

DC-Micromotors				Page
0615 ... S	Precious Metal Commutation	0,11 mNm	31	
0816 ... S	Precious Metal Commutation	0,15 mNm	32	
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	
1336 ... C	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	
2224 ... SR	Precious Metal Commutation	5,0 mNm	48	
2230 ... S	Precious Metal Commutation	2,5 mNm	49	
2232 ... SR	Precious Metal Commutation	10 mNm	50	
2233 ... S	Precious Metal Commutation	3,0 mNm	51	
2237 ... CXR	Graphite Commutation	11 mNm	52	
2342 ... CR	Graphite Commutation	16 mNm	53	
2642 ... CXR	Graphite Commutation	23 mNm	54	
2642 ... CR	Graphite Commutation	28 mNm	55	
2657 ... CXR	Graphite Commutation	35 mNm	56	
2657 ... CR	Graphite Commutation	44 mNm	57	
3242 ... CR	Graphite Commutation	35 mNm	58	
3257 ... CR	Graphite Commutation	70 mNm	59	
3557 ... CS	Graphite Commutation	50 mNm	60	
3863 ... C	Graphite Commutation	110 mNm	61	

Flat DC-Micromotors and DC-Gearmotors				Page
1506 ... SR	Precious Metal Commutation	0,3 mNm	64	
1506 ... SR IE2-8	with integrated Encoder	0,3 mNm	65 – 66	
1512 ... SR	with integrated Gearhead	30 mNm	67	
1512 ... SR IE2-8	with integrated Gearhead and Encoder	30 mNm	68 – 69	
2607 ... SR	Precious Metal Commutation	3,0 mNm	70	
2607 ... SR IE2-16	with integrated Encoder	2,0 mNm	71 – 72	
2619 ... SR	with integrated Gearhead	100 mNm	73	
2619 ... SR IE2-16	with integrated Gearhead and Encoder	100 mNm	74 – 75	

DC-Micromotors

Technical Information

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.

DC-Micromotors

Precious Metal Commutation

Series 0615 ... S

	0615 N
1 Nominal voltage	U_N
2 Terminal resistance	R
3 Output power	$P_{2 \max.}$
4 Efficiency	$\eta_{\max.}$
5 No-load speed	n_o

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: $\alpha_{22} = 0,004 \text{ K}^{-1}$).

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.

$$k_n = \frac{n_o}{U_N - I_o \cdot R} = \frac{1000}{k_E}$$

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.

$$\frac{\Delta n}{\Delta M} = \frac{30000}{\pi} \cdot \frac{R}{k_M^2}$$

Rotor inductance L [μ H]

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 α_{max} [$\cdot 10^3$ rad/s²]

The acceleration obtained from standstill under no-load conditions and at nominal voltage.

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

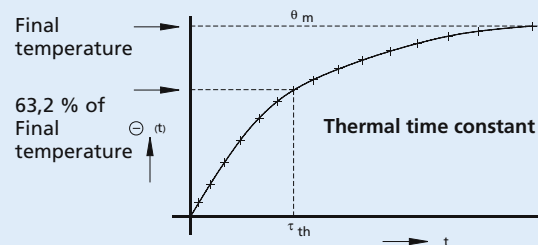
Thermal resistance R_{th1}/R_{th2} [K/W]

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.

Current $I_{e \max.}$ [A]

The maximum allowable current, based on the thermal limits of the max. permissible standard rotor temperature at 22 °C ambient.

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:

$$P_2 = M \cdot n \cdot \frac{\pi}{30 \cdot 1000} \quad [\text{W}]$$

$$P_2 = 3 \cdot 5500 \cdot \frac{\pi}{30 \cdot 1000} = 1,73 \quad \text{W}$$

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.

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

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	\emptyset	= 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:

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

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

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 [n₀] at nominal voltage, and the load torque [M] has to be less than half the stall torque [M_H].

$$n \geq \frac{n_0}{2} \quad M \leq \frac{M_H}{2}$$

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

$$n \text{ (5 500 rpm)} \geq \frac{n_0}{2} \text{ is greater than } \frac{8\,800}{2} = 4\,400 \text{ rpm}$$

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

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 [n₀], 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 [n₀], 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

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

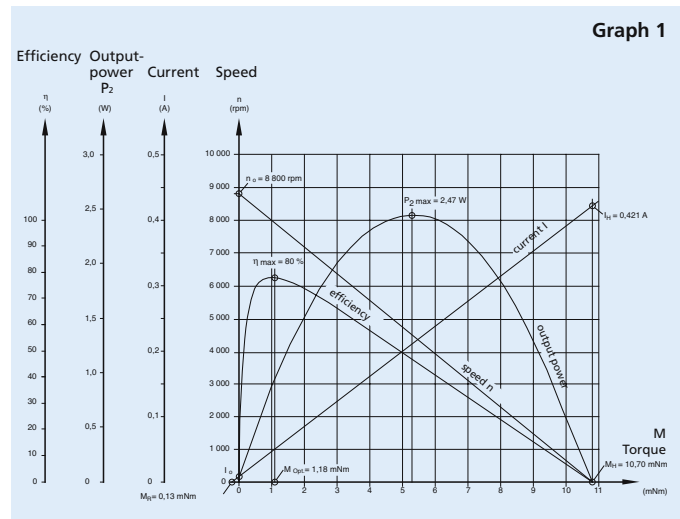
$$I = \frac{24}{57} = 0,421 \text{ A}$$

Torque at max. efficiency

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

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

It is now possible to make a graphic presentation and draw the motor diagram (see 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 n₀ at 20 V DC

$$n_0 = \frac{U - (I_0 \cdot R)}{K_E} \cdot 1000 \quad [rpm]$$

inserting the values

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

$$n_0 = \frac{20 - (0,005 \cdot 57)}{2,690} \cdot 1000$$

$$\text{Stall current } I_H = 7\,315 \text{ rpm}$$

$$I_H = \frac{U}{R}$$

$$I_H = \frac{20}{57} \quad [A]$$

$$\text{Stall torque } M_H = 0,351 \text{ A}$$

$$M_H = k_M (I_H - I_0)$$

inserting the value

Torque constant	k _M	= 25,70	$\frac{[mNm]}{mNm/A}$
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$$M_H = 25,70 (0,351 - 0,005) = 8,91 \text{ mNm}$$

DC-Micromotors

Technical Information

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

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

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

Efficiency, max. η_{\max} .

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

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

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

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

inserting the values

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

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

Calculation of the operating point at 20 V DC

When the torque ($M=3 \text{ mNm}$) at the working point is taken into consideration I , n , P_2 and η can be calculated:

Current at the operating point

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

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

Speed at the operating point

$$n = \frac{U - R \cdot I}{k_E} \cdot 1000 \quad [\text{rpm}]$$

$$n = \frac{20 - 57 \cdot 0,122}{2,690} \cdot 1000 = 4841 \quad \text{rpm}$$

Output power at the operating point

$$P_2 = M \cdot n \cdot \frac{\pi}{30 \cdot 1000} \quad [\text{W}]$$

$$P_2 = 3 \cdot 4841 \cdot \frac{\pi}{30 \cdot 1000} = 1,52 \quad \text{W}$$

Efficiency at the operating point

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

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

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:

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

$$U = 57 \cdot 0,122 + 2,695 \cdot 5500 \cdot 10^{-3} = 21,78 \quad \text{V DC}$$

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

Supply voltage	U	=	21,78	V DC
Speed	n	=	5500	rpm
Output torque	M_N	=	3	mNm
Current	I	=	0,12	A
Output power	P_2	=	1,72	W
Efficiency	η	=	66	%

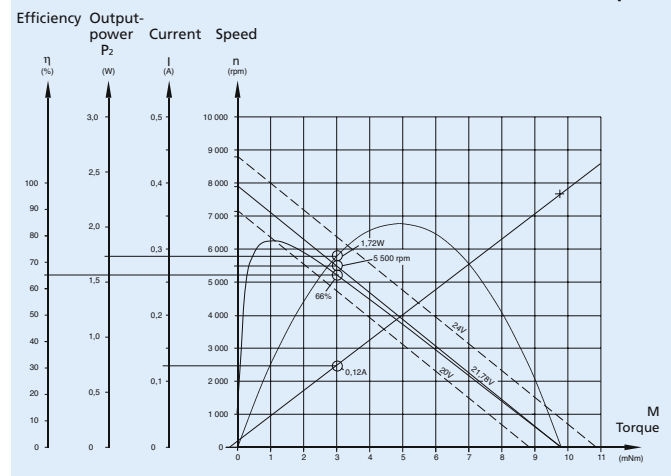
Motor characteristic curves

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.

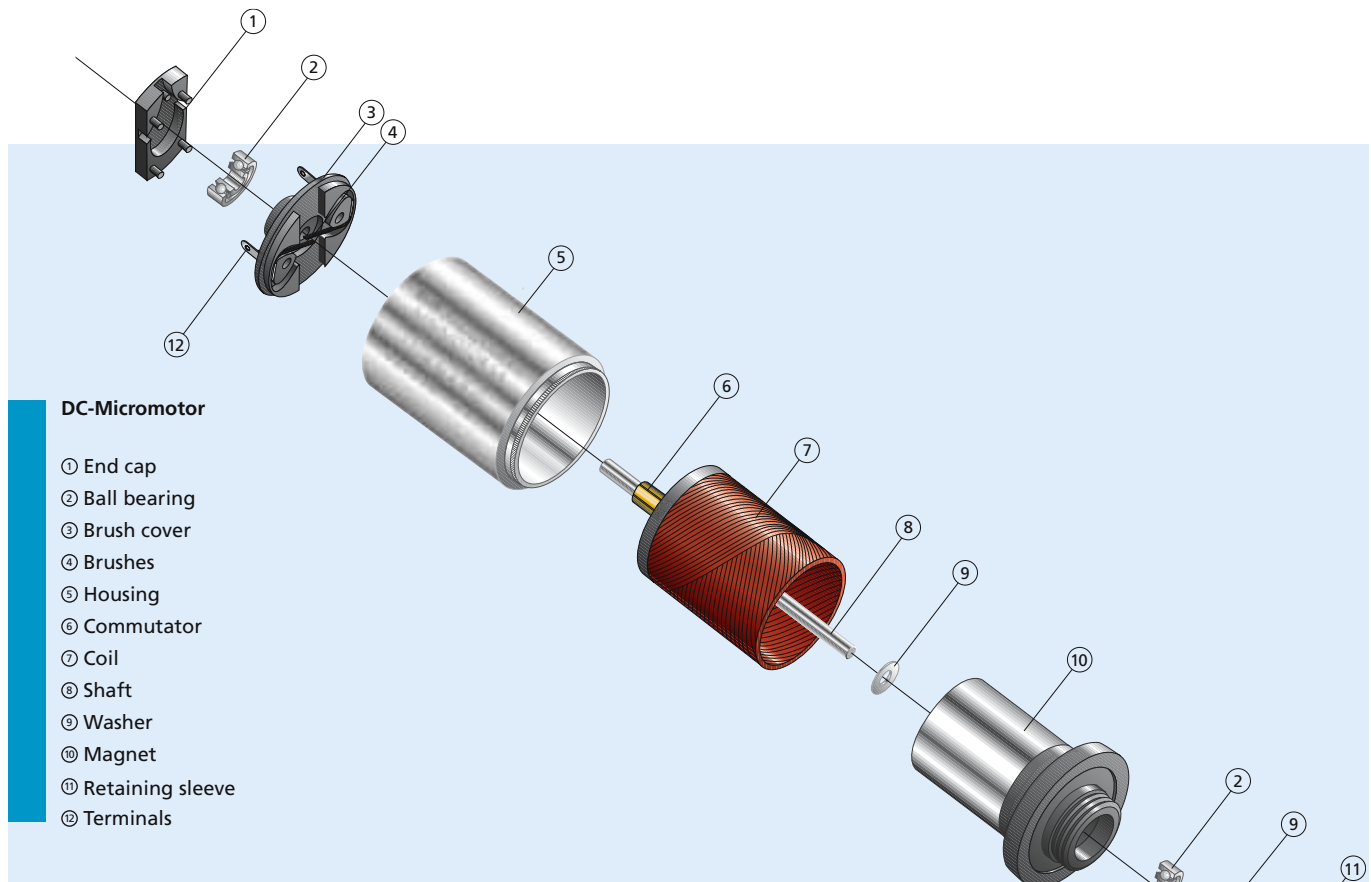
In certain cases the influence of temperature should, however, be taken into consideration.

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 vacuum 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



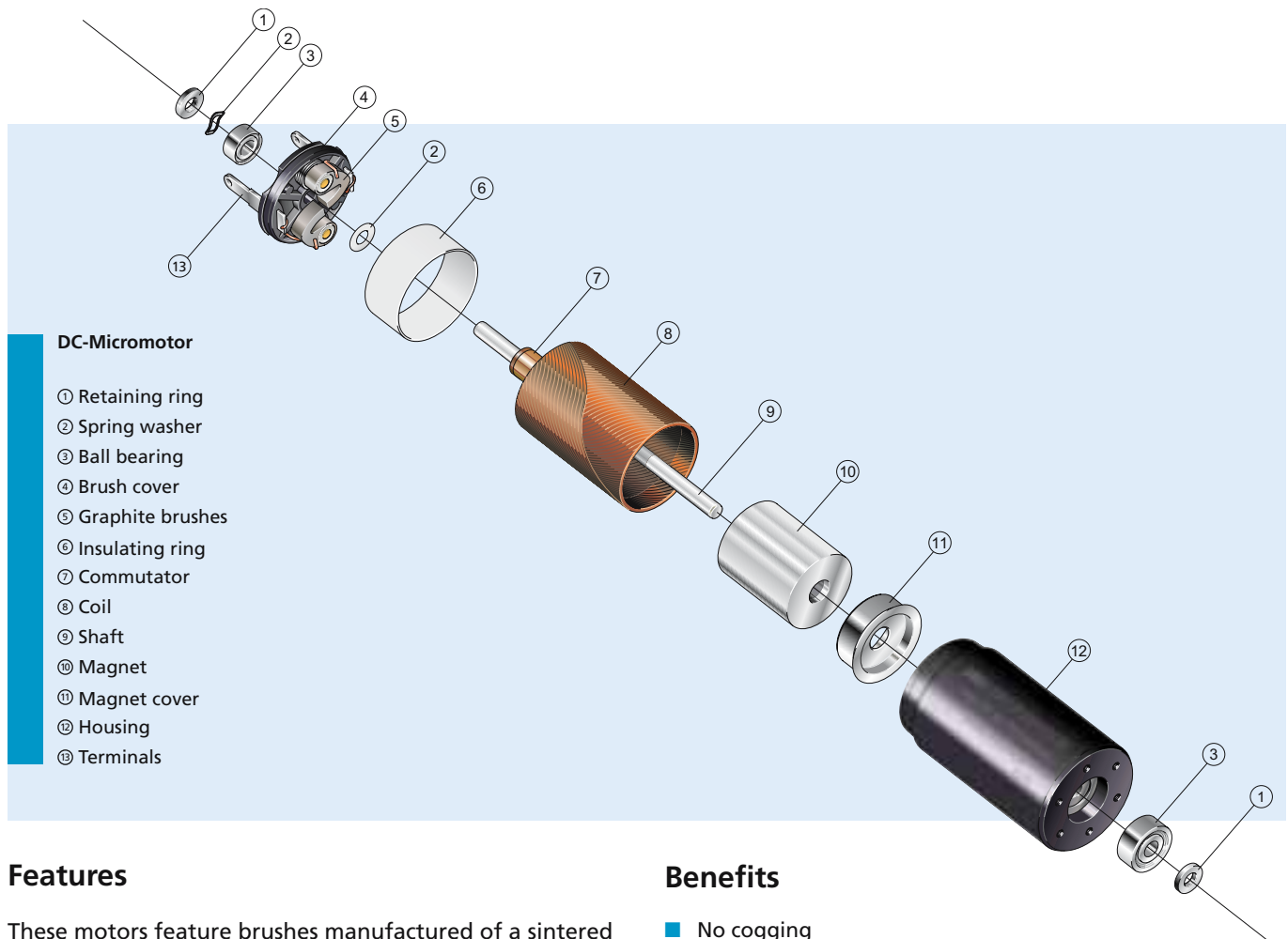
- 12 Motor diameter
- 19 Motor length [mm]
- N Shaft type
- 012 Nominal voltage [V]
- G Type of commutation (precious metal)

12 19 N 012 G

DC-Micromotors

Graphite Commutation

DC-Micromotors



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



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)

2342 S 024 CR

DC-Micromotors

Precious Metal Commutation

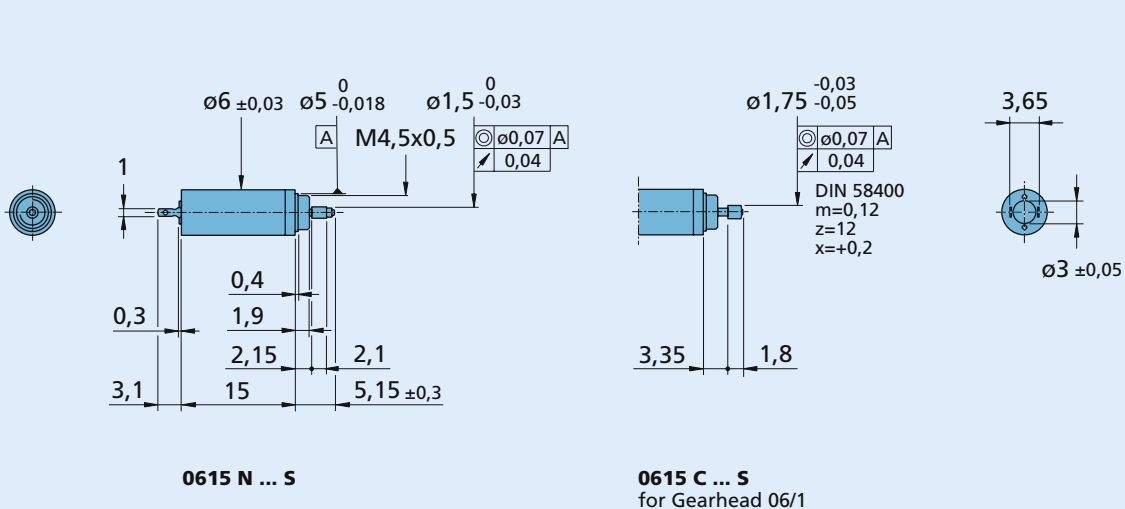
0,11 mNm

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

DC-Micromotors

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.	η_{\max}	52	50	48	%
5 No-load speed	n_0	19 100	20 200	20 000	rpm
6 No-load current (with shaft \varnothing 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	μ H
15 Mechanical time constant	τ_m	8	10	10	ms
16 Rotor inertia	J	0,01	0,01	0,01	gcm ²
17 Angular acceleration	α_{\max}	244	221	213	$\cdot 10^3$ rad/s ²
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	\leq	0,03			mm
– axial	\leq	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
29 Current up to (thermal limits)	$I_{e \max}$	0,341	0,167	0,11	A



DC-Micromotors

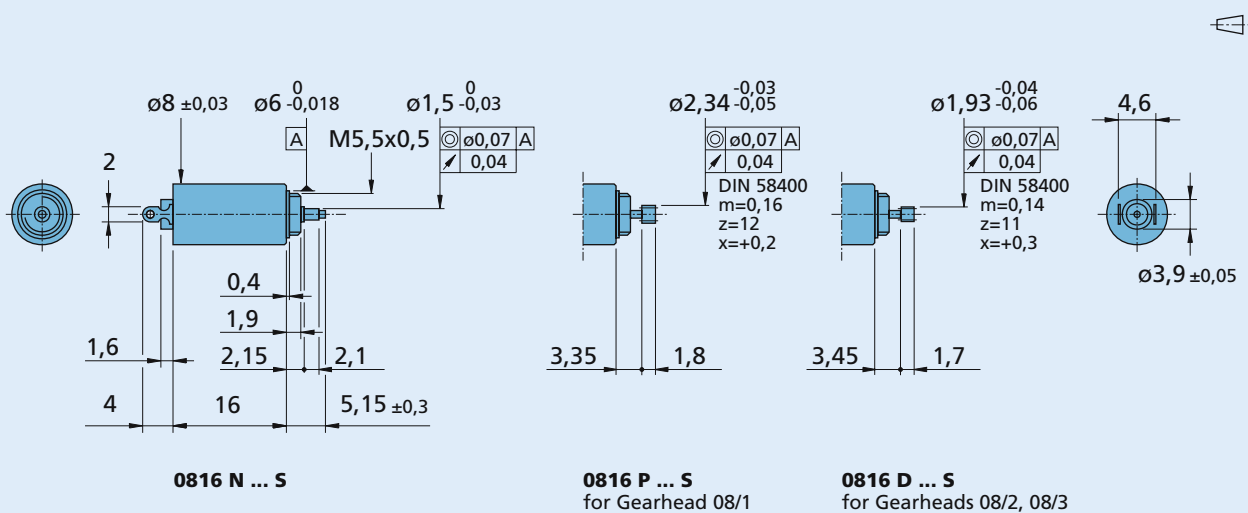
Precious Metal Commutation

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.	η_{\max}	52	51	50	%	
5 No-load speed	n_0	15 700	15 800	16 500	rpm	
6 No-load current (with shaft \varnothing 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	μ H	
15 Mechanical time constant	τ_m	12	13	14	ms	
16 Rotor inertia	J	0,03	0,03	0,03	gcm ²	
17 Angular acceleration	α_{\max}	138	132	133	$\cdot 10^3$ rad/s ²	
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	\leq	0,03			mm	
– axial	\leq	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
29 Current up to (thermal limits)	$I_{e \max}$		0,211	0,103	0,085	A



DC-Micromotors

Precious Metal Commutation

0,48 mNm

For combination with

Gearheads:

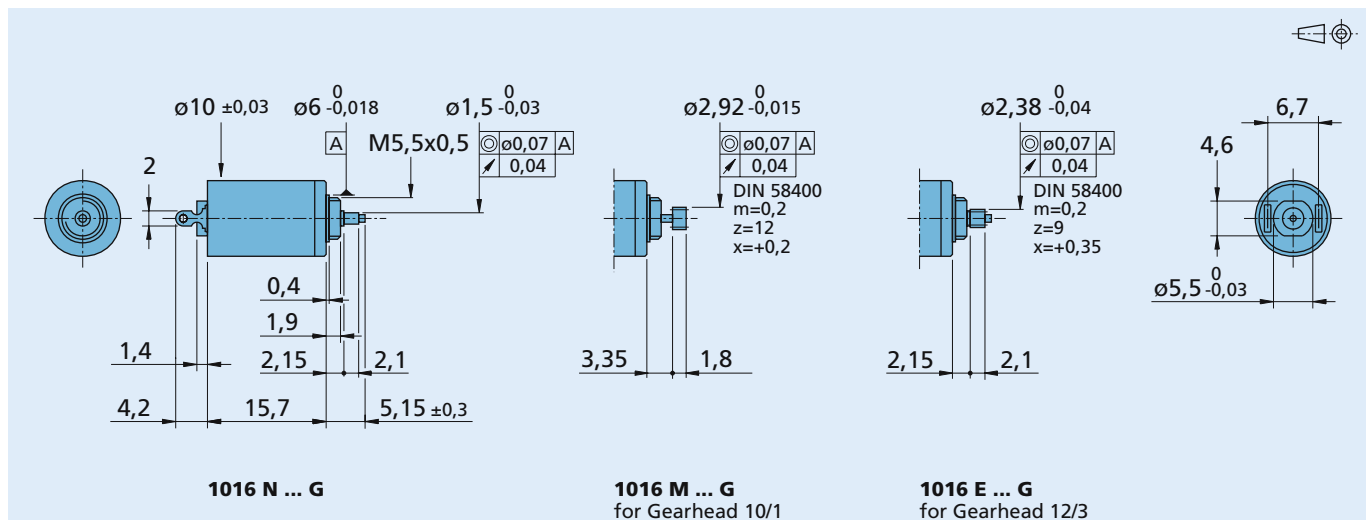
10/1, 12/3

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.	η_{\max}	63	67	68	%
5 No-load speed	n_0	14 200	18 400	16 500	rpm
6 No-load current (with shaft \varnothing 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	μ H
15 Mechanical time constant	τ_m	9	13	10	ms
16 Rotor inertia	J	0,04	0,06	0,05	gcm ²
17 Angular acceleration	α_{\max}	159	145	165	$\cdot 10^3$ rad/s ²
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
29 Current up to (thermal limits)	$I_{e \max}$	0,26	0,17	0,08	A



DC-Micromotors

Precious Metal Commutation

1,28 mNm

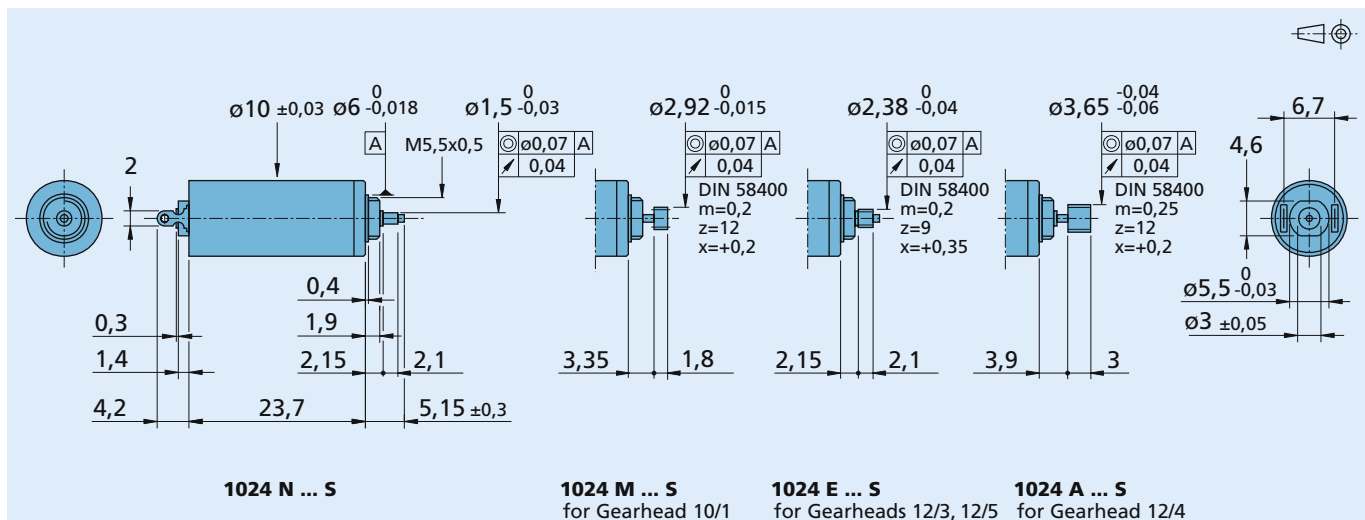
For combination with

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.	η_{\max}	79	78	79	%
5 No-load speed	n_0	13 800	13 200	14 700	rpm
6 No-load current (with shaft \varnothing 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	μ H
15 Mechanical time constant	τ_m	6	7	6	ms
16 Rotor inertia	J	0,12	0,12	0,12	gcm ²
17 Angular acceleration	α_{\max}	224	195	241	$\cdot 10^3$ rad/s ²
18 Thermal resistance	$R_{th 1} / R_{th 2}$	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	\leq	0,03			mm
– axial	\leq	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
29 Current up to (thermal limits)	$I_{e \max}$	0,636	0,291	0,17	A



DC-Micromotors

Precious Metal Commutation

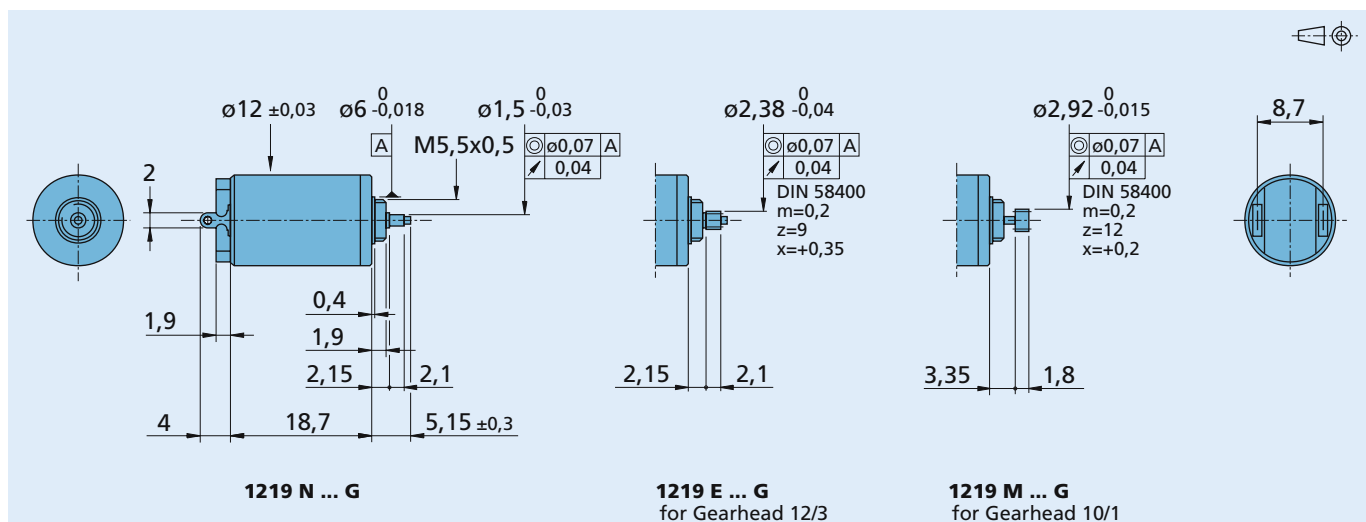
0,6 mNm

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

DC-Micromotors

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.	η_{\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 \varnothing 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	μ H	
15 Mechanical time constant	τ_m	20	20	18	19	ms	
16 Rotor inertia	J	0,14	0,14	0,13	0,11	gcm ²	
17 Angular acceleration	α_{\max}	81	84	92	87	$\cdot 10^3$ rad/s ²	
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)			$^{\circ}$ C	
- rotor, max. permissible		+85 (optional version	+125)			$^{\circ}$ 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		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
29 Current up to (thermal limits)	$I_{e \max}$		0,26	0,2	0,1	0,07	A



DC-Micromotors

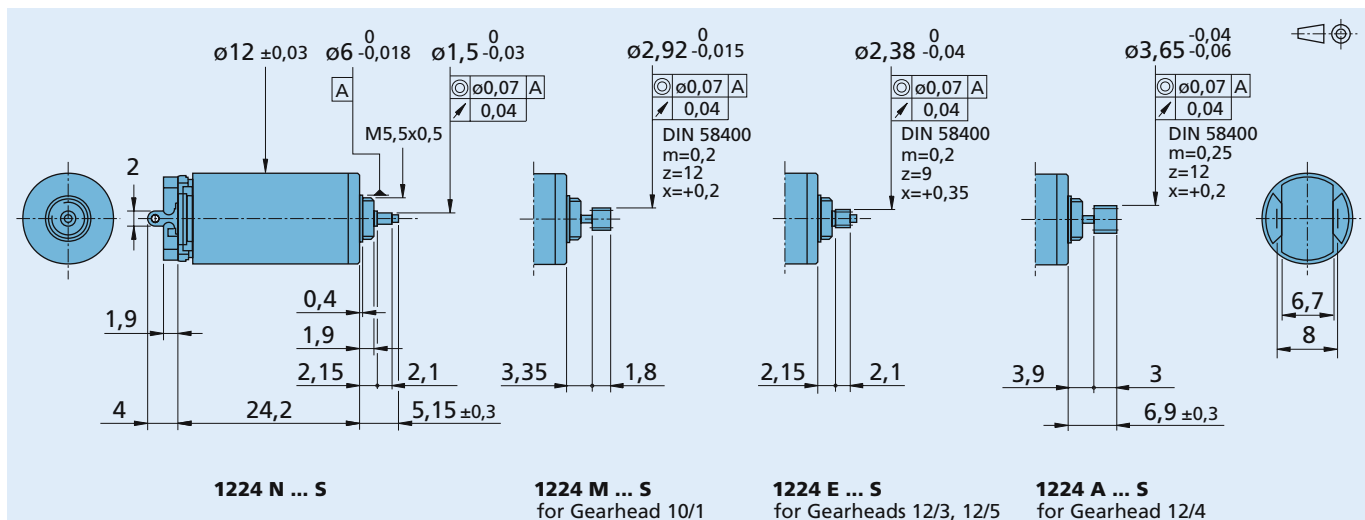
Precious Metal Commutation

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.	η_{\max}	78	78	78	%	
5 No-load speed	n_0	12 700	13 100	12 400	rpm	
6 No-load current (with shaft \varnothing 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	μ H	
15 Mechanical time constant	τ_m	7	7	7	ms	
16 Rotor inertia	J	0,18	0,18	0,18	gcm ²	
17 Angular acceleration	α_{\max}	205	200	201	$\cdot 10^3$ rad/s ²	
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	\leq	0,03			mm	
– axial	\leq	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
29 Current up to (thermal limits)	$I_{e \max}$		0,33	0,165	0,13	A



DC-Micromotors

Precious Metal Commutation

1,8 mNm

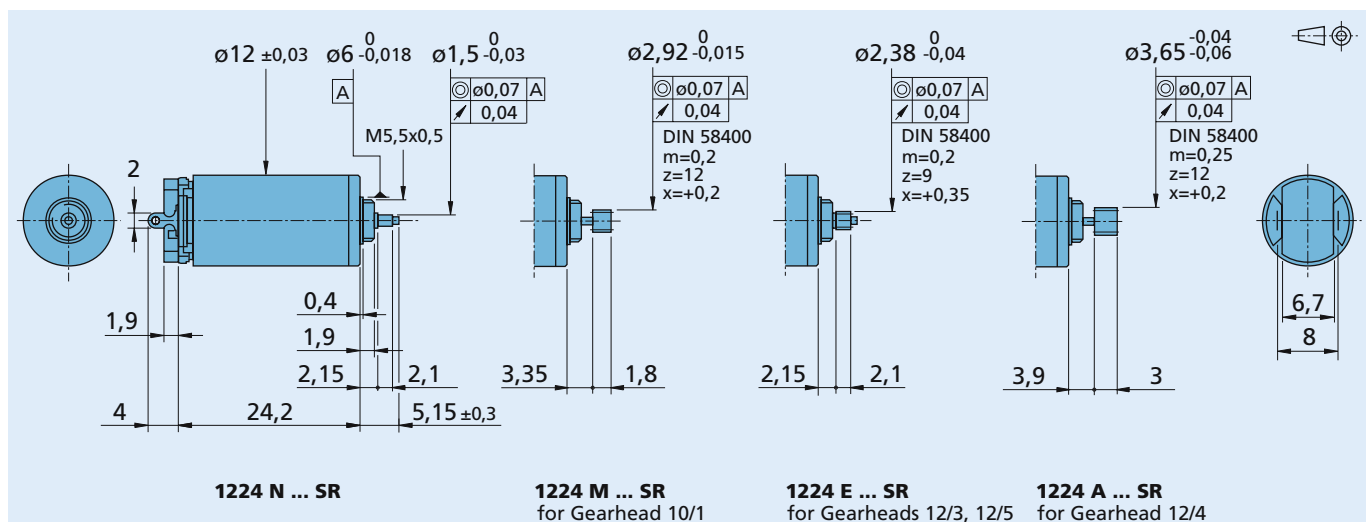
For combination with

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.	η_{\max}	82	83	83	%
5 No-load speed	n_0	13 800	13 700	13 400	rpm
6 No-load current (with shaft \varnothing 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	μ H
15 Mechanical time constant	τ_m	5	5	5	ms
16 Rotor inertia	J	0,18	0,18	0,18	gcm ²
17 Angular acceleration	α_{\max}	295	302	298	$\cdot 10^3$ rad/s ²
18 Thermal resistance	$R_{th 1} / R_{th 2}$	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)		$^{\circ}$ C
- rotor, max. permissible		+85 (optional version	+125)		$^{\circ}$ 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	\leq	0,03			mm
- axial	\leq	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
29 Current up to (thermal limits)	$I_{e \max}$	0,45	0,23	0,18	A



DC-Micromotors

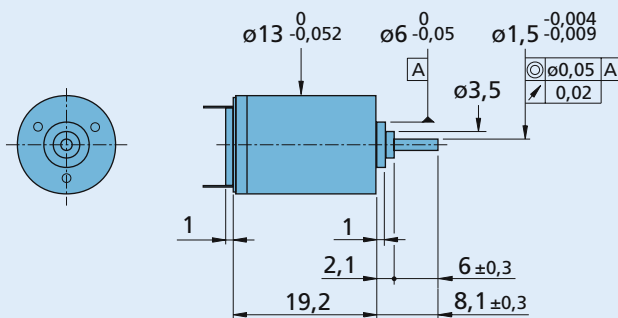
Precious Metal Commutation

1,3 mNm

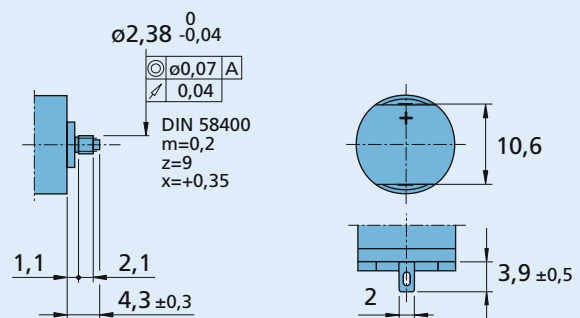
For combination with
Gearheads:
13A, 14/1, 15/5, 15/5 S
Encoders:
IE2-400

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.	η_{\max}	66	65	66	%
5 No-load speed	n_0	13 100	12 800	14 600	rpm
6 No-load current (with shaft \varnothing 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	μ H
15 Mechanical time constant	τ_m	19	19	19	ms
16 Rotor inertia	J	0,4	0,4	0,36	gcm ²
17 Angular acceleration	α_{\max}	72	71	80	$\cdot 10^3$ rad/s ²
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	\leq	0,03			mm
– axial	\leq	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
29 Current up to (thermal limits)	$I_{e \max}$	0,41	0,2	0,1	A



1319 T ... SR



1319 E ... SR

DC-Micromotors

Precious Metal Commutation

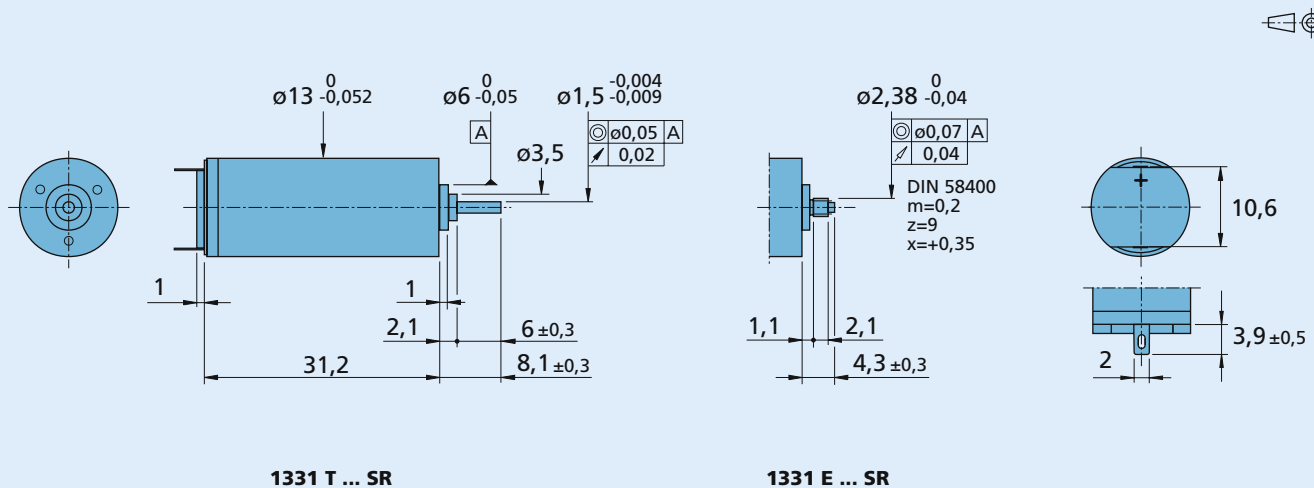
3,2 mNm

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

DC-Micromotors

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.	η_{\max}	81	80	80	%
5 No-load speed	n_0	10 600	9 900	10 400	rpm
6 No-load current (with shaft \varnothing 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	μ H
15 Mechanical time constant	τ_m	7	7	7	ms
16 Rotor inertia	J	0,71	0,67	0,63	gcm ²
17 Angular acceleration	α_{\max}	160	150	160	$\cdot 10^3 \text{ rad/s}^2$
18 Thermal resistance	$R_{th 1} / R_{th 2}$	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)			$^{\circ}$ C
– rotor, max. permissible		+125			$^{\circ}$ 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	\leq	0,03			mm
– axial	\leq	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
29 Current up to (thermal limits)	$I_{e \max}$	0,81	0,37	0,19	A



DC-Micromotors

Graphite Commutation

4 mNm

For combination with

Gearheads:

13A, 14/1

Encoders:

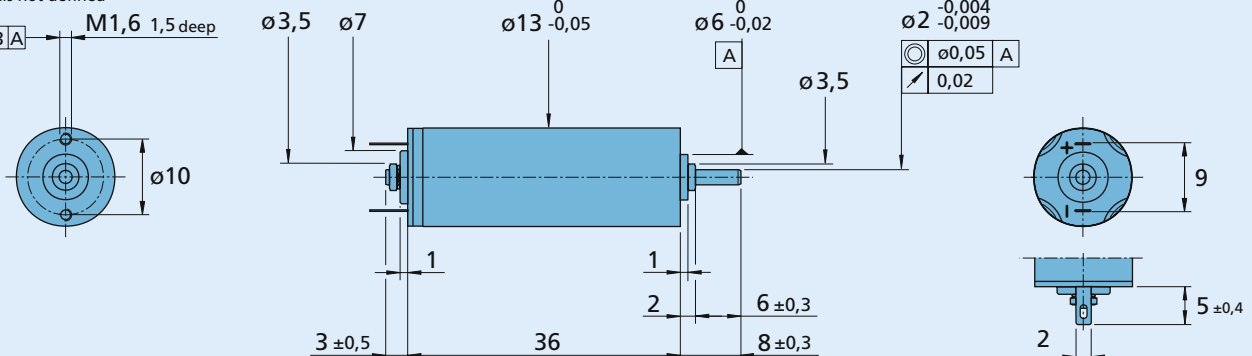
20B, 21B, 30B, IE2-1024, IE2-16

Series 1336 ... C

	1336 U	006 C	012 C	024 C	
1 Nominal voltage	U_N	6	12	24	V
2 Terminal resistance	R	4	15,6	63,6	Ω
3 Output power	$P_{2 \text{ max.}}$	1,75	1,98	2,02	W
4 Efficiency, max.	$\eta_{\text{ max.}}$	68	69	68	%
5 No-load speed	n_0	8 600	9 000	9 200	rpm
6 No-load current (with shaft \varnothing 2 mm)	I_0	0,051	0,025	0,013	A
7 Stall torque	M_H	7,79	8,4	8,39	mNm
8 Friction torque	M_R	0,3	0,29	0,31	mNm
9 Speed constant	k_n	1 620	810	406	rpm/V
10 Back-EMF constant	k_E	0,616	1,23	2,46	mV/rpm
11 Torque constant	k_M	5,88	11,8	23,5	mNm/A
12 Current constant	k_I	0,17	0,085	0,042	A/mNm
13 Slope of n-M curve	$\Delta n / \Delta M$	1 100	1 070	1 100	rpm/mNm
14 Rotor inductance	L	80	300	1 200	μH
15 Mechanical time constant	τ_m	5,5	5,5	5,5	ms
16 Rotor inertia	J	0,48	0,49	0,48	gcm^2
17 Angular acceleration	$\alpha_{\text{ max.}}$	160	170	180	$\cdot 10^3 \text{ rad/s}^2$
18 Thermal resistance	$R_{\text{th} 1} / R_{\text{th} 2}$	7 / 21			K/W
19 Thermal time constant	τ_{w1} / τ_{w2}	5,5 / 168			s
20 Operating temperature range:					
– motor		-30 ... +100			$^{\circ}\text{C}$
– rotor, max. permissible		+125			$^{\circ}\text{C}$
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	\leq	0,015			mm
– axial	\parallel	0			mm
24 Housing material		steel, black coated			
25 Weight		23			g
26 Direction of rotation		clockwise, viewed from the front face			
Recommended values - mathematically independent of each other					
27 Speed up to	$n_{e \text{ max.}}$	9 000	9 000	9 000	rpm
28 Torque up to	$M_{e \text{ max.}}$	4	4	4	mNm
29 Current up to (thermal limits)	$I_{e \text{ max.}}$	0,8	0,4	0,2	A

Orientation with respect to motor terminals not defined

2x $\oplus \varnothing 0,3 \text{ A}$ M1,6 1,5 deep



1336 U ... C

DC-Micromotors

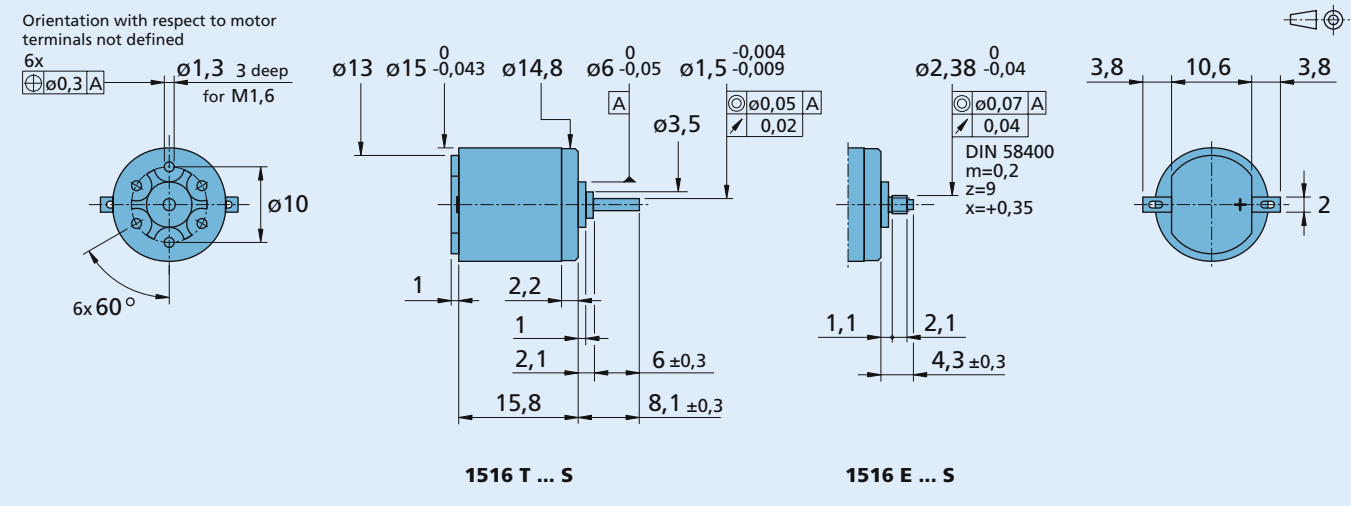
Precious Metal Commutation

0,4 mNm

For combination with
Gearheads:
15/5, 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.	η_{\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 \varnothing 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	μ H	
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	gcm ²	
17 Angular acceleration	α_{\max}	39	32	28	28	27	$\cdot 10^3 \text{ rad/s}^2$	
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:		-30 ... +65 (optional version -55 ... +125)					$^{\circ}$ C	
- motor							$^{\circ}$ C	
- rotor, max. permissible		+65 (optional version +125)					$^{\circ}$ 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	\leq	0,03	0,015	0,015			mm	
- axial	\leq	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
29 Current up to (thermal limits)	$I_{e \max}$		0,78	0,46	0,22	0,15	0,077	A



DC-Micromotors

Precious Metal Commutation

0,8 mNm

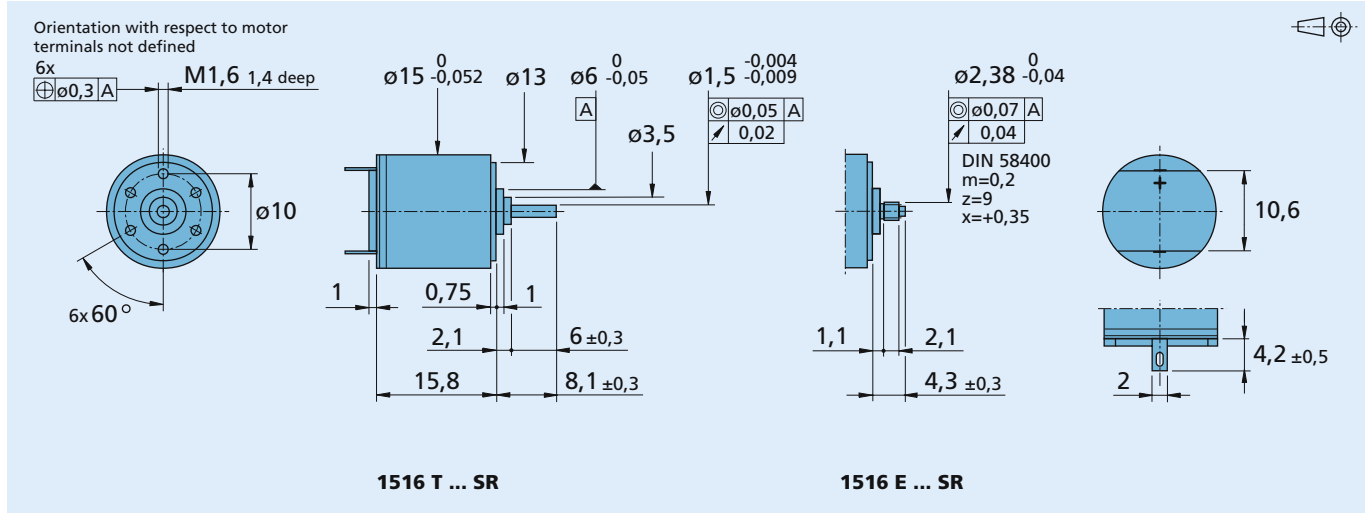
For combination with

Gearheads:
15/5, 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.	η_{\max}	57	58	58	%	
5 No-load speed	n_0	12 800	12 800	12 900	rpm	
6 No-load current (with shaft \varnothing 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	μ H	
15 Mechanical time constant	τ_m	35	35	35	ms	
16 Rotor inertia	J	0,4	0,42	0,4	gcm ²	
17 Angular acceleration	α_{\max}	38	38	39	$\cdot 10^3$ rad/s ²	
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)			$^{\circ}$ C	
- rotor, max. permissible		+125			$^{\circ}$ 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	\leq	0,03	0,015	0,015	mm	
- axial	\leq	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
29 Current up to (thermal limits)	$I_{e \max}$		0,33	0,22	0,16	A



DC-Micromotors

Precious Metal Commutation

2,5 mNm

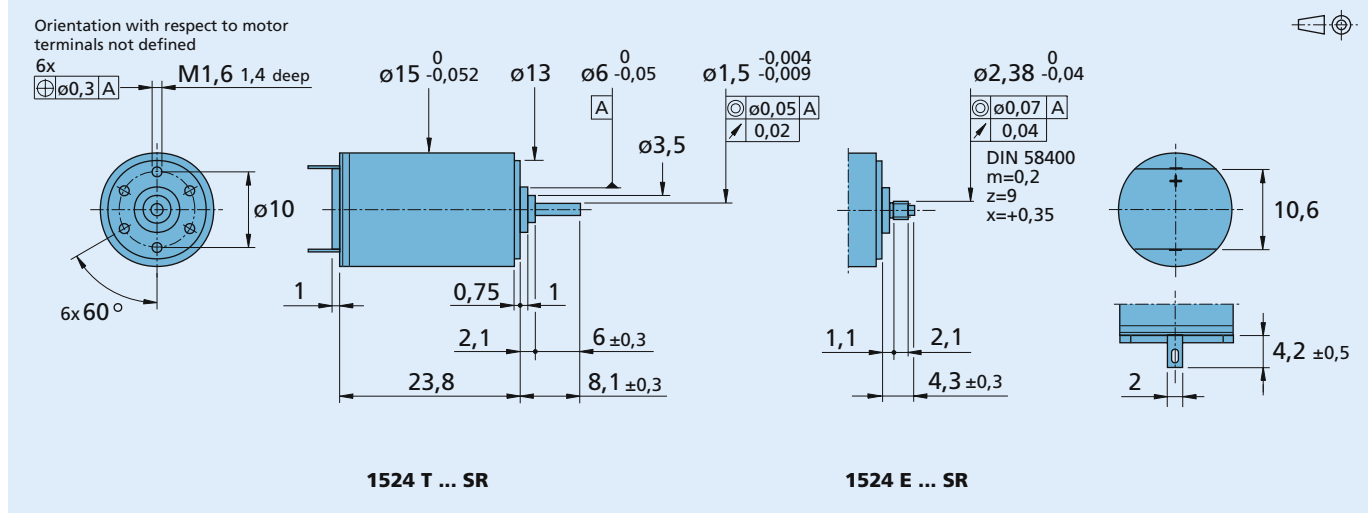
For combination with

Gearheads:
15/5, 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.	η_{\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 \varnothing 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	μ H
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	gcm ²
17 Angular acceleration	α_{\max}	110	100	110	100	100	100	$\cdot 10^3$ rad/s ²
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:		-30 ... +85 (optional version -55 ... +125)						°C
- motor								
- 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	\leq	0,03		0,015		0,015		mm
- axial	\leq	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
29 Current up to (thermal limits)	$I_{e \max}$	1,3	0,63	0,44	0,32	0,21	0,16	A



DC-Micromotors

Precious Metal Commutation

1,5 mNm

For combination with

Gearheads:

15A, 16/5, 16/5 S, 16/7, 16/8, 16A

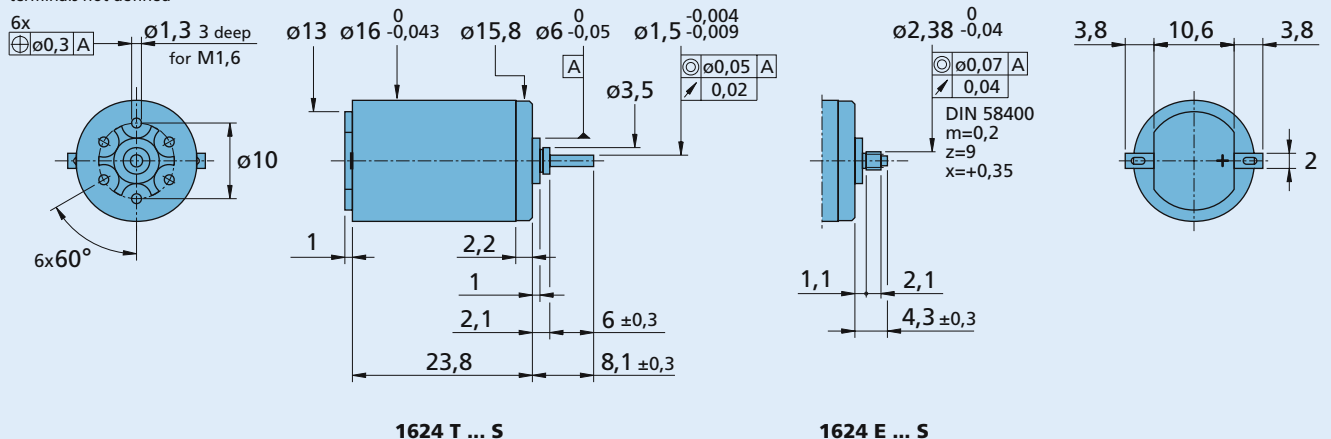
DC-Motor-Tacho Combinations:

1841 ... S

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.	η_{\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 \varnothing 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	μ H
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	gcm ²
17 Angular acceleration	α_{\max}	66	50	63	72	76	63	$\cdot 10^3$ rad/s ²
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)						$^{\circ}$ C
- rotor, max. permissible		+125						$^{\circ}$ 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		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	\leq	0,03		0,015		0,015		mm
- axial	\leq	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
29 Current up to (thermal limits)	$I_{e \max}$	0,98	0,37	0,32	0,25	0,19	0,14	A

Orientation with respect to motor terminals not defined



DC-Micromotors

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2 mNm

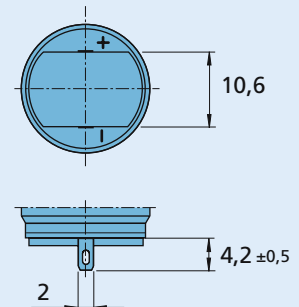
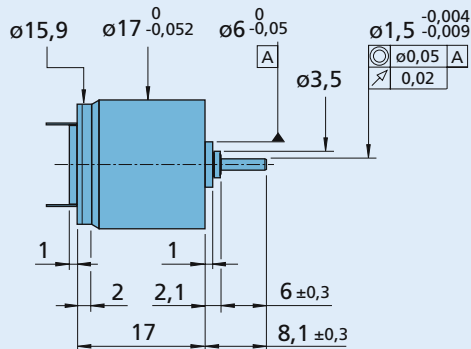
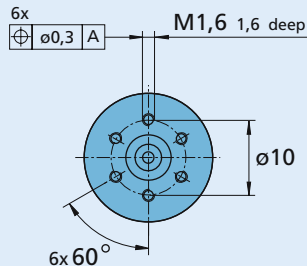
For combination with
Gearheads:
15A, 16/7, 16A
Encoders:
IE2-1024, IE2-16

DC-Micromotors

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.	η_{\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 \varnothing 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	μ H
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	gcm ²
17 Angular acceleration	α_{\max}	92	92	92	80	92	$\cdot 10^3 \text{ rad/s}^2$
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:		-30 ... +85 (optional version -55 ... +125)					°C
- motor							
- 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	\leq	0,03	0,015	0,015			mm
- axial	\leq	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
29 Current up to (thermal limits)	$I_{e \max}$	1,2	0,6	0,3	0,18	0,15	A

Orientation with respect to motor terminals not defined



1717 T ... SR

DC-Micromotors

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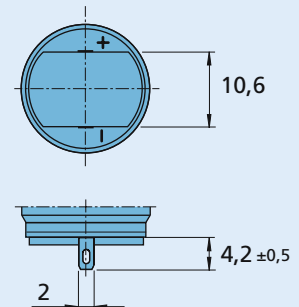
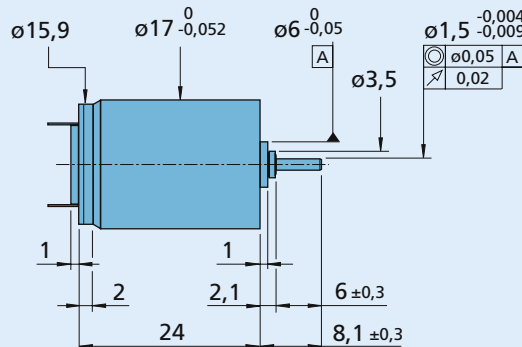
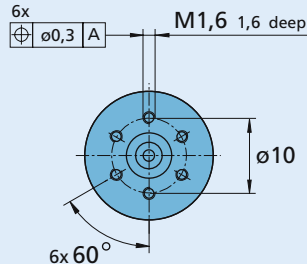
4,2 mNm

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.	η_{\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 \varnothing 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	μ H
15 Mechanical time constant	τ_m	8	8	8	8	8	ms
16 Rotor inertia	J	1,2	1	1	1	1	gcm ²
17 Angular acceleration	α_{\max}	110	110	100	100	100	$\cdot 10^3 \text{rad/s}^2$
18 Thermal resistance	$R_{th 1} / R_{th 2}$	4 / 24,5					K/W
19 Thermal time constant	τ_{w1} / τ_{w2}	2,6 / 270					s
20 Operating temperature range:		-30 ... +85 (optional version -55 ... +125)					°C
- motor							
- 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	\leq	0,03	0,015	0,015			mm
- axial	\leq	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
29 Current up to (thermal limits)	$I_{e \max}$	1,6	0,76	0,35	0,25	0,19	A

Orientation with respect to motor terminals not defined



1724 T ... SR

DC-Micromotors

Graphite Commutation

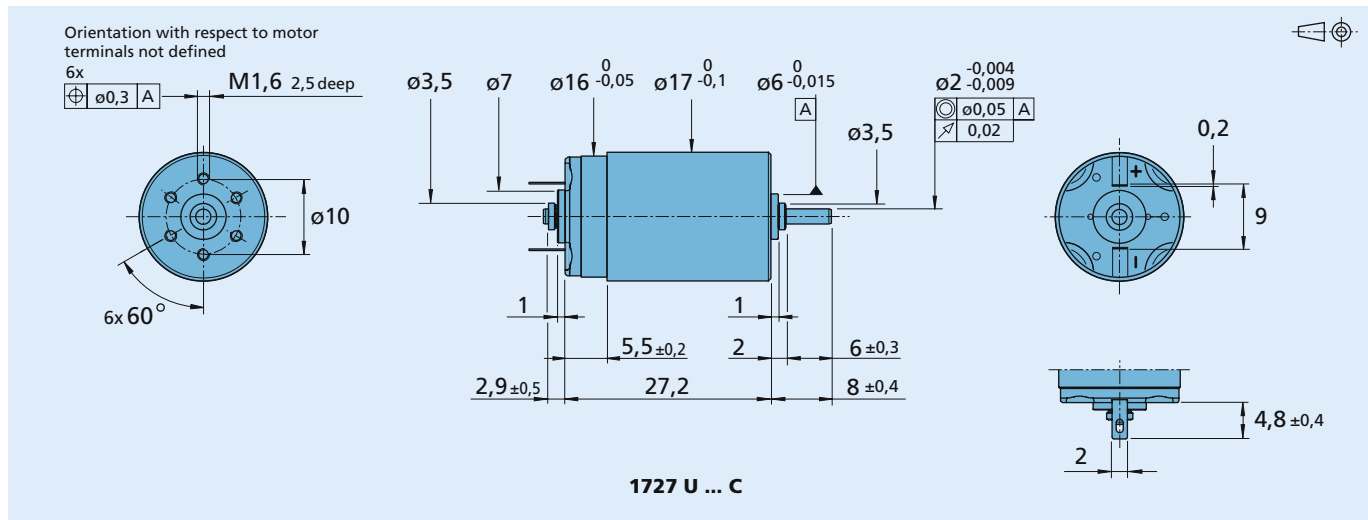
5 mNm

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

DC-Micromotors

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.	η_{\max}	70	70	70	%
5 No-load speed	n_0	7 800	7 800	7 800	rpm
6 No-load current (with shaft \varnothing 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	μ H
15 Mechanical time constant	τ_m	9	9	9	ms
16 Rotor inertia	J	1,3	1,2	1,2	gcm ²
17 Angular acceleration	α_{\max}	91	91	91	$\cdot 10^3$ rad/s ²
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			$^{\circ}$ C
- rotor, max. permissible		+125			$^{\circ}$ 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	\leq	0,015			mm
- axial	\parallel	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
29 Current up to (thermal limits)	$I_{e \max}$	0,9	0,42	0,2	A



DC-Micromotors

5 mNm

Precious Metal Commutation

For combination with

Gearheads:

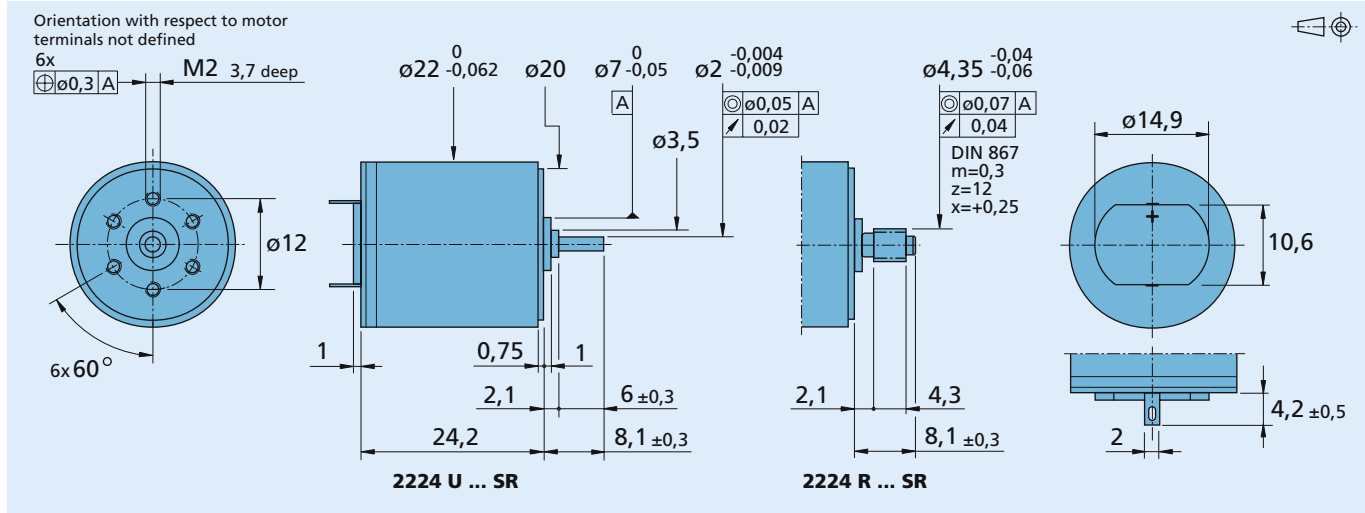
20/1, 22/2, 22/5, 22/7, 22E, 22EKV, 22F, 23/1, 38/3

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.	η_{\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 \varnothing 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	μ H
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	gcm ²
17 Angular acceleration	α_{\max}	77	78	74	77	74	74	$\cdot 10^3$ rad/s ²
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)						$^{\circ}$ C
- rotor, max. permissible		+125						$^{\circ}$ C
21 Shaft bearings		sintered bearings (standard)		ball bearings (optional version)		ball bearings, preloaded (optional version)		
22 Shaft load max.:								
- 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	Δr	0,03		0,015		0,015		mm
- axial	Δa	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
29 Current up to (thermal limits)	$I_{e \max}$	2,2	1,2	0,57	0,4	0,28	0,18	A



DC-Micromotors

Precious Metal Commutation

2,5 mNm

For combination with

Gearheads:

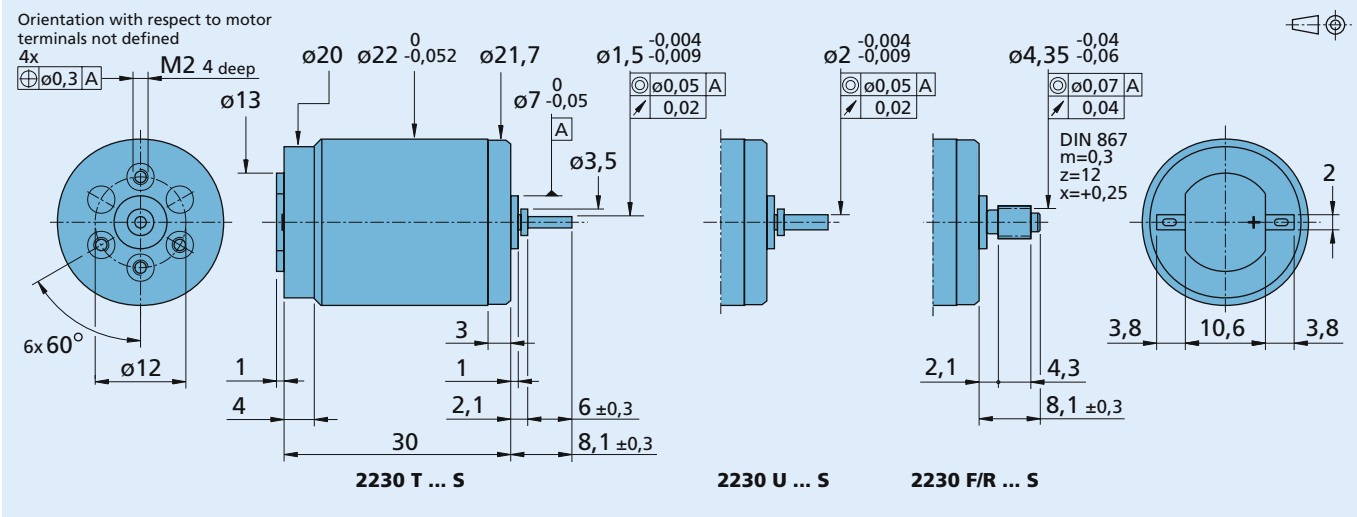
20/1, 22/2, 22/5, 22/7, 22E, 22EKV, 23/1, 38/3

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.	η_{\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 \varnothing 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	μ H
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	gcm ²
17 Angular acceleration	α_{\max}	40	49	50	44	50	39	$\cdot 10^3$ rad/s ²
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:		-30 ... +85 (optional version -55 ... +125)						°C
- motor								
- rotor, max. permissible		+125						°C
21 Shaft bearings		sintered bearings (standard)		ball bearings (optional version)		ball bearings, preloaded (optional version)		
22 Shaft load max.:		1,5		2		2		mm
- with shaft diameter		1,2		8		8		N
- radial at 3 000 rpm (3 mm from bearing)		0,2		0,8		0,8		N
- axial at 3 000 rpm		20		10		10		N
- axial at standstill								
23 Shaft play								
- radial	Δr	0,03		0,015		0,015		mm
- axial	Δa	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
29 Current up to (thermal limits)	$I_{e \max}$	1,94	0,87	0,45	0,32	0,21	0,1	A



DC-Micromotors

10 mNm

Precious Metal Commutation

For combination with

Gearheads:
20/1, 22/2, 22/5, 22/7, 22E, 22EKV, 22F, 23/1, 26A, 38/3

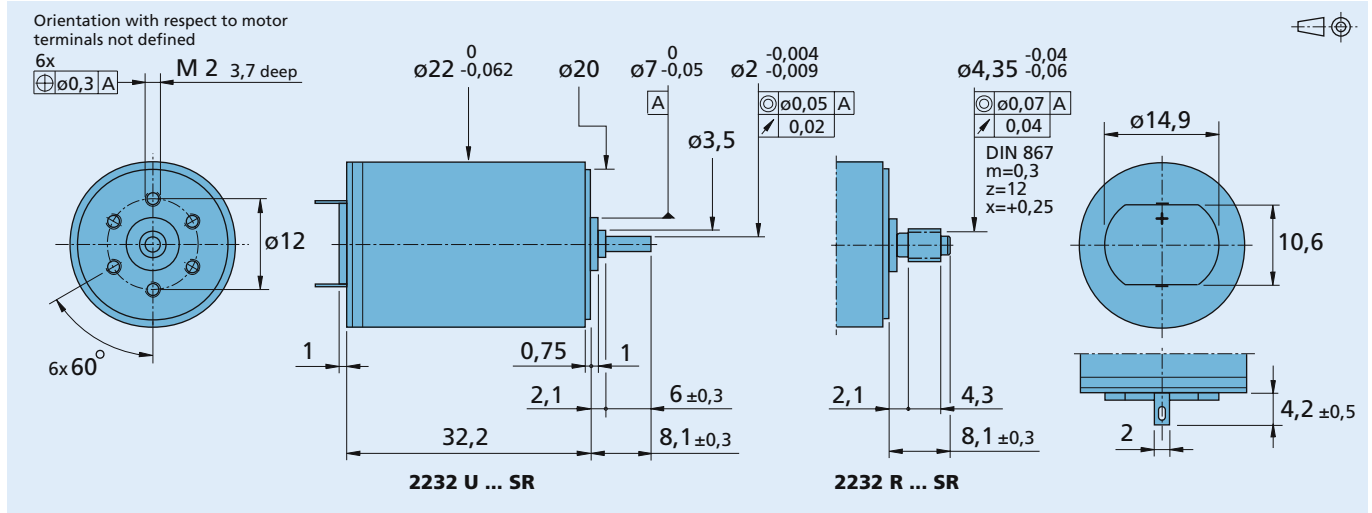
Encoders:
IE2-1024, IE2-16

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.	η_{\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 \varnothing 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	μ H
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	gcm ²
17 Angular acceleration	α_{\max}	120	120	120	120	120	120	$\cdot 10^3 \text{rad/s}^2$
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)						$^{\circ}\text{C}$
- rotor, max. permissible		+125						$^{\circ}\text{C}$
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	\leq	0,03		0,015		0,015		mm
- axial	\leq	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
29 Current up to (thermal limits)	$I_{e \max}$	1,87	1,3	0,94	0,74	0,63	0,46	A



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

DC-Motor-Tacho Combinations:

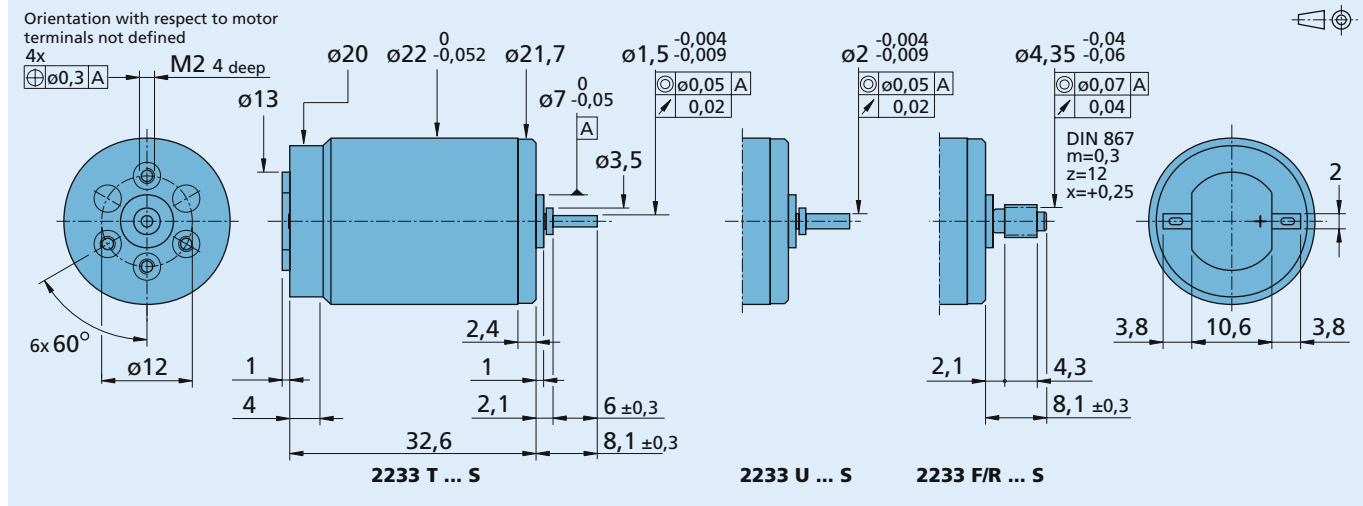
2251 ... S

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.	η_{\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 \varnothing 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	μ H
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	gcm ²
17 Angular acceleration	α_{\max}	70	76	74	65	84	81	$\cdot 10^3$ rad/s ²
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:		-30 ... +85 (optional version -55 ... +125)						°C
- motor								
- rotor, max. permissible		+125						°C
21 Shaft bearings		sintered bearings (standard)		ball bearings (optional version)		ball bearings, preloaded (optional version)		
22 Shaft load max.:		1,5		2		2		mm
- with shaft diameter		1,2		8		8		N
- radial at 3 000 rpm (3 mm from bearing)		0,2		0,8		0,8		N
- axial at 3 000 rpm		20		10		10		N
- axial at standstill								
23 Shaft play								
- radial	\leq	0,03		0,015		0,015		mm
- axial	\leq	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
29 Current up to (thermal limits)	$I_{e \max}$	1,34	0,9	0,49	0,3	0,2	0,14	A



DC-Micromotors

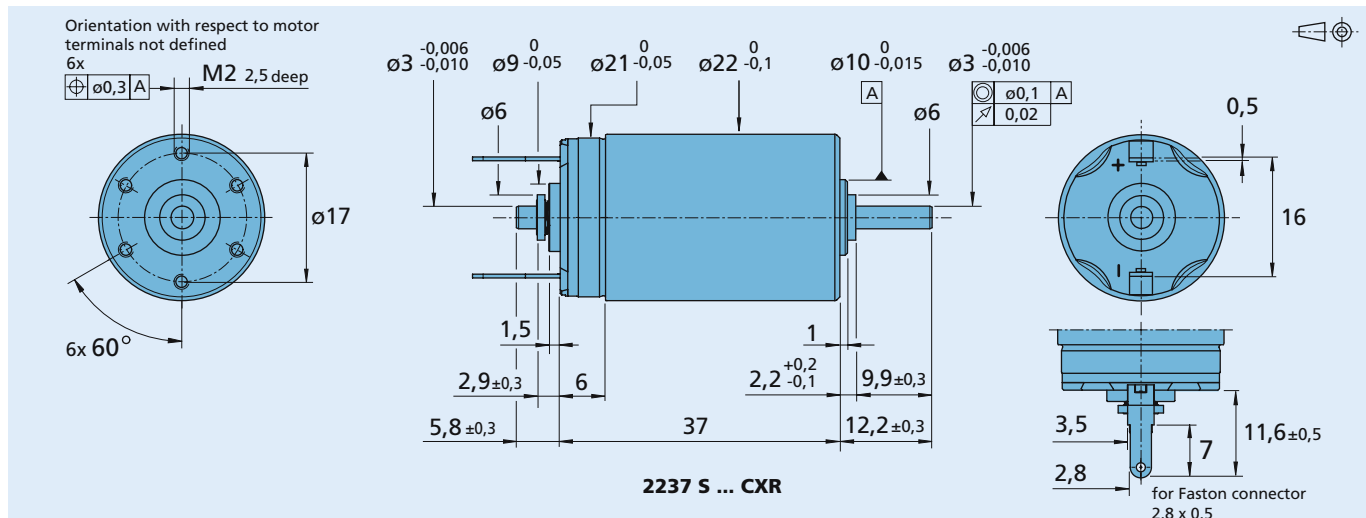
Graphite Commutation

11 mNm

For combination with
Gearheads:
22/7, 22F, 23/1, 26A
Encoders:
IE3-1024, 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	$P_{2 \text{ max.}}$	8,6	8,1	8,7	8,5	9,2	8,6	W
4 Efficiency, max.	$\eta_{\text{max.}}$	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 \varnothing 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	gcm^2
17 Angular acceleration	$\alpha_{\text{max.}}$	152	147	152	150	157	152	$\cdot 10^3 \text{rad/s}^2$
18 Thermal resistance	$R_{\text{th} 1} / R_{\text{th} 2}$	8 / 17						K/W
19 Thermal time constant	τ_{w1} / τ_{w2}	13 / 500						s
20 Operating temperature range:								
- motor		-30 ... +100						$^{\circ}\text{C}$
- rotor, max. permissible		+125						$^{\circ}\text{C}$
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	\leq	0,03		0,015				mm
- axial	\leq	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	$n_{e \text{ max.}}$	7 000	7 000	7 000	7 000	7 000	7 000	rpm
28 Torque up to	$M_{e \text{ max.}}$	10	10,5	10,5	10,5	11	11	mNm
29 Current up to (thermal limits)	$I_{e \text{ max.}}$	1,65	0,8	0,55	0,41	0,28	0,2	A



DC-Micromotors

Graphite Commutation

16 mNm

For combination with

Gearheads:
22/7, 22F, 23/1, 26/1, 26/1 S, 26A, 30/1, 30/1 S, 38/3

Encoders:

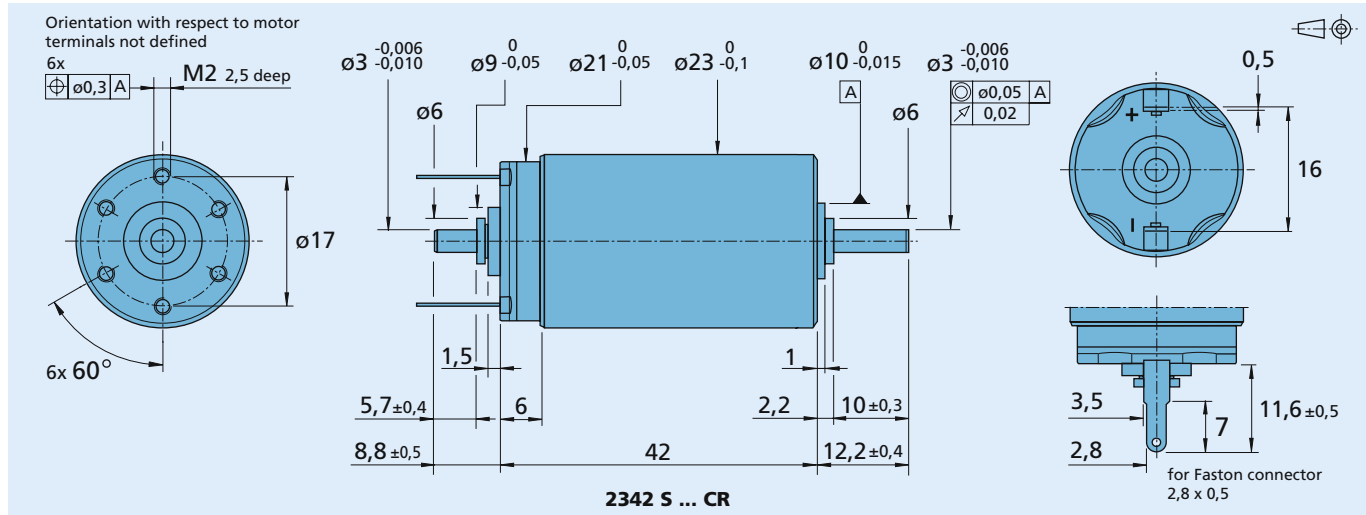
HEDL 5540, HEDM 5500, HEDS 5500, HEDS 5540, IE2-1024, IE2-16, IE3-1024, IE3-1024 L

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.	η_{\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 \varnothing 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	μ H
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	gcm ²
17 Angular acceleration	α_{\max}	160	140	140	150	140	140	$\cdot 10^3$ rad/s ²
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	\leq	0,015						mm
- axial	\parallel	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
29 Current up to (thermal limits)	$I_{e\max}$	2,7	1,4	0,95	0,72	0,48	0,35	A



DC-Micromotors

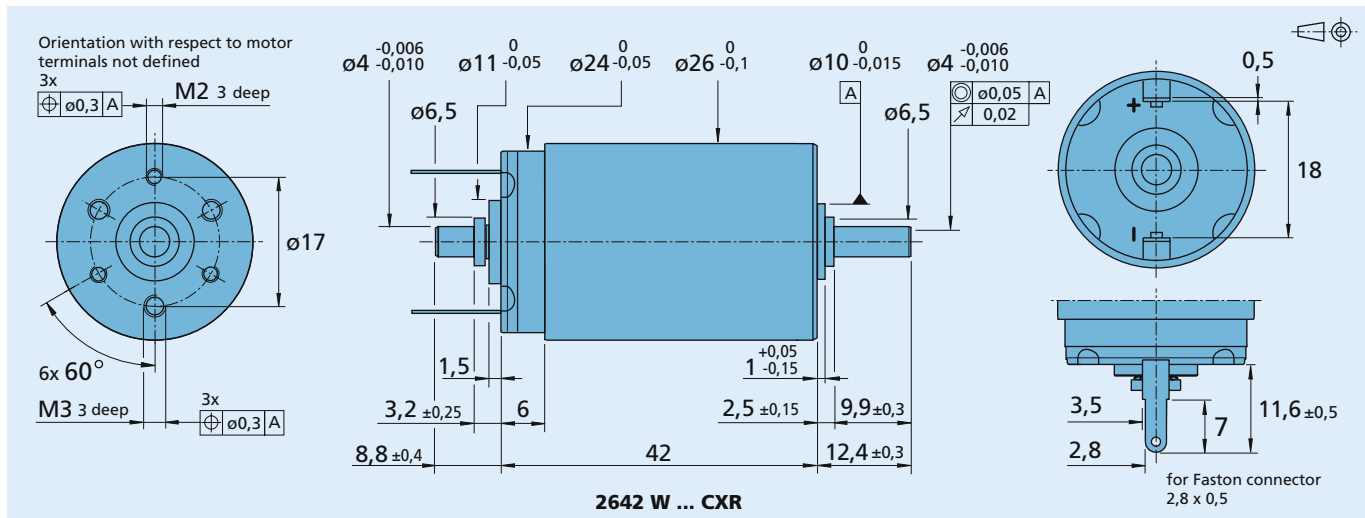
Graphite Commutation

23 mNm

For combination with
 Gearheads:
 26/1, 26/1 S, 26A, 30/1, 30/1 S, 32A
 Encoders:
 IE3-1024, 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 \varnothing 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	μ H
15 Mechanical time constant	τ_m	5,1	4,9	5	ms
16 Rotor inertia	J	12	12	12	gcm ²
17 Angular acceleration	$\alpha_{\ max}$	121	125	124	$\cdot 10^3$ rad/s ²
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	\leq	0,03	0,015		mm
– axial	\leq	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
29 Current up to (thermal limits)	$I_{e\ max}$	1,34	0,7	0,35	A



DC-Micromotors

Graphite Commutation

28 mNm

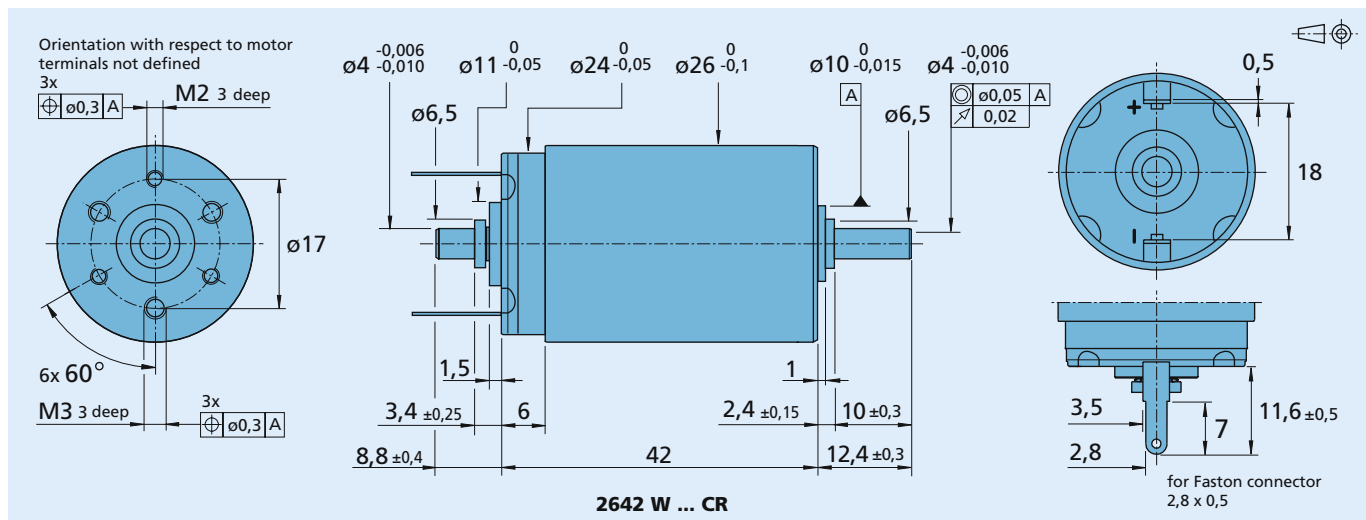
For combination with

Gearheads:
26/1, 26/1 S, 26A, 30/1, 30/1 S, 32A

Encoders:
HEDL 5540, HEDM 5500, HEDS 5500, HEDS 5540,
IE2-1024, IE2-16, IE3-1024, 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 \varnothing 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	μ H
15 Mechanical time constant	τ_m	5,4	5,4	5,4	ms
16 Rotor inertia	J	11	11	11	gcm ²
17 Angular acceleration	$\alpha_{\ max.}$	120	120	120	$\cdot 10^3$ rad/s ²
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			$^{\circ}$ C
– rotor, max. permissible		+155			$^{\circ}$ 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	\perp	0,015			mm
– axial	\parallel	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
29 Current up to (thermal limits)	$I_{e\ max.}$	1,97	0,98	0,48	A



DC-Micromotors

Graphite Commutation

35 mNm

For combination with

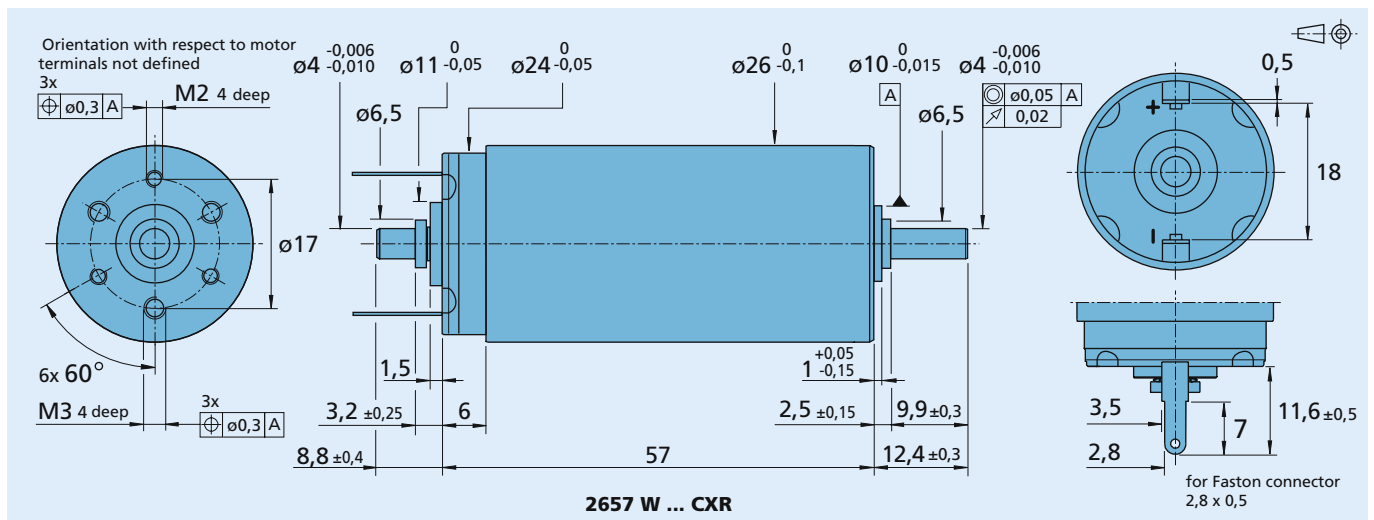
Gearheads:
26/1, 26/1 S, 26A, 30/1, 30/1 S, 32A

Encoders:

IE3-1024, 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	$P_{2 \text{ max.}}$	45,3	45,7	44,1	W
4 Efficiency, max.	$\eta_{\text{ max.}}$	81	83	83	%
5 No-load speed	n_0	5 600	5 800	5 800	rpm
6 No-load current (with shaft \varnothing 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	gcm^2
17 Angular acceleration	$\alpha_{\text{ max.}}$	180	178	172	$\cdot 10^3 \text{ rad/s}^2$
18 Thermal resistance	$R_{\text{th} 1} / R_{\text{th} 2}$	4,4 / 12,6			K/W
19 Thermal time constant	τ_{w1} / τ_{w2}	28 / 810			s
20 Operating temperature range:					
- motor		-30 ... +100			$^{\circ}\text{C}$
- rotor, max. permissible		+125			$^{\circ}\text{C}$
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	\leq	0,03	0,015		mm
- axial	\leq	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	$n_{e \text{ max.}}$	6 000	6 000	6 000	rpm
28 Torque up to	$M_{e \text{ max.}}$	33	34	35	mNm
29 Current up to (thermal limits)	$I_{e \text{ max.}}$	2,03	1,05	0,53	A



DC-Micromotors

Graphite Commutation

44 mNm

For combination with

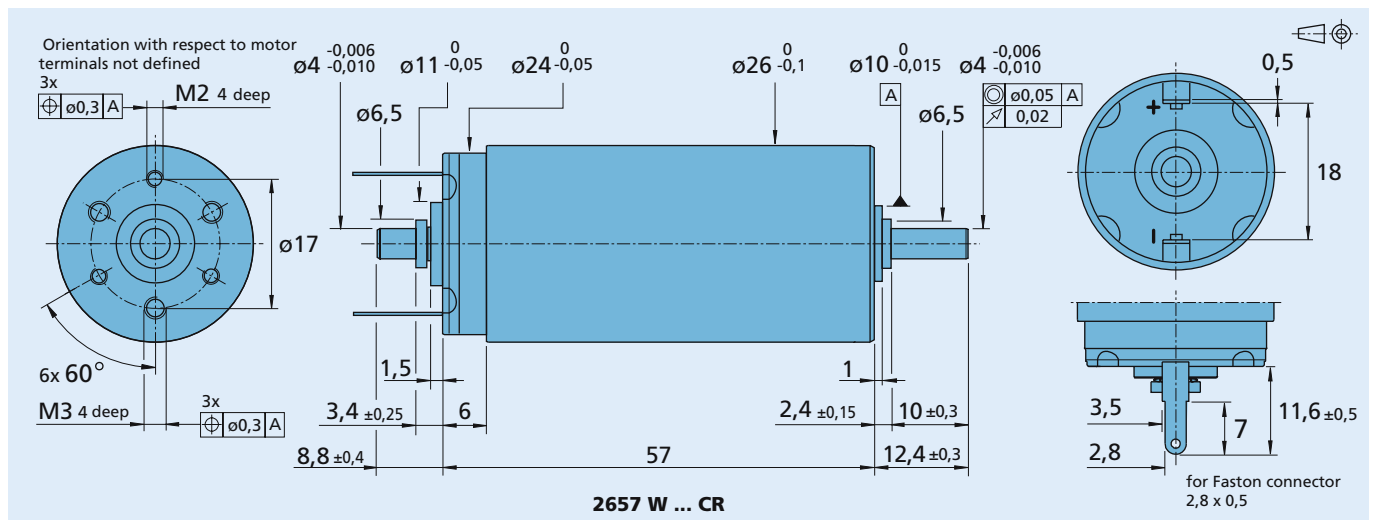
Gearheads:
26/1, 26/1 S, 26A, 30/1, 30/1 S, 32A

Encoders:

HEDL 5540, HEDM 5500, HEDS 5500, HEDS 5540,
IE2-1024, IE2-16, IE3-1024, 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	$P_{2 \text{ max.}}$	45,9	47,9	44,5	W
4 Efficiency, max.	$\eta_{\text{max.}}$	84	85	84	%
5 No-load speed	n_0	6 300	6 400	6 400	rpm
6 No-load current (with shaft \varnothing 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	τ_m	3,9	3,9	3,9	ms
16 Rotor inertia	J	16	17	15	gcm^2
17 Angular acceleration	$\alpha_{\text{max.}}$	170	170	170	$\cdot 10^3 \text{rad/s}^2$
18 Thermal resistance	$R_{\text{th} 1} / R_{\text{th} 2}$	1,9 / 9			K/W
19 Thermal time constant	τ_{w1} / τ_{w2}	10 / 580			s
20 Operating temperature range:					
– motor		-30 ... +125			$^{\circ}\text{C}$
– rotor, max. permissible		+155			$^{\circ}\text{C}$
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	\perp	0,015			mm
– axial	\parallel	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	$n_{e \text{ max.}}$	6 000	6 000	6 000	rpm
28 Torque up to	$M_{e \text{ max.}}$	44	44	44	mNm
29 Current up to (thermal limits)	$I_{e \text{ max.}}$	3,1	1,54	0,73	A



DC-Micromotors

Graphite Commutation

35 mNm

For combination with

Gearheads:

32/3, 32/3 S, 32A, 38/1, 38/1 S, 38/2, 38/2 S, 38A

Encoders:

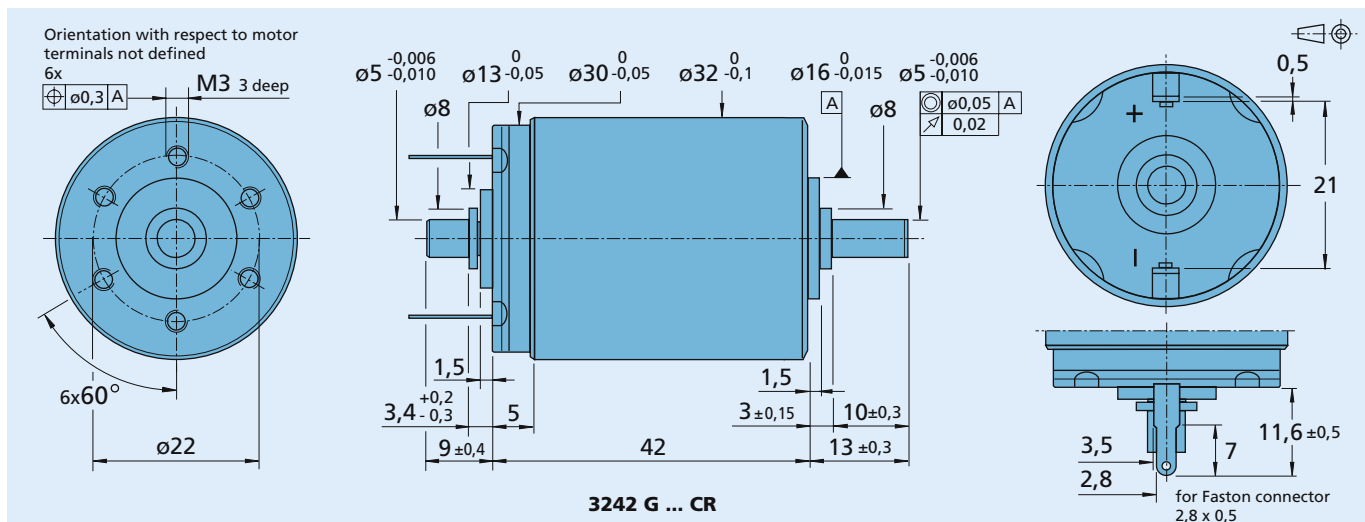
HEDL 5540, HEDM 5500, HEDS 5500, HEDS 5540, IE2-1024, IE2-16, IE3-1024, IE3-1024 L

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.	η_{\max}	72	73	73	%
5 No-load speed	n_0	5 200	5 300	5 400	rpm
6 No-load current (with shaft \varnothing 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	μ H
15 Mechanical time constant	τ_m	7,5	7,5	7,5	ms
16 Rotor inertia	J	25	26	26	gcm ²
17 Angular acceleration	α_{\max}	73	74	75	$\cdot 10^3$ rad/s ²
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			$^{\circ}$ C
– rotor, max. permissible		+155			$^{\circ}$ 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	\leq	0,015			mm
– axial	\parallel	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
29 Current up to (thermal limits)	$I_{e \max}$	2,4	1,2	0,6	A



DC-Micromotors

Graphite Commutation

70 mNm

For combination with

Gearheads:

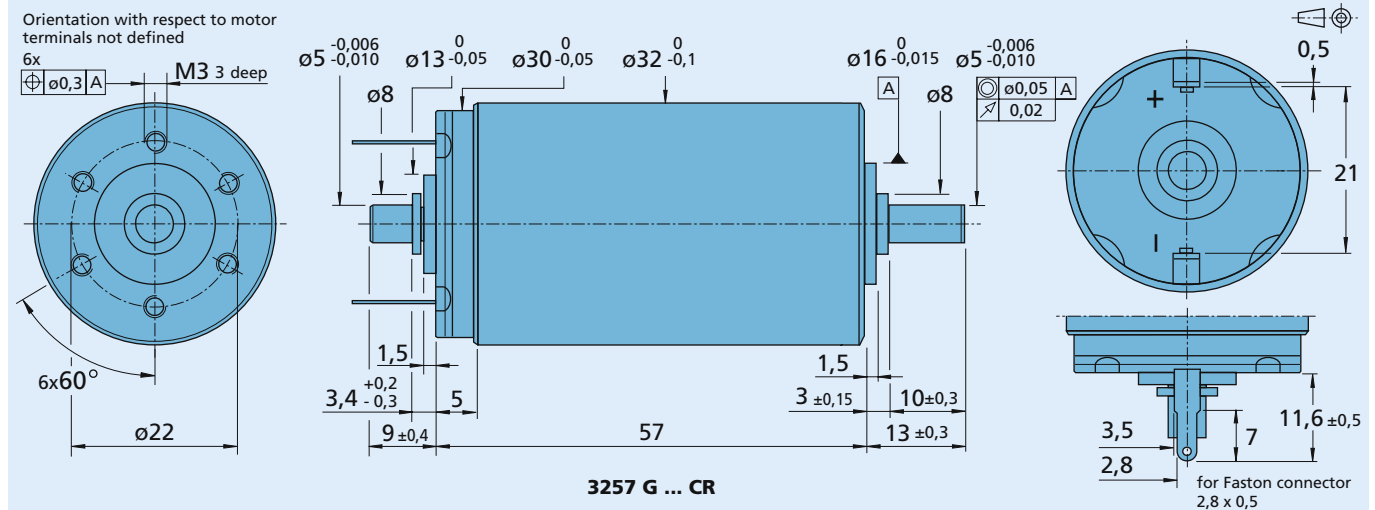
32/3, 32/3 S, 32A, 38/1, 38/1 S, 38/2, 38/2 S, 38A

Encoders:

HEDL 5540, HEDM 5500, HEDS 5500, HEDS 5540, IE2-1024, IE2-16, IE3-1024, 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.	η_{\max}	83	83	83	%
5 No-load speed	n_0	5 700	5 900	5 900	rpm
6 No-load current (with shaft \varnothing 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	μ H
15 Mechanical time constant	τ_m	4,7	4,7	4,7	ms
16 Rotor inertia	J	42	41	42	gcm ²
17 Angular acceleration	α_{\max}	130	130	130	$\cdot 10^3$ rad/s ²
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			$^{\circ}$ C
– rotor, max. permissible		+155			$^{\circ}$ 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	\perp	0,015			mm
– axial	\parallel	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
29 Current up to (thermal limits)	$I_{e \max}$	4,6	2,3	1,15	A



DC-Micromotors

Graphite Commutation

50 mNm

For combination with

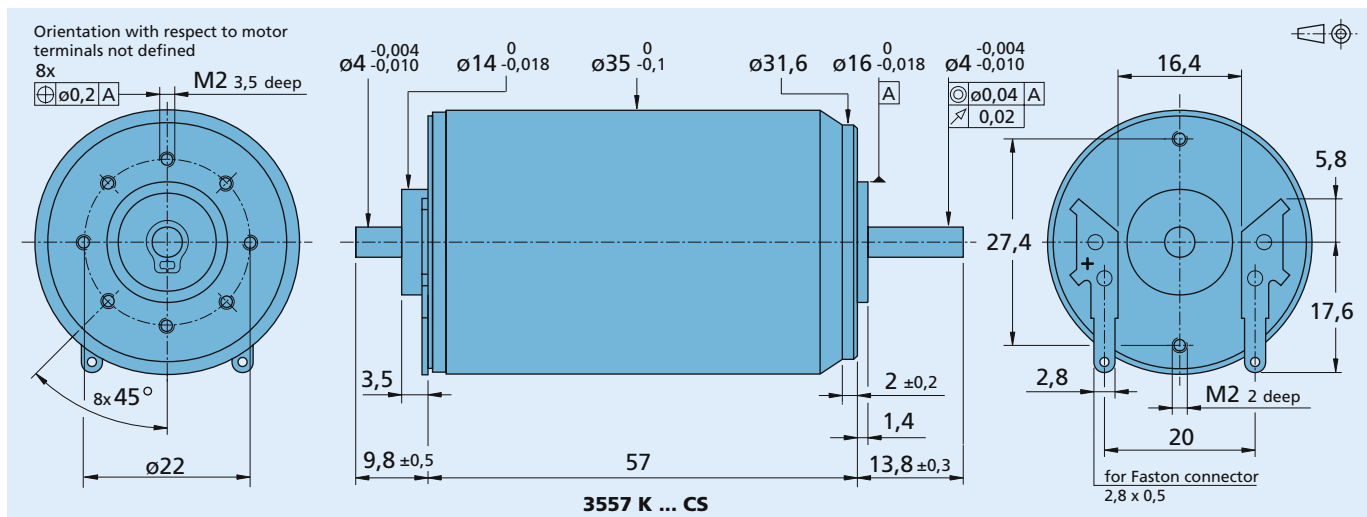
Gearheads:
30/1, 30/1 S, 32/3, 32/3 S, 38/1, 38/1 S, 38/2,
38/2 S, 38A

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.	η_{\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 \varnothing 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	μ H
15 Mechanical time constant	τ_m	16	16	16	16	16	ms
16 Rotor inertia	J	50	52	47	49	52	gcm ²
17 Angular acceleration	α_{\max}	37	35	36	36	34	$\cdot 10^3$ rad/s ²
18 Thermal resistance	$R_{th 1} / R_{th 2}$	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		+125					°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	\perp	0,015					mm
– axial	\parallel	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
29 Current up to (thermal limits)	$I_{e \max}$	3,15	2,26	1,3	1,1	0,54	A

¹⁾ thermal resistance $R_{th 2}$ by 40% reduced



DC-Micromotors

Graphite Commutation

110 mNm

For combination with

Gearheads:
38/1, 38/1 S, 38/2, 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.	η_{\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 \varnothing 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	μ H
15 Mechanical time constant	τ_m	6	6,5	6	6	6	ms
16 Rotor inertia	J	110	100	110	100	110	gcm ²
17 Angular acceleration	α_{\max}	110	110	120	110	120	$\cdot 10^3 \text{rad/s}^2$
18 Thermal resistance	$R_{th 1} / R_{th 2}$	1,5 / 6					K/W
19 Thermal time constant	τ_{w1} / τ_{w2}	33 / 843					s
20 Operating temperature range:							
– motor		-30 ... +125					$^{\circ}\text{C}$
– rotor, max. permissible		+155					$^{\circ}\text{C}$
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	\perp	0,015					mm
– axial	\parallel	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							
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
29 Current up to (thermal limits)	$I_{e \max}$	7,6	4,9	3,8	2,4	1,9	A

