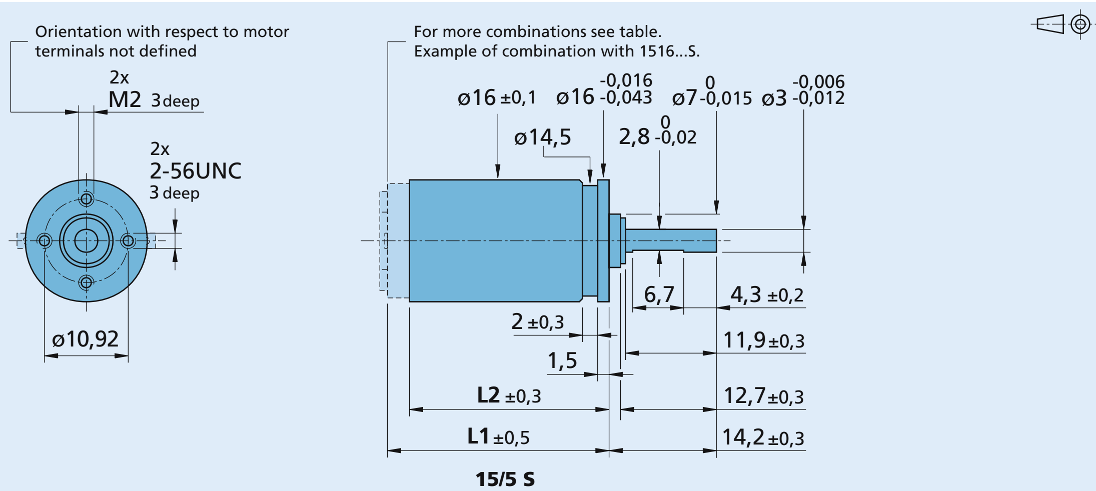
Series 15/5 S

	15/5 S
Housing material	metal
Geartrain material	steel
Recommended max. input speed for:	
– continuous operation	5 000 rpm
Backlash, at no-load	≤ 3 °
Bearings on output shaft	ball bearings, preloaded
Shaft load, max.:	
– radial (6,5 mm from mounting face)	≤ 25 N
– axial	≤ 5 N
Shaft press fit force, max.	≤ 5 N
Shaft play	
– radial (6,5 mm from mounting face)	≤ 0,02 mm
– axial	= 0 mm
Operating temperature range	- 30 ... + 100 °C

Specifications											
Number of gear stages			2	3	4	4	5	5	6	6	7
Continuous torque		mNm	60	60	100	100	100	100	100	100	100
Intermittent torque		mNm	150	150	300	150	300	150	300	150	300
Weight without motor, ca.		g	17	19	21	21	22	22	24	24	25
Efficiency, max.		%	81	73	66	66	59	59	53	53	48
Direction of rotation, drive to output			=	≠	=	=	≠	≠	=	=	≠
Reduction ratio [1] (rounded)			**6,3:1** **11,8:1**	**22:1** **41:1**	**76:1**	**141:1**	**262:1**	**485:1**	**900:1**	**1 670:1**	**3 101:1**
L2 [mm] = length without motor			26,2	29,9	32,0	32,0	34,1	34,1	36,2	36,2	38,3
L1 [mm] = length with motor	1319E...SR		32,5	36,2	38,3	38,3	40,4	40,4	42,5	42,5	44,6
	1331E...SR		44,5	48,2	50,3	50,3	52,4	52,4	54,5	54,5	56,6
	1516E...S		29,1	32,8	34,9	34,9	37,0	37,0	39,1	39,1	41,2
	1516E...SR		29,1	32,8	34,9	34,9	37,0	37,0	39,1	39,1	41,2
	1524E...SR		37,1	40,8	42,9	42,9	45,0	45,0	47,1	47,1	49,2
	1524E...BSL		37,5	41,2	43,3	43,3	45,4	45,4	47,5	47,5	49,6
	1536E...BSL		49,9	53,6	55,7	55,7	57,8	57,8	59,9	59,9	62,0
	AM1524...-57		30,0	33,7	35,8	35,8	37,9	37,9	40,0	40,0	42,1

[1] The reduction ratios are rounded, the exact values are available on request or at www.faulhaber.com.

Note: Reduction ratios from 5 752:1 to 235 067:1 are available on request.
The gearheads as S-type have all steel gears and heavy duty lubricant for extended lifetime performance.



Precision Gearheads

Spur Gearheads

Zero Backlash

0,1 Nm

For combination with
DC-Micromotors
Brushless DC-Motors
Stepper Motors

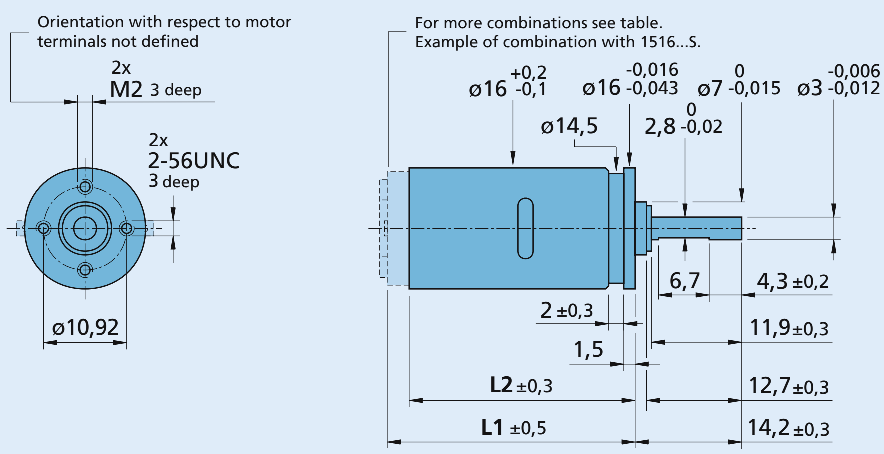
Series 15/8

	15/8
Housing material	metal
Geartrain material	steel
Recommended max. input speed for:	
– continuous operation	5 000 rpm
Backlash, at no-load	0 °
Bearings on output shaft	ball bearings, preloaded
Shaft load, max.:	
– radial (6,5 mm from mounting face)	≤ 25 N
– axial	≤ 5 N
Shaft press fit force, max.	≤ 5 N
Shaft play	
– radial (6,5 mm from mounting face)	≤ 0,02 mm
– axial	= 0 mm
Operating temperature range	- 30 ... + 100 °C

Specifications								
Number of gear stages			4	4	5	5	6	6
Continuous torque		mNm	100	100	100	100	100	100
Intermittent torque		mNm	300	150	300	150	300	150
Weight without motor, ca.		g	24	24	26	26	28	28
Efficiency, max.			-	-	-	-	-	-
Direction of rotation, drive to output			=	=	≠	≠	=	=
Reduction ratio [1] (rounded)			**76:1**	**141:1**	**262:1**	**485:1**	**900:1**	**1 670:1**
L2 [mm] = length without motor			32,0	32,0	34,1	34,1	36,2	36,2
L1 [mm] = length with motor	1516E...SR		34,9	34,9	37,0	37,0	39,1	39,1
	1524E...SR		42,9	42,9	45,0	45,0	47,1	47,1
	1524E...BSL		43,3	43,3	45,4	45,4	47,5	47,5
	1536E...BSL		55,7	55,7	57,8	57,8	59,9	59,9
	AM1524...-57		35,8	35,8	37,9	37,9	40,0	40,0

[1] The reduction ratios are rounded, the exact values are available on request or at www.faulhaber.com.

Note: These gearheads are available only with motors mounted.



15/8

Spur Gearheads

0,03 Nm

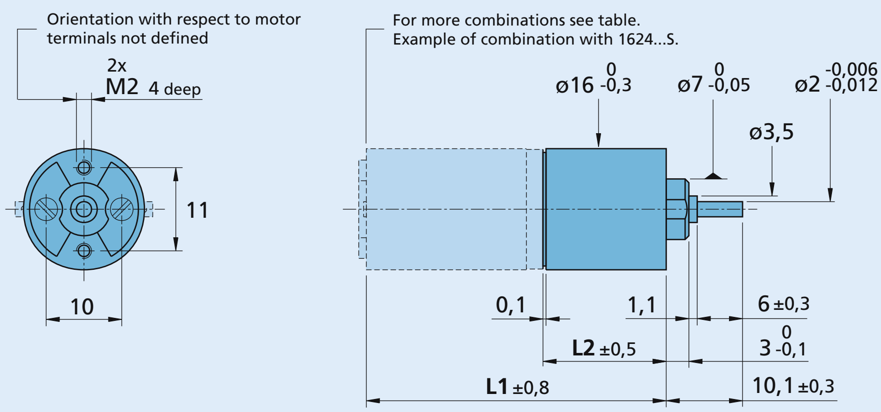
For combination with
DC-Micromotors

Series 16A

	16A	16AC	16AK
Housing material	plastic	plastic	plastic
Geartrain material	metal	metal	metal
Recommended max. input speed for:			
– continuous operation	5 000 rpm	5 000 rpm	5 000 rpm
Backlash, at no-load	≤ 4 °	≤ 4 °	≤ 4 °
Bearings on output shaft	sintered bearings	ceramic bearings	ball bearings
Shaft load, max.:			
– radial (5 mm from mounting face)	≤ 2 N	≤ 6 N	≤ 10 N
– axial	≤ 1 N	≤ 2 N	≤ 5 N
Shaft press fit force, max.	≤ 10 N	≤ 10 N	≤ 10 N
Shaft play			
– radial (5 mm from mounting face)	≤ 0,05 mm	≤ 0,06 mm	≤ 0,06 mm
– axial	≤ 0,25 mm	≤ 0,25 mm	≤ 0,25 mm
Operating temperature range	- 30 ... + 65 °C	- 20 ... + 65 °C	- 30 ... + 65 °C

Specifications									
Number of gear stages		**2**	**3**	**3**	**4**	**4**	**5**	**6**	**7**
Continuous torque	mNm	10	10	20	20	30	30	30	30
Intermittent torque	mNm	100	100	100	100	100	100	100	100
Weight without motor, ca.	g	3	4	4	4	4	5	5	6
Efficiency, max.	%	81	73	73	66	66	59	53	48
Direction of rotation, drive to output		=	≠	≠	=	=	≠	=	≠
Reduction ratio [1]		**11,9:1**	**22:1**	**41:1**	**76:1**	**141:1**	**262:1**	**900:1**	**3 101:1**
(rounded)							**485:1**	**1 670:1**	**5 752:1**
L2 [mm] = length without motor		9,2	11,0	11,0	12,8	12,8	14,5	16,3	18,0
L1 [mm] = length with motor	1516E...S	25,0	26,8	26,8	28,6	28,6	30,3	32,1	33,8
	1516E...SR	25,0	26,8	26,8	28,6	28,6	30,3	32,1	33,8
	1524E...SR	33,0	34,8	34,8	36,6	36,6	38,3	40,1	41,8
	1624E...S	33,0	34,8	34,8	36,6	36,6	38,3	40,1	41,8
	1717E...SR	26,2	28,0	28,0	29,8	29,8	31,5	33,3	35,0
	1724E...SR	33,0	34,8	34,8	36,6	36,6	38,3	40,1	41,8

[1] The reduction ratios are rounded, the exact values are available on request or at www.faulhaber.com.



16A, 16AC, 16AK

Precision Gearheads

Spur Gearheads

0,1 Nm

For combination with
DC-Micromotors

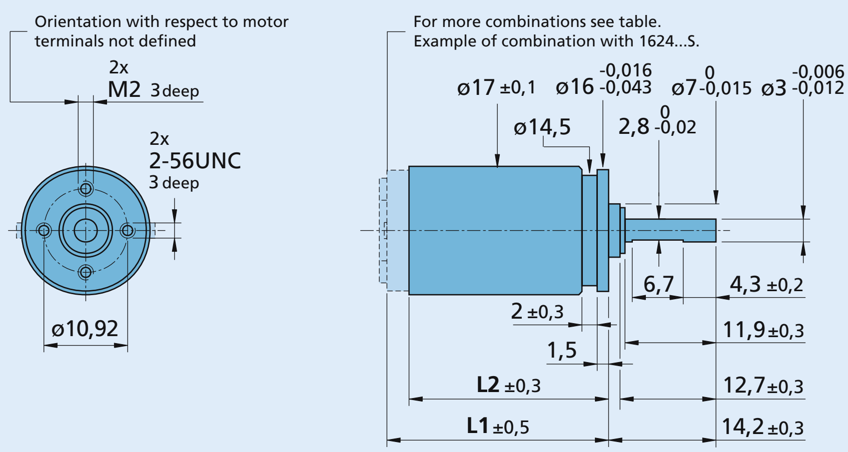
Series 16/5

	16/5
Housing material	metal
Geartrain material [1]	plastic/steel
Recommended max. input speed for:	
– continuous operation	5 000 rpm
Backlash, at no-load	≤ 3 °
Bearings on output shaft	ball bearings, preloaded
Shaft load, max.:	
– radial (6,5 mm from mounting face)	≤ 25 N
– axial	≤ 5 N
Shaft press fit force, max.	≤ 5 N
Shaft play	
– radial (6,5 mm from mounting face)	≤ 0,02 mm
– axial	= 0 mm
Operating temperature range	- 30 ... + 100 °C

Specifications										
Number of gear stages		**2**	**3**	**4**	**4**	**5**	**5**	**6**	**6**	**7**
Continuous torque	mNm	60	60	100	100	100	100	100	100	100
Intermittent torque	mNm	150	150	300	150	300	150	300	150	300
Weight without motor, ca.	g	17	19	21	21	22	22	24	24	25
Efficiency, max.	%	81	73	66	66	59	59	53	53	48
Direction of rotation, drive to output		=	≠	=	=	≠	≠	=	=	≠
Reduction ratio [2] (rounded)		**6,3:1** **11,8:1**	**22:1** **41:1**	**76:1**	**141:1**	**262:1**	**485:1**	**900:1**	**1 670:1**	**3 101:1**
L2 [mm] = length without motor		26,2	29,9	32,0	32,0	34,1	34,1	36,2	36,2	38,3
L1 [mm] = length with motor 1624E...S		37,1	40,8	42,9	42,9	45,0	45,0	47,1	47,1	49,2

[1] Gearheads with ratios < 3 101:1 have all steel gears.
[2] The reduction ratios are rounded, the exact values are available on request or at www.faulhaber.com.

Note: Reduction ratios from 5 752:1 to 235 067:1 are available on request.



16/5

Spur Gearheads

0,1 Nm

For combination with
DC-Micromotors

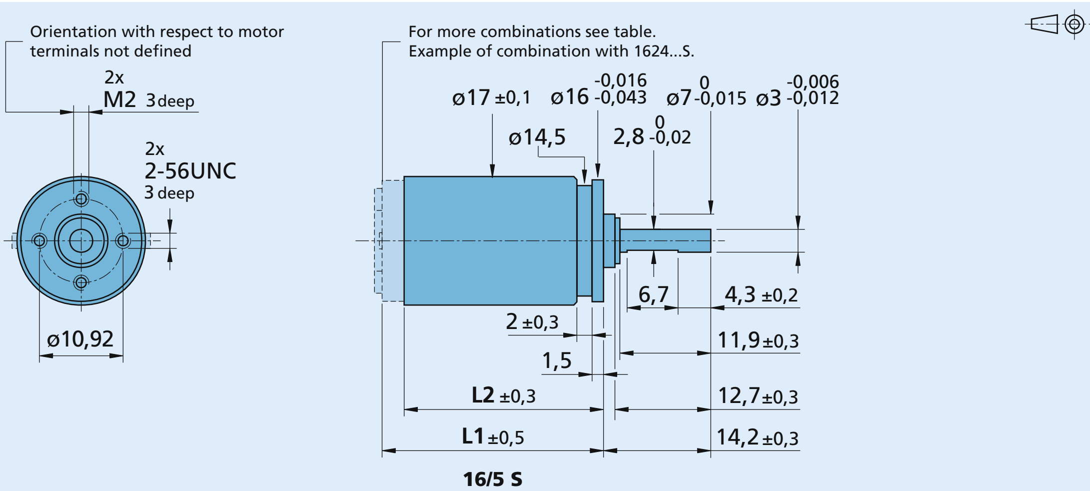
Series 16/5 S

	16/5 S
Housing material	metal
Geartrain material	steel
Recommended max. input speed for:	
– continuous operation	5 000 rpm
Backlash, at no-load	≤ 3 °
Bearings on output shaft	ball bearings, preloaded
Shaft load, max.:	
– radial (6,5 mm from mounting face)	≤ 25 N
– axial	≤ 5 N
Shaft press fit force, max.	≤ 5 N
Shaft play	
– radial (6,5 mm from mounting face)	≤ 0,02 mm
– axial	= 0 mm
Operating temperature range	- 30 ... + 100 °C

Specifications										
Number of gear stages		**2**	**3**	**4**	**4**	**5**	**5**	**6**	**6**	**7**
Continuous torque	mNm	60	60	100	100	100	100	100	100	100
Intermittent torque	mNm	150	150	300	150	300	150	300	150	300
Weight without motor, ca.	g	17	19	21	21	22	22	24	24	25
Efficiency, max.	%	81	73	66	66	59	59	53	53	48
Direction of rotation, drive to output		=	≠	=	=	≠	≠	=	=	≠
Reduction ratio [1] (rounded)		**6,3:1** **11,8:1**	**22:1** **41:1**	**76:1**	**141:1**	**262:1**	**485:1**	**900:1**	**1 670:1**	**3 101:1**
L2 [mm] = length without motor		26,2	29,9	32,0	32,0	34,1	34,1	36,2	36,2	38,3
L1 [mm] = length with motor 1624E...S		37,1	40,8	42,9	42,9	45,0	45,0	47,1	47,1	49,2

[1] The reduction ratios are rounded, the exact values are available on request or at www.faulhaber.com.

Note: Reduction ratios from 5 752:1 to 235 067:1 are available on request.
The gearheads as S-type have all steel gears and heavy duty lubricant for extended lifetime performance.



Planetary Gearheads

0,3 Nm

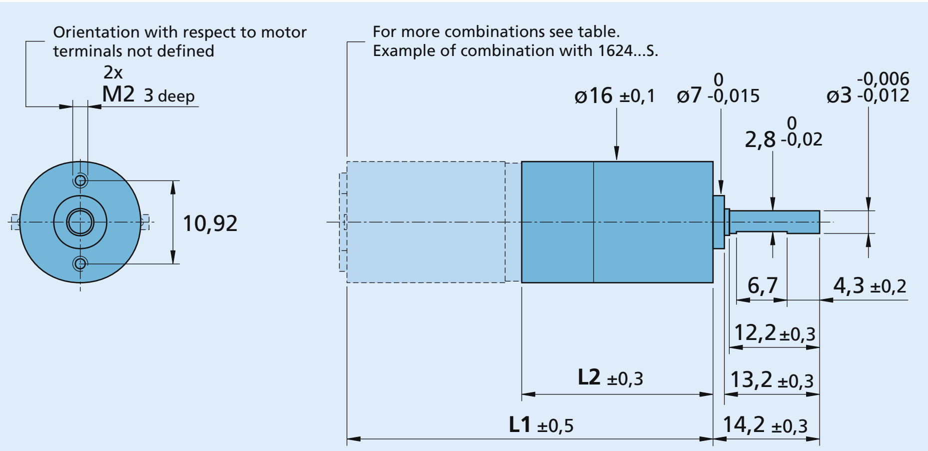
For combination with
DC-Micromotors
Brushless DC-Motors
Stepper Motors

Series 16/7

	16/7
Housing material	metal
Geartrain material	steel
Recommended max. input speed for:	
– continuous operation	5 000 rpm
Backlash, at no-load	≤ 1 °
Bearings on output shaft	ball bearings, preloaded
Shaft load, max.:	
– radial (6,5 mm from mounting face)	≤ 30 N
– axial	≤ 5 N
Shaft press fit force, max.	≤ 5 N
Shaft play	
– radial (6,5 mm from mounting face)	≤ 0,02 mm
– axial	= 0 mm
Operating temperature range	- 30 ... + 100 °C

Specifications							
Number of gear stages		**1**	**2**	**3**	**4**	**5**	**6**
Continuous torque	mNm	200	300	300	300	300	300
Intermittent torque	mNm	300	450	450	450	450	450
Weight without motor, ca.	g	18	23	28	33	38	43
Efficiency, max.	%	90	80	70	60	55	50
Direction of rotation, drive to output		=	=	=	=	=	=
Reduction ratio [1] (rounded)		**3,71:1**	**9,7:1** **14:1**	**43:1** **66:1**	**94:1** **112:1** **134:1** **159:1** **190:1** **246:1**	**415:1** **592:1** **989:1** **1 526:1**	**2 608:1** **4 365:1** **5 647:1**
L2 [mm] = length without motor		17,0	21,2	25,3	29,4	33,5	37,6
L1 [mm] = length with motor	1516T...SR	32,8	37,0	41,1	45,2	49,3	53,4
	1524T...SR	40,8	45,0	49,1	53,2	57,3	61,4
	1624T...S	40,8	45,0	49,1	53,2	57,3	61,4
	1717T...SR	34,0	38,2	42,3	46,4	50,5	54,6
	1724T...SR	41,0	45,2	49,3	53,4	57,5	61,6
	1727U...C	44,2	48,4	52,5	56,6	60,7	64,8
	1741U...CXR	58,2	62,4	66,5	70,6	74,7	78,8
	1524U...BSL	41,2	45,4	49,5	53,6	57,7	61,8
	1536U...BSL	53,6	57,8	61,9	66,0	70,1	74,2
	1628T...B	45,0	49,2	53,3	57,4	61,5	65,6
	AM1524...-55	33,4	37,6	41,7	45,8	49,9	54,0

[1] The reduction ratios are rounded, the exact values are available on request or at www.faulhaber.com.



16/7

Spur Gearheads

Zero Backlash

0,1 Nm

For combination with
DC-Micromotors

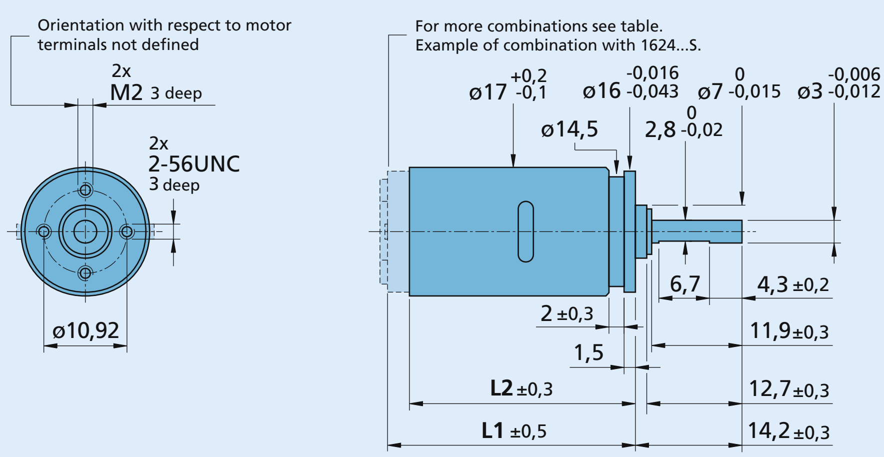
Series 16/8

	16/8
Housing material	metal
Geartrain material	steel
Recommended max. input speed for:	
– continuous operation	5 000 rpm
Backlash, at no-load	0 °
Bearings on output shaft	ball bearings, preloaded
Shaft load, max.:	
– radial (6,5 mm from mounting face)	≤ 25 N
– axial	≤ 5 N
Shaft press fit force, max.	≤ 5 N
Shaft play	
– radial (6,5 mm from mounting face)	≤ 0,02 mm
– axial	= 0 mm
Operating temperature range	- 30 ... + 100 °C

Specifications							
Number of gear stages		**4**	**4**	**5**	**5**	**6**	**6**
Continuous torque	mNm	100	100	100	100	100	100
Intermittent torque	mNm	300	150	300	150	300	150
Weight without motor, ca.	g	24	24	26	26	28	28
Efficiency, max.		-	-	-	-	-	-
Direction of rotation, drive to output		=	=	≠	≠	=	=
Reduction ratio [1] (rounded)		**76:1**	**141:1**	**262:1**	**485:1**	**900:1**	**1 670:1**
L2 [mm] = length without motor		32,0	32,0	34,1	34,1	36,2	36,2
L1 [mm] = length with motor 1624E...S		42,9	42,9	45,0	45,0	47,1	47,1

[1] The reduction ratios are rounded, the exact values are available on request or at www.faulhaber.com.

Note: These gearheads are available only with motors mounted.



16/8

Precision Gearheads

Planetary Gearheads

0,5 Nm

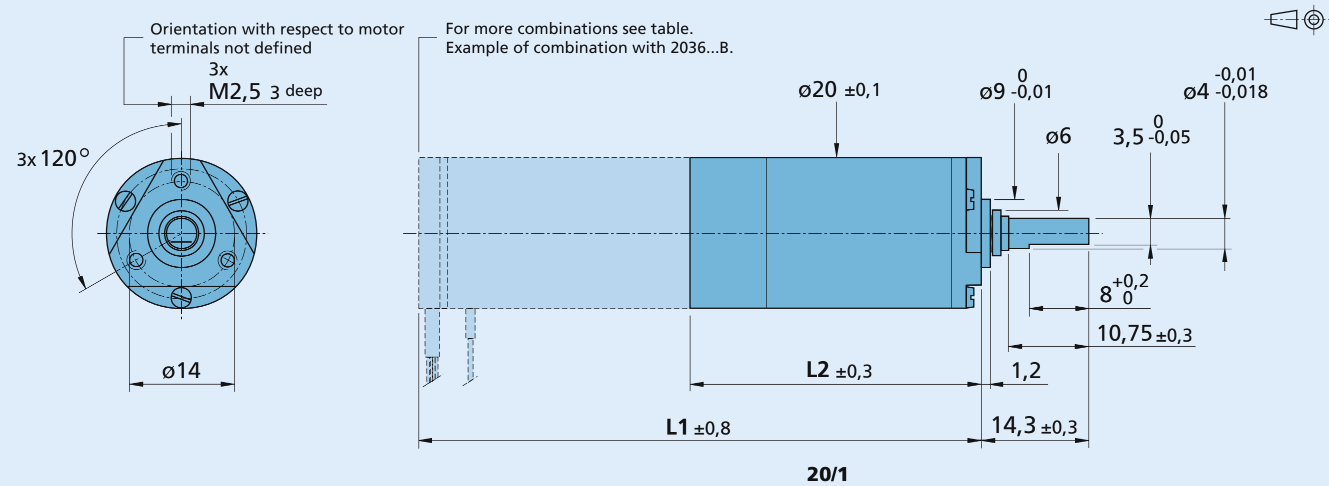
For combination with
DC-Micromotors
Brushless DC-Motors

Series 20/1

	20/1
Housing material	steel
Geartrain material	metal
Recommended max. input speed for:	
– continuous operation	5 000 rpm
Backlash, at no-load	≤ 1 °
Bearings on output shaft	ball bearings, preloaded
Shaft load, max.:	
– radial (8,5 mm from mounting face)	≤ 75 N
– axial	≤ 20 N
Shaft press fit force, max.	≤ 35 N
Shaft play	
– radial (8,5 mm from mounting face)	≤ 0,04 mm
– axial	= 0 mm
Operating temperature range	- 30 ... + 100 °C

Specifications								
Number of gear stages		1	2	2	3	3	4	5
Continuous torque	mNm	500	500	500	500	500	500	500
Intermittent torque	mNm	700	700	700	700	700	700	700
Weight without motor, ca.	g	28	38	38	48	48	58	68
Efficiency, max.	%	88	80	80	70	70	60	55
Direction of rotation, drive to output		=	=	=	=	=	=	=
Reduction ratio [1] (rounded)		**3,71:1**	**9,7:1** **14:1**	**23:1**	**43:1** **66:1**	**86:1**	**112:1** **134:1** **159:1** **190:1** **246:1**	**415:1** **592:1** **989:1** **1 526:1**
L2 [mm] = length without motor [2]		18,4	23,5	23,5	28,6	28,6	33,7	38,8
L1 [mm] = length with motor	1727U...C	45,6	50,7	50,7	55,8	55,8	60,9	66,0
	1741U...CXR	59,6	64,7	64,7	69,8	69,8	74,9	80,0
	2224U...SR	42,6	47,7	47,7	52,8	52,8	57,9	63,0
	2230U...S	48,4	53,5	53,5	58,6	58,6	63,7	68,8
	2232U...SR	50,6	55,7	55,7	60,8	60,8	65,9	71,0
	2233U...S	51,0	56,1	56,1	61,2	61,2	66,3	71,4
	2036U...B	54,4	59,5	59,5	64,6	64,6	69,7	74,8
	2057S...B	77,3	82,4	87,9	87,5	93,0	92,6	97,7
	2232U...BSL	54,5	59,6	59,6	64,7	64,7	69,8	74,9
	2248U...BSL	70,1	75,2	75,2	80,3	80,3	85,4	90,5

[1] The reduction ratios are rounded, the exact values are available on request or at www.faulhaber.com.
[2] L2 + 1,9 mm or 7,4 mm, in combination with 2057S...B.



20/1

FAULHABER

Planetary Gearheads

0,6 Nm

For combination with
DC-Micromotors
Stepper Motors

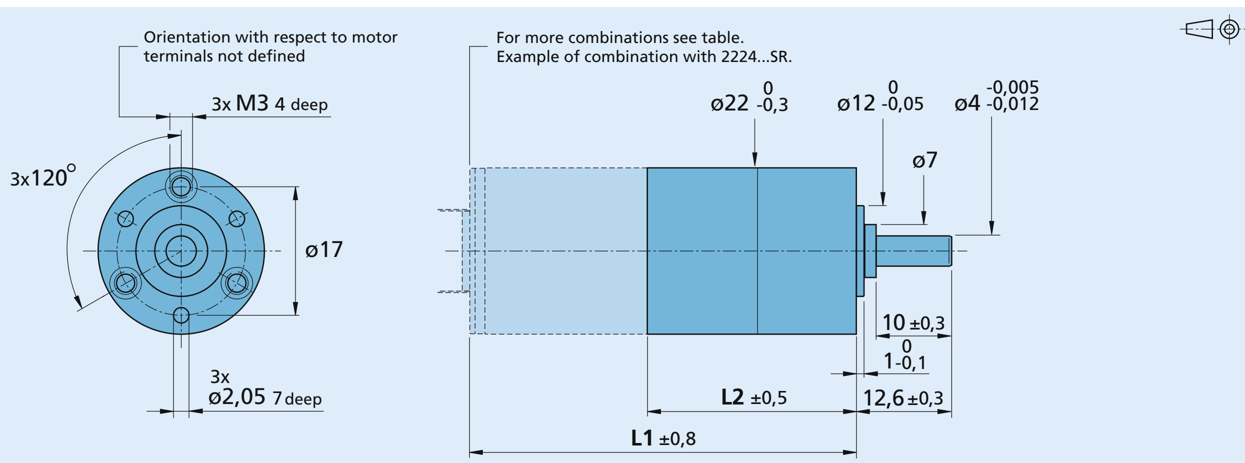
Series 22E

	22E	22EC	22EK
Housing material	plastic	plastic	plastic
Geartrain material	plastic	plastic	plastic
Recommended max. input speed for:			
– continuous operation	5 000 rpm	5 000 rpm	5 000 rpm
Backlash, at no-load	≤ 3 °	≤ 3 °	≤ 3 °
Bearings on output shaft	sintered bearings	ceramic bearings	ball bearings
Shaft load, max.:			
– radial (5 mm from mounting face)	≤ 3 N	≤ 15 N	≤ 50 N
– axial	≤ 3 N	≤ 2 N	≤ 5 N
Shaft press fit force, max.	≤ 15 N	≤ 15 N	≤ 15 N
Shaft play			
– radial (5 mm from mounting face)	≤ 0,05 mm	≤ 0,06 mm	≤ 0,07 mm
– axial	≤ 0,25 mm	≤ 0,25 mm	≤ 0,25 mm
Operating temperature range	- 30 ... + 65 °C	- 20 ... + 85 °C	- 30 ... + 85 °C

Specifications										
Number of gear stages			2	3	3	4	4	4	5	6
Continuous torque		mNm	200	300	400	400	500	600	600	600
Intermittent torque		mNm	400	600	800	800	1 000	1 000	1 000	1 000
Weight without motor, ca.		g	17	19	19	20	20	20	22	24
Efficiency, max.		%	78	69	67	62	61	60	55	49
Direction of rotation, drive to output			=	=	=	=	=	=	=	=
Reduction ratio [1] (rounded)	Code B [2]		**19:1**	**69:1**		**249:1**			**896:1**	**3 225:1**
	Code A [2]		**28:1**	**102:1**	**152:1**		**369:1**	**546:1** **809:1**	**1 327:1** **1 966:1** **2 913:1** **4 315:1**	**4 778:1** **7 078:1** **10 486:1** **15 534:1** **23 014:1**
L2 [mm] = length without motor [3]			27,1	32,1	32,1	37,1	37,1	37,1	42,1	47,1
L1 [mm] = length with motor	2224A/B...SR		51,3	56,3	56,3	61,3	61,3	61,3	66,3	71,3
	2230A/B...S		57,1	62,1	62,1	67,1	67,1	67,1	72,1	77,1
	2232A/B...SR		59,3	64,3	64,3	69,3	69,3	69,3	74,3	79,3
	2233A/B...S		59,7	64,7	64,7	69,7	69,7	69,7	74,7	79,7
	AM2224...-12		54,8	59,8	59,8	64,8	64,8	64,8	69,8	74,8

[1] The reduction ratios are rounded, the exact values are available on request or at www.faulhaber.com.
[2] Example of ordering information: 2224 **B** 012 SR + 22E 19:1, not for AM2224.
[3] L2 + 0,7 mm, in combination with 2224A/B...SR and 2232A/B...SR.

Note: These gearheads are available only with motors mounted.



22E, 22EC, 22EK

Precision Gearheads

Planetary Gearheads

1,2 Nm

For combination with
DC-Micromotors
Stepper Motors

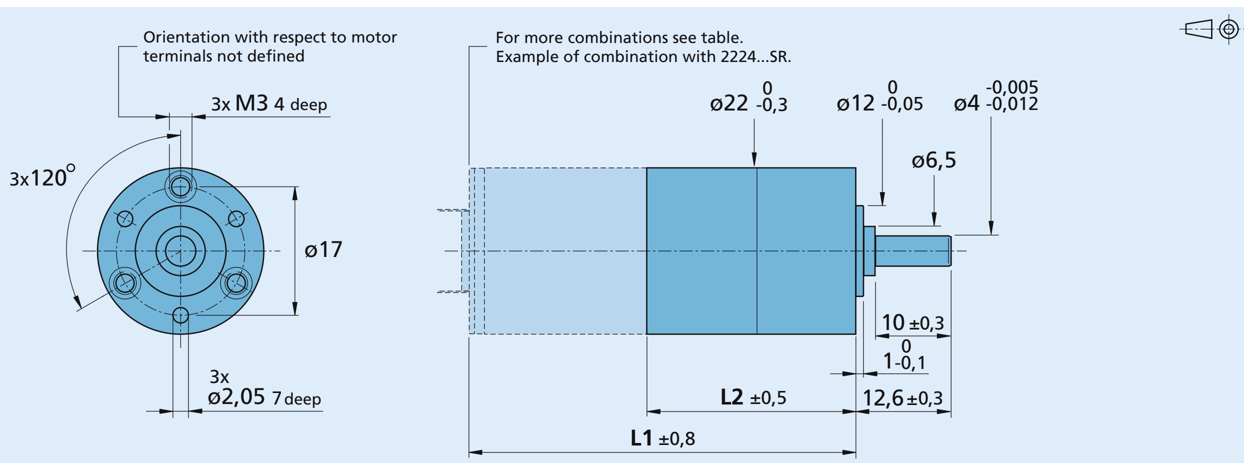
Series 22EKV

	22EKV
Housing material	plastic
Geartrain material	plastic/steel/ceramic
Recommended max. input speed for:	
– continuous operation	5 000 rpm
Backlash, at no-load	≤ 3 °
Bearings on output shaft	ball bearings
Shaft load, max.:	
– radial (5 mm from mounting face)	≤ 50 N
– axial	≤ 5 N
Shaft press fit force, max.	≤ 15 N
Shaft play	
– radial (5 mm from mounting face)	≤ 0,07 mm
– axial	≤ 0,25 mm
Operating temperature range	- 30 ... + 85 °C

Specifications										
Number of gear stages			**2**	**3**	**3**	**4**	**4**	**4**	**5**	**6**
Continuous torque		Nm	0,4	0,6	0,8	0,8	1	1,2	1,2	1,2
Intermittent torque		Nm	0,8	1,2	1,6	1,6	2	2	2	2
Weight without motor, ca.		g	27	29	29	30	30	30	32	34
Efficiency, max.		%	77	68	68	61	61	61	53	47
Direction of rotation, drive to output			=	=	=	=	=	=	=	=
Reduction ratio [1] (rounded)	Code B [2]		**19:1**	**69:1**		**249:1**			**896:1**	**3 225:1**
	Code A [2]		**28:1**	**102:1**	**152:1**		**369:1**	**546:1** **809:1**	**1 327:1** **1 966:1** **2 913:1** **4 315:1**	**4 778:1** **7 078:1** **10 486:1** **15 534:1** **23 014:1**
L2 [mm] = length without motor [3]			27,1	32,1	32,1	37,1	37,1	37,1	42,1	47,1
L1 [mm] = length with motor	2224A/B...SR		51,3	56,3	56,3	61,3	61,3	61,3	66,3	71,3
	2230A/B...S		57,1	62,1	62,1	67,1	67,1	67,1	72,1	77,1
	2232A/B...SR		59,3	64,3	64,3	69,3	69,3	69,3	74,3	79,3
	2233A/B...S		59,7	64,7	64,7	69,7	69,7	69,7	74,7	79,7
	AM2224...-12		54,8	59,8	59,8	64,8	64,8	64,8	69,8	74,8

[1] The reduction ratios are rounded, the exact values are available on request or at www.faulhaber.com.
[2] Example of ordering information: 2224 **B** 012SR + 22EKV 19:1, not for AM2224.
[3] L2 + 0,7 mm, in combination with 2224A/B...SR and 2232A/B...SR.

Note: These gearheads are available only with motors mounted.



22EKV

Precision Gearheads

Planetary Gearheads

1 Nm

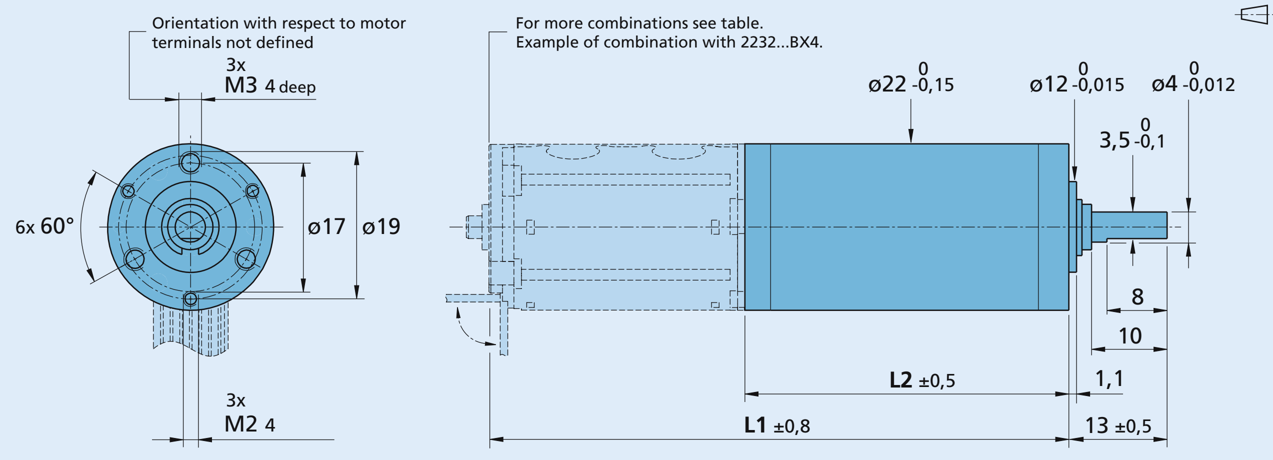
For combination with
DC-Micromotors
Brushless DC-Motors

Series 22F

	22F
Housing material	steel
Geartrain material	metal
Recommended max. input speed for:	
– continuous operation	6 000 rpm
Backlash, at no-load	≤ 3,5 °
Bearings on output shaft	ball bearings
Shaft load, max.:	
– radial (10 mm from mounting face)	≤ 70 N
– axial	≤ 100 N
Shaft press fit force, max.	≤ 100 N
Shaft play	
– radial (10 mm from mounting face)	≤ 0,06 mm
– axial	≤ 0,2 mm
Operating temperature range	- 30 ... + 100 °C

Specifications					
Number of gear stages		**1**	**2**	**3**	**4**
Continuous torque	mNm	400	600	900	1 000
Intermittent torque	mNm	600	900	1 350	1 500
Weight without motor, ca.	g	41	57	75	90
Efficiency, max.	%	80	75	70	60
Direction of rotation, drive to output		=	=	=	=
Reduction ratio [1] (rounded)		**4:1**	**14:1**	**51:1**	**189:1**
			16:1	**59:1**	**218:1**
			19:1	**68:1**	**252:1**
			25:1	**71:1**	**264:1**
				93:1	**292:1**
				100:1	**305:1**
				107:1	**344:1**
				130:1	
				169:1	
L2 [mm] = length without motor		26,6	34,8	42,9	51,1
L1 [mm] = length with motor	2224U...SR	50,8	59,0	67,1	75,3
	2232U...SR	58,8	67,0	75,1	83,3
	2237S...CXR	63,6	71,8	79,9	88,1
	2342S...CR	68,6	76,8	84,9	93,1
	2232S...BX4(S)	60,4	68,6	76,7	84,9
	2250S...BX4(S)	78,4	86,6	94,7	102,9

[1] The reduction ratios are rounded, the exact values are available on request or at www.faulhaber.com.



22F

Spur Gearheads

0,1 Nm

For combination with
DC-Micromotors
Brushless DC-Motors
Stepper Motors

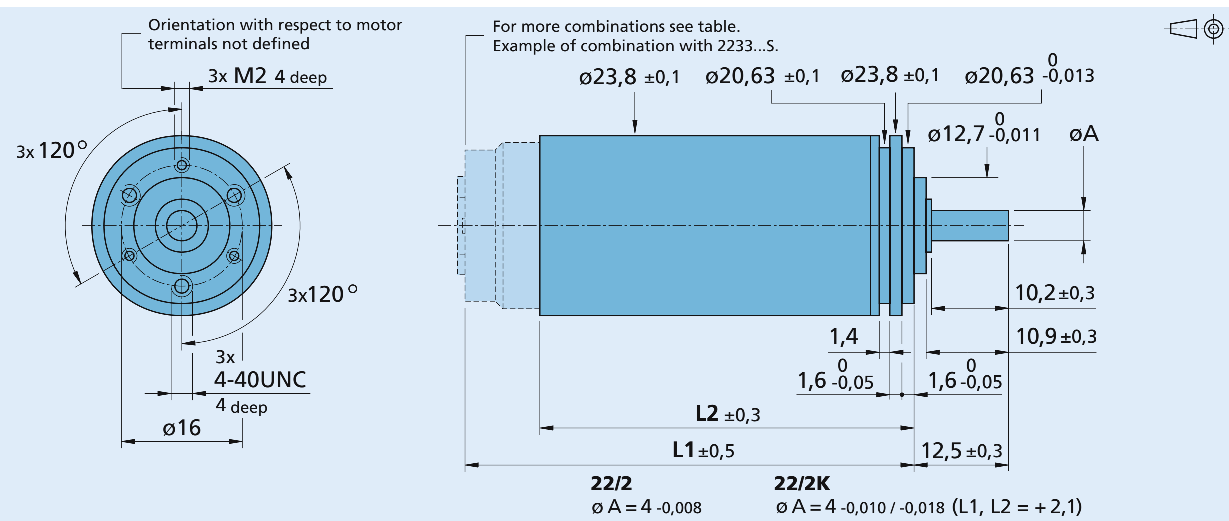
Series 22/2

	22/2	22/2K
Housing material	metal	metal
Geartrain material	metal	metal
Recommended max. input speed for:		
– continuous operation	4 000 rpm	4 000 rpm
Backlash, at no-load	≤ 3 °	≤ 3 °
Bearings on output shaft	sintered bearings	ball bearings, preloaded
Shaft load, max.:		
– radial (6 mm from mounting face)	≤ 3 N	≤ 100 N
– axial	≤ 5 N	≤ 5 N
Shaft press fit force, max.	≤ 50 N	≤ 5 N
Shaft play		
– radial (6 mm from mounting face)	≤ 0,04 mm	≤ 0,03 mm
– axial	≤ 0,2 mm	= 0 mm
Operating temperature range	- 30 ... + 100 °C	- 30 ... + 100 °C

Specifications										
Number of gear stages		**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Continuous torque	mNm	100	100	100	100	100	100	100	100	100
Intermittent torque	mNm	400	400	400	400	400	400	400	400	400
Weight without motor, ca.	g	58	68	72	77	82	88	93	98	103
Efficiency, max.	%	90	86	81	73	66	59	53	48	43
Direction of rotation, drive to output		=	≠	=	≠	=	≠	=	≠	=
Reduction ratio [1] (rounded)		**3,1:1** **5,4:1**	**9,7:1**	**17,2:1** **30,7:1**	**54,6:1** **97,3:1**	**173:1** **308:1**	**548:1** **975:1**	**1 734:1** **3 088:1**	**5 490:1** **9 780:1**	**17 386:1** **30 969:1**
L2 [mm] = length without motor		40,8	46,6	49,5	52,4	55,3	58,2	61,1	64,0	66,9
L1 [mm] = length with motor	2224R...SR	45,4	50,0	53,6	56,5	59,4	62,3	65,2	68,1	71,0
	2230F/R...S	51,2	55,8	59,4	62,3	65,2	68,1	71,0	73,9	76,8
	2232U...SR	53,4	58,0	61,6	64,5	67,4	70,3	73,2	76,1	79,0
	2233F/R...S	54,0	58,6	62,2	65,1	68,0	70,9	73,8	76,7	79,6
	2232U...BSL	57,3	61,9	65,5	68,4	71,3	74,2	77,1	80,0	82,9
	2248U...BSL	72,9	77,5	81,1	84,0	86,9	89,8	92,7	95,6	98,5
	AM2224...-14	48,9	53,5	57,1	60,0	62,9	65,8	68,7	71,6	74,5

[1] The reduction ratios are rounded, the exact values are available on request or at www.faulhaber.com.

Note: Reduction ratios from 55 057:1 to 983 447:1 are available on request.



Spur Gearheads

Zero Backlash

0,1 Nm

For combination with
DC-Micromotors
Brushless DC-Motors
Stepper Motors

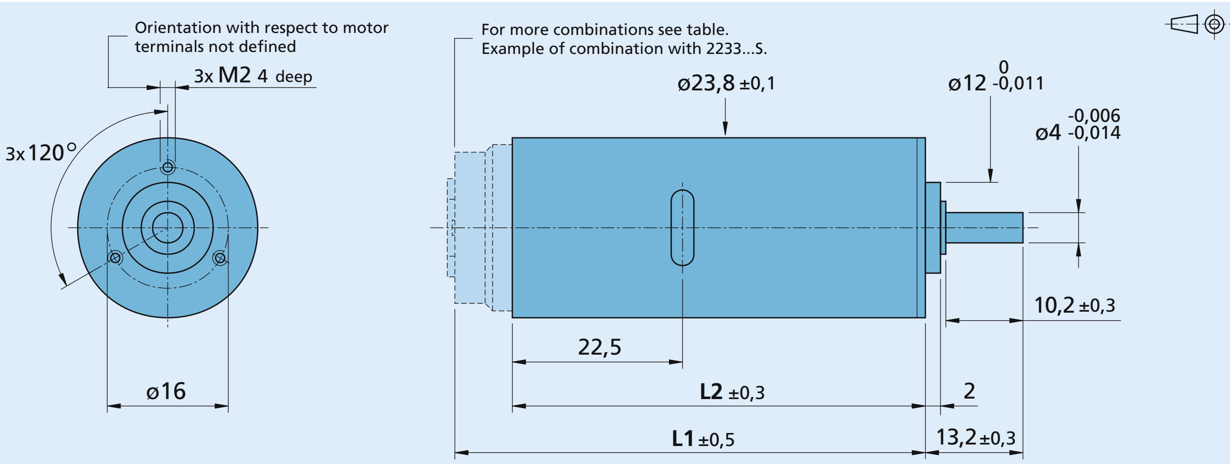
Series 22/5

	22/5
Housing material	metal
Geartrain material	metal
Recommended max. input speed for:	
– continuous operation	4 000 rpm
Backlash, at no-load	0 °
Bearings on output shaft	ball bearings, preloaded
Shaft load, max.:	
– radial (6 mm from mounting face)	≤ 100 N
– axial	≤ 5 N
Shaft press fit force, max.	≤ 5 N
Shaft play	
– radial (6 mm from mounting face)	≤ 0,02 mm
– axial	= 0 mm
Operating temperature range	- 30 ... + 100 °C

Specifications							
Number of gear stages			5	6	7	8	9
Continuous torque		mNm	100	100	100	100	100
Intermittent torque		mNm	400	400	400	400	400
Weight without motor, ca.		g	80	85	90	95	105
Efficiency, max.			-	-	-	-	-
Direction of rotation, drive to output			≠	=	≠	=	≠
Reduction ratio [1] (rounded)			**69,2:1**	**161:1**	**377:1**	**879:1**	**2 050:1**
L2 [mm] = length without motor			50,9	54,6	59,5	63,2	68,1
L1 [mm] = length with motor	2224R...SR		57,8	61,6	66,5	70,3	75,2
	2230F/R...S		63,6	67,4	72,3	76,1	81,0
	2232U...SR		65,8	69,6	74,5	78,3	83,2
	2233F/R...S		66,2	70,0	74,9	78,7	83,6
	2232U...BSL		69,7	73,5	78,4	82,2	87,1
	2248U...BSL		85,3	89,1	94,0	97,8	102,7
	AM2224...-14		61,4	65,2	70,1	73,9	78,8

[1] The reduction ratios are rounded, the exact values are available on request or at www.faulhaber.com.

Note: These gearheads are available only with motors mounted.



22/5

Planetary Gearheads

0,7 Nm

For combination with
DC-Micromotors
Brushless DC-Motors

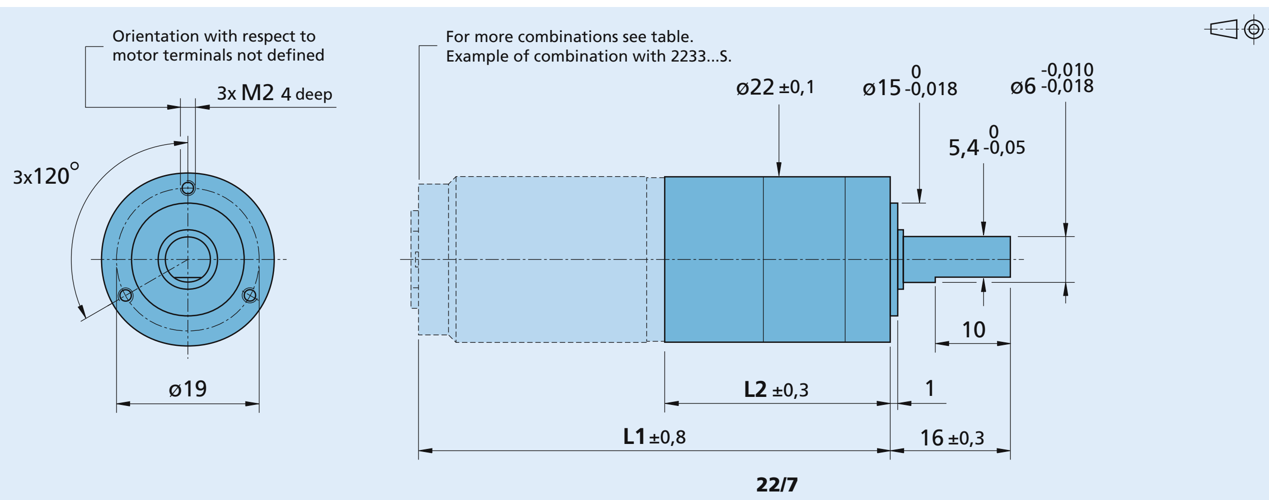
Series 22/7

	22/7
Housing material	metal
Geartrain material	steel
Recommended max. input speed for:	
– continuous operation	4 000 rpm
Backlash, at no-load	≤ 1 °
Bearings on output shaft	ball bearings, preloaded
Shaft load, max.:	
– radial (10 mm from mounting face)	≤ 170 N
– axial	≤ 150 N
Shaft press fit force, max.	≤ 150 N
Shaft play	
– radial (10 mm from mounting face)	≤ 0,03 mm
– axial	≤ 0,1 mm
Operating temperature range	- 30 ... + 100 °C

Specifications						
Number of gear stages		1	2	3	4	5
Continuous torque	mNm	200	300	700	700	700
Intermittent torque	mNm	400	600	1 000	1 000	1 000
Weight without motor, ca.	g	68	63	76	88	102
Efficiency, max.	%	88	80	70	60	55
Direction of rotation, drive to output		=	=	=	=	=
Reduction ratio [1]		**3,71:1**	**9,7:1**	**43:1**	**94:1**	**415:1**
(rounded)			**14:1**	**66:1**	**112:1**	**592:1**
					134:1	**989:1**
					159:1	**1 526:1**
					190:1	
					246:1	
L2 [mm] = length without motor [2]		27,9	34,1	40,3	46,4	52,6
L1 [mm] = length with motor	2224U...SR	48,2	54,4	60,6	66,7	72,9
	2230U...S	54,0	60,2	66,4	72,5	78,7
	2232U...SR	56,2	62,4	68,6	74,7	80,9
	2233U...S	56,6	62,8	69,0	75,1	81,3
	2237S...CXR	64,9	71,1	77,3	83,4	89,6
	2342S...CR	69,9	76,1	82,3	88,4	94,6
	2232S...BSL	60,3	66,5	72,7	78,8	85,0
	2232S...BX4(S)	61,7	67,9	74,1	80,2	86,4
	2248S...BSL	75,9	82,1	88,3	94,4	100,6
	2250S...BX4(S)	79,7	85,9	92,1	98,2	104,4
	2444S...B	71,9	78,1	84,3	90,4	96,6

[1] The reduction ratios are rounded, the exact values are available on request or at www.faulhaber.com.
[2] L2 - 3,9 mm, in combination with 2224U...SR, 2230U...S, 2232U...SR and 2233U...S.

Note: Reduction ratio 3,71:1 with motor types 2224U...SR, 2230U...S, 2232U...SR and 2233U...S shall be ordered as 22/7 3,71:1 - K288.



Precision Gearheads

Planetary Gearheads

0,7 Nm

For combination with
DC-Micromotors
Brushless DC-Motors
Stepper Motors

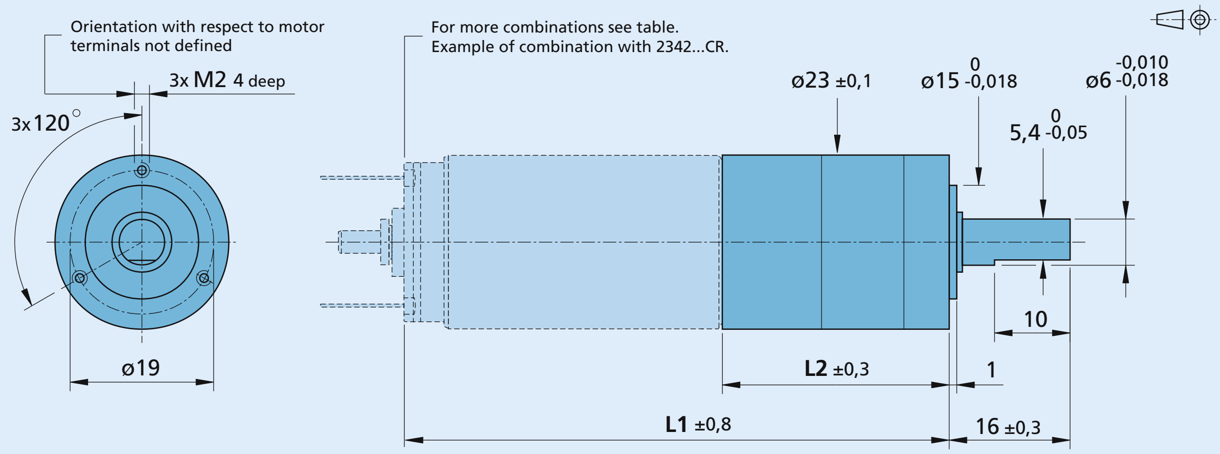
Series 23/1

	23/1
Housing material	metal
Geartrain material	steel
Recommended max. input speed for:	
– continuous operation	4 000 rpm
Backlash, at no-load	≤ 1 °
Bearings on output shaft	ball bearings, preloaded
Shaft load, max.:	
– radial (10 mm from mounting face)	≤ 170 N
– axial	≤ 150 N
Shaft press fit force, max.	≤ 150 N
Shaft play	
– radial (10 mm from mounting face)	≤ 0,03 mm
– axial	≤ 0,1 mm
Operating temperature range	- 30 ... + 100 °C

Specifications							
Number of gear stages			1	2	3	4	5
Continuous torque		mNm	200	300	700	700	700
Intermittent torque		mNm	400	600	1 000	1 000	1 000
Weight without motor, ca.		g	60	70	90	100	110
Efficiency, max.		%	88	80	70	60	55
Direction of rotation, drive to output			=	=	=	=	=
Reduction ratio [1]			**3,71:1**	**9,7:1**	**43:1**	**94:1**	**415:1**
(rounded)				**14:1**	**66:1**	**112:1**	**592:1**
						134:1	**989:1**
						159:1	**1 526:1**
						190:1	
						246:1	
L2 [mm] = length without motor [2]			27,9	34,1	40,3	46,4	52,6
L1 [mm] = length with motor	2224U...SR		48,2	54,4	60,6	66,7	72,9
	2230U...S		54,0	60,2	66,4	72,5	78,7
	2232U...SR		56,2	62,4	68,6	74,7	80,9
	2233U...S		56,6	62,8	69,0	75,1	81,3
	2237S...CXR		64,9	71,1	77,3	83,4	89,6
	2342S...CR		69,9	76,1	82,3	88,4	94,6
	2057S...B		84,9	91,1	97,3	103,4	109,6
	2232S...BSL		60,3	66,5	72,7	78,8	85,0
	2248S...BSL		75,9	82,1	88,3	94,4	100,6
	2444S...B		71,9	78,1	84,3	90,4	96,6
	AM2224...-10		55,6	61,8	68,0	74,1	80,3

[1] The reduction ratios are rounded, the exact values are available on request or at www.faulhaber.com.
[2] L2 - 3,9 mm, in combination with 2224U...SR, 2230U...S, 2232U...SR, 2233U...S and AM2224.

Note: Reduction ratio 3,71:1 with motor types 2224U...SR, 2230U...S, 2232U...SR and 2233U...S shall be ordered as 23/1 3,71:1 - K288.



23/1

Planetary Gearheads

1 Nm

For combination with
DC-Micromotors
Brushless DC-Motors

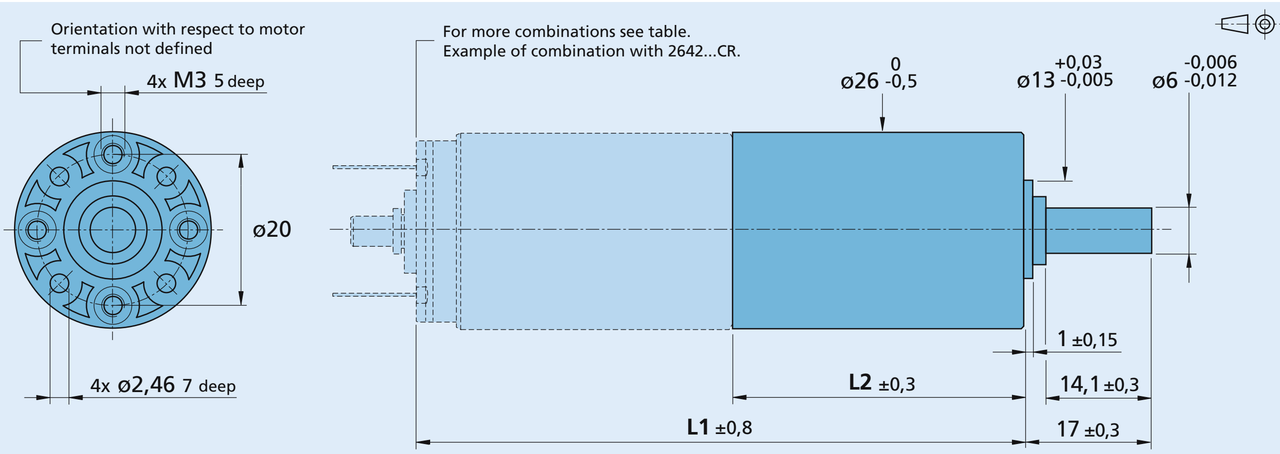
Series 26A

	26A	26AK
Housing material	plastic	plastic
Geartrain material	plastic	plastic
Recommended max. input speed for:		
– continuous operation	5 000 rpm	5 000 rpm
Backlash, at no-load	≤ 3 °	≤ 3 °
Bearings on output shaft	sintered bearings	ball bearings
Shaft load, max.:		
– radial (10 mm from mounting face)	≤ 4 N	≤ 60 N
– axial	≤ 4 N	≤ 15 N
Shaft press fit force, max.	≤ 20 N	≤ 20 N
Shaft play		
– radial (10 mm from mounting face)	≤ 0,08 mm	≤ 0,1 mm
– axial	≤ 0,25 mm	≤ 0,25 mm
Operating temperature range	- 30 ... + 65 °C	- 30 ... + 85 °C

Specifications								
Number of gear stages			**2**	**2**	**3**	**3**	**4**	**4**
Continuous torque		mNm	300	300	750	800	900	1 000
Intermittent torque		mNm	500	600	1 100	1 200	1 400	1 500
Weight without motor, ca.		g	21	21	23	23	25	25
Efficiency, max.		%	81	81	73	73	64	64
Direction of rotation, drive to output			=	=	=	=	=	=
Reduction ratio [1] (rounded)			**13:1**	**16:1**	**40:1**	**50:1** **64:1**	**124:1**	**158:1** **201:1** **256:1**
L2 [mm] = length without motor			32,7	32,7	38,5	38,5	44,3	44,3
L1 [mm] = length with motor	2232U...SR		67,4	67,4	73,2	73,2	79,0	79,0
	2237S...CXR		69,7	69,7	75,5	75,5	81,3	81,3
	2342S...CR		74,7	74,7	80,5	80,5	86,3	86,3
	2642W...CR		74,7	74,7	80,5	80,5	86,3	86,3
	2642W...CXR		74,7	74,7	80,5	80,5	86,3	86,3
	2657W...CR		89,7	89,7	95,5	95,5	101,3	101,3
	2657W...CXR		89,7	89,7	95,5	95,5	101,3	101,3
	2232S...BX4(S)		66,5	66,5	72,3	72,3	78,1	78,1
	2250S...BX4(S)		84,5	84,5	90,3	90,3	96,1	96,1

[1] The reduction ratios are rounded, the exact values are available on request or at www.faulhaber.com.

Note: These gearheads are available only with motors mounted.



26A, 26AK

Planetary Gearheads

3,5 Nm

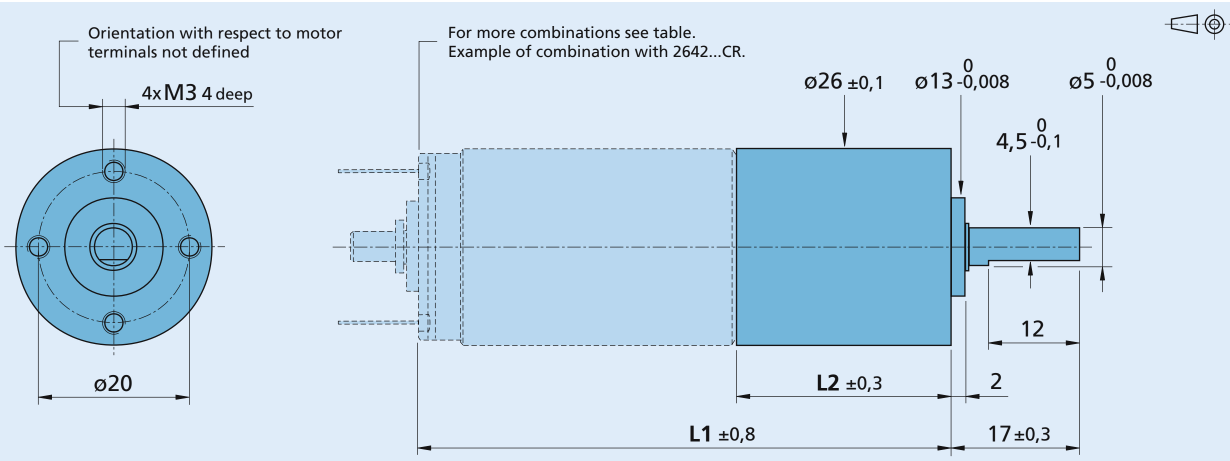
For combination with
DC-Micromotors
Brushless DC-Motors

Series 26/1

	26/1
Housing material	steel
Geartrain material [1]	plastic/steel
Recommended max. input speed for:	
– continuous operation	4 000 rpm
Backlash, at no-load	≤ 1 °
Bearings on output shaft	ball bearings, preloaded
Shaft load, max.:	
– radial (10 mm from mounting face)	≤ 150 N
– axial	≤ 100 N
Shaft press fit force, max.	≤ 150 N
Shaft play	
– radial (10 mm from mounting face)	≤ 0,03 mm
– axial	≤ 0,1 mm
Operating temperature range	- 30 ... + 100 °C

Specifications								
Number of gear stages		1	2	3	3	4	4	5
Continuous torque	Nm	1,1	0,3	1	1,5	2,5	3,5	3,5
Intermittent torque	Nm	2,3	0,4	1,2	1,8	3,5	4,5	4,5
Weight without motor, ca.	g	93	116	139	139	162	162	185
Efficiency, max.	%	88	80	70	70	60	60	55
Direction of rotation, drive to output		=	=	=	=	=	=	=
Reduction ratio [2]		**3,71:1**	**14:1**	**43:1**	**66:1**	**134:1**	**159:1**	**415:1**
(rounded)							**246:1**	**592:1**
								989:1
								1 526:1
L2 [mm] = length without motor		28,4	36,4	44,4	44,4	52,4	52,4	60,5
L1 [mm] = length with motor	2342S...CR	70,4	78,4	86,4	86,4	94,4	94,4	102,5
	2642W...CR	70,4	78,4	86,4	86,4	94,4	94,4	102,5
	2642W...CXR	70,4	78,4	86,4	86,4	94,4	94,4	102,5
	2657W...CR	85,4	93,4	101,4	101,4	109,4	109,4	117,5
	2657W...CXR	85,4	93,4	101,4	101,4	109,4	109,4	117,5
	2232S...BSL	60,8	68,8	76,8	76,8	84,8	84,8	92,9
	2248S...BSL	76,4	84,4	92,4	92,4	100,4	100,4	108,5
	2444S...B	72,4	80,4	88,4	88,4	96,4	96,4	104,5

[1] Gearheads with ratios < 14:1 have all steel gears.
[2] The reduction ratios are rounded, the exact values are available on request or at www.faulhaber.com.



26/1

Precision Gearheads

Planetary Gearheads

3,5 Nm

For combination with
DC-Micromotors
Brushless DC-Motors

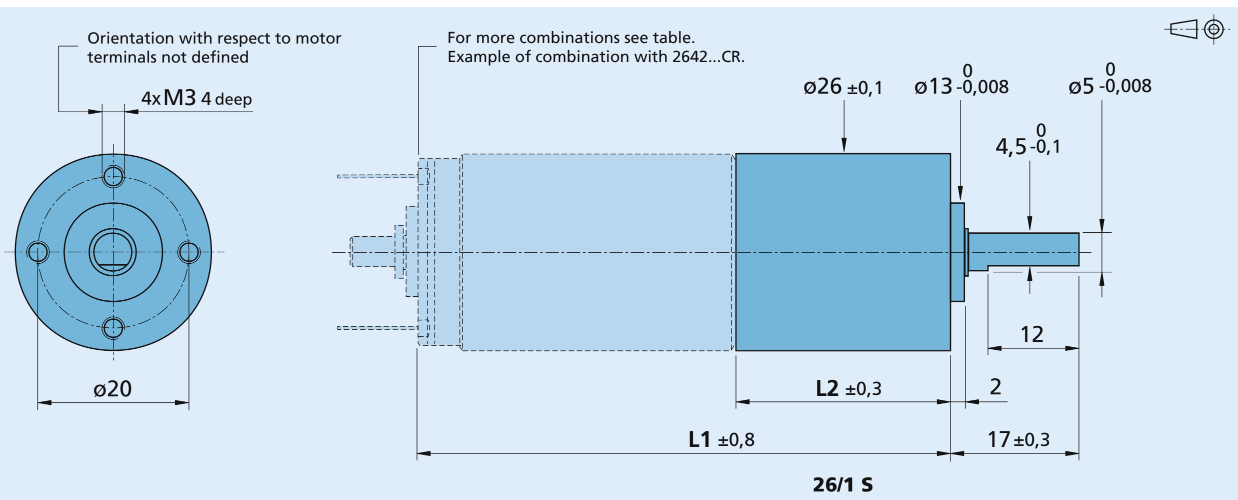
Series 26/1 S

	26/1 S
Housing material	steel
Geartrain material	steel
Recommended max. input speed for:	
– continuous operation	4 000 rpm
Backlash, at no-load	≤ 1 °
Bearings on output shaft	ball bearings, preloaded
Shaft load, max.:	
– radial (10 mm from mounting face)	≤ 150 N
– axial	≤ 100 N
Shaft press fit force, max.	≤ 150 N
Shaft play	
– radial (10 mm from mounting face)	≤ 0,03 mm
– axial	≤ 0,1 mm
Operating temperature range	- 30 ... + 100 °C

Specifications						
Number of gear stages			2	3	4	5
Continuous torque		Nm	3,5	3,5	3,5	3,5
Intermittent torque		Nm	4,5	4,5	4,5	4,5
Weight without motor, ca.		g	116	139	162	185
Efficiency, max.		%	80	70	60	55
Direction of rotation, drive to output			=	=	=	=
Reduction ratio [1]			**9,7:1**	**43:1**	**134:1**	**415:1**
(rounded)			**14:1**	**66:1**	**159:1**	**592:1**
			23:1	**86:1**	**246:1**	**989:1**
						1 526:1
L2 [mm] = length without motor			36,4	44,4	52,4	60,5
L1 [mm] = length with motor	2342S...CR		78,4	86,4	94,4	102,5
	2642W...CR		78,4	86,4	94,4	102,5
	2642W...CXR		78,4	86,4	94,4	102,5
	2657W...CR		93,4	101,4	109,4	117,5
	2657W...CXR		93,4	101,4	109,4	117,5
	2232S...BSL		68,8	76,8	84,8	92,9
	2248S...BSL		84,4	92,4	100,4	108,5
	2444S...B		80,4	88,4	96,4	104,5

[1] The reduction ratios are rounded, the exact values are available on request or at www.faulhaber.com.

Note: The gearheads as S-type have all steel gears and heavy duty lubricant for extended lifetime performance.



Planetary Gearheads

4,5 Nm

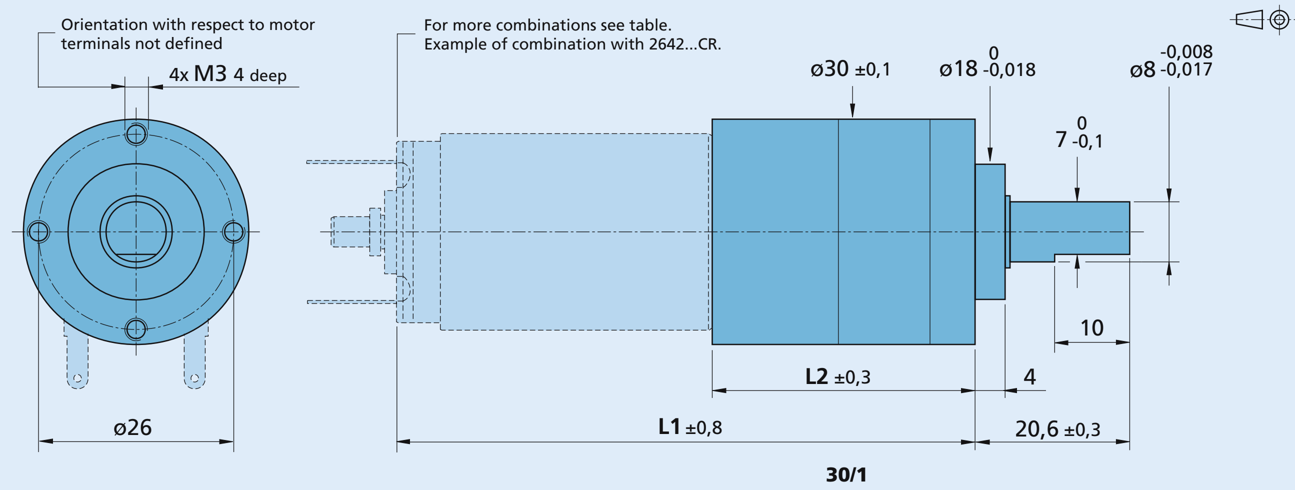
For combination with
DC-Micromotors
Brushless DC-Motors

Series 30/1

	30/1
Housing material	metal
Geartrain material 1)	plastic/steel
Recommended max. input speed for:	
– continuous operation	4 000 rpm
Backlash, at no-load	≤ 1 °
Bearings on output shaft	ball bearings, preloaded
Shaft load, max.:	
– radial (15 mm from mounting face)	≤ 150 N
– axial	≤ 150 N
Shaft press fit force, max.	≤ 200 N
Shaft play	
– radial (15 mm from mounting face)	≤ 0,03 mm
– axial	≤ 0,15 mm
Operating temperature range	- 30 ... + 100 °C

Specifications								
Number of gear stages		**1**	**2**	**3**	**3**	**4**	**4**	**5**
Continuous torque	Nm	1,5	0,35	1,2	1,8	3,5	4,5	4,5
Intermittent torque	Nm	3	0,5	1,6	2,4	4,5	6	6
Weight without motor, ca.	g	107	139	171	171	203	203	235
Efficiency, max.	%	88	80	70	70	60	60	55
Direction of rotation, drive to output		=	=	=	=	=	=	=
Reduction ratio 2) (rounded)		**3,71:1**	**14:1**	**43:1**	**66:1**	**134:1**	**159:1** **246:1**	**415:1** **592:1** **989:1** **1 526:1**
L2 [mm] = length without motor 3)		27,1	35,1	43,1	43,1	51,2	51,2	59,2
L1 [mm] = length with motor	2342S...CR	69,1	77,1	85,1	85,1	93,2	93,2	101,2
	2642W...CR	69,1	77,1	85,1	85,1	93,2	93,2	101,2
	2642W...CXR	69,1	77,1	85,1	85,1	93,2	93,2	101,2
	2657W...CR	84,1	92,1	100,1	100,1	108,2	108,2	116,2
	2657W...CXR	84,1	92,1	100,1	100,1	108,2	108,2	116,2
	3557K...CS	85,5	93,5	101,5	101,5	109,6	109,6	117,6
	2232S...BSL	59,5	67,5	75,5	75,5	83,6	83,6	91,6
	2248S...BSL	75,1	83,1	91,1	91,1	99,2	99,2	107,2
	2444S...B	71,1	79,1	87,1	87,1	95,2	95,2	103,2
	3056K...B	84,5	92,5	100,5	100,5	108,6	108,6	116,6
	3242G...BX4	71,3	79,3	87,3	87,3	95,4	95,4	103,4
	3268G...BX4	97,3	105,3	113,3	113,3	121,4	121,4	129,4
	3564K...B	92,5	100,5	108,5	108,5	116,6	116,6	124,6

1) Gearheads with ratios < 14:1 have all steel gears.
2) The reduction ratios are rounded, the exact values are available on request or at www.faulhaber.com.
3) L2 + 1,4 mm, in combination with 3056K...B, 3557K...CS and 3564K...B.



Planetary Gearheads

4,5 Nm

For combination with
DC-Micromotors
Brushless DC-Motors

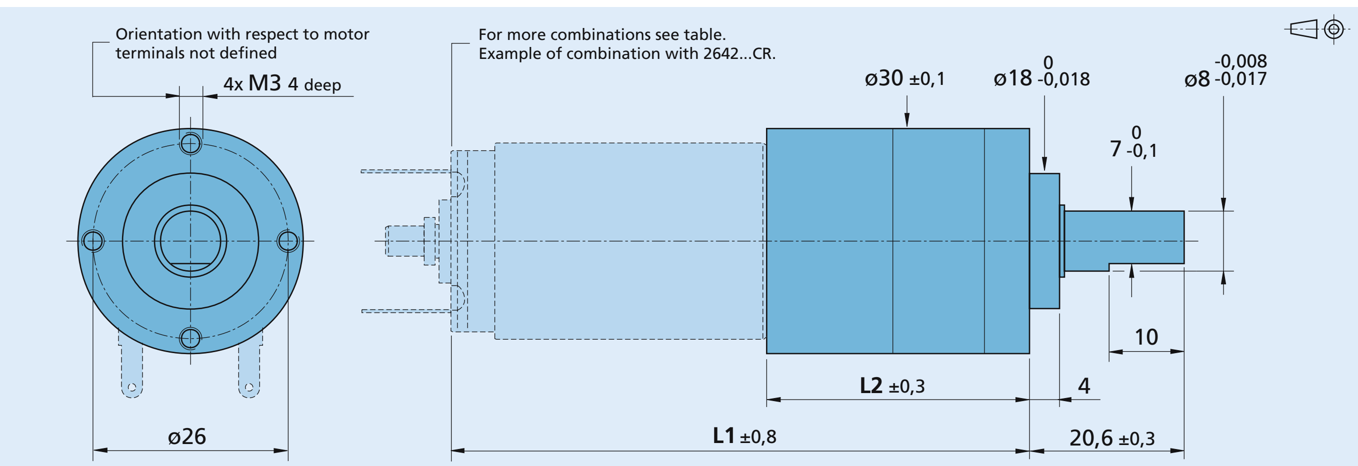
Series 30/1 S

	30/1 S
Housing material	metal
Geartrain material	steel
Recommended max. input speed for:	
– continuous operation	4 000 rpm
Backlash, at no-load	≤ 1 °
Bearings on output shaft	ball bearings, preloaded
Shaft load, max.:	
– radial (15 mm from mounting face)	≤ 150 N
– axial	≤ 150 N
Shaft press fit force, max.	≤ 200 N
Shaft play	
– radial (15 mm from mounting face)	≤ 0,03 mm
– axial	≤ 0,15 mm
Operating temperature range	- 30 ... + 100 °C

Specifications					
Number of gear stages		**2**	**3**	**4**	**5**
Continuous torque	Nm	4,5	4,5	4,5	4,5
Intermittent torque	Nm	6	6	6	6
Weight without motor, ca.	g	139	171	203	235
Efficiency, max.	%	80	70	60	55
Direction of rotation, drive to output		=	=	=	=
Reduction ratio [1]		**9,7:1**	**43:1**	**134:1**	**415:1**
(rounded)		**14:1**	**66:1**	**159:1**	**592:1**
		23:1	**86:1**	**246:1**	**989:1**
					1 526:1
L2 [mm] = length without motor [2]		35,1	43,1	51,2	59,2
L1 [mm] = length with motor	2342S...CR	77,1	85,1	93,2	101,2
	2642W...CR	77,1	85,1	93,2	101,2
	2642W...CXR	77,1	85,1	93,2	101,2
	2657W...CR	92,1	100,1	108,2	116,2
	2657W...CXR	92,1	100,1	108,2	116,2
	3557K...CS	93,5	101,5	109,6	117,6
	2232S...BSL	67,5	75,5	83,6	91,6
	2248S...BSL	83,1	91,1	99,2	107,2
	2444S...B	79,1	87,1	95,2	103,2
	3056K...B	92,5	100,5	108,6	116,6
	3242G...BX4	79,3	87,3	95,4	103,4
	3268G...BX4	105,3	113,3	121,4	129,4
	3564K...B	100,5	108,5	116,6	124,6

[1] The reduction ratios are rounded, the exact values are available on request or at www.faulhaber.com.
[2] L2 + 1,4 mm, in combination with 3056K...B, 3557K...CS and 3564K...B.

Note: The gearheads as S-type have all steel gears and heavy duty lubricant for extended lifetime performance.



30/1 S

Planetary Gearheads

4,5 Nm

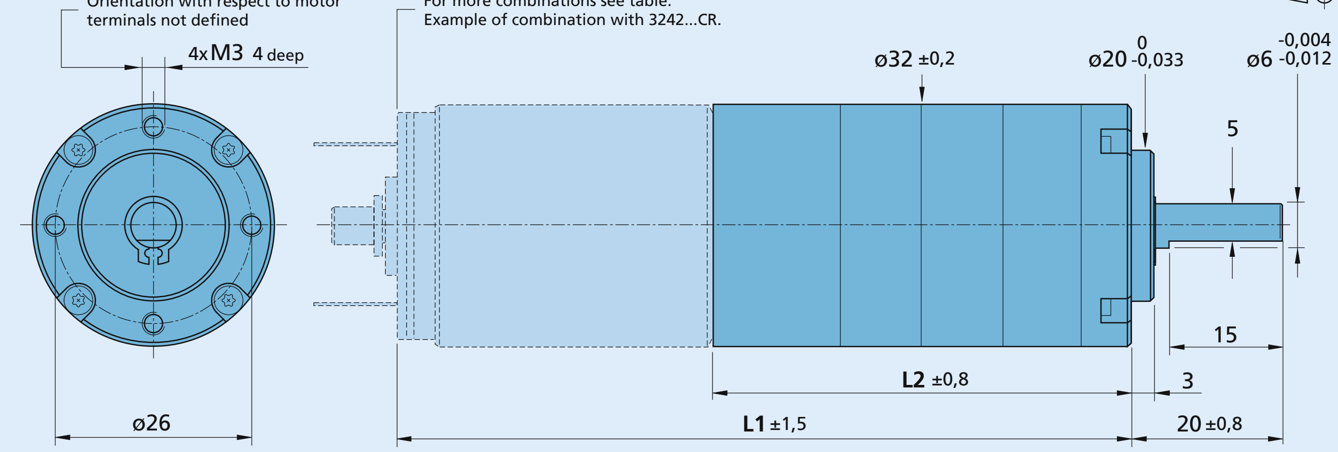
For combination with
DC-Micromotors
Brushless DC-Motors

Series 32A

	32A
Housing material	metal
Geartrain material	steel
Recommended max. input speed for:	
– continuous operation	3 000 rpm
Backlash, at no-load	≤ 2 °
Bearings on output shaft	ball bearings
Shaft load, max.:	
– radial (10 mm from mounting face)	≤ 100 N
– axial	≤ 30 N
Shaft press fit force, max.	≤ 120 N
Shaft play	
– radial (10 mm from mounting face)	≤ 0,1 mm
– axial	≤ 0,3 mm
Operating temperature range	- 25 ... + 80 °C

Specifications						
Number of gear stages			**1**	**2**	**3**	**4**
Continuous torque		Nm	0,75	2,25	4,5	4,5
Intermittent torque		Nm	1	3	6	6
Weight without motor, ca.		g	150	195	240	290
Efficiency, max.		%	88	85	75	65
Direction of rotation, drive to output			=	=	=	=
Reduction ratio [1]			**4:1**	**14:1**	**68:1**	**344:1**
(rounded)			**7:1**	**19:1**	**93:1**	**626:1**
				25:1	**124:1**	**1 140:1**
				29:1	**169:1**	**2 076:1**
				46:1	**236:1**	
					308:1	
L2 [mm] = length without motor			37,8	47,3	56,8	66,4
L1 [mm] = length with motor	2642W...CR		79,8	89,3	98,8	108,4
	2642W...CXR		79,8	89,3	98,8	108,4
	2657W...CR		94,8	104,3	113,8	123,4
	2657W...CXR		94,8	104,3	113,8	123,4
	3242G...CR		79,8	89,3	98,8	108,4
	3257G...CR		94,8	104,3	113,8	123,4
	3272G...CR		109,8	119,3	128,8	138,4
	3242G...BX4		82,0	91,5	101,0	110,6
	3268G...BX4		108,0	117,5	127,0	136,6

[1] The reduction ratios are rounded, the exact values are available on request or at www.faulhaber.com.



32A

NEW

Planetary Gearheads

Low noise

4,5 Nm

For combination with
DC-Micromotors
Brushless DC-Motors

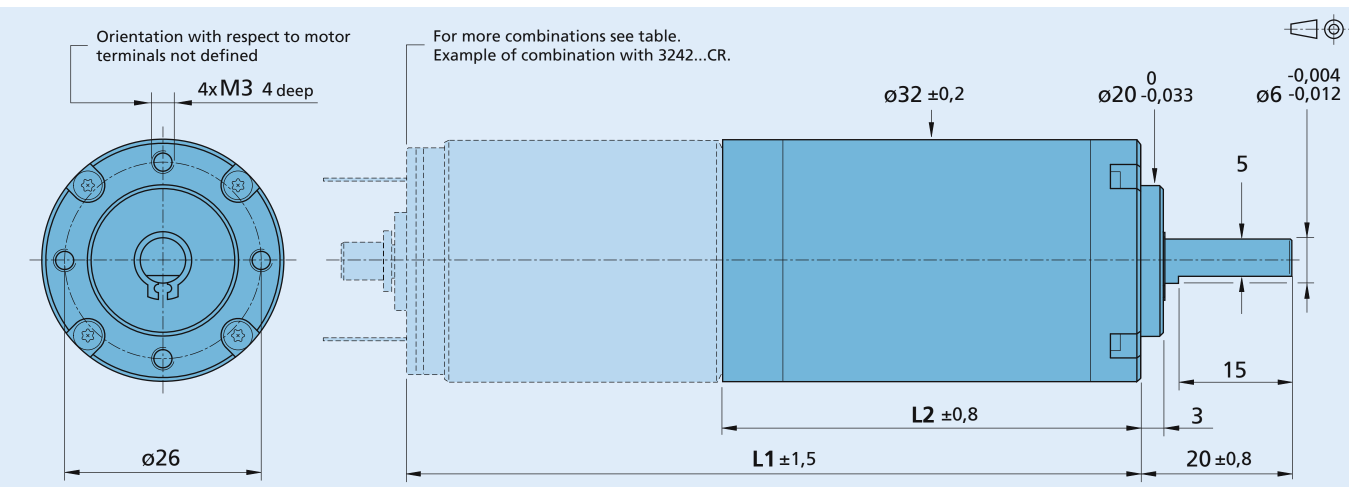
Series 32ALN

	32ALN
Housing material	metal
Geartrain material	plastic/steel
Recommended max. input speed for:	
– continuous operation	3 000 rpm
Backlash, at no-load	≤ 2 °
Bearings on output shaft	ball bearings
Shaft load, max.:	
– radial (10 mm from mounting face)	≤ 100 N
– axial	≤ 30 N
Shaft press fit force, max.	≤ 120 N
Shaft play	
– radial (10 mm from mounting face)	≤ 0,1 mm
– axial	≤ 0,3 mm
Operating temperature range	- 15 ... + 65 °C

Specifications					
Number of gear stages		**1**	**2**	**3**	**4**
Continuous torque	Nm	0,75	2,25	4,5	4,5
Intermittent torque	Nm	1	3	6	6
Weight without motor, ca.	g	125	195	240	290
Efficiency, max.	%	88	85	75	65
Direction of rotation, drive to output		=	=	=	=
Reduction ratio [1]		**4:1**	**14:1**	**68:1**	**344:1**
(rounded)		**7:1**	**19:1**	**93:1**	**626:1**
			25:1	**124:1**	**1 140:1**
			29:1	**169:1**	**2 076:1**
			46:1	**236:1**	
				308:1	
L2 [mm] = length without motor		37,8	47,3	56,8	66,4
L1 [mm] = length with motor	2642W...CR	79,8	89,3	98,8	108,4
	2657W...CR	94,8	104,3	113,8	123,4
	3242G...CR	79,8	89,3	98,8	108,4
	3257G...CR	94,8	104,3	113,8	123,4
	3272G...CR	109,8	119,3	128,8	138,4
	3242G...BX4	82,0	91,5	101,0	110,6
	3268G...BX4	108,0	117,5	127,0	136,6

[1] The reduction ratios are rounded, the exact values are available on request or at www.faulhaber.com.

Note: Motor option - 3888 is required for combination with 2642W...CR, 2657W...CR, 3242G...CR and 3257G...CR.



32ALN

Planetary Gearheads

7 Nm

For combination with
DC-Micromotors
Brushless DC-Motors

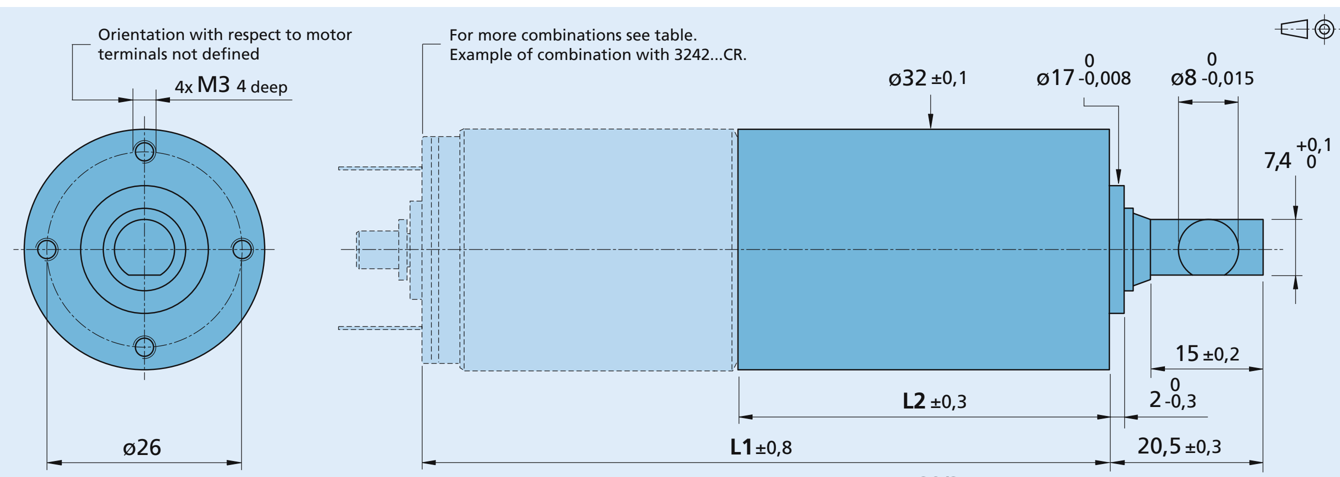
Series 32/3

	32/3
Housing material	metal
Geartrain material [1]	plastic/steel
Recommended max. input speed for:	
– continuous operation	4 000 rpm
Backlash, at no-load	≤ 1 °
Bearings on output shaft	ball bearings, preloaded
Shaft load, max.:	
– radial (10 mm from mounting face)	≤ 200 N
– axial	≤ 200 N
Shaft press fit force, max.	≤ 250 N
Shaft play	
– radial (10 mm from mounting face)	≤ 0,03 mm
– axial	≤ 0,15 mm
Operating temperature range	- 20 ... + 125 °C

Specifications

Specifications										
Number of gear stages		**1**	**2**	**3**	**3**	**4**	**4**	**4**	**5**	**5**
Continuous torque	Nm	4,2	0,4	1,4	2	4	4,9	5,8	7	7
Intermittent torque	Nm	5,3	0,6	1,9	2,6	5,2	6,5	8	10	10
Weight without motor, ca.	g	160	190	230	230	260	260	260	290	300
Efficiency, max.	%	88	80	70	70	60	60	60	55	55
Direction of rotation, drive to output		=	=	=	=	=	=	=	=	=
Reduction ratio [2] (rounded)		**3,71:1**	**14:1**	**43:1**	**66:1**	**134:1**	**159:1**	**246:1**	**415:1** **592:1** **989:1**	**1 526:1**
L2 [mm] = length without motor		33,9	41,6	49,4	49,4	57,2	57,2	57,2	65,0	65,0
L1 [mm] = length with motor	3242G...CR	75,9	83,6	91,4	91,4	99,2	99,2	99,2	107,0	107,0
	3257G...CR	90,9	98,6	106,4	106,4	114,2	114,2	114,2	122,0	122,0
	3557K...CS	90,9	98,6	106,4	106,4	114,2	114,2	114,2	122,0	122,0
	3242G...BX4	78,1	85,8	93,6	93,6	101,4	101,4	101,4	109,2	109,2
	3268G...BX4	104,1	111,8	119,6	119,6	127,4	127,4	127,4	135,2	135,2
	3564K...B	97,9	105,6	113,4	113,4	121,2	121,2	121,2	129,0	129,0

[1] Gearheads with ratios < 14:1 have all steel gears.
[2] The reduction ratios are rounded, the exact values are available on request or at www.faulhaber.com.



32/3

Planetary Gearheads

7 Nm

For combination with
DC-Micromotors
Brushless DC-Motors

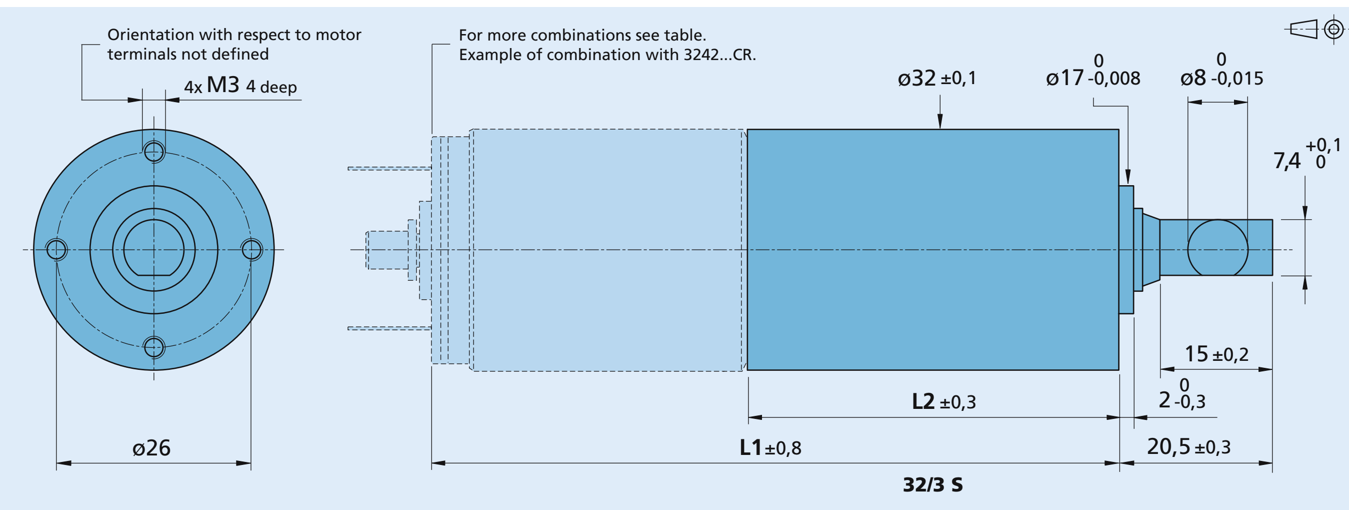
Series 32/3 S

	32/3 S
Housing material	metal
Geartrain material	steel
Recommended max. input speed for:	
– continuous operation	4 000 rpm
Backlash, at no-load	≤ 1 °
Bearings on output shaft	ball bearings, preloaded
Shaft load, max.:	
– radial (10 mm from mounting face)	≤ 200 N
– axial	≤ 200 N
Shaft press fit force, max.	≤ 250 N
Shaft play	
– radial (10 mm from mounting face)	≤ 0,03 mm
– axial	≤ 0,15 mm
Operating temperature range	- 20 ... + 125 °C

Specifications							
Number of gear stages			**2**	**3**	**4**	**5**	**5**
Continuous torque		Nm	7	7	7	7	7
Intermittent torque		Nm	10	10	10	10	10
Weight without motor, ca.		g	190	230	260	290	300
Efficiency, max.		%	80	70	60	55	55
Direction of rotation, drive to output			=	=	=	=	=
Reduction ratio [1]			**14:1**	**43:1**	**134:1**	**415:1**	**1 526:1**
(rounded)			**23:1**	**66:1**	**159:1**	**592:1**	
				86:1	**246:1**	**989:1**	
L2 [mm] = length without motor			41,6	49,4	57,2	65,0	65,0
L1 [mm] = length with motor	3242G...CR		83,6	91,4	99,2	107,0	107,0
	3257G...CR		98,6	106,4	114,2	122,0	122,0
	3557K...CS		98,6	106,4	114,2	122,0	122,0
	3242G...BX4		85,8	93,6	101,4	109,2	109,2
	3268G...BX4		111,8	119,6	127,4	135,2	135,2
	3564K...B		105,6	113,4	121,2	129,0	129,0

[1] The reduction ratios are rounded, the exact values are available on request or at www.faulhaber.com.

Note: The gearheads as S-type have all steel gears and heavy duty lubricant for extended lifetime performance.



FAULHABER

Planetary Gearheads

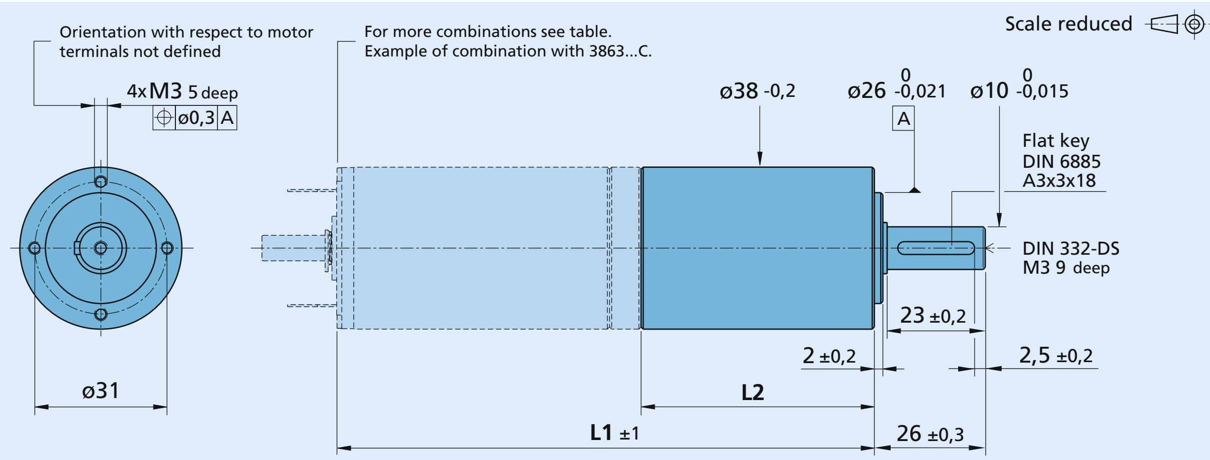
20 Nm

For combination with
DC-Micromotors
Brushless DC-Motors

Series 38A

	38A
Housing material	steel
Geartrain material	steel
Recommended max. input speed for:	
– continuous operation	4 500 rpm
Backlash, at no-load	≤ 0,6 °
Bearings on output shaft	ball bearings
Shaft load, max.:	
– radial (14,5 mm from mounting face)	≤ 200 N
– axial	≤ 200 N
Shaft press fit force, max.	≤ 490 N
Shaft play	
– radial (14,5 mm from mounting face)	≤ 0,02 mm
– axial	≤ 0,3 mm
Operating temperature range	- 25 ... + 90 °C

Specifications									
Number of gear stages			**1**	**2**	**2**	**3**	**3**	**4**	**4**
Continuous torque		Nm	6	20	18	20	18	20	18
Intermittent torque		Nm	9,6	32	29	32	29	32	29
Weight without motor, ca.		g	190	260	260	330	330	410	410
Efficiency, max.		%	96	94	94	90	90	80	80
Direction of rotation, drive to output			=	=	=	=	=	=	=
Reduction ratio (exact)			**4:1** **5:1**	**12:1** **16:1** **20:1**	**25:1**	**36:1** **45:1** **60:1** **80:1** **100:1** **120:1** **160:1**	**200:1**	**240:1** **360:1** **480:1** **800:1**	**1 600:1**
L2 [mm] = length without motor			42,2	55,0	55,0	67,6	67,6	80,2	80,2
L1 [mm] = length with motor	3242G...CR		78,8	91,6	91,6	104,2	104,2	116,8	116,8
	3257G...CR		93,8	106,6	106,6	119,2	119,2	131,8	131,8
	3272G...CR		108,8	121,6	121,6	134,2	134,2	146,8	146,8
	3557K...CS		99,2	112,0	112,0	124,6	124,6	137,2	137,2
	3863H...C		113,6	126,4	126,4	139,0	139,0	151,6	151,6
	3863H...CR		113,6	126,4	126,4	139,0	139,0	151,6	151,6
	3564K...B		106,2	119,0	119,0	131,6	131,6	144,2	144,2
	4490H...B		139,6	152,4	152,4	165,0	165,0	177,6	177,6
	4490H...BS		139,6	152,4	152,4	165,0	165,0	177,6	177,6



38A

Planetary Gearheads

10 Nm

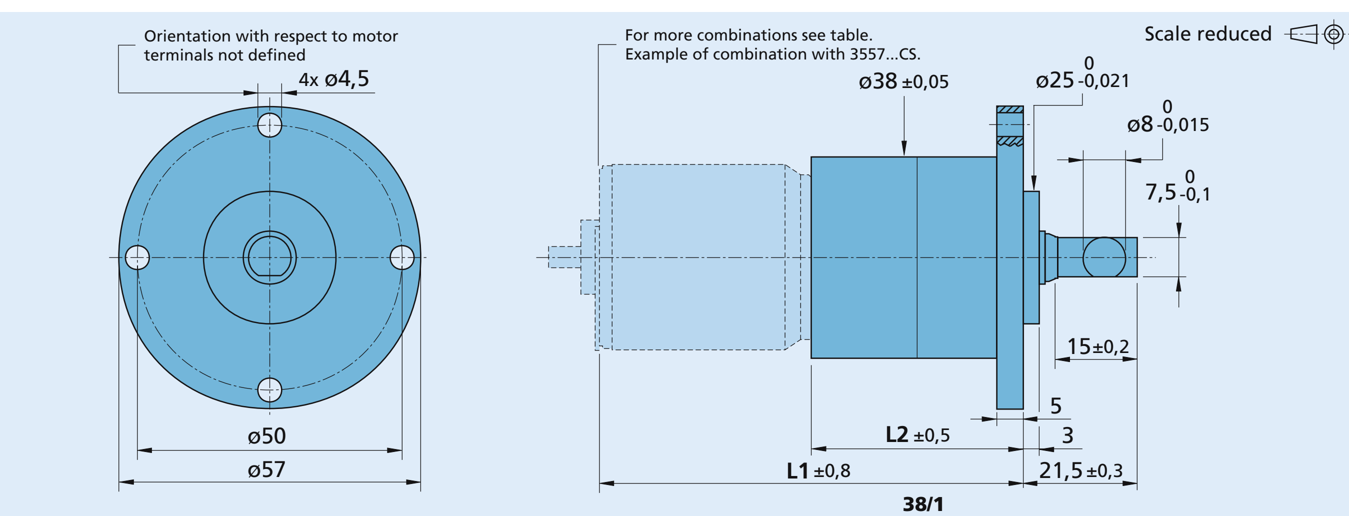
For combination with
DC-Micromotors
Brushless DC-Motors

Series 38/1

	38/1
Housing material	metal
Geartrain material [1]	plastic/steel
Recommended max. input speed for:	
– continuous operation	4 000 rpm
Backlash, at no-load	≤ 1 °
Bearings on output shaft	ball bearings, preloaded
Shaft load, max.:	
– radial (10 mm from mounting face)	≤ 300 N
– axial	≤ 300 N
Shaft press fit force, max.	≤ 350 N
Shaft play	
– radial (10 mm from mounting face)	≤ 0,03 mm
– axial	≤ 0,15 mm
Operating temperature range	- 20 ... + 125 °C

Specifications									
Number of gear stages		**1**	**2**	**3**	**3**	**4**	**4**	**4**	**5**
Continuous torque	Nm	6	0,4	1,4	2,2	4,5	5,3	8,2	10
Intermittent torque	Nm	8	0,6	1,9	2,9	6	7	11	15
Weight without motor, ca.	g	166	215	268	268	320	320	320	375
Efficiency, max.	%	88	80	70	70	60	60	60	55
Direction of rotation, drive to output		=	=	=	=	=	=	=	=
Reduction ratio [2] (rounded)		**3,71:1**	**14:1**	**43:1**	**66:1**	**134:1**	**159:1**	**246:1**	**415:1**
									592:1
									989:1
									1 526:1
L2 [mm] = length without motor [3]		32,3	40,1	47,9	47,9	55,7	55,7	55,7	63,5
L1 [mm] = length with motor	3242G...CR	74,3	82,1	89,9	89,9	97,7	97,7	97,7	105,5
	3257G...CR	89,3	97,1	104,9	104,9	112,7	112,7	112,7	120,5
	3272G...CR	104,3	112,1	119,9	119,9	127,7	127,7	127,7	135,5
	3557K...CS	89,3	97,1	104,9	104,9	112,7	112,7	112,7	120,5
	3863A...C	91,3	99,1	106,9	106,9	114,7	114,7	114,7	122,5
	3863A...CR	91,3	99,1	106,9	106,9	114,7	114,7	114,7	122,5
	3056K...B	88,3	96,1	103,9	103,9	111,7	111,7	111,7	119,5
	3242G...BX4	76,5	84,3	92,1	92,1	99,9	99,9	99,9	107,7
	3268G...BX4	102,5	110,3	118,1	118,1	125,9	125,9	125,9	133,7
	3564K...B	96,3	104,1	111,9	111,9	119,7	119,7	119,7	127,5

[1] Gearheads with ratios < 14:1 have all steel gears.
[2] The reduction ratios are rounded, the exact values are available on request or at www.faulhaber.com.
[3] L2 - 5 mm, in combination with 3863A...C and 3863A...CR.



Precision Gearheads

Planetary Gearheads

10 Nm

For combination with
DC-Micromotors
Brushless DC-Motors

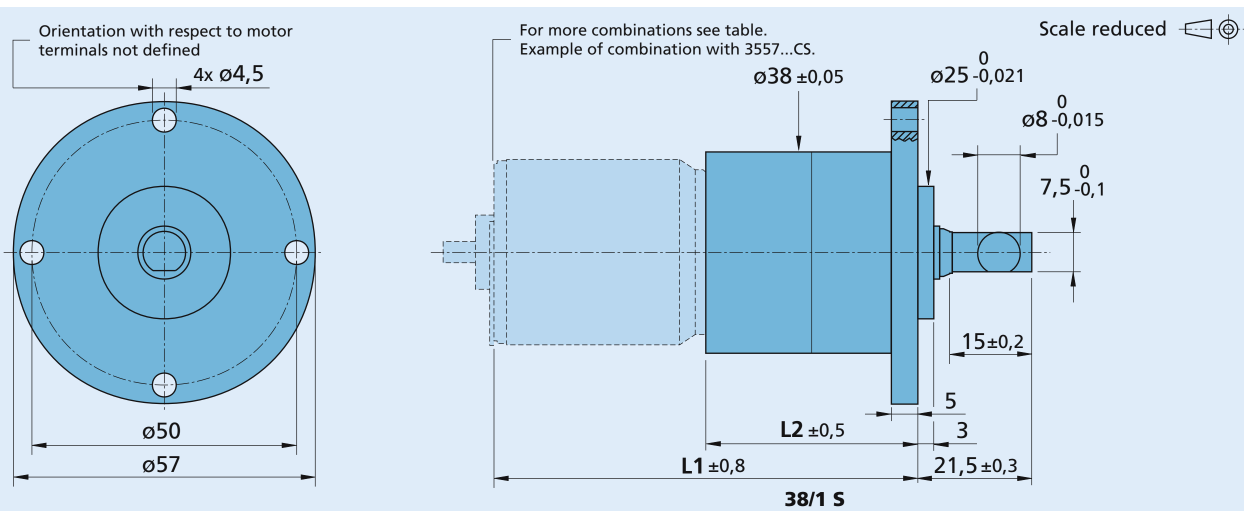
Series 38/1 S

	38/1 S
Housing material	metal
Geartrain material	steel
Recommended max. input speed for:	
– continuous operation	4 000 rpm
Backlash, at no-load	≤ 1 °
Bearings on output shaft	ball bearings, preloaded
Shaft load, max.:	
– radial (10 mm from mounting face)	≤ 300 N
– axial	≤ 300 N
Shaft press fit force, max.	≤ 350 N
Shaft play	
– radial (10 mm from mounting face)	≤ 0,03 mm
– axial	≤ 0,15 mm
Operating temperature range	- 20 ... + 125 °C

Specifications						
Number of gear stages			**2**	**3**	**4**	**5**
Continuous torque		Nm	10	10	10	10
Intermittent torque		Nm	15	15	15	15
Weight without motor, ca.		g	215	268	320	375
Efficiency, max.		%	80	70	60	55
Direction of rotation, drive to output			=	=	=	=
Reduction ratio [1] (rounded)			**14:1**	**43:1** **66:1**	**134:1** **159:1** **246:1**	**415:1** **592:1** **989:1** **1 526:1**
L2 [mm] = length without motor [2]			40,1	47,9	55,7	63,5
L1 [mm] = length with motor	3242G...CR		82,1	89,9	97,7	105,5
	3257G...CR		97,1	104,9	112,7	120,5
	3272G...CR		112,1	119,9	127,7	135,5
	3557K...CS		97,1	104,9	112,7	120,5
	3863A...C		99,1	106,9	114,7	122,5
	3863A...CR		99,1	106,9	114,7	122,5
	3056K...B		96,1	103,9	111,7	119,5
	3242G...BX4		84,3	92,1	99,9	107,7
	3268G...BX4		110,3	118,1	125,9	133,7
	3564K...B		104,1	111,9	119,7	127,5

[1] The reduction ratios are rounded, the exact values are available on request or at www.faulhaber.com.
[2] L2 - 5 mm, in combination with 3863A...C and 3863A...CR.

Note: The gearheads as S-type have all steel gears and heavy duty lubricant for extended lifetime performance.



Precision Gearheads

Planetary Gearheads

10 Nm

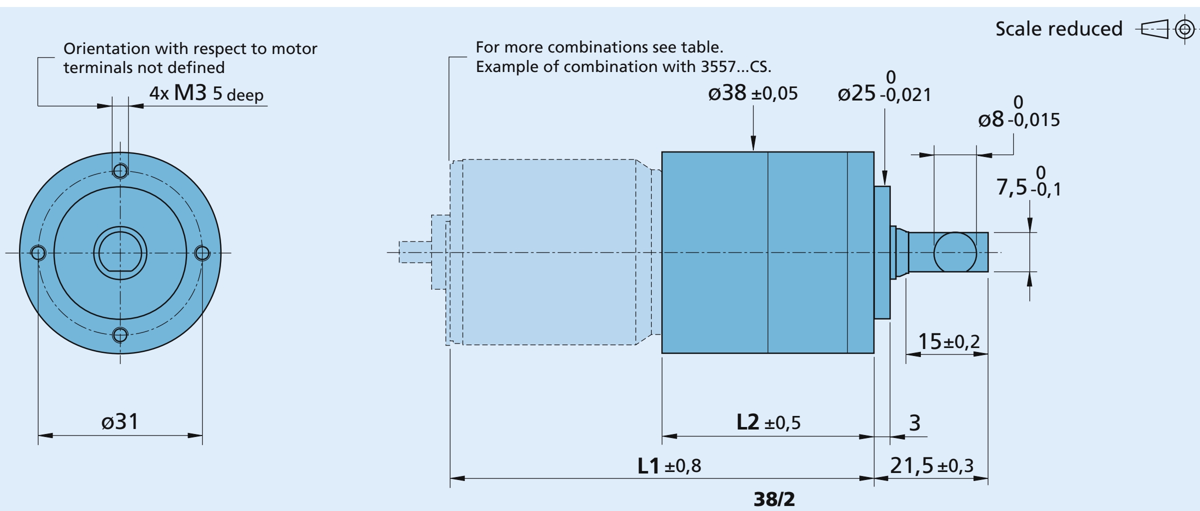
For combination with
DC-Micromotors
Brushless DC-Motors

Series 38/2

	38/2
Housing material	metal
Geartrain material [1]	plastic/steel
Recommended max. input speed for:	
– continuous operation	4 000 rpm
Backlash, at no-load	≤ 1 °
Bearings on output shaft	ball bearings, preloaded
Shaft load, max.:	
– radial (10 mm from mounting face)	≤ 300 N
– axial	≤ 300 N
Shaft press fit force, max.	≤ 350 N
Shaft play	
– radial (10 mm from mounting face)	≤ 0,03 mm
– axial	≤ 0,15 mm
Operating temperature range	- 20 ... + 125 °C

Specifications									
Number of gear stages		**1**	**2**	**3**	**3**	**4**	**4**	**4**	**5**
Continuous torque	Nm	6	0,4	1,4	2,2	4,5	5,3	8,2	10
Intermittent torque	Nm	8	0,6	1,9	2,9	6	7	11	15
Weight without motor, ca.	g	145	195	245	245	296	296	296	348
Efficiency, max.	%	88	80	70	70	60	60	60	55
Direction of rotation, drive to output		=	=	=	=	=	=	=	=
Reduction ratio [2] (rounded)		**3,71:1**	**14:1**	**43:1**	**66:1**	**134:1**	**159:1**	**246:1**	**415:1**
									592:1
									989:1
									1 526:1
L2 [mm] = length without motor [3]		32,3	40,1	47,9	47,9	55,7	55,7	55,7	63,5
L1 [mm] = length with motor	3242G...CR	74,3	82,1	89,9	89,9	97,7	97,7	97,7	105,5
	3257G...CR	89,3	97,1	104,9	104,9	112,7	112,7	112,7	120,5
	3272G...CR	104,3	112,1	119,9	119,9	127,7	127,7	127,7	135,5
	3557K...CS	89,3	97,1	104,9	104,9	112,7	112,7	112,7	120,5
	3863A...C	91,3	99,1	106,9	106,9	114,7	114,7	114,7	122,5
	3863A...CR	91,3	99,1	106,9	106,9	114,7	114,7	114,7	122,5
	3056K...B	88,3	96,1	103,9	103,9	111,7	111,7	111,7	119,5
	3242G...BX4	76,5	84,3	92,1	92,1	99,9	99,9	99,9	107,7
	3268G...BX4	102,5	110,3	118,1	118,1	125,9	125,9	125,9	133,7
	3564K...B	96,3	104,1	111,9	111,9	119,7	119,7	119,7	127,5

[1] Gearheads with ratios < 14:1 have all steel gears.
[2] The reduction ratios are rounded, the exact values are available on request or at www.faulhaber.com.
[3] L2 - 5 mm, in combination with 3863A...C and 3863A...CR.



Planetary Gearheads

10 Nm

For combination with
DC-Micromotors
Brushless DC-Motors

Series 38/2 S

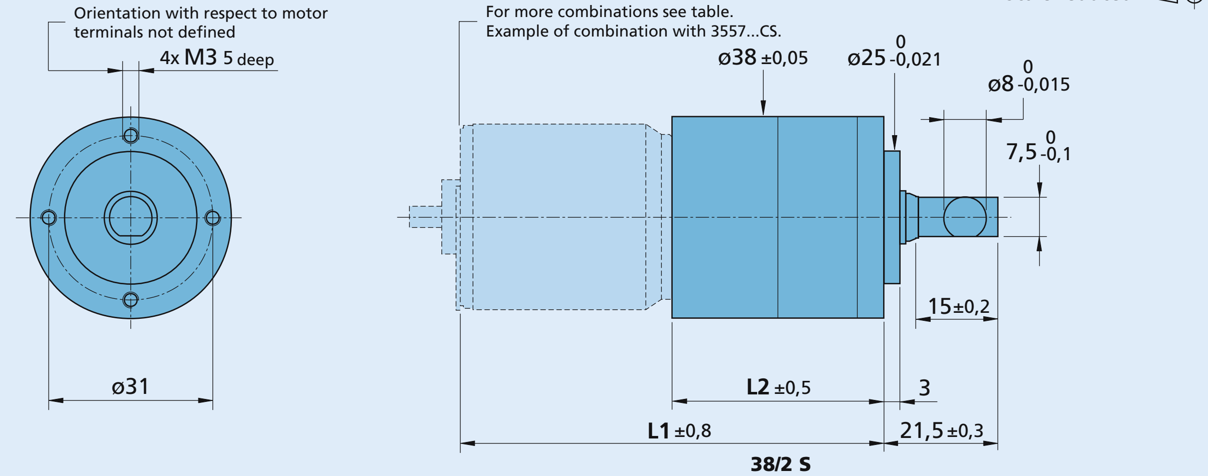
	38/2 S
Housing material	metal
Geartrain material	steel
Recommended max. input speed for:	
– continuous operation	4 000 rpm
Backlash, at no-load	≤ 1 °
Bearings on output shaft	ball bearings, preloaded
Shaft load, max.:	
– radial (10 mm from mounting face)	≤ 300 N
– axial	≤ 300 N
Shaft press fit force, max.	≤ 350 N
Shaft play	
– radial (10 mm from mounting face)	≤ 0,03 mm
– axial	≤ 0,15 mm
Operating temperature range	- 20 ... + 125 °C

Specifications					
Number of gear stages		**2**	**3**	**4**	**5**
Continuous torque	Nm	10	10	10	10
Intermittent torque	Nm	15	15	15	15
Weight without motor, ca.	g	195	245	296	348
Efficiency, max.	%	80	70	60	55
Direction of rotation, drive to output		=	=	=	=
Reduction ratio [1]		**14:1**	**43:1**	**134:1**	**415:1**
(rounded)			**66:1**	**159:1**	**592:1**
				246:1	**989:1**
					1 526:1
L2 [mm] = length without motor [2]		40,1	47,9	55,7	63,5
L1 [mm] = length with motor	3242G...CR	82,1	89,9	97,7	105,5
	3257G...CR	97,1	104,9	112,7	120,5
	3272G...CR	112,1	119,9	127,7	135,5
	3557K...CS	97,1	104,9	112,7	120,5
	3863A...C	99,1	106,9	114,7	122,5
	3863A...CR	99,1	106,9	114,7	122,5
	3056K...B	96,1	103,9	111,7	119,5
	3242G...BX4	84,3	92,1	99,9	107,7
	3268G...BX4	110,3	118,1	125,9	133,7
	3564K...B	104,1	111,9	119,7	127,5

[1] The reduction ratios are rounded, the exact values are available on request or at www.faulhaber.com.
[2] L2 - 5 mm, in combination with 3863A...C and 3863A...CR.

Note: The gearheads as S-type have all steel gears and heavy duty lubricant for extended lifetime performance.

Scale reduced



Spur Gearheads

1,2 Nm

For combination with
DC-Micromotors
Brushless DC-Motors

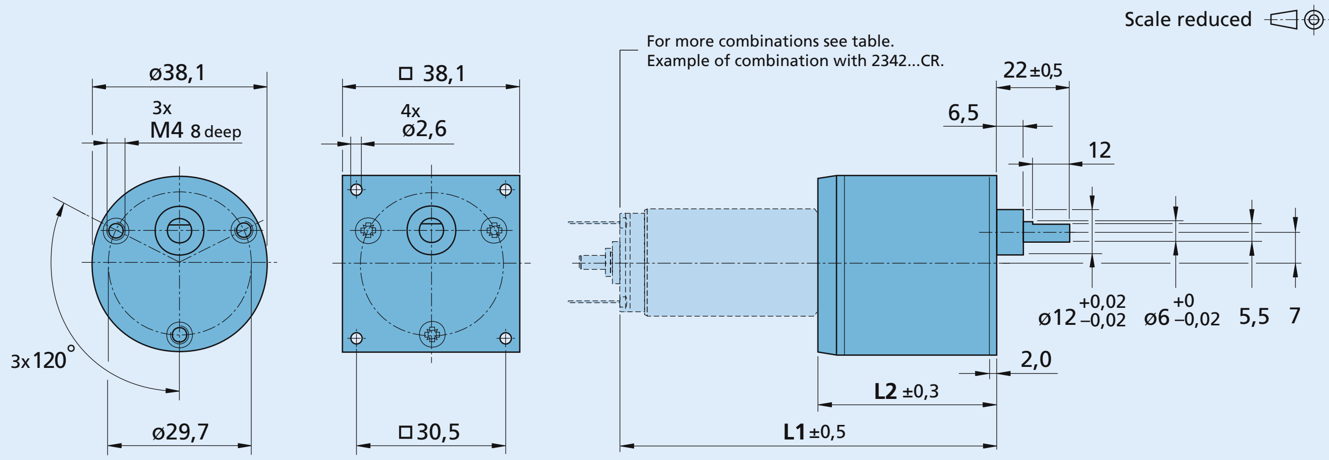
Series 38/3

	38/3
Housing material	plastic/metal
Geartrain material	plastic/steel
Recommended max. input speed for:	
– continuous operation	5 000 rpm
Backlash, at no-load	≤ 2 °
Bearings on output shaft	sintered bearings
Shaft load, max.:	
– radial (15 mm from mounting face)	≤ 50 N
– axial	≤ 30 N
Shaft press fit force, max.	≤ 500 N
Shaft play	
– radial (15 mm from mounting face)	≤ 0,07 mm
– axial	≤ 0,5 mm
Operating temperature range	- 15 ... + 65 °C

Specifications										
Number of gear stages		**2**	**3**	**3**	**4**	**4**	**5**	**5**	**6**	**6**
Continuous torque	mNm	75	150	225	325	450	600	800	1 000	1 200
Intermittent torque	mNm	2 000	2 000	2 000	2 000	2 000	2 000	2 000	2 000	2 000
Weight without motor, ca. [1]	g	66	71	71	79	79	85	85	92	92
Efficiency, max.	%	81	73	73	66	66	59	59	53	53
Direction of rotation, drive to output		=	≠	≠	=	=	≠	≠	=	=
Reduction ratio [2] (rounded)		**5,42:1**	**10,3:1**	**18,2:1**	**34,7:1**	**61,1:1**	**116:1**	**205:1**	**391:1**	**689:1**
L2 [mm] = length without motor [3]		23,8	23,8	23,8	29,8	29,8	29,8	29,8	32,9	32,9
L1 [mm] = length with motor	2224U...SR	43,5	43,5	43,5	49,5	49,5	49,5	49,5	52,6	52,6
	2230U...S	49,3	49,3	49,3	55,3	55,3	55,3	55,3	58,4	58,4
	2232U...SR	51,5	51,5	51,5	57,5	57,5	57,5	57,5	60,6	60,6
	2233U...S	51,9	51,9	51,9	57,9	57,9	57,9	57,9	61,0	61,0
	2342S...CR	65,8	65,8	65,8	71,8	71,8	71,8	71,8	74,9	74,9
	2232S...BSL	56,2	56,2	56,2	62,2	62,2	62,2	62,2	65,3	65,3
	2248S...BSL	71,8	71,8	71,8	77,8	77,8	77,8	77,8	80,9	80,9
	2444S...B	67,8	67,8	67,8	73,8	73,8	73,8	73,8	76,9	76,9

[1] Type 38/3… - K700 with square flange has an additional weight of 17 g.
[2] The reduction ratios are rounded, the exact values are available on request or at www.faulhaber.com.
[3] L2 - 4,5 mm, in combination with 2224U...SR, 2230U...S, 2232U...SR and 2233U...S.

Note: Reduction ratios from 586:1 and 1034:1 are available on request.



38/3 ... -K 700 with flange

38/3

Planetary Gearheads

16 Nm

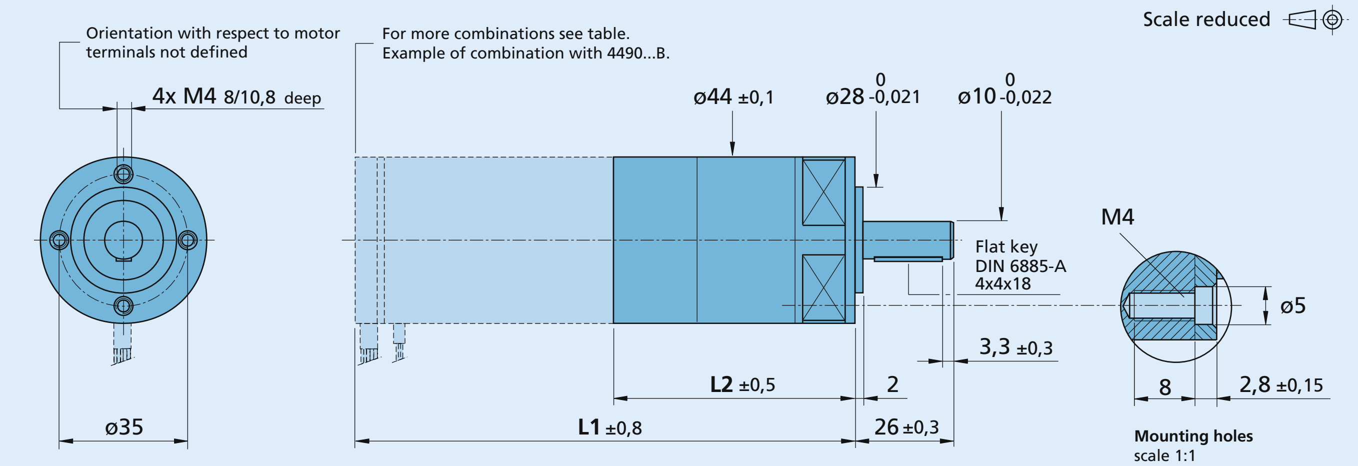
For combination with
DC-Micromotors
Brushless DC-Motors

Series 44/1

	44/1
Housing material	metal
Geartrain material	metal
Recommended max. input speed for:	
– continuous operation	3 500 rpm
Backlash, at no-load	≤ 1 °
Bearings on output shaft	ball bearings, preloaded
Shaft load, max.:	
– radial (12 mm from mounting face)	≤ 400 N
– axial	≤ 350 N
Shaft press fit force, max.	≤ 500 N
Shaft play	
– radial (12 mm from mounting face)	≤ 0,03 mm
– axial	= 0 mm
Operating temperature range	- 30 ... + 125 °C

Specifications							
Number of gear stages			**1**	**2**	**3**	**4**	**5**
Continuous torque		Nm	16	16	16	16	16
Intermittent torque		Nm	20	20	20	20	20
Weight without motor, ca.		g	480	600	720	840	960
Efficiency, max.		%	90	80	70	65	60
Direction of rotation, drive to output			=	=	=	=	=
Reduction ratio [1] (rounded)			**4,8:1**	**23:1**	**111:1**	**531:1**	**2 548:1**
L2 [mm] = length without motor			62,2	77,8	93,2	108,6	124,0
L1 [mm] = length with motor	3863H...C		126,2	141,8	157,2	172,6	188,0
	3863H...CR		126,2	141,8	157,2	172,6	188,0
	4490H...B		152,2	167,8	183,2	198,6	214,0
	4490H...BS		152,2	167,8	183,2	198,6	214,0

[1] The reduction ratios are rounded, the exact values are available on request or at www.faulhaber.com.



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Notes

Linear Components

WE CREATE MOTION

FAULHABER

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Ball Screw

Technical information

General information

Function:
Ball screws convert rotational movements into an axial movement. Ball screws, which are designed as a recirculating ball screw, have a very high level of efficiency in comparison with planetary screw drives (such as trapezoidal screws or metric screws) due to the lower rolling friction that occurs. In addition, the superior manufacturing precision enables a very low axial play, accompanied by a very high positioning accuracy.

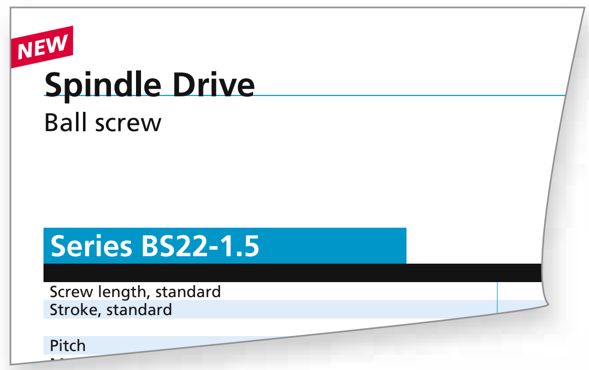
In addition to the ball screw, the BS product series also includes both the bearing and the coupling to the motor. The duplex bearing used in this case – a pair of angular ball bearings with backlash-free mounting – enables the absorption of axial tensile and compressive forces. The high-precision pin coupling transmits the motor torque to the screw virtually backlash-free.

Mounting
A number of threaded holes are provided on the front of the housing for the purpose of attaching the motor-screw combination.

Because of the high-precision raceways and the low-backlash or backlash-free adjustment, the ball screw nut cannot compensate for radial deviations between screw axis and any additional guides of an attachment to the nut. A radial decoupling element must be provided here if necessary. This relates to deviations of the radial distance (misalignment) and angular deviations (tipping) of the guides.

In order to reduce radial forces on the bearing, it is recommended that the screw is supported by an additional bearing.

Handling
The ball raceways on the ball screws are exposed. For this reason, the screw drives have to be protected against dirt and contamination. The ball screw nut must never, either in operation or during mounting, be moved out beyond the raceway area of the ball screw.


NEW

Spindle Drive

Ball screw

Series BS22-1.5

Screw length, standard
Stroke, standard

Pitch

Explanations regarding the data sheets

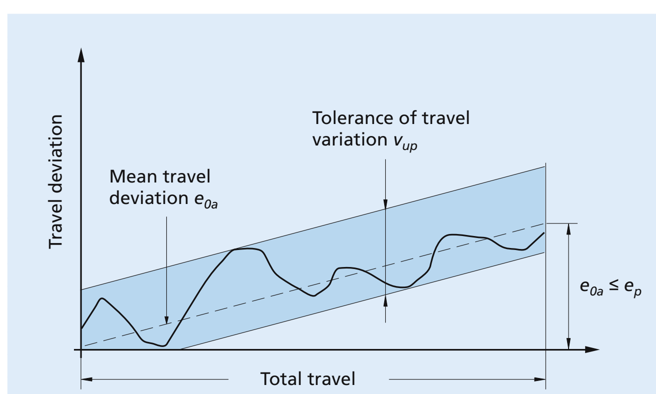
Ball screw length, standard [mm]
Designates the length of the ball screw between the front of the housing and the end of the ball screw.

Stroke [mm]
Maximum path which the ball screw nut may axially travel. The metric fastening thread of the ball screw nut can protrude beyond the raceway area of the ball screw.

Pitch P_h [mm]
Axial displacement when rotating the ball screw by 360° relative to the ball screw nut.

Average actual travel deviation, max. permissible e_p [µm]
The averaged deviation of the actual travel from the ideal nominal travel is called the average actual travel deviation e_{0a}. This is limited by the value e_p over the entire travel ($e_{0a} \leq e_p$).

Tolerance of travel variation V_{up} [µm]
In parallel with the average actual travel deviation, short-wave travel variations can occur. The bandwidth, represented as a blue band in the following, is limited by the value of the tolerance of travel variation v_{up}.

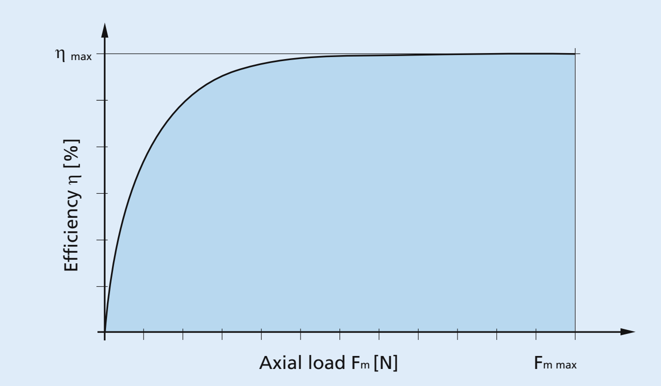


Linear Components

Ball Screw

Technical information

Efficiency $\eta_{max.}$ [%]
Describes the ratio between the power input and power output of the ball screw at axial load $F_{m\ max.}$



Please observe the dependence of the efficiency on the axial load, especially for small axial loads.

Operating temperature range [C°]
Designates the maximum and minimum permissible operating temperature of the ball screw.

Axial load capacity, dynamic C_{am} [N]
Parameter for calculating the theoretical service life. This corresponds to a constant axial load in a constant direction, at which a theoretical service life of 10^6 revolutions is achieved. This is based on a life expectancy of 90%.

Axial load capacity, static C_{oa} [N]
Maximum permissible axial loading of the ball screw nut. Unless specified otherwise, this is also the maximum permissible axial loading of the ball screw. To prevent exceeding of the permissible loading, the motor current must be limited if necessary.

Max. permissible shaft loading, radial $F_{rs\ max}$ [N]
Maximum permissible radial loading of the ball screw. This is dependent on the acting lever arm.

Screw nut, axial play [µm]
Maximum axial displacement of the ball screw nut in relation to the ball screw, if these are not twisted towards each other. This is determined using an axial test force of 3.5 N.

Max. permissible nut loading, radial $F_{rn\ max}$ [N]
Maximum permissible radial loading of the ball screw nut.

Direction of rotation
Direction of rotation of the ball screw, observed from the direction of the ball screw. With a right-hand thread the clockwise direction of rotation of the drive shaft (= rotating clockwise) results in an increase in the distance between drive and ball screw nut.

Recommended values

The maximum permissible values for continuous operation in order to obtain an optimal service life are listed below. The values are mathematically independent of each other.

Continuous axial load $F_{m\ max.}$ [N]
Designates the maximum recommended axial load during continuous operation.

Intermittent axial load $F_{p\ max.}$ [N]
Designates the maximum permissible axial load. The motor current must be limited if necessary in order to prevent exceeding of the permissible loading.

Rotational speed, max. [rpm]
Designates the maximum permissible rotational speed.

Linear speed, max. [mm/s]
Designates the maximum permissible linear speed. This results from the product of the maximum permissible rotational speed and the pitch P_h.

Calculations

Calculation of the motor drive torque

The minimum required motor drive torque can be derived as follows

$$M_{mot} = \frac{F_m \cdot P_h \cdot 100}{2\pi \cdot \eta}$$

Required motor torque	M_{mot}	[mNm]
Continuous axial load	F_m	[N]
Pitch	P_h	[mm]
Efficiency	η	[%]

Calculation of the motor drive speed

$$n_{mot} = \frac{v \cdot 60}{P_h}$$

Required motor speed	n_{mot}	[rpm]
Linear speed	v	[mm/s]
Pitch	P_h	[mm]

Calculation of the theoretical lifetime

The service life depends on the following factors:

- Axial load
- Linear speed
- Operating conditions
- Environment and installation in other systems

As a very large number of parameters come into play in any application, a precise service life definition is not possible.

As a non-binding reference value a theoretical service life can be calculated on the basis of standard ISO 3408:

The theoretical service life is generally defined by the number of revolutions. Alternatively, it can also be specified in hours or as travel. It is based on a life expectancy of 90%.

The theoretical service life is calculated as follows:

$$L_{rev} = \left(\frac{C_{am}}{F_m}\right)^3 \cdot 10^6$$

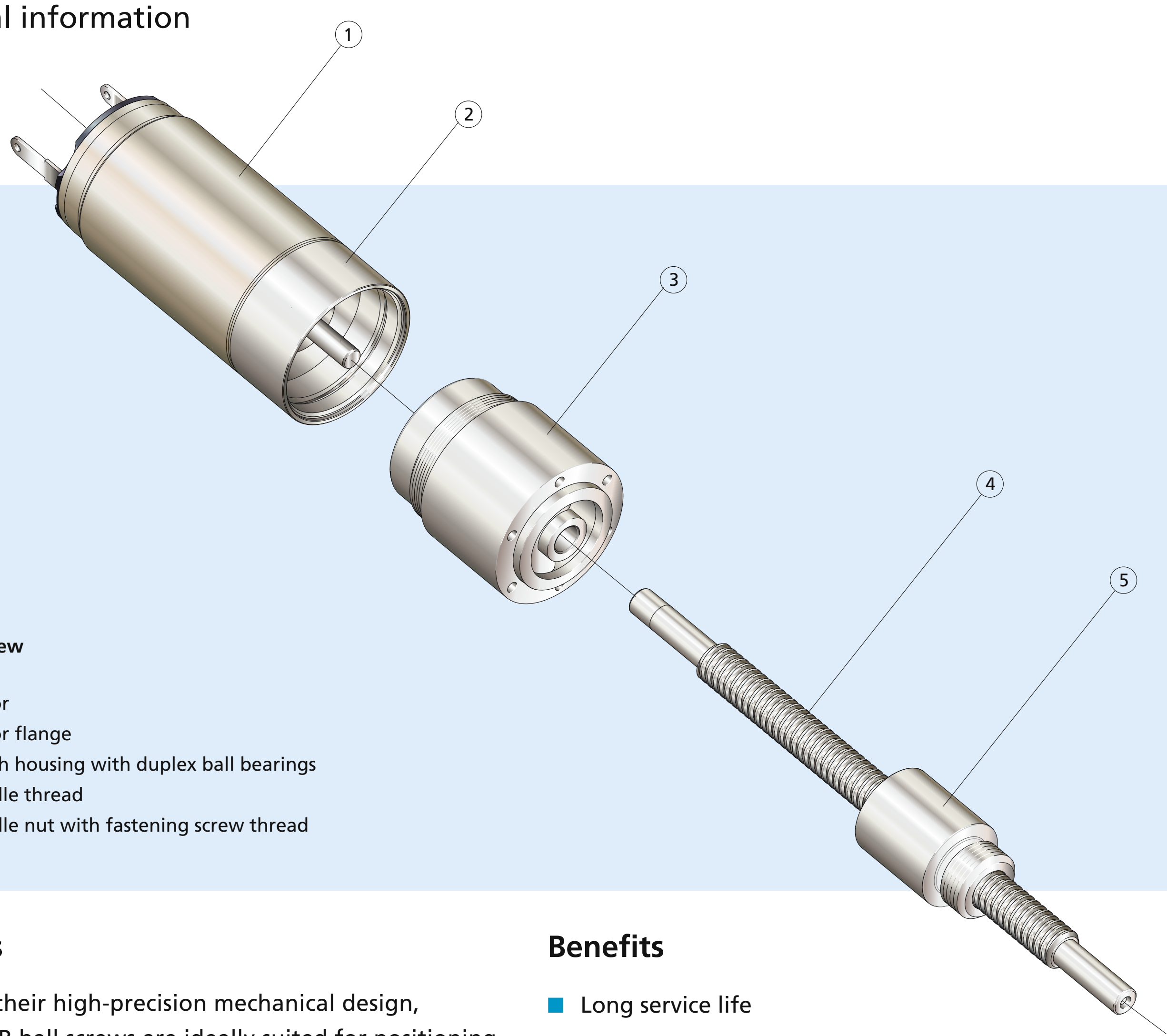
$$L_h = \frac{L_{rev}}{n_m \cdot 60}$$

$$L_s = P_h \cdot \left(\frac{C_{am}}{F_m}\right)^3 \cdot 10^3$$

Service life in revolutions	L_{rev}	[rev]
Service life in hours	L_h	[h]
Service life in meters	L_s	[m]
Dynamic axial load capacity	C_{am}	[N]
Continuous axial load	F_m	[N]
Average motor speed	n_m	[min^{-1}]
Pitch	P_h	[mm]

Ball Screw

Technical information



Ball Screw

① Motor
② Motor flange
③ Clutch housing with duplex ball bearings
④ Spindle thread
⑤ Spindle nut with fastening screw thread

Features

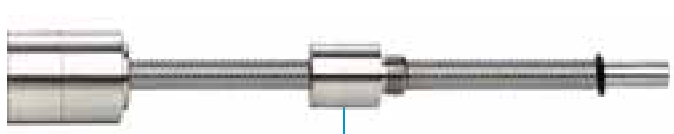
Thanks to their high-precision mechanical design, FAULHABER ball screws are ideally suited for positioning tasks requiring a high degree of accuracy. Combinations with DC-Micromotors with high-resolution encoders, integrated Motion Controllers or Stepper Motors represent a superior system solution for the most demanding applications in optical systems, special machine construction, automation or medical technology.

Compact design in conjunction with numerous modification options translates into the perfect drive solution for a wide range of applications.

Benefits

- Long service life
- High efficiency
- Variable length
- Customized versions with special lubrication for extended application areas
- High positioning accuracy thanks to considerably reduced play

Product Code



BS	Ball screw
22	Coupling diameter [mm]
1.5	Pitch [mm]

BS 22-1.5

NEW

Spindle Drive

Ball screw

105 N

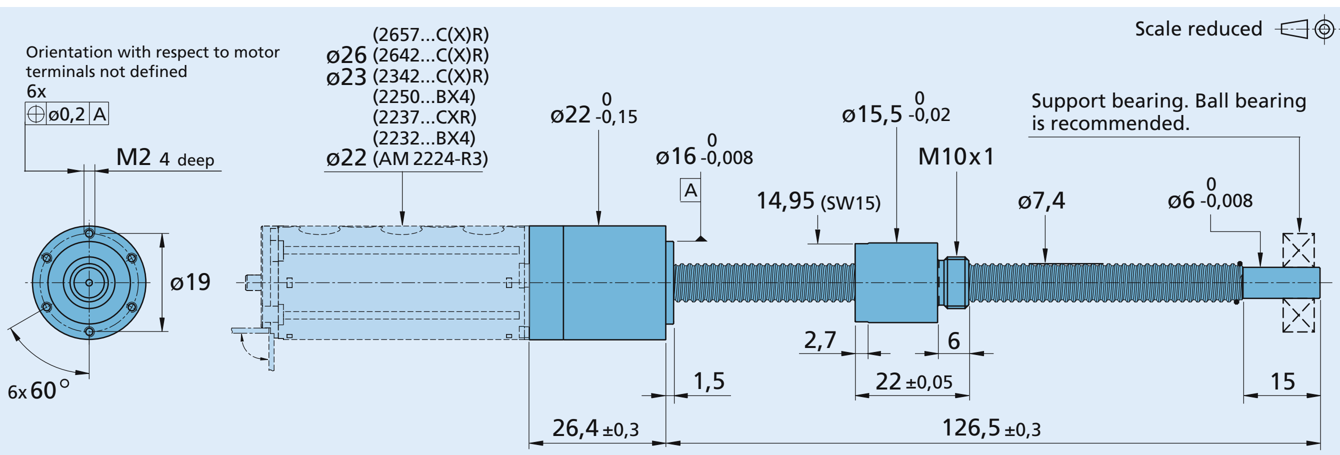
For combination with
DC-Micromotors
Brushless DC-Servomotors
Stepper Motors

Series BS22-1.5

			BS22-1.5	
Screw length, standard			126,5	mm
Stroke, standard			94	mm
Pitch	P_h		1,5	mm
Mean actual travel deviation e_{0a}:				
– maximum permissible	e_p		5 (According to accuracy class 1)	µm
Tolerance of travel variation	v_{up}		5 (According to accuracy class 1)	µm
Efficiency, max.	$\eta_{max.}$		89	%
Operating temperature range		–35 ... +100		°C
Bearing		ball bearings, preloaded		
Axial load capacity:				
– dynamic	C_{am}	≤ 519		N
– static	C_{oa}	≤ 475		N
Shaft load, max.:				
– radial (50 mm from mounting face)	$F_{rs\ max}$	≤ 43		N
Screw nut:				
– axial play		≤ 5		µm
Screw nut load, max.:				
– radial	$F_{rn\ max}$	≤ 23		N
Material				
– screw		stainless steel		
– nut		stainless steel		
– balls		stainless steel		
Direction of rotation		right hand thread		

Recommended values - mathematically independent of each other				
Continous axial load, max.	$F_{m\ max.}$		105	N
Intermittent axial load, max.	$F_{p\ max.}$		475	N
Rotational speed, max.			5 000	rpm
Linear speed, max.			125	mm/s

Note: Specifications are valid over the whole entire travel according to ISO 3408.
A clean and contamination/dust free operating environment is required for performance as specified in the datasheet.
Do not remove the nut from the screw! No relubrication allowed.



BS22-1.5

NEW

Spindle Drive

Ball screw

176 N

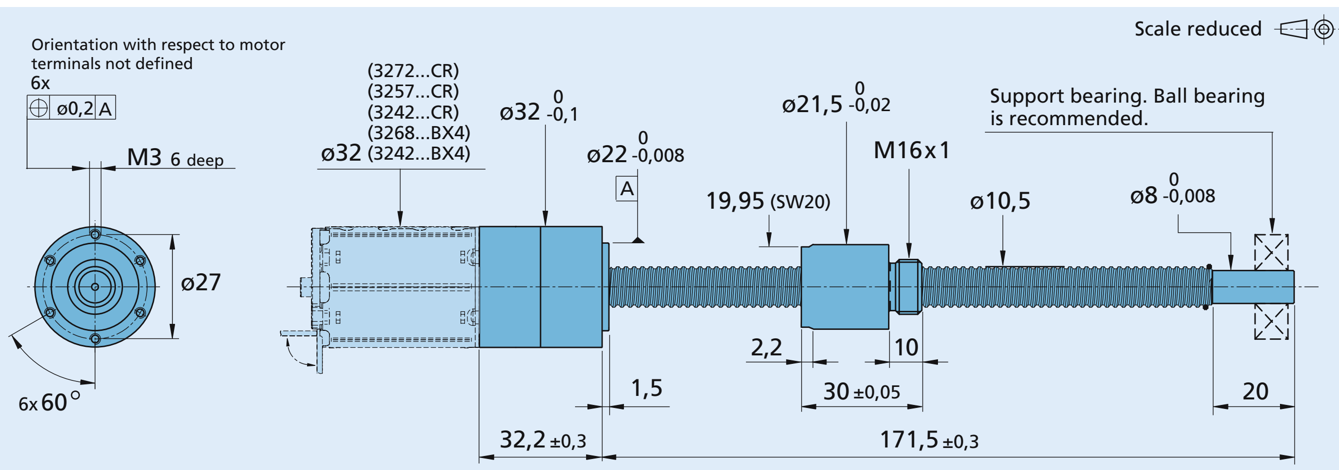
For combination with
DC-Micromotors
Brushless DC-Servomotors

Series BS32-2.0

			BS32-2.0	
Screw length, standard			171,5	mm
Stroke, standard			130	mm
Pitch	P_h		2,0	mm
Mean actual travel deviation e_{0a}:				
– maximum permissible	e_p		5 (According to accuracy class 1)	µm
Tolerance of travel variation	v_{up}		5 (According to accuracy class 1)	µm
Efficiency, max.	$\eta_{max.}$		91	%
Operating temperature range		–35 ... +100		°C
Bearing		ball bearings, preloaded		
Axial load capacity:				
– dynamic	C_{am}	≤ 890		N
– static	C_{oa}	≤ 887		N
Shaft load, max.:				
– radial (50 mm from mounting face)	$F_{rs\ max}$	≤ 100		N
Screw nut:				
– axial play		≤ 5		µm
Screw nut load, max.:				
– radial	$F_{rn\ max}$	≤ 44		N
Material				
– screw		stainless steel		
– nut		stainless steel		
– balls		stainless steel		
Direction of rotation		right hand thread		

Recommended values - mathematically independent of each other				
Continous axial load, max.	$F_{m\ max.}$		176	N
Intermittent axial load, max.	$F_{p\ max.}$		887	N
Rotational speed, max.			5 000	rpm
Linear speed, max.			166	mm/s

Note: Specifications are valid over the whole entire travel according to ISO 3408.
A clean and contamination/dust free operating environment is required for performance as specified in the datasheet.
Do not remove the nut from the screw! No relubrication allowed.



BS32-2.0

Linear Components

Lead Screws and Options

Technical Information

Lead Screws Parameters

Resolution (travel/step)

A lead screw combined with a PRECIstep® stepper motor can achieve a positioning with a resolution of 10µm.

The resolution of the position depends on the pitch and number of steps per revolution:

$$P = \frac{P_h}{n}$$

With P_h the pitch of the screw and n the number of steps per revolution of the motor.

Driving the motor with half-stepping or microstepping will improve the resolution up to a certain extent. The resolution must be balanced with another parameter: the precision.

Precision

The rolled thread ensures a pitch precision <500nm per pitch but is cumulative (100 revolutions = error <50µm). This error can nevertheless be digitally compensated (step number correction).

The motor step angle accuracy cannot be neglected. It varies between ±3 and ±10% of a full step angle depending on the motor model (see line 9 on motor datasheet) and remains the same with microstepping. It is however not cumulative.

Axial play

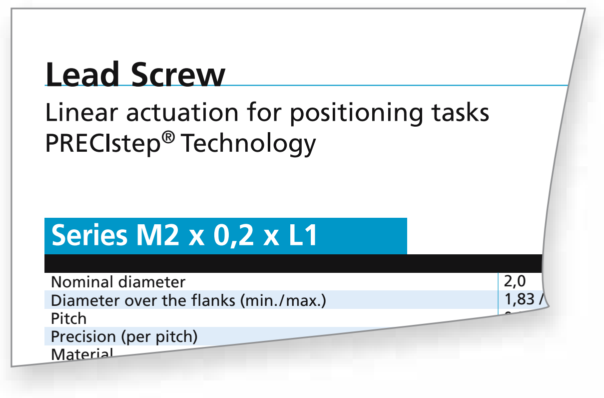
An axial play up to 30µm is measured with optional nuts offered in this catalogue. However, it is possible to negate the axial play by implementing a preloading system in the design of the application (for instance with a spring mechanism).

The “zero” axial play between the lead screw and motor housing is ensured thanks to a preload of the motor ball bearings (in standard configuration: spring washer on rear ball bearing). An axial play up to 0.2 mm will occur if the axial load on the lead screw exceeds the ball bearing preload.

This does not cause any damage to the motor and is reversible. This limit is translated into a flat portion on the force vs speed curves of lead screws datasheet. This occurs only while pulling on the shaft. On request, customization can overcome this limitation.

Backdriving

Backdriving the motors while applying an axial load on the lead screws is impossible. The pitch vs. diameter ratio does not allow it.


Lead Screw

Linear actuation for positioning tasks
PRECIstep® Technology

Series M2 x 0,2 x L1

Nominal diameter	2,0
Diameter over the flanks (min./max.)	1,83 /
Pitch	
Precision (per pitch)	
Material	

Force vs speed curves

The force that a linear system can provide depends on the type of screw and stepper motor selected. Torque vs speed curves for each solution are provided in this catalogue. Those curves do already consider a 40% safety factor on the motor torque as well as the lead screw efficiency in the calculation.

Tip for bearings

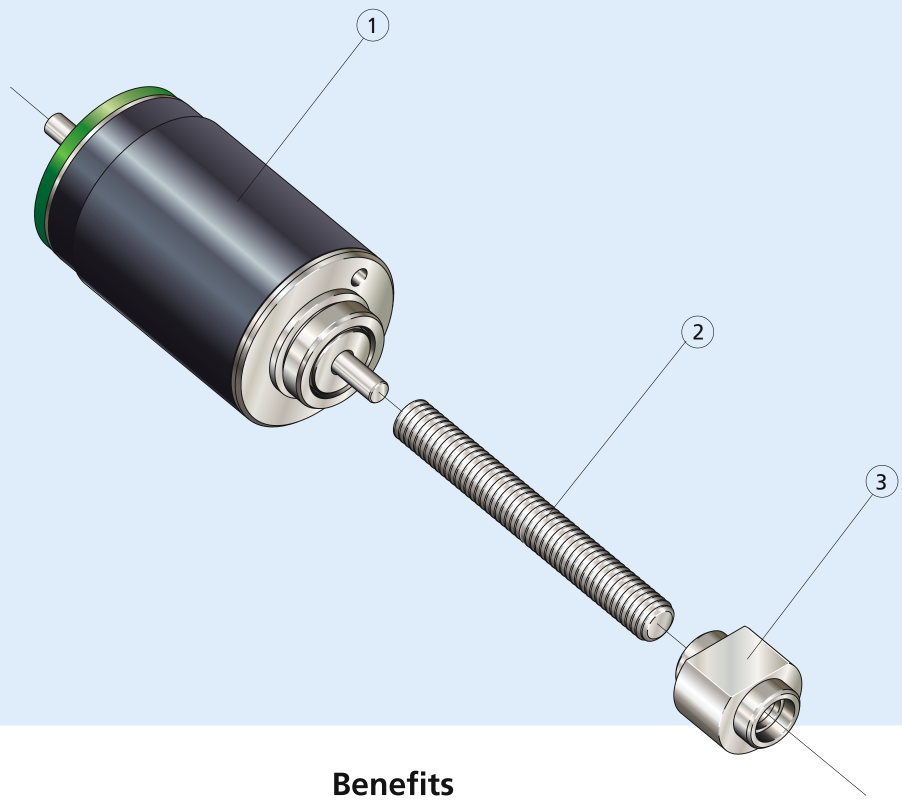
Ideally, the application should handle radial loads and the lead screw only axial loads. If it is not the case, it is possible to get lead screws with a tip suitable for bearing at its front end in order to handle radial loads. With this configuration, a special care to the alignment of the motor and bearing must be paid to not deteriorate the thrust force achievable. Optional mating ball bearings are available in the dedicated datasheet for options.

Nut

Optional nuts offered in this catalogue are made of aluminum bronze alloy and are shaped with a flat in order to prevent its rotations in the application. Alternatively, tapped holes on the application are a convenient solution since metric taps are readily available.

Lead Screws and Options

Technical Information



Lead Screws

① Stepper motor
② Lead screw
③ Nut

Features

Stepper motors can be used for more than just a rotation. When combined with lead screws, they provide a high accuracy linear positioning system that provides the benefits of a stepper (open loop control, long life, high torque density, etc.).

The lead screws available on stepper motors are all based on metric dimensions (M1.2 up to M3) and specifically designed to be assembled with PRECIstep® stepper motors. The rolling technique used to produce the thread ensures a very high precision and consistency of quality. A large choice of standard lengths is available from stock and customization is possible on request.

Such a combination is ideal for any application such as requiring accurate linear movement or lens adjustment (zoom, focus), microscope stages or medical syringes.

Benefits

- Cost effective positioning drive without encoder
- High accuracy
- Wide range of lead screws available
- Short lead time for standard length
- Flexibility offered by optional nuts and ball bearings
- Custom length on request

Product Code

AM1524-2R-V-12-150-55

AM1524	Motor series
2R	Bearing type
V-12-150	Coil type
55	Motor version

M3 x 0,5 x 15

M3	Screw type
0.5	Pitch (mm)
15	Length (mm)

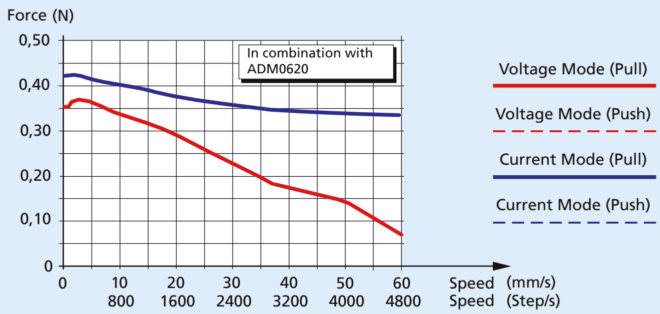
Lead Screw

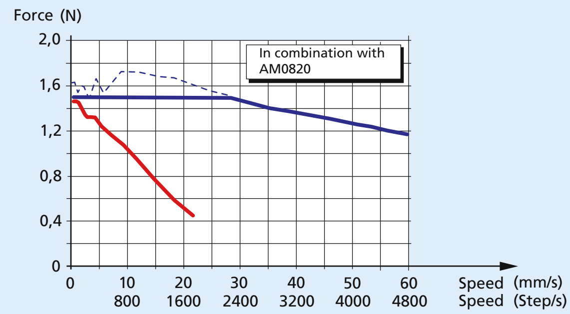
Linear actuation for positioning tasks
PRECIstep® Technology

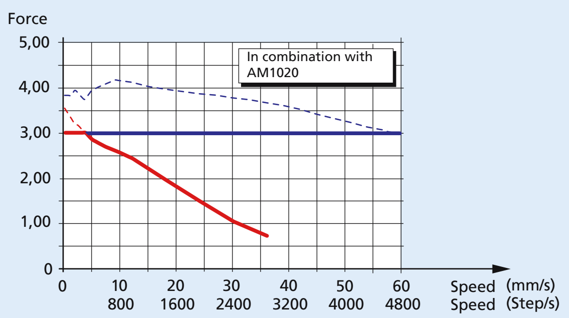
For combination with
Stepper Motors: ADM0620, AM0820, AM1020

Series M1,2 x 0,25 x L1

Nominal diameter	1,2	mm
Diameter over the flanks (min./max.)	0,998 / 1,018	mm
Pitch	0,25	mm
Precision (per pitch)	< 0,5	µm
Material	316L	



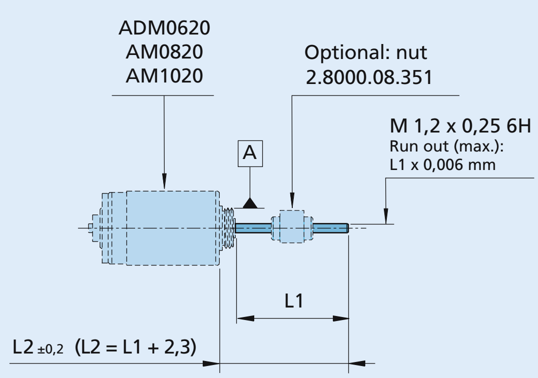




Important notes: The thrust curves include already a safety factor for the use of the stepper motor.
Please read the "Technical information" for a better understanding of the curves.

Ordering information	L1 (mm) =	7,5	15	Custom
Order code (no bearing tip)		M1,2x0,25x7,5	M1,2x0,25x15	M1,2x0,25xL1*
Order code (with bearing tip)		–	–	–

* For custom length, please inquire with your point of sales



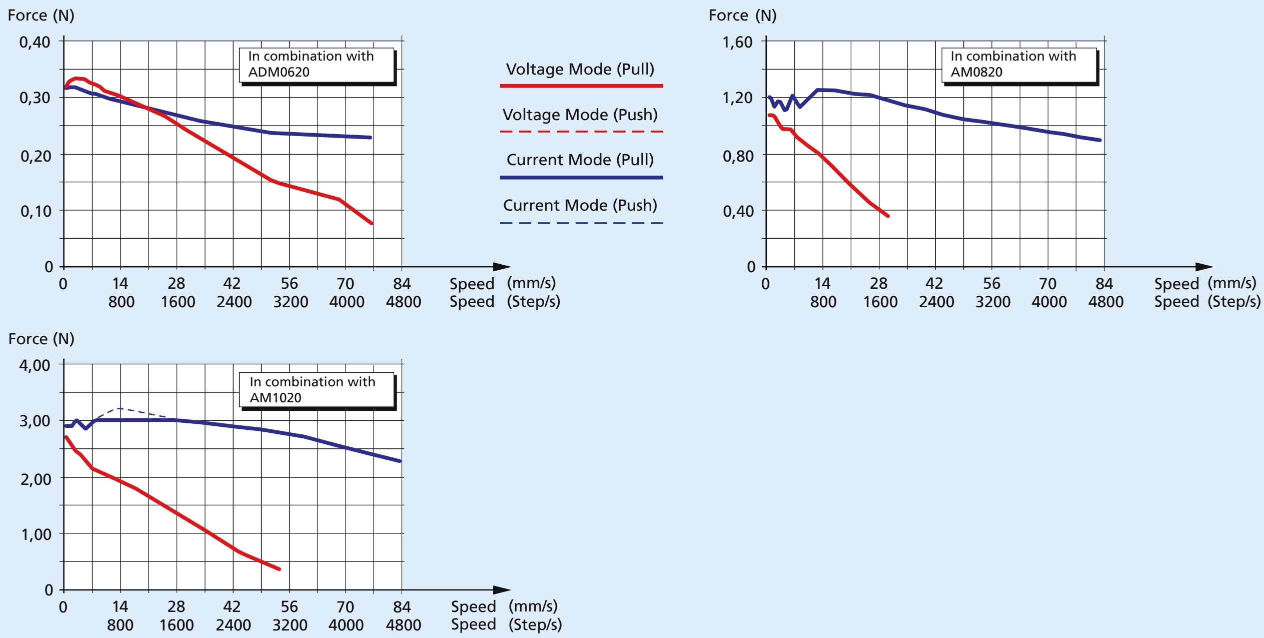
Lead Screw

Linear actuation for positioning tasks
PRECIstep® Technology

For combination with
Stepper Motors: ADM0620, AM0820, AM1020

Series M1,6 x 0,35 x L1

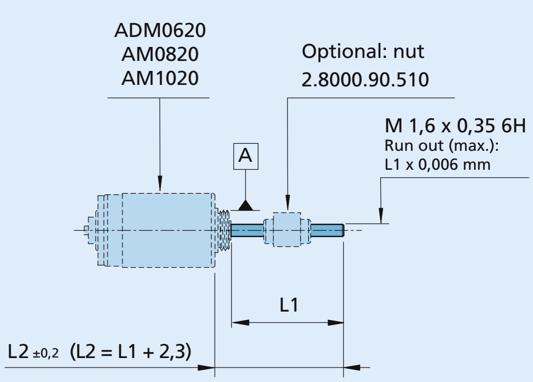
Nominal diameter	1,6	mm
Diameter over the flanks (min./max.)	1,310 / 1,353	mm
Pitch	0,35	mm
Precision (per pitch)	< 0,5	µm
Material	316L	

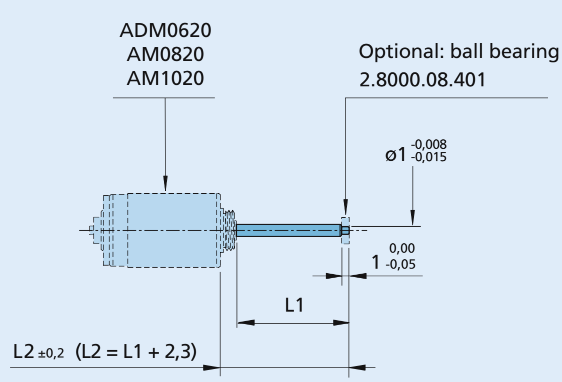


Important notes: The thrust curves include already a safety factor for the use of the stepper motor.
Please read the "Technical information" for a better understanding of the curves.

Ordering information	L1 (mm) =	7,5	15	25	Custom
Order code (no bearing tip)		M1,6x0,35x7,5	M1,6x0,35x15	–	M1,6x0,35xL1*
Order code (with bearing tip)		–	M1,6x0,35x15T	M1,6x0,35x25T	M1,6x0,35xL1*T

* For custom length, please inquire with your point of sales





Version with bearing tip

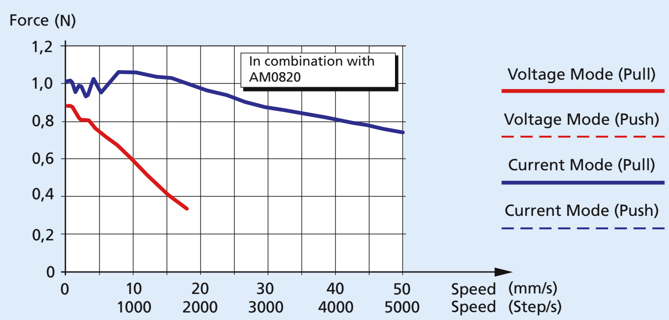
Lead Screw

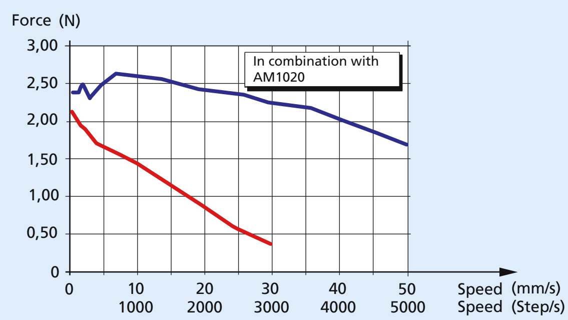
Linear actuation for positioning tasks
PRECIstep® Technology

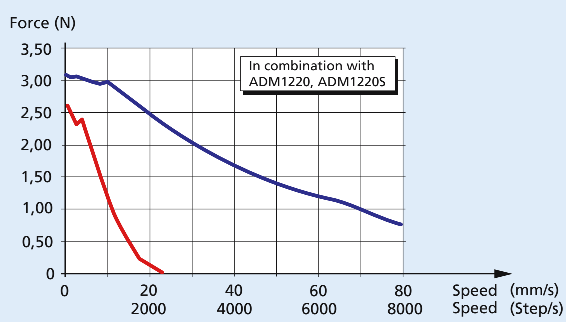
For combination with
Stepper Motors: AM0820, AM1020, ADM1220, ADM1220S, AM1524

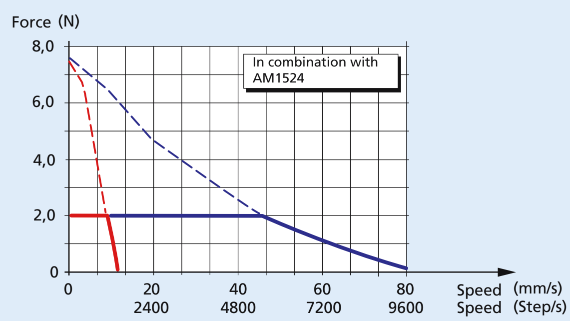
Series M2 x 0,2 x L1

Nominal diameter	2,0	mm
Diameter over the flanks (min./max.)	1,83 / 1,85	mm
Pitch	0,2	mm
Precision (per pitch)	< 0,5	µm
Material	316L	





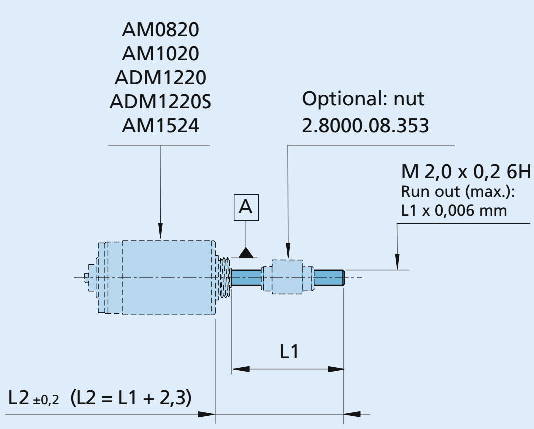


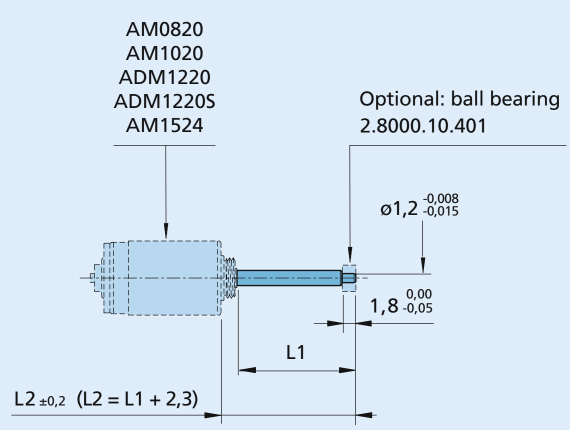


Important notes: The thrust curves include already a safety factor for the use of the stepper motor.
Please read the "Technical information" for a better understanding of the curves.

Ordering information	L1 (mm) = 7,5	15	25	Custom
Order code (no bearing tip)	M2x0,2x7,5	M2x0,2x15	M2x0,2x25	M2x0,2xL1*
Order code (with bearing tip)	–	M2x0,2x15T	M2x0,2x25T	M2x0,2xL1*T

* For custom length, please inquire with your point of sales





Version with bearing tip

FAULHABER

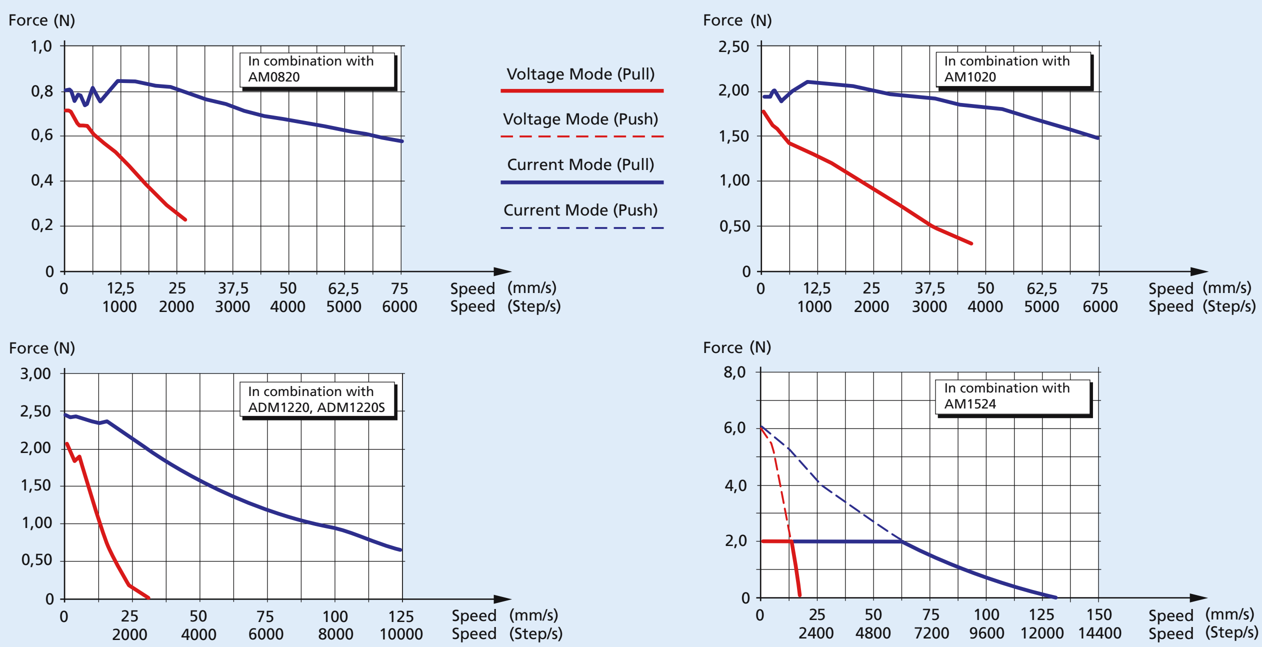
Lead Screw

Linear actuation for positioning tasks
PRECIstep® Technology

For combination with
Stepper Motors: AM0820, AM1020, ADM1220, ADM1220S, AM1524

Series M2,5 x 0,25 x L1

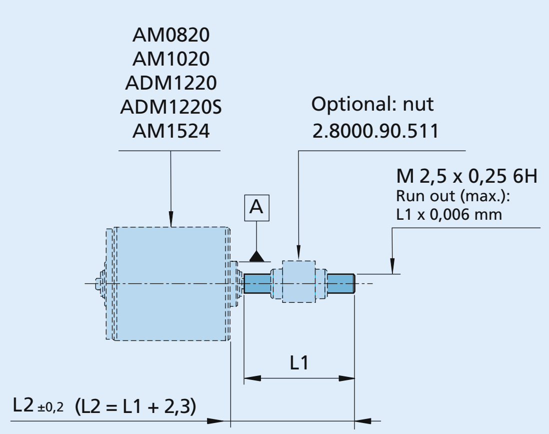
Nominal diameter	2,5	mm
Diameter over the flanks (min./max.)	2,298 / 2,318	mm
Pitch	0,25	mm
Precision (per pitch)	< 0,5	µm
Material	316L	

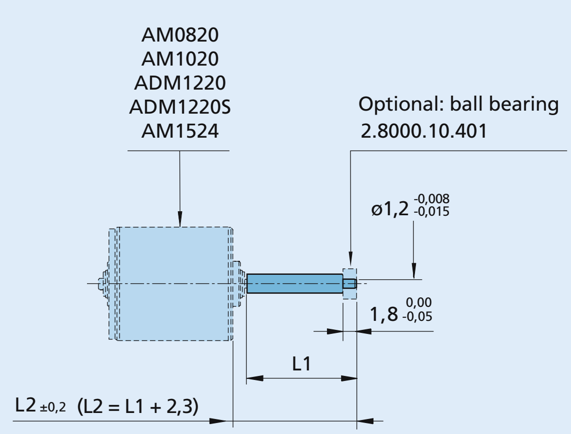


Important notes: The thrust curves include already a safety factor for the use of the stepper motor. Please read the "Technical information" for a better understanding of the curves.

Ordering information	L1 (mm) = 7,5	15	25	Custom
Order code (no bearing tip)	M2,5x0,25x7,5	M2,5x0,25x15	M2,5x0,25x25	M2,5x0,25xL1*
Order code (with bearing tip)	–	M2,5x0,25x15T	M2,5x0,25x25T	M2,5x0,25xL1*T

* For custom length, please inquire with your point of sales





Version with bearing tip

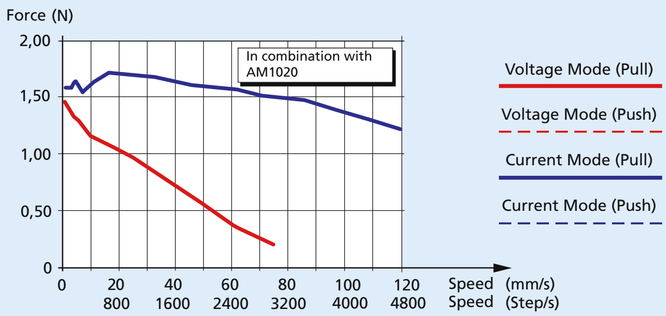
Lead Screw

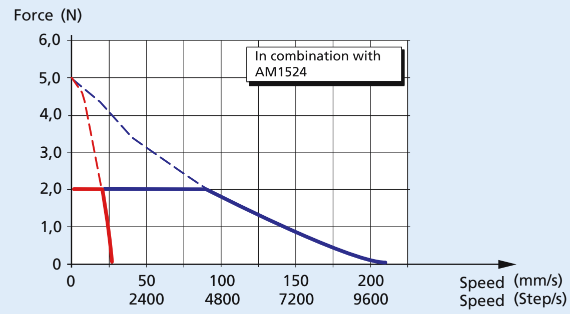
Linear actuation for positioning tasks
PRECIstep® Technology

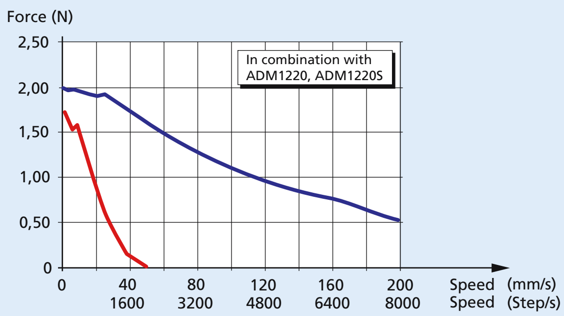
For combination with
Stepper Motors: AM0820, AM1020, ADM1220, ADM1220S, AM1524, AM2224-R3

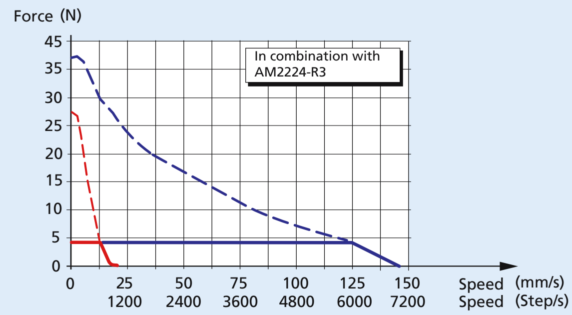
Series M3 x 0,5 x L1

Nominal diameter	3,0	mm
Diameter over the flanks (min./max.)	2,600 / 2,675	mm
Pitch	0,5	mm
Precision (per pitch)	< 0,5	µm
Material	316L	





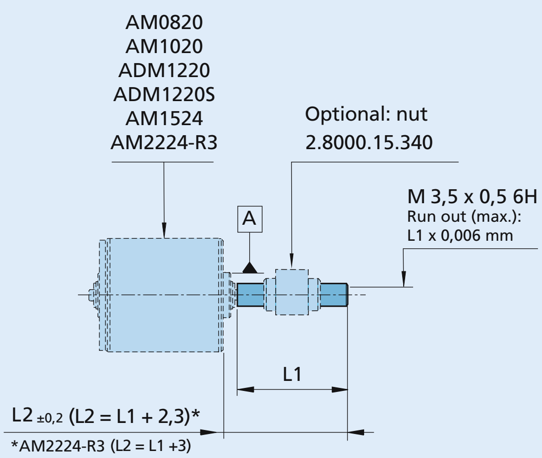


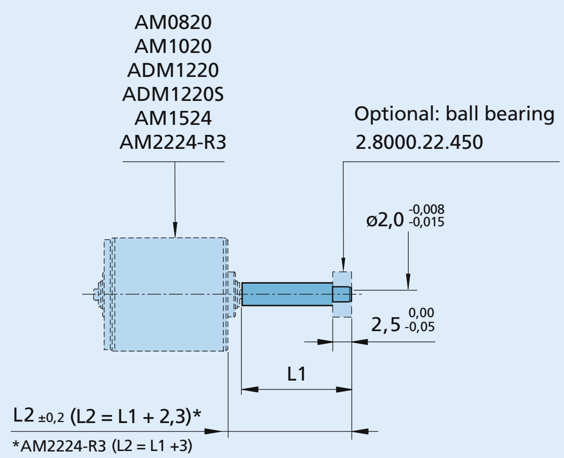


Important notes: The thrust curves include already a safety factor for the use of the stepper motor. Please read the "Technical information" for a better understanding of the curves.

Ordering information	L1 (mm) =	15	25	Custom
Order code (no bearing tip)		M3x0,5x15	M3x0,5x25	M3x0,5xL1*
Order code (with bearing tip)		M3x0,5x15T	M3x0,5x25T	M3x0,5xL1*T

* For custom length, please inquire with your point of sales





Version with bearing tip

Linear Components

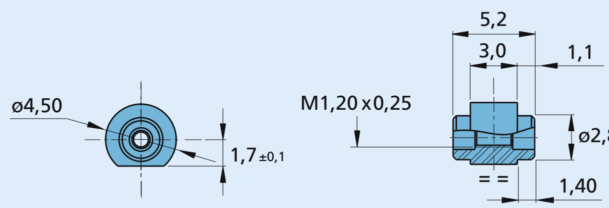
Lead Screw

Optional nuts and bearings
PRECIstep® Technology

Options

For M1,2 x 0,25 Lead screws

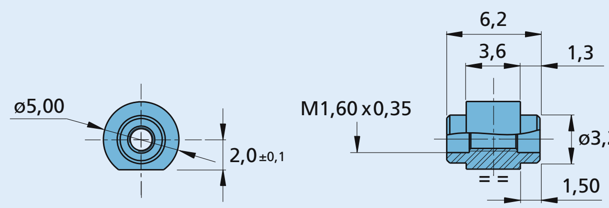
Scale 2:1



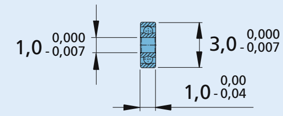
Nut Part No. 2.8000.08.351, Material CuAl10Ni5Fe4

For M1,6 x 0,35 Lead screws

Scale 2:1



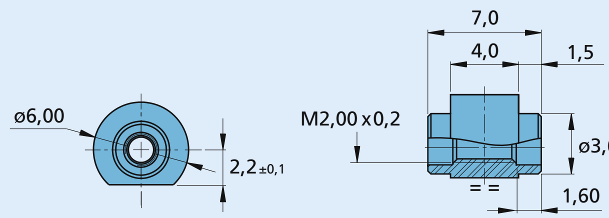
Nut Part No. 2.8000.90.510, Material CuAl10Ni5Fe4



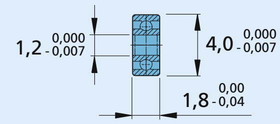
Bearing for leadscrew tip Part No. 2.8000.08.401

For M2,0 x 0,2 Lead screws

Scale 2:1



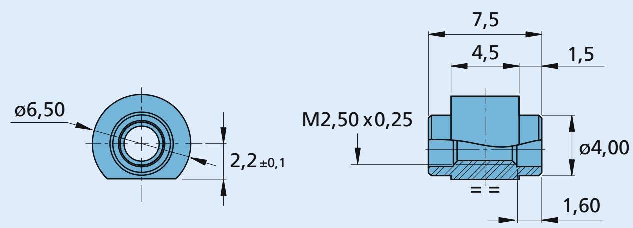
Nut Part No. 2.8000.08.353, Material CuAl10Ni5Fe4



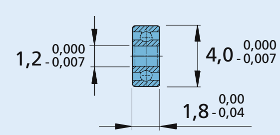
Bearing for leadscrew tip Part No. 2.8000.10.401

For M2,5 x 0,25 Lead screws

Scale 2:1



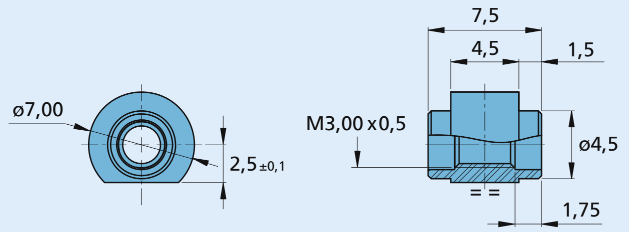
Nut Part No. 2.8000.90.511, Material CuAl10Ni5Fe4



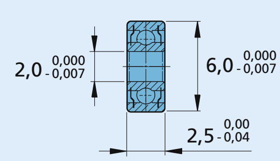
Bearing for leadscrew tip Part No. 2.8000.10.401

For M3,0 x 0,5 Lead screws

Scale 2:1



Nut Part No. 2.8000.15.340, Material CuAl10Ni5Fe4



Bearing for leadscrew tip Part No. 2.8000.22.450

Linear Components

Encoders

WE CREATE MOTION

FAULHABER

Encoders – 2 Channel

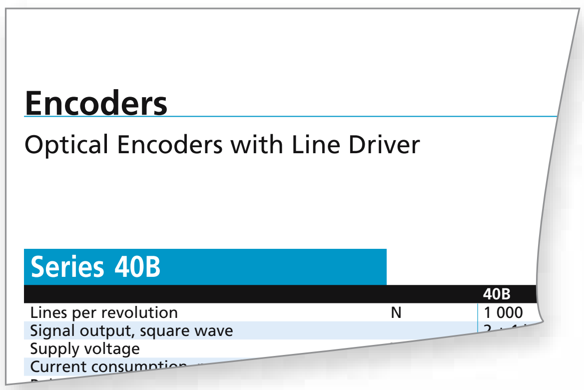
		Page
PA2-50	optical	361 – 363
PA2-100	optical	364 – 366
IE2-16	magnetic	367
IE2-400	magnetic	368
IE2-1024	magnetic	369 – 376
30B	magnetic	377 – 378
20B, 21B	magnetic	379 – 380
AE 30B19	magnetic	381
AE 23B8	magnetic	382
PE22-120	optical	383

Encoders – 3 Channel

		Page
HXM3-64	magnetic	384 – 386
HEM3-256-W	magnetic	387 – 389
IE3-1024	magnetic	390 – 391
IE3-1024L	magnetic, Line Driver	392 – 393
HEDS, HEDM 55x0	optical	394
HEDL 5540	optical, Line Driver	395 – 397
40B	optical, Line Driver	398 – 399

Encoders

Technical Information


Encoders

Optical Encoders with Line Driver

Series 40B

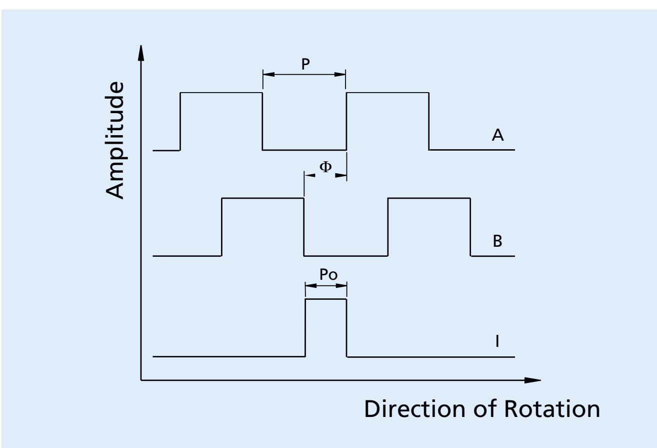
		40B
Lines per revolution	N	1 000
Signal output, square wave		
Supply voltage		
Current consumption		

Notes on technical data

Lines per revolution (N)
The number of incremental encoder pulses per revolution per channel.

The output signal is a quadrature signal which means that both the leading and following edge, or flank, can be evaluated. For example, an encoder with two channels and 256 lines per revolution has 1024 edges, or flanks per revolution.

Output signal
The number of output channels. For example, the IE3 encoders offer 2 channels, A and B, plus an 1 additional index channel.



Supply Voltage (U_{DD})
Defines the range of supply voltage necessary for the encoder to function properly.

Current consumption, typical (I_{DD})
Indicates the typical current consumption of the encoder at the given supply voltage.

Output current, max. (I_{OUT})
Indicates the maximum allowable load current at the signal outputs.

Puls width (P)
Width of the output signal in electrical degrees (°e) of the channels A and B. The value corresponds to one full period, or 360°e at channel A or B.

Index pulse width (P_0)
Indicates the width of the index pulse signal in electrical degrees.

Tolerance ΔP_0:

$$P_0 = \left| 90° - \frac{P_0}{P} * 180° \right|$$

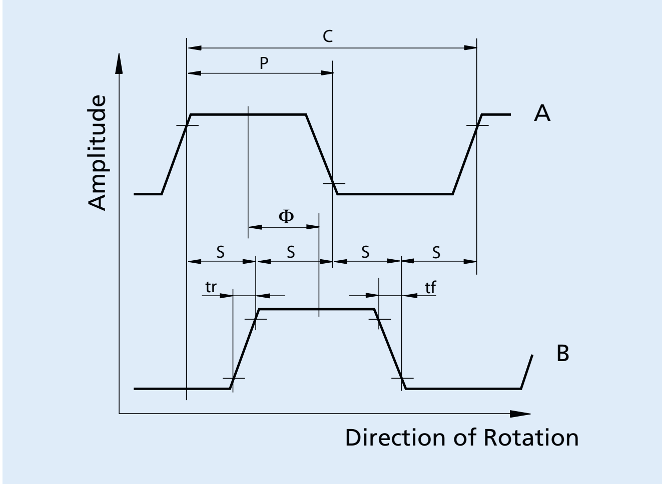
Phase shift, channel A to B (Φ)
The phase shift in electrical degrees between the following edge of output channel A and the leading edge of output channel B.

Phase shift tolerance ($\Delta\Phi$)
Indicates the allowable position error, in electrical degrees, between the following edge of channel A to the leading edge of channel B.

$$\Phi = \left| 90° - \frac{\Phi}{P} * 180° \right|$$

Signal period (C)
The total period, measured in electrical degrees of one pulse on channel A or B.

Typically one period is 360 °e.



Logic state width (S)
The distance measured in electrical degrees (°e) between two neighbouring signal edges, for example the leading edge of signal A to the leading edge of signal B.

Typically this has a value of 90 °e.

Signal rise/fall time, typical (tr/tf)
Corresponds to the slope of the rising and falling signal edges.

Frequency range (f)
Indicates the maximum encoder frequency. The maximum achievable motor speed can be derived using the following formula.

$$n = \frac{60 \cdot f}{N}$$

Inertia of the code disc (J)
Indicates the additional inertial load due on the motor due to the code wheel.

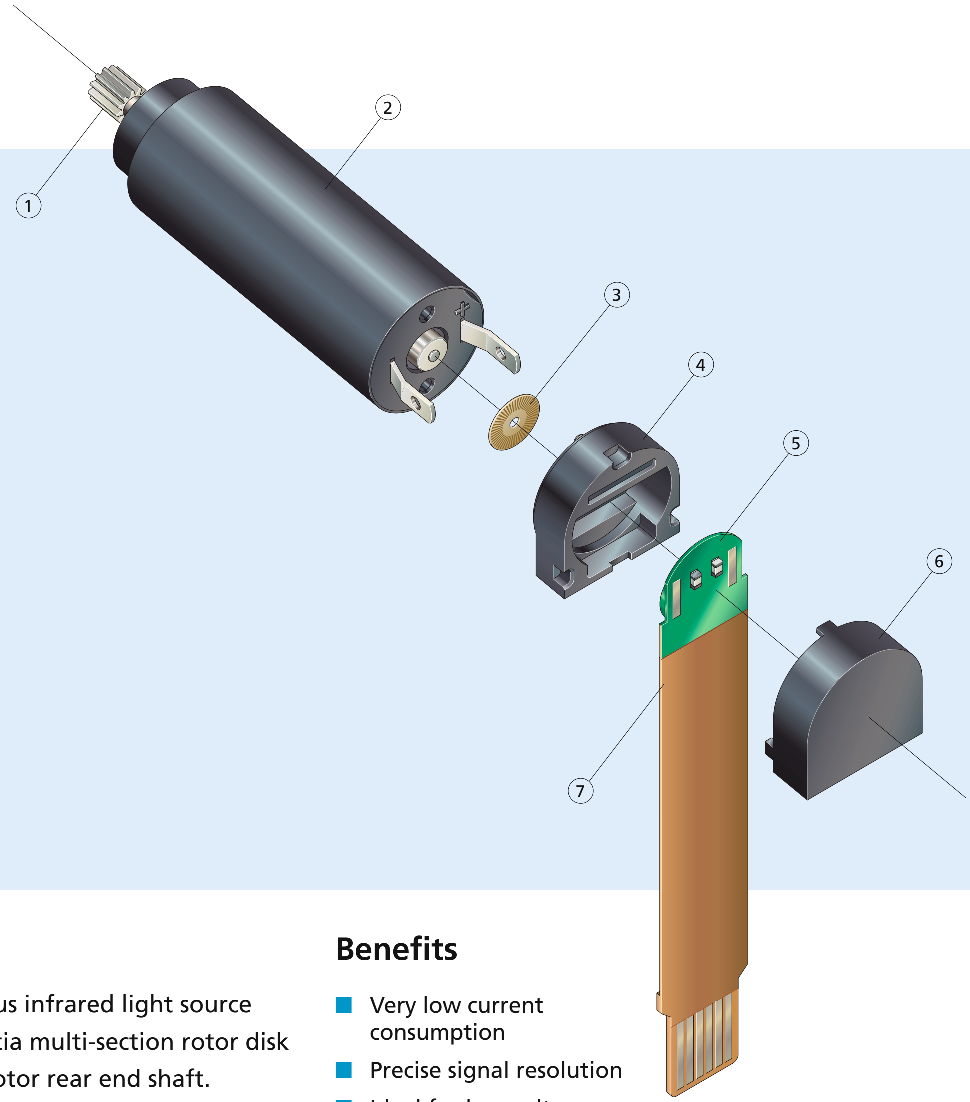
Operating temperature range
Indicates the minimum and maximum allowable temperature range for encoder operation.

Test speed
The speed at which the encoder specifications were measured.

Line Driver
This is an integrated signal amplifier in the encoder that makes it possible to send the encoder signals through much longer connection cables. It is a differential signal with complementary signals to all channels which eliminates sensitivity to ambient electrical noise.

Optical Encoders

Technical Information



Optical Encoder

① Output shaft
② Motor
③ Code wheel
④ Adapter flange
⑤ Encoder PCB
⑥ End cap
⑦ Flex cable

Features

Optical encoders use a continuous infrared light source transmitting through a low-inertia multi-section rotor disk which is fitted directly on the motor rear end shaft. The unit thus generates two output signals with a 90° phase shift.

In optoreflective encoders, the light source is sent and reflected back or alternately absorbed to create the necessary phase shifted pulse.

Benefits

- Very low current consumption
- Precise signal resolution
- Ideal for low voltage battery operation
- Insensitive to magnetic interference
- Extremely light and compact

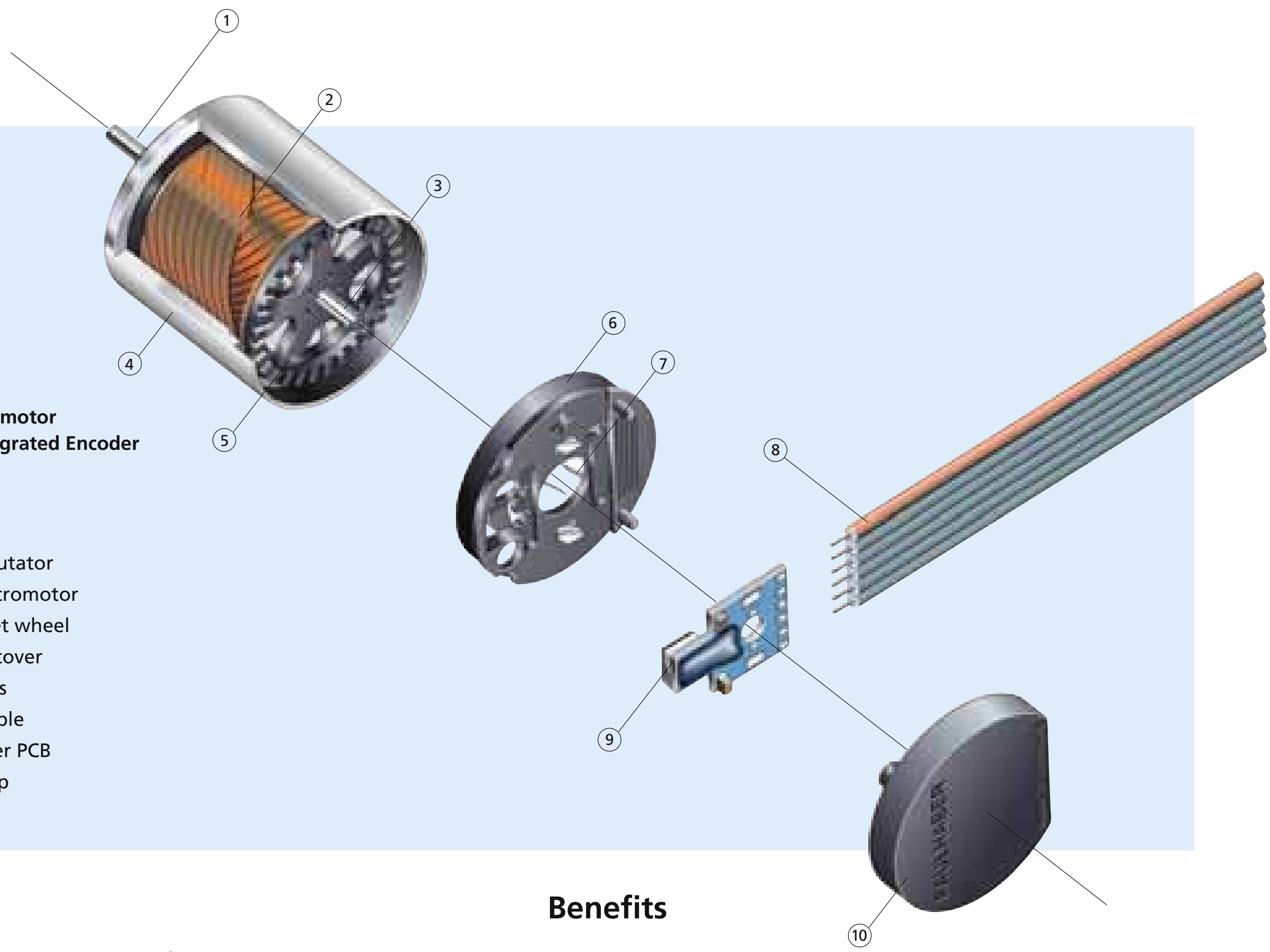
Product Code

PA	Encoder series
2	Number of Channels
50	Resolution

PA2 - 50

Integrated Encoders

Technical Information



DC-Micromotor with integrated Encoder

① Shaft
② Coil
③ Commutator
④ DC-Micromotor
⑤ Magnet wheel
⑥ Brush cover
⑦ Brushes
⑧ Flat cable
⑨ Encoder PCB
⑩ End cap

Features

Series IE2 encoders consist of a rotormounted magnetic toothed ring and a special hybrid circuit.
The magnetic field differences between the tip and base of each tooth are converted into electrical signals by a sensor integrated into the circuit.
This signal is then processed by a proprietary circuit.
The output consists of two 90°-offset square-wave signals with up to 1024 pulses.

The encoder is integrated into the SR-Series motors, increasing its length by a mere 1,4 mm and as built-on option for DC-Micromotors and brushless DC-Servomotors.

Benefits

- Highly compact design
- High resolution up to 4096 steps per revolution (corresponding to an angular resolution of 0,18°)
- No pull-up resistors across outputs because no open-collector outputs
- Symmetrical pulse edges, CMOS- and TTL -compatible
- Low power consumption
- Available in many combinations

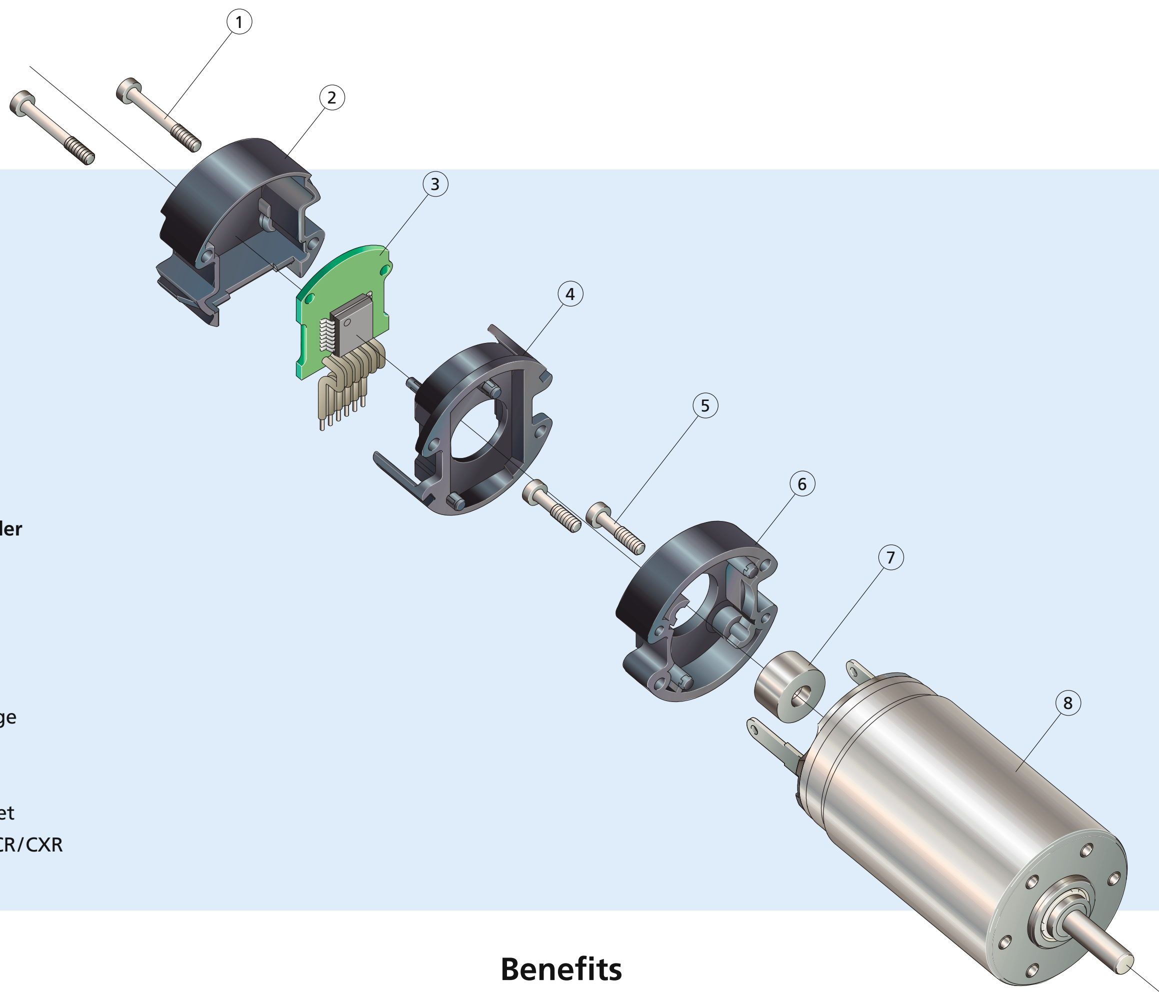
Product Code

IE2 – 1024

IE	Incremental Encoder
2	Number of Channels
1024	Resolution

Magnetic Encoders

Single Chip



**Magnetic Encoder
Single Chip**

① Screws
② Rear cover
③ Encoder PCB
④ Encoder flange
⑤ Screws
⑥ Motor flange
⑦ Sensor magnet
⑧ Motor Serie CR/CXR

Features

FAULHABER IE3 encoders are designed with a diametrically magnetized code wheel which is pressed onto the motor shaft and provides the axial magnetic field to the encoder electronics. The electronics contain all the necessary functions of an encoder including Hall sensors, interpolation, and driver. The Hall sensors sensed the rotational position of the sensor magnet and the signal is interpolated to provide a high resolution position signal.

The encoder signal is a two channel quadrature output with a 90 °e phase shift between channels.
A third channel provides a single index pulse per revolution. These encoders are available as attachable kits or preassembled to FAULHABER DC-Motors with graphite commutation, or as integrated assemblies for many FAULHABER Brushless DC-Servomotors.

Benefits

- Compact modular system
- A wide range of resolutions are available
- Index channel
- Line Drivers are available
- Standardized encoder outupts
- Ideal for combination with FAULHABER Motion Controllers and Speed Controllers
- Custom modifications including custom resolution, index position and index pulse width are possible

Product Code

IE	Incremental Encoder
3	Number of Channels
1024	Resolution
L	with integrated Line Driver

IE3 – 1024 L

Encoders

Optical Encoders

Features:
50 Lines per revolution
2 Channels
Digital output

Series PA2 – 50

		PA2 – 50	
Signal output, square wave		2	channels
Supply voltage (ripple < 100 $mV_{p\text{-}p}$)	V_{CC}	2,7 ... 3,3	V DC
Current consumption, typical (V_{CC} = 3 V DC)	I_{CC}	8,5	mA
Current output, per channel	I_{out}	– 1 ... 8	mA
Pulse width	P	180 ± 50	°e
Phase shift, channel A to B	Φ	90 ± 45	°e
Logic state width	S	90 ± 50	°e
Cycle	C	360 ± 36	°e
Signal rise/fall time, typical (C_{LOAD} = 25 pF)	tr/tf	0,3 / 0,1	µs
Frequency range [1]	f	up to 35	kHz
Inertia of code disc	J	0,02	gcm^2
Operating temperature range		– 30 ... + 85	°C

[1] Velocity (rpm) = f (Hz) x 60/N

Ordering information

Encoder	number of channels	lines per revolution	for combination with:
PA2-50	2	50	**DC-Micromotors serie 0615 ... S [2], 0816 ... S** **Brushless DC-Servomotor serie 0620 ... B [2]**

Note: Lines per revolution refers to pre-quadrature resolution and equals the cycles per revolution
[2] Channel B Leads channel A

Features

These incremental shaft encoders in combination with the DC-Micromotors and Brushless DC-Servomotors are designed for both indication and control of both shaft velocity and direction of rotation as well as for positioning.

An all-in-one emitter and detector chip transmits and receives LED light reflected off a low inertia reflective disc providing two channels with 90° phase shift.

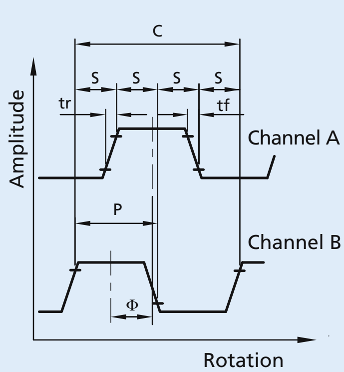
The supply voltage for the encoder and the Micromotor as well as the output signals are interfaced with a flexible printed circuit (FPC).

Details for the DC-Micromotors and Brushless DC-Servomotors and suitable reduction gearheads are on separate catalog pages.

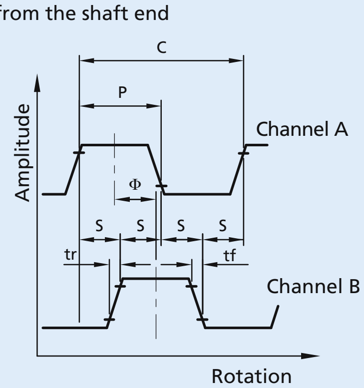
An optional interface board with suitable connector is also available on request.

Output signals / Circuit diagram / Connector information

Output signals
with clockwise rotation as seen from the shaft end

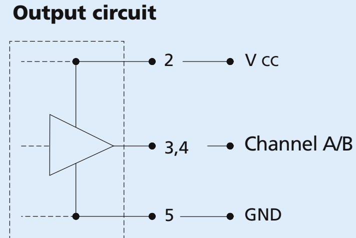


0615 ... S / 0620 ... B



0816 ... S

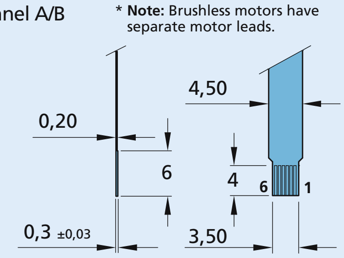
Output circuit



Pin Function

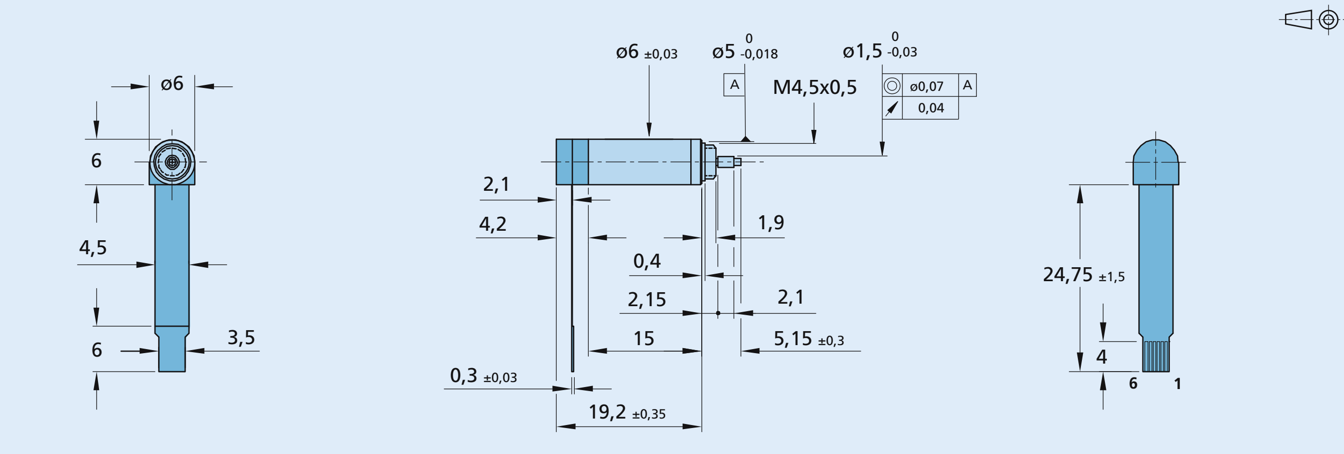
1 Motor + *
2 Vcc
3 Channel A
4 Channel B
5 GND
6 Motor - *

* **Note:** Brushless motors have separate motor leads.



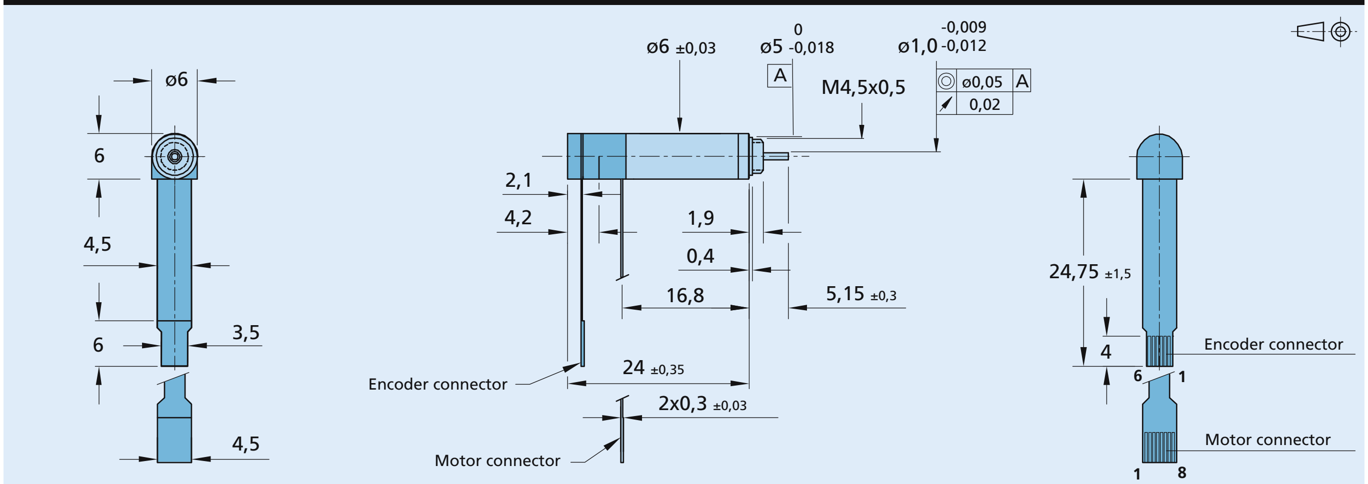
Connector
Molex 52745
grid 0,5 mm
FPC / FFC, 6-conductors

DC-Micromotor 0615 N ... S - K1655 with encoder PA2-50



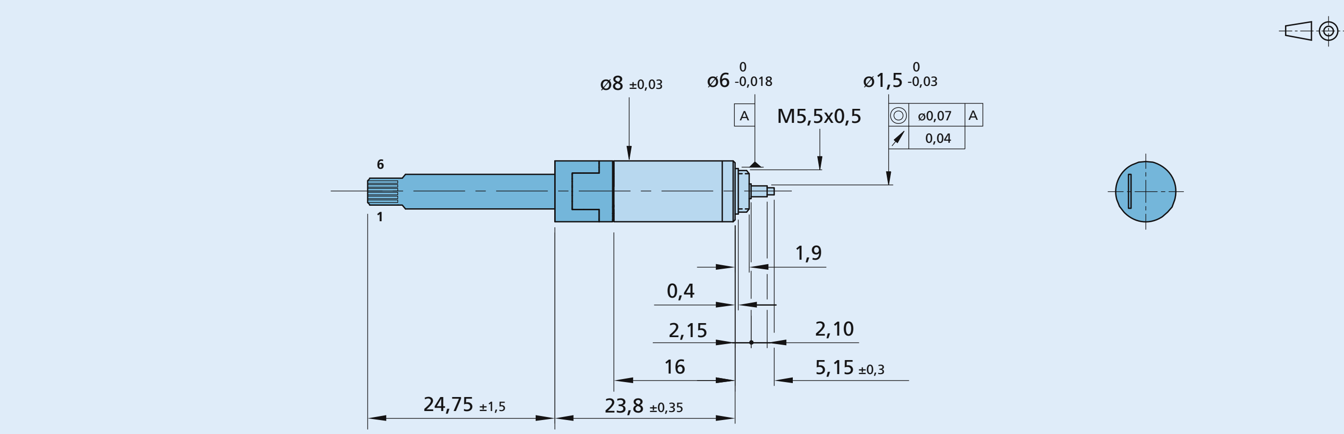
PA2-50 + 0615 N

Brushless DC-Servomotor 0620 K ... B - K1719 with encoder PA2-50



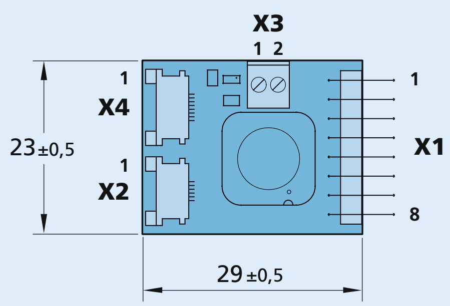
PA2-50 + 0620 K

DC-Micromotor 0816 N ... S - K1752 with encoder PA2-50



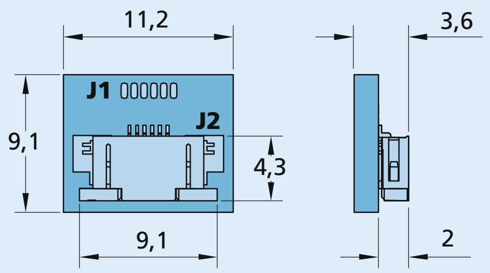
PA2-50 + 0816 N

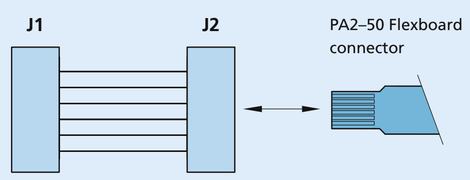
Interface board for MCDC 3002 S



Interface board PA2-50 / PA2-100
Part No.: 6501.00144

Optional interface board





Interface board PA2–50
Part No.: D100315100

Connector
J1 – Solder Pads
J2 – Molex 52475-0690

Encoders

Optical Encoders

Features:
100 Lines per revolution
2 Channels
Digital output

Series PA2 – 100

		PA2 – 100	
Signal output, square wave		2	channels
Supply voltage	V_{CC}	2,7 ... 3,3	V DC
Current consumption, typical (V_{CC} = 3 V DC)	I_{CC}	8	mA
Pulse width	P	180 ± 45	°e
Phase shift, channel A to B	Φ	90 ± 45	°e
Logic state width	S	90 ± 45	°e
Cycle	C	360 ± 30	°e
Signal rise/fall time, typical (C_{LOAD} = 50 pF)	tr/tf	0,1 / 0,1	µs
Frequency range [1]	f	up to 35	kHz
Inertia of code disc	J	0,02	gcm²
Operating temperature range		-25 ... +85	°C

[1] Velocity (rpm) = f (Hz) x 60/N

Ordering information

Encoder	number of channels	lines per revolution	for combination with: DC-Micromotors series
PA2-100	2	100	**1016 ... G** **1024 ... S** **1224 ... SR**

Note: Lines per revolution refers to pre-quadrature resolution and equals the cycles per revolution

Features

These incremental shaft encoders in combination with the DC-Micromotors are designed for both indication and control of both shaft velocity and direction of rotation as well as for positioning.

An all-in-one emitter and detector chip transmits and receives LED light reflected off a low inertia reflective disc providing two channels with 90° phase shift.

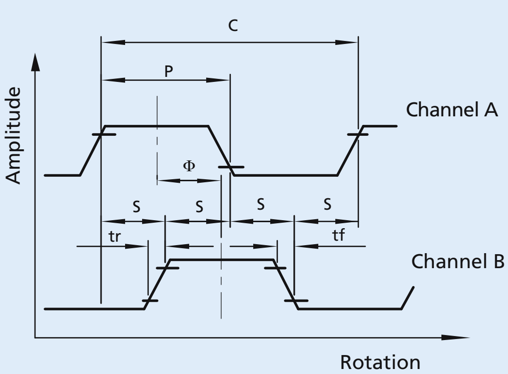
The supply voltage for the encoder and the Micromotor as well as the output signals are interfaced with a flexible printed circuit (FPC).

Details for the DC-Micromotors and suitable reduction gearheads are on separate catalog pages.

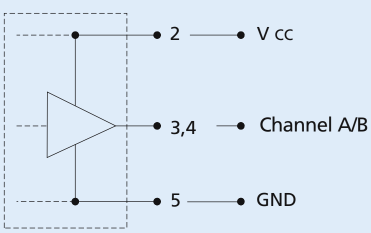
An optional interface board with suitable connector is also available on request.

Output signals / Circuit diagram / Connector information

Output signals
with clockwise rotation as seen from the shaft end

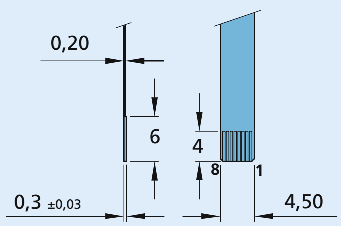


Output circuit



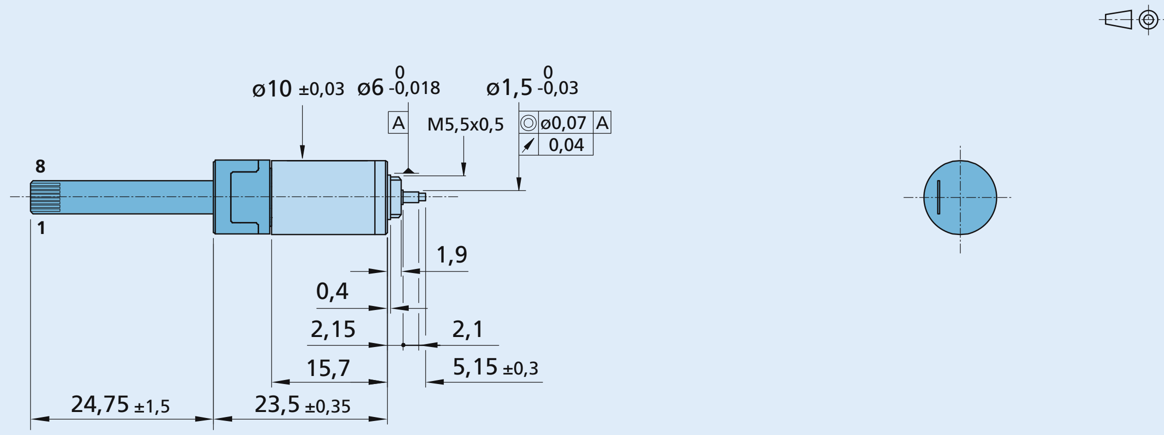
Pin Function

1 Motor +
2 Motor +
3 Vcc
4 Channel A
5 Channel B
6 GND
7 Motor -
8 Motor -



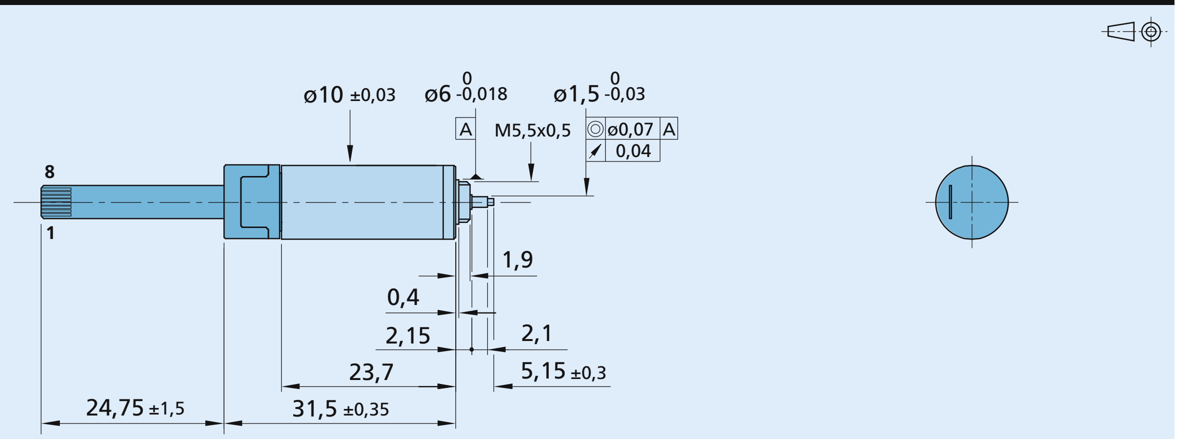
Connector
Molex 52745
grid 0,5 mm
FPC / FFC, 8-conductors

DC-Micromotor 1016 N ... G - K1752 with encoder PA2-100



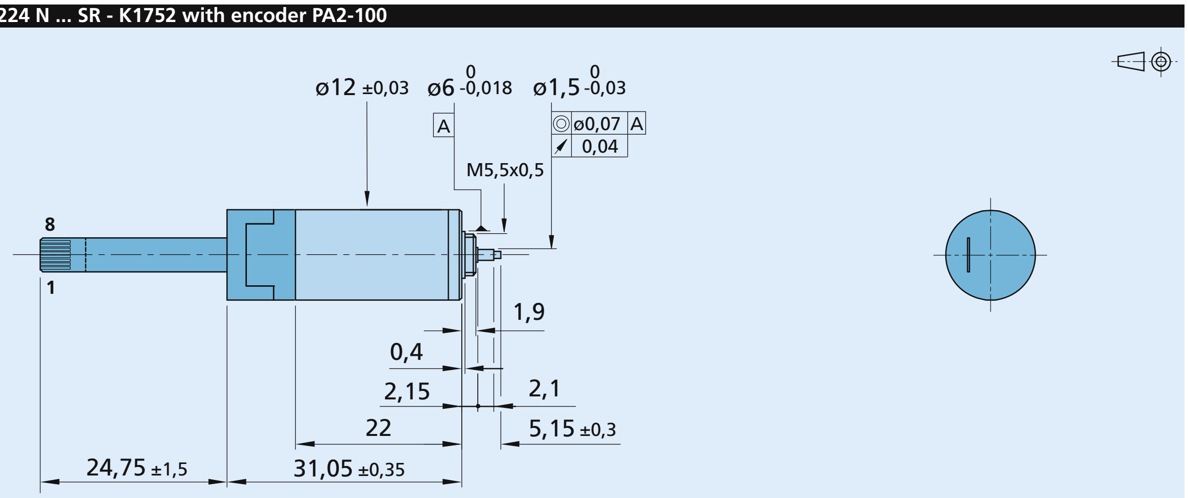
PA2-100 + 1016 N

DC-Micromotor 1024 N ... S - K1752 with encoder PA2-100



PA2-100 + 1024 N

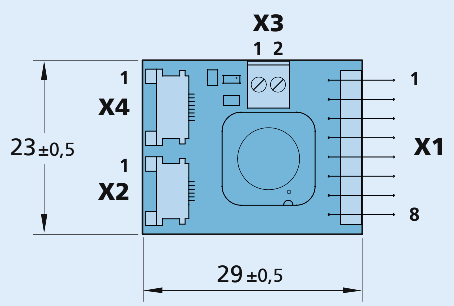
DC-Micromotor 1224 N ... SR - K1752 with encoder PA2-100



PA2-100 + 1224 N

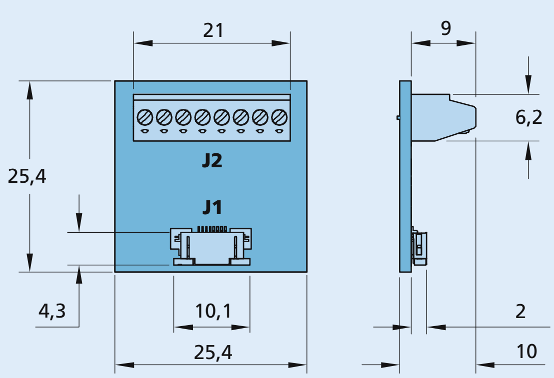
Encoders

Interface board for MCDC 3002 S

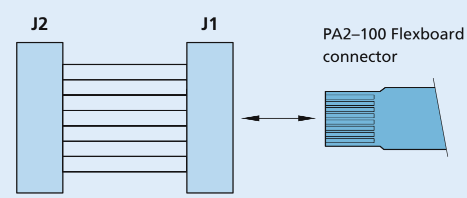


Interface board PA2-50 / PA2-100
Part No.: 6501.00144

Optional interface board



Interface board PA2–100
Part No.: D100308900



Connector
J1 – Molex 52745-0896
J2 – Phoenix 1725711

Encoders

Magnetic Encoders

Features:
16 Lines per revolution
2 Channels
Digital output

Series IE2 – 16

		IE2 – 16	
Lines per revolution	N	16	
Signal output, square wave		2	channels
Supply voltage	V_{DD}	4 ... 18	V DC
Current consumption, typical (V_{DD} = 12 V DC)	I_{DD}	typ. 6, max. 12	mA
Output current, max. admissible	I_{OUT}	15	mA
Phase shift, channel A to B [2]	Φ	90 ± 45	°e
Signal rise/fall time, max. (C_{LOAD} = 100 pF)	tr/tf	2,5 / 0,3	µs
Frequency range [1], up to	f	7	kHz
Inertia of code disc	J	0,11	gcm^2
Operating temperature range		– 25 ... +85	°C

[1] Velocity (rpm) = f (Hz) x 60/N
[2] Tested at 2 kHz

Ordering information

Encoder type	number of channels	lines per revolution	in combination with:
IE2 – 16	2	16	DC-Micromotors 1336 ... CXR, 1516 ... SR, 1524 ... SR, 1717 ... SR, 1724 ... SR, 1727 ... C, 1741 ... CXR, 2224 ... SR, 2232 ... SR, 2342 ... CR, 2642 ... CR, 2657 ... CR, 3242 ... CR, 3257 ... CR, 3272 ... CR, 3863 ... C, 3863 ... CR

Features

These incremental shaft encoders in combination with the FAULHABER DC-Micromotors are used for the indication and control of both shaft velocity and direction of rotation as well as for positioning.

The encoder is integrated in the DC-Micromotors SR-Series and extends the overall length by only 1,4 mm!

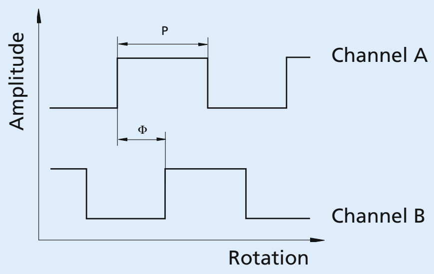
Solid state Hall sensors and a low inertia magnetic disc provide two channels with 90° phase shift.

The supply voltage for the encoder and the DC-Micromotor as well as the two channel output signals are interfaced through a ribbon cable with connector.

Details for the DC-Micromotors and suitable reduction gearheads are on separate catalogue pages.

Output signals / Circuit diagram / Connector information

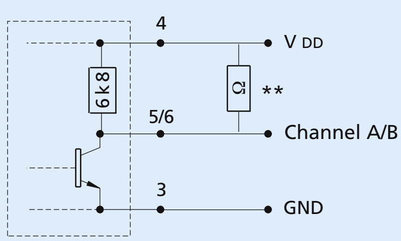
Output signals
with clockwise rotation as seen from the shaft end



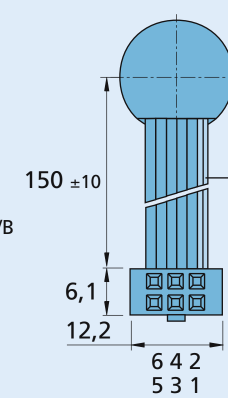
Admissible deviation of phase shift:

$$\Delta\Phi = \left| 90° - \frac{\Phi}{P} * 180° \right| \le 45°$$

Output circuit



** An additional external pull-up resistor can be added to improve the rise time.
Caution: I_{OUT} max. 15 mA must not be exceeded!



Pin Function
1 Motor – *
2 Motor + *
3 GND
4 V_{DD}
5 channel B
6 channel A

PVC-Ribbon cable
6 conductors 0,09 mm^2

***Note:** The terminal resistance of all motors with precious metal commutation is increased by approx. 0.4 Ω, and the max. allowable motor current in combination is 1A. Motors with graphite commutation and brushless motors have separate motor leads and higher motor current is allowed.

Connector
DIN-41651
grid 2,54 mm

Encoders

Magnetic Encoders

Features:
50 to 400 Lines per revolution
2 Channels
Digital output

Series IE2 – 400

		IE2 – 50	IE2 – 100	IE2 – 200	IE2 – 400	
Lines per revolution	N	50	100	200	400	
Signal output, square wave		2				channels
Supply voltage	V_{DD}	4,5 ... 5,5				V DC
Current consumption, typical (V_{DD} = 5 V DC)	I_{DD}	typ. 6, max. 12				mA
Output current, max. [1]	I_{OUT}	5				mA
Phase shift, channel A to B	Φ	90 ± 45				°e
Signal rise/fall time, max. (C_{LOAD} = 50 pF)	tr/tf	0,1 / 0,1				µs
Frequency range [2], up to	f	20	40	80	160	kHz
Inertia of code disc	J	0,05				gcm^2
Operating temperature range		– 25 ... + 85				°C

[1] V_{DD} = 5 V DC: Low logic level < 0,5 V, high logic level > 4,5 V: CMOS and TTL compatible
[2] Velocity (rpm) = f (Hz) x 60/N

Ordering information

Encoder	number of channels	lines per revolution	in combination with:
IE2 – 50	2	50	**DC-Micromotors**
IE2 – 100	2	100	**1319 ... SR,**
IE2 – 200	2	200	**1331 ... SR**
IE2 – 400	2	400	

Features

These incremental shaft encoders in combination with the FAULHABER DC-Micromotors are used for the indication and control of both shaft velocity and direction of rotation as well as for positioning.

The encoder is integrated in the DC-Micromotors SR-Series and extends the overall length by only 1,7 mm!

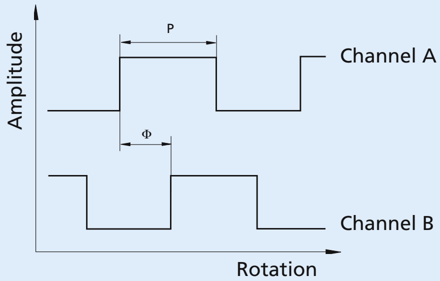
Hybrid circuits with sensors and a low inertia magnetic disc provide two channels with 90° phase shift.

The supply voltage for the encoder and the DC-Micromotor as well as the two channel output signals are interfaced through a ribbon cable with connector.

Details for the DC-Micromotors and suitable reduction gearheads are on separate catalogue pages.

Output signals / Circuit diagram / Connector information

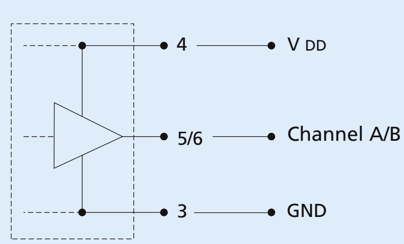
Output signals
with clockwise rotation as seen from the shaft end

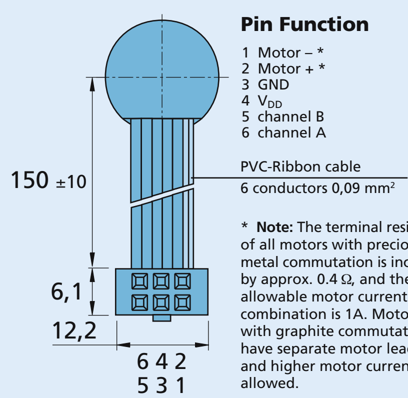


Admissible deviation of phase shift:

$$\Delta\Phi = \left| 90° - \frac{\Phi}{P} * 180° \right| \le 45°$$

Output circuit





Pin Function
1 Motor – *
2 Motor + *
3 GND
4 V_{DD}
5 channel B
6 channel A

PVC-Ribbon cable
6 conductors 0,09 mm^2

* **Note:** The terminal resistance of all motors with precious metal commutation is increased by approx. 0.4 Ω, and the max. allowable motor current in combination is 1A. Motors with graphite commutation have separate motor leads and higher motor current is allowed.

Connector
DIN-41651
grid 2,54 mm

Encoders

Magnetic Encoders

Features:
64 to 1 024 Lines per revolution
2 Channels
Digital output

Series IE2 – 1 024

		IE2 – 64	IE2 – 128	IE2 – 256	IE2 – 512	IE2 – 1 024	
Lines per revolution	N	64	128	256	512	1 024	
Signal output, square wave		2					channels
Supply voltage	V_{DD}	4,5 … 5,5					V DC
Current consumption, typical (V_{DD} = 5 V DC)	I_{DD}	typ. 6, max. 12				typ. 8,5	mA
Output current, max. [1]	I_{OUT}	5					mA
Phase shift, channel A to B	Φ	90 ± 45					°e
Signal rise/fall time, max. (C_{LOAD} = 50 pF)	tr/tf	0,1 / 0,1					µs
Frequency range [2], up to	f	20	40	80	160	300	kHz
Inertia of code disc [3]	J	0,09					gcm^2
Operating temperature range		– 25 … + 85					°C

[1] V_{DD} = 5 V DC: Low logic level < 0,5 V, high logic level > 4,5 V: CMOS and TTL compatible
[2] Velocity (rpm) = f (Hz) x 60/N
[3] For the brushless DC-Servomotors the inertia of code disc is J = 0,14 gcm^2

Ordering information

Encoder	number of channels	lines per revolution	in combination with:
IE2 – 64	2	64	**DC-Micromotors**
IE2 – 128	2	128	**1336 … CXR,**
IE2 – 256	2	256	**1516 … SR, 1524 … SR,**
IE2 – 512	2	512	**1717 … SR, 1724 … SR,**
IE2 – 1 024	2	1024	**1727 … C, 1741 … CXR**
			2224 … SR, 2232 … SR, 2342 … CR,
			2642 … CR, 2657 … CR,
			3242 … CR, 3257 … CR, 3272 … CR
			3863 … C, 3863 … CR
			Brushless DC-Servomotors
			1628 … B, 2036 … B, 2057 … B,
			2444 … B

Features

These incremental shaft encoders in combination with the FAULHABER DC-Micromotors and Brushless DC-Servomotors are used for the indication and control of both shaft velocity and direction of rotation as well as for positioning.

The encoder is integrated in the DC-Micromotors SR-Series and extends the overall length by only 1,4 mm. Built-on option for DC-Micromotors and Brushless DC-Servomotors.

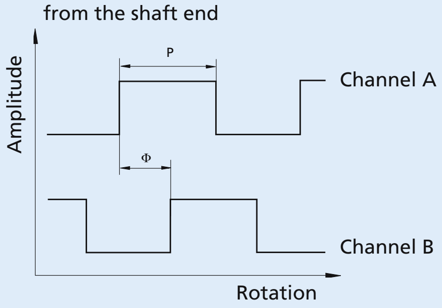
Hybrid circuits with sensors and a low inertia magnetic disc provide two channels with 90° phase shift.

The supply voltage for the encoder and the DC-Micromotor as well as the two channel output signals are interfaced through a ribbon cable with connector.

Details for the DC-Micromotors and suitable reduction gearheads are on separate catalogue pages.

Output signals / Circuit diagram / Connector information

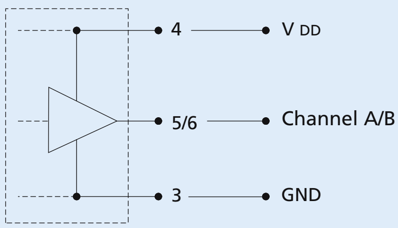
Output signals
with clockwise rotation as seen from the shaft end

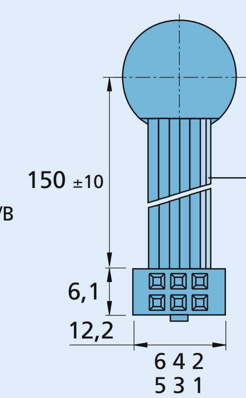


Admissible deviation of phase shift:

$$\Delta\Phi = \left| 90° - \frac{\Phi}{P} * 180° \right| \leq 45°$$

Output circuit





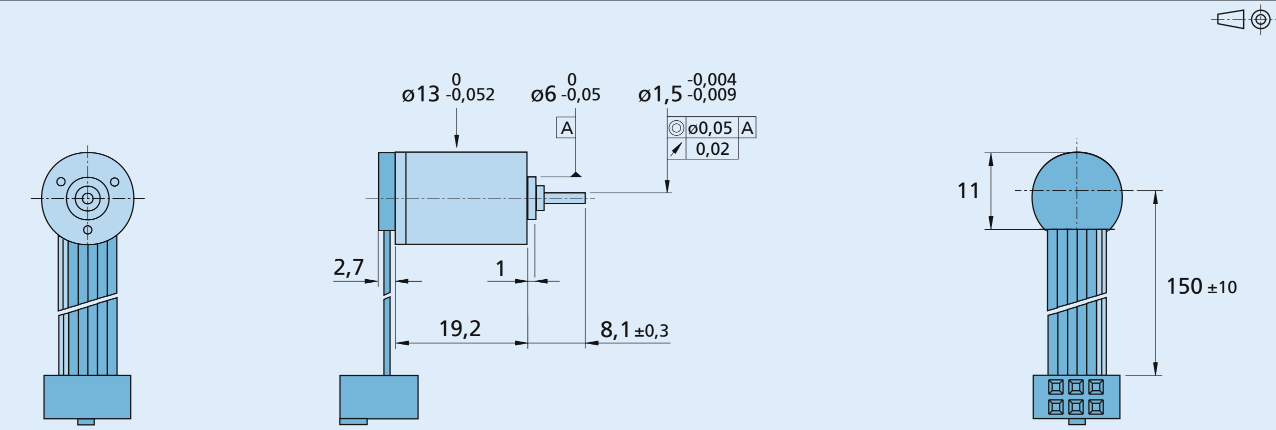
Pin Function
1 Motor – *
2 Motor + *
3 GND
4 V_{DD}
5 channel B
6 channel A

PVC-Ribbon cable
6 conductors 0,09 mm^2

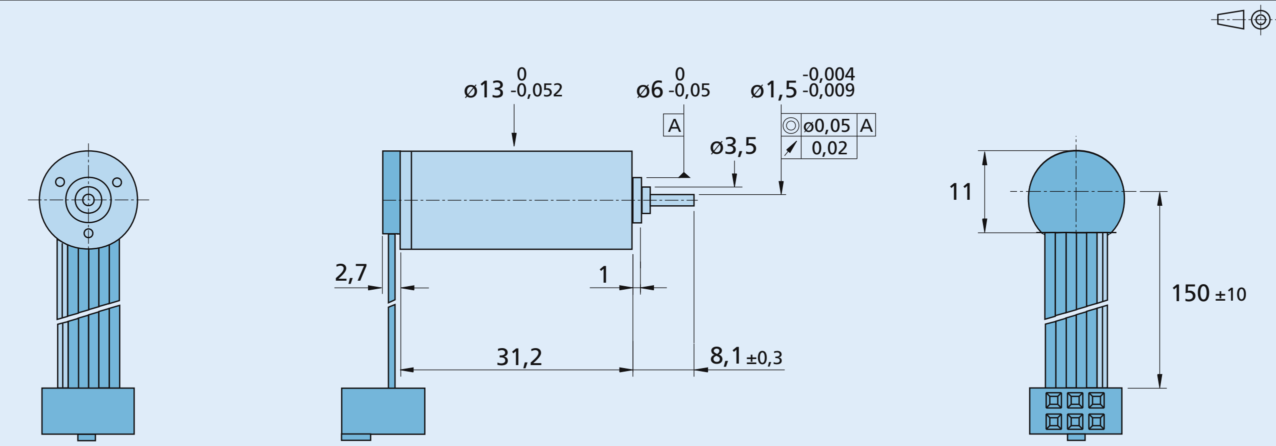
***Note:** The terminal resistance of all motors with precious metal commutation is increased by approx. 0.4 Ω, and the max. allowable motor current in combination is 1A. Motors with graphite commutation and brushless motors have separate motor leads and higher motor current is allowed.

Connector
DIN-41651
grid 2,54 mm

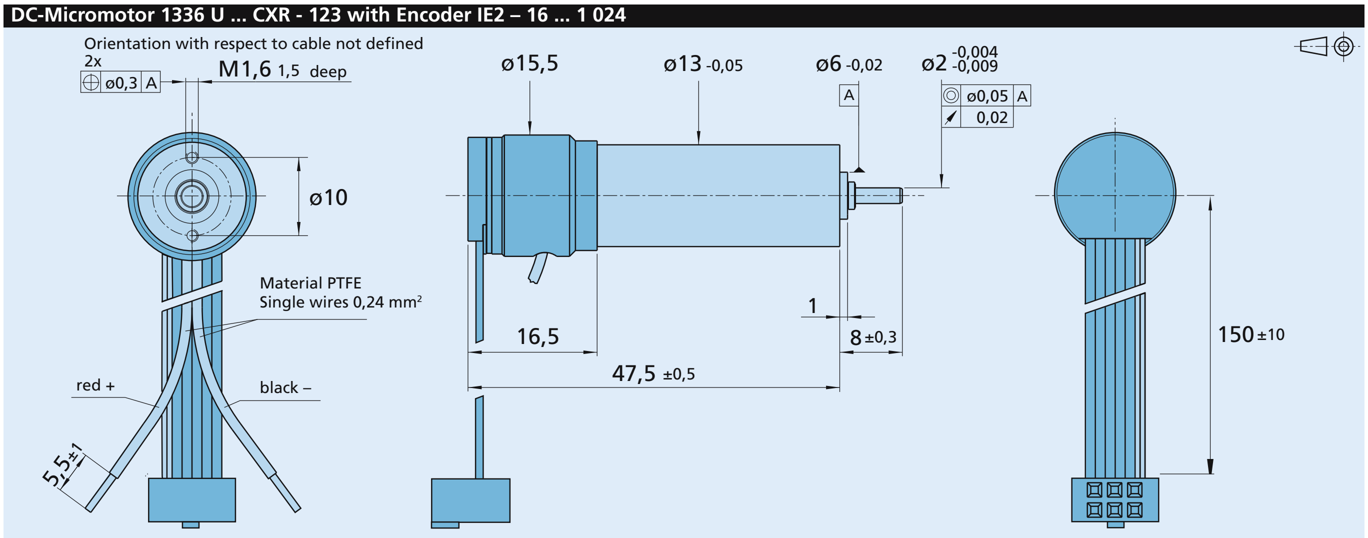
DC-Micromotor 1319 T ... SR with Encoder IE2 – 50 ... 400



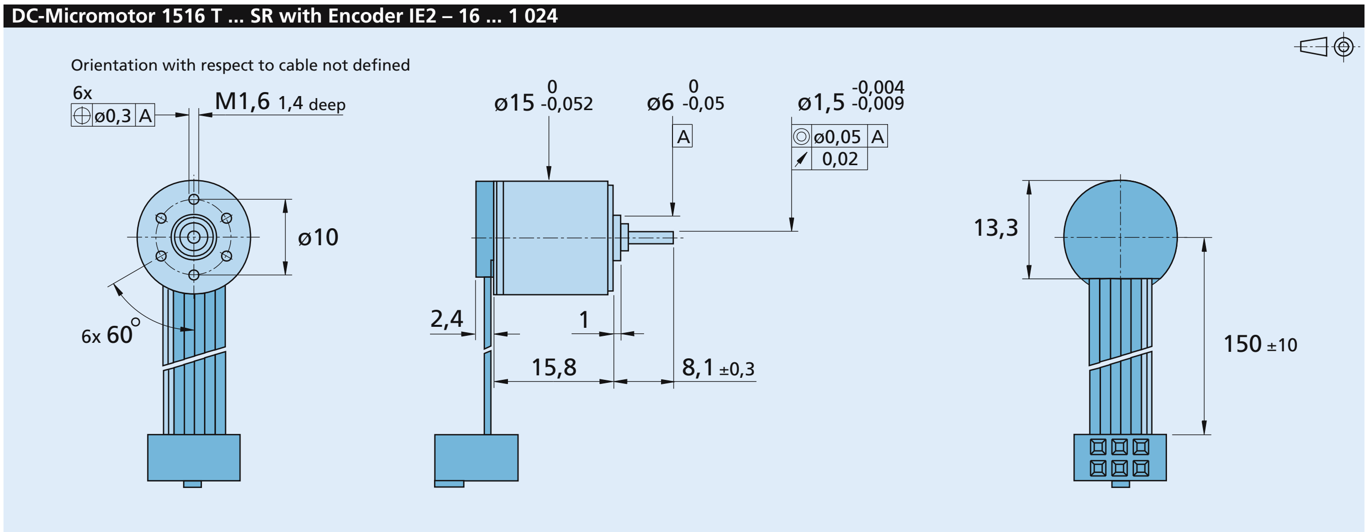
DC-Micromotor 1331 T ... SR with encoder IE2 – 50 ... 400



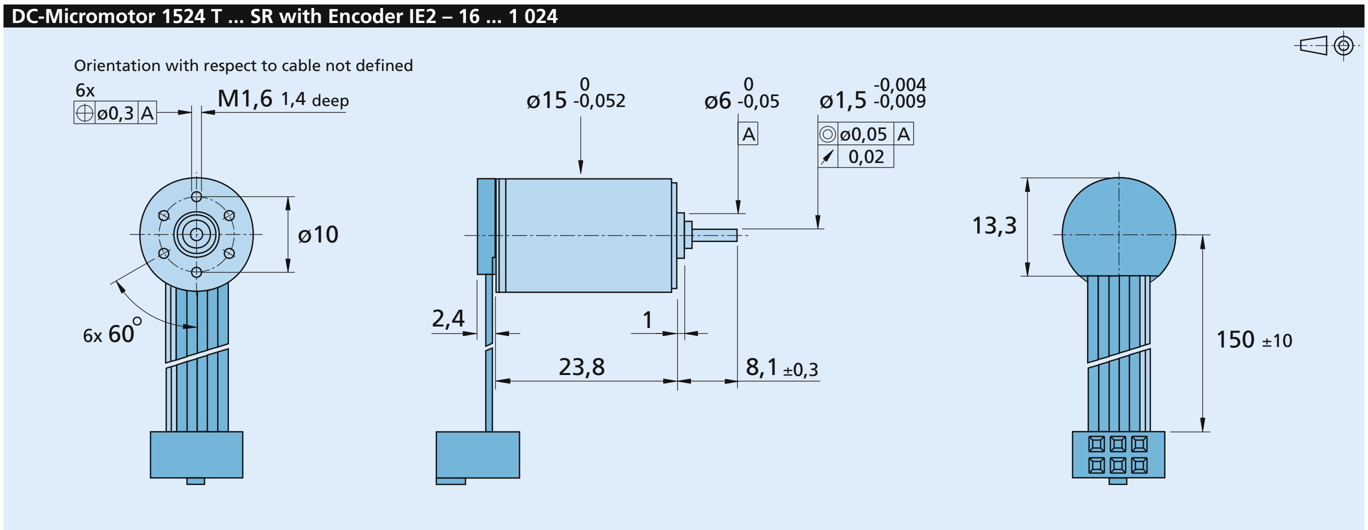
DC-Micromotor 1336 U ... CXR - 123 with Encoder IE2 – 16 ... 1 024



DC-Micromotor 1516 T ... SR with Encoder IE2 – 16 ... 1 024

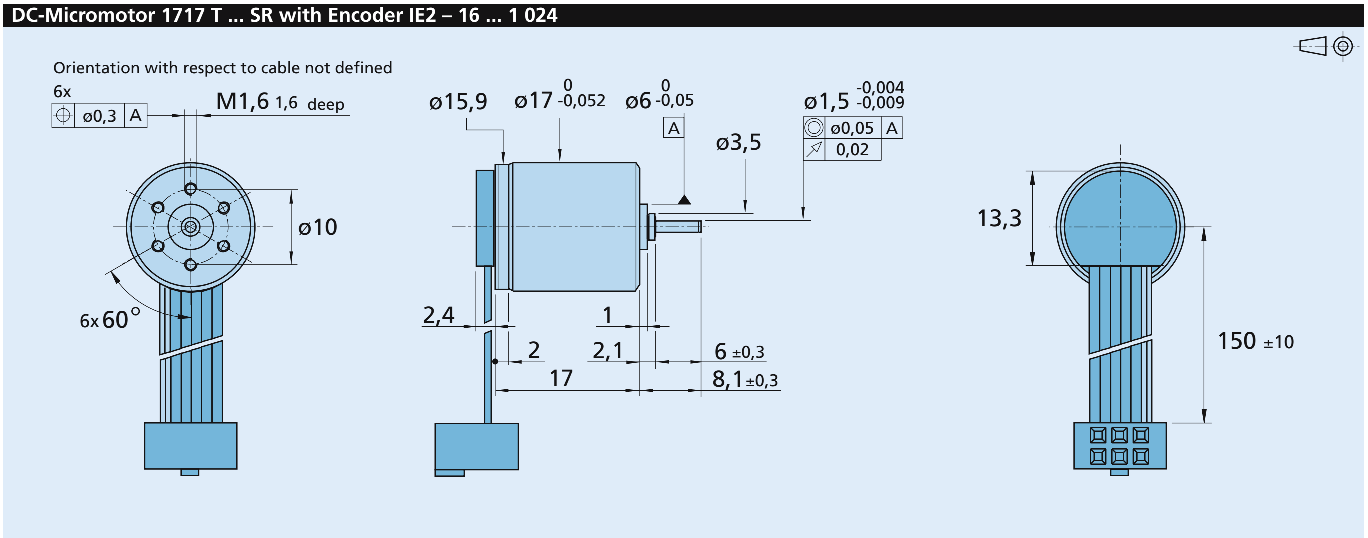


DC-Micromotor 1524 T ... SR with Encoder IE2 – 16 ... 1 024

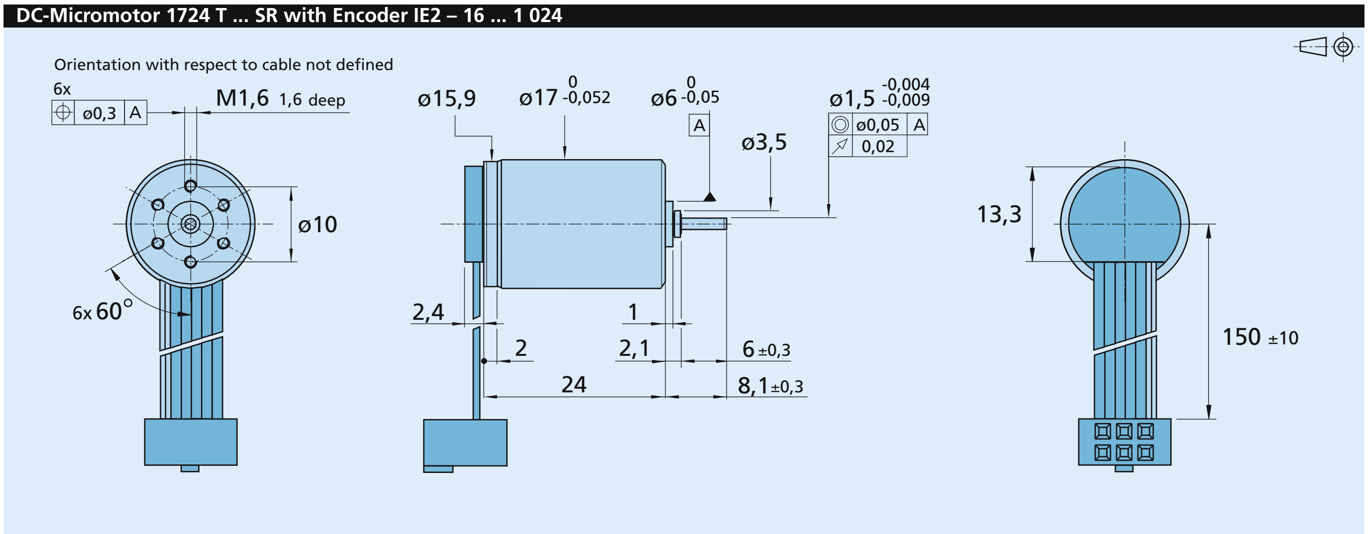


Encoders

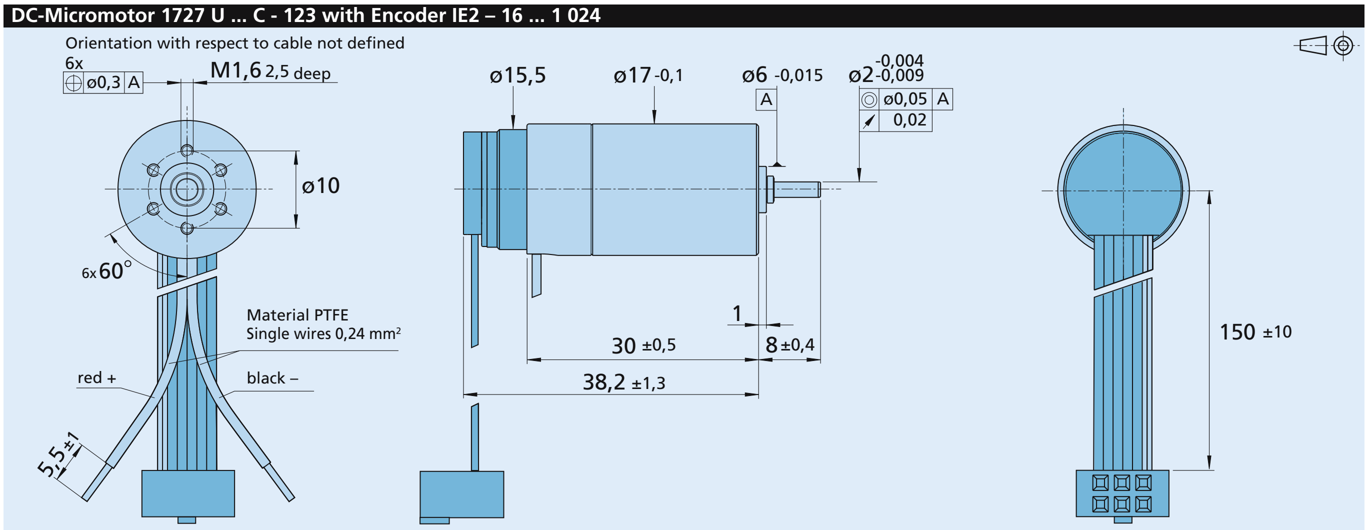
DC-Micromotor 1717 T ... SR with Encoder IE2 – 16 ... 1 024



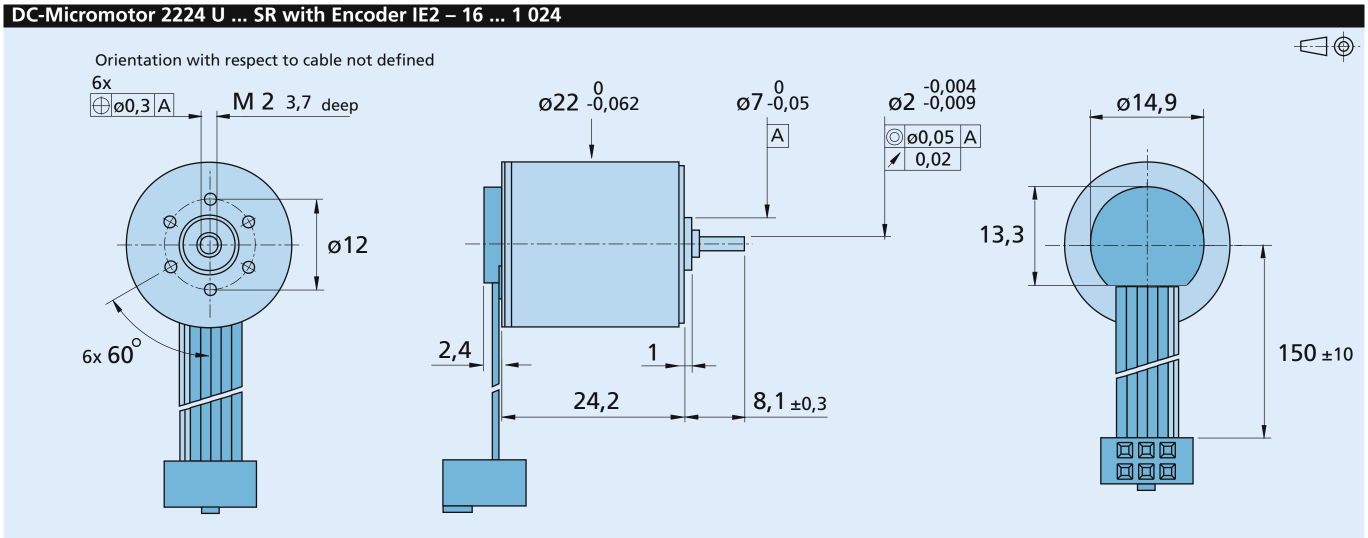
DC-Micromotor 1724 T ... SR with Encoder IE2 – 16 ... 1 024



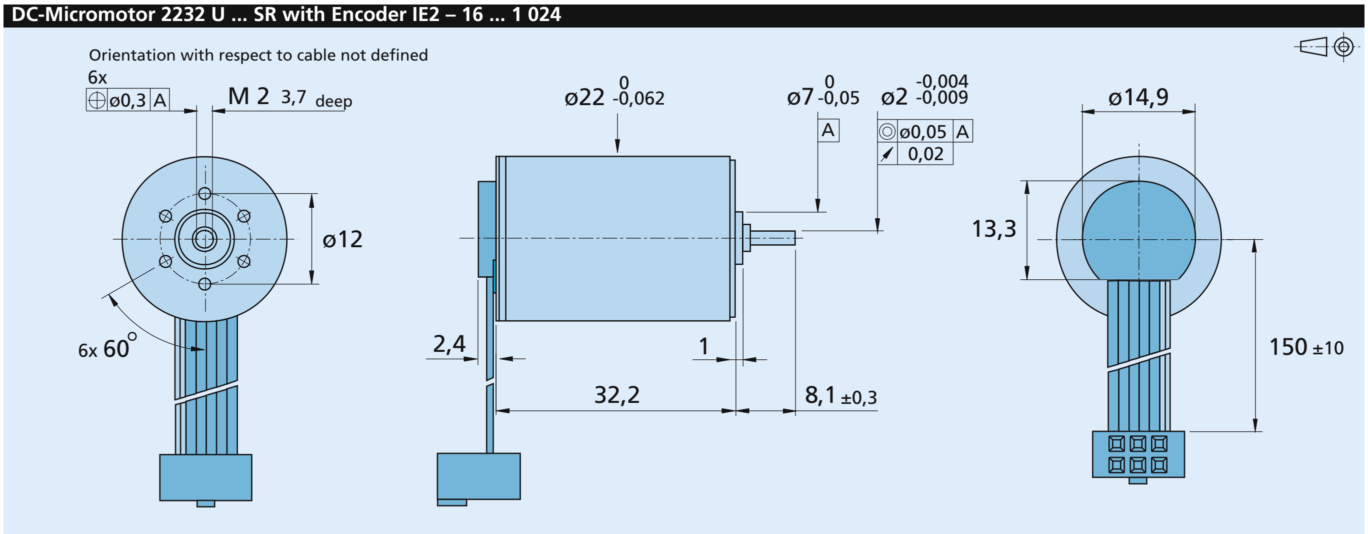
DC-Micromotor 1727 U ... C - 123 with Encoder IE2 – 16 ... 1 024



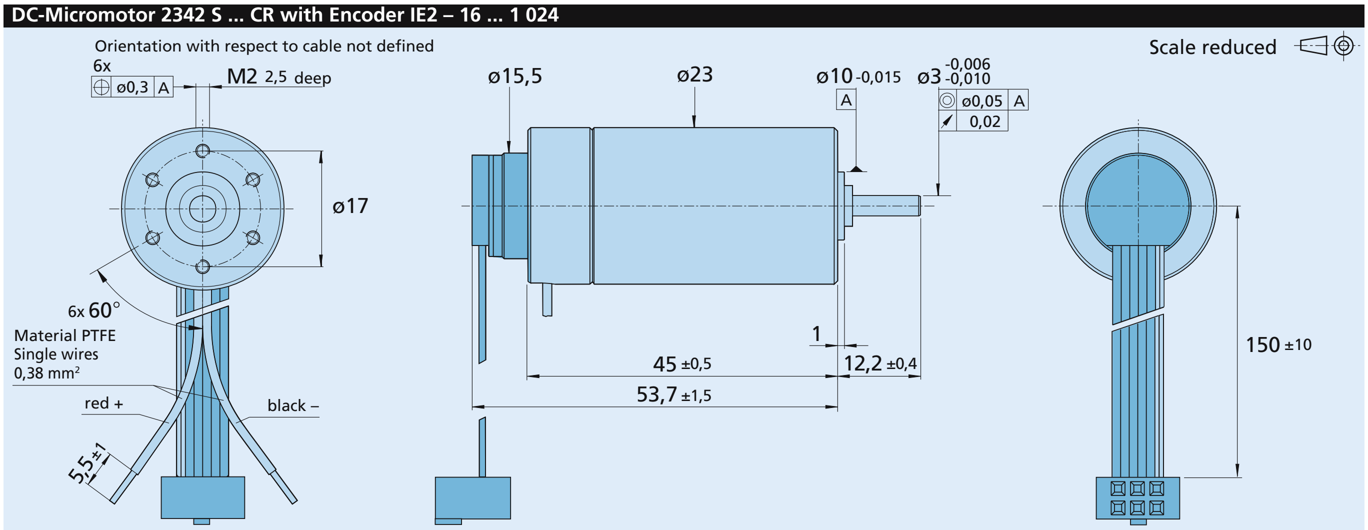
DC-Micromotor 2224 U ... SR with Encoder IE2 – 16 ... 1 024



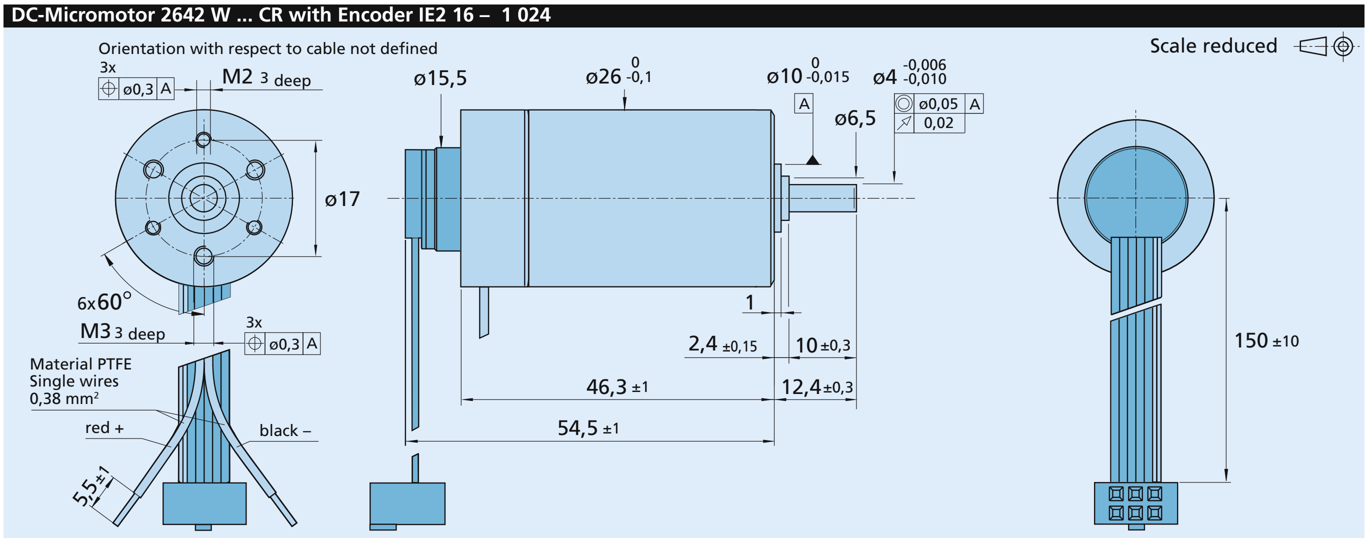
DC-Micromotor 2232 U ... SR with Encoder IE2 – 16 ... 1 024



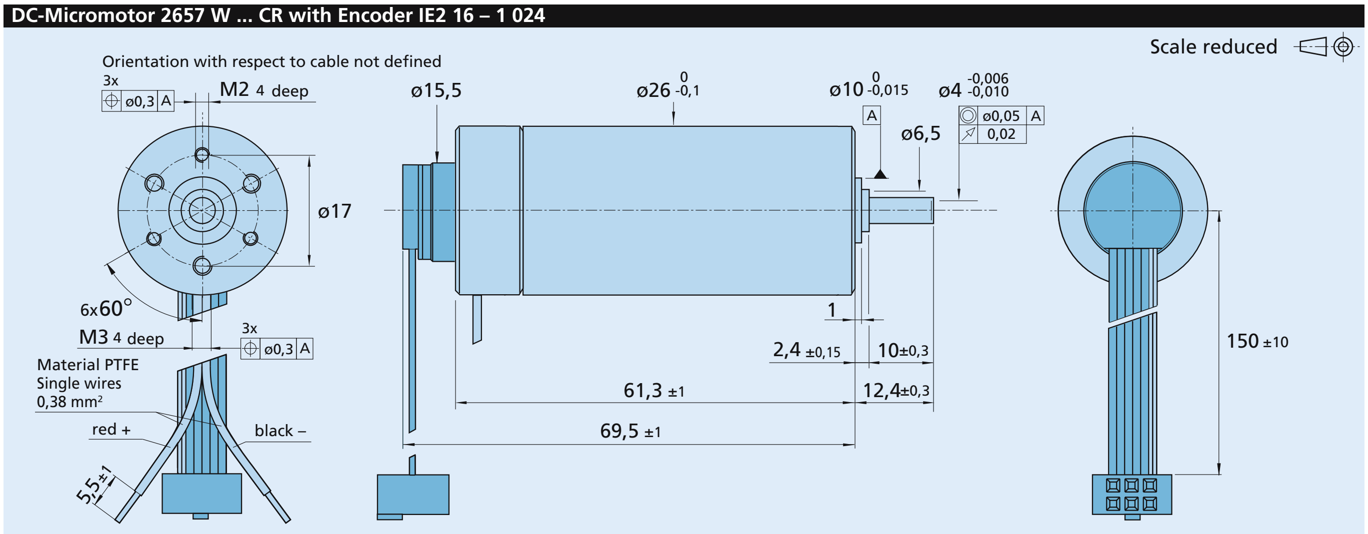
DC-Micromotor 2342 S ... CR with Encoder IE2 – 16 ... 1 024



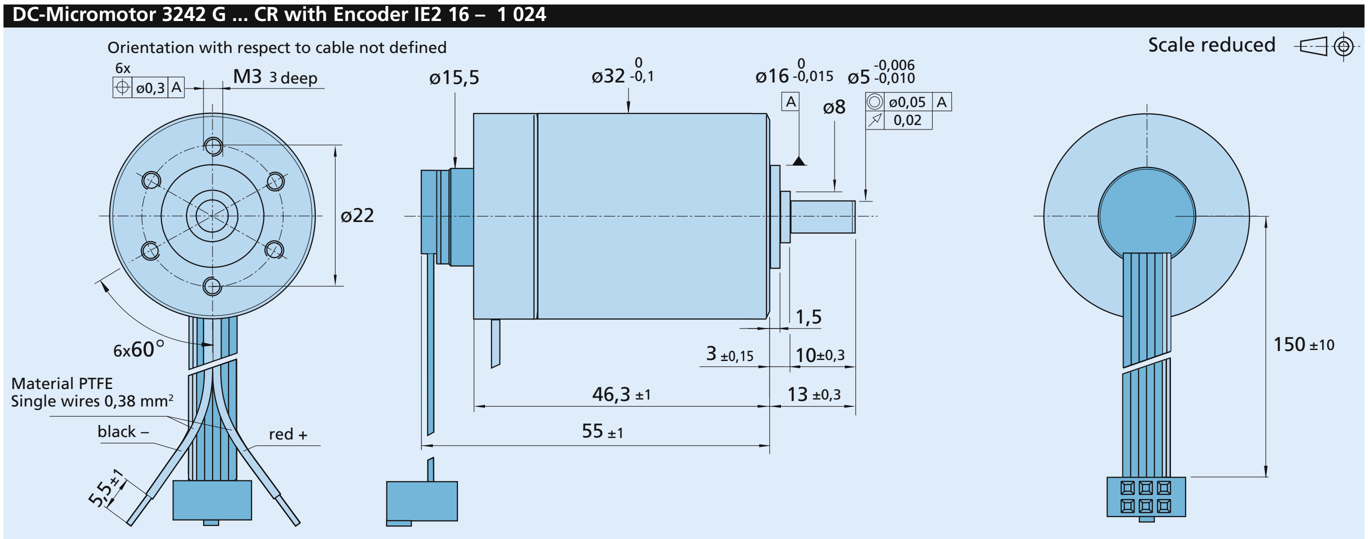
DC-Micromotor 2642 W ... CR with Encoder IE2 16 – 1 024



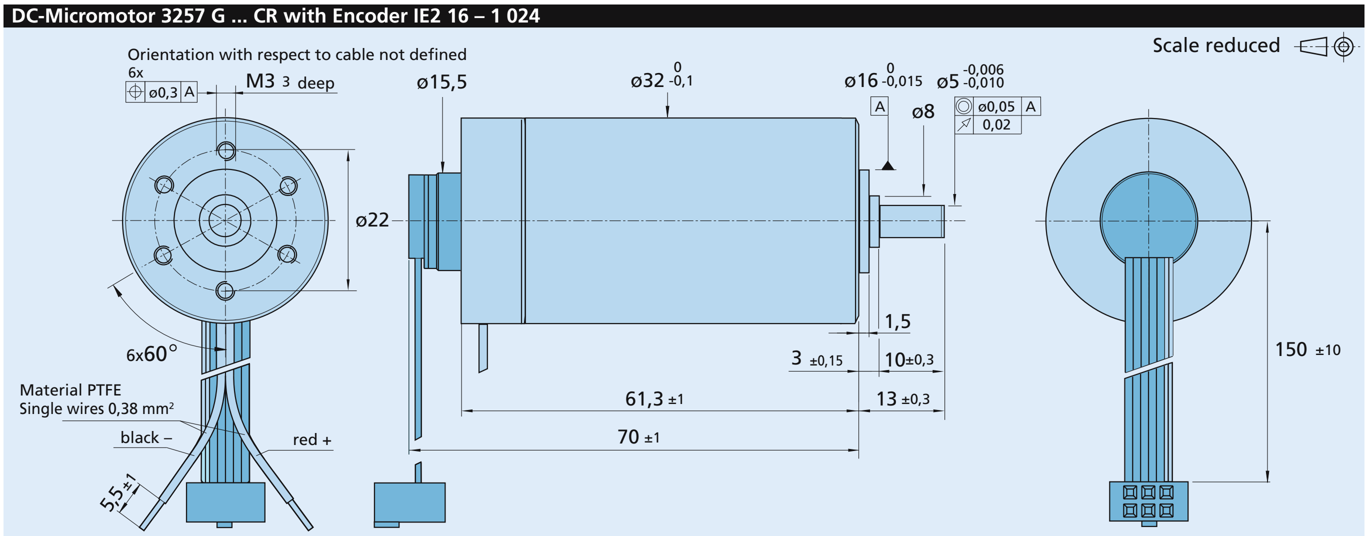
DC-Micromotor 2657 W ... CR with Encoder IE2 16 – 1 024



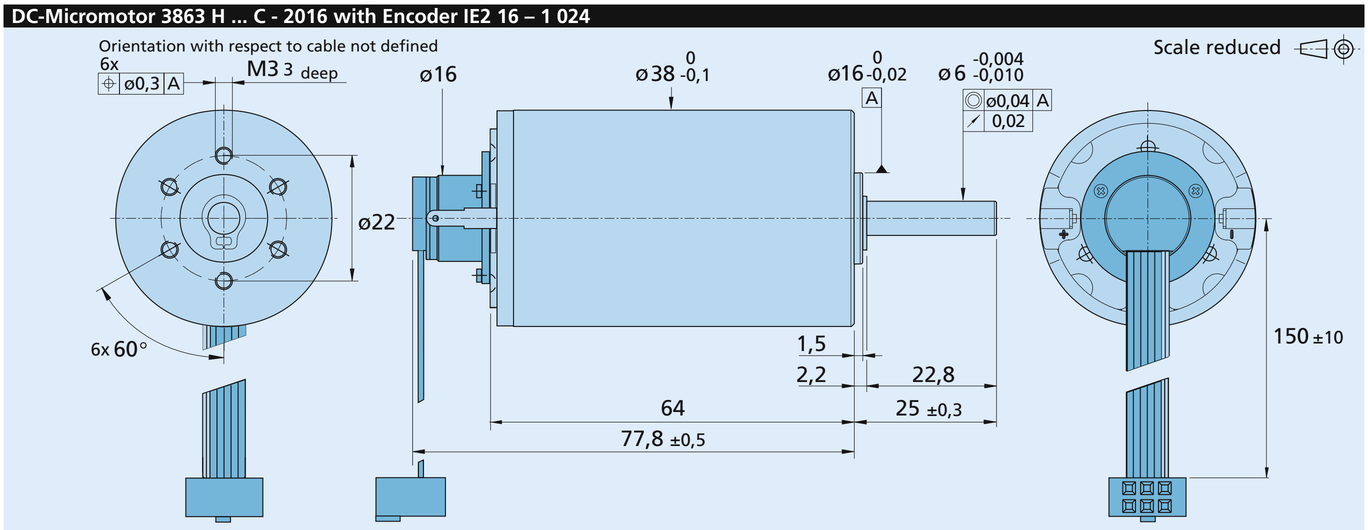
DC-Micromotor 3242 G ... CR with Encoder IE2 16 – 1 024



DC-Micromotor 3257 G ... CR with Encoder IE2 16 – 1 024

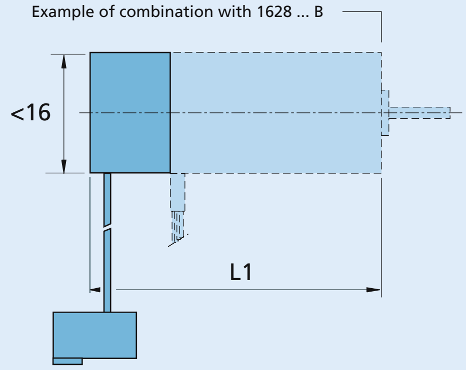


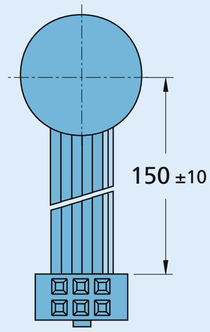
DC-Micromotor 3863 H ... C - 2016 with Encoder IE2 16 – 1 024



Brushless DC-Servomotors 1628... B - K313 , 2036 ... B - K313 , 2057 ... B - K313 and 2444 S ... B - K313 with Encoder IE2 – 64 ... 1 024

M 1:1

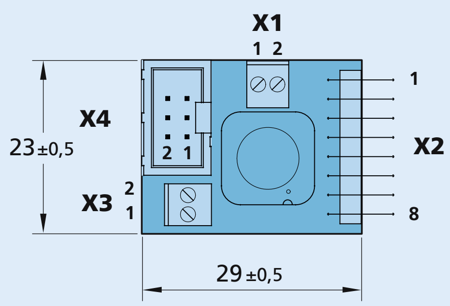




Connector DIN-4651
Grid 2,54 mm

Motor type	< L1
1628	38,8
2036	46,8
2057	68,3
2444	54,8

Interface board for MCDC 3002 S



Interface board IE2
Part No.: 6501.00143

Encoders

Magnetic Encoders

Features:
10 Lines per revolution
2 Channels
Digital output

Series 30B

		30B	
Lines per revolution	N	10	
Signal output, square wave		2	channels
Supply voltage	V_{CC}	4,5 ... 5,5	V DC
Current consumption, typical (V_{CC} = 5 V DC)	I_{CC}	5	mA
Pulse width	P	180 ± 45	°e
Phase shift, channel A to B	Φ	90 ± 45	°e
Logic state width	S	90 ± 45	°e
Cycle	C	360 ± 30	°e
Signal rise/fall time, typical	tr/tf	5 / 0,2	µs
Frequency range [1]	f	up to 7,2	kHz
Inertia of code disc	J	0,09	gcm^2
Operating temperature range		– 20 ... + 85	°C

[1] Velocity (rpm) = f (Hz) x 60/N

Ordering information

Encoder type	number of channels	lines per revolution	in combination with DC-Micromotors
30B19	2	10	**1016 ... G , 1024 ... S**
30B20	2	10	**1219 ... G**
30B381	2	10	**1336 ... CXR**
30B201	2	10	**1224 ... S, 1224 ... SR**

Features

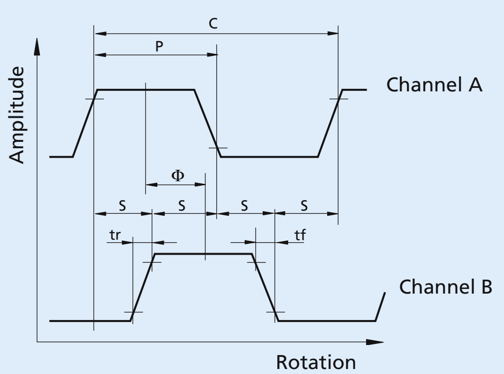
These incremental shaft encoders in combination with the FAULHABER DC-Micromotors are designed for the indication and control of both shaft velocity and direction of rotation as well as for positioning.

Solid state Hall sensors and a low inertia magnetic disc provide two channels with 90° phase shift.

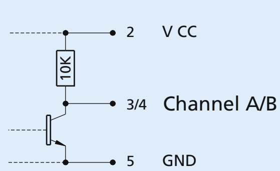
The supply voltage for the encoder and the DC-Micromotor as well as the two channel output signals are interfaced with a 150 mm ribbon cable and a connector.

Details for the DC-Micromotors and suitable reduction gearheads are on separate catalogue pages.

Output signals / Circuit diagram / Connector information

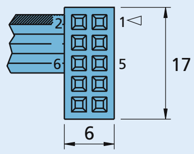


Output signals
with clockwise rotation as seen
from the shaft end
Encoders 30B19, 30B20 channel A leads B
Encoders 30B381 channel B leads A

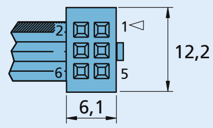


Output circuit

Connectors



Standard 10P
(Panduit 050-010-455)



Option 6P
(DIN-41651 grid 2,54 mm)

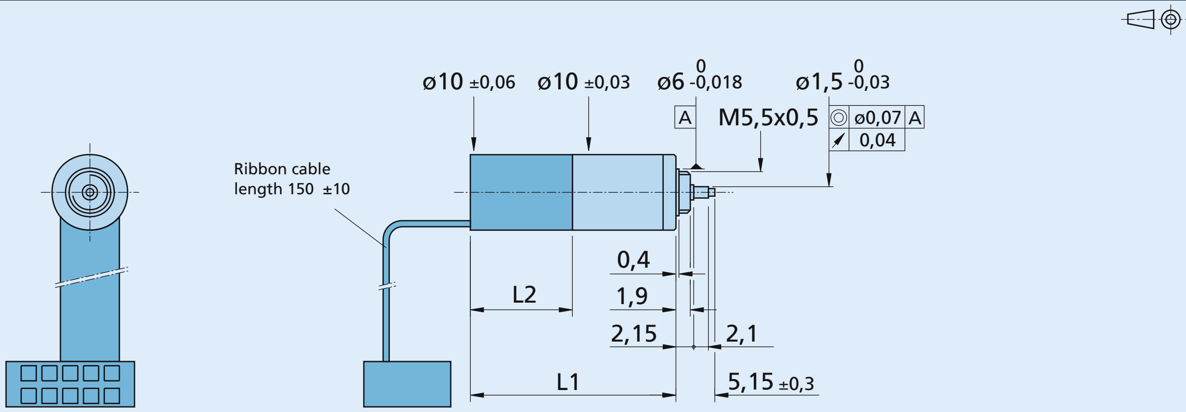
Pin Function

1 Motor +
2 V_{CC}
3 Channel A
4 Channel B
5 GND
6 Motor –
7 –
8 –
9 –
10 –

Ribbon cable
PVC - 6 conductors
0,09 mm^2 / 28 AWG

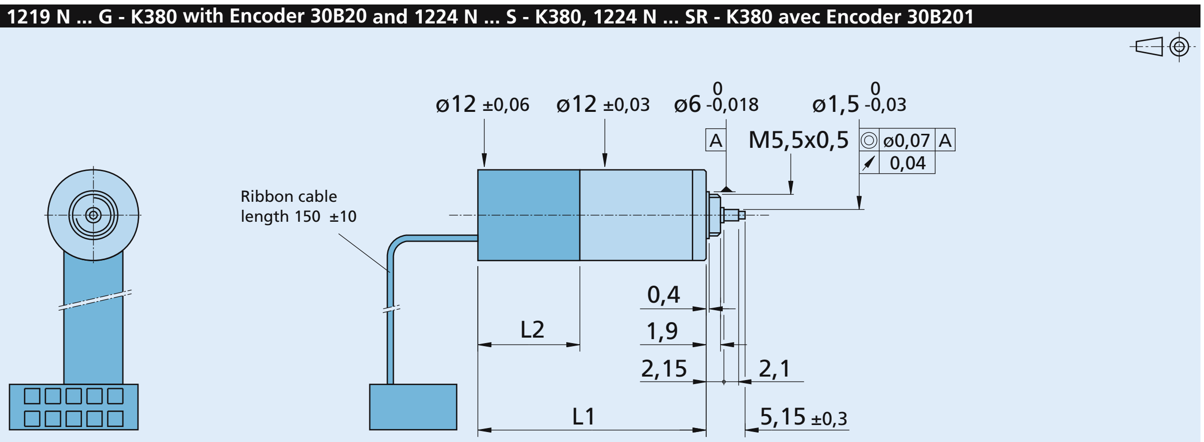
Encoders

DC-Micromotors 1016 N ... G - K380, 1024 N ... S - K380 with Encoder 30B19



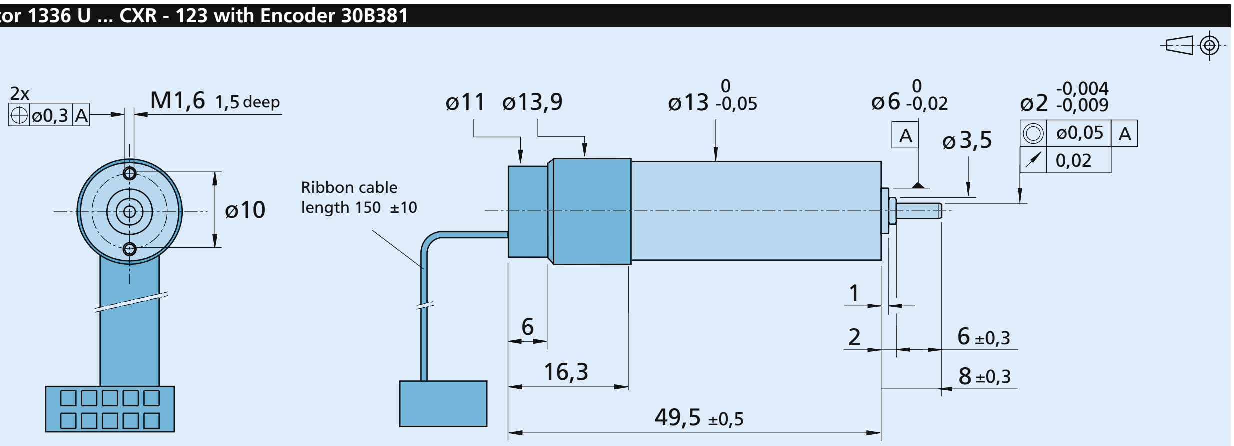
Motor type	L1	L2
1016	27,2	13,5
1024	35,2	13,5

DC-Micromotors 1219 N ... G - K380 with Encoder 30B20 and 1224 N ... S - K380, 1224 N ... SR - K380 avec Encoder 30B201



Motor type	L1	L2
1219	30,2	13,5
1224	33,7	11,7

DC-Micromotor 1336 U ... CXR - 123 with Encoder 30B381



Encoders

Magnetic Encoders

Features:
15 or 16 Lines per revolution
2 Channels
Digital output

Series 20B, 21B

		20B	21B	
Lines per revolution	N	15	16	
Signal output, square wave		2	2	channels
Supply voltage	V_{CC}	4,5 ... 5,5	4,5 ... 5,5	V DC
Current consumption, typical (V_{CC} = 5 V DC)	I_{CC}	5	5	mA
Pulse width	P	180 ± 45	180 ± 45	°e
Phase shift, channel A to B	Φ	90 ± 45	90 ± 45	°e
Logic state width	S	90 ± 45	90 ± 45	°e
Cycle	C	360 ± 30	360 ± 30	°e
Signal rise/fall time, typical	tr/tf	5 / 0,2	5 / 0,2	µs
Frequency range [1]	f	up to 7,2	up to 7,2	kHz
Inertia of code disc	J	0,2	0,2	gcm^2
Operating temperature range		– 20 ... + 85	– 20 ... + 85	°C

[1] Velocity (rpm) = f (Hz) x 60/N

Ordering information

Encoder type		number	lines per revolution 20B	21B	in combination with DC-Micromotors
20B3	**21B3**	2	15	16	**free standing for independent use**
20B18	**21B18**	2	15	16	**series 1336 ... CXR**

Features

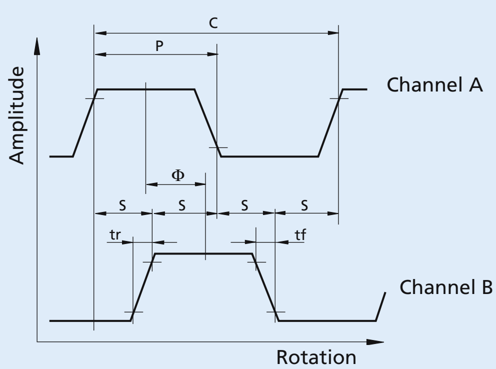
These incremental shaft encoders in combination with the FAULHABER DC-Micromotors are designed for the indication and control of both shaft velocity and direction of rotation as well as for positioning.

Solid state Hall sensors and a low inertia magnetic disc provide two channels with 90° phase shift.

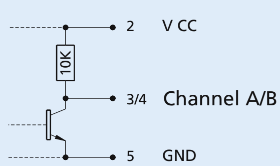
The supply voltage for the encoder and the DC-Micromotor as well as the two channel output signals are interfaced with a 150 mm ribbon cable and a 10-pin connector.

Details for the DC-Micromotors and suitable reduction gearheads are on separate catalogue pages.

Output signals / Circuit diagram / Connector information

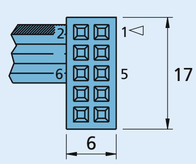


Output signals
with clockwise rotation as seen from the shaft end
Encoders 20B channel A leads B
Encoders 21B channel B leads A

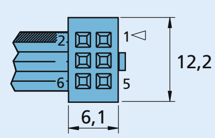


Output circuit

Connectors



Standard 10P
(Panduit 050-010-455)



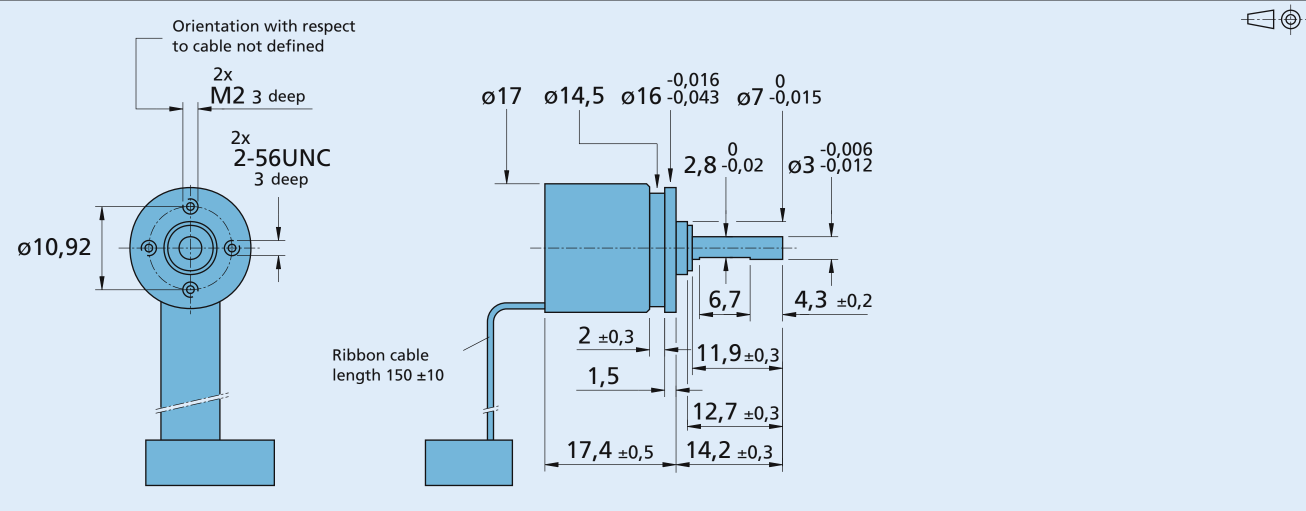
Option 6P
(DIN-41651 grid 2,54 mm)

Pin Function

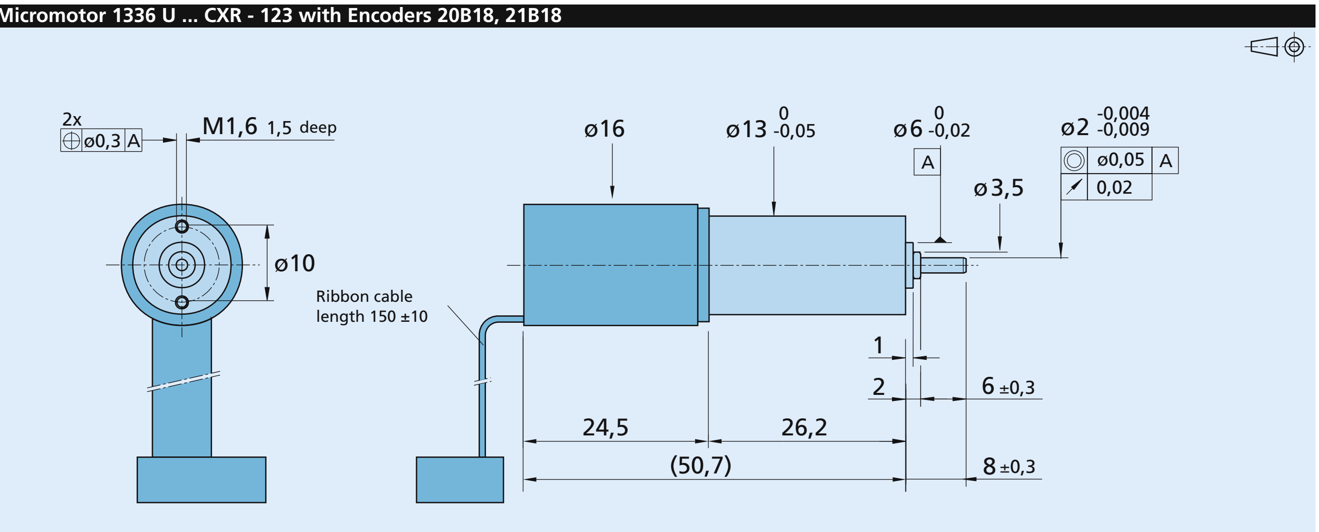
1 Motor +
2 V_{CC}
3 Channel A
4 Channel B
5 GND
6 Motor –
7 –
8 –
9 –
10 –

Ribbon cable
PVC - 6 conductors
0,09 mm^2 / 28 AWG

Encoders 20B3, 21B3 free standing, with ball bearings



DC-Micromotor 1336 U ... CXR - 123 with Encoders 20B18, 21B18



Encoders

Magnetic Encoders

For combination with:
Stepper Motor: AM1020

Series AE 30B19

		AE 30B19	
Lines per revolution	N	10	
Signal output, square wave		2	channels
Supply voltage	V CC	4,5 … 5,5	V DC
Current consumption, typical (V CC = 5 V DC)	I CC	5	mA
Pulse width	P	180 ±45	°e
Phase shift, channel A to B	Φ	90 ±45	°e
Logic state width	S	90 ±45	°e
Cycle	C	360 ±30	°e
Signal rise/fall time, typical	tr / tf	5 / 0,2	µs
Frequency range [1]	f	up to 7,2	kHz
Inertia of code disc	J	9	$\cdot 10^{-9}$ kgm²
Operating temperature range		–20 … +85	°C

[1] Velocity (rpm) = f (Hz) x 60/N

Features / Output signals / Circuit diagram

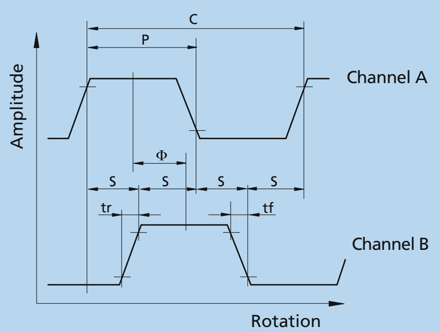
These incremental shaft encoders are designed for indication and control of shaft velocity and direction of rotation as well as for position verification.

Solid state Hall sensors and a low inertia magnetic disc provide two channels with 90° phase shift.

The supply voltages for the encoder and the stepper motor as well as the two channel output signals are interfaced through a individual lead wires with 125 mm in length with an 8-pin connector.

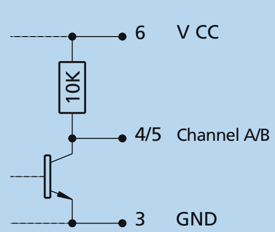
Details for the stepper motors and suitable reduction gearheads are on the coresponding data sheets.

Output signals



Valid for clockwise rotation, seen from the shaft end.

Circuit diagram

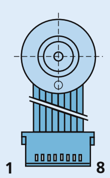


Reccomendation:
Please use a latch to capture the outputs.

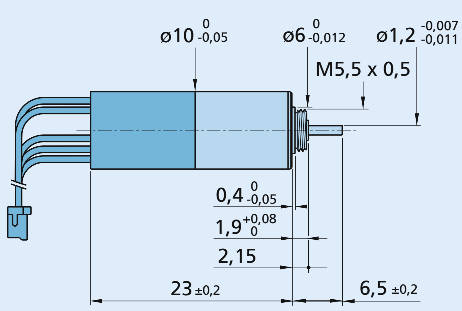
Cable connection

Pin	Function	Colour
1	Motor Phase A +	black
2	Motor Phase B –	orange
3	GND	green
4	Channel B	red
5	Channel A	violet
6	Vcc	yellow
7	Motor Phase A –	white
8	Motor Phase B +	blue

Connector type:	JST#08ZR-3H
Receptacle type:	(not supplied)
Top entry:	B8B-ZR
Side entry:	S8B-ZR



Individual lead wires, AWG30, length 125 mm.



AE 30B19

Encoders

Magnetic Encoders

For combination with:
Stepper Motor: AM1524

Series AE 23B8

		AE 23B8	
Lines per revolution	N	12	
Signal output, square wave		2	channels
Supply voltage	V CC	5 … 15	V DC
Current consumption, typical (V CC = 5 V DC)	I CC	5	mA
Pulse width	P	180 ±45	°e
Phase shift, channel A to B	Φ	90 ±45	°e
Logic state width	S	90 ±45	°e
Cycle	C	360 ±30	°e
Signal rise/fall time, typical	tr / tf	5 / 0,2	µs
Frequency range [1]	f	up to 7,2	kHz
Inertia of code disc	J	20	$\cdot 10^{-9}$ kgm²
Operating temperature range		–20 … +85	°C

[1] Velocity (rpm) = f (Hz) x 60/N

Features / Output signals / Circuit diagram

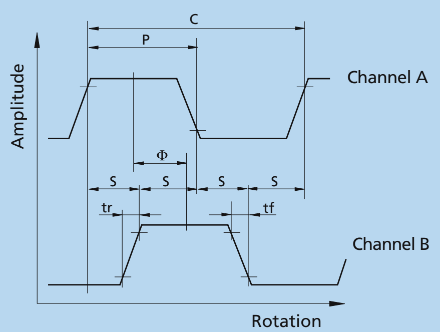
These incremental shaft encoders are designed for indication and control of shaft velocity and direction of rotation as well as for position verification.

Solid state Hall sensors and a low inertia magnetic disc provide two channels with 90° phase shift.

The supply voltages for the encoder and the stepper motor as well as the two channel output signals are interfaced through a cable and 10-pin connector.

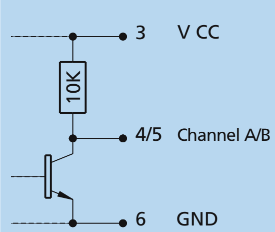
Details for the stepper motors and suitable reduction gearheads are on the corresponding data sheets.

Output signals



Valid for clockwise rotation, seen from the shaft end.

Circuit diagram

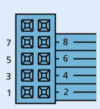


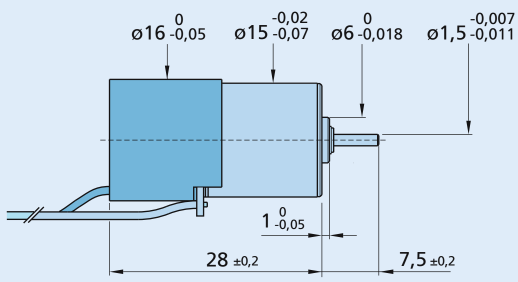
Recommendation:
Please use a latch to capture the outputs.

Cable connection

Pin	Function
1	Motor Phase B –
2	Motor Phase B +
3	Vcc
4	Channel A
5	Channel B
6	GND
7	Motor Phase A –
8	Motor Phase A +

Connector type Panduit 050-010-455
Ribbon cable, 120 mm - PVC
8 conductors - 0,09 mm²





AE 23B8

Encoders

Optical Encoders
PRECIstep® Technology

For combination with:
Stepper Motor: AM2224, AM2224-R3

Series PE 22–120

		PE 22–120	
Lines per revolution	N	120	
Signal output, square wave		2	channels
Supply voltage	V CC	4,5 … 5,5	V DC
Current consumption, typical (V CC = 5 V DC)	I CC	20	mA
Pulse width	P	180 ±45	°e
Phase shift, channel A to B	Φ	90 ±45	°e
Logic state width	S	90 ±45	°e
Cycle	C	360 ±30	°e
Signal rise/fall time, typical	tr / tf	0,5 / 0,1	µs
Frequency range [1]	f	up to 30	kHz
Inertia of code disc	J	24	$\cdot 10^{-9}$ kgm²
Operating temperature range		–20 … +85	°C

[1] Velocity (rpm) = f (Hz) x 60/N

Features / Output signals / Circuit diagram

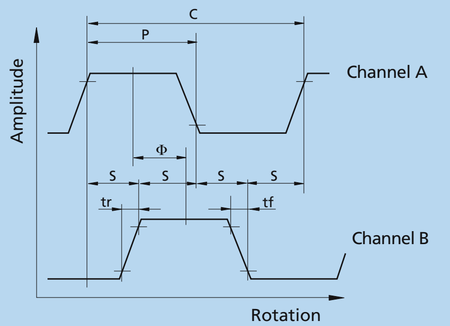
These incremental shaft encoders in combination with two phases stepper motors are designed for indication and control of both, shaft velocity and direction of rotation as well as for position verification.

The encoder is integrated in the Stepper Motors and extends the overall length by only 11 mm.

The supply voltage for the encoder and the stepper motors as well as the two channel output signals are interfaced through a ribbon cable with connector.

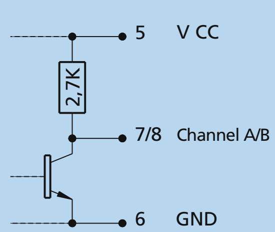
Details for the stepper motors and suitable reduction gearheads are on the corresponding data sheets.

Output signals



Valid for clockwise rotation, seen from the shaft end.

Circuit diagram

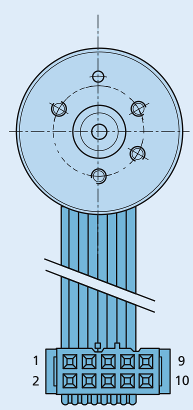


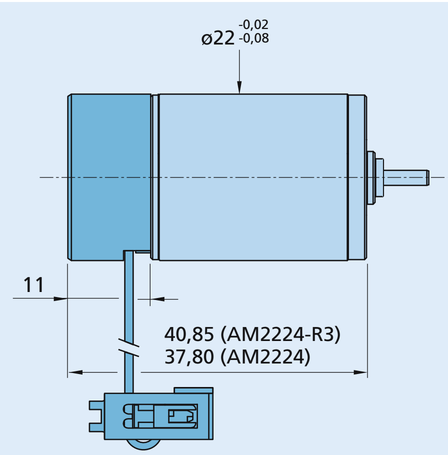
Recommendation:
Please use a latch to capture the outputs.

Cable connection

Pin	Function
1	Motor Phase A +
2	Motor Phase A –
3	Motor Phase B +
4	Motor Phase B –
5	Vcc
6	GND
7	Channel A
8	Channel B
9	N.C.
10	N.C.

Connector type FCI serie 71600-010LF
Ribbon cable, 180 mm - PVC





PE 22–120

Encoders

Magnetic Encoders

Features:
16, 32, 64 Lines per revolution
3 Channels
Digital output

Series HXM3-64

		HXM3-64	
Signal output, square wave		3	channels
Supply voltage [1]	V_{CC}	4,5 ... 5,5	V DC
Current consumption, typical (V_{CC} = 5 V DC)	I_{CC}	9	mA
Pulse width	P	180 ± 45	°e
Phase shift, channel A to B	Φ	90 ± 45	°e
Logic state width	S	90 ± 45	°e
Cycle	C	360 ± 30	°e
Signal rise/fall time, typical (C_{LOAD} = 50 pF)	tr/tf	60 / 60	µs
Rotational speed up to	$n_{max.}$	30 000	rpm
Inertia of code disc [1]	J	0,02	gcm²
Operating temperature range		-25 ... +85	°C

[1] No additional inertia for series 0620...B

Ordering information

Encoder	number of channels	lines per revolution	in combination with:
HXM3-64	3	64	**DC-Micromotors** **0615...S**
			Brushless DC-Servomotors **0620...B**

Note: Lines per revolution refers to pre-quadrature resolution and equals the cycles per revolution

Features

These incremental shaft encoders in combination with the FAULHABER DC-Micromotors and Brushless DC-Servomotors are designed for indication and control of both shaft velocity and direction of rotation as well as for positioning.

Solid state sensors and a low inertia magnetic disc provide two channels with 90° phase shift and one index channel.

The supply voltage for the encoder and the DC-Micromotor as well as the output signals are interfaced with a flexible printed circuit (FPC) to a 8-pin ZIF connector.

Encoder is programmable by user to 16, 32, and 64 lines per revolution by setting the CFG2 pin to high, open, or ground respectively. The input power must be cycled off and on to change the settings.

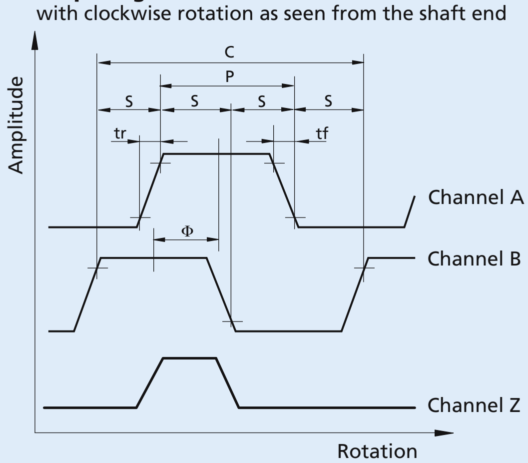
Please note: Velocity (rpm) = f (Hz) x 60/N

Details for the DC-Micromotors and suitable reduction gearheads are on separate catalog pages.

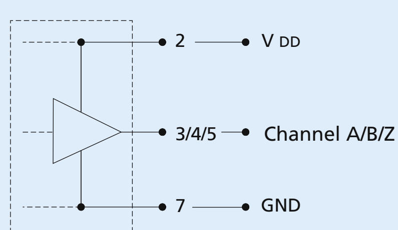
An optional interface board with suitable connector is also available on request.

Output signals / Circuit diagram / Connector information

Output signals
with clockwise rotation as seen from the shaft end

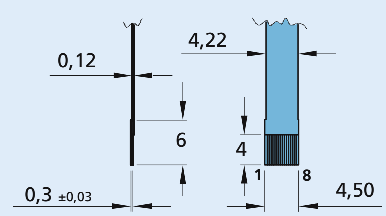


Output circuit



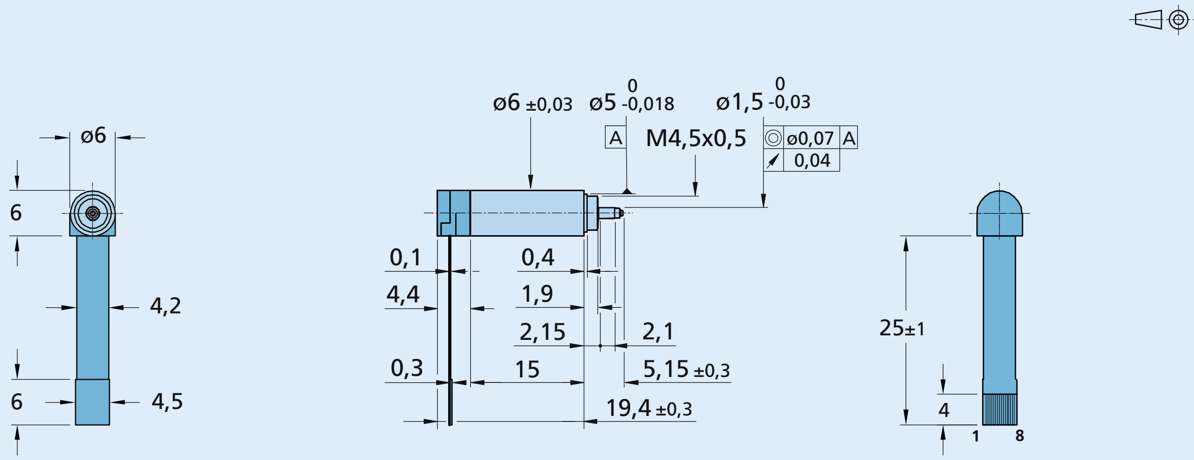
Pin Function
1 Motor + *
2 V_{DD}
3 Channel Z
4 Channel A
5 Channel B
6 Cfg2
7 GND
8 Motor – *

* Note: Brushless motors have separate motor leads.



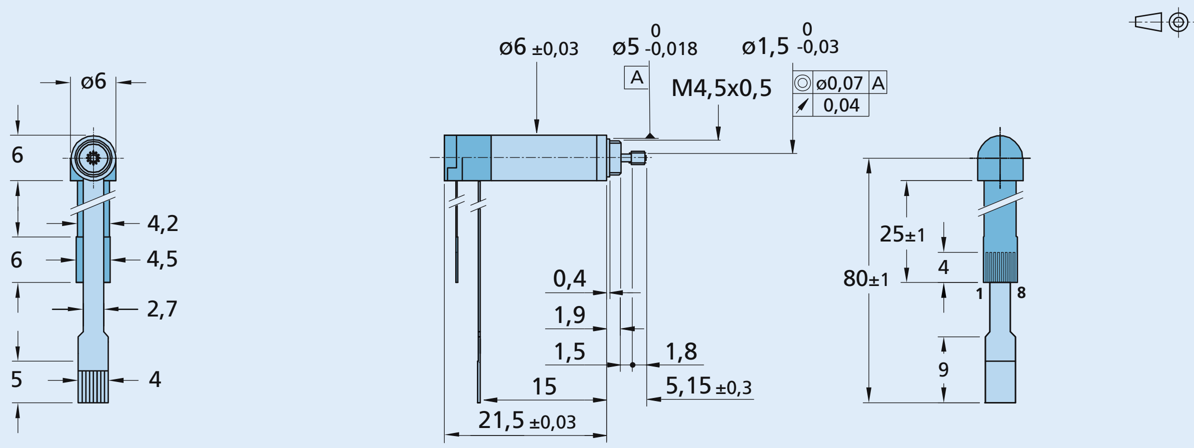
Connector
Molex 52745, grid 0,5 mm
FPC / FFC, 8-conductors

DC-Micromotor 0615 N ... S - K1707 with Encoder HXM3-64



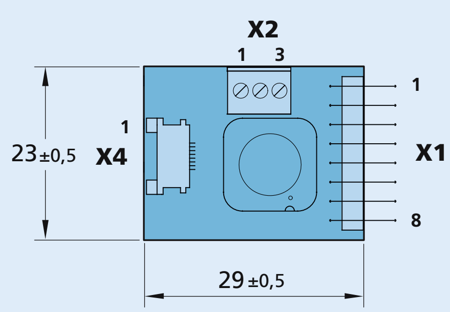
HXM3-64+0615N

Brushless DC-Servomotor 0620 K ... B - K1674 with Encoder HXM3-64



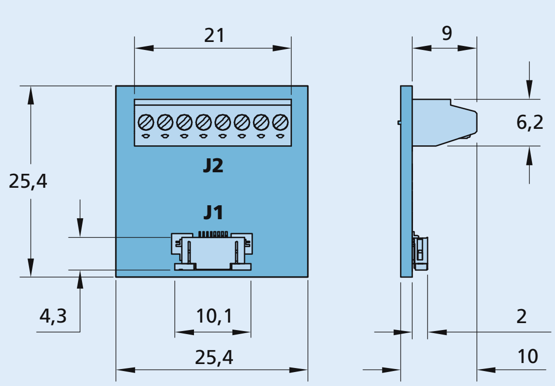
HXM3-64+0620K

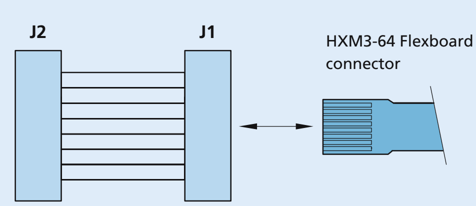
Interface board for MCDC 3002 S



Interface board HXM3-64
Part No.: 6501.00145

Optional interface board





Interface board HXM3-64
Part No. D100308900

Connector
J1 – Molex 52745-0896
J2 – Phoenix 1725711

Encoders

Magnetic Encoders

Features:
32, 64, 128, 256 Lines per revolution
3 Channels
Digital output

Series HEM3-256-W

		HEM3-256-W	
Signal output, square wave		3	channels
Supply voltage [1]	V_{DD}	3,0 ... 3,6	V DC
Supply voltage [2]	V_{DD}	4,5 ... 5,5	V DC
Current consumption, typical (V_{DD} = 3,3 or 5 V DC)	I_{DD}	16	mA
Output current, max. [3] (V_{DD} = 3,3 / 5 V DC)	I_{OUT}	2 / 4	mA
Pulse width	P	180 ± 45	°e
Phase shift, channel A to B	Φ	90 ± 45	°e
Logic state width	S	90 ± 45	°e
Signal rise/fall time, max (C_{LOAD} = 50 pF)	tr/tf	0,1 / 0,1	µs
Rotational speed up to	$n_{max.}$	30 000	rpm
Inertia of code disc	J	0,02	gcm²
Operating temperature range		-30 ... +85	°C

[1] V_{DD} = 3,3 V DC: Connect pins 3 and 4 to 3,3 V DC
[2] V_{DD} = 5 V DC: Connect pin 3 to 5 V DC, do not connect pin 4
[3] V_{DD} = 5 V DC: Low logic level < 0,5 V, high logic level > 4,5 V: CMOS and TTL compatible

Ordering information

Encoder	number of channels	lines per revolution	for combination with:
HEM3-032-W	3	32	**DC-Micromotors series**
HEM3-064-W	3	64	**0816 ... S**
HEM3-128-W	3	128	**1016 ... G, 1024 ... S**
HEM3-256-W	3	256	**1224 ... SR**

Note: Lines per revolution refers to pre-quadrature resolution and equals the cycles per revolution

Features

These incremental shaft encoders in combination with the FAULHABER DC-Micromotors are designed for indication and control of both shaft velocity and direction of rotation as well as for positioning.

Solid state sensors and a low inertia magnetic disc provide two channels with 90° phase shift and one index channel.

The nominal supply voltage for the encoder is selectable and either 3,3 VDC or 5,0 VDC.

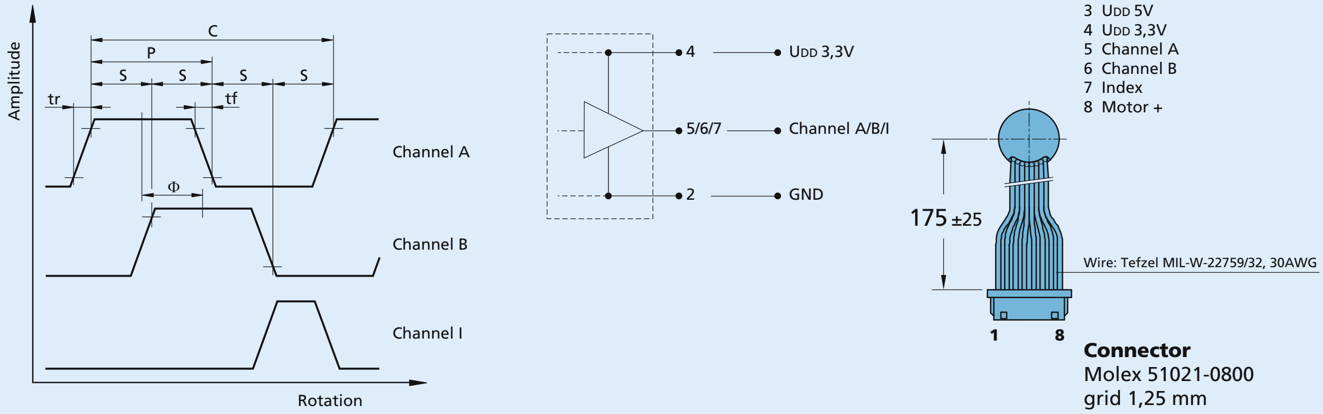
The supply voltage for the encoder and the DC-Micromotor as well as the output signals are interfaced with discrete wires and an 8-pin Molex crimp style connector.

Details for the DC-Micromotors and suitable reduction gearheads are on separate catalog pages.

Output signals / Circuit diagram / Connector information

Output signals
with clockwise rotation as seen from the shaft end

Output circuit

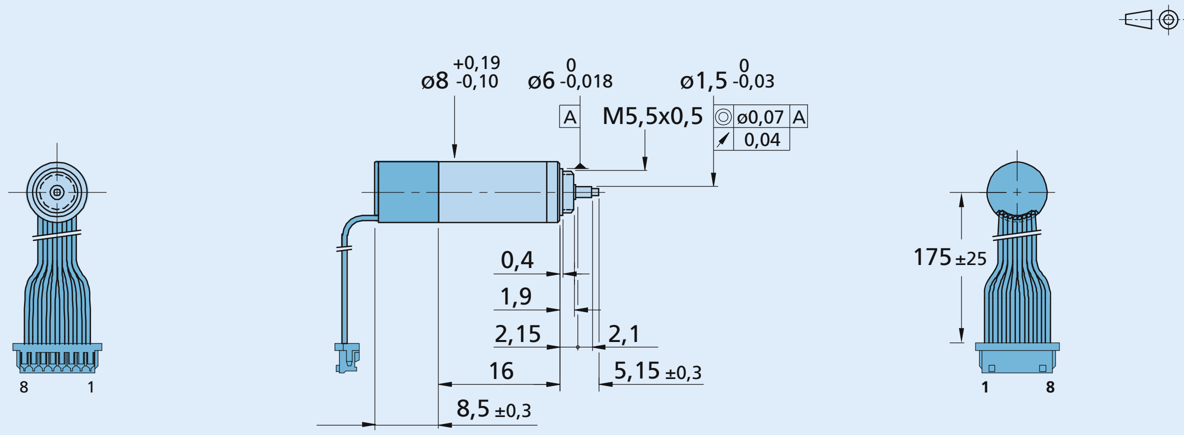


Pin Function
1 Motor –
2 GND
3 UDD 5V
4 UDD 3,3V
5 Channel A
6 Channel B
7 Index
8 Motor +

Connector
Molex 51021-0800
grid 1,25 mm

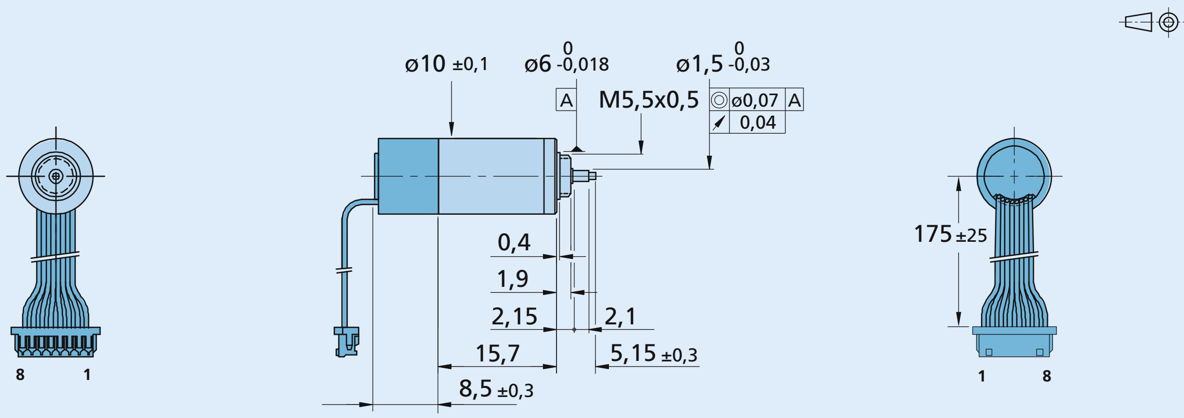
Encoders

DC-Micromotor 0816 N ... S - K1707 with Encoder HEM3-XXX-W



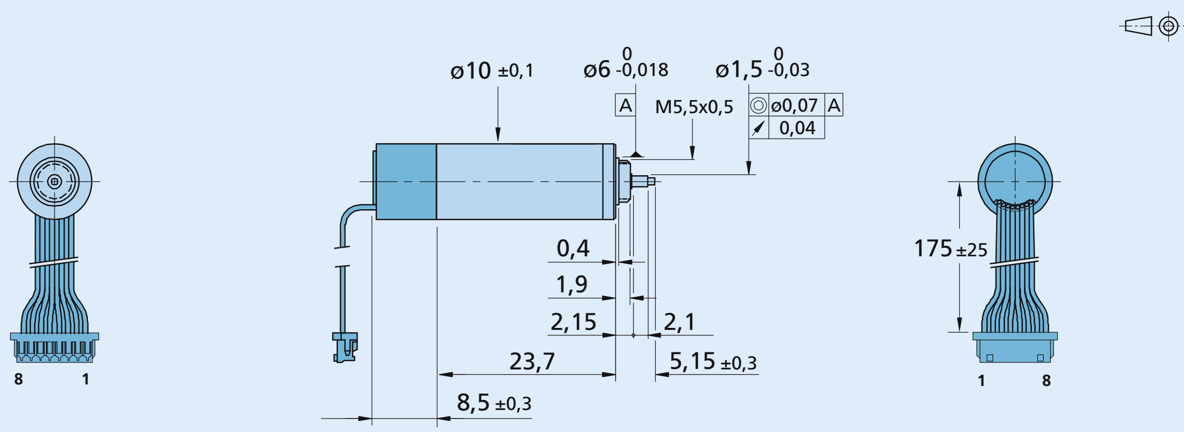
HEM3-XXX-W+0816N

DC-Micromotor 1016 N ... G - K1707 with Encoder HEM3-XXX-W



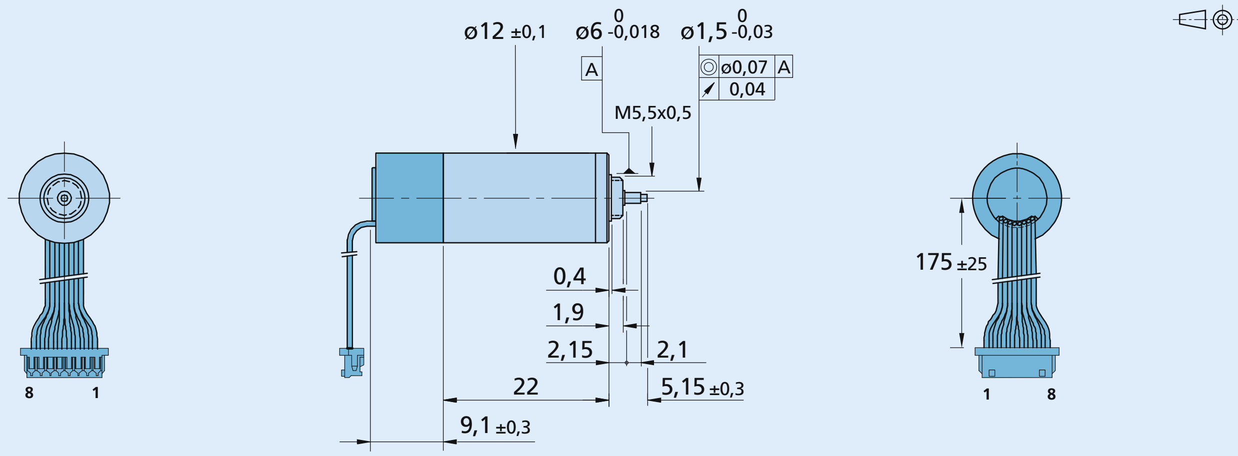
HEM3-XXX-W+1016N

DC-Micromotor 1024 N ... S - K1707 with Encoder HEM3-XXX-W



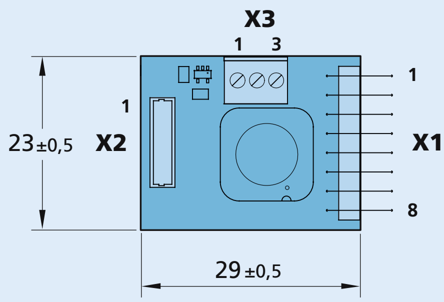
HEM3-XXX-W+1024N

DC-Micromotor 1224 N ... SR - K1707 with Encoder HEM3-XXX-W



HEM3-XXX-W+1224N

Interface board for MCDC 3002 S



Note:
Version U_{DD} = 5V
(U_{DD} = 3,3V available on request)

Interface board HEM3-256 W
Part No.: 6501.00146

Encoders

Magnetic Encoders

Features:
32 to 1 024 Lines per revolution
3 Channels
Digital output

Series IE3 – 1 024

		IE3 – 32	IE3 – 64	IE3 – 128	IE3 – 256	IE3 – 512	IE3 – 1 024	
Lines per revolution	N	32	64	128	256	512	1 024	
Frequency range [1], up to	f	15	30	60	120	240	430	kHz
Signal output, square wave		2+1 index						channels
Supply voltage	U_{DD}	4,5 … 5,5						V DC
Current consumption, typical [2]	I_{DD}	typ. 16, max. 23						mA
Output current, max. [3]	I_{OUT}	4						mA
Index Pulse width [4]	P_0	90 ± 45				90 ± 75		°e
Phase shift, channel A to B [4]	Φ	90 ± 45				90 ± 75		°e
Signal rise/fall time, max. (C_{LOAD} = 50 pF)	tr/tf	0,1 / 0,1						µs
Inertia of encoder magnet	J	0,08						gcm²
Operating temperature range		– 40 ... + 100						°C

[1] speed (rpm) = f (Hz) x 60/N
[2] $U_{DD\ Enc}$ = 5 V: with unloaded outputs
[3] $U_{DD\ Enc}$ = 5 V: low logic level < 0,4 V, high logic level > 4,5 V: CMOS- and TTL compatible
[4] at 5 000 rpm

Ordering information

Encoder	number of channels	lines per revolution	in combination with:
IE3 – 32	2+1	32	**DC-Micromotors**
IE3 – 64	2+1	64	**2342 ... CR, 2642 ... CR, 2657 ... CR,**
IE3 – 128	2+1	128	**3242 ... CR, 3257 ... CR,**
IE3 – 256	2+1	256	**2237 ... CXR, 2642 ... CXR, 2657 ... CXR**
IE3 – 512	2+1	512	**3272 ... CR, 3863 ... CR**
IE3 – 1 024	2+1	1 024	
			Brushless DC-Servomotors
			2444 ... B, 3056 ... B, 3564 ... B,
			4490 ... B, 4490 ... BS

Features

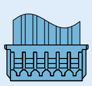
These incremental shaft encoders in combination with the FAULHABER DC-Micromotors are used for the indication and control of both shaft velocity and direction of rotation as well as for positioning.

A permanent magnet on the shaft creates a moving magnetic field which is captured using a single-chip angular sensor and further processed. At the encoder outputs, two 90° phase-shifted rectangular signals are available with up to 1 024 impulses and an index impulse per motor revolution.

The encoder is available in a variety of different resolutions and is suitable for speed control and positioning applications.
The motor and encoder are connected via separate ribbon cables.

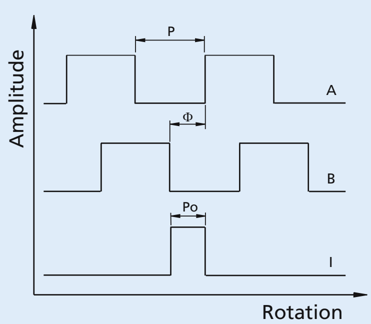
Options

- Connector variants (Option no.: 3807)
  AWG 28 / PVC ribbon cable (6-conductors), with connector PicoBlade (pitch 1,25 mm)
- Resolutions from 1 - 127 lines per revolution are available by request.



Output signals / Circuit diagram / Connector information

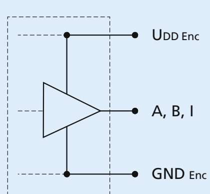
Output signals
with clockwise rotation as seen from the shaft end



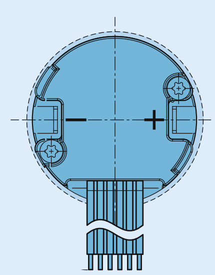
Admissible deviation of phase shift:

$$\Delta\Phi = \left|90° - \frac{\Phi}{P} * 180°\right| \leq 75° \qquad \Delta P_0 = \left|90° - \frac{P_0}{P} * 180°\right| \leq 75°$$

Output circuit



Connection Encoder

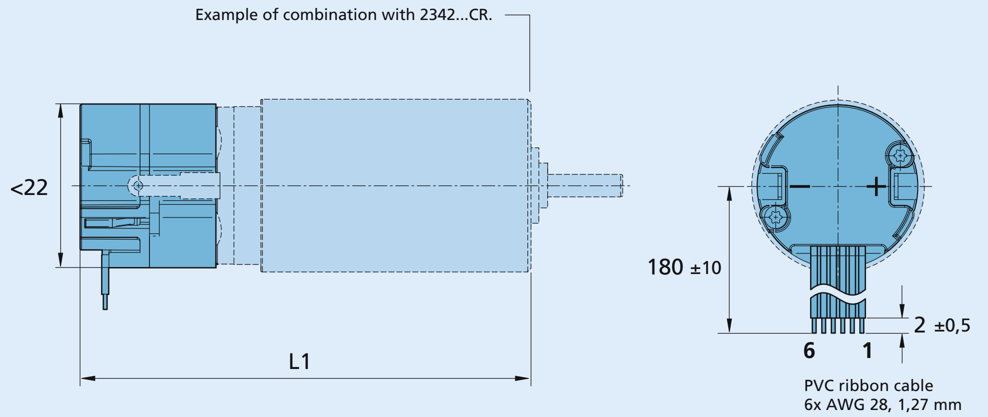


No.	Function
1	n.c.
2	Channel I (Index)
3	GND_{Enc}
4	$U_{DD\ Enc}$
5	Channel B
6	Channel A

Caution:
Incorrect lead connection will damage the motor electronics!
When using the encoder at low temperature it is important to keep the cable unmoved.

DC-Micromotors 23xx ... CR up to 32xx ... CR and 22xx up to 26xx ... CXR with encoder IE3 – 32 ... 1 024

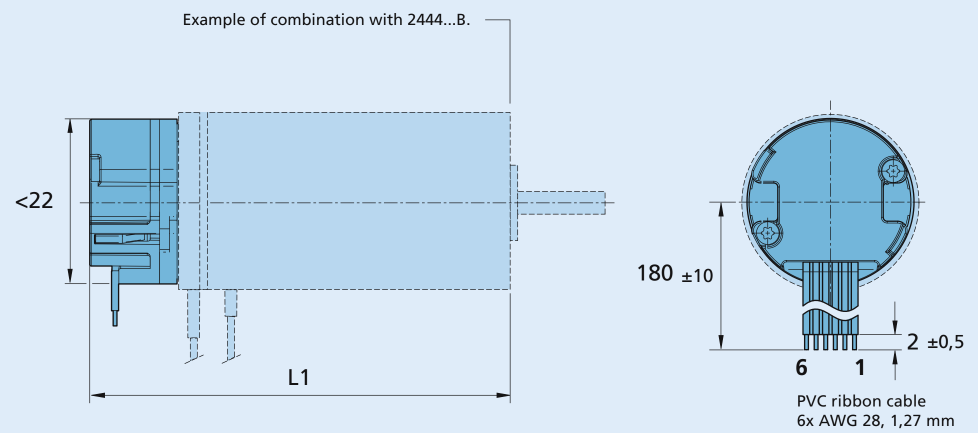
M 1:1



Motor type	< L1
2237	52,5
2342	60,5
2642	60,5
2657	75,5
3242	60,5
3257	75,5

Brushless DC-Servomotors 2444 ... B -K1838, 3056 ... B -K1838, 3564 ... B -K1838 and 4490 ... B/BS -K1838 with encoder IE3 – 32 ... 1 024

M 1:1



Motor type	< L1
2444	55,2
3056	67,2
3564	75,2
4490	100,2

Encoders

Magnetic Encoders with Line Driver

Features:
32 to 1 024 Lines per revolution
3 Channels + complementary outputs
Digital output

Series IE3 – 1 024 L

		IE3 – 32 L	IE3 – 64 L	IE3 – 128 L	IE3 – 256 L	IE3 – 512 L	IE3 – 1 024 L	
Lines per revolution	N	32	64	128	256	512	1 024	
Frequency range [1], up to	f	15	30	60	120	240	430	kHz
Signal output, square wave		2+1 index and complementary outputs						channels
Supply voltage	U_{DD}	4,5 ... 5,5						V DC
Current consumption, typical [2]	I_{DD}	typ. 17, max. 25						mA
Index Pulse width [3]	P_0	90 ± 45				90 ± 75		°e
Phase shift, channel A to B [3]	Φ	90 ± 45				90 ± 75		°e
Inertia of encoder magnet	J	0,08						gcm^2
Operating temperature range		– 40 ... + 85				– 40 ... + 100		°C

[1] speed (rpm) = f (Hz) x 60/N
[2] $U_{DD\ Enc}$ = 5 V: with unloaded outputs
[3] at 5 000 rpm

Notes: The output signals are TIA-422 compatible.
Examples of Line driver Receivers: ST26C32ABD (STM), ST26C32IP16 (EXAR), DS26C32AT (NSC).

Ordering information

Encoder	number of channels	lines per revolution	in combination with:
IE3 – 32 L	2+1	32	**DC-Micromotors**
IE3 – 64 L	2+1	64	**2342 ... CR, 2642 ... CR, 2657 ... CR,**
IE3 – 128 L	2+1	128	**3242 ... CR, 3257 ... CR,**
IE3 – 256 L	2+1	256	**2237 ... CXR, 2642 ... CXR, 2657 ... CXR**
IE3 – 512 L	2+1	512	**3272 ... CR, 3863 ... CR**
IE3 – 1 024 L	2+1	1 024	
			Brushless DC-Servomotors
			2444 ... B, 3056 ... B, 3564 ... B,
			4490 ... B, 4490 ... BS

Features

These incremental encoders have 3 output channels, in combination with the FAULHABER DC-Micromotors are used for the indication and control of both shaft velocity and direction of rotation as well as for positioning.

A permanent magnet on the shaft creates a moving magnetic field which is captured using a single-chip angular sensor and further processed. At the encoder outputs, two 90° phase-shifted rectangular signals are available with up to 1 024 impulses and an index impulse per motor revolution.

The Line Driver version has differential signal outputs (TIA-422). Differential signals reduce ambient interference and are suitable for applications with high ambient interference.

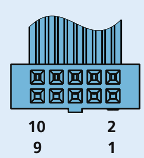
The line driver amplifies the encoder signal which means that long cables can be used without signal degradation.

Differential signal outputs must be decoded by the appropriate receiver module.

The motor and encoder are connected via separate ribbon cables.

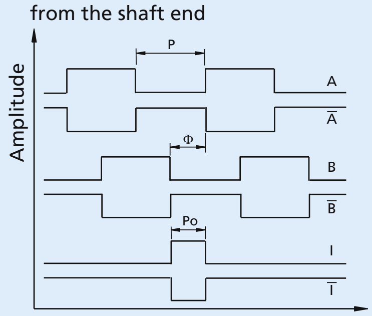
Options

- Connector variants (Option no.: 3806) AWG 28 / PVC ribbon cable (10-conductors), with connector DIN-41651 (pitch 2,54 mm)
- Resolutions from 1 - 127 lines per revolution are available by request.



Output signals / Circuit diagram / Connector information

Output signals
with clockwise rotation as seen from the shaft end

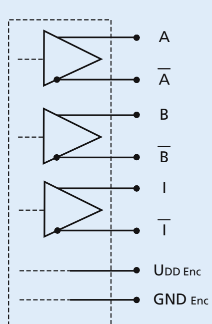


Rotation

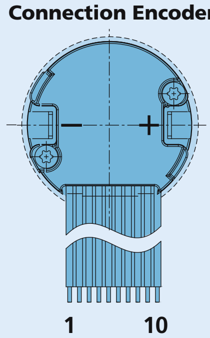
Admissible deviation of phase shift/Index pulse:

$$\Delta\Phi = \left| 90° - \frac{\Phi}{P} * 180° \right| \leq 75° \qquad \Delta P_0 = \left| 90° - \frac{P_0}{P} * 180° \right| \leq 75°$$

Output circuit



Connection Encoder

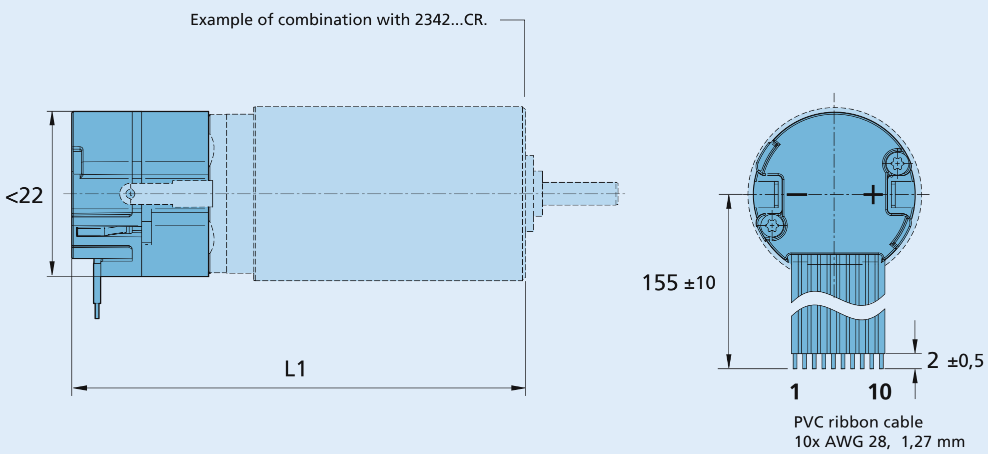


No.	Function
1	n.c.
2	$U_{DD\ Enc}$
3	GND Enc
4	n.c.
5	Channel $\overline{A}$
6	Channel A
7	Channel $\overline{B}$
8	Channel B
9	Channel $\overline{I}$ (Index)
10	Channel I (Index)

Caution:
Incorrect lead connection will damage the motor electronics!
When using the encoder at low temperature it is important to keep the cable unmoved.

DC-Micromotors 23xx ... CR up to 32xx ... CR and 22xx up to 26xx ... CXR with encoder IE3 – 32 ... 1 024 L

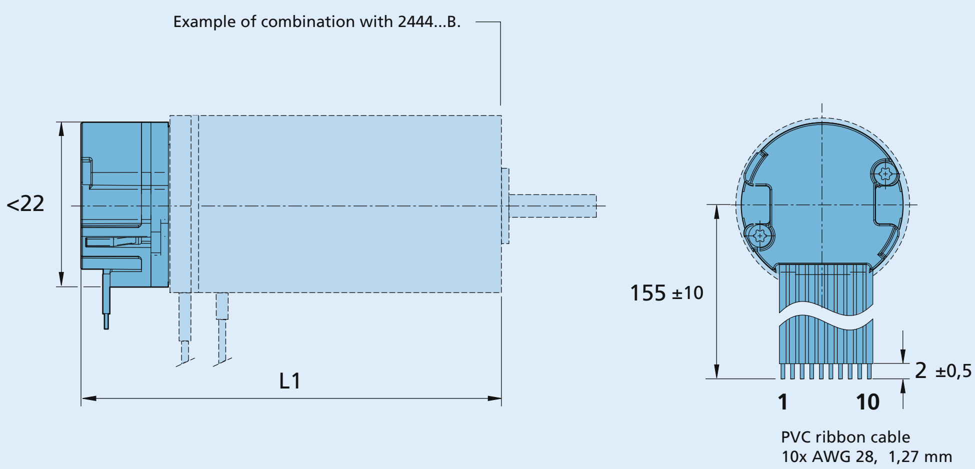
M 1:1



Motor Type	< L1
2237	52,5
2342	60,5
2642	60,5
2657	75,5
3242	60,5
3257	75,5

Brushless DC-Servomotors 2444 ... B -K1838, 3056 ... B -K1838, 3564 ... B -K1838 and 4490 ... B/BS -K1838 with encoder IE3 – 32 ... 1 024 L

M 1:1



Motor Type	< L1
2444	55,2
3056	67,2
3564	75,2
4490	100,2

Encoders

Optical Encoders

Features:
100 to 1024 Lines per revolution
2 or 3 Channels
Digital output

Series 5500, 5540

		HEDS 5500	HEDS 5540	HEDM 5500	
Lines per revolution	N	100 - 500	100 - 500	1 000 -1 024	
Signal output, square wave		2	2+1 index	2	channels
Supply voltage	V_{CC}	4,5 ... 5,5			V DC
Current consumption, typical (V_{CC} = 5 V DC)	I_{CC}	17	57	57	mA
Pulse width	P	180 ± 45	180 ± 35	180 ± 45	°e
Phase shift, channel A to B	Φ	90 ± 20	90 ± 15	90 ± 15	°e
Logic state width	S	90 ± 45	90 ± 35	90 ± 45	°e
Cycle	C	360 ± 5,5	360 ± 5,5	360 ± 7,5	°e
Signal rise/fall time, typical	tr/tf	0,25 / 0,25			µs
Frequency range [1]	f	up to 100	up to 100 [2]	up to 100	kHz
Inertia of code disc	J	0,6			gcm²
Operating temperature range		– 40 ... + 100		– 40 ... + 70	°C

[1] Velocity (rpm) = f (Hz) x 60/N
[2] HEDS 5540 requires pull-up resistors of 2,7 kΩ between pins 2, 3, 5 and 4 (V_{CC})

Ordering information

Encoder type	number of channels	lines per revolution	For combination with:
HEDS 5500 C	2	100	**DC-Micromotors**
HEDS 5500 A	2	500	**2230 ... S, 2233 ... S, 2342 ... CR**
HEDS 5540 C	2+1	100	**2642 ... CXR, 2657 ... CXR**
HEDS 5540 A	2+1	500	**3242 ... CR, 3257 ... CR, 3272 ... CR,**
HEDM 5500 B	2	1 000	**3557 ... CS, 3863 ... C, 3863 ... CR**
HEDM 5500 J	2	1 024	
			brushless DC-Servomotors
			2036 ... B, 2057 ... B, 2444 ... B,
			3056 ... B, 3564 ... B

Interlocking connector options: extension cables 300 mm length, on request.

Features

These incremental shaft encoders in combination with the DC-Micromotors and brushless DC-Servomotors are designed for the indication and control of both shaft velocity and direction of rotation as well as for positioning.

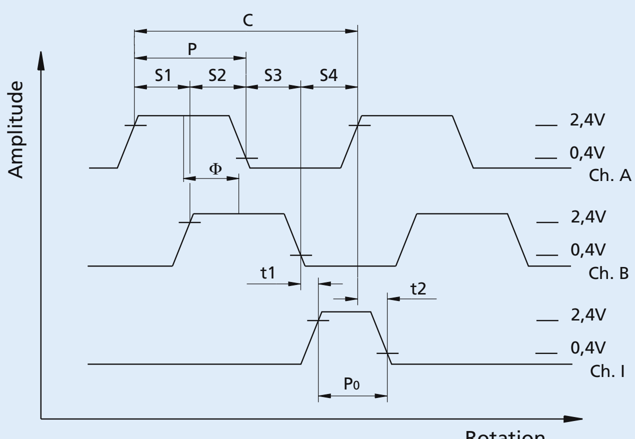
A LED source and lens system transmits collimated light through a low inertia metal disc to give two channels with 90° phase shift.

The single 5 volt supply and the two or three channel digital output signals are interfaced with a 5-pin connector.

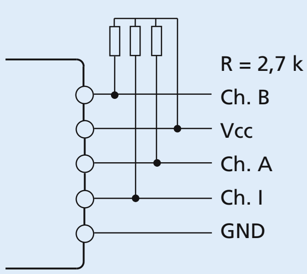
Motors with ball bearings are recommended for continuous operation at low and high speeds and for elevated radial shaft load.

Details for the Motors and suitable reduction gearheads are on separate catalogue pages.

Output signals / Circuit diagram / Connector information

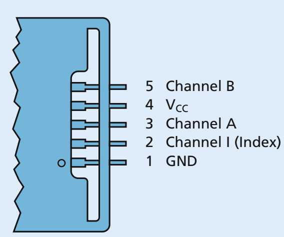


Output signals HEDS, HEDM
with clockwise rotation as seen from the shaft end



Connection diagram
HEDS 5540 requires pull-up resistors

Pin Function



Connector
suggested connectors
AMP 103686-4/640442-5,
Molex 2695/2759
FCI 65039-032 / 4825x-000

Encoders

Optical Encoders with Line Driver

Features:
500 Lines per revolution
3 Channels + complementary outputs
Digital output
Line driver

Series 5540

		HEDL 5540	
Lines per revolution	N	500	
Signal output, square wave		2+1 index and complementary outputs	channels
Supply voltage	V_{CC}	4,5 ... 5,5	V DC
Current consumption, typical (V_{CC} = 5 V DC)	I_{CC}	57	mA
Pulse width	P	180 ± 35	°e
Index pulse width	P_O	90 ± 35	°e
Phase shift, channel A to B	Φ	90 ± 15	°e
Logic state width	S	90 ± 35	°e
Cycle	C	360 ± 5,5	°e
Signal rise/fall time, typical	tr/tf	0,25 / 0,25	µs
Frequency range [1]	f	up to 100	kHz
Inertia of code disc	J	0,6	gcm^2
Operating temperature range		- 40 ... + 100	°C

[1] Velocity (rpm) = f (Hz) x 60/N

Ordering information

Encoder type	number of channels	lines per revolution	For combination with:
HEDL 5540 A	2+1	500	**DC-Micromotors** **2230 ... S, 2233 ... S, 2342 ... CR** **2642 ... CXR, 2657 ... CXR** **3242 ... CR, 3257 ... CR, 3272 ... CR,** **3557 ... CS, 3863 ... C, 3863 ... CR** **brushless DC-Servomotors** **2036 ... B, 2057 ... B, 2444 ... B,** **3056 ... B, 3564 ... B**

The housing dimensions of the HEDL encoder are the same as the HEDS/HEDM encoders, but there is a ribbon cable instead of plain connector pins.

Suggested Line Receivers: AM26LS32, SN75175, MC3486

Features

These incremental shaft encoders in combination with the DC-Micromotors and Brushless DC-Servomotors are designed for the indication and control of both shaft velocity and direction of rotation as well as for positioning.

A LED source and lens system transmits collimated light through a low inertia metal disc to give two channels with 90° phase shift.

The index pulse is synchronized with the channel $\overline{B}$.
Each encoder channel provides complementary output signals.

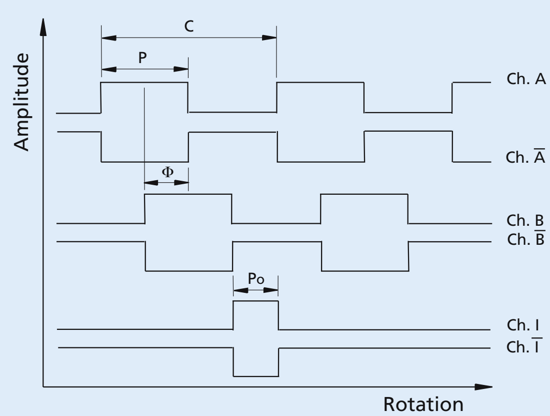
The single 5 volt supply and the digital output signals are interfaced with a connector.

The line driver offers enhanced performance when the encoder is used in noisy environments, or when it is required to drive long distances.

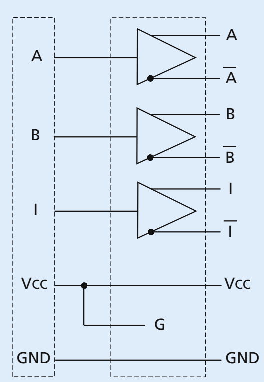
Motor with ball bearings are recommended for continuous operation at low and high speeds and for elevated radial shaft load.

Details for the motors and suitable reduction gearheads are on separate catalogue pages.

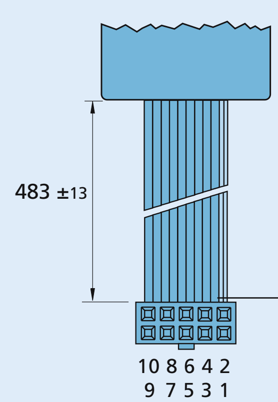
Output signals / Circuit diagram / Connector information



Output signals HEDL 5540
with clockwise rotation as seen from the shaft end



Connection diagram



Connector
DIN-41651
grid 2,54 mm

Pin Function

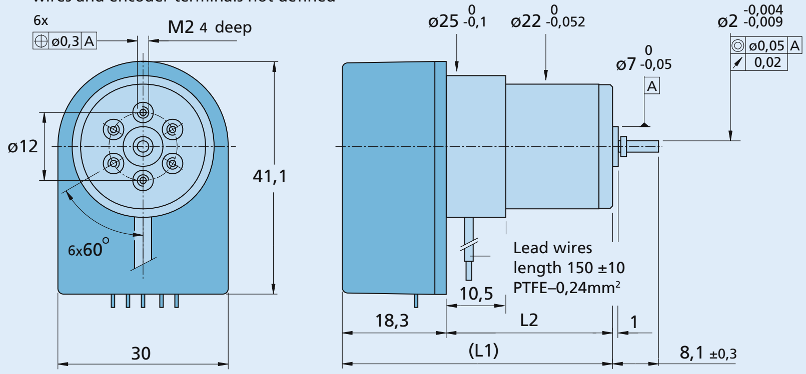
No.	function
1	N.C.
2	Vcc (+5V)
3	GND
4	N.C.
5	$\overline{A}$
6	A
7	$\overline{B}$
8	B
9	$\overline{I}$ (index
10	I (index)

PVC-Ribbon cable
10 conductors 0,09 mm^2

FAULHABER

scale reduced

Orientation with respect to the motor lead wires and encoder terminals not defined

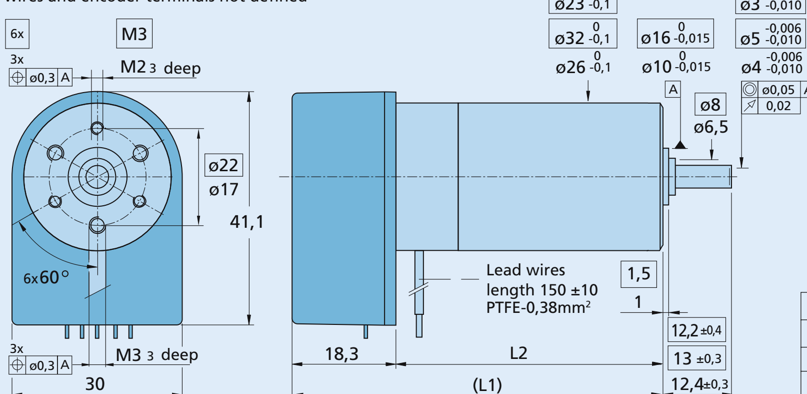


Encoders HEDS 5500, 5540
with DC-Micromotors 2230, 2233

Motor type	L1	L2
2230	52,8	34,5
2233	55,6	37,3

scale reduced

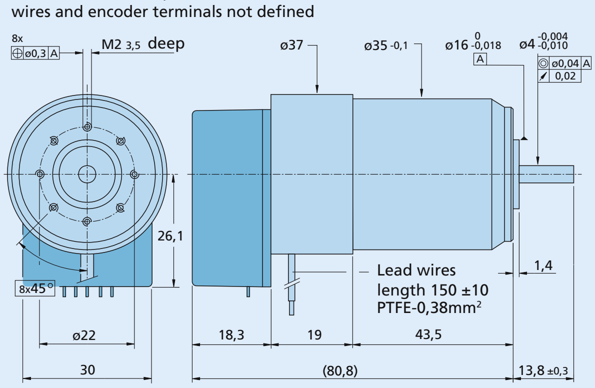
Orientation with respect to the motor lead wires and encoder terminals not defined



Encoders HEDS 5500, 5540
with DC-Micromotors 2342, 2642, 2657, 3242, 3257

Motor type	L1	L2
2342	63,8	45,5
2642	64,8	46,5
2657	79,8	61,5
3242	65,3	47,0
3257	80,3	62,0

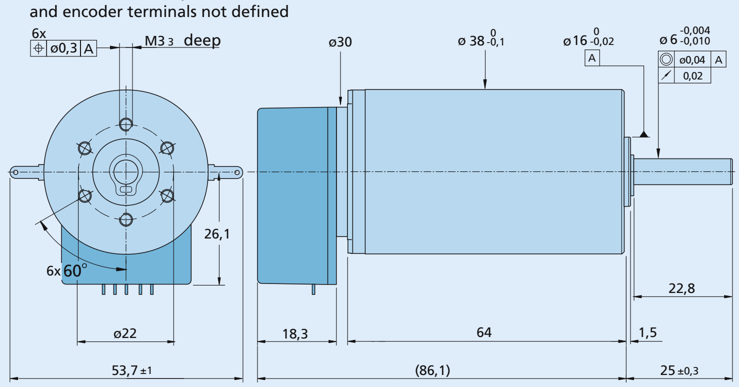
Orientation with respect to the motor lead wires and encoder terminals not defined



Encoders HEDS 5500, 5540
with DC-Micromotor 3557

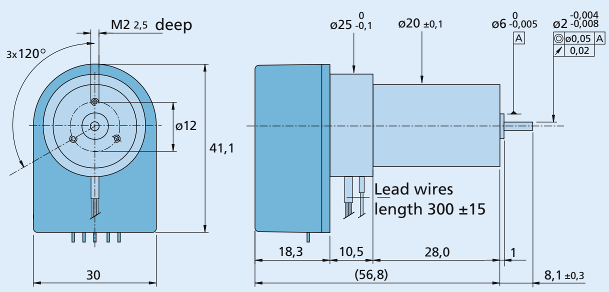
scale reduced

Orientation with respect to the motor and encoder terminals not defined

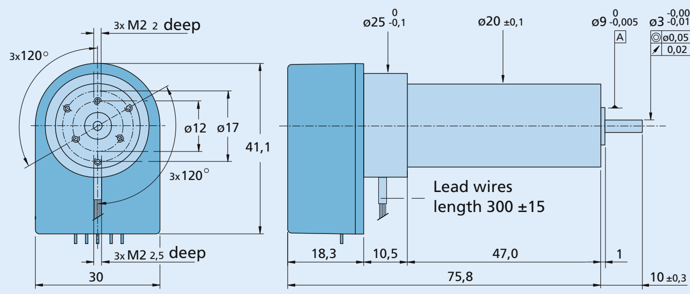


Encoders HEDS 5500, 5540
with DC-Micromotor 3863

scale reduced

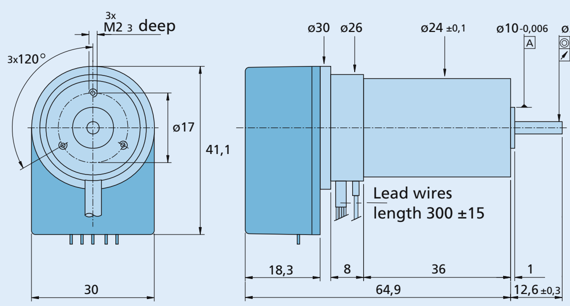


Encoders HEDS 5500, 5540
with Brushless DC-Servomotor 2036 U ... B - K312

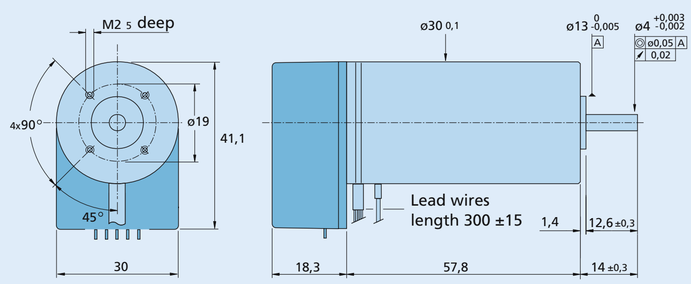


Encoders HEDS 5500, 5540
with Brushless DC-Servomotor 2057 S ... B - K312

scale reduced

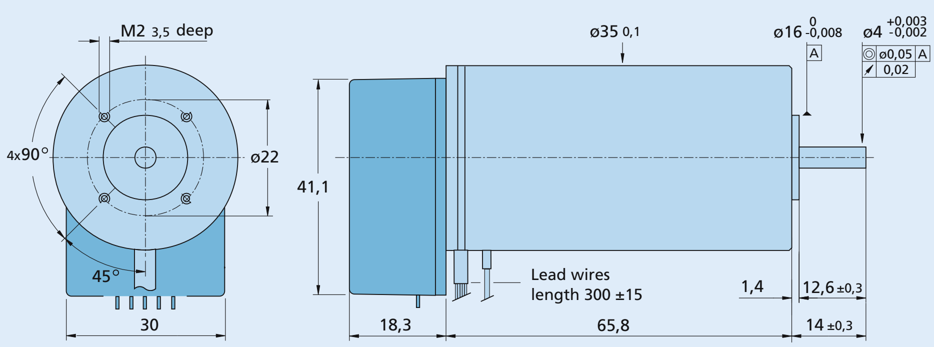


Encoders HEDS 5500, 5540
with Brushless DC-Servomotor 2444 S ... B - K312



Encoders HEDS 5500, 5540
with Brushless DC-Servomotor 3056 K ... B - K312

scale reduced



Encoders HEDS 5500, 5540
with Brushless DC-Servomotor 3564 K ... B - K312

Encoders

Optical Encoders with Line Driver

Features:
1 000 Lines per revolution
3 Channels + complementary signals
Digital output
Line driver

Series 40B

		40B	
Lines per revolution	N	1 000	
Signal output, square wave		2 + 1 index and complementary signals	channels
Supply voltage	V_{CC}	4,5 ... 5,5	V DC
Current consumption, max. (V_{CC} = 5 V DC)	I_{CC}	100	mA
Pulse width	P	180 ± 18	°e
Index pulse width	P_O	180 ± 36	°e
Phase shift, channel A to B	Φ	90 ± 18	°e
Signal rise/fall time, typical	tr/tf	0,25 / 0,25	µs
Frequency range [1]	f	up to 200	kHz
Inertia of code disc	J	4,7	gcm^2
Operating temperature range		– 40 ... + 120	°C
EMC radiated emission		EN 50081–2	
Protection classification		IP54	

[1] Velocity (rpm) = f (Hz) x 60/N

Ordering information

Encoder type	number of channels	lines per revolution	For combination with brushless DC-Servomotors
40B27 - 1000/3	2+1	1 000	**4490 ... B, 4490 ... BS**

Suggested Line Receivers: AM26LS32, SN75175, MC3486

Features

Designed for industrial environments, this high-performance incremental shaft encoder in combination with the Brushless DC-Servomotors is for the indication and control of both shaft velocity and direction of rotation as well as for positioning.

A LED source and lens system transmits collimated light through a low inertia disc to give two channels with 90° phase shift.

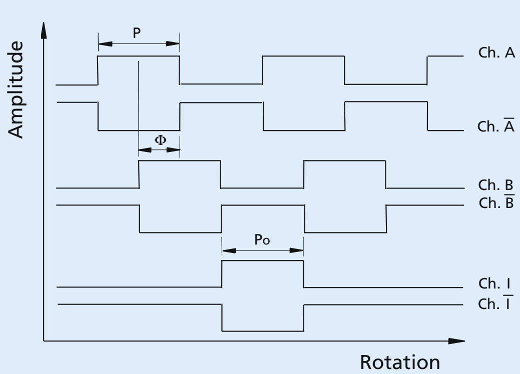
The index pulse is synchronized with the channel $\overline{B}$.
Each encoder channel provides complementary output signals.

The single 5 volt supply and the digital output signals are interfaced with a shielded cable.

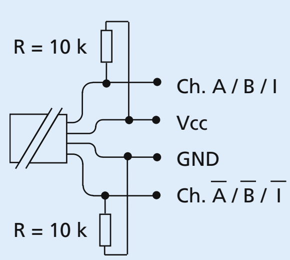
The line driver offers enhanced performance when the encoder is used in noisy environment, or when it is required to operate over long cables.

Details for the Brushless DC-Servomotors and suitable reduction gearheads are on separate catalogue pages.

Output signals / Circuit diagram

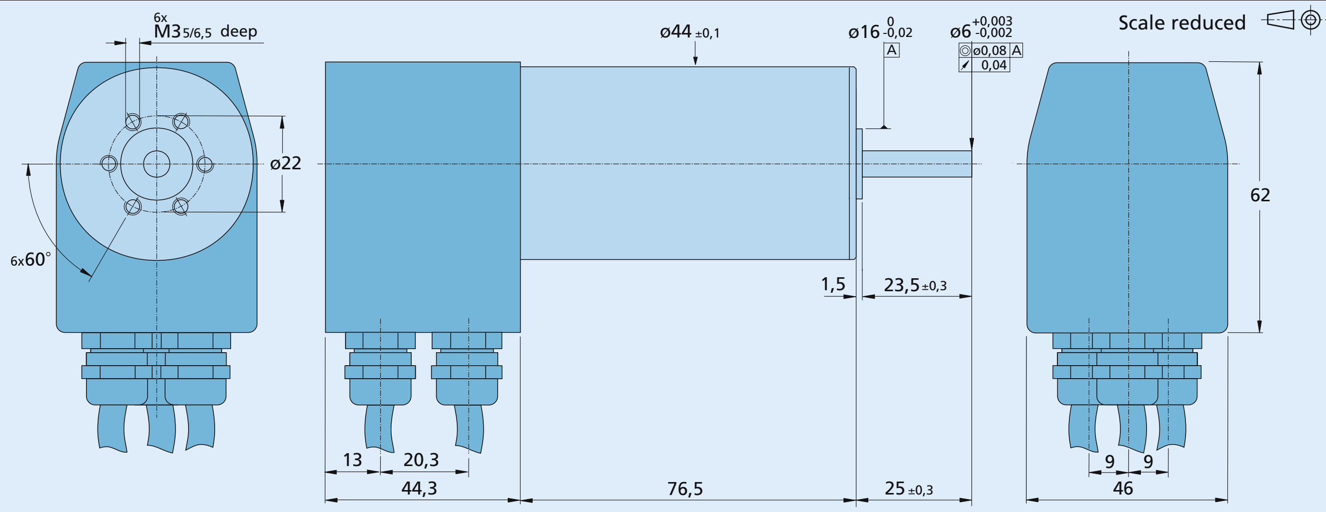


Output signals
with clockwise rotation as seen from the shaft end



Connection diagram
Recommended pull-up and pull-down resistors for best signal quality

Brushless DC-Servomotor 4490 H ... B - K1300, 4490 H ... BS - K1300 with Encoder 40B



Connection informations

Cables
Shielded cables, PVC insulation, black
Length 300 mm ± 15mm

Motor power
3 conductors, AWG 16

Encoder signals
8 conductors, AWG 28

Motor logic
5 conductors, AWG 26

Encoder signals

Function	Colour
V_{CC}	red
GND	black
A	green
$\overline{A}$	red / black
B	orange
$\overline{B}$	white / black
I	white
$\overline{I}$	blue

Motor power

Function	Colour
Phase A	brown
Phase B	orange
Phase C	yellow

Motor logic

Function	Colour
Hall sensor A	green
Hall sensor B	blue
Hall sensor C	grey
Logical supply +5V	red
GND Logical	black

Drive Electronics

WE CREATE MOTION

FAULHABER

Speed Controller

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Motion Controller

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NEW	MCDC 3006	for DC-Micromotors	6 A	432 – 433
NEW	MCBL 3002	for Brushless Motors	2 A	434 – 437
NEW	MCBL 3003	for Brushless Motors	3 A	438 – 439
NEW	MCBL 3006	for Brushless Motors	6 A	440 – 441
NEW	MCBL 3002 AES	for Brushless Motors with AES	2 A	442 – 445
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NEW	MCBL 3006 AES	for Brushless Motors with AES	6 A	448 – 449
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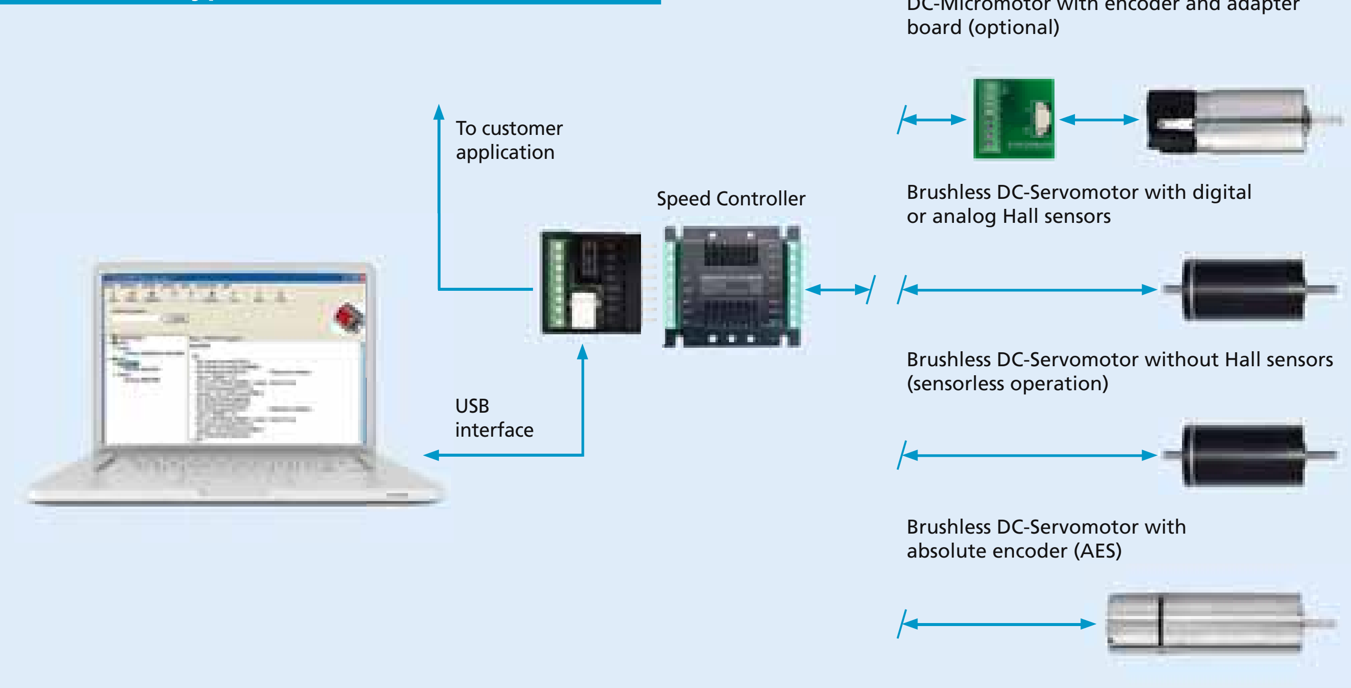
NEW	MCLM 3003	for Linear Motors	3 A	454 – 455
NEW	MCLM 3006	for Linear Motors	6 A	456 – 457

Speed Controller

Technical Information

Connection types



Function

FAULHABER Speed Controllers are highly dynamic speed governors that are optimized for the operation of micro-motors.

The Speed Controllers are available as separate controllers for

- DC-Micromotors
- Brushless DC-Servomotors.

The minimal wiring requirement and compact design of the Speed Controllers allow them to be used in a wide range of applications. The flexible interfacing options make them suitable for a variety of uses in all areas, e.g. in distributed automation systems, handling and tooling devices or pumps.

Benefits

- Compact design
- Flexible reconfiguration capacity
- Minimal wiring required
- Parameter setting using FAULHABER Motion Manager software and USB interface adapter
- Wide range of accessories

Product code

SC 28 04 S 3530

SC	Speed Controller
28	Max. supply voltage (28V)
04	Max. continuous output current (4A)
S	Housing with screw terminal
3530	Operating mode (brushless motor with digital Hall sensors)

Speed Controller

Description & Operating Modes

Description

Covering almost the entire range of FAULHABER GROUP motors, Faulhaber Speed Controllers are suitable for both Brushless DC-Servomotors (BL motors) and DC-Micromotors (DC motors).

- The Speed Controllers are extremely versatile and can be configured as required using a programming adapter and FAULHABER Motion Manager software.
- Depending on configuration, either a BL motor or DC motor can be run with the appropriate sensors for rotational speed measurement.
- The Speed Controllers are designed as velocity regulators. Control is via a PI controller.
- Sensorless operation, in which the rotational speed is determined by evaluating the counter-EMF (also known as back electromotive force), is also available.
- All Speed Controllers have a current limiter that limits the maximum motor current in the event of excessive thermal loads. In the standard configuration this current limiter is set to the maximum admissible value for the respective Speed Controller.

Standard models

To allow fast setup without programming adapter and software, the Speed Controllers come in various standard models. The variants specified for each type of controller can be reconfigured as required.

Operating modes

Depending on the type of controller, the Speed Controllers can be reconfigured to some or all of the following operating modes (cf. „Note“ below) using a programming adapter and FAULHABER Motion Manager software.

BL motors with digital or analog Hall sensors
In this configuration, the motors are operated with speed control, using the signals from the Hall sensors to commutate and determine the actual speed.

BL motors without Hall sensors (sensorless operation)
Instead of applying Hall sensors, this configuration uses the counter-EMF of the motor for commutation and speed control.

BL motors with absolute encoder
This mode can only be used in conjunction with the relevant hardware. In this configuration the encoder provides absolute position data, which is used for commutation and speed control. Thanks to the encoder signal's high resolution, low rotational speeds can be achieved in this operating mode.

BL motors with digital Hall sensors and brake/enable input
In this configuration the motors are operated with speed control. Thanks to the additional brake/enable inputs, it is easier to connect the controller – e.g. to a PLC or fail-safe circuits.

BL motors with digital Hall sensors and encoder
In this configuration the Hall sensors provide the information for the commutation. The speed is adjusted to the signal from the incremental encoder. This is why a high resolution encoder is able to achieve very low speeds.

DC motors with encoder
In this configuration the motors are operated with speed control. An incremental encoder is necessary to transmit the actual rpm value.

DC motors without encoder
In the sensorless DC motor configuration the motors are operated with speed control using either the counter-electromotive force or an IxR compensation to register the actual rotational speed, depending on load. This operating mode has to be matched to the motor type.

In addition, other parameters can be modified using the **FAULHABER Motion Manager software**:

- Controller parameters
- Output current limitation
- Fixed rotational speed
- Encoder resolution
- Rpm setpoint via analog or PWM signal
- Maximum rotational speed or speed range

Note

All Speed Controllers come with an instruction manual for installation and commissioning. Please note that not all Speed Controllers are suitable for all operating modes. Detailed information on the various operating modes is provided in the respective data sheets.

FAULHABER

Speed Controller

2-Quadrant PWM
configurable via PC

For combination with:
DC-Micromotors and
Brushless DC-Servomotors

Series SC 1801

		SC 1801 P	SC 1801 F	SC 1801 S	
Power supply for electronic	U_P	4,0 ... 18	4,0 ... 18	4,0 ... 18	V DC
Power supply for motor	U_{mot}	1,8 ... 18	1,8 ... 18	1,8 ... 18	V DC
Max. continuous output current [1]	I_{dauer}	1	1	1	A
Max. peak output current	I_{max}	2	2	2	A
Total standby current	$I_{el\ max}$	0,018	0,018	0,018	A
Input/output (partially free configurable)		3	3	3	
Tightening torque, terminal strip		-	0,12 ... 0,15	0,12 ... 0,15	Nm
Weight		4	10	12	g
PWM switching frequency	f_{PWM}	96 (24)			kHz
Efficiency	η	95			%
Speed range:					
– BL motors with Hall sensors (digital)		500 ... 100 000			rpm
– BL motors with Hall sensors (analog)		50 ... 60 000			rpm
– DC motors with encoder		100 ... 30 000			rpm
Scanning rate		500			µs
Resolution of encoder with DC motors		≤ 65 535			inc./rev.
Operating temperature range		– 25 ... + 60			°C
Storage temperature		– 25 ... + 85			°C

[1] at 22°C ambient temperature

Versions

		Version					
Speed Controller	Option	Motor Type	Sensor Type	Set speed value specification [1]	Speed at U_{nsoll} =10 V	Part No.	Conformity
SC 1801 S	**3530**	BL	Hall sensors (digital) [3]	0 ... 10 V	30 000 rpm	**6500.01377**	**CE**
SC 1801 S	**3531**	DC	Incremental encoder [2]	0 ... 10 V	10 000 rpm	**6500.01393**	**CE**
SC 1801 F	**3533**	BL	sensorless (high speed)	0 ... 10 V	40 000 rpm	**6500.01378**	**CE**
SC 1801 P	**3530**	BL	Hall sensors (digital) [3]	0 ... 10 V	30 000 rpm	**6500.01379**	
SC 1801 P	**3531**	DC	Incremental encoder [2]	0 ... 10 V	10 000 rpm	**6500.01394**	
SC 1801 S	**3980**	BL	Absolute encoder	0 ... 10 V	30 000 rpm	**6500.01435**	
SC 1801 P	**3980**	BL	Absolute encoder	0 ... 10 V	30 000 rpm	**6500.01440**	
SC 1801 F	**3980**	BL	Absolute encoder	0 ... 10 V	50 000 rpm	**6500.01441**	
SC 1801 S	**4289**	BL	Hall sensors (analog) [3]	0 ... 10 V	40 000 rpm	**6500.01475**	
SC 1801 P	**4289**	BL	Hall sensors (analog) [3]	0 ... 10 V	40 000 rpm	**6500.01476**	
SC 1801 F	**4289**	BL	Hall sensors (analog) [3]	0 ... 10 V	40 000 rpm	**6500.01477**	

[1] The velocity range can be configured by software. Versions with PWM and other configurations are available on request.
[2] preset value is 512 lines
[3] Factory pre-configured for 2 pole motors. For operation with 4 pole motors the speed controller must be reconfigured with the software "Faulhaber Motion Manager".

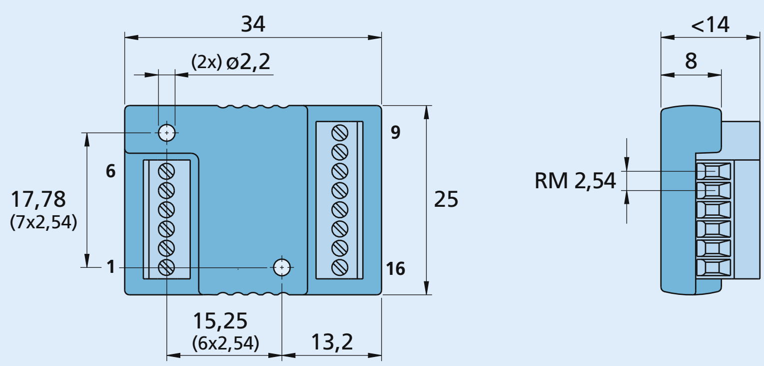
Accessories

		Motor Type	for SC 1801 S Part No.
Programming adapter	**Starterkit**		**6501.00088**
Programming adapter			**6501.00097**
Motor connector adapter	**0620 ... B**	BL	**6501.00083**
	penny-motor	BL	**6501.00090**
	BX4	BL	**6501.00085**
Encoder adapter	**IE2**	DC	**6501.00084**
	HEDS	DC	**6501.00001**

Drive Electronics

Dimensional drawing and connection information SC 1801 S

M 1:1



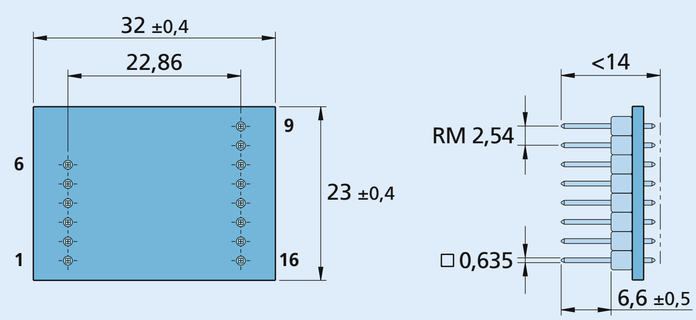
SC 1801 S

Connection

Pin	Function
1	U_P
2	U_{mot}
3	GND
4	U_{soll}
5	DIR
6	FG
9	Mot C
10	Mot B
11	Mot A
12	SGND
13	V_{CC}
14	Sens C
15	Sens B
16	Sens A

Dimensional drawing and connection information SC 1801 P

M 1:1



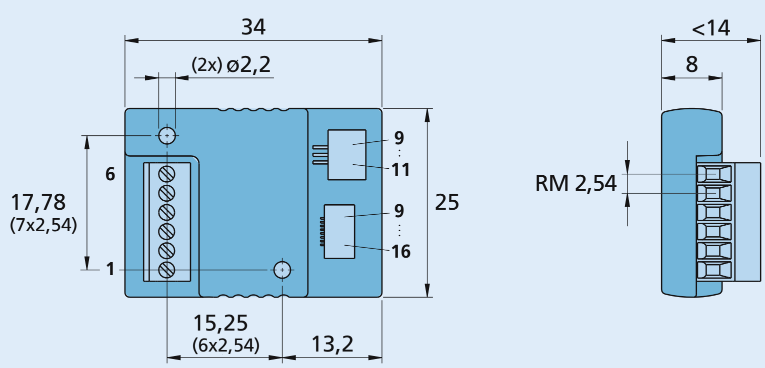
SC 1801 P

Connection

Pin	Function
1	U_P
2	U_{mot}
3	GND
4	U_{soll}
5	DIR
6	FG
9	Mot C
10	Mot B
11	Mot A
12	SGND
13	V_{CC}
14	Sens C
15	Sens B
16	Sens A

Dimensional drawing and connection information SC 1801 F

M 1:1



SC 1801 F

Connector Information
LIF-Connector
3-pole and 8-pole

Connection

Pin	Function
1	U_P
2	U_{mot}
3	GND
4	U_{soll}
5	DIR
6	FG
9	Mot C
10	Mot B
11	Mot A
12	SGND
13	V_{CC}
14	Sens C
15	Sens B
16	Sens A

Speed Controller

2-Quadrant PWM
configurable via PC

For combination with:
DC-Micromotors and
Brushless DC-Servomotors

Series SC 2402

		SC 2402 P	
Power supply for electronic	U_P	5 ... 24	V DC
Power supply for motor	U_{mot}	0 ... 24	V DC
Max. continuous output current [1]	I_{dauer}	2	A
Max. peak output current	I_{max}	4	A
Total standby current	$I_{el\ max}$	0,03	A
Input/output (partially free configurable)		5	
Weight		14	g
PWM switching frequency	f_{PWM}	96 (24)	kHz
Efficiency	η	95	%
Speed range:			
– BL motors with Hall sensors (digital)		500 ... 100 000	rpm
– BL motors with Hall sensors (analog)		50 ... 60 000	rpm
– BL motors with digital Hall + encoder		50 ... 30 000	rpm
– DC motors with encoder		100 ... 30 000	rpm
Scanning rate		500	µs
Resolution of encoder with DC motors		≤ 65 535	inc./rev.
Operating temperature range		– 25 ... + 60	°C
Storage temperature		– 25 ... + 85	°C

1) at 22°C ambient temperature

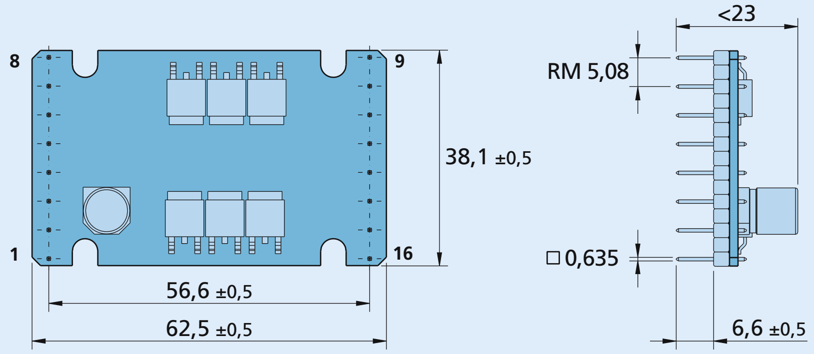
Versions

Speed Controller	Option	Motor Type	Sensor Type	Set speed value specification [1]	Speed at U_{nsoll} =10 V	Part No.
SC 2402 P	**3530**	BL	Hall sensors (digital) [3]	0 ... 10 V	20 000 rpm	**6500.01381**
SC 2402 P	**3531**	DC	Incremental encoder [2]	0 ... 10 V	10 000 rpm	**6500.01392**
SC 2402 P	**3980**	BL	Absolute encoder	0 ... 10 V	20 000 rpm	**6500.01439**
SC 2402 P	**4289**	BL	Hall sensors (analog) [3]	0 ... 10 V	20 000 rpm	**6500.01474**
SC 2402 P	**4475**	BL	Digital Hall + encoder [3]	0 ... 10 V	20 000 rpm	**6500.01520**
SC 2402 P	**4476**	BL	Digital Hall + brake/enable [3]	0 ... 10 V	20 000 rpm	**6500.01522**

1) The velocity range can be configured by software. Versions with PWM and other configurations are available on request.
2) preset value is 512 lines.
3) Factory pre-configured for 2 pole motors. For operation with 4 pole motors the speed controller must be reconfigured with the software “Faulhaber Motion Manager”.

Dimensional drawing and connection information SC 2402 P

Scale reduced



SC 2402 P

Connection

Pin	Function
1	U_P
2	U_{mot}
3	GND
4	U_{nsoll}
5	DIR
6	FG
7	IO 2
8	IO 1
9	Mot C
10	Mot B
11	Mot A
12	SGND
13	V_{CC}
14	Sens C
15	Sens B
16	Sens A

Drive Electronics

FAULHABER

Speed Controller

2-Quadrant PWM
configurable via PC

For combination with:
DC-Micromotors and
Brushless DC-Servomotors

Series SC 2804

		SC 2804 S	
Power supply for electronic	U_P	5 ... 28	V DC
Power supply for motor	U_{mot}	0 ... 28	V DC
Max. continuous output current [1]	I_{dauer}	4	A
Max. peak output current	I_{max}	8	A
Total standby current	$I_{el\ max}$	0,03	A
Input/output (partially free configurable)		5	
Tightening torque, terminal strip		0,5 ... 0,6	Nm
Weight		160	g
PWM switching frequency	f_{PWM}	96 (24)	kHz
Efficiency	η	95	%
Speed range:			
– BL motors with Hall sensors (digital)		500 ... 100 000	rpm
– BL motors with Hall sensors (analog)		50 ... 60 000	rpm
– BL motors with digital Hall + encoder		50 ... 30 000	rpm
– DC motors with encoder		100 ... 30 000	rpm
Scanning rate		500	µs
Resolution of encoder with DC motors		≤ 65 535	inc./rev.
Operating temperature range		– 25 ... + 60	°C
Storage temperature		– 25 ... + 85	°C

[1] at 22°C ambient temperature

Versions

Speed Controller	Option	Motor Type	Sensor Type	Set speed value specification [1]	Speed at U_{nsoll} =10 V	Part No.	Conformity
SC 2804 S	**3530**	BL	Hall sensors (digital) [3]	0 ... 10 V	20 000 rpm	**6500.01390**	**CE**
SC 2804 S	**3531**	DC	Incremental encoder [2]	0 ... 10 V	10 000 rpm	**6500.01391**	**CE**
SC 2804 S	**3980**	BL	Absolute encoder	0 ... 10 V	20 000 rpm	**6500.01438**	
SC 2804 S	**4289**	BL	Hall sensors (analog) [3]	0 ... 10 V	20 000 rpm	**6500.01473**	
SC 2804 S	**4475**	BL	Digital Hall + encoder [3]	0 ... 10 V	20 000 rpm	**6500.01521**	
SC 2804 S	**4476**	BL	Digital Hall + brake/enable [3]	0 ... 10 V	20 000 rpm	**6500.01523**	

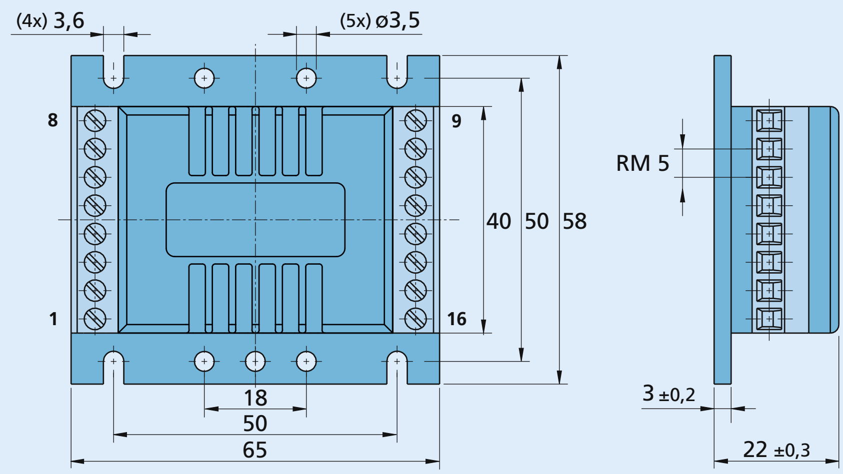
[1] The velocity range can be configured by software. Versions with PWM and other configurations are available on request.
[2] preset value is 512 lines
[3] Factory pre-configured for 2 pole motors. For operation with 4 pole motors the speed controller must be reconfigured with the software "Faulhaber Motion Manager".

Accessories

		Motor-typ	for SC 2804 S Part No.
Programming adapter	**Starterkit**		**6501.00088**
Programming adapter			**6501.00096**
Motor connector adapter	**5 mm » 2,54 mm**		**6501.00087**
	BX4	BL	**6501.00086**
Encoder adapter	**IE2**	DC	**6501.00063**
	HEDS	DC	**6501.00001**

Dimensional drawing and connection information SC 2804 S

Scale reduced



Connection

Pin	Function
1	U_P
2	U_{mot}
3	GND
4	U_{soll}
5	DIR
6	FG
7	IO 2
8	IO 1
9	Mot C
10	Mot B
11	Mot A
12	SGND
13	V_{CC}
14	Sens C
15	Sens B
16	Sens A

Speed Controller

4-Quadrant PWM
configurable via PC

For combination with:
DC-Micromotors and
Brushless DC-Servomotors

Series SC 5004

		SC 5004 P	
Power supply for electronic	U_P	6 ... 50	V DC
Power supply for motor	U_{mot}	0 ... 50	V DC
Max. continuous output current [1]	I_{dauer}	4	A
Max. peak output current	I_{max}	8	A
Total standby current	$I_{el\ max}$	100	mA
Input/output (partially free configurable)		5	
Weight		14	g
PWM switching frequency	f_{PWM}	96 (24)	kHz
Efficiency	η	95	%
Speed range:			
– BL motors with Hall sensors (digital)		500 ... 100 000	rpm
– BL motors with Hall sensors (analog)		50 ... 60 000	rpm
– BL motors with absolute encoder		50 ... 60 000	rpm
– BL motors with digital Hall + encoder		50 ... 30 000	rpm
– DC motors with encoder		100 ... 30 000	rpm
Scanning rate		500 / 1 000	µs
Resolution of encoder with DC motors		≤ 65 535	inc./rev.
Operating temperature range		– 25 ... + 60	°C
Storage temperature		– 25 ... + 85	°C

[1] at 22°C ambient temperature

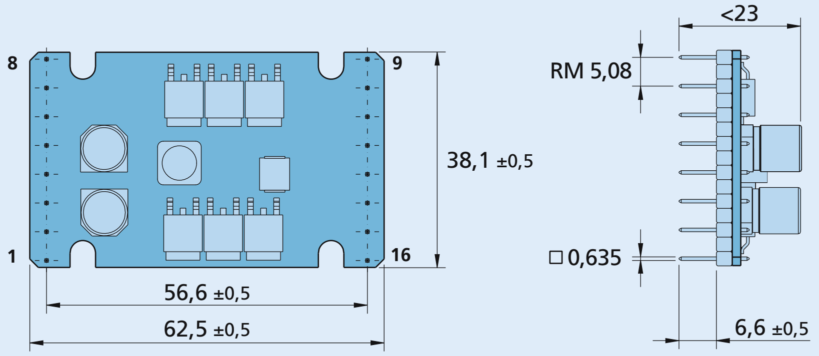
Versions

Speed Controller	Option	Motor Type	Sensor Type	Set speed value specification [1]	Speed at U_{soll} =10 V	Part No.
SC 5004 P	**3530**	BL	Hall sensors (digital) [3]	0 ... 10 V	20 000 rpm	**6500.01481**
SC 5004 P	**3531**	DC	Incremental encoder [2]	0 ... 10 V	10 000 rpm	**6500.01483**
SC 5004 P	**4289**	BL	Hall sensors (analog) [3]	0 ... 10 V	20 000 rpm	**6500.01485**
SC 5004 P	**3980**	BL	Absolute encoder [4]	0 ... 10 V	20 000 rpm	**6500.01528**
SC 5004 P	**4475**	BL	Digital Hall + encoder [3]	0 ... 10 V	20 000 rpm	**6500.01524**
SC 5004 P	**4476**	BL	Digital Hall + brake/enable [3]	0 ... 10 V	20 000 rpm	**6500.01526**

[1] The velocity range can be configured by software. Versions with PWM and other configurations are available on request.
[2] preset value is 512 lines
[3] Factory pre-configured for 2 pole motors. For operation with 4 pole motors the speed controller must be reconfigured with the software "Faulhaber Motion Manager".
[4] Factory pre-configured for 4 pole motors. For operation with 2 pole motors the speed controller must be reconfigured with the software "Faulhaber Motion Manager".

Dimensional drawing and connection information SC 5004 P

Scale reduced



SC 5004 P

Connection

Pin	Function
1	U_P
2	U_{mot}
3	GND
4	U_{nsoll}
5	DIR
6	FG
7	IO 2
8	IO 1
9	Mot C
10	Mot B
11	Mot A
12	SGND
13	V_{CC}
14	Sens C
15	Sens B
16	Sens A

FAULHABER

Speed Controller

4-Quadrant PWM
configurable via PC

For combination with:
DC-Micromotors and
Brushless DC-Servomotors

Series SC 5008

		SC 5008 S	
Power supply for electronic	U_P	6 ... 50	V DC
Power supply for motor	U_{mot}	0 ... 50	V DC
Max. continuous output current [1]	I_{dauer}	8	A
Max. peak output current	I_{max}	16	A
Total standby current	$I_{el\ max}$	100	mA
Input/output (partially free configurable)		5	
Tightening torque, terminal strip		0,5 ... 0,6	Nm
Weight		160	g
PWM switching frequency	f_{PWM}	96 (24)	kHz
Efficiency	η	95	%
Speed range:			
– BL motors with Hall sensors (digital)		500 ... 100 000	rpm
– BL motors with Hall sensors (analog)		50 ... 60 000	rpm
– BL motors with absolute encoder		50 ... 60 000	rpm
– BL motors with digital Hall + encoder		50 ... 30 000	rpm
– DC motors with encoder		100 ... 30 000	rpm
Scanning rate		500 / 1 000	µs
Resolution of encoder with DC motors		≤ 65 535	inc./rev.
Operating temperature range		– 25 ... + 60	°C
Storage temperature		– 25 ... + 85	°C

[1] at 22°C ambient temperature

Versions

Speed Controller	Option	Motor Type	Sensor Type	Set speed value specification [1]	Speed at U_{soll} =10 V	Part No.
SC 5008 S	**3530**	BL	Hall sensors (digital) [3]	0 ... 10 V	20 000 rpm	**6500.01480**
SC 5008 S	**3531**	DC	Incremental encoder [2]	0 ... 10 V	10 000 rpm	**6500.01482**
SC 5008 S	**4289**	BL	Hall sensors (analog) [3]	0 ... 10 V	20 000 rpm	**6500.01484**
SC 5008 S	**3980**	BL	Absolute encoder [4]	0 ... 10 V	20 000 rpm	**6500.01529**
SC 5008 S	**4475**	BL	Digital Hall + encoder [3]	0 ... 10 V	20 000 rpm	**6500.01525**
SC 5008 S	**4476**	BL	Digital Hall + brake/enable [3]	0 ... 10 V	20 000 rpm	**6500.01527**

[1] The velocity range can be configured by software. Versions with PWM and other configurations are available on request.
[2] preset value is 512 lines
[3] Factory pre-configured for 2 pole motors. For operation with 4 pole motors the speed controller must be reconfigured with the software "Faulhaber Motion Manager".
[4] Factory pre-configured for 4 pole motors. For operation with 2 pole motors the speed controller must be reconfigured with the software "Faulhaber Motion Manager".

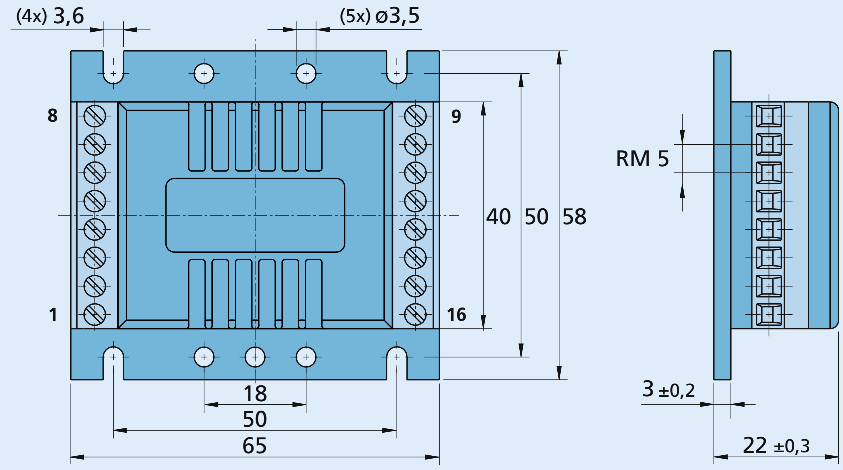
Accessories

		Motor-typ	for SC 5008 S Part No.
Programming adapter	**Starterkit**		**6501.00088**
Programming adapter			**6501.00096**
Motor connector adapter	**5 mm » 2,54 mm**		**6501.00087**
	BX4	BL	**6501.00086**
Encoder adapter	**IE2**	DC	**6501.00063**
	HEDS	DC	**6501.00001**

Drive Electronics

Dimensional drawing and connection information SC 5008 S

Scale reduced



Connection

Pin	Function
1	U_P
2	U_{mot}
3	GND
4	U_{soll}
5	DIR
6	FG
7	IO 2
8	IO 1
9	Mot C
10	Mot B
11	Mot A
12	SGND
13	V_{CC}
14	Sens C
15	Sens B
16	Sens A

SC Function

Description of connections (Motor-dependent)

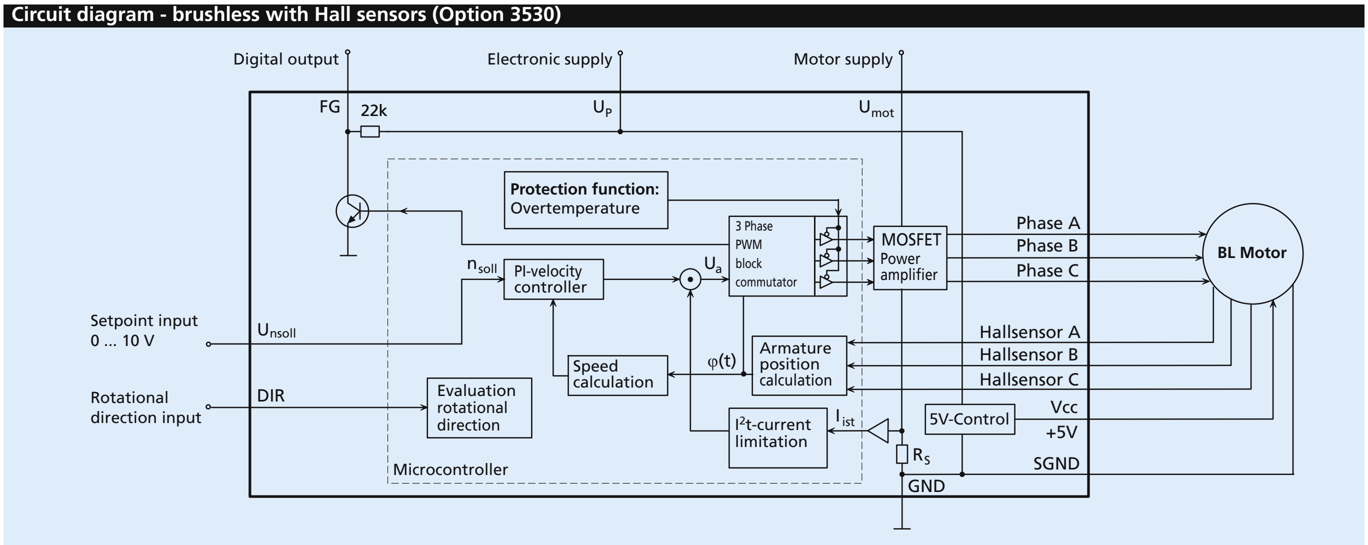
		DC-Motors with Encoder	BL-Motors with Hall sensors	BL-Motors with Absolute encoder	BL-Motors with digital Hall sensors + encoder	BL-Motors with digital Hall sensors + brake/enable
Connection "Mot A", "Mot B", "Mot C":						
– Motor connection	Mot A	Mot +	Phase A	Phase A	Phase A	Phase A
	Mot B	Mot -	Phase B	Phase B	Phase B	Phase B
	Mot C	*reserved*	Phase C	Phase C	Phase C	Phase C
Connection "Sens A", "Sens B", "Sens C":						
– Sensor input	Sens A	*reserved*	Hall sensor A	DATA	Hall sensor A	Hall sensor A
	Sens B	encoder canal A	Hall sensor B	CS	Hall sensor B	Hall sensor B
	Sens C	encoder canal B	Hall sensor C	CLK	Hall sensor C	Hall sensor C
	f	≤ 400 kHz				
Connection „IO1", „IO2"						
- logic input	IO1	*reserved*	*reserved*	*reserved*	encoder B	brake
	IO2	*reserved*	*reserved*	*reserved*	encoder A	enable

Connection information (general)

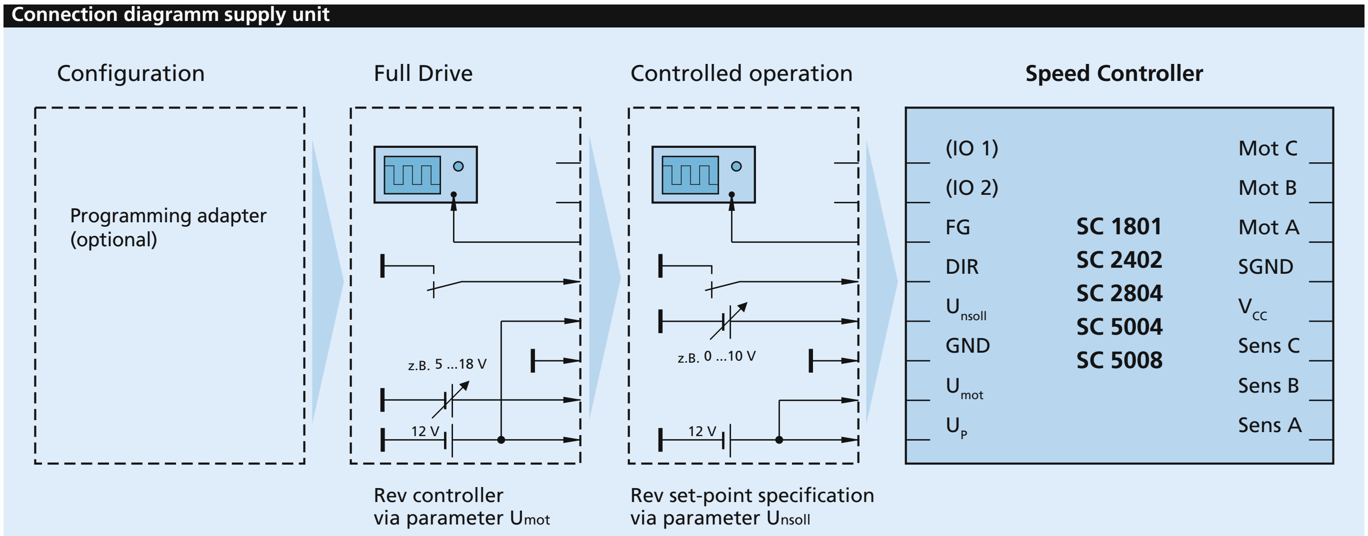
Connection "U_P":		U_P	power supply electronic
Connection "U_{mot}":		U_{mot}	power supply motor coil
Connection "GND":			ground
Connection "U_{nsoll}":		U_{in} = 0 ... 10 V / > 10 V ... max. U_P [1]	(standard version)
– analog input	set speed value	U_{in} < 0,15 V	motor stops
		U_{in} > 0,3 V (0,5 V) [2]	motor starts
– digital input	PWM for set speed value	500 ... 18 000 Hz	
	duty cycle	d = 0%	motor stopped
		d = 50%	half of maximum speed
		d = 100%	maximum speed
	input resistance	R_{in} ≥ 5 kΩ	
	signal level PLC	7,5 ... U_P	high
		0 ... 2	low
	signal level TTL [3]	2,8 ... U_P	high
		0 ... 0,5	low
Connection "DIR":			
– digital input	direction of rotation	to ground or level < 0,5 V	counterclockwise
		level > 3,0 V	clockwise
	input resistance	R_{in} ≥ 10 kΩ	
Connection "FG":		max. U_P/15 mA	open collector with pull-up resistor [4]
– fault output		switched through to GND	no error
– frequency output (BL motor only)		1, 3, 6, 8, 16 [5]	lines per revolution
Connection "IO1", "IO2":		n.c.	*reserved*
– digital input [6]			
	signal level TTL	2,8 ... Up	high
		0 ... 0,5	low
	(IO2)	high	motor enabled
		low	motor disabled
	(IO1)	high	motor stopped
		low	motor run
Connection "V_{CC}":			
	output voltage	5 V DC	for external use
	max. output current for	SC 1801 S, F, P	» I_{CC} = 25 mA
		SC 2402 P	» I_{CC} = 20 mA
		SC 2804 S	» I_{CC} = 30 mA
		SC 5004 P	» I_{CC} = 100 mA
		SC 5008 S	» I_{CC} = 100 mA
Connection "SGND":			signal ground

1) > 10 V for set speed value not defined.
2) Data in parentheses apply to BL motors operating without sensors.
3) Not available for SC 5004 / SC 5008
4) 22 kΩ (SC 1801, SC 2402, SC 2804)
47 kΩ (SC 5004, SC 5008)
An additional external pull-up resistor can be added to improve the rise time.
Caution: I_{out} max. 15 mA must not be exceeded.
5) Values apply to 2-pole motors. The given values double for 4-pole motors.
6) With appropriate hardware.

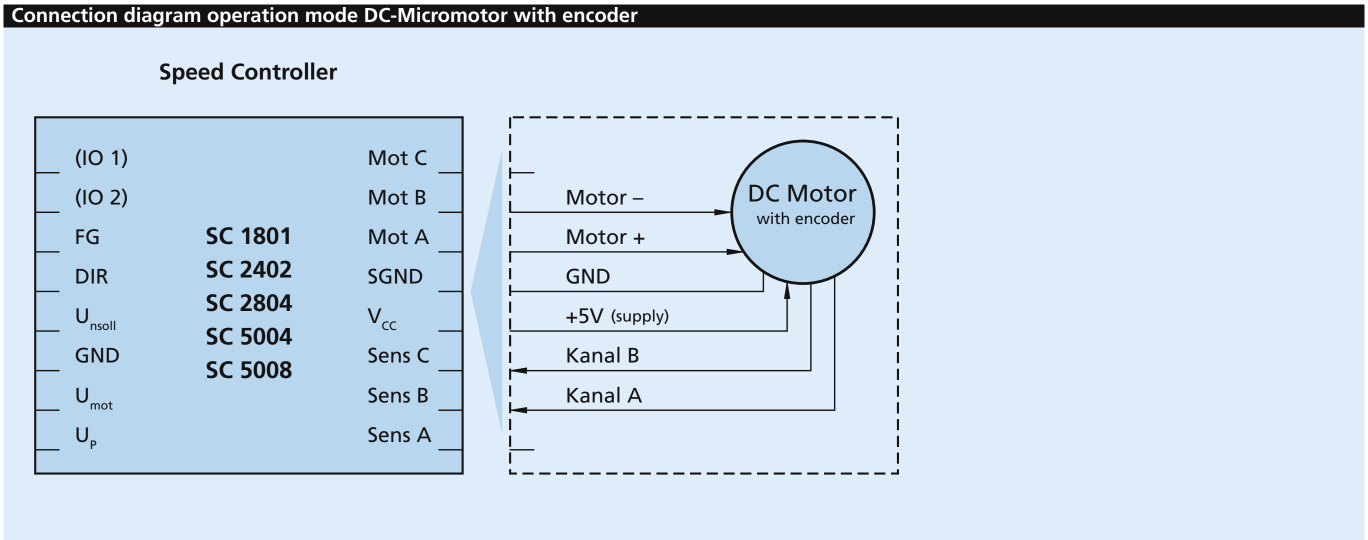
Circuit diagram - brushless with Hall sensors (Option 3530)



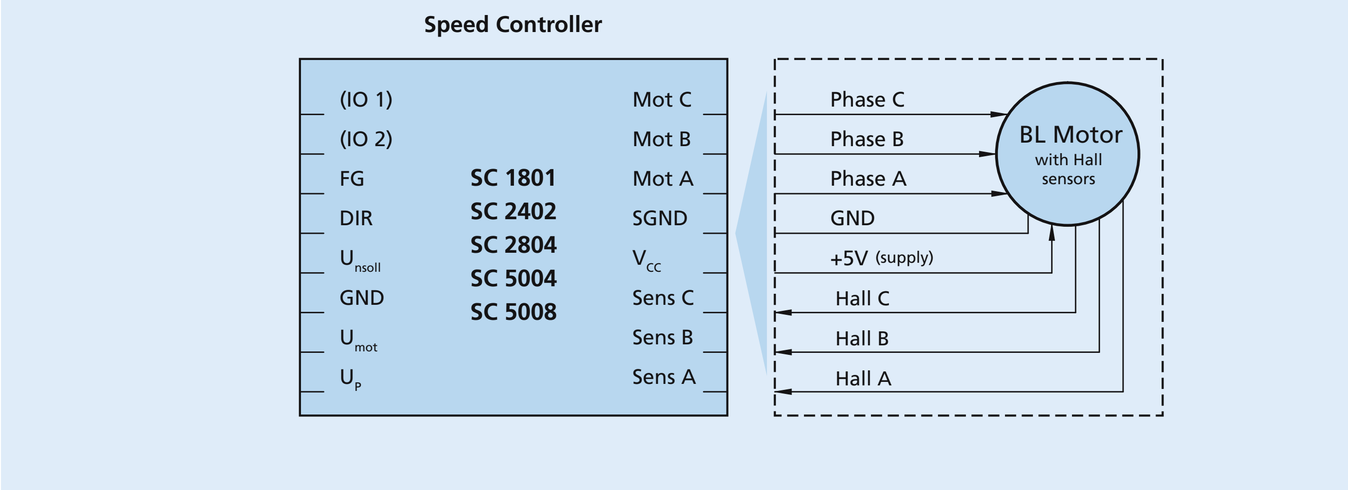
Connection diagramm supply unit



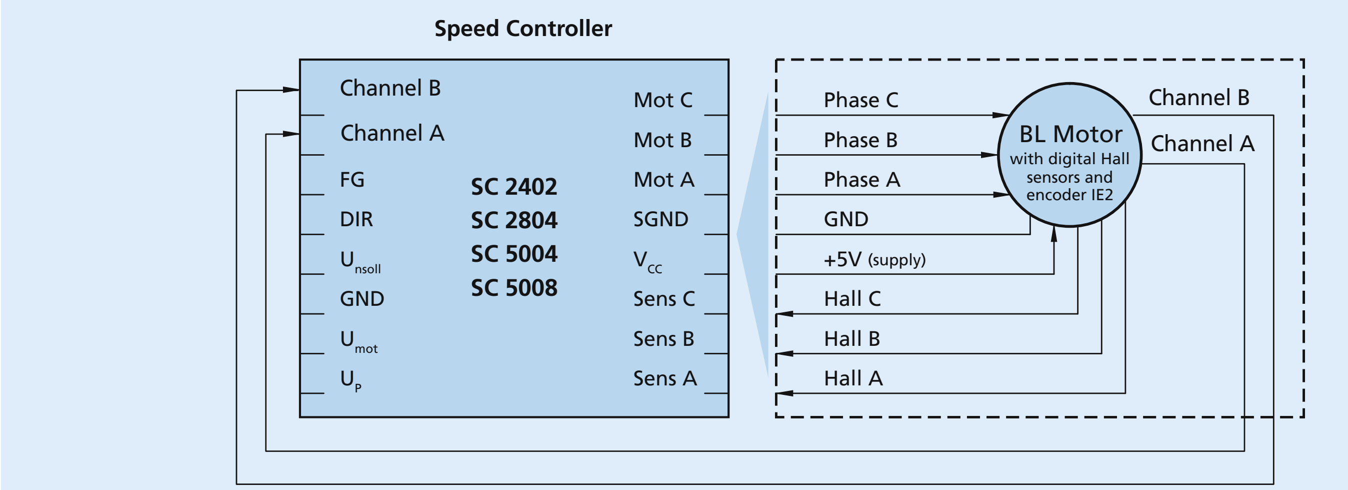
Connection diagram operation mode DC-Micromotor with encoder



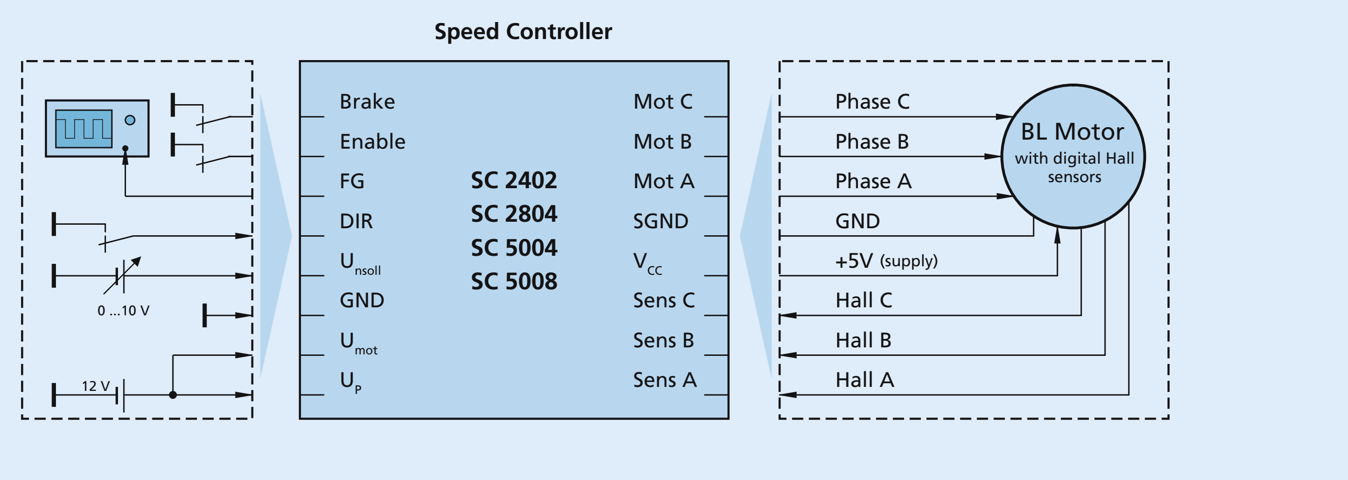
Connection diagram operation mode BL motor with Hall Sensors



Connection diagram operation mode BL motor with digital Hall Sensors and Encoder

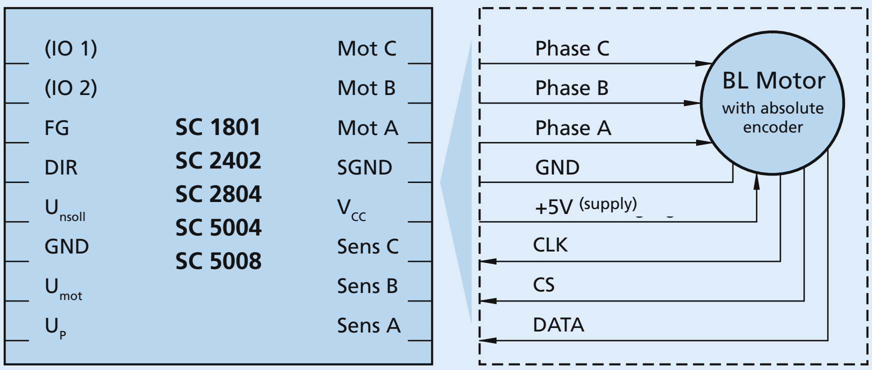


Connection diagram operation mode BL motor with digital Hall Sensors and Brake / Enable



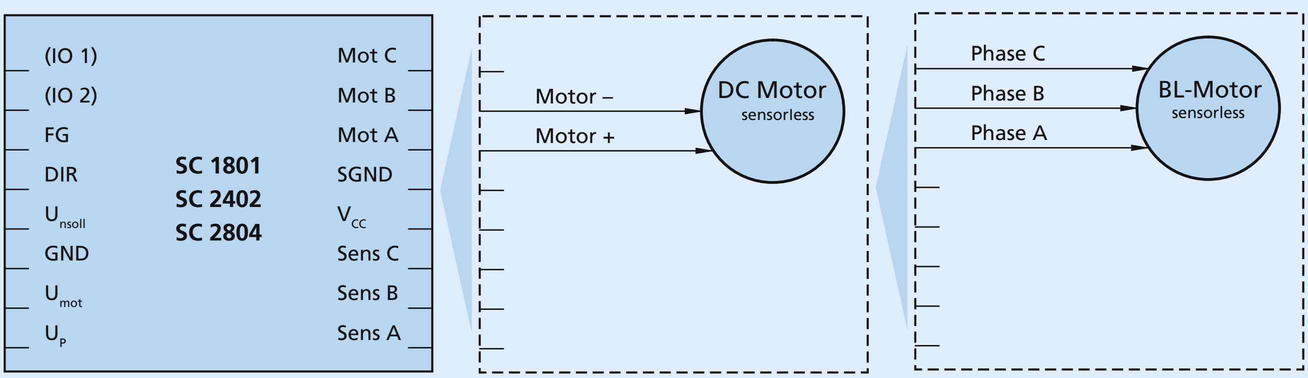
Connection diagram operation mode BL motor with AES

Speed Controller



Connection diagram operation mode DC and BL motor sensorless

Speed Controller



Drive Electronics

Servo Amplifier

4-Quadrant PWM

For combination with:
Brushless DC-Servomotors

Series BLD 7010

	BLD 7010-SC4P	
Power supply	11 ÷ 70	V DC
Switching frequency	49	kHz
Continuous output current @ TA = 22°C	10	A
Peak current limit	20	A
Analog input command: [1]		
– Voltage range	± 10	V DC
Logic input:		
– Encoder	TTL	
– Encoder frequency	100	kHz
– Enable	8 - 30	V DC
Output voltage for external use:		
– Positive (max. 20 mA)	+15	V DC
(max. 100 mA)	+5	V DC
– Negative (max. 20 mA)	–15	V DC
Maximum controllable speed with Hall Sensor [2]	5 000 / 40 000	rpm
Minimum controllable speed with Hall Sensor [3]	250 / 2 000	rpm
Maximum controllable speed with Encoder (with 1 000 lines per revolution) [2]	1 250 / 10 000	rpm
Minimum controllable speed with Encoder [3]	5 / 40	rpm
External inductance [4]	100 ÷ 300	µH
Temperature range:		
– Operating temperature	–10 ... + 45	°C
– Storage temperature	–40 ... + 80	°C
Dimension and Weight:		
– Dimensions (L x W x H)	180 x 100 x 40	mm
– Weight	650	g

[1] Analog input command may be set by an external potentiometer or an external voltage.
[2] The maximum controllable speed depends on the power supply, the motor type, the load and the feedback.
[3] The minimum controllable speed depends on the motor type, the load and the feedback.
[4] The appropriate value depends on the operating cycle and working conditions. An external inductance from 100 to 300 µH can be use to reduce the temperature of the motor series 4490 ... B.

Note: The Servo Amplifier is supplied with an operating instruction manual for installation and start-up.

General description

The Servo Amplifier BLD 7010 is a powerful 4-Quadrant PWM Controller with electronic commutation for our three-phase brushless DC-Servomotors with Hall sensors.

Operating modes:

- Torque / current control
- Speed control by Encoder
- Speed control by Hall sensors

The required operation mode is selected by setting jumpers.
The Servo Amplifier is protected against over current, overheat and short-circuit of the motor connections against each other and to the power supply.

Advanced technology design with power MOSFET assure high efficency of up to 95%.
The robust controller design and screw terminals assure simple and easy installation and safe operation.
The solid aluminium case offers several mounting possibilities to allow easy system integration.

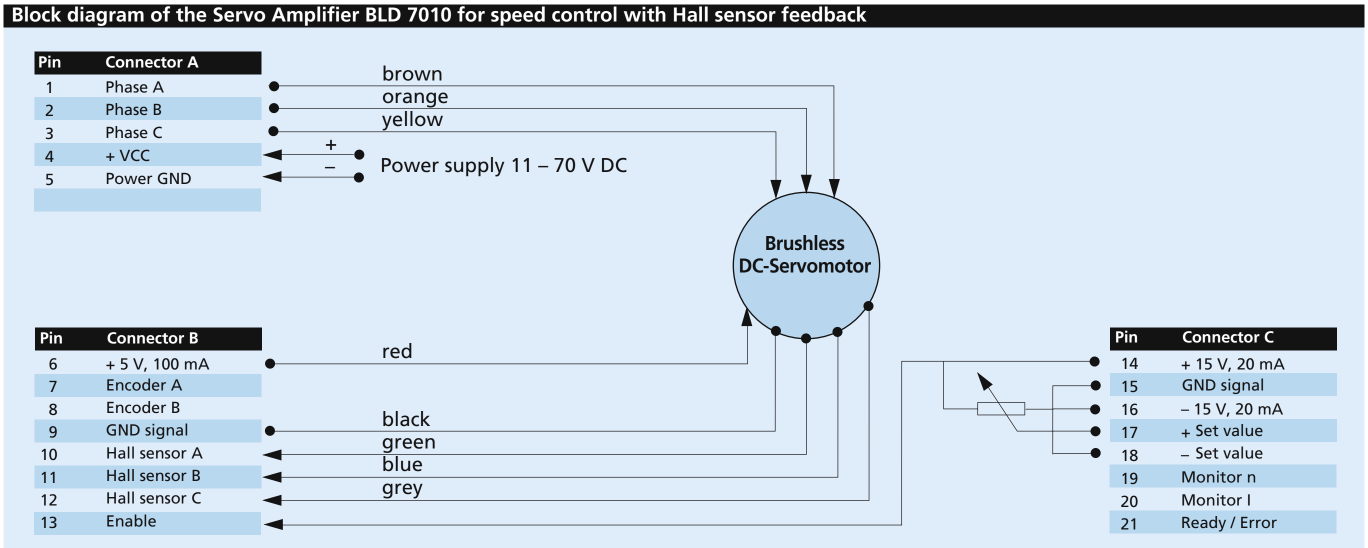
Features:

- Operation from a single supply source
- 4-Quadrant PWM
- Efficiency 95%
- Excellent linearity
- User friendly
- Torque / current control
- Speed control
- Bandwidth of current control 2,5 kHz

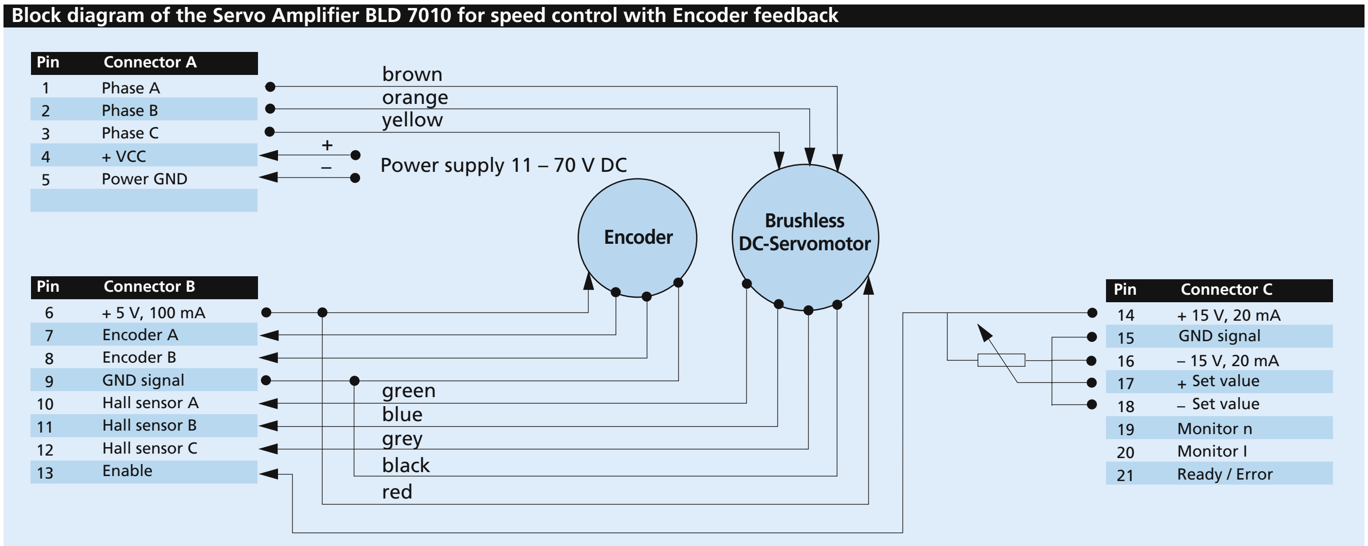
Full product description:

Servo Amplifiers	Brushless DC-Servomotors	Encoders
BLD 7010-SC4P	4490 H 024 B	
BLD 7010-SC4P	4490 H 036 B	
BLD 7010-SC4P	4490 H 048 B	
BLD 7010-SC4P	4490 H 024 B - K 1300	40B27 - 1000/3
BLD 7010-SC4P	4490 H 036 B - K 1300	40B27 - 1000/3
BLD 7010-SC4P	4490 H 048 B - K 1300	40B27 - 1000/3

Block diagram of the Servo Amplifier BLD 7010 for speed control with Hall sensor feedback

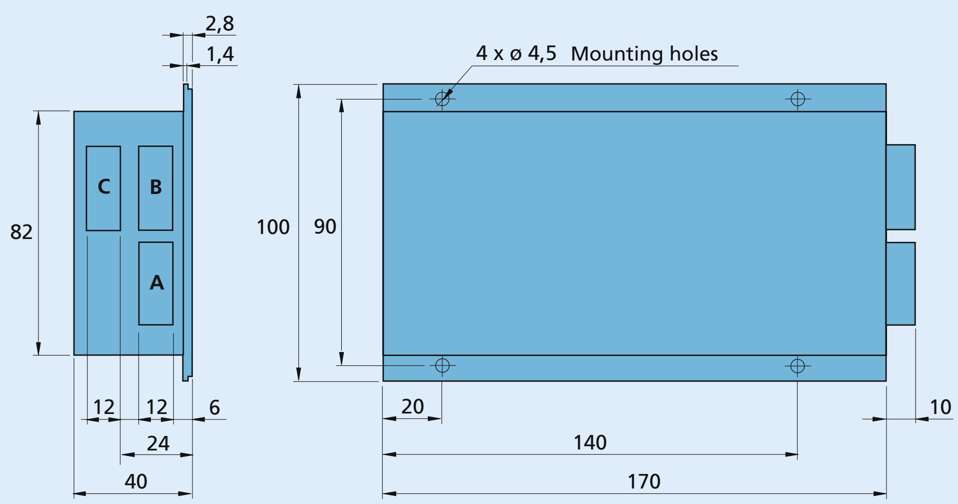


Block diagram of the Servo Amplifier BLD 7010 for speed control with Encoder feedback



Dimensional drawing

Scale reduced



Connection

	Function
A	Motor and power supply
B	Hall signals and encoder
C	Logical

Drive Electronics

for Stepper Motors
PRECIstep® Technology

For combination with:
PRECIstep 2-Phase Stepper Motors

Series AD xx M1S

xx =	VL	VM	CM	
	Voltage Mode	Voltage Mode	Current Mode	
Power supply voltage:				
- min.	3	6	10	V DC
- max.	14	24	28	V DC
Power supply current	14	14	13	mA
Output current, max. (for each phase)	500	500	750	mA
Logic input level:				
- low	0 ... 0,6			V DC
- high	2,5 ... 14	2,5 ... 24	2,5 ... 24	V DC
Internal pulse generator frequency[1] (AD xx M3S series only):				
- min.	0	0	0	Hz
- max.	2 000	2 000	6 000	Hz
Direction of rotation	CW / CCW			
Step modes	full step / half step			
Operating temperature range	0 ... +70			°C
Weight	22			g
Dimensions	76,3 x 53,5	76,3 x 53,5	83,2 x 53,5	mm

[1] There is no limitation of the frequency if an external pulse generator is used.

General description

The Drivers Series AD VL M1S, AD VM M1S and AD CM M1S have been designed for safe and simple operation for evaluation of all PRECIstep motors from ø6 to 22 mm.

The AD xx M1S versions are controlled by an external clock signal and a direction bit.

Voltage Mode Drivers

These drivers allow operating a step motor at low supply voltage (for example batteries). The motor phase current is not controlled by the driver. For that reason you need to use these drivers at the nominal voltage of the selected motor in voltage mode.

Please refer to the voltage mode performance curve in the motor datasheet to know the torque of the motor at your operational speed.

These drivers are recommended for all application operating below 10 V DC.

Current Mode Drivers

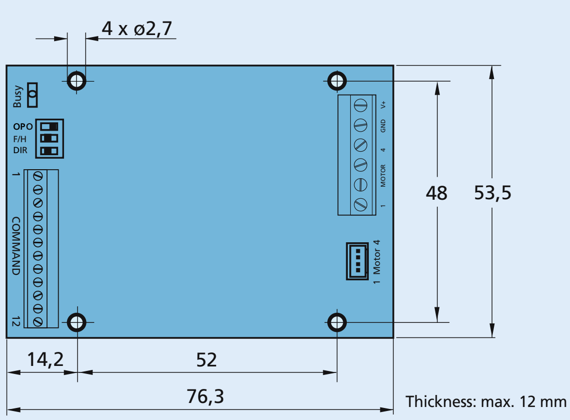
These drivers have an integrated phase current control circuit (chopper). The supply voltage can be selected much higher which increases the motor performance at higher operational speed.

Please refer to the current mode performance curve in the motor datasheet to know the torque of the motor at your operational speed.

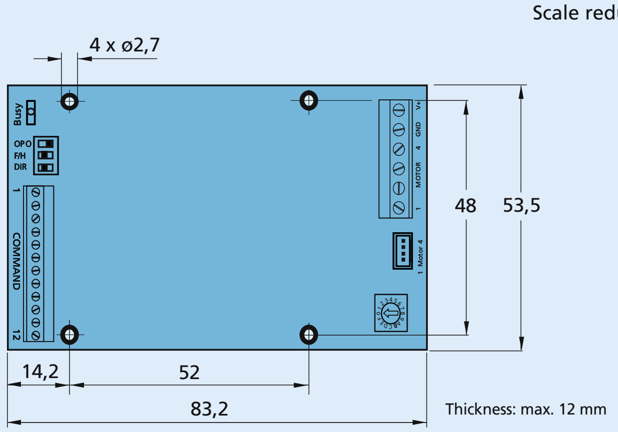
This driver must be used above 10 V DC. It is recommended to use a higher voltage for increased performance.

Dimensional drawing

Scale reduced



AD VL M1S, AD VM M1S



AD CM M1S

For Pin-Out of the command connector, please refer to the next page

Drive Electronics

for Stepper Motors
PRECIstep® Technology

For combination with:
PRECIstep 2-Phase Stepper Motors

Series AD xx M3S

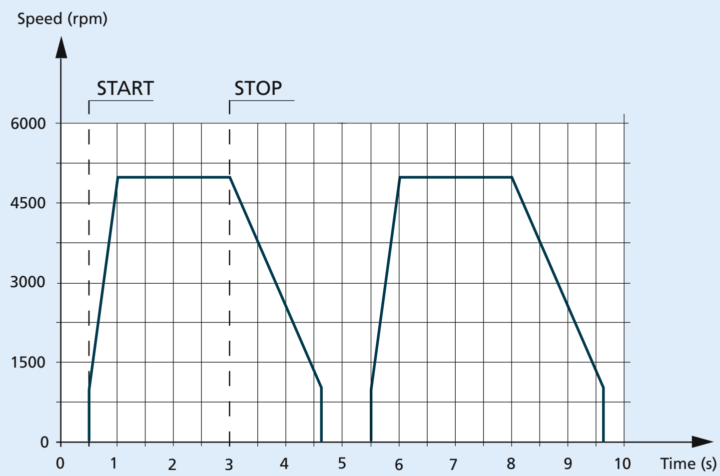
The driver extension board, plugged into the M1S versions described on page 1, transforms the basic stepper motor driver with pulse and direction control into a stand-alone speed control driver AD xx M3S. The following control parameters can be set by the user by on board potentiometers:

- pull-in speed
- maximum speed
- acceleration rate
- deceleration rate

To execute the set speed profile, please refer to the graph, the control of START; STOP and DIR signals are sufficient.

All other functions and settings remain identi-cal with the M1S versions.

Velocity profile example M3S



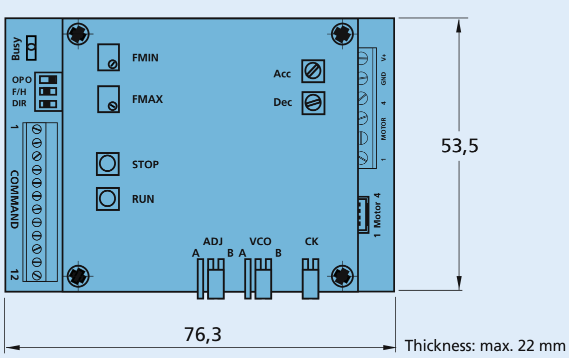
Connection information

Pin	I/O	Function	Description	M1	M3
1	I	OPO	Full-step; 1-phase ON (wave)	x	x
2	I	FS/HS	Full Step/Half Step mode switch	x	x
3	I	CCW/CW	Sense of rotation switch, default = CW	x	x
4	I	CLK	External clock input	x	x
5	I	RUN	Starts the clock generator		x
6	I	STOP	Stops the clock generator		x
7	I	BOOST (ADCM)	Current boost	x	x
	I	INHIBIT (ADVM/VL)	Disables the phase current(s)	x	x
8	O	BUSY	Output = low when clock is active		x
9	I	STB (ADCM)	Current Standby	x	x
	I	GND (ADVM/VL)	Ground potential ≥ 0 Volt	x	x
10	O	VCC	+5V power supply	x	x
11	O	GND	Ground potential ≥ 0 Volt	x	x
12*	I	VCO	External control voltage for the oscillator		x
	O	HOME	Active when Phase A is commutated with positive current	x	

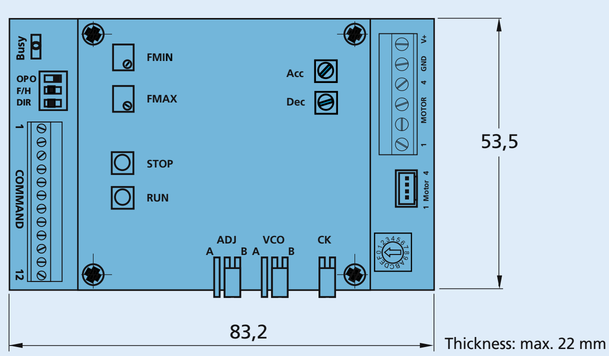
*Pin 12 can be switched as Input or output as described. Please refer to User Manual.

Dimensional drawing

Scale reduced



AD VL M3S, AD VM M3S



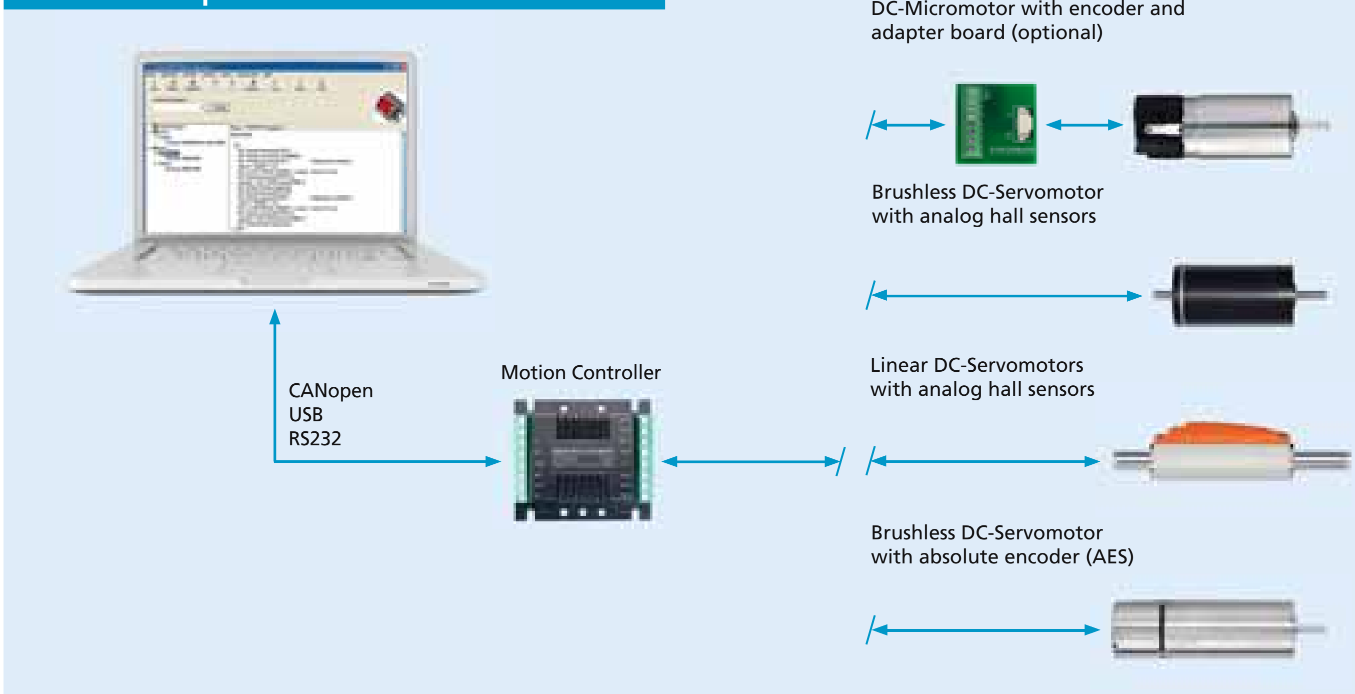
AD CM M3S

Drive Electronics

Motion Controller

Technical Information

Connection options



Features

FAULHABER Motion Controllers are highly dynamic positioning systems tailored specifically to the requirements of micromotor operations.

In addition to being deployed as a positioning system, they can also operate as speed or current controllers.

The Motion Controllers are available as separate controllers for:

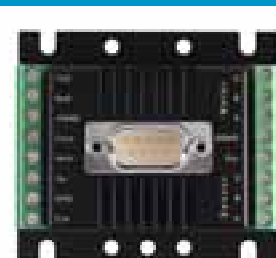
- DC-Micromotors (MCDC)
- Brushless DC-Servomotors (MCBL)
- Linear DC-Servomotors (MCLM)

Motion Control Systems – highly dynamic, low-maintenance BLDC servomotors with integrated motion controls – deliver the ultimate in slimline design. The integrated systems require less space, as well as making installation much simpler thanks to their reduced wiring.

Benefits

- Compact construction
- Controlled via RS232 or CAN interface
- Minimal wiring
- Parametrization with „FAULHABER Motion Manager“ software and USB interface
- Extensive accessories

Product Code



MC BL 30 06 S AES CF

MC	Motion Controller
BL	For Brushless DC-Motors
30	Max. supply voltage (30 V)
06	Max. continuous output current (6 A)
S	Housing with screw terminal
AES	Only for BLDC-Motors with absolute encoders
CF	CAN interface, FAULHABER CAN

Motion Controller

Configuration, Networking, Interfaces

Operating Modes

Speed control
PI speed controls, even for demanding synchronization requirements

Positioning
For moving to defined positions with a high level of re solution. Using a PD Controller, the dynamic response can be adjusted to suit the application. Reference and limit switches are evaluated by means of various homing modes.

Speed profiles
Acceleration ramps, deceleration ramps and maximum velocity can also be defined for each section. As a result, even complex profiles can be implemented quickly and effectively.

Current control
Protects the drive by limiting the motor current to the set peak current. The current is limited to the continuous current by means of integrated I^2t monitoring if required.

Protective features

- Protection against ESD
- Overload protection for electronics and motor
- Self-protection from overheating
- Overvoltage protection in generator mode

Extended operating modes

- Stepper motor mode
- Gearing mode
- Position control to analog set point
- Operation as servo amplifier in voltage adjuster mode
- Torque/force controller using variable set current input

Options

Separate supply of power to the motor and electronic actuator is optional (important for safety-critical applications). Third Input is not available with this option. Depending on the controller, additional programming adapters and connection aids are available. The modes and parameters can be specially pre-configured on request.

Interfaces - Discrete I/O

Setpoint input
Depending on the operating mode, setpoints can be input via the command interface, via an analog voltage value, a PWM signal or a quadrature signal.

Error output (Open Collector)
Configured as error output (factory setting). Also usable as digital input, free switch output, for speed control or signaling an achieved position.

Additional digital inputs
For evaluating reference switches.

Interfaces - Position Sensor

Depending on the model, one of the listed interfaces for the position and speed sensor is supported.

Analog Hall signals
Three analog Hall signals, offset by 120°, in Brushless DC-Motors and Linear DC-Servomotors.

Incremental encoders
In DC-Micromotors and as additional sensors for Brushless DC-Motors.

Absolute encoders
Serial SSI port, matching Brushless DC-Servomotors with AES encoders

Motion Controller

Configuration, Networking, Interfaces

Networking

Integration in higher level control systems
The ASCII commands and CAN telegrams make it possible to integrate the drive into a higher level control system as well as the inclusion of the Motion Controller in field bus-based control environments.

Visual Basic Script can be written and tested directly in the Motion Manager.

Furthermore, any high-level language (Basic, C/C++, Delphi, LabView, ...) can be used to develop applications on the PC which send commands via RS232 or a CAN adapter directly to the drive or read messages sent from there. Commands can also be used within a PLC program for data exchange with the drive unit.

Interfaces - Bus Connection

Version with RS232 interface
For coupling to a PC with a transfer rate of up to 115 kbaud. Multiple drives can be connected to a single controller using the RS232 interface. As regards the control computer, no special arrangements are necessary. The interface also offers the possibility of retrieving online operational data and values.

A comprehensive ASCII command set is available for programming and operation. This can be preset from the PC using the „FAULHABER Motion Manager" software or from another control computer.

Additionally, there is the possibility of creating complex processes from these commands and storing them on the drive. Once programmed as a speed or positioning controller via the analog input, as step motor or electronic gear unit, the drive can operate independently of the RS232 interface.

Version with CAN interface
Multiple drives can be connected to and operated by a single higher level controller. For integration in a CAN network, transfer rates up to 1 Mbit/s are available.

In addition to the CANopen standard profiles, the CAN version supports a special FAULHABER mode that allows the drive to be operated as if it were running the RS232 version. With the help of the „FAULHABER Motion Manager" software and the implemented command interpreter, CAN drives can be configured and operated with standard ASCII commands.

In addition, all functions and parameters of the drive unit can be activated very easily using a special FAULHABER PDO channel.

Motion Controllers with FAULHABER CANopen support the standard protocols CiA DS301 / DSP402 / DSP305. Motion Controllers support the CANopen communication profile under DS301 V4.02 in accordance with the CiA specification for slave devices with the following services:

- 1 server SDO
- 3 transmit PDOs, 3 receive PDOs
- Static PDO mapping
- NMT with node guarding
- Emergency object

The following features are also supported from the CiA device profile for Motion Controllers (DSP 402):

- Profile position mode and position control function
- Homing mode
- Profile velocity mode

Transfer rates and node number are set via the network in accordance with the LSS protocol as per DSP305 V1.1; automatic baud rate detection has also been implemented.

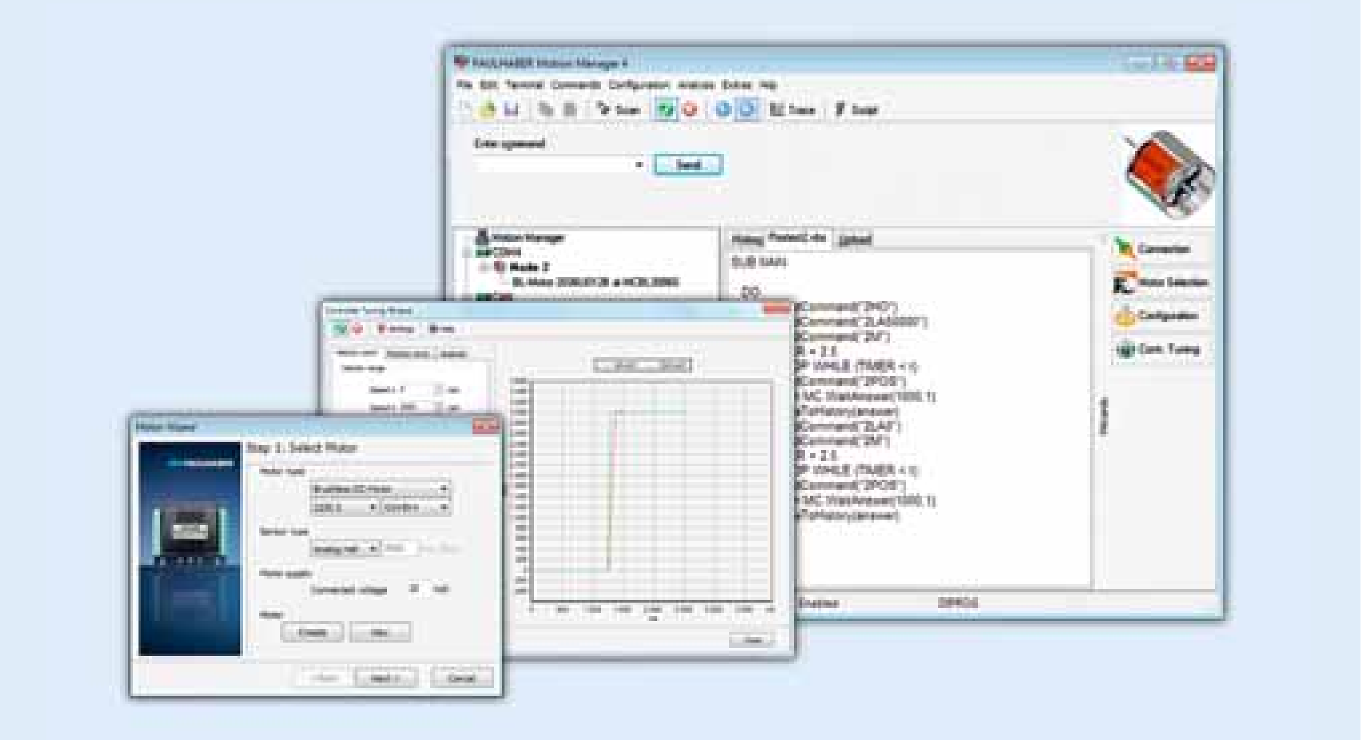
The CAN interface offers a wide range of other features. Details on use and configuration can be found in the corresponding manuals.

Notes

Motion Controllers and Motion Control Systems are accompanied by a device manual for installation and operation. Communication and function manuals as well as the „FAULHABER Motion Manager" software are available on request and on the Internet at www.faulhaber.com.

Motion Controller

Software



Motion Manager

The high-performance “FAULHABER Motion Manager” software enables users to control and configure drive systems with Motion Controllers.

Operation is identical for drives with RS232 or CAN interface. This simplifies the introduction to CAN Technology.

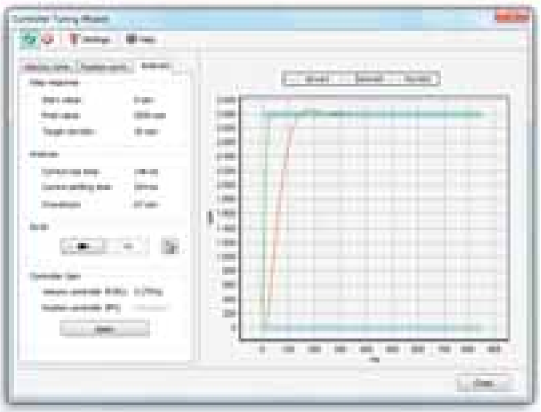
“FAULHABER Motion Manager” for Microsoft Windows can be downloaded free of charge in German or English from www.faulhaber.com.

Startup and Configuration

The software provides convenient access to the settings and parameters of connected motor controls.

The graphical user interface can be used to read out, change and reload configurations. Individual commands or complete parameter sets and program sequences can be entered and transferred to the control.

In addition, analysis options are available in the form of status displays and graphic trace windows.



From version 4.6 and up, operation of the drives is supported by a:

- Connection assistant
- Motor selection assistant
- Tuning assistant

This is complemented by an online help section and the integrated Visual Basic Script language.

NEW

Motion Controller

V2.5, 4-Quadrant PWM
with RS232 or CAN interface

For combination with:
DC-Micromotors

Series MCDC 3002

		MCDC 3002 P	MCDC 3002 F	MCDC 3002 S	
Power supply	U_B	5 ... 30	5 ... 30	5 ... 30	V DC
PWM switching frequency	f_{PWM}	78,12	78,12	78,12	kHz
Efficiency	η	95	95	95	%
Max. continuous output current [1]	I_{dauer}	2	2	2	A
Max. peak output current	I_{max}	3	3	3	A
Total standby current	I_{el}	0,04	0,04	0,04	A
Speed range		5 ... 30 000	5 ... 30 000	5 ... 30 000	rpm
Scanning rate	N	100	100	100	µs
External encoder resolution		≤ 65 535	≤ 65 535	≤ 65 535	inc./rev.
Input/output (partially free configurable)		5	5	5	
Program memory: [2]					
– memory size		3,3	3,3	3,3	kWord
– Number of instructions		ca. 1 000	ca. 1 000	ca. 1 000	instructions
Operating temperature range		– 25 ... + 85	– 25 ... + 85	– 25 ... + 85	°C
Weight		7	13	16	g

[1] at 22°C ambient temperature
[2] Only for version with serial interface

Connection information					
Connection communication:					
Interface			RS232	CAN	
Communication profile			Faulhaber - ASCII	CANopen	
Max. transfer speed rate RS232			115 200		baud
Max. transfer speed rate CAN				1	Mbit/s
Connection 3 “AGND”:					
– analog ground			analog GND		
– digital input	external encoder		channel B		
		R_{In}	10		kΩ
		f	≤ 400		kHz
Connection 4 “Fault”:					
– digital input		R_{In}	100		kΩ
– digital output (open collector)		U	≤ U_B		V
		I	≤ 30		mA
		clear	switched to GND		
		set	high-impedance		
	fault output	no error	switched to GND		
		error	high-impedance		
Connection 5 “AnIn”:			“AGND” as GND		
– analog input	set speed value	U_{In}	± 10		V
– digital input	PWM set speed value	f	100 ... 2 000		Hz
		T	50% ≙ 0 rpm		
	external encoder		channel A		
		f	≤ 400		kHz
	step frequency input	f	≤ 400		kHz
		R_{In}	5		kΩ
Connection 6 “U_B”:		U_B	5 … 30		V DC
Connection 7 “GND”:			ground		
Connection 8 “3. In”:					
– digital input		R_{In}	22		kΩ
– electronic supply voltage		U_{EL}	5 … 30		V DC
Connection 9 “5. In”:					
– digital input		R_{In}	22		kΩ
Connection 10 “4. In”:					
– digital input		R_{In}	22		kΩ

Drive Electronics

Connection information

Connection 11-12 "Ch A", "Ch B":				
Encoder input	CH A		encoder channel A	
	CH B		encoder channel B	
Integrated pullup resistance + 5V		R	2,2	kΩ
		f	≤ 400	kHz
Connection 13 "U_{CC}":				
Output voltage for external use [1]		U_{Out}	5	V
Load current		I_{Out}	≤ 60	mA
Connection 14 "SGND":				
Signal GND			signal ground	
Connection 15-16 "Mot +", "Mot -":				
Motor connection	Mot +		Motor +	
	Mot –		Motor –	
		U_{Out}	0 … U_B	V DC
PWM switching frequency		f_{PWM}	78,12	kHz

[1] E.g. encoder

The signal level (PLC or TTL) of the digital inputs can be set over the interface (see operating instruction manual).
Standard (PLC): Low 0...4,5V / High 12,5V...U_B, TTL: Low 0...0,5V / High 2,5V...U_B

Options

- Separate power supply (Option no.: 3085)

Full product description

- Example:
  MCDC 3002 S RS (RS232)
  MCDC 3002 F CF (CANopen with Faulhaber CAN)
  MCDC 3002 P RS (RS232)

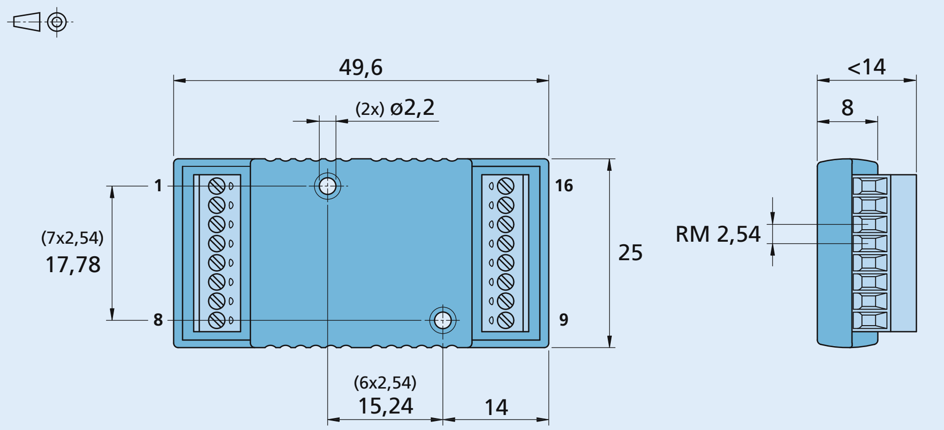
Accessories

		Motor Type	Part No. for MCDC 3002 S
Encoder adapter	**IE2**	DC	**6501.00143**
	PA2-50 / PA2-100	DC	**6501.00144**
	HEM3-256 [1]	DC	**6501.00146**
	HXM3-64	DC	**6501.00145**
			for MCDC 3002 S, F
Programming adapter	**RS232/CAN**	DC	**6501.00121**

[1] Only for $U_{DD\ Enc} = 5V$

Drive Electronics

Dimensional drawing and connection information MCDC 3002 S



MCDC 3002 S

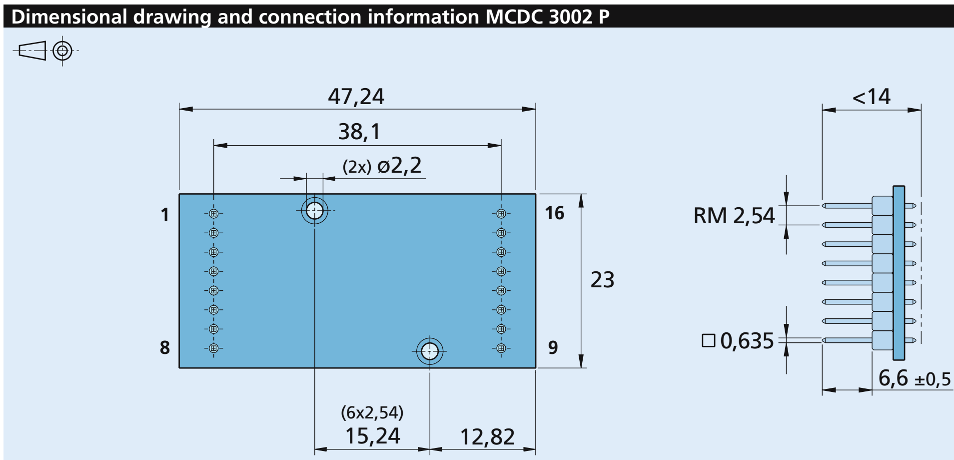
Supply connection

No.	Function
1	TxD / CAN_H
2	RxD / CAN_L
3	AGND
4	Fault
5	AnIn
6	U_B
7	GND
8	3. In

Motor connection

No.	Function
9	4. In
10	Ch A
11	Ch B
12	U_{CC}
13	SGND
14	Mot +
15	Mot –
16	5. In

Dimensional drawing and connection information MCDC 3002 P



MCDC 3002 P

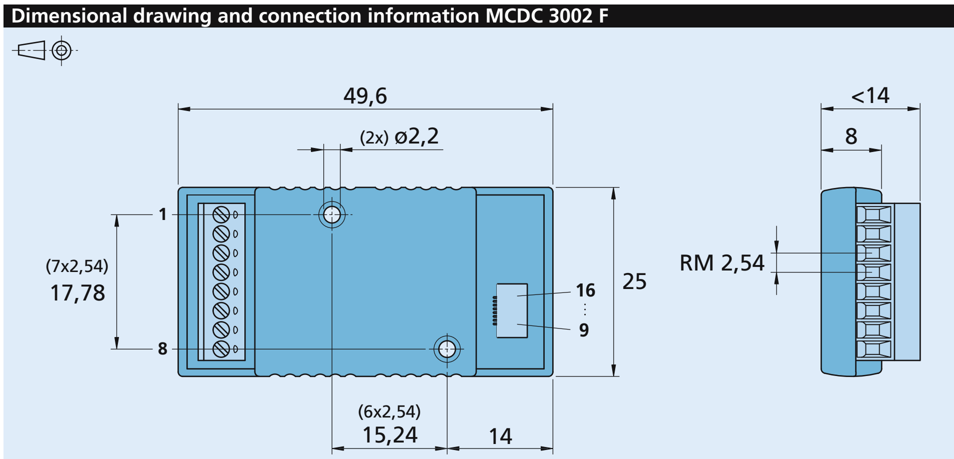
Supply connection

No.	Function
1	TxD / CAN_H
2	RxD / CAN_L
3	AGND
4	Fault
5	AnIn
6	U_B
7	GND
8	3. In

Motor connection

No.	Function
9	4. In
10	Ch A
11	Ch B
12	U_{CC}
13	SGND
14	Mot +
15	Mot –
16	5. In

Dimensional drawing and connection information MCDC 3002 F



MCDC 3002 F

Connector Information
LIF-Connector 8-pole

Supply connection

No.	Function
1	TxD / CAN_H
2	RxD / CAN_L
3	AGND
4	Fault
5	AnIn
6	U_B
7	GND
8	3. In

Motor connection

No.	Function
9	4. In
10	Ch A
11	Ch B
12	U_{CC}
13	SGND
14	Mot +
15	Mot –
16	5. In

Notes

NEW

Motion Controller

V2.5, 4-Quadrant PWM
with RS232 or CAN interface

For combination with:
DC-Micromotors

Series MCDC 3003

		MCDC 3003 P	
Power supply	U_B	12 ... 30	V DC
PWM switching frequency	f_{PWM}	78,12	kHz
Efficiency	η	95	%
Max. continuous output current [1]	I_{dauer}	3	A
Max. peak output current	I_{max}	10	A
Total standby current	I_{el}	0,06	A
Speed range		5 ... 30 000	rpm
Scanning rate	N	100	µs
External encoder resolution		≤ 65 535	inc./rev.
Input/output (partially free configurable)		5	
Program memory: [2]			
– memory size		3,3	kWord
– Number of instructions		ca. 1 000	instructions
Operating temperature range		– 40 ... + 85	°C
Housing material		without housing	
Weight		18	g

[1] at 22°C ambient temperature
[2] Only for version with serial interface

Connection information					
Connection communication:					
Interface			RS232	CAN	
Communication profile			Faulhaber - ASCII	CANopen	
Max. transfer speed rate RS232			115 200		baud
Max. transfer speed rate CAN				1	Mbit/s
Connection 3 “AGND”:					
– analog ground			analog GND		
– digital input	external encoder		channel B		
		R_{In}	10		kΩ
		f	≤ 400		kHz
Connection 4 “Fault”:					
– digital input		R_{In}	100		kΩ
– digital output (open collector)		U	≤ U_B		V
		I	≤ 30		mA
		clear	switched to GND		
		set	high-impedance		
	fault output	no error	switched to GND		
		error	high-impedance		
Connection 5 “AnIn”:			“AGND” as GND		
– analog input	set speed value	U_{In}	± 10		V
– digital input	PWM set speed value	f	100 ... 2 000		Hz
		T	50% ≙ 0 rpm		
	external encoder		channel A		
		f	≤ 400		kHz
	step frequency input	f	≤ 400		kHz
		R_{In}	5		kΩ
Connection 6 “U_B”:		U_B	12 … 30		V DC
Connection 7 “GND”:			ground		
Connection 8 “3. In”:					
– digital input		R_{In}	22		kΩ
– electronic supply voltage		U_{EL}	12 … 30		V DC
Connection 9 “5. In”:					
– digital input		R_{In}	22		kΩ
Connection 10 “4. In”:					
– digital input		R_{In}	22		kΩ

Connection information

Connection 11-12 "Ch A", "Ch B":			
Encoder input CH A		encoder channel A	
CH B		encoder channel B	
Integrated pullup resistance + 5V	R	2,2	kΩ
	f	≤ 400	kHz
Connection 13 "U_{CC}":			
Output voltage for external use [1]	U_{Out}	5	V
Load current	I_{Out}	≤ 60	mA
Connection 14 "SGND":			
Signal GND		signal ground	
Connection 15-16 "Mot +", "Mot -":			
Motor connection Mot +		Motor +	
Mot –		Motor –	
	U_{Out}	0 … U_B	V DC
PWM switching frequency	f_{PWM}	78,12	kHz

[1] E.g. encoder

The signal level (PLC or TTL) of the digital inputs can be set over the interface (see operating instruction manual).
Standard (PLC): Low 0...7V / High 12,5V...U_B, TTL: Low 0...0,5V / High 3,5V...U_B

Options

- Separate power supply (Option no.: 3085)

Full product description

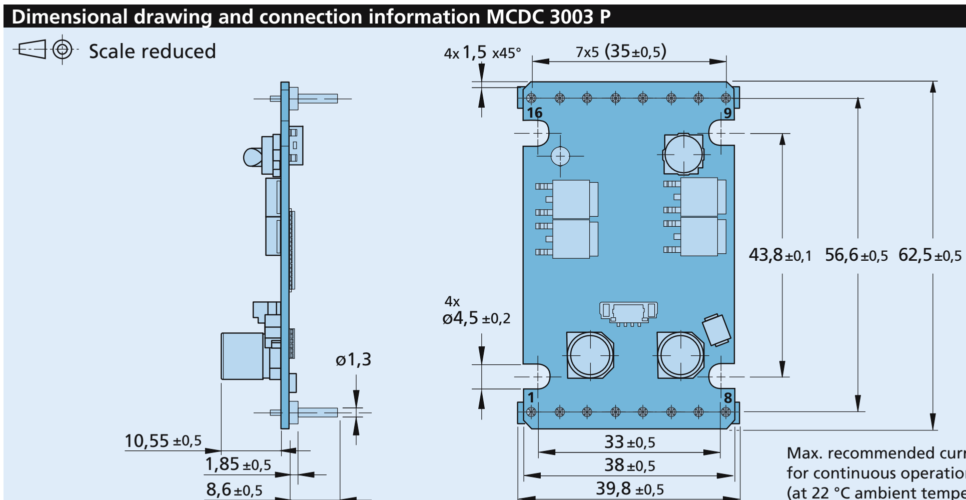
- Example:

  MCDC 3003 P RS (RS232)

  MCDC 3003 P CF (CANopen with Faulhaber CAN)

Dimensional drawing and connection information MCDC 3003 P

Scale reduced



Max. recommended current for continuous operation: 3A (at 22 °C ambient temperature)
CAUTION: Thermal shutdown is NOT guaranteed!

Connection

Pin	Function
1	TxD / CAN_H
2	RxD / CAN_L
3	AGND
4	Fault
5	AnIn
6	U_B
7	GND
8	3. In
9	5. In
10	4. In
11	Ch A
12	Ch B
13	U_{CC}
14	SGND
15	Mot +
16	Mot –

NEW

Motion Controller

V2.5, 4-Quadrant PWM
with RS232 or CAN interface

For combination with:
DC-Micromotors

Series MCDC 3006

		MCDC 3006 S	
Power supply	U_B	12 ... 30	V DC
PWM switching frequency	f_{PWM}	78,12	kHz
Efficiency	η	95	%
Max. continuous output current [1]	I_{dauer}	6	A
Max. peak output current	I_{max}	10	A
Total standby current	I_{el}	0,06	A
Speed range		5 ... 30 000	rpm
Scanning rate	N	100	µs
External encoder resolution		≤ 65 535	inc./rev.
Input/output (partially free configurable)		5	
Program memory: [2]			
– memory size		3,3	kWord
– Number of instructions		ca. 1 000	instructions
Operating temperature range		– 40 ... + 85	°C
Housing material		zinc, black coated	
Weight		160	g

[1] at 22°C ambient temperature
[2] Only for version with serial interface

Connection information					
Connection communication:					
Interface			RS232	CAN	
Communication profile			Faulhaber - ASCII	CANopen	
Max. transfer speed rate RS232			115 200		baud
Max. transfer speed rate CAN				1	Mbit/s
Connection 3 "AGND":					
– analog ground			analog GND		
– digital input	external encoder		channel B		
		R_{In}	10		kΩ
		f	≤ 400		kHz
Connection 4 "Fault":					
– digital input		R_{In}	100		kΩ
– digital output (open collector)		U	≤ U_B		V
		I	≤ 30		mA
		clear	switched to GND		
		set	high-impedance		
	fault output	no error	switched to GND		
		error	high-impedance		
Connection 5 "AnIn":			"AGND" as GND		
– analog input	set speed value	U_{In}	± 10		V
– digital input	PWM set speed value	f	100 ... 2 000		Hz
		T	50% ≙ 0 rpm		
	external encoder		channel A		
		f	≤ 400		kHz
	step frequency input	f	≤ 400		kHz
		R_{In}	5		kΩ
Connection 6 "U_B":		U_B	12 … 30		V DC
Connection 7 "GND":			ground		
Connection 8 "3. In":					
– digital input		R_{In}	22		kΩ
– electronic supply voltage		U_{EL}	12 … 30		V DC
Connection 9 "5. In":					
– digital input		R_{In}	22		kΩ
Connection 10 "4. In":					
– digital input		R_{In}	22		kΩ

Drive Electronics

Connection information				
Connection 11-12 “Ch A”, “Ch B”:				
Encoder input	CH A		encoder channel A	
	CH B		encoder channel B	
Integrated pullup resistance + 5V		R	2,2	kΩ
		f	≤ 400	kHz
Connection 13 “U_{CC}”:				
Output voltage for external use [1]		U_{Out}	5	V
Load current		I_{Out}	≤ 60	mA
Connection 14 “SGND”:				
Signal GND			signal ground	
Connection 15-16 “Mot +”, “Mot -”:				
Motor connection	Mot +		Motor +	
	Mot –		Motor –	
		U_{Out}	0 … U_B	V DC
PWM switching frequency		f_{PWM}	78,12	kHz

[1] E.g. encoder
The signal level (PLC or TTL) of the digital inputs can be set over the interface (see operating instruction manual).
Standard (PLC): Low 0...7V / High 12,5V...U_B, TTL: Low 0...0,5V / High 3,5V...U_B

D-SUB-connector information		
Connection D-SUB-connector:	**RS232**	**CAN**
Pin 2	RxD	CAN-L
Pin 3	TxD	GND
Pin 5	GND	-
Pin 7	-	CAN-H

Options

- Separate power supply (Option no.: 3085)

Accessories

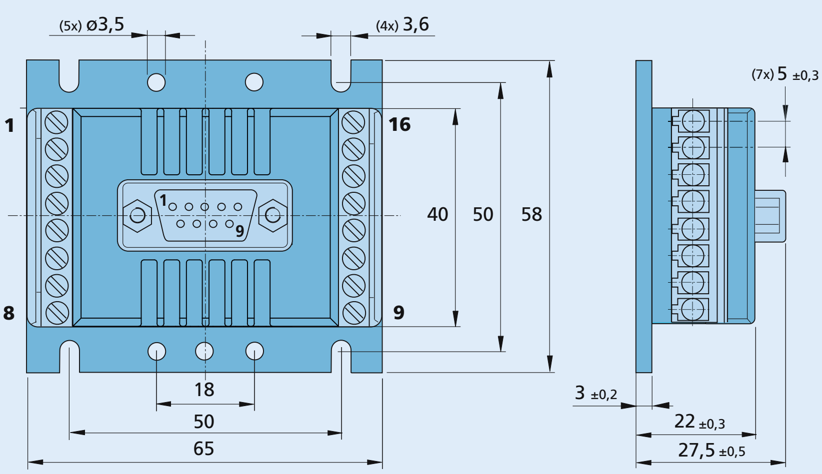
- 6501.00128: USB-CAN-Adapter
(only for version with CAN interface)
- 6501.00131: USB-RS232 Adapter
(only for version with serial interface)
- 6501.00063: Adapter for motors with IE2 Encoder
- 6501.00064: Adapter for motors with HEDL Encoder

Full product description

- Example:
MCDC 3006 S RS (RS232)
MCDC 3006 S CF (CANopen with Faulhaber CAN)

Dimensional drawing and connection information MCDC 3006 S

Scale reduced



Supply connection

No.	Function
1	TxD / CAN_H
2	RxD / CAN_L
3	AGND
4	Fault
5	AnIn
6	U_B
7	GND
8	3. In

Motor connection

No.	Function
9	5. In
10	4. In
11	Ch A
12	Ch B
13	U_{CC}
14	SGND
15	Mot +
16	Mot –

NEW

Motion Controller

V2.5, 4-Quadrant PWM
with RS232 or CAN interface

For combination with:
Brushless DC-Servomotors
with analog Hall sensors

Series MCBL 3002

		MCBL 3002 P	MCBL 3002 F	MCBL 3002 S	
Power supply	U_B	5 ... 30	5 ... 30	5 ... 30	V DC
PWM switching frequency	f_{PWM}	78,12	78,12	78,12	kHz
Efficiency	η	95	95	95	%
Max. continuous output current [1]	I_{dauer}	2	2	2	A
Max. peak output current	I_{max}	3	3	3	A
Total standby current	I_{el}	0,04	0,04	0,04	A
Speed range		5 ... 30 000	5 ... 30 000	5 ... 30 000	rpm
Scanning rate	N	200	200	200	µs
Encoder resolution with linear Hall Sensors		3 000	3 000	3 000	inc./rev.
Resolution with external encoder		≤ 65 535	≤ 65 535	≤ 65 535	inc./rev.
Input/output (partially free configurable)		3	3	3	
Program memory: [2]					
– memory size		3,3	3,3	3,3	kWord
– Number of instructions		ca. 1 000	ca. 1 000	ca. 1 000	instructions
Operating temperature range		– 25 ... + 85	– 25 ... + 85	– 25 ... + 85	°C
Weight		7	13	16	g

[1] at 22°C ambient temperature
[2] Only for version with serial interface

Connection information					
Connection communication:					
Interface			RS232	CAN	
Communication profile			Faulhaber - ASCII	CANopen	
Max. transfer speed rate RS232			115 200		baud
Max. transfer speed rate CAN				1	Mbit/s
Connection 3 “AGND”:					
– analog ground			analog GND		
– digital input	external encoder		channel B		
		R_{In}	10		kΩ
		f	≤ 400		kHz
Connection 4 “Fault”:					
– digital input		R_{In}	100		kΩ
– digital output (open collector)		U	≤ U_B		V
		I	≤ 30		mA
		clear	switched to GND		
		set	high-impedance		
	fault output	no error	switched to GND		
		error	high-impedance		
	signal output	f	≤ 2		kHz
		resolution	1...255		inc./rev.
Connection 5 “AnIn”:			“AGND” as GND		
– analog input	set speed value	U_{In}	± 10		V
– digital input	PWM set speed value	f	100 ... 2 000		Hz
		T	50% ≙ 0 rpm		
	external encoder		channel A		
		f	≤ 400		kHz
	step frequency input	f	≤ 400		kHz
		R_{In}	5		kΩ
Connection 6 “U_B”:		U_B	5 … 30		V DC
Connection 7 “GND”:			ground		
Connection 8 “3. In”:					
– digital input		R_{In}	22		kΩ
– electronic supply voltage		U_{EL}	5 … 30		V DC

Drive Electronics

Connection information				
Connection 9-11 „Sensor A, B, C“:				
Hall sensor input	Sensor A		Hall Sensor A	
	Sensor B		Hall Sensor B	
	Sensor C		Hall Sensor C	
		U_{In}	≤ 5	V
Connection 12 “U_{CC}”:				
Output voltage for external use [1]		U_{Out}	5	V
Load current		I_{Out}	≤ 60	mA
Connection 13 “SGND”:				
Signal GND			Signal masse	
Connection 14-16 „Motor A, B, C“:				
Motor connection	Motor A		Phase A	
	Motor B		Phase B	
	Motor C		Phase C	
		U_{Out}	0 … U_B	V DC
PWM switching frequency		f_{PWM}	78,12	kHz

[1] E.g. Hall sensor

The signal level (PLC or TTL) of the digital inputs can be set over the interface (see operating instruction manual).
Standard (PLC): Low 0...4,5V / High 12,5V...U_B, TTL: Low 0...0,5V / High 2,5V...U_B

Options

- Separate power supply (Option no.: 3085)

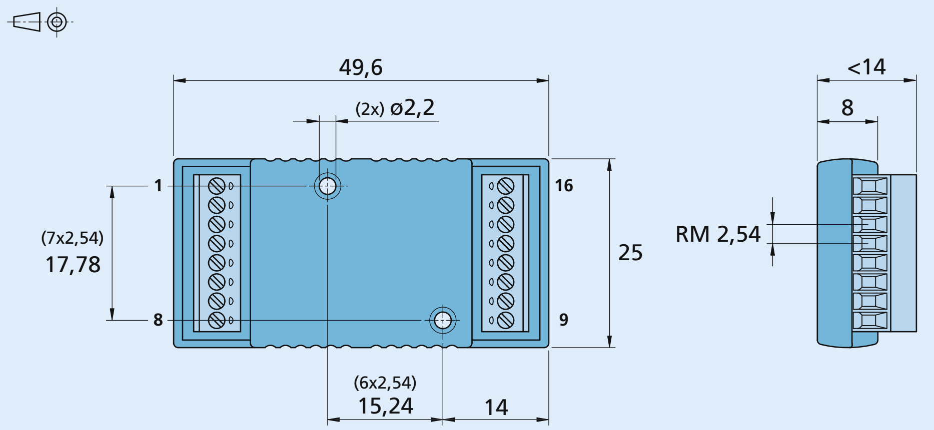
Full product description

- Example:
  MCBL 3002 S RS (RS232)
  MCBL 3002 F CF (CANopen with Faulhaber CAN)
  MCBL 3002 P RS (RS232)

Accessories		Motor Type	Part No.
			for MCBL 3002 S
Motor connector adapter	**0620 ... B**	BL	**6501.00083**
			for MCBL 3002 S, F
Programming adapter	**RS232/CAN**	BL	**6501.00121**

Drive Electronics

Dimensional drawing and connection information MCBL 3002 S



MCBL 3002 S

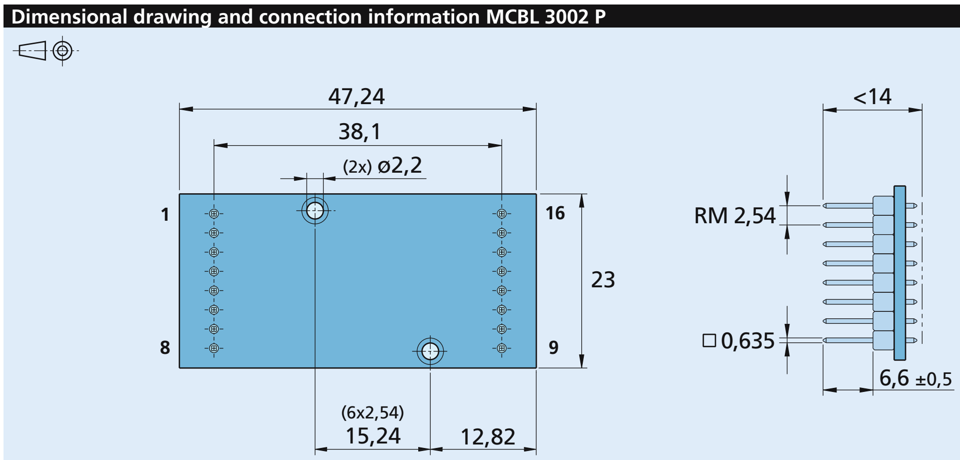
Supply connection

No.	Function
1	TxD / CAN_H
2	RxD / CAN_L
3	AGND
4	Fault
5	AnIn
6	U_B
7	GND
8	3. In

Motor connection

No.	Function
9	Sensor A
10	Sensor B
11	Sensor C
12	U_{CC}
13	SGND
14	Motor A
15	Motor B
16	Motor C

Dimensional drawing and connection information MCBL 3002 P



MCBL 3002 P

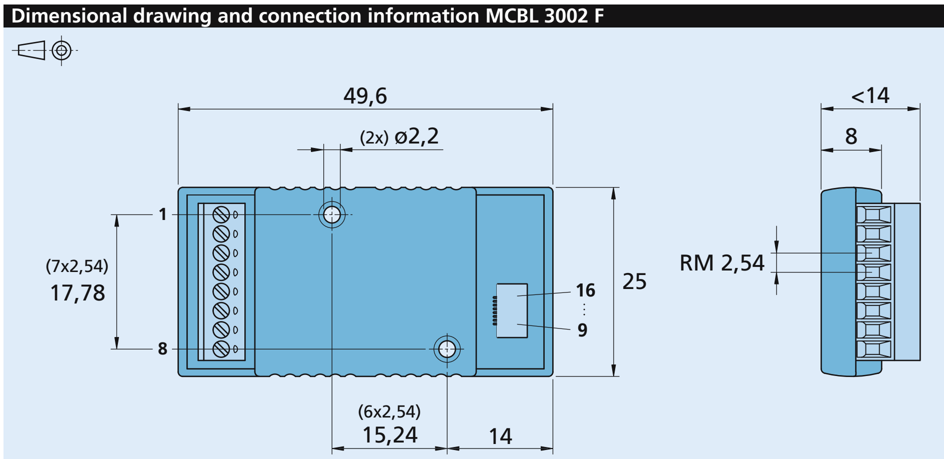
Supply connection

No.	Function
1	TxD / CAN_H
2	RxD / CAN_L
3	AGND
4	Fault
5	AnIn
6	U_B
7	GND
8	3. In

Motor connection

No.	Function
9	Sensor A
10	Sensor B
11	Sensor C
12	U_{CC}
13	SGND
14	Motor A
15	Motor B
16	Motor C

Dimensional drawing and connection information MCBL 3002 F



MCBL 3002 F

Connector Information
LIF-Connector 8-pole

Supply connection

No.	Function
1	TxD / CAN_H
2	RxD / CAN_L
3	AGND
4	Fault
5	AnIn
6	U_B
7	GND
8	3. In

Motor connection

No.	Function
9	Sensor A
10	Sensor B
11	Sensor C
12	U_{CC}
13	SGND
14	Motor A
15	Motor B
16	Motor C

Notes

FAULHABER

NEW

Motion Controller

V2.5, 4-Quadrant PWM
with RS232 or CAN interface

For combination with:
Brushless DC-Servomotors
with analog Hall sensors

Series MCBL 3003

		MCBL 3003 P	
Power supply	U_B	12 ... 30	V DC
PWM switching frequency	f_{PWM}	78,12	kHz
Efficiency	η	95	%
Max. continuous output current [1]	I_{dauer}	3	A
Max. peak output current	I_{max}	10	A
Total standby current	I_{el}	0,06	A
Speed range		5 ... 30 000	rpm
Scanning rate	N	200	µs
Encoder resolution with linear Hall Sensors		≤ 3 000	inc./rev.
Resolution with external encoder		≤ 65 535	inc./rev.
Input/output (partially free configurable)		3	
Program memory: [2]			
– memory size		3,3	kWord
– Number of instructions		ca. 1 000	instructions
Operating temperature range		– 40 ... + 85	°C
Housing material		without housing	
Weight		18	g

[1] at 22°C ambient temperature
[2] Only for version with serial interface

Connection information					
Connection communication:					
Interface			RS232	CAN	
Communication profile			Faulhaber - ASCII	CANopen	
Max. transfer speed rate RS232			115 200		baud
Max. transfer speed rate CAN				1	Mbit/s
Connection 3 “AGND”:					
– analog ground			analog GND		
– digital input	external encoder		channel B		
		R_{In}	10		kΩ
		f	≤ 400		kHz
Connection 4 “Fault”:					
– digital input		R_{In}	100		kΩ
– digital output (open collector)		U	≤ U_B		V
		I	≤ 30		mA
		clear	switched to GND		
		set	high-impedance		
	fault output	no error	switched to GND		
		error	high-impedance		
	signal output	f	≤ 2		kHz
		resolution	1...255		inc./rev.
Connection 5 “AnIn”:			“AGND” as GND		
– analog input	set speed value	U_{In}	± 10		V
– digital input	PWM set speed value	f	100 ... 2 000		Hz
		T	50% ≙ 0 rpm		
	external encoder		channel A		
		f	≤ 400		kHz
	step frequency input	f	≤ 400		kHz
		R_{In}	5		kΩ
Connection 6 “U_B”:		U_B	12 … 30		V DC
Connection 7 “GND”:			ground		
Connection 8 “3. In”:					
– digital input		R_{In}	22		kΩ
– electronic supply voltage		U_{EL}	12 … 30		V DC

Drive Electronics

Connection information

Connection 9-11 „Sensor A, B, C“:				
Hall sensor input	Sensor A		Hall sensor A	
	Sensor B		Hall sensor B	
	Sensor C		Hall sensor C	
		U_{In}	≤ 5	V
Connection 12 “U_{CC}”:				
Output voltage for external use [1]		U_{Out}	5	V DC
Load current		I_{Out}	≤ 60	mA
Connection 13 “SGND”:				
Signal GND			Signal ground	
Connection 14-16 „Motor A, B, C“:				
Motor connection	Motor A		Phase A	
	Motor B		Phase B	
	Motor C		Phase C	
		U_{Out}	0 … U_B	V
PWM switching frequency		f_{PWM}	78,12	kHz

[1] E.g. Hall sensor

The signal level (PLC or TTL) of the digital inputs can be set over the interface (see operating instruction manual).
Standard (PLC): Low 0...7V / High 12,5V...U_B, TTL: Low 0...0,5V / High 3,5V...U_B

Options

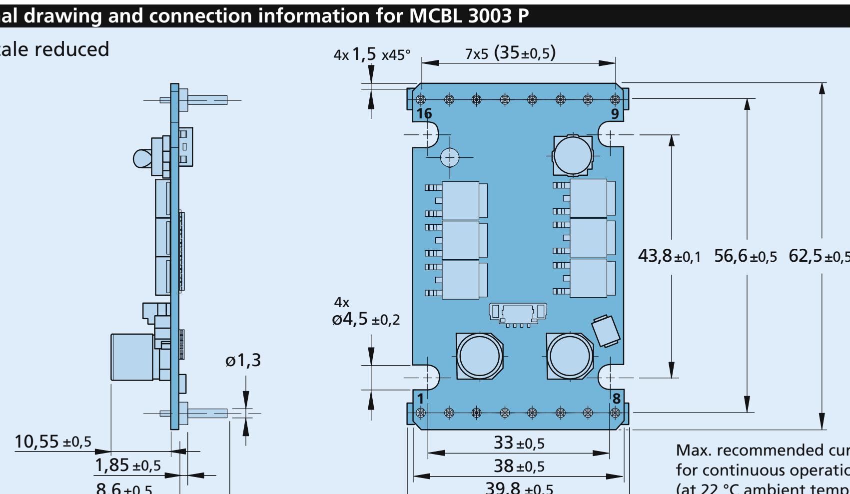
- Separate power supply (Option no.: 3085)

Full product description

- Example:
  MCBL 3003 P RS (RS232)
  MCBL 3003 P CF (CANopen with Faulhaber CAN)

Dimensional drawing and connection information for MCBL 3003 P

Scale reduced



Max. recommended current
for continuous operation: 3A
(at 22 °C ambient temperature)
CAUTION: Thermal shutdown is
NOT guaranteed!

Connection

Pin	Function
1	TxD / CAN_H
2	RxD / CAN_L
3	AGND
4	Fault
5	AnIn
6	U_B
7	GND
8	3. In
9	Sensor A
10	Sensor B
11	Sensor C
12	U_{CC}
13	SGND
14	Motor A
15	Motor B
16	Motor C

NEW

Motion Controller

V2.5, 4-Quadrant PWM with RS232 or CAN interface

For combination with:
Brushless DC-Servomotors
with analog Hall sensors

Series MCBL 3006

		MCBL 3006 S	
Power supply	U_B	12 ... 30	V DC
PWM switching frequency	f_{PWM}	78,12	kHz
Efficiency	η	95	%
Max. continuous output current [1]	I_{dauer}	6	A
Max. peak output current	I_{max}	10	A
Total standby current	I_{el}	0,06	A
Speed range		5 ... 30 000	rpm
Scanning rate	N	200	µs
Encoder resolution with linear Hall Sensors		≤ 3 000	inc./rev.
Resolution with external encoder		≤ 65 535	inc./rev.
Input/output (partially free configurable)		3	
Program memory: [2]			
– memory size		3,3	kWord
– Number of instructions		ca. 1 000	instructions
Operating temperature range		– 40 ... + 85	°C
Housing material		zinc, black coated	
Weight		160	g

[1] at 22°C ambient temperature
[2] Only for version with serial interface

Connection information					
Connection communication:					
Interface			RS232	CAN	
Communication profile			Faulhaber - ASCII	CANopen	
Max. transfer speed rate RS232			115 200		baud
Max. transfer speed rate CAN				1	Mbit/s
Connection 3 "AGND":					
– analog ground			analog GND		
– digital input	external encoder		channel B		
		R_{In}	10		kΩ
		f	≤ 400		kHz
Connection 4 "Fault":					
– digital input		R_{In}	100		kΩ
– digital output (open collector)		U	≤ U_B		V
		I	≤ 30		mA
		clear	switched to GND		
		set	high-impedance		
	fault output	no error	switched to GND		
		error	high-impedance		
	signal output	f	≤ 2		kHz
		resolution	1...255		inc./rev.
Connection 5 "AnIn":			"AGND" as GND		
– analog input	set speed value	U_{In}	± 10		V
– digital input	PWM set speed value	f	100 ... 2 000		Hz
		T	50% ≙ 0 rpm		
	external encoder		channel A		
		f	≤ 400		kHz
	step frequency input	f	≤ 400		kHz
		R_{In}	5		kΩ
Connection 6 "U_B":		U_B	12 … 30		V DC
Connection 7 "GND":			ground		
Connection 8 "3. In":					
– digital input		R_{In}	22		kΩ
– electronic supply voltage		U_{EL}	12 … 30		V DC

Connection information

Connection 9-11 „Sensor A, B, C":				
Hall sensor input	Sensor A		Hall Sensor A	
	Sensor B		Hall Sensor B	
	Sensor C		Hall Sensor C	
		U_{In}	≤ 5	V
Connection 12 "U_{CC}":				
Output voltage for external use [1]		U_{Out}	5	V
Load current		I_{Out}	≤ 60	mA
Connection 13 "SGND":				
Signal GND			Signal masse	
Connection 14-16 „Motor A, B, C":				
Motor connection	Motor A		Phase A	
	Motor B		Phase B	
	Motor C		Phase C	
		U_{Out}	0 … U_B	V DC
PWM switching frequency		f_{PWM}	78,12	kHz

[1] E.g. Hall sensor
The signal level (PLC or TTL) of the digital inputs can be set over the interface (see operating instruction manual).
Standard (PLC): Low 0...7V / High 12,5V...U_B, TTL: Low 0...0,5V / High 3,5V...U_B

D-SUB-connector information

Connection D-SUB-connector:	RS232	CAN
Pin 2	RxD	CAN-L
Pin 3	TxD	GND
Pin 5	GND	-
Pin 7	-	CAN-H

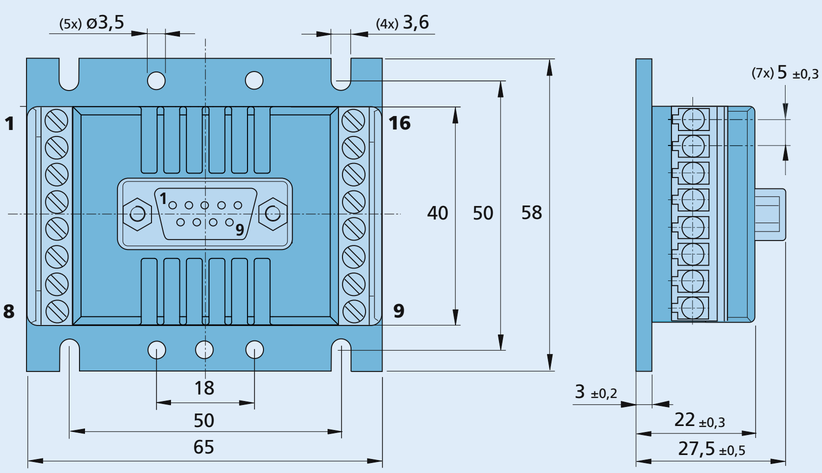
Options
- Separate power supply (Option no.: 3085)

Accessories
- 6501.00128: USB-CAN-Adapter (only for version with CAN interface)
- 6501.00131: USB-RS232 Adapter (only for version with serial interface)
- 6501.00086: Adapter for BX4 Motors with connector

Full product description
- Example:
  MCBL 3006 S RS (RS232)
  MCBL 3006 S CF (CANopen with Faulhaber CAN)

Dimensional drawing and connection information MCBL 3006 S

Scale reduced



Supply connection

No.	Function
1	TxD / CAN_H
2	RxD / CAN_L
3	AGND
4	Fault
5	AnIn
6	U_B
7	GND
8	3. In

Motor connection

No.	Function
9	Sensor A
10	Sensor B
11	Sensor C
12	U_{CC}
13	SGND
14	Motor A
15	Motor B
16	Motor C

Drive Electronics

NEW

Motion Controller

V2.5, 4-Quadrant PWM
with RS232 or CAN interface

For combination with:
Brushless DC-Servomotors
with absolute encoder

Series MCBL 3002 AES

		MCBL 3002 P AES	MCBL 3002 F AES	MCBL 3002 S AES	
Power supply	U_B	5 ... 30	5 ... 30	5 ... 30	V DC
PWM switching frequency	f_{PWM}	78,12	78,12	78,12	kHz
Efficiency	η	95	95	95	%
Max. continuous output current [1]	I_{dauer}	2	2	2	A
Max. peak output current	I_{max}	3	3	3	A
Total standby current	I_{el}	0,04	0,04	0,04	A
Speed range		5 ... 30 000	5 ... 30 000	5 ... 30 000	rpm
Scanning rate	N	100	100	100	µs
Encoder resolution with AES encoder		≤ 4 096	≤ 4 096	≤ 4 096	inc./rev.
Resolution with external encoder		≤ 65 535	≤ 65 535	≤ 65 535	inc./rev.
Input/output (partially free configurable)		3	3	3	
Program memory: [2]					
– memory size		3,3	3,3	3,3	kWord
– Number of instructions		ca. 1 000	ca. 1 000	ca. 1 000	instructions
Operating temperature range		– 25 ... + 85	– 25 ... + 85	– 25 ... + 85	°C
Weight		7	13	16	g

[1] at 22°C ambient temperature
[2] Only for version with serial interface

Connection information					
Connection communication:					
Interface			RS232	CAN	
Communication profile			Faulhaber - ASCII	CANopen	
Max. transfer speed rate RS232			115 200		baud
Max. transfer speed rate CAN				1	Mbit/s
Connection 3 "AGND":					
– analog ground			analog GND		
– digital input	external encoder		channel B		
		R_{In}	10		kΩ
		f	≤ 400		kHz
Connection 4 "Fault":					
– digital input		R_{In}	100		kΩ
– digital output (open collector)		U	≤ U_B		V
		I	≤ 30		mA
		clear	switched to GND		
		set	high-impedance		
	fault output	no error	switched to GND		
		error	high-impedance		
	signal output	f	≤ 2		kHz
		resolution	1...32		inc./rev.
Connection 5 "AnIn":			"AGND" as GND		
– analog input	set speed value	U_{In}	± 10		V
– digital input	PWM set speed value	f	100 ... 2 000		Hz
		T	50% ≙ 0 rpm		
	external encoder		channel A		
		f	≤ 400		kHz
	step frequency input	f	≤ 400		kHz
		R_{In}	5		kΩ
Connection 6 "U_B":		U_B	5 … 30		V DC
Connection 7 "GND":			ground		
Connection 8 "3. In":					
– digital input		R_{In}	22		kΩ
– electronic supply voltage		U_{EL}	5 … 30		V DC

Drive Electronics

Connection information			
Connection 9-11 „DATA, CS, CLK ":			
DATA	U_{In}	≤ 5	V
$\overline{CS}$	U_{Out}	0 ... 5	V
CLK	U_{Out}	0 ... 5	
Connection 12 "U_{CC}":			
Output voltage for external use [1]	U_{Out}	5	V
Load current	I_{Out}	≤ 60	mA
Connection 13 "SGND":			
Signal GND		Signal ground	
Connection 14-16 „Motor A, B, C":			
Motor connection Motor A		Phase A	
Motor B		Phase B	
Motor C		Phase C	
	U_{Out}	0 … U_B	V DC
PWM switching frequency	f_{PWM}	78,12	kHz

[1] E.g. encoder

The signal level (PLC or TTL) of the digital inputs can be set over the interface (see operating instruction manual).
Standard (PLC): Low 0...4,5V / High 12,5V...U_B, TTL: Low 0...0,5V / High 2,5V...U_B

Options

- Separate power supply (Option no.: 3085)

Full product description

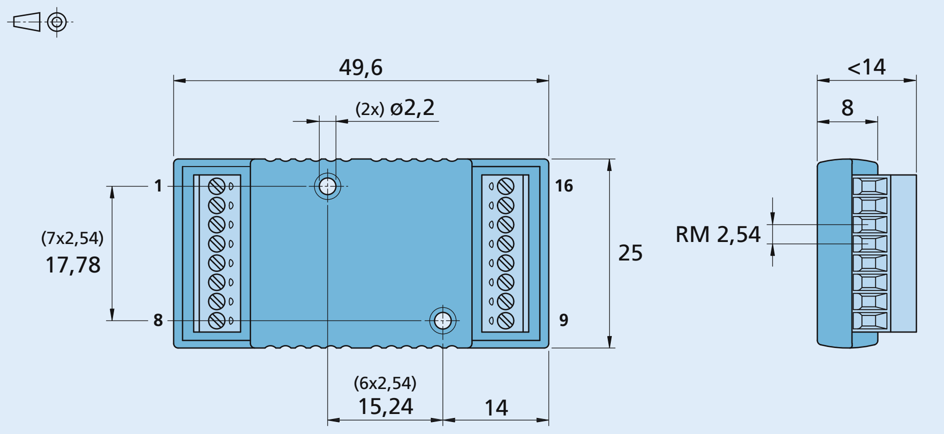
- Example:
  MCBL 3002 S AES RS (RS232)
  MCBL 3002 F AES CF (CANopen with Faulhaber CAN)
  MCBL 3002 P AES RS (RS232)

Accessories

		Motor Type	Part No. for MCBL 3002 S AES, F AES
Programming adapter	**RS232/CAN**	BL	**6501.00121**

Drive Electronics

Dimensional drawing and connection information MCBL 3002 S AES



MCBL 3002 S AES

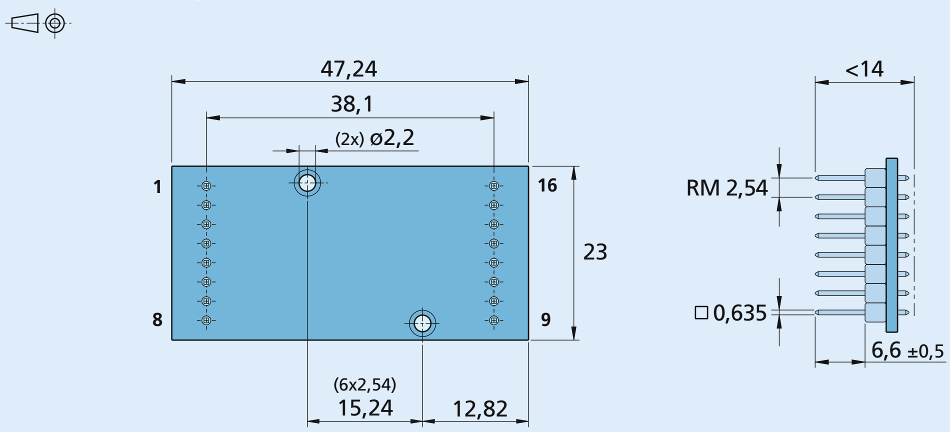
Supply connection

No.	Function
1	TxD / CAN_H
2	RxD / CAN_L
3	AGND
4	Fault
5	AnIn
6	U_B
7	GND
8	3. In

Motor connection

No.	Function
9	Sensor A / DATA
10	Sensor B / $\overline{CS}$
11	Sensor C / CLK
12	U_{CC}
13	SGND
14	Motor A
15	Motor B
16	Motor C

Dimensional drawing and connection information MCBL 3002 P AES



MCBL 3002 P AES

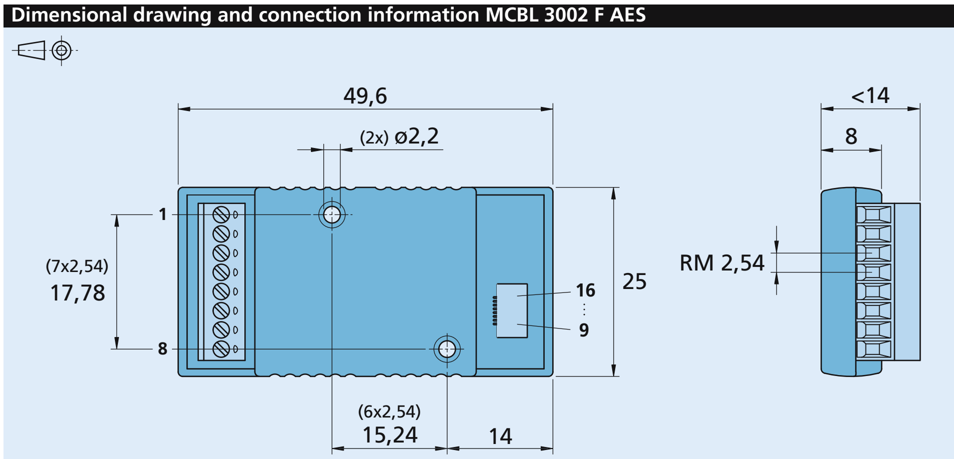
Supply connection

No.	Function
1	TxD / CAN_H
2	RxD / CAN_L
3	AGND
4	Fault
5	AnIn
6	U_B
7	GND
8	3. In

Motor connection

No.	Function
9	Sensor A / DATA
10	Sensor B / $\overline{CS}$
11	Sensor C / CLK
12	U_{CC}
13	SGND
14	Motor A
15	Motor B
16	Motor C

Dimensional drawing and connection information MCBL 3002 F AES



MCBL 3002 F AES

Connector Information
LIF-Connector 8-pole

Supply connection

No.	Function
1	TxD / CAN_H
2	RxD / CAN_L
3	AGND
4	Fault
5	AnIn
6	U_B
7	GND
8	3. In

Motor connection

No.	Function
9	Sensor A / DATA
10	Sensor B / $\overline{CS}$
11	Sensor C / CLK
12	U_{CC}
13	SGND
14	Motor A
15	Motor B
16	Motor C

Notes

NEW

FAULHABER

Motion Controller

V2.5, 4-Quadrant PWM
with RS232 or CAN interface

For combination with:
Brushless DC-Servomotors
with absolute encoder

Series MCBL 3003 AES

		MCBL 3003 P AES	
Power supply	U_B	12 ... 30	V DC
PWM switching frequency	f_{PWM}	78,12	kHz
Efficiency	η	95	%
Max. continuous output current [1]	I_{dauer}	3	A
Max. peak output current	I_{max}	10	A
Total standby current	I_{el}	0,06	A
Speed range		5 ... 30 000	rpm
Scanning rate	N	100	µs
Encoder resolution with AES encoder		≤ 4 096	inc./rev.
Resolution with external encoder		≤ 65 535	inc./rev.
Input/output (partially free configurable)		3	
Program memory: [2]			
– memory size		3,3	kWord
– Number of instructions		ca. 1 000	instructions
Operating temperature range		– 40 ... + 85	°C
Housing material		without housing	
Weight		18	g

[1] at 22°C ambient temperature
[2] Only for version with serial interface

Connection information					
Connection communication:					
Interface			RS232	CAN	
Communication profile			Faulhaber - ASCII	CANopen	
Max. transfer speed rate RS232			115 200		baud
Max. transfer speed rate CAN				1	Mbit/s
Connection 3 "AGND":					
– analog ground			analog GND		
– digital input	external encoder		channel B		
		R_{In}	10		kΩ
		f	≤ 400		kHz
Connection 4 "Fault":					
– digital input		R_{In}	100		kΩ
– digital output (open collector)		U	≤ U_B		V
		I	≤ 30		mA
		clear	switched to GND		
		set	high-impedance		
	fault output	no error	switched to GND		
		error	high-impedance		
	signal output	f	≤ 2		kHz
		resolution	1...32		inc./rev.
Connection 5 "AnIn":			"AGND" as GND		
– analog input	set speed value	U_{In}	± 10		V
– digital input	PWM set speed value	f	100 ... 2 000		Hz
		T	50% ≙ 0 rpm		
	external encoder		channel A		
		f	≤ 400		kHz
	step frequency input	f	≤ 400		kHz
		R_{In}	5		kΩ
Connection 6 "U_B":		U_B	12 … 30		V DC
Connection 7 "GND":			ground		
Connection 8 "3. In":					
– digital input		R_{In}	22		kΩ
– electronic supply voltage		U_{EL}	12 … 30		V DC

Connection information

Connection 9-11 „DATA, $\overline{CS}$, CLK ":				
	DATA	U_{In}	≤ 5	V
	$\overline{CS}$	U_{Out}	0 ... 5	V
	CLK	U_{Out}	0 ... 5	
Connection 12 "U_{CC}":				
Output voltage for external use [1)]		U_{Out}	5	V DC
Load current		I_{Out}	≤ 60	mA
Connection 13 "SGND":				
Signal GND			Signal ground	
Connection 14-16 „Motor A, B, C":				
Motor connection	Motor A		Phase A	
	Motor B		Phase B	
	Motor C		Phase C	
		U_{Out}	0 … U_B	V
PWM switching frequency		f_{PWM}	78,12	kHz

1) E.g. encoder

The signal level (PLC or TTL) of the digital inputs can be set over the interface (see operating instruction manual).
Standard (PLC): Low 0...7V / High 12,5V...U_B, TTL: Low 0...0,5V / High 3,5V...U_B

Options

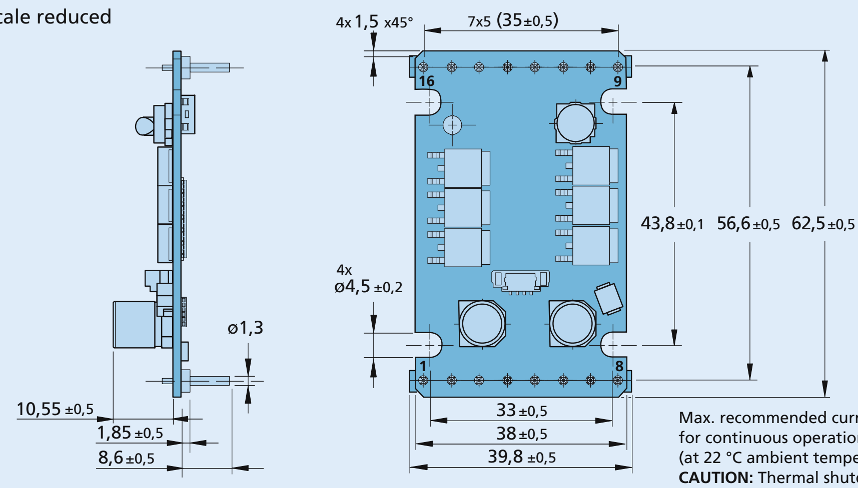
- Separate power supply (Option no.: 3085)

Full product description

- Example:
  MCBL 3003 P AES RS (RS232)
  MCBL 3003 P AES CF (CANopen with Faulhaber CAN)

Dimensional drawing and connection information for MCBL 3003 P AES

Scale reduced



Max. recommended current
for continuous operation: 3A
(at 22 °C ambient temperature)
CAUTION: Thermal shutdown is
NOT guaranteed!

Connection

Pin	Function
1	TxD / CAN_H
2	RxD / CAN_L
3	AGND
4	Fault
5	AnIn
6	U_B
7	GND
8	3. In
9	Sensor A / DATA
10	Sensor B / $\overline{CS}$
11	Sensor C / CLK
12	U_{CC}
13	SGND
14	Motor A
15	Motor B
16	Motor C

Drive Electronics

NEW

Motion Controller

V2.5, 4-Quadrant PWM
with RS232 or CAN interface

For combination with:
Brushless DC-Servomotors
with absolute encoder

Series MCBL 3006 AES

		MCBL 3006 S AES	
Power supply	U_B	12 ... 30	V DC
PWM switching frequency	f_{PWM}	78,12	kHz
Efficiency	η	95	%
Max. continuous output current [1]	I_{dauer}	6	A
Max. peak output current	I_{max}	10	A
Total standby current	I_{el}	0,06	A
Speed range		5 ... 30 000	rpm
Scanning rate	N	100	µs
Encoder resolution with AES encoder		≤ 4 096	inc./rev.
Resolution with external encoder		≤ 65 535	inc./rev.
Input/output (partially free configurable)		3	
Program memory: [2]			
– memory size		3,3	kWord
– Number of instructions		ca. 1 000	instructions
Operating temperature range		– 40 ... + 85	°C
Housing material		zinc, black coated	
Weight		160	g

[1] at 22°C ambient temperature
[2] Only for version with serial interface

Connection information					
Connection communication:					
Interface			RS232	CAN	
Communication profile			Faulhaber - ASCII	CANopen	
Max. transfer speed rate RS232			115 200		baud
Max. transfer speed rate CAN				1	Mbit/s
Connection 3 “AGND”:					
– analog ground			analog GND		
– digital input	external encoder		channel B		
		R_{In}	10		kΩ
		f	≤ 400		kHz
Connection 4 “Fault”:					
– digital input		R_{In}	100		kΩ
– digital output (open collector)		U	≤ U_B		V
		I	≤ 30		mA
		clear	switched to GND		
		set	high-impedance		
	fault output	no error	switched to GND		
		error	high-impedance		
	signal output	f	≤ 2		kHz
		resolution	1...32		inc./rev.
Connection 5 “AnIn”:			“AGND” as GND		
– analog input	set speed value	U_{In}	± 10		V
– digital input	PWM set speed value	f	100 ... 2 000		Hz
		T	50% ≙ 0 rpm		
	external encoder		channel A		
		f	≤ 400		kHz
	step frequency input	f	≤ 400		kHz
		R_{In}	5		kΩ
Connection 6 “U_B”:		U_B	12 … 30		V DC
Connection 7 “GND”:			ground		
Connection 8 “3. In”:					
– digital input		R_{In}	22		kΩ
– electronic supply voltage		U_{EL}	12 … 30		V DC

Connection information

Connection 9-11 „DATA, CS, CLK ":				
	DATA	U_{In}	≤ 5	V
	$\overline{CS}$	U_{Out}	0 ... 5	V
	CLK	U_{Out}	0 ... 5	
Connection 12 "U_{CC}":				
Output voltage for external use [1]		U_{Out}	5	V
Load current		I_{Out}	≤ 60	mA
Connection 13 "SGND":				
Signal GND			Signal ground	
Connection 14-16 „Motor A, B, C":				
Motor connection	Motor A		Phase A	
	Motor B		Phase B	
	Motor C		Phase C	
		U_{Out}	0 ... U_B	V DC
PWM switching frequency		f_{PWM}	78,12	kHz

[1] E.g. encoder

The signal level (PLC or TTL) of the digital inputs can be set over the interface (see operating instruction manual).
Standard (PLC): Low 0...7V / High 12,5V...U_B, TTL: Low 0...0,5V / High 3,5V...U_B

D-SUB-connector information

Connection D-SUB-connector:	**RS232**	**CAN**
Pin 2	RxD	CAN-L
Pin 3	TxD	GND
Pin 5	GND	-
Pin 7	-	CAN-H

Options

- Separate power supply (Option no.: 3085)

Accessories

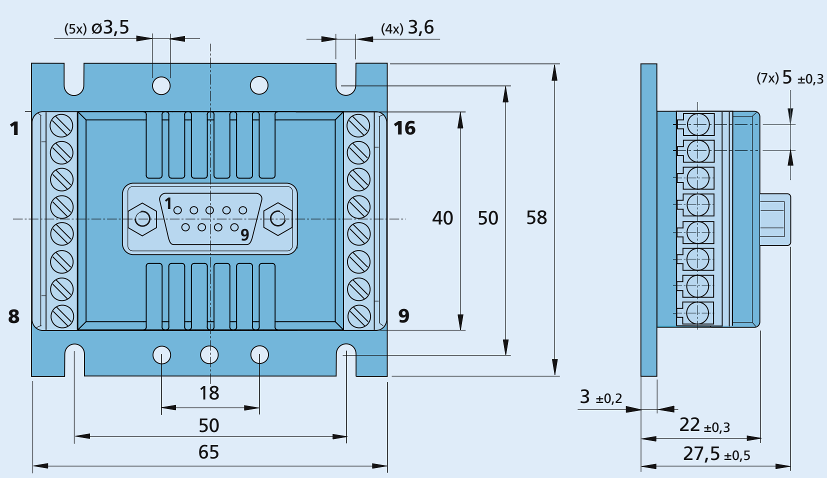
- 6501.00128: USB-CAN-Adapter
  (only for version with CAN interface)
- 6501.00131: USB-RS232 Adapter
  (only for version with serial interface)
- 6501.00086: Adapter for BX4 Motors with connector

Full product description

- Example:
  MCBL 3006 S AES RS (RS232)
  MCBL 3006 S AES CF (CANopen with Faulhaber CAN)

Dimensional drawing and connection information MCBL 3006 S AES

Scale reduced



Supply connection

No.	Function
1	TxD / CAN_H
2	RxD / CAN_L
3	AGND
4	Fault
5	AnIn
6	U_B
7	GND
8	3. In

Motor connection

No.	Function
9	Sensor A / DATA
10	Sensor B / $\overline{CS}$
11	Sensor C / CLK
12	U_{CC}
13	SGND
14	Motor A
15	Motor B
16	Motor C

NEW

Motion Controller

V2.5, 4-Quadrant PWM with RS232 or CAN interface

For combination with:
Linear DC-Servomotors
with analog Hall sensors

Series MCLM 3002

		MCLM 3002 P	MCLM 3002 F	MCLM 3002 S	
Power supply	U_B	5 ... 30	5 ... 30	5 ... 30	V DC
PWM switching frequency	f_{PWM}	78,12	78,12	78,12	kHz
Efficiency	η	95	95	95	%
Max. continuous output current [1]	I_{dauer}	2	2	2	A
Max. peak output current	I_{max}	3	3	3	A
Total standby current	I_{el}	0,04	0,04	0,04	A
Speed range [2]		2 ... 10 000	2 ... 10 000	2 ... 10 000	rpm
Scanning rate	N	200	200	200	µs
Encoder resolution with linear Hall Sensors [3]		3 000	3 000	3 000	inc./τ_m
Resolution with external encoder		≤ 65 535	≤ 65 535	≤ 65 535	inc./mm
Input/output (partially free configurable)		3	3	3	
Program memory: [4]					
– memory size		3,3	3,3	3,3	kWord
– Number of instructions		ca. 1 000	ca. 1 000 approx. 1 000	ca. 1 000	instructions
Operating temperature range		– 25 ... + 85	– 25 ... + 85	– 25 ... + 85	°C
Weight		7	13	16	g

[1] at 22°C ambient temperature
[2] Speed in the range 1 ... 5 mm/s may have fluctuations due to the motor type, load characteristics and controller parameters
[3] τ_m is the magnetic pitch of the linear motor
[4] Only for version with serial interface

Connection information					
Connection communication:					
Interface			RS232	CAN	
Communication profile			Faulhaber - ASCII	CANopen	
Max. transfer speed rate RS232			115 200		baud
Max. transfer speed rate CAN				1	Mbit/s
Connection 3 **"AGND":**					
– analog ground			analog GND		
– digital input	external encoder		channel B		
		R_{In}	10		kΩ
		f	≤ 400		kHz
Connection 4 **"Fault":**					
– digital input		R_{In}	100		kΩ
– digital output (open collector)		U	≤ U_B		V
		I	≤ 30		mA
		clear	switched to GND		
		set	high-impedance		
	fault output	no error	switched to GND		
		error	high-impedance		
	signal output	f	≤ 2		kHz
		resolution	1...255		inc./τ_m
Connection 5 **"AnIn":**			"AGND" as GND		
– analog input	set position value	U_{In}	± 10		V
– digital input	external encoder		channel A		
		f	≤ 400		kHz
	step frequency input	f	≤ 400		kHz
		R_{In}	5		kΩ
Connection 6 **"U_B":**		U_B	5 … 30		V DC
Connection 7 **"GND":**			ground		
Connection 8 **"3. In":**					
– digital input		R_{In}	22		kΩ
– electronic supply voltage		U_{EL}	5 … 30		V DC

Drive Electronics

Connection information			
Connection 9-11 „Sensor A, B, C“:			
Hall sensor input Sensor A		Hall Sensor A	
Sensor B		Hall Sensor B	
Sensor C		Hall Sensor C	
	U_{In}	≤ 5	V
Connection 12 “U_{CC}”:			
Output voltage for external use [1]	U_{Out}	5	V
Load current	I_{Out}	≤ 60	mA
Connection 13 “SGND”:			
Signal GND		Signal masse	
Connection 14-16 „Motor A, B, C“:			
Motor connection Motor A		Phase A	
Motor B		Phase B	
Motor C		Phase C	
	U_{Out}	0 … U_B	V DC
PWM switching frequency	f_{PWM}	78,12	kHz

[1] E.g. Hall Sensors

The signal level (PLC or TTL) of the digital inputs can be set over the interface (see operating instruction manual).
Standard (PLC): Low 0...4,5V / High 12,5V...U_B, TTL: Low 0...0,5V / High 2,5V...U_B

Options

- Separate power supply (Option no.: 3085)

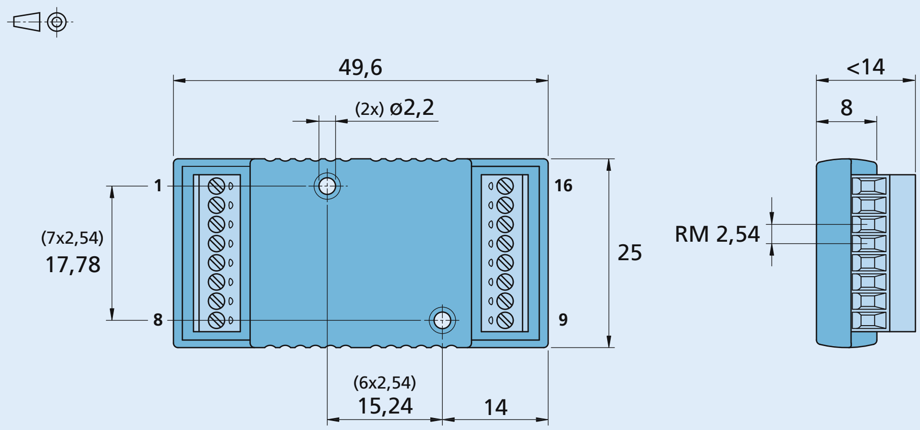
Full product description

- Example:
  MCLM 3002 S RS (RS232)
  MCLM 3002 F CF (CANopen with Faulhaber CAN)
  MCLM 3002 P RS (RS232)

Accessories		Motor Type	Part No. for MCLM 3002 S, F
Programming adapter	**RS232/CAN**	BL	**6501.00121**

Drive Electronics

Dimensional drawing and connection information MCLM 3002 S



MCLM 3002 S

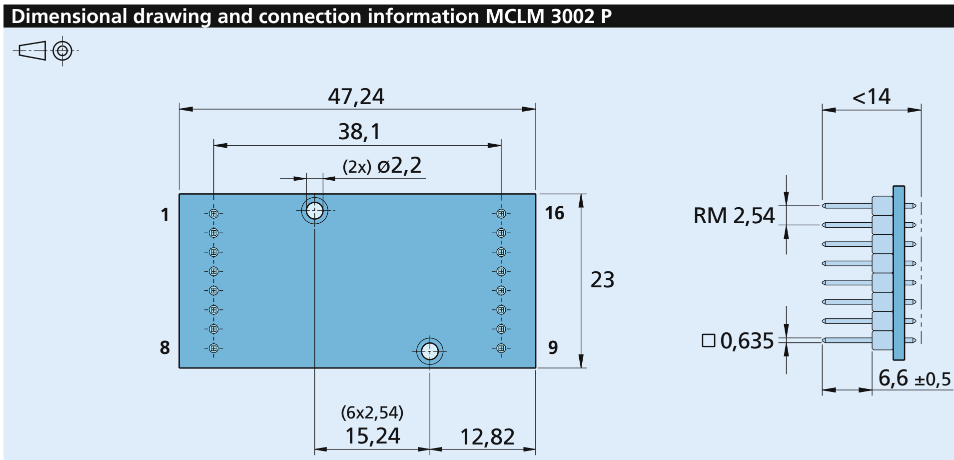
Supply connection

No.	Function
1	TxD / CAN_H
2	RxD / CAN_L
3	AGND
4	Fault
5	AnIn
6	U_B
7	GND
8	3. In

Motor connection

No.	Function
9	Sensor A
10	Sensor B
11	Sensor C
12	U_{CC}
13	SGND
14	Motor A
15	Motor B
16	Motor C

Dimensional drawing and connection information MCLM 3002 P



MCLM 3002 P

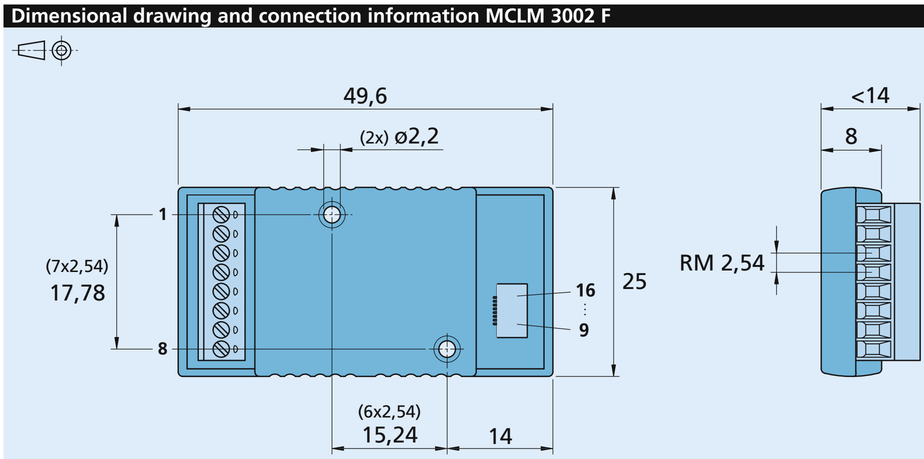
Supply connection

No.	Function
1	TxD / CAN_H
2	RxD / CAN_L
3	AGND
4	Fault
5	AnIn
6	U_B
7	GND
8	3. In

Motor connection

No.	Function
9	Sensor A
10	Sensor B
11	Sensor C
12	U_{CC}
13	SGND
14	Motor A
15	Motor B
16	Motor C

Dimensional drawing and connection information MCLM 3002 F



MCLM 3002 F

Connector Information
LIF-Connector 8-pole

Supply connection

No.	Function
1	TxD / CAN_H
2	RxD / CAN_L
3	AGND
4	Fault
5	AnIn
6	U_B
7	GND
8	3. In

Motor connection

No.	Function
9	Sensor A
10	Sensor B
11	Sensor C
12	U_{CC}
13	SGND
14	Motor A
15	Motor B
16	Motor C

Notes

NEW

Motion Controller

V2.5, 4-Quadrant PWM
with RS232 or CAN interface

For combination with:
Linear DC-Servomotors
with analog Hall sensors

Series MCLM 3003

		MCLM 3003 P	
Power supply	U_B	12 ... 30	V DC
PWM switching frequency	f_{PWM}	78,12	kHz
Efficiency	η	95	%
Max. continuous output current [1]	I_{dauer}	3	A
Max. peak output current	I_{max}	10	A
Total standby current	I_{el}	0,06	A
Speed range [2]		2 ... 10 000	mm/s
Scanning rate	N	200	µs
Encoder resolution with linear Hall Sensors [3]		≤ 3 000	inc./τ_m
Resolution with external encoder		≤ 65 535	inc./mm
Input/output (partially free configurable)		3	
Program memory: [4]			
– memory size		3,3	kWord
– Number of instructions		approx. 1 000	instructions
Operating temperature range		– 40 ... + 85	°C
Housing material		without housing	
Weight		18	g

[1] at 22°C ambient temperature
[2] speed in the range 1 ... 5 mm/s may have fluctuations due to the motor type, load characteristics and controller parameters
[3] τ_m is the magnetic pitch of the linear motor
[4] only for version with serial interface

Connection information					
Connection communication:					
Interface			RS232	CAN	
Communication profile			Faulhaber - ASCII	CANopen	
Max. transfer speed rate RS232			115 200		baud
Max. transfer speed rate CAN				1	Mbit/s
Connection 3 "AGND":					
– analog ground			analog GND		
– digital input	external encoder		channel B		
		R_{In}	10		kΩ
		f	≤ 400		kHz
Connection 4 "Fault":					
– digital input		R_{In}	100		kΩ
– digital output (open collector)		U	≤ U_B		V
		I	≤ 30		mA
		clear	switched to GND		
		set	high-impedance		
	fault output	no error	switched to GND		
		error	high-impedance		
	signal output	f	≤ 2		kHz
		resolution	1...255		inc./τ_m
Connection 5 "AnIn":			"AGND" as GND		
– analog input	set position value	U_{In}	± 10		V
– digital input	external encoder		channel A		
		f	≤ 400		kHz
	step frequency input	f	≤ 400		kHz
		R_{In}	5		kΩ
Connection 6 "U_B":		U_B	12 … 30		V DC
Connection 7 "GND":			ground		
Connection 8 "3. In":					
– digital input		R_{In}	22		kΩ
– electronic supply voltage		U_{EL}	12 … 30		V DC

Connection information				
Connection 9-11 „Sensor A, B, C":				
Hall sensor input	Sensor A		Hall sensor A	
	Sensor B		Hall sensor B	
	Sensor C		Hall sensor C	
		U_{In}	≤ 5	V
Connection 12 "U_{CC}":				
Output voltage for external use [1]		U_{Out}	5	V DC
Load current		I_{Out}	≤ 60	mA
Connection 13 "SGND":				
Signal GND			Signal ground	
Connection 14-16 „Motor A, B, C":				
Motor connection	Motor A		Phase A	
	Motor B		Phase B	
	Motor C		Phase C	
		U_{Out}	0 … U_B	V
PWM switching frequency		f_{PWM}	78,12	kHz

[1] E.g. Hall Sensors

The signal level (PLC or TTL) of the digital inputs can be set over the interface (see operating instruction manual).
Standard (PLC): Low 0...7V / High 12,5V...U_B, TTL: Low 0...0,5V / High 3,5V...U_B

Options

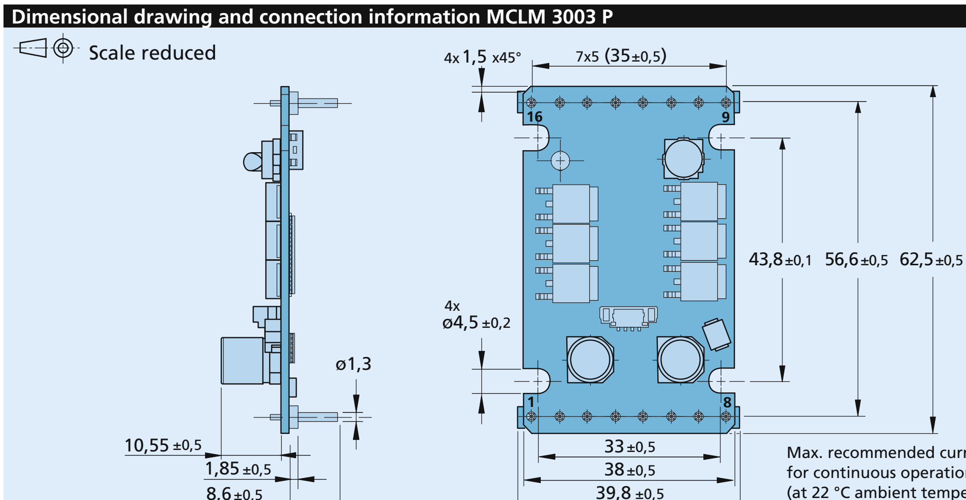
- Separate power supply (Option no.: 3085)

Full product description

- Example:
  MCLM 3003 P RS (RS232)
  MCLM 3003 P CF (CANopen with Faulhaber CAN)

Dimensional drawing and connection information MCLM 3003 P

Scale reduced



Max. recommended current for continuous operation: 3A (at 22 °C ambient temperature)
CAUTION: Thermal shutdown is NOT guaranteed!

Connection

Pin	Function
1	TxD / CAN_H
2	RxD / CAN_L
3	AGND
4	Fault
5	AnIn
6	U_B
7	GND
8	3. In
9	Sensor A
10	Sensor B
11	Sensor C
12	U_{CC}
13	SGND
14	Motor A
15	Motor B
16	Motor C

NEW

Motion Controller

V2.5, 4-Quadrant PWM
with RS232 or CAN interface

For combination with:
Linear DC-Servomotors
with analog Hall sensors

Series MCLM 3006

		MCLM 3006 S	
Power supply	U_B	12 ... 30	V DC
PWM switching frequency	f_{PWM}	78,12	kHz
Efficiency	η	95	%
Max. continuous output current [1]	I_{dauer}	6	A
Max. peak output current	I_{max}	10	A
Total standby current	I_{el}	0,06	A
Speed range [2]		2 ... 10 000	mm/s
Scanning rate	N	200	µs
Encoder resolution with linear Hall Sensors [3]		≤ 3 000	inc./τ_m
Resolution with external encoder		≤ 65 535	inc./mm
Input/output (partially free configurable)		3	
Program memory: [4]			
– memory size		3,3	kWord
– Number of instructions		approx. 1 000	instructions
Operating temperature range		– 40 ... + 85	°C
Housing material		zinc, black coated	
Weight		160	g

[1] at 22°C ambient temperature
[2] Speed in the range 1 ... 5 mm/s may have fluctuations due to the motor type, load characteristics and controller parameters
[3] τ_m is the magnetic pitch of the linear motor
[4] Only for version with serial interface

Connection information				
Connection communication:				
Interface		RS232	CAN	
Communication profile		Faulhaber - ASCII	CANopen	
Max. transfer speed rate RS232		115 200		baud
Max. transfer speed rate CAN			1	Mbit/s
Connection 3 "AGND":				
– analog ground		analog GND		
– digital input external encoder		channel B		
	R_{In}	10		kΩ
	f	≤ 400		kHz
Connection 4 "Fault":				
– digital input	R_{In}	100		kΩ
– digital output (open collector)	U	≤ U_B		V
	I	≤ 30		mA
	clear	switched to GND		
	set	high-impedance		
fault output	no error	switched to GND		
	error	high-impedance		
signal output	f	≤ 2		kHz
	resolution	1...255		inc./τ_m
Connection 5 "AnIn":		"AGND" as GND		
– analog input set position value	U_{In}	± 10		V
– digital input external encoder		channel A		
	f	≤ 400		kHz
step frequency input	f	≤ 400		kHz
	R_{In}	5		kΩ
Connection 6 "U_B":	U_B	12 … 30		V DC
Connection 7 "GND":		ground		
Connection 8 "3. In":				
– digital input	R_{In}	22		kΩ
– electronic supply voltage	U_{EL}	12 … 30		V DC

Connection information				
Connection 9-11 „Sensor A, B, C“:				
Hall sensor input	Sensor A		Hall Sensor A	
	Sensor B		Hall Sensor B	
	Sensor C		Hall Sensor C	
		U_{In}	≤ 5	V
Connection 12 “U_{CC}”:				
Output voltage for external use [1]		U_{Out}	5	V
Load current		I_{Out}	≤ 60	mA
Connection 13 “SGND”:				
Signal GND			Signal masse	
Connection 14-16 „Motor A, B, C“:				
Motor connection	Motor A		Phase A	
	Motor B		Phase B	
	Motor C		Phase C	
		U_{Out}	0 … U_B	V DC
PWM switching frequency		f_{PWM}	78,12	kHz

[1] E.g. Hall Sensors
The signal level (PLC or TTL) of the digital inputs can be set over the interface (see operating instruction manual).
Standard (PLC): Low 0...7V / High 12,5V...U_B, TTL: Low 0...0,5V / High 3,5V...U_B

D-SUB-connector information		
Connection D-SUB-connector:	**RS232**	**CAN**
Pin 2	RxD	CAN-L
Pin 3	TxD	GND
Pin 5	GND	-
Pin 7	-	CAN-H

Options
- Separate power supply (Option no.: 3085)

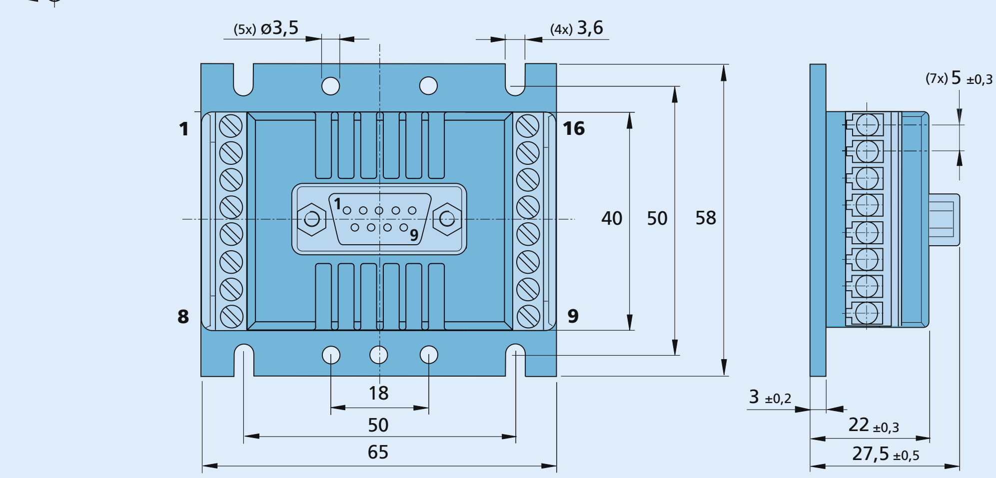
Accessories
- 6501.00128: USB-CAN-Adapter (only for version with CAN interface)
- 6501.00131: USB-RS232 Adapter (only for version with serial interface)
- 6501.00117: Adapter for LM 0830
- 6501.00118: cable with connector for Adapter LM 0830

Full product description
- Example:

  MCLM 3006 S RS (RS232)
  MCLM 3006 S CF (CANopen with Faulhaber CAN)

Dimensional drawing and connection information for MCLM 3006 S

Scale reduced



Supply connection

No.	Function
1	TxD / CAN_H
2	RxD / CAN_L
3	AGND
4	Fault
5	AnIn
6	U_B
7	GND
8	3. In

Motor connection

No.	Function
9	Sensor A
10	Sensor B
11	Sensor C
12	U_{CC}
13	SGND
14	Motor A
15	Motor B
16	Motor C

Accessories

WE CREATE MOTION

FAULHABER

Adapters

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Brakes

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Accessories

USB Programming Board

For combination with
Speed Controller:
SC 1801 S / F, SC 2804 S, SC 5008 S

Part No.: 6501.0009x

		6501.00096 and 6501.00097	
Power supply for electronics	U_{elo}	5 ... 30	V
Power supply for motor	U_{mot}	0 ... 30	V
Current consumption of electronics	I_{el}	20	mA
Temperature range:			
– Operating temperature		0 … + 65	°C
Dimensions and weight:			
– Dimensions (L x B x H)		55 x 48 x 18	mm
– Weight		35	g

General information

Standard programming board for configuration and changes of the operating modes for Speed Controller series SC 1801 S / F, SC 2804 S and SC 5008 S.

Automatic parameter download in connection with FAULHABER Motion Manager (from version 4.2) via USB interface.

Immediate test operation after successful data transfer within the customers application is feasible.

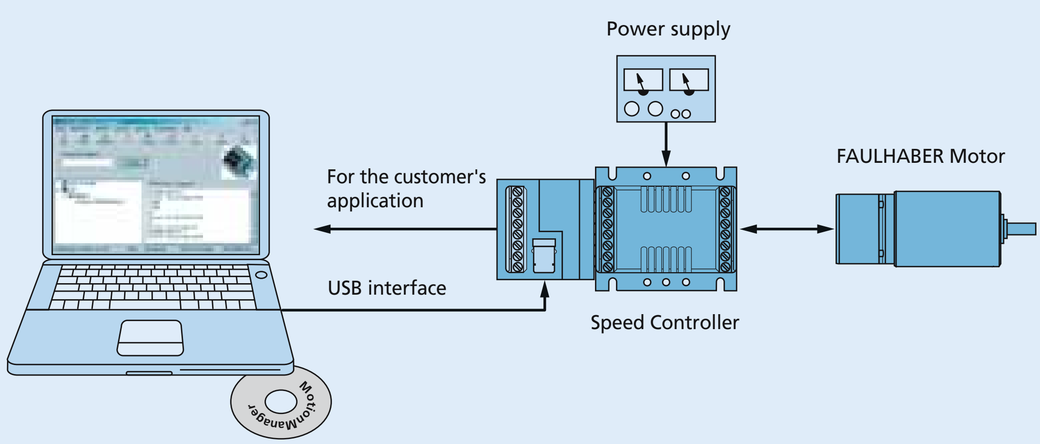
The programming board is to be operated via an USB interface. Therefore the installation of a special USB driver is required.

Driver installation

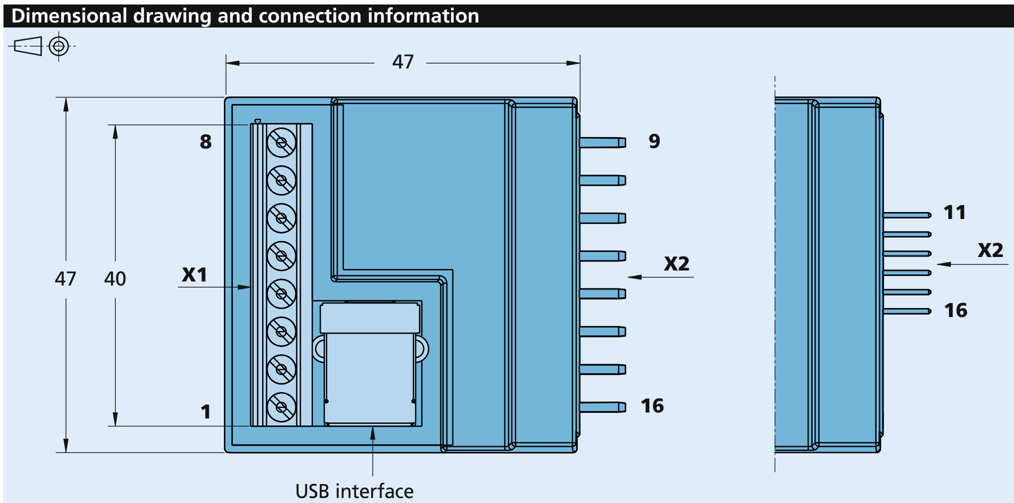
The driver is included in the setup package of FAULHABER Motion Manager (from version 4.2), which can be downloaded from the FAULHABER internet site www.faulhaber.com/MotionManager.

For detailed informations to install the driver please see instruction manual of SC programming board USB.

Connection diagram



Dimensional drawing and connection information



6501.00096 6501.00097

Connection

No.	Function
X1 Customer interface	
1	Up
2	Umot
3	GND
4	Unsoll
5	DIR
6	FG
7	IO2
8	IO1
X2 Controller interface	
9	IO1
10	IO2
11	FG
12	DIR
13	Unsoll
14	GND
15	Umot
16	Up

Accessories

Programming Board

For combination with
Speed Controller:
SC 1801, SC 2402, SC 2804, SC 5004 , SC 5008
Brushless DC-Micromotors
1525...BRC, 3153...BRC,
2232...BX4 SC, 2232...BX4S SC, 2250...BX4 SC,
2250...BX4S SC, 3242...BX4 SC, 3268...BX4 SC

Part No.: 6501.00088

		6501.00088	
Power supply for electronics	U_{elo}	3,5 ... 30	V
Power supply for motor	U_{mot}	0 ... 30	V
Current consumption of electronics	I_{el}	0,1	A
Temperature range:			
– Operating temperature		0 ... + 65	°C
Dimensions and weight:			
– Dimensions (L x B x H)		80 x 65 x 31	mm
– Weight		45	g

General information

Description of connectors / controls:

X1 Terminals for power supplies
- Pin 1: GND Ground connection of power supply/supplies
- Pin 2: U_{elo} Power supply for electronics
- Pin 3: U_{mot} Power supply for motor winding

X2, X3, X6, X10 Terminals for motor / motor controller
- Pin 1: U_P Power supply for motor electronics
- Pin 2: U_{mot} Power supply for motor winding
- Pin 3: GND Power supply negative pole
- Pin 4: U_{nsoll} Output for nominal speed setting 0...10V
- Pin 5: DIR Output for direction of rotation setting
- Pin 6: FG Input for speed signal from motor controller

X5 RS232 connector, may optionally be used instead of X9 in PROG mode for programming

X9 USB connector, may optionally be used instead of X5 in PROG mode for programming

JP1 Jumper can be removed and connected to an amperemeter for motor current measurement at U_{mot}.

JP3 Jumper to separate power supply for electronics and motor
- 1-2: U_P = U_{mot} » Joint power supply to electronics and motor winding via terminal Umot
- 2-3: U_P = U_{elo} » Power supply to electronics via separate terminal U_{elo} (separate power supply for electronics and motor winding). Power supply for adapter board also via the terminal selected for U_P

JP9 Connector for external signal for Unsoll, e.g. PWM signal for speed setting. Note: JP10 must then be removed.

JP10 Jumper for selection of the source for U_{nsoll}. Closed: U_{nsoll} adjustable with P1.

S1 Switch for setting the operating mode
PROG mode = software update
MOT mode = motor operation

S2 Switch for setting the direction of rotation of the motor

S3 Switch for switching the power supply U_P for the electronics on/off

P1 P1 is used to set U_{nsoll} from 0...10V. JP10 must be closed. The power supply U_P must be at least 10,5V.

LED 1 Indicates the adapter board is ready for operation

LED 2 Indicates the external controller status.
ON = ready for operation, OFF = error

Start-up

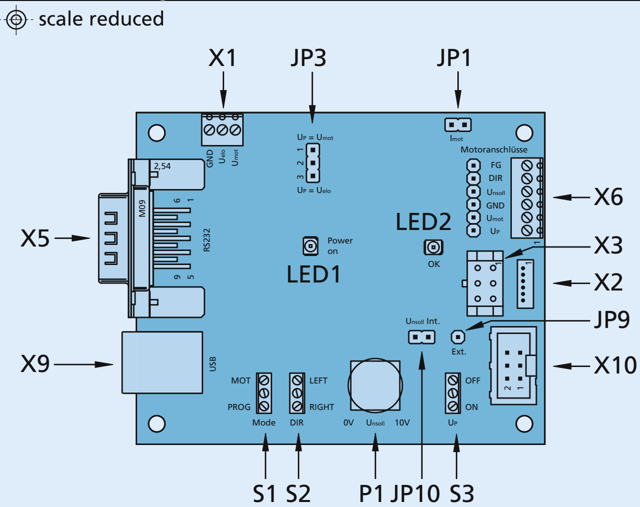
- Connect operating voltage to X1. Use alternatively joint or separate operating voltage for electronics and motor.
  Note: Pay attention to correct setting of JP3.
  Pay attention to minimum/maximum values for U_{mot} and U_{elo}.
- S3 in position OFF; JP1 and JP10 closed.
- Connect motor/motor controller to X2, X3, X6 or X10.
- For PROG mode, connect to a Windows PC at X5 (null modem cable) or X9 (USB connection cable type B).
- LED 1 and LED 2 lights up after power-on for U_{mot} or U_{mot} and U_{elo}.

Driver installation:

If the adapter board is to be operated via the USB connector X9, a special USB driver must be installed if using Windows XP (further details on request).

Dimensional drawing and connection information

scale reduced



Connection information

No.	Function
LED 1	Ready for operation
LED 2	Status external controller
Terminals	
X1	Power supply
X2, X3, X6, X10	Connector for motor or SC controller
X5	RS232 connector
X9	USB connector, type B
Jumpers	
JP1	Motor current measurement
JP3	Separation of U_P from U_{mot}
JP9	U_{nsoll} external input signal
JP10	U_{nsoll} int. setting with P1
Switches	
S1	Operating mode
S2	Direction of motor rotation
S3	Power switch on/off
Potentiometer	
P1	U_{nsoll} setting

PROG mode

Settings	
S1	PROG
S2	RIGHT
S3	OFF
P1	0V
JP1	Closed
JP10	Closed

MOT mode

Settings	
S1	MOT
S2	RIGHT or LEFT
S3	OFF - ON
P1	0V ... 10V
JP1	Opt. current measurement
JP10	Select source for U_{nsoll}

Accessories

Adapter board

For combination with
Brushless DC-Servomotos with integrated Motion Controller:
3242 ... BX4 CS/CC, 3268 ... BX4 CS/CC,
3564 ... B CS/CC

Part No.: 6501.00065

	6501.00065	
Temperature range:		
– Operating temperature	– 10 ... + 65	°C
Dimension and Weight:		
– Dimension (L x B x H)	64 x 44,5 x 13,8	mm
– Weight	29,5	g

Note: The board has installation feet for 35 mm mounting rails.
All switches are in the "OFF" position in the as-delivered condition. These switches must be set accordingly depending on the application.

General information

The adapter board is used to connect Brushless DC-Servomotors with integrated Motion Controller and a serial RS232 or CAN interface.

The different operating modes can be selected using the 6 DIP switches.
A Brushless DC-Servomotor with integrated Motion Controller can be connected to each adapter board.

Description of DIP switch (S1) settings

1: Fault	ON	Pull-up resistor with LED connected to adapter board.
	OFF	Open collector
2: Term	ON	120 Ω terminating resistor for the final node in the CAN network connected to the adapter board.
	OFF	Terminating resistor not connected
3: CAN [1)]	ON	Operation with CAN interface
	OFF	Deactivated
4: RS232 [1)]	ON	Operation with RS232 interface
	OFF	Deactivated
5: NETMODE	ON	Pull-down resistor (10 kΩ) for RS232 wiring connected. This may only be connected to a node in the RS232 network.
	OFF	Deactivated
6: AGND	ON	AGND and GND interconnected.
	OFF	AGND and GND disconnected (with separate ground).

Connection

Pin	Connection X1
1	3. In
2	GND
3	+24V
4	An In
5	Fault
6	AGND

Pin	Connection X2	Wires
1	RS-232 TxD	green
2	RS-232 RxD	yellow
3	AGND	grey
4	Fault	white
5	An In	brown
6	+24V	pink
7	GND	blue
8	3. In	red

at RS232 operation [1)]

Pin	Connection X3
2	RS-232 / RxD
3	RS-232 / TxD
5	GND

at CAN operation [1)]

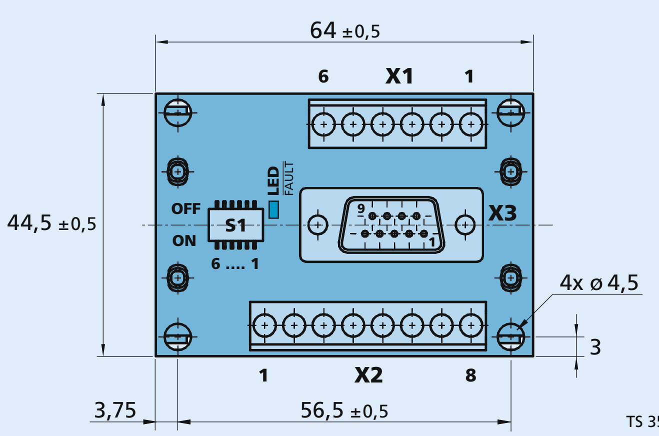
Pin	Connection X3
2	CAN_L
3	GND
7	CAN_H

LED	Status	
(filled)	LED illuminates	no error fault output switched to GND
(empty)	LED does not illuminate	error fault output high-impedance

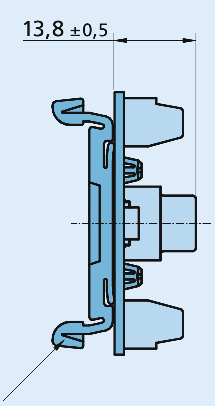
[1)] The pin assignments of X3 depend on the position of switches 3 and 4 of DIP switch S1.

Dimensional drawing and connection information

Scale reduced



6501.00065



TS 35 Typ Wago 209-188
for top hat rail mounting

Connection

Nr.	Function
X1	Supply connector; I/O
X2	Motor connector
X3	RS-232 / CAN

Nr.	Switch
S1	DIP-switch (6 switches)

Accessories

Adapter board BX4 CxD

For combination with
Brushless DC-Servomotos with
integrated Motion Controller:
2232...BX4 CSD / CCD, 2250...BX4 CSD / CCD

Part No.: 6501.00113

	6501.00113	
Temperature range:		
– Operating temperature	– 10 … + 65	°C
Dimension and Weight:		
– Dimension (L x B x H)	60 x 50 x 15	mm
– Weight	30	g

Note: All switches are in the “OFF” position in the as-delivered condition. These switches must be set accordingly depending on the application.

General information

The adapter board is used to connect Brushless DC-Servomotors with integrated Motion Controller and a serial RS232 or CAN interface.

The different operating modes can be selected using the 6 DIP switches.
A Brushless DC-Servomotor with integrated Motion Controller can be connected to each adapter board.

Description of DIP switch (S1) settings

1: Fault	ON	Pull-up resistor with LED connected to adapter board.
	OFF	Open collector
2: Term	ON	120 Ω terminating resistor for the final node in the CAN network connected to the adapter board.
	OFF	Terminating resistor not connected
3: CAN [1)]	ON	Operation with CAN interface
	OFF	Deactivated
4: RS232 [1)]	ON	Operation with RS232 interface
	OFF	Deactivated
5: NETMODE	ON	Pull-down resistor (2,2 kΩ) for RS232 wiring connected. This may only be connected to a node in the RS232 network.
	OFF	Deactivated
6: AGND	ON	AGND and GND interconnected.
	OFF	AGND and GND disconnected (with separate ground).

[1)] The pin assignments of X3 depend on the position of switches 3 and 4 of DIP switch S1.

Connection

Pin	Connection X1
1	3. In
2	+24V
3	GND
4	An In
5	AGND
6	Fault
7	RS-232 RxD / CAN-L
8	RS-232 TxD / CAN-H

Pin	Connection X2
1	3. In
2	+24V
3	GND
4	An In
5	AGND
6	Fault
7	RS-232 RxD / CAN-L
8	RS-232 TxD / CAN-H
9	n.c.
10	n.c.

at RS232 operation [1)]

Pin	Connection X3
2	RS-232 / RxD
3	RS-232 / TxD
5	GND

at CAN operation [1)]

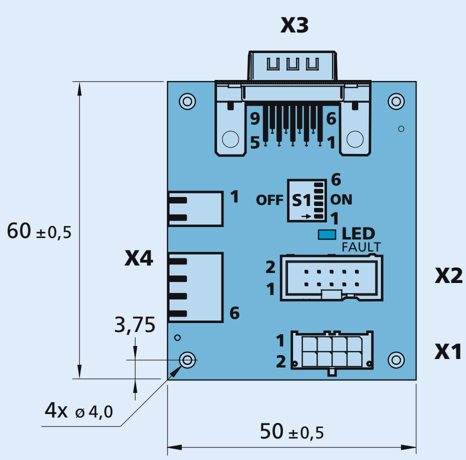
Pin	Connection X3
2	CAN_L
3	GND
7	CAN_H

Pin	Connection X4
1	+24V
2	GND
3	An In
4	AGND
5	Fault
6	3. In

LED	Status
(illuminated)	LED illuminates no error fault output switched to GND
(not illuminated)	LED does not illuminate error fault output high-impedance

Dimensional drawing and connection information

Scale reduced



6501.00113

Connection

Nr.	Function
X1, X2	Motor connector
X3	RS232 / CAN
X4	Supply connector; I/O

Nr.	Switch
S1	DIP-switch (6 switches)

Accessories

NEW

Accessories

Adapter board MCxx 3002

For combination with
Motion Controller:
MCDC 3002 S / F, MCBL 3002 S / F, MCLM 3002 S / F

Part No.: 6501.00121

	6501.00121	
Temperature range:		
– Operating temperature	– 10 ... + 65	°C
Dimension and Weight:		
– Dimension (L x B x H)	47,5 x 31,5 x 15	mm
– Weight	21	g

Note: All switches are in the "OFF" position in the as-delivered condition. These switches must be set accordingly depending on the application.

General information

The adapter board is used to connect and for the parameter set-up of Motion Controller series MCxx 3002 S / F with serial RS232 or CAN interface.

The different operating modes can be selected using the 6 DIP switches. A Motion Controller can be connected to each adapter board.

Description of DIP switch (S1) settings

1: Fault	ON	Pull-up resistor with LED connected to adapter board.
	OFF	Open collector
2: Term	ON	120 Ω terminating resistor for the final node in the CAN network connected to the adapter board.
	OFF	Terminating resistor not connected
3: CAN [1]	ON	Operation with CAN interface
	OFF	Deactivated
4: RS232 [1]	ON	Operation with RS232 interface
	OFF	Deactivated
5: NETMODE	ON	Pull-down resistor (2,2 kΩ) for RS232 wiring connected. This may only be connected to a node in the RS232 network.
	OFF	Deactivated
6: AGND	ON	AGND and GND interconnected.
	OFF	AGND and GND disconnected (with separate ground).

Connection

at RS232 operation [1]

Pin	Connection X1
2	RS-232 / RxD
3	RS-232 / TxD
5	GND

at CAN operation [1]

Pin	Connection X1
2	CAN_L
3	GND
7	CAN_H

Pin	Connection X2 / X3
1	+24V
2	GND
3	An In
4	AGND
5	Fault
6	3. In

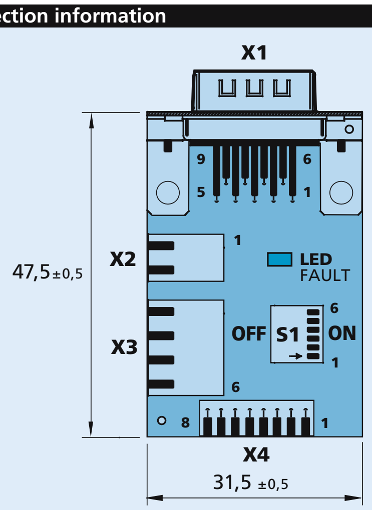
Pin	Connection X4
1	RS232 TxD / CAN-H
2	RS232 RxD / CAN-L
3	AGND
4	Fault
5	AnIn
6	U_b
7	GND
8	3. In

LED	Status
LED illuminates	no error fault output switched to GND
LED does not illuminate	error fault output high-impedance

[1] The pin assignments of X1 depend on the position of switches 3 and 4 of DIP switch S1.

Dimensional drawing and connection information

Scale reduced



6501.00121

Connection

Nr.	Function
X1,	RS232 / CAN
X2 / X3	Supply connector; I/O
X4	Controller connector

Nr.	Switch
S1	DIP-switch (6 switches)

Brakes

Electromagnetically Released System

For combination with
DC-Micromotors:
2342, 2642, 2657, 3242, 3257, 3557, 3863
Brushless DC-Servomotors:
2444, 3056, 3564, 4490

Series MBZ

	MBZ	12 V	22 V	24 V	
Nominal coil data at 20°C					
Supply voltage (DC) ±10%	U_N	12	22	24	Volt
Resistance	R	24	81	96	Ω
Current	A	0,50	0,27	0,25	A
Power	$P_{2\,max.}$	6	6	6	W
Mechanical response times [1]					
Coupling time		13			ms
Disconnection time		27			ms
Static torque rating [2]		400			mNm
Moment of inertia		10			gcm^2
Max. permissible speed		16 000			rpm
Temperature range: [3]					
Operating temperature		– 5…+120			°C
Storage temperature		–25…+ 55			°C
Weight		50			g

[1] Depending on the requirements, a Switch-off voltage-limitation function can be applied using an anti-parallel diode, varistor or other. However, this will influence the brake switching time.
[2] Under dry operation conditions, absolutely oil-free.
[3] Non condensing atmosphere.

Features

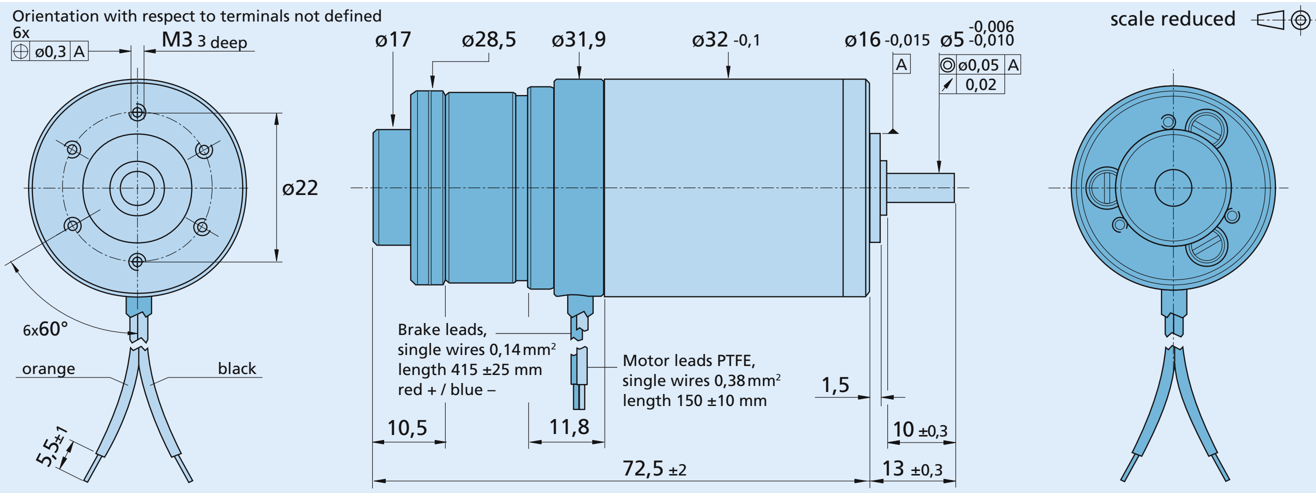
The brakes are designed as DC operated permanentmagnet single-surface brakes characterised by the fact that the braking effect is produced by a permanentmagnetic field (electromagnetically released system). This means that the required braking force is generated when voltage is removed.

In order to neutralise the braking effect, the permanentmagnetic field is counteracted by an opposing electromagnetic field.

The brakes are intended only for use as holding brakes (unsuitable for braking rotating motor shaft).

Full product description

- Examples:
  3242G024CR MBZ22V



MBZ with combination example **3242G...CR**

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