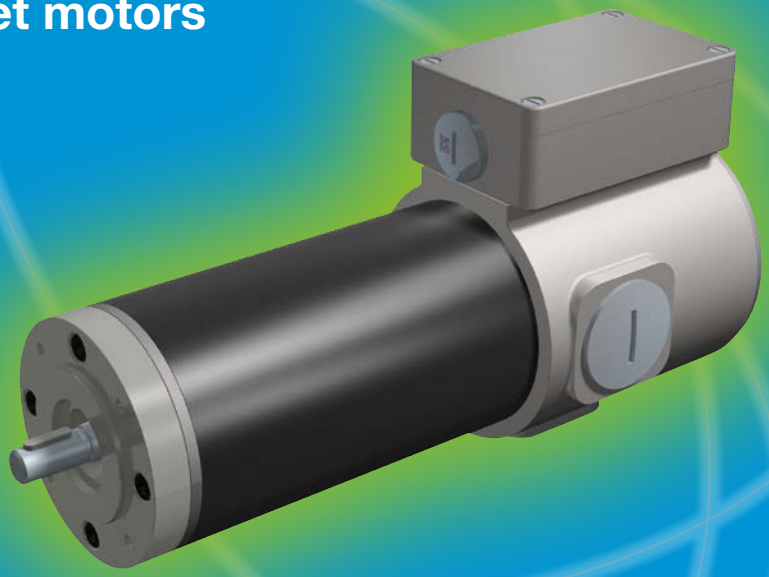
mayr®

your reliable partner

tendo®-PM

Permanent magnet motors and servomotors



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www.mayr.com

If the following is the case in your machines:

- **Basic “Windscreen-wiper motors” do not fulfil your requirements**
- **Carbon service times, lifetime and reliability play a particularly important role**
- **An open and unprotected design is not sufficient**
- **Running noises and vibrations are not required**
- **Emphasis is placed on low maintenance effort and expenses**
- **Gear backlash is a problem**
- **The gear not only has to reduce speeds but also has to transmit significant torques**

then our *tendo*®-PM motors are perfectly suited to your application.

We are happy to provide you with a motor so that you can test it thoroughly and convince yourself that our *tendo*®-PM motor is better than the conventional market standard.

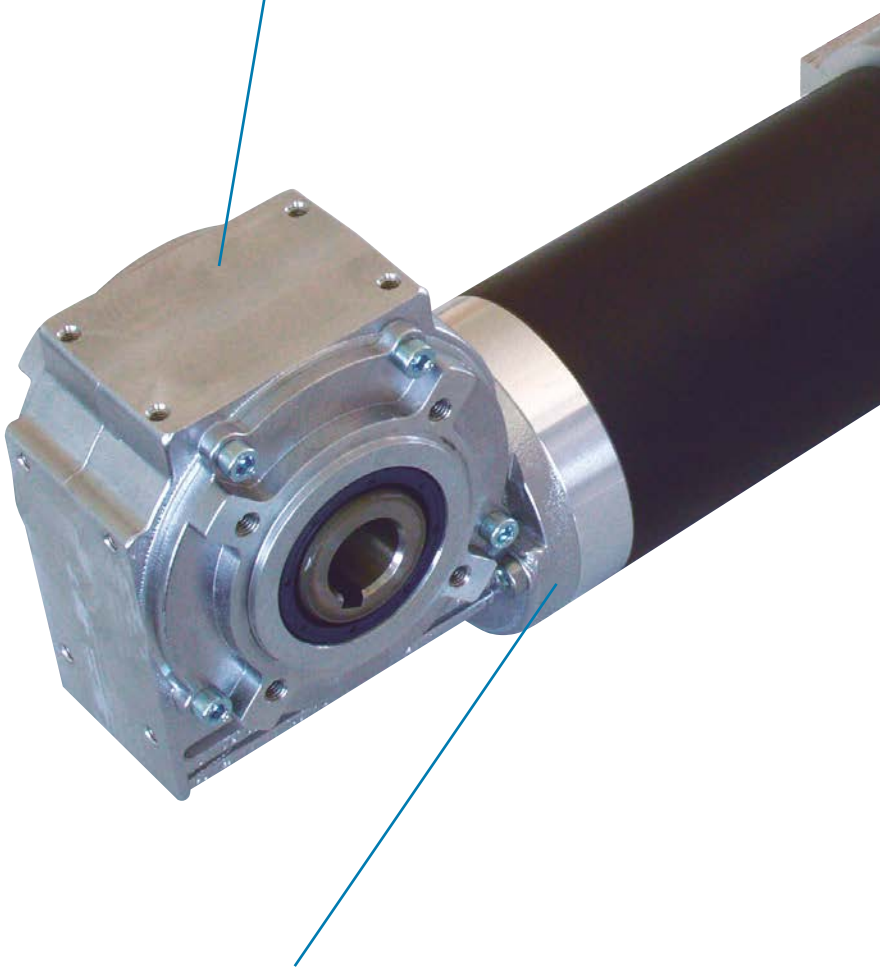
***tendo*®-PM** DC motors

The optimum drive

High-power gears

Many DC gear motors are designed to reduce speeds, and are not suitable for the transmission of high torques. ***tendo***®-PM motors reliably transmit every torque possible based on the motor output and gear transmission, and run very quietly due to:

- Generous gear dimensions
- High tooth contact
- Low circumferential backlash
- Minimal gear tolerances



Fixed bearing with optimised ball bearing

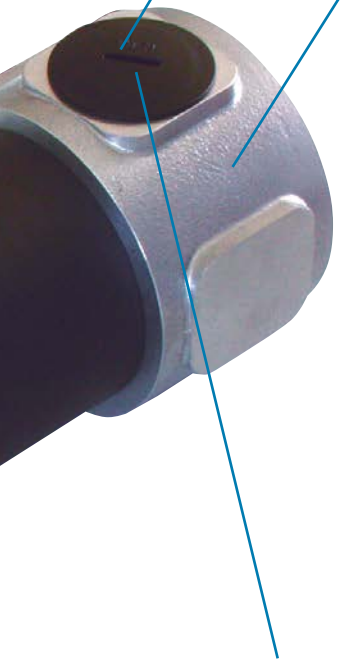
The optimised fixed bearing with special grease filling on the A-side of the motor plays a major role in the good running and favourable noise characteristics of the motor.

Many motor manufacturers do without fixed bearing and adapted grease filling, consciously risking unnecessary noises, harmful vibrations and premature failure.

Optimally sealed

The largest problem with most DC motors is their open construction. They cannot be used in critical environmental influences.
Here, too, ***tendo***®-PM motors show their superior quality through:

- Protection IP54
- Protection IP65 (up to IP68 on request)



Very comfortable and extremely reliable through unique commutation

tendo®-PM motors feature a conspicuous commutation system with a generously dimensioned collector, a high number of collector lamellae and large-area carbons with appropriately high wear volumes.
This technical “luxury” provides the *tendo*®-PM with advantages which lift it substantially above the standard:

- Carbon lifetimes from 5000 to 6000 hours (usually 2000 to 3000 hours)
- Even running through low torque ripple and high speed constancy
- Exceptionally low-noise

Almost maintenance-free

On conventional DC motors, the carbons have to be replaced regularly, and usually the collector also has to be machined (turned).

On the ***tendo***®-PM, it is sufficient to remove the carbon dust and to replace the carbons when completely worn.

Application-optimised customer solutions

In addition to the standard designs, the ***tendo***®-PM module provides a lot of room for solutions specifically tailored to the respective application.

Talk to us about the task you have at hand.

Our flexible team will quickly prepare for you an economically-viable solution right up to the production of a prototype drive.

Consultation, service, samples

Our service is as special as the motors themselves.

- Detailed and competent consultation
- Fast preparation of an application-optimised and economically viable drive solution
- Fast provision of drives for your tests
- Support during installation and commissioning
- Fast and reliably customer service

Application-optimised drive solutions

The modular system of the ***tendo***®-PM motors stands for a fast, uncomplicated and economic drive optimisation, tailored to your application:

- 7 different motor sizes
- 2 types of gear (worm and planetary gears)
- 2 different gear sizes for some motor sizes
- Tacho generators and incremental encoders for positioning tasks and servo applications
- Work and holding brakes
- Different overload protection to protect the motor and gear
- Mains-connection capable single and multiple quadrant controllers

The optimum motor for every task

The name ***tendo***®-PM stands for a DC motor series which is mainly characterised by

- ❒ **Modular concept**
- ❒ **Long service lifetime**
- ❒ **Reliability**
- ❒ **Quality**
- ❒ **Protection IP54 and IP65**

tendo®-PM – these are motors with good concentricity even at the lowest speeds, good speed stability even when subjected to large load fluctuations, and a high degree of efficacy. They can also be used as direct drives.
The following are available as standard:

- ❒ Voltages 24 V and 160 V (60 V)
- ❒ Speeds 2000 rpm and 3000 rpm.

The ***tendo***®-PM concept is modular. You will find exactly what will suit your requirements:

- ❒ A drive with adjustable speeds
- ❒ Servomotors for drive solutions in the positioning range
- ❒ Drives with gears
- ❒ Motors with brakes
- ❒ Connection via cable, plug or terminal box

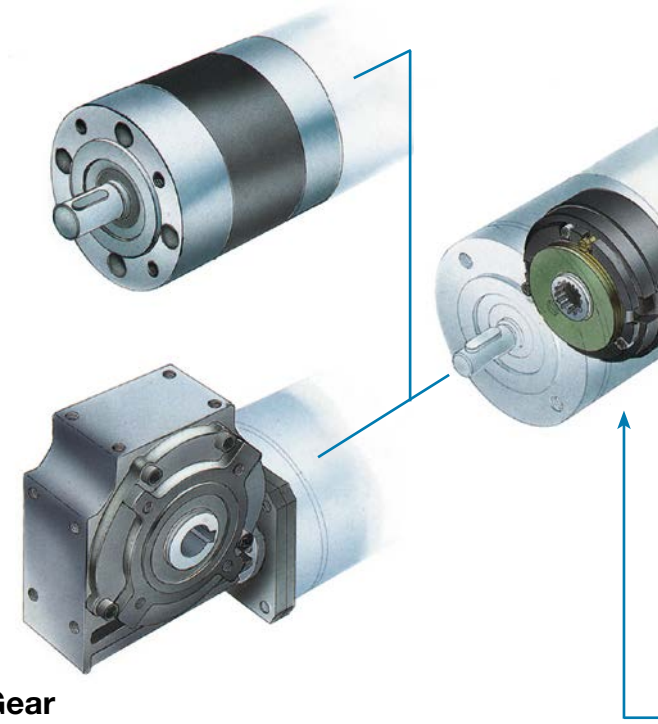
Performance overview

Size	Power	Nominal torque	Continuous operating torque up to	
			with worm gear	with planetary gear
	[W]	[Nm]	[Nm]	[Nm]
tendo®-PM 41	63	0.22	5	25
tendo®-PM 42	115	0.4	10	30
tendo®-PM 52	160	0.55	14.5	63
tendo®-PM 53	235	0.79	22.5	70
tendo®-PM 61	190	0.6	18	70
tendo®-PM 62	350	1.15	34	70
tendo®-PM 63	500	1.7	50	70

Table 1

Planetary Gear

- ❒ Compact design
- ❒ Optionally available in low-backlash design
- ❒ Coaxial output
- ❒ High impact loads permitted
- ❒ High degree of efficacy
- ❒ Low mass moment of inertia



Worm Gear

- ❒ Large reduction range
- ❒ Universal housing for different attachment options
- ❒ Standard design hollow shaft drive
- ❒ Stub shaft, 1-sided or 2-sided on request
- ❒ Low-noise
- ❒ With integrated slip hub on request, also with activation

Contents

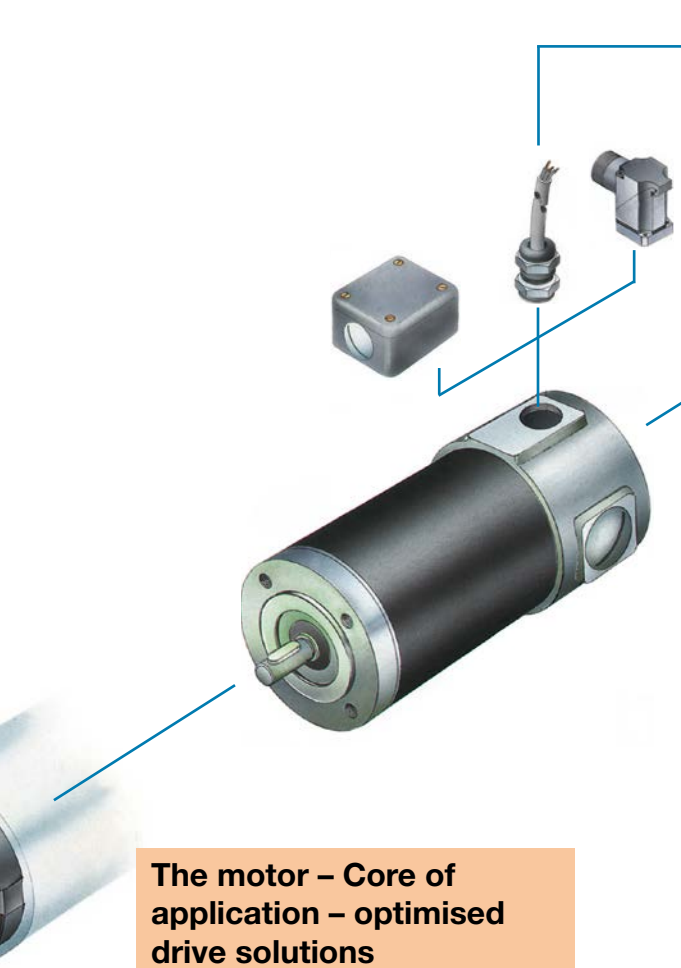
Motor connection

In the standard design, the connection of the motor and the components takes place via cable, optionally with a terminal box or plug connection.

Control

A typical characteristic of ***tendo***®-PM motors is that the speed follows the armature voltage in a linear manner, and the torque follows the armature current. This means that these motors can be controlled highly effectively with little effort. For this task, we offer you different control devices:

- 1Q transistor controller (drives in one direction)
- 4Q transistor controller (drives and brakes in both directions)

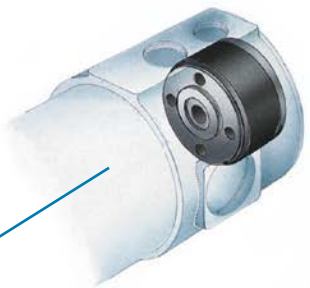


Mounting Variations

Tacho

Analogue speed measurement

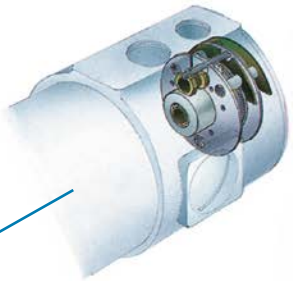
Direct current tacho 15V/1000 rpm suitable for 1Q and 4Q operation in control range up to 1:1000



Incremental encoder

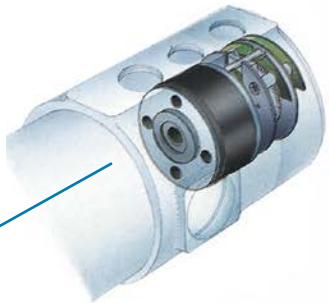
Digital speed measurement/ positioning

Standard 1000 p./rev; 5V TTL
Other pulse counts available on request



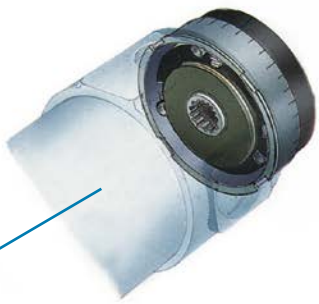
Servo design

Combination of **DC tacho** and **incremental encoder** for accurate positioning tasks in servo applications



ROBA-stop®-positioning brake

Attachment of a performance brake for brake motor tasks,
Standard voltages 24 VDC / 207 VDC (104 VDC)
other voltages available on request



The motor – Core of application – optimised drive solutions

tendo®-PM permanent magnet-excited DC motors accord with a shunt motor in their operating characteristics (shunt characteristics). The speed is therefore only slightly influenced in case of load changes

ROBA-stop®-holding brake

Spring pressure holding brake:

- Integrated into the motor housing
- Same protection as motor
- Standard voltages 24 VDC / 207 VDC (104 VDC)
- Low heating through optimised coil performance

tendo®-PM – Technical description

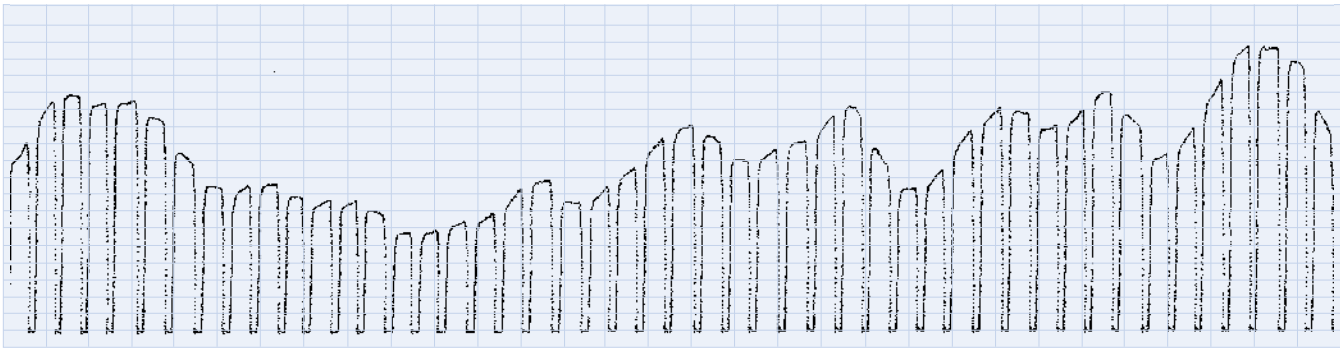
1. General information

1.1 *tendo*®-PM motors

- ❒ The motors accord with the IEC recommendations and the DIN VDE 0 530 regulations.
- ❒ Depending on the design, the protection accords with IP54 or IP65 acc. DIN 40 050.
- ❒ The coil accords with class of insulation F.
- ❒ The motors are self-cooled (cooling type IC 40 acc. IEC 34-6), i.e. cooling takes place through free convection and radiation.
- ❒ The roller bearings acc. DIN 625 are generously dimensioned, noise-tested and provided with lifetime lubrication.
- ❒ The A-side bearing is designed as a fixed bearing.
- ❒ The motors are dynamically balanced with a half key if no other balance arrangements were made.
- ❒ For thermal monitoring, the motor can be equipped with a thermal switch as signalling contact (Nominal data: AC 250V/1,6A; DC 60V/1A 120 °C ± 5K).
- ❒ On request, the motors can be equipped with signalling or switch-off carbon brushes.
- ❒ The motors are not radio interference-suppressed. Should interference suppression be necessary, the required suppression means must be determined on the complete system under operating conditions.
- ❒ The carbon lifetime is dependent on many factors. Through the selection of the optimum carbon quality and the high quality standards in the production of ***tendo***®-motors, in particular the collector processing, lifetimes of up to 10 000 h are possible depending on the design and the operating conditions.
- ❒ Paint: the bearing shields are bright aluminium;
  the central part of the stator is painted black (RAL 9005).
- ❒ Special designs are possible regarding the following:
  - Armature voltage
  - Output shaft
  - Mounting flanges
  - Special attachments
  - Nominal speed
  - 2nd shaft end
  - Paint
  - Electrical connection
  - And complete, customer-tailored drive solutions

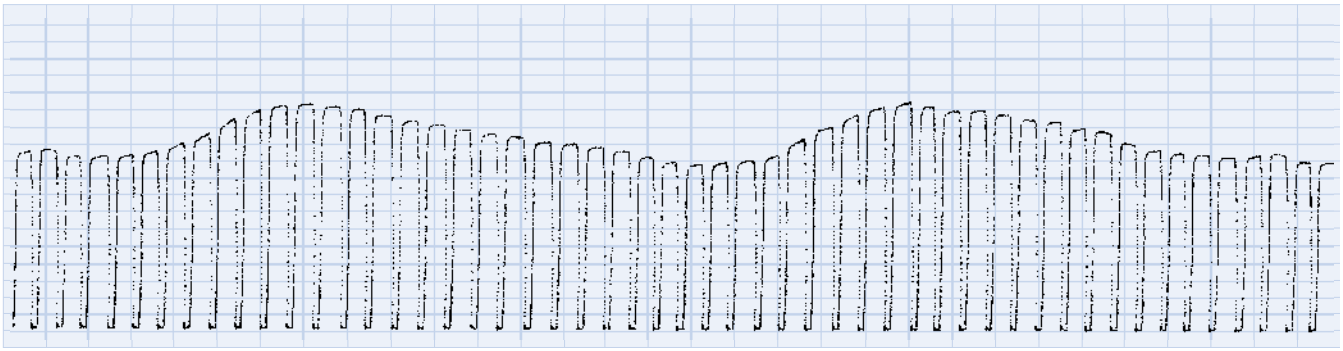
Examples for the appearance of different collector surfaces

(1 Height graduation mark ^= 1 μm)



Unfavourable collector surface finish: large fissures between adjacent copper lamellae and high total out-of-roundness. **Fig. 1**

- ❒ The carbon brushes are excited and vibrate; sparking occurs; the collector is damaged still further.
- ❒ Only short lifetimes are achieved



Good ***mayr***® collector surface finish: optimally-produced collector surface due to appropriate machining; low out-of-roundness; very small fissures between the lamellae; correct roughness depth of tread, for optimum run-in characteristics and long carbon lifetimes. **Fig. 2**

tendo®-PM – Technical description

1.2 Gear for *tendo*®-PM motors

1.2.1 Worm gears

Worm gears are universal-use hollow shaft gears. This means that they can be directly mounted onto the machine shaft to save space, or used to realise a shaft output via a one-sided or two-sided stub shaft.

The worm gears are mainly used where high reductions are required with small construction volumes, or where damping characteristics are required in retroactive operation. In addition, they are suitable for use in cases where having the drive positioned at an angle to the machine provides advantages.

The use of precision wheelsets and synthetic lubricating oil permits high torque, good degrees of efficacy, restricted backlashes and high running smoothness. The worm gear is also supported on counter bearings. Normally, neither ventilation nor lubrication replacement are required over the entire lifetime.

Worm gears can be used both for more simple applications, such as continuous or reversing operation, as well as for servo application cases. In case of high reductions (see data sheet), hard brake operation (brake or 4Q controller) must be avoided due to the retroactive self-limiting.

The worm gears can also be equipped with an overload protection in the form of an **integrated slip hub** (see page 32) or an **EAS® Safety Clutch** (on request).

1.2.2 Planetary gear

The planetary gears are mainly characterised in appearance by their low relative construction volume and the coaxiality of input and output.

The gears guarantee smooth running and can also be executed with low backlash. The one to two-stage gears provides a very large reduction range. Neither ventilation nor lubrication replacement is required over the entire lifetime.

Planetary gears are primarily used in servo applications. Due to the low mass moment of inertia, the high torsional rigidity and impact resistance, the high degree of efficacy even in retroactive operation and the low torsional backlash, these gears are particularly suitable for highly-dynamic applications.

2. Designs / Flanges / Installation Position

2.1 Motors

The ***tendo***®-PM motors can be supplied as standard in four different attachment versions, each in two size designs (except for PM 41/42). If possible, the flange dimensions accord with DIN EN 50 347. The flange accuracy accords with DIN 42 955.

Because any spatial installation position can be selected for the motors, the relative position of the electrical connection to the base must only be determined on base designs.

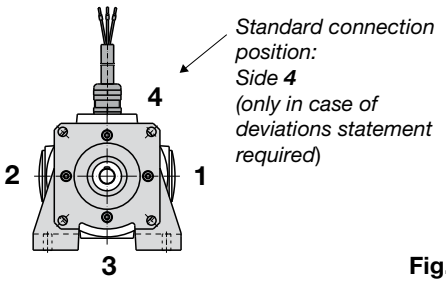


Fig. 3

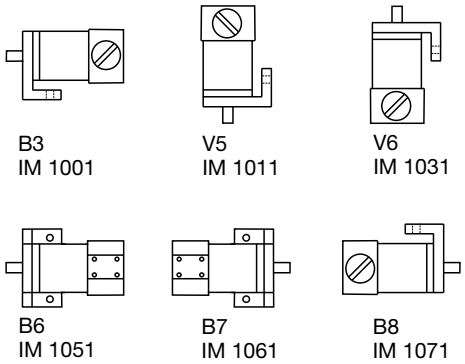
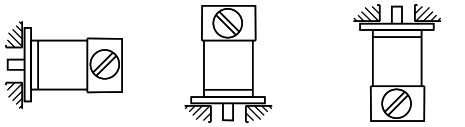
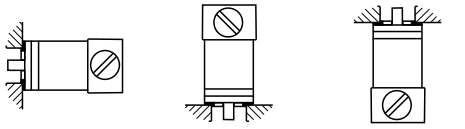
Order information	Possible designs or installation positions IEC-Code II
Base design (B3) (Small shaft / Large shaft)	 B3 IM 1001 · V5 IM 1011 · V6 IM 1031 · B6 IM 1051 · B7 IM 1061 · B8 IM 1071
B5 flange (Small / Large) **Four-cornered flange** (Small shaft / Large shaft)	 B5 IM 3001 · V1 IM 3011 · V3 IM 3031
B14 flange (Small / Large) **Four-cornered flange** (Small shaft / Large shaft)	 B14 IM 3601 · V18 IM 3611 · V19 IM 3631

Table 2

2.2 Geared motors

2.2.1 Planetary gears

The output-side flange on the planetary gears accords with flange form “C” acc. DIN EN 50 347 (“B14 flange”). By mounting a flange, the conversion from “B14” to “B5” is possible.
The standard version of the planetary gear motors have no base. As the drive can be rotated around its axis into any position, the position of the electrical connection need not be defined. Accordingly, only the determination of the spatial position is required.

Vertical installation acc. V18 is required in case of full continuous torque; special measures may be required and this must therefore be stated in your order.

Installation positions

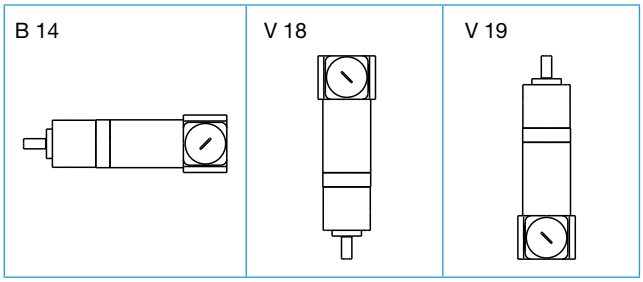


Fig. 4

tendo®-PM – Technical description

2.2.2 Worm gears

The output-side flange dimensions of the worm gear are based on flange form “FT” for design B14, or on flange form “FF” for design B5 (DIN EN 50 347). In addition, screw-on surfaces are available on the facing and upper side, each featuring four fastening threads.
On request, the gear can also feature stub shafts or special output shafts.
On the worm gear motors, both the spatial position of the entire drive and the position of the electrical connection and flange or output shaft must be determined. See the installation positions in Figure 5, Page 8.

Installation positions

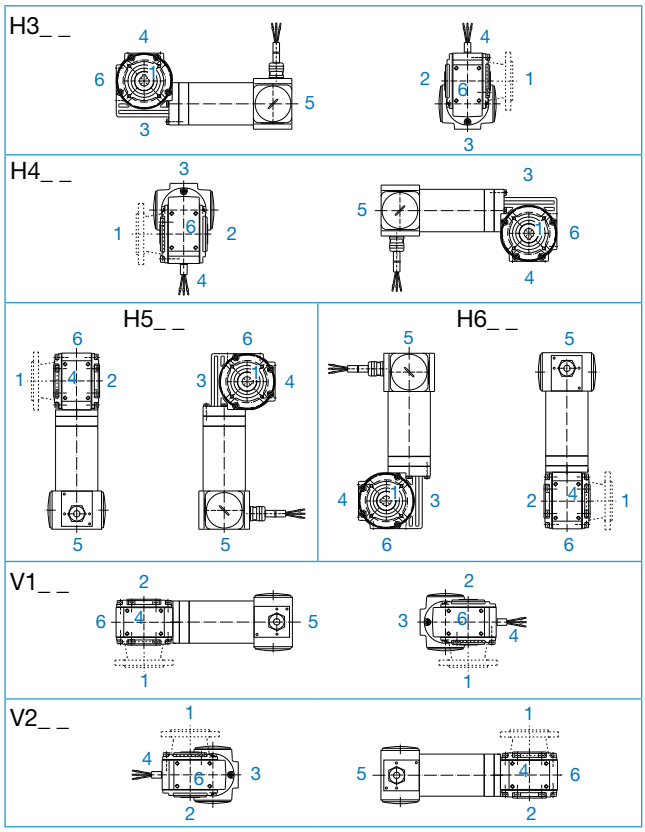


Fig. 5

Order information

Installation position		Position of the electr. connection	Position of the connection side
H3	H... Horizontal output shaft	**1** on side 1	**0** without B5 flange or shaft
H4		**2** on side 2	**1** on side 1*
H5	V... Vertical output shaft	**3** on side 3	**2** on side 2*
H6		**4** on side 4	**7** on both sides
V1	1...6 Gear side positioned underneath		
V2			

* On slip hubs, the adjusting nut is always positioned opposite the connection side.

Example: H340 (frequent installation position on hollow shaft design with B14 flange)

3. Attachments

Due to the modular structure, the ***tendo***®-PM permanent magnet motors can very easily be realised with their many attachment options in a wide diversity of design versions with tacho-generators, brakes, rotary encoders and much more. These versions are listed in detail on pages 4 and 5 of this catalogue.

4. Determination of the drive configuration

(Selection of motor, attachments, gears and controller)

Decisive for the correct and required operation of a drive is the correct selection of the motor, its attachments, the controller and, if applicable, the gear. To do this, exact knowledge regarding the load is necessary.
The following selection criteria are to be observed:

- ❒ Nominal speed / gear / reduction
- ❒ Controller connection voltage / nominal armature voltage
- ❒ Torque / armature current
- ❒ Operating conditions
- ❒ Power supply / control
- ❒ Protection
- ❒ Electrical connection
- ❒ Brake selection

4.1 Nominal speed / gear / reduction

If the maximum speed occurring lies under approx. 500 – 1000 rpm, a gear motor should be used.
The maximum required motor speed should always be smaller or the same as the motor nominal speed. On gear motors, the reduction of the gear must be selected appropriately.
Section 1.2 provides assistance in the selection of planetary or worm gears.

4.2 Controller connection voltage / nominal armature voltage

For mains connection:	Controller for single-phase mains connection 230 V / 50.60 Hz => Armature voltage 160 V
For connection to the battery or protective low voltage:	Controller for connection to low voltage 24 - 48 V => armature voltage 24 V (see also Section 4.5)

4.3 Torque / armature current

The determination of the necessary motor size, gear motor size and controller size must be conducted in different ways depending on the application conditions.

- ❒ Drives primarily for operation against a load torque, with only occasional, temporally non-critical start-up and braking procedures (**Operating mode S1**).
  - The motor size or gear motor size can be determined purely according to the torque and speed.
  - The controller should be able to supply at least the motor nominal current. To guarantee a certain overload capability, the controller nominal current should total approx. 1.2 .... 1.5 times the motor nominal current.
- ❒ Drives with temporary operation (**Operating mode S2**).
  - For temporary operation, the motor can be dimensioned smaller than for continuous operation. In case such application cases are needed, we ask you to make a separate enquiry.
- ❒ Drives primarily for operation with acceleration and braking procedures (**Servo application; Operating modes S3, S4...**).
  - During determination of the required acceleration and braking torques, the motor moment of inertia must be taken into account in addition to the external mass moments of inertia.
  - The max. permitted motor current must never be exceeded; not even temporarily (**Demagnetization limit**). The gear must be able to transmit the max. occurring peak torques.
  - The root mean square (effective values) of the torque or current seen over the temporal progression must be smaller or the same as the nominal values (see 4.4.1).
  - The controller must be in a position to provide sufficiently high voltages and currents so that the motor can achieve the required speed and torque values (see 4.4.1 – deviating operating mode).

tendo®-PM – Technical description

4.4 Operating Conditions

The stated nominal powers (nominal torques) apply for **Continuous operation (S1)**, max. 40 °C ambient temperature, form factor F_F = 1.05 and set-up height up to 1000 metres over sea level.

4.4.1 Operating mode

With an **operating mode deviating from S1**, the following relationship applies:

$$M_{RMS} = \sqrt{\frac{M_1^2 \times t_1 + M_2^2 \times t_2 + ...}{t_1 + t_2 + ...}}$$

The effective load torque (of the square mean value) over the time period must be smaller than or the same as the nominal torque.

$$M_{RMS} \leq M_N$$

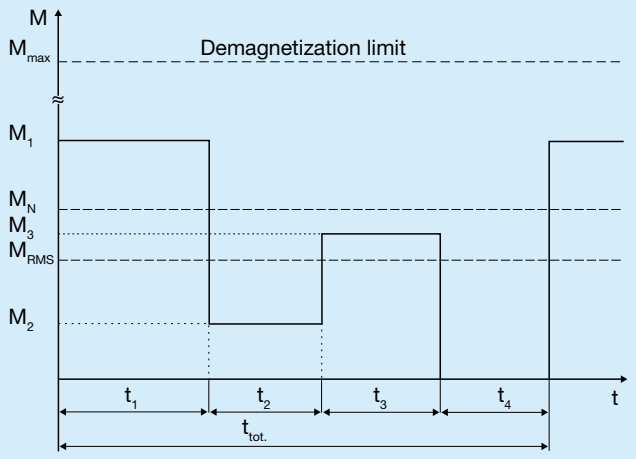


Fig. 6

4.4.2 Cooling conditions

In case of **deviating cooling conditions** through ambient temperatures over 40 °C or set-up heights over 1000 metres above sea level, we ask you to kindly contact us as the amount of power reduction necessary is strongly dependent on the type and design.

4.4.3 Form factor

In case of a **deviating form factor** (larger than 1.05) of the armature current, the motor power must be reduced according to the following relationship:

$$P_2 = P_N \times 1.05 / F_F$$

Form factors occurring in practice:

Power source	Form factor F_F
2-pulse phase angle control e.g. thyristor controller	1.6 .... 1.9
As above but with armature chokes	1.2 .... 1.3
Transistor controller with DC voltage intermediate circuit and PMW with cycle frequencies≥ 16 kHz	≤ 1.05

Table 3

4.5 Power supply / control / operating quadrants (1Q / 4Q)

On the ***tendo***®-PM permanent magnet motors, the speed is approximately directly proportional to the applied voltage, and the torque is approximately directly proportional to the armature current (minor deviations occur due to the friction losses and the internal resistance).
From these direct relationships between the electrical and the mechanical parameters, we achieve the excellent control properties of the motors.

Because the motors are **not switch-on safe** in standard design (in case of direct connection of the nominal voltage during shutdown, a current would flow which would lead to partial demagnetization of the ferrite magnets), it must always be ensured that the start-up current is limited, or that the stated maximum current is never exceeded, not even temporarily. The stated values apply at temperatures over 0 °C. In case of lower temperatures, a lower maximum current is permitted.

ATTENTION

If a customer-side DC voltage is available for the motor or brake supply, a varistor for protection against switching overvoltage is to be connected between motor terminal A1 and A2 or the brake terminals are to be connected in addition to the limitation of the max. permitted motor current.

Depending on the application case, different requirements are placed on the drive control. These requirements have a decisive influence on the selection of the control device and the motor attachments.

- **1-quadrant controllers** can be used if no regenerative brake operation is required (if the setpoint value is reduced, the drive is only braked through friction and the load torque). By swapping the motor connection lines via a relay or contactor, two rotary directions can be realised (switching only permitted at a standstill)! For tacho control with a DC tacho, the tacho lines must also be swapped). This means that operation in the quadrants I and II is also possible.
- **4-quadrant controllers** permit continuous transition during operation of the drive in all 4 quadrants (drives and brakes in both directions).

Operating quadrants

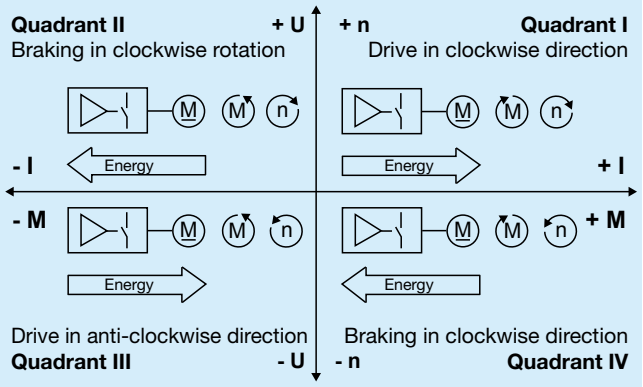


Fig. 7

tendo®-PM – Technical description

4.5.1 Controller principle (thyristor/transistor)

- **Thyristor controllers** are characterised through their simple and robust construction. The motor voltage is obtained directly from the mains half-waves with a controlled bridge rectifier (phase angle control). The duration of the superimposed AC voltage totals at 10 ms approximately 3 times the electrical time constant of the motor from 2 .. 4 ms. The resulting ripple of the current and therefore the torque can be reduced through the use of a smoothing reactor. This is primarily of significance in connection with motors with brake attachments as the brakes can be excited through the ripple torque and produce noises.
- With **transistor controllers,** the motor voltage is obtained via pulse width modulation (PWM) with cycle times of less than 0.06 ms from a fixed intermediate circuit DC voltage. Because these cycle times are much smaller than the electrical time constants of the motor, an almost pure DC current with a form factor close to 1.0 and thus also a very even torque result. This leads to a very smooth-running motor and optimum utilisation of the motor power. The low cycle times make excellent control properties possible.

4.5.2 Armature voltage control (“I x R”)/tacho control

- With **armature voltage controls**, the terminal voltage of the motor is returned as the actual value. The speed reduction under load is compensated for through an appropriate, current-dependent increase in the armature voltage (compensation of the ohmic voltage drops in the armature “I x R”). The degree of the increase in voltage can be adjusted on the control device and optimised for one speed each. In this way, control ranges up to 1: 50 are possible with control accuracies of 3 %.

  e. g. nominal speed n_N = 3000 rpm => n_{min} = 60 rpm

  Temperature influences cannot be balanced out, i.e. the speed changes depending on the load condition more or less strongly between the cold and warm motor states.
- If larger control ranges and/or control accuracies are required, or if temperature influences are to be corrected, the motor must be equipped with a **tacho-generator**. The voltage of the tacho-generator then serves the actual value return.

  DC current tacho (4Q)

  - For 1Q and 4Q operation
  - Control range up to 1 : 1000
  - Control accuracy < 1 %

  On some of the control devices, an incremental encoder can be used as actual value return.

4.5.3 Position control

On drives with positioning tasks, it is usually necessary to mount an incremental encoder. A fitted incremental encoder is offered as standard.

However, any rotary encoder with “Standard servo flange” can be attached to the motor.

The rotary encoder signals can be evaluated via a suitable device (e.g. PLC) in order to obtain the reference variable for the controller.

Example of a conventional layout:

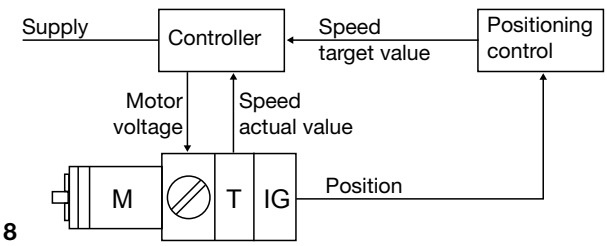


Fig. 8

4.6 Protection

Generally, Protection IP54 should be sufficient for the motors and gears in most applications. Should the ambient conditions necessitate special requirements with regard to water and dust-tightness, we recommend the use of IP65.

4.7 Electrical Connection

Different connection versions are available for the motors and attachment options:

- The standard design with **connection cable (P)** is the most economically-viable solution. The cables are approximately 500 mm long. Suitable connection options must be provided close to the motor.
- Should the supply line be connected directly to the motor, this can be realised using a **terminal box (K)**.
- Designs with **plug (S)** permit fast replacement, and the connection can also be undertaken by personnel who do not have electrotechnical knowledge.
- Wiring diagram for motor and attachments (see Installation and Operational Instructions for ***tendo***®-PM motors).

4.8 Brake Selection

The ***tendo***®-motors and gear motors can be equipped with quiescent current-operated spring-applied safety brakes (the brake releases when the nominal voltage is applied)

24 VDC and 207 VDC or 104 VDC are available as nominal voltages.

207 VDC: Bridge rectifier on 230 VAC mains voltage

104 VDC: Half-wave rectifier on 230 VAC mains voltage

ATTENTION

Use a varistor to protect against switching overvoltages between brake terminals A1 and A2 (see also Section 4.5).

A-side holding brake

This brake is designed to provide the holding torque at a standstill. Friction work can only be dealt with to a very limited extent. Its application is primarily expedient on servo applications if the motor is electrically braked with a 4Q controller and the mechanical brake is then intended to hold the drive in the position it has reached. Readjustment of the air gap is not possible. The brake protection accords with that of the motor.

B-side positioning brake

This brake is designed as a performance brake for the execution of friction work. It is recommended for brake motor tasks when the motor is only switched in de-energised state, and the brake then has to brake the overall drive mechanically.

tendo®-PM – Technical description

5. Calculation guidelines

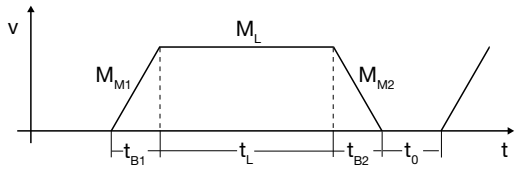
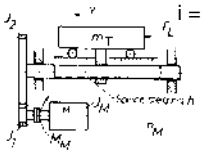
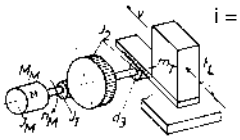
		Spindle drive	Toothed rack drive
			$i = \frac{n_M}{n_{spindle}} = \frac{d_2}{d_1}$ 	$i = \frac{n_M}{n_{pinion}} = \frac{d_2}{d_1}$ 
Motor speed	[rpm]	$n_M = \frac{v \times 6 \times 10^4 \times i}{h}$	$n_M = \frac{v \times 6 \times 10^4 \times i}{\pi \times d_3}$
Load torque (= torque during constant speed)	[Nm]	$M_L = h \times \frac{F_L}{2000 \times \pi \times i} + M_{idle}$	$M_L = d_3 \times \frac{F_L}{2000 \times i} + M_{idle}$
Translatory mass moment of inertia	[kgm²]	$J_T = m_T \times (\frac{h}{2 \times \pi})^2 \times 10^{-6}$	$J_T = m_T \times (\frac{d_3}{2})^2 \times 10^{-6}$
Rotatory mass moment of inertia (for steel)	[kgm²]	$J_R = 7.7 \times d^4 \times l \times 10^{-13}$ For aluminium, the value is to multiplied by a factor of 0.35	
Sum of reduced mass moments of inertia	[kgm²]	$J = J_M + J_1 + (J_R + J_T + J_2) \times \frac{1}{i^2}$	
Acceleration torque or braking torque $M_B = f(n_M)$ (load and friction-free)	[Nm]	$M_{B1/2} = \frac{n_M \times J}{9.55 \times t_{B1/2}}$	
Acceleration torque or braking torque $M_B = f(v)$ (load and friction-free)	[Nm]	$M_{B\,1/2} = \frac{\pi \times J \times i \times v^2 \times 2000}{h \times s_{B1/2}}$	$M_{B\,1/2} = \frac{J \times i \times v^2 \times 2000}{d_3 \times s_{B1/2}}$
Acceleration time or braking time $t_B = f(n_M)$ (with load torque)	[s]	$t_{B1/2} = \frac{n_M \times J}{9.55 \times (M_B \pm M_L)}$	Acceler.: $- M_L$, deceler.: $+ M_L$
Acceleration time or braking time $t_B = f(v)$ (with load torque)	[s]	$t_{B\,1/2} = \frac{\pi \times v \times J \times i \times 2000}{h \times (M_{B1/2} \pm M_L)}$	$t_{B\,1/2} = \frac{v \times J \times i \times 2000}{d_3 \times (M_{B1/2} \pm M_L)}$
Speed reached after acceleration	[rpm]	$n_M = \frac{120 \times s_{B1} \times i}{h \times t_{B1}}$	$n_M = \frac{120 \times s_{B1} \times i}{d_3 \times \pi \times t_{B1}}$
During the acceleration / deceleration path traversed	[mm]	$s_{B1/2} = \frac{n_M \times J}{120 \times i}$	$s_{B1/2} = \frac{n_M \times t_{B1/2} \times d_3 \times \pi}{120 \times i}$
Sum of the torques to be overcome by the motor during acceleration (with load and friction torque)	[Nm]	$M_{M1} = \frac{1}{\eta} \times (M_{B1} + M_L) < M_{max.,\,mot.}$	
Sum of the torques to be overcome by the motor during deceleration (with load and friction torque)	[Nm]	$M_{M2} = \eta \times (M_{B2} - M_L) < M_{max.,\,mot.}$	
Effective value of output motor torque	[Nm]	$M_{RMS} = \sqrt{\frac{M_{M1}^2 \times t_{B1} + M_L^2 \times t_L + M_{M2}^2 \times t_{B2}}{t_{B1} + t_L + t_{B2} + t_0}} \leq M_N$ (see Section 4.4.1)	
Output power	[W]	$P_A = \frac{M_N \times n_M}{9.55}$	

Table 4

Formula key

d	[mm]	Spindle diameter
d_1	[mm]	Diameter driving wheel
d_2	[mm]	Diameter driven wheel
d_3	[mm]	Diameter pinion or toothed belt disk
F_L	[N]	Feed force
h	[mm]	Spindle pitch
i	[-]	Reduction
J	[kgm²]	Mass moment of inertia (reduced)
J_1	[kgm²]	Mass moment of inertia Driving wheel
J_2	[kgm²]	Mass moment of inertia Driven wheel
J_M	[kgm²]	Mass moment of inertia of the motor
J_R	[kgm²]	Rotatory mass moment of inertia
J_T	[kgm²]	Translatory mass moment of inertia
l	[mm]	Spindle length
$M_{B1/2}$	[Nm]	Acceleration torque or braking torque (load and friction-free)
M_{idle}	[Nm]	Idle torque
$M_{M1/2}$	[Nm]	Required motor torque
$M_{max.,\,mot.}$	[Nm]	Motor peak torque (catalogue)
M_N	[Nm]	Motor nominal torque (value in motor catalogue)
M_{eff}	[Nm]	Effective value of output motor torque
M_L	[Nm]	Load torque
m_T	[kg]	External load (linear-moved mass)
n_M	[rpm]	Motor speed
P_A	[W]	Output power
$s_{B1/2}$	[mm]	Acceleration distance or braking distance
$t_{B1/2}$	[s]	Acceleration time or braking time
t_L	[s]	Runtime with load torque
t_0	[s]	Downtime without load
v	[m/s]	Feed rate
η	[-]	Mechanical degree of efficacy referring to the motor shaft

tendo®-PM 41/42

Technical Data			Motor size 41 Nominal power up to 63 W				Motor size 42 Nominal power up to 115 W			
Nominal voltage [1]	U_N	[V]	160		24		160		24	
Nominal speed [1]	n_N	[rpm]	2000	3000	2000	3000	2000	3000	2000	3000
Nominal torque	M_N	[Nm]	0.22	0.2	0.2	0.18	0.4	0.37	0.37	0.35
Nominal power	P_N	[W]	46	63	42	57	83	115	77	110
Nominal current	I_{AN}	[A]	0.46	0.57	2.9	3.6	0.75	1.0	5.4	6.0
Form factor [2]	F_F	[-]	1.05	1.05	1.05	1.05	1.05	1.05	1.05	1.05
Operating mode		[-]	S1							
Protection		[-]	IP54 / IP65							
Cooling type acc. IEC 34-6		[-]	IC 40 (self-cooled)							
ISO class		[-]	F							
Max. ambient temperature	R_T	[°C]	40							
Housing temperature	$\Delta\theta$	[K]	50	50	50	50	50	50	50	50
Thermal time constant	T_{th}	[min]	25	25	20	20	30	30	25	25
Max. permitted current [3]	I_{Amax}	[A]	2.4	3.2	16.5	22	4.3	6.1	32	39
Max. torque	M_{max}	[Nm]	0.9	0.9	0.9	0.9	1.8	1.8	1.8	1.8
Continuous downtime torque	M_o	[Nm]	0.3	0.3	0.3	0.3	0.5	0.5	0.5	0.5
Armature resistance [6]	R_A	[Ω]	71	38	1.7	1.0	33	16.5	0.68	0.45
Connection resistance [6]	R_a	[Ω]	73	40	1.9	1.2	35	18.5	0.88	0.65
Armature inductivity	L_A	[mH]	141	78	3	1.7	69	35	1.2	0.85
Electrical time constant [6]	T_a	[ms]	1.9	2.0	1.6	1.4	2.0	1.9	1.4	1.3
Friction torque	M_R	[Nm]	0.032	0.035	0.032	0.035	0.05	0.055	0.05	0.055
EMF constant [6]	K_E	[V/1000rp^m]	61	44.8	8.9	6.6	66.5	47	9.0	7.5
Torque constant [6]	K_T	[Nm/A]	0.583	0.427	0.085	0.063	0.635	0.45	0.086	0.072
Mass moment of inertia	J_d	[kgm²]	0.089×10^{-3}				0.14×10^{-3}			
Mechanical time constant [6]	T_m	[ms]	18	19	22	26	11.5	12	16	17
Weight		[kg]	1.75				2.5			

			Tacho-generator [4]
Voltage constant		[V/1000rp^m]	15
Calibration tolerance			± 10 %
Max. current / rated impedance			15 mA / 15 kΩ
Linearity deviation			≤ 0.2 %
Harmonic content (eff)			≤ 0.6 %
Control range lower limit		[rpm]	0
Mass moment of inertia		[kgm²]	0.008×10^{-3}
Weight (incl. attachment)		[kg]	0.5

			Incremental encoder [4]
Pulses / rotation [1]			1000
Limit frequency			> 100 kHz
Channels			A, B, N + inversion
Outputs			acc. RS 422 (opp. TTL)
Supply voltage			4 - 6 VDC; 100 mA
Mass moment of inertia		[kgm²]	0.0015×10^{-3}
Weight (incl. attachment)		[kg]	0.5

			Brakes [4]	
			Holding brake	**Positioning brake** [5]
Torque		[Nm]	0.6	1
Electr. connection power [6]		[W]	9	13
Voltage		[VDC]	24 / 104	24 / 104
Perm. friction work per braking action		[J]	-	200
Perm. friction power		[W]	-	25
Total friction work		[J]	-	18×10^6
Mass moment of inertia		[kgm²]	0.00448×10^{-3}	0.00448×10^{-3}
Weight (incl. attachment)		[kg]	0.5	0.45

Tolerance acc. VDE 0530, otherwise ± 10 %
1) Deviating nominal data available on request
2) In case of larger AC current proportions, the power must be reduced appropriately. $P_2' = 1.05 / F_F' \times P_N$ ($F_F = I_{A\ RMS} / I_{A\ arith.}$)
3) The value may not even be temporarily exceeded, otherwise the magnets may in part be demagnetized (valid for temp. ≥ 0 °C).
4) Other Technical Data on request
5) Positioning brake without readjustment option
6) At 20°C

tendo®-PM 41/42

Designs and Flange Dimensions

B14 flange (FT)

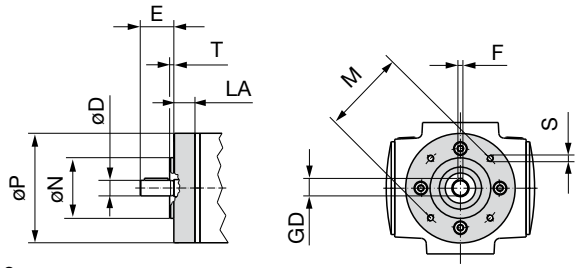


Fig. 9

Four-cornered flange

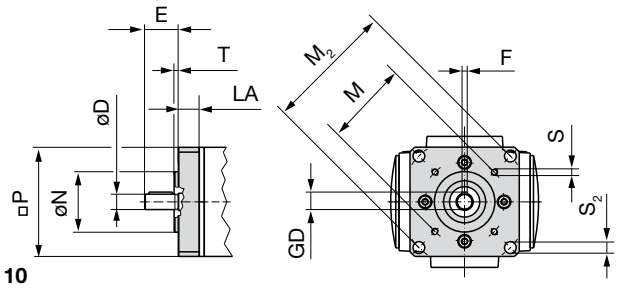


Fig. 10

Base design

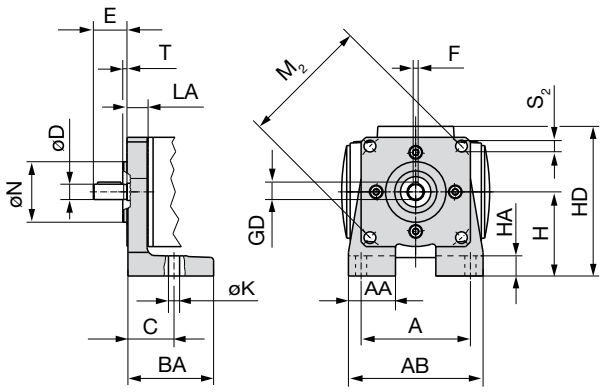


Fig. 11

Dimensions [mm] DIN EN 50347 (DIN 42939)		A (b)	AA (n)	AB (f)	BA (m)	C (w_1)	D_{k6} (d_{k6})	E (l)	F (u)	GD (t)	H (h)	HA (c)	HD (p)	K (s)	LA (c_1)	M (e_1)	M_2 (e_2)	N_{j6} ($b_{1\ j6}$)	P (a_1)	S (s_1)	S_2 (s_2)	T (f_1)
B14 flange	**small / FT 50**	-	-	-	-	-	9	20	3	10.2	-	-	-	-	12.5	50	-	36	65	M4	-	2.5
	large / FT 65	-	-	-	-	-	9	20	3	10.2	-	-	-	-	12.5	65	-	50	80	M5	-	2.5
Four-cornered flange		-	-	-	-	-	9	20	3	10.2	-	-	-	-	12.5	50	77	36	65	M4	6.6	2.5
Base design		65	28	80	51	28	9	20	3	10.2	50	12	82.5	6.6	12.5	-	77	36	65	-	6.6	2.5

Order Number

Connection		Thermal switch		Protection [1]	Speed	Hand release	
Pg with cable	**P**						
Plug [2) 5)]	**S**						
Terminal box [6)]	**K**						
Terminal box + Pg with cable [7)]	**KP**						
Terminal box + plug [2) 8)]	**KS**						
Terminal box + Pg + Pg [9)]	**KPP**	**...**	without	**IP54**	**2000 rpm**	without	**...**
Terminal box + plug + plug [2) 9)]	**KSS**	**T**	with [4)]	**IP65**	**3000 rpm**	with [3)]	**HL**

__ / M 1 0 . 0 __ . __ / __ __ / __ / __ / __ / __ / __ / __

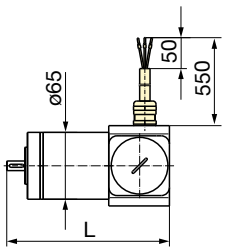
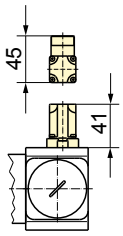
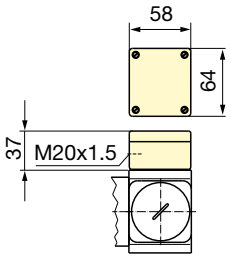
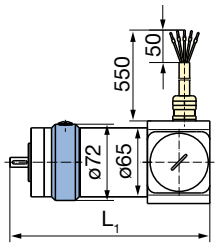
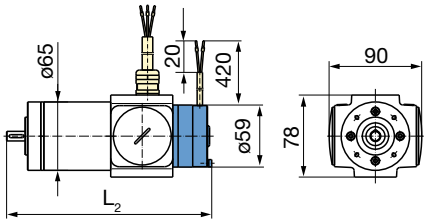
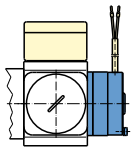
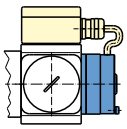
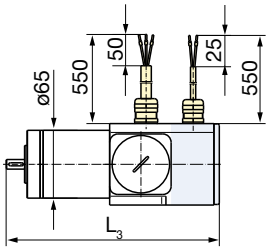
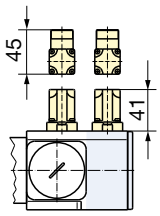
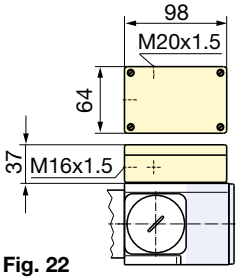
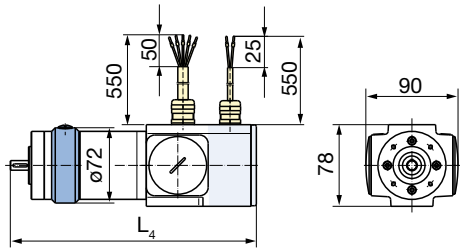
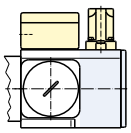
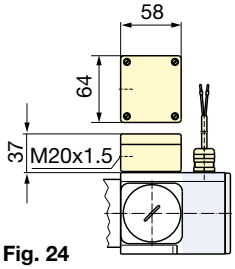
Size	Attachments		Design	Connection position	Armature voltage	Brake voltage
41	Without attachment	**01**	**3** B14 small	Only with base designs see page 7	**24 V**	**24 VDC**
42	Holding brake	**02**	**4** B14 large		**160 V**	**104 VDC**
	Positioning brake [1)]	**04**	**5** Four-cornered flange			
	Tacho	**05**				
	Incremental encoder	**08**				
	Tacho + incremental encoder	**20**	**7** Base design			
	Holding brake + tacho	**30**				
	Holding brake + incremental encoder	**41**				
	Holding brake + tacho + incremental encoder	**50**				

1) IP65 for positioning brake available on request (not in combination with hand release)
2) Mating plug not included in the standard scope of delivery (on request)
3) Hand release only for positioning brake and IP54
4) Thermal switch in combination with cable design available on request
5) Not for Type M10.004._
6) Only Types M10.001._, M10.002._, M10.004._, M10.005._, M10.030._
7) Not for Types M10.001._ and M10.002._
8) Not for Types M10.001._, M10.002._ and M10.004._
9) Only Types M10.020._ and M10.050._

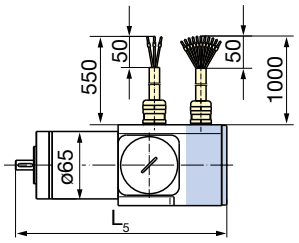
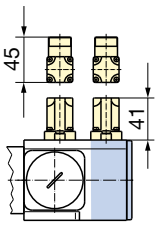
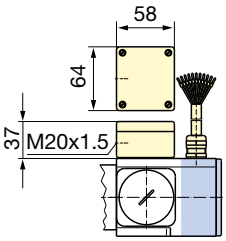
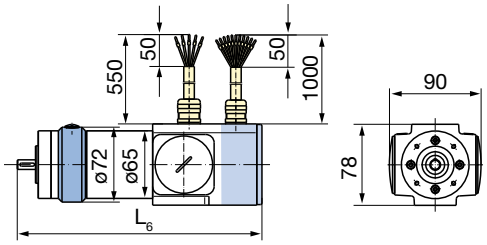
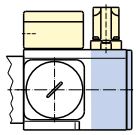
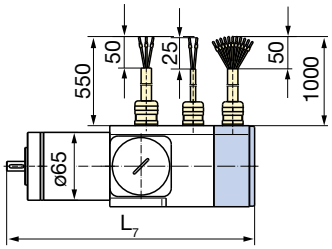
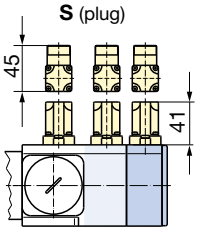
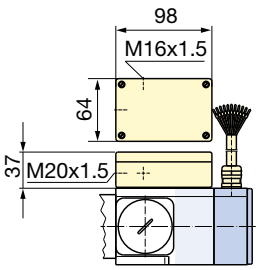
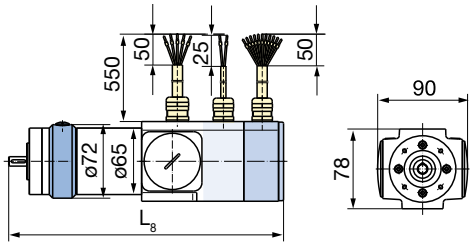
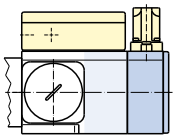
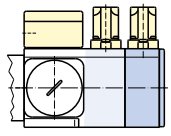
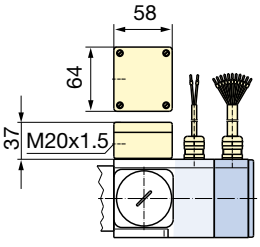
Example: 41 / M10.004.3 / K / IP54 / 160 V / 3000 rpm / 104 VDC / HL

tendo®-PM 41/42

Designs and Dimensions

	Standard connection P (Pg with cable)	Further connection possibilities	
Basic motor Type M10.001._	 **Fig. 12**	**S** (plug)  **Fig. 14**	**K** (terminal box)  **Fig. 15**
Brake motor (holding brake in A-bearing shield) Type M10.002._	 **Fig. 13**		
Basic motor with positioning brake Type M10.004._	 **Fig. 16**	**KP** (terminal box + cable)  **Fig. 17**	**K** (terminal box)  **Fig. 18**
Basic motor with tacho Type M10.005._	 **Fig. 19**	**S** (plug)  **Fig. 21**	**K** (terminal box)  **Fig. 22**
Brake motor (holding brake) with tacho Type M10.030._	 **Fig. 20**	**KS** (terminal box + plug)  **Fig. 23**	**KP** (Terminal box + Pg with cable)  **Fig. 24**

tendo®-PM 41/42

	Standard connection P (Pg with cable)	Further conection possibilities	
Basic motor with incremental encoder Type M10.008._	 **Fig. 25**	**S** (plug)  **Fig. 27**	**KP** (terminal box + Pg with cable) 
Brake motor (holding brake) with incremental encoder Type M10.041._	 **Fig. 26**	**KS** (terminal box + plug)  **Fig. 28**	**Fig. 29**
Basic motor with tacho and incremental encoder Type M10.020._	 **Fig. 30**	**S** (plug)  **Fig. 32**	**KP** (terminal box + Pg with cable) 
Brake motor (holding brake) with tacho and incremental encoder Type M10.050._	 **Fig. 31**	**KS** (terminal box + plug)  **Fig. 34**	**Fig. 33**
		KSS (terminal box + plug + plug)  **Fig. 35**	**KPP** (terminal box + Pg with cable + Pg with cable)  **Fig. 36**

Dimensions [mm]	L	L_1	L_2	L_3	L_4	L_5	L_6	L_7	L_8	Shaft øD x E
tendo®-PM 41	158	189	195	204	235	204	235	232	263	9 x 20
tendo®-PM 42	194	225	231	240	271	240	271	268	299	9 x 20

tendo®-PM 52/53

Technical Data			Motor size 52 Nominal power up to 160 W				Motor size 53 Nominal power up to 235 W			
Nominal voltages [1]	U_N	[V]	160		24		160		24	
Nominal speed [1]	n_N	[rpm]	2000	3000	2000	3000	2000	3000	2000	3000
Nominal torque	M_N	[Nm]	0.55	0.51	0.5	0.48	0.79	0.75	0.74	0.7
Nominal power	P_N	[W]	115	160	105	150	165	235	155	220
Nominal current	I_{AN}	[A]	0.95	1.25	6.4	8.3	1.3	1.85	8.8	11.5
Form factor [2]	F_F	[-]	1.05	1.05	1.05	1.05	1.05	1.05	1.05	1.05
Operating mode		[-]	S1							
Protection		[-]	IP54 / IP65							
Cooling type acc. IEC 34-6		[-]	IC 40 (self-cooled)							
ISO class		[-]	F							
Max. ambient temperature	R_T	[°C]	40							
Housing temperature	$\Delta\theta$	[K]	50	50	50	50	50	50	50	50
Thermal time constant	T_{th}	[min]	40	40	30	30	50	50	40	40
Max. permitted current [3]	I_{Amax}	[A]	5.7	8.25	40	53	8.4	12.3	60	80
Max. torque	M_{max}	[Nm]	2.8	2.9	2.7	2.6	4.3	4.2	4.3	4.1
Continuous downtime torque	M_o	[Nm]	0.6	0.6	0.6	0.6	1.0	1.0	1.0	1.0
Armature resistance [5]	R_A	[Ω]	19	10	0.5	0.27	12.2	5.5	0.29	0.15
Connection resistance [5]	R_a	[Ω]	20.5	11.5	0.6	0.37	13.7	7.0	0.40	0.25
Armature inductivity	L_A	[mH]	58	30	1.3	0.65	40	18	0.8	0.45
Electrical time constant [5]	T_a	[ms]	2.8	2.6	2.2	1.8	2.9	2.6	2.0	1.8
Friction torque	M_R	[Nm]	0.06	0.08	0.06	0.08	0.06	0.08	0.06	0.08
EMF constant [5]	K_E	[V/1000rp^m]	67.5	50.5	9.9	7.4	69.7	49.8	10.0	7.5
Torque constant [5]	K_T	[Nm/A]	0.646	0.483	0.095	0.071	0.666	0.476	0.095	0.071
Mass moment of inertia	J_d	[kgm²]	0.27×10^{-3}				0.38×10^{-3}			
Mechanical time constant [5]	T_m	[ms]	12.8	13	17	19	11.6	12.4	16	18
Weight		[kg]	3.4				4.1			

			Tacho-generator [4]
Voltage constant		[V/1000rp^m]	15
Calibration tolerance			± 10 %
Max. current / rated impedance			15 mA / 15 kΩ
Linearity deviation			≤ 0.2 %
Harmonic content (eff)			≤ 0.6 %
Control range lower limit		[rpm]	0
Mass moment of inertia		[kgm²]	0.008×10^{-3}
Weight (incl. attachment)		[kg]	0.45

			Incremental encoder [4]
Pulses / rotation [1]			1000
Limit frequency			> 100 kHz
Channels			A, B, N + inversion
Outputs			acc. RS 422 (opp. TTL)
Supply voltage			4 - 6 VDC; 100 mA
Mass moment of inertia		[kgm²]	0.0015×10^{-3}
Weight (incl. attachment)		[kg]	0.5

			Brakes [4]	
			Holding brake	**Positioning brake**
Torque		[Nm]	1	2
Electr. connection power [5]		[W]	11	19
Voltage		[VDC]	24 / 207	24 / 207
Max. friction work		[J]	-	1500
Permitted friction work as switching frequency function [6]		[J]	-	$1500 \times (1 - e^{(-65/S_h)})$
Total friction work		[J]	-	95×10^6
Mass moment of inertia		[kgm²]	0.0077×10^{-3}	0.012×10^{-3}
Weight (incl. attachment)		[kg]	0.7	0.76

Tolerance acc. VDE 0530, otherwise ± 10 %
1) Deviating nominal data available on request
2) In case of larger AC current proportions, the power must be reduced appropriately. $P_2' = 1.05 / F_F' \times P_N$ $(F_F = I_{A\ RMS} / I_{A\ arith.})$
3) The value may not even be temporarily exceeded, otherwise the magnets may in part be demagnetized (valid for temp. ≥ 0 °C).
4) Other Technical Data on request
5) At 20°C
6) Determination of the permitted friction work ($Q_{zul.}$) depending on the prevailing switching frequency (S_h)
Example: S_h = 100 1/h
$Q_{zul.}(100) = 1500 \times (1 - e^{(-65/100)}) = 717$ J

tendo®-PM 52/53

Designs and Flange Dimensions

B5 flange (FF)

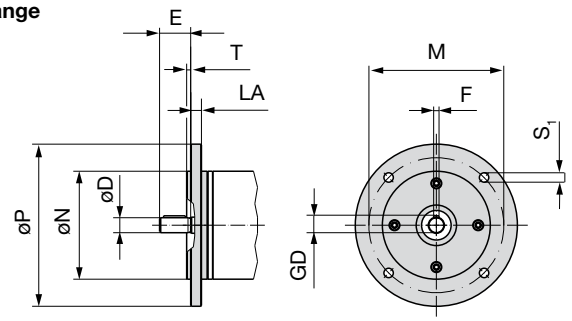


Fig. 37

B14 flange (FT)

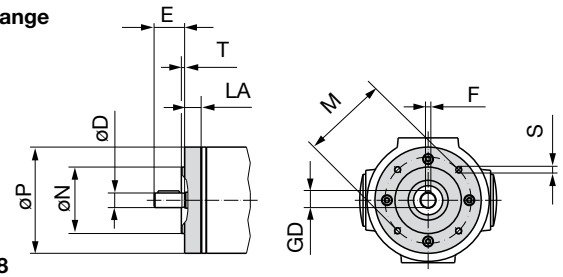


Fig. 38

Four-cornered flange

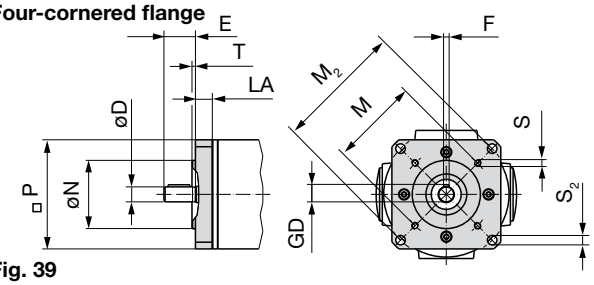


Fig. 39

Base design

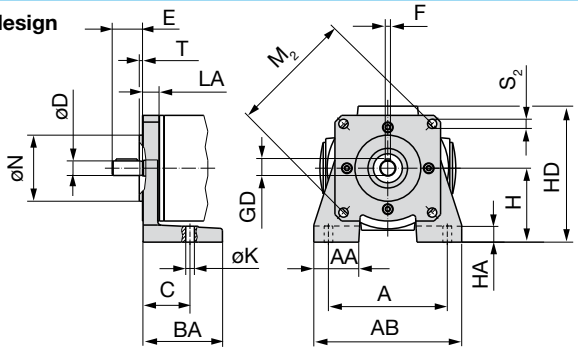


Fig. 40

Dimensions [mm]	DIN EN 50347 / (DIN 42939)	A (b)	AA (n)	AB (f)	BA (m)	C (w_1)	D_{k6} (d_{k6})	E (l)	F (u)	GD (t)	H (h)	HA (c)	HD (p)	K (s)	LA (c_1)	M (e_1)	M_2 (e_2)	N_{j6} ($b_{1\ j6}$)	P (a_1)	S (s_1)	S_2 (s_2)	T (f_1)
B5 flange	small / FF 100	-	-	-	-	-	9	20	3	10.2	-	-	-	-	8	100	-	80	120	7	-	3
	large / FF 115	-	-	-	-	-	11	23	4	12.5	-	-	-	-	10	115	-	95	140	9	-	3
B14 flange	small / FT 65	-	-	-	-	-	9	20	3	10.2	-	-	-	-	12.5	65	-	50	80	M5	-	2.5
	large / FT 75	-	-	-	-	-	11	23	4	12.5	-	-	-	-	12.5	75	-	60	90	M5	-	2.5
Four-cornered flange	small shaft	-	-	-	-	-	9	20	3	10.2	-	-	-	-	12.5	65	95	50	80	M5	7	2.5
	large shaft	-	-	-	-	-	11	23	4	12.5	-	-	-	-	12.5	65	95	50	80	M5	7	2.5
Base design	small shaft	90	34	112	60	36	9	20	3	10.2	56	12	96	6.6	12.5	-	95	50	80	-	7	2.5
	large shaft	90	34	112	60	36	11	23	4	12.5	56	12	96	6.6	12.5	-	95	50	80	-	7	2.5

Order Number

Connection		Thermal switch		Protection	Speed	Hand release	
Pg with cable	P	...	without	IP54	2000 rpm	without	...
Plug [1) 4)]	S	T	with [3)]	IP65	3000 rpm	with [2)]	HL
Terminal box [5)]	K						
Terminal box + Pg with cable [6)]	KP						
Terminal box + plug [1) 7)]	KS						
Terminal box + Pg + Pg [8)]	KPP						
Terminal box + plug + plug [1) 8)]	KSS						

__ / M 1 0 . 0 __ . __ / __ __ / __ / __ / __ / __ / __ / __

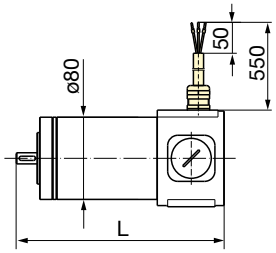
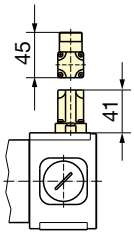
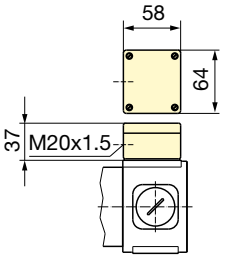
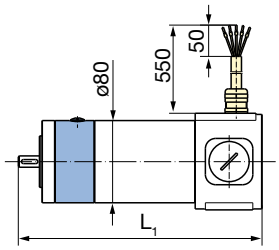
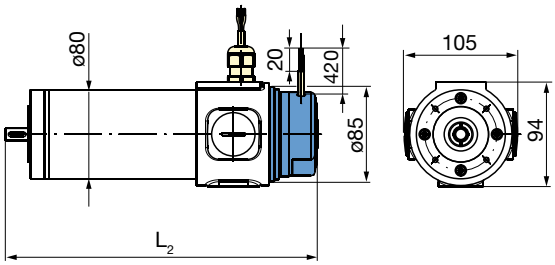
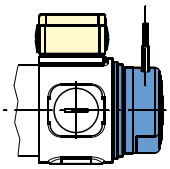
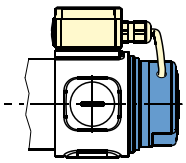
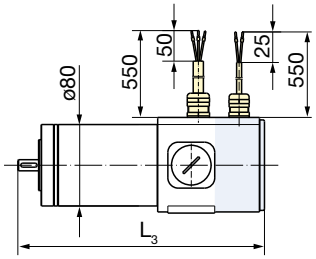
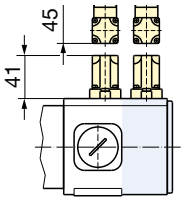
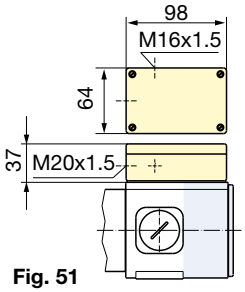
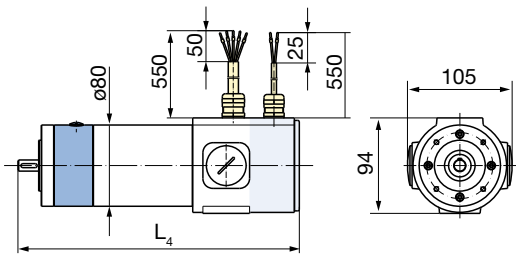
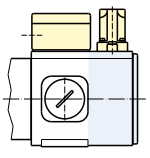
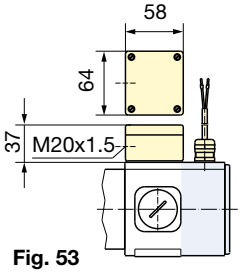
Size	Attachments		Design		Connection position	Armature voltage	Brake voltage
52	without attachment	01	1	B5 small	Only with base designs see page 7	24 V	24 VDC
53	Holding brake	02	2	B5 large		160 V	207 VDC
	Positioning brake	04	3	B14 small			
	Tacho	05	4	B14 large			
	Incremental encoder	08	5	Four-cornered flange, small shaft			
	Tacho + incremental encoder	20					
	Holding brake + tacho	30	6	Four-cornered flange, large shaft			
	Holding brake + incremental encoder	41	7	Base design, small shaft			
	Holding brake + tacho + incremental encoder	50	8	Base design, large shaft			

1) Mating plug not included in the standard scope of delivery (on request)
2) Hand release only for positioning brake
3) Thermal switch in combination with cable design available on request
4) Not for Type M10.004._
5) Only Types M10.001._, M10.002._, M10.004._, M10.005._, M10.030._
6) Not for Types M10.001._ and M10.002._
7) Not for Types M10.001._, M10.002._ and M10.004._
8) Only Types M10.020._ and M10.050._

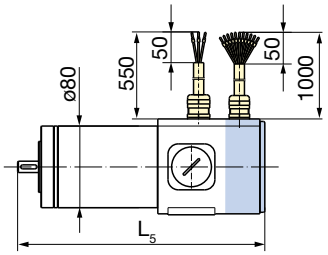
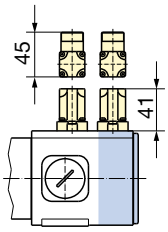
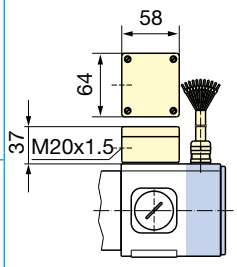
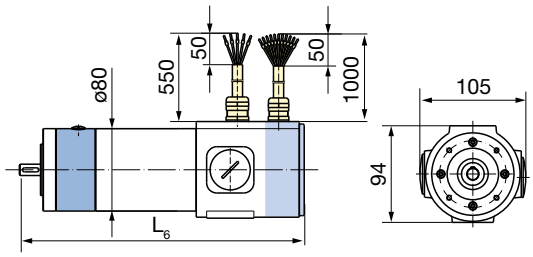
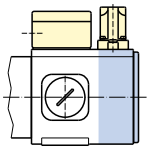
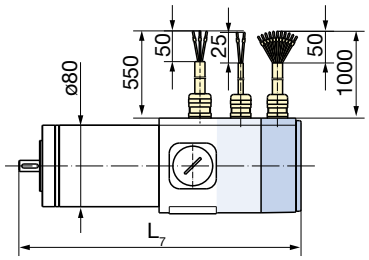
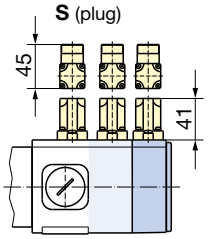
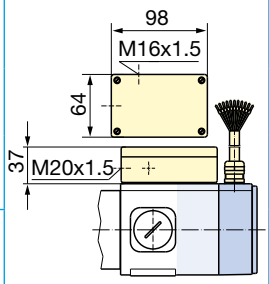
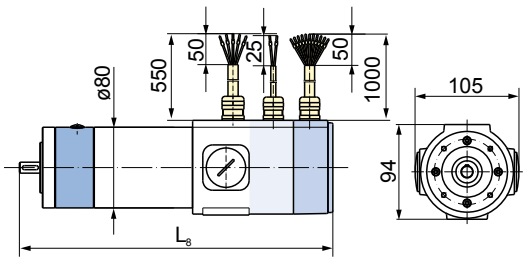
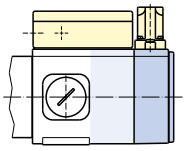
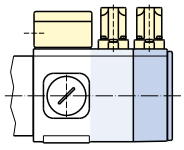
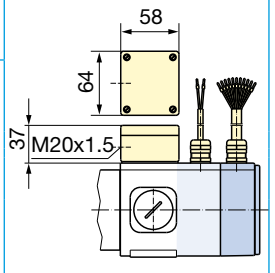
Example: 52 / M10.004.3 / P / IP54 / 160 V / 3000 rpm / 207 VDC / HL

tendo®-PM 52/53

Designs and Dimensions

	Standard connection P (Pg with cable)	Further conection possibilities	
Basic motor Type M10.001._	 **Fig. 41**	**S** (plug)  **Fig. 43**	**K** (terminal box)  **Fig. 44**
Brake motor (holding brake in A-bearing shield) Type M10.002._	 **Fig. 42**		
Basic motor with positioning brake Type M10.004._	 **Fig. 45**	**KP** (terminal box + cable)  **Fig. 46**	**K** (terminal box)  **Fig. 47**
Basic motor with tacho Type M10.005._	 **Fig. 48**	**S** (plug)  **Fig. 50**	**K** (terminal box)  **Fig. 51**
Brake motor (holding brake) with tacho Type M10.030._	 **Fig. 49**	**KS** (terminal box + plug)  **Fig. 52**	**KP** (terminal box + Pg with cable)  **Fig. 53**

tendo®-PM 52/53

	Standard connection P (Pg with cable)	Further conection possibilities	
Basic motor with incremental encoder Type M10.008._	 **Fig. 54**	**S** (plug)  **Fig. 56**	**KP** (terminal box + Pg with cable) 
Brake motor (holding brake) with incremental encoder Type M10.041._	 **Fig. 55**	**KS** (terminal box + plug)  **Fig. 57**	**Fig. 58**
Basic motor with tacho and incremental encoder Type M10.020._	 **Fig. 59**	**S** (plug)  **Fig. 61**	**KP** (terminal box + Pg with cable) 
Brake motor (holding brake) with tacho and incremental encoder Type M10.050._	 **Fig. 60**	**KS** (terminal box + plug)  **Fig. 63** **KSS** (terminal box + plug + plug)  **Fig. 64**	**KPP** (terminal box + Pg with cable + Pg with cable)  **Fig. 62** **Fig. 65**

Dimensions [mm]		L	L_1	L_2	L_3	L_4	L_5	L_6	L_7	L_8	Shaft øD x E
tendo®-PM 52	small design	199.5	234	243.5	239.5	274	239.5	274	273.5	308	9 x 20
	large design	202.5	237	246.5	242.5	277	242.5	277	276.5	311	11 x 23
tendo®-PM 53	small design	234.5	269	278.5	274.5	309	274.5	309	308.5	343	9 x 20
	large design	237.5	272	281.5	277.5	312	277.5	312	311.5	346	11 x 23

tendo®-PM 61/62/63

Technical Data			Motor size 61 Nominal power up to 190 W				Motor size 62 Nominal power up to 350 W				Motor size 63 Nominal power up to 500 W			
Nominal voltages [1]	U_N	[V]	160		24		160		24		160		24	
Nominal speed [1]	n_N	[rpm]	2000	3000	2000	3000	2000	3000	2000	3000	2000	3000	2000	-
Nominal torque	M_N	[Nm]	0.65	0.6	0.6	0.57	1.15	1.1	1.1	1.0	1.7	1.6	1.6	-
Nominal power	P_N	[W]	135	190	125	180	240	350	230	315	355	500	335	-
Nominal current	I_{AN}	[A]	1.14	1.43	7.1	9.1	2.0	2.8	12.5	18	2.85	3.85	17.0	-
Form factor [2]	F_F	[-]	1.05	1.05	1.05	1.05	1.05	1.05	1.05	1.05	1.05	1.05	1.05	-
Operating mode		[-]	S1				S1				S1			
Protection		[-]	IP54 / IP65				IP54 / IP65				IP54 / IP65			
Cooling type acc. IEC 34-6		[-]	IC 40 (self-cooled)				IC 40 (self-cooled)				IC 40 (self-cooled)			
ISO class		[-]	F				F				F			
Max. ambient temperature	R_T	[°C]	40				40				40			
Housing temperature	$\Delta\theta$	[K]	55	55	55	55	55	55	55	55	55	55	55	-
Thermal time constant	T_{th}	[min]	40	40	30	30	45	45	35	35	50	50	40	-
Max. permitted current [3]	I_{Amax}	[A]	5.0	6.9	35	46	9.5	13.5	65	95	14.5	21	95	-
Max. torque	M_{max}	[Nm]	2.4	2.4	2.4	2.4	4.9	4.8	5.1	4.9	7.8	7.9	8.0	-
Continuous downtime torque	M_o	[Nm]	0.7	0.7	0.7	0.7	1.25	1.25	1.25	1.25	1.8	1.8	1.8	-
Armature resistance [5]	R_A	[Ω]	17.0	8.6	0.35	0.19	7.05	3.50	0.171	0.078	3.55	1.76	0.098	-
Connection resistance [5]	R_a	[Ω]	18.0	9.6	0.45	0.3	8.05	4.50	0.28	0.18	4.6	2.8	0.2	-
Armature inductivity	L_A	[mH]	67	35	1.42	0.80	28	14	0.64	0.30	16	8	0.39	-
Electrical time constant [5]	T_a	[ms]	3.8	3.6	3.2	2.7	3.4	3.1	2.3	1.7	3.5	2.9	2.0	-
Friction torque	M_R	[Nm]	0.07	0.09	0.09	0.11	0.09	0.11	0.09	0.11	0.12	0.13	0.12	-
EMF constant [5]	K_E	[V/1000rp^m]	67.5	49	9.8	7.4	72	51	10.8	7.2	72.0	50.0	11.0	-
Torque constant [5]	K_T	[Nm/A]	0.64	0.47	0.094	0.070	0.69	0.49	0.1	0.069	0.69	0.48	0.10	-
Mass moment of inertia	J_d	[kgm²]	0.5 x 10^{-3}				0.95 x 10^{-3}				1.4 x 10^{-3}			
Mechanical time constant [5]	T_m	[ms]	22.0	21.7	25.5	30.6	15	17	24	34	13.3	16.5	25	-
Weight		[kg]	5.3				6.8				8.3			

		Tacho-generator [4]
Voltage constant	[V/1000rp^m]	15
Calibration tolerance		± 10 %
Max. current / rated impedance		15 mA / 15 kΩ
Linearity deviation		≤ 0.2 %
Harmonic content (eff)		≤ 0.6 %
Control range lower limit	[rpm]	0
Mass moment of inertia	[kgm²]	0.008 x 10^{-3}
Weight (incl. attachment)	[kg]	0.55

		Incremental encoder [4]
Pulses / rotation [1]		1000
Limit frequency		> 100 kHz
Channels		A, B, N + inversion
Outputs		acc. RS 422 (opp. TTL)
Supply voltage		4 - 6 VDC; 100 mA
Mass moment of inertia	[kgm²]	0.0015 x 10^{-3}
Weight (incl. attachment)	[kg]	0.6

		Brakes [4]	
		Holding brake	Positioning brake
Torque	[Nm]	2	4
Electr. connection power [5]	[W]	12	25
Voltage	[VDC]	24 / 207	24 / 207
Max. friction work	[J]	-	3000
Permitted friction work as switching frequency function [6]	[J]	-	3000 x (1 - e $^{(-60/S_h)}$)
Total friction work	[J]	-	100 x 10 ^{6}
Mass moment of inertia	[kgm²]	0.023 x 10^{-3}	0.021 x 10^{-3}
Weight (incl. attachment)	[kg]	1.3	1.1

Tolerance acc. VDE 0530, otherwise ± 10 %
1) Deviating nominal data available on request
2) In case of larger AC current proportions, the power must be reduced appropriately. $P_2' = 1.05 / F_F' \times P_N$ $(F_F = I_{A\ RMS} / I_{A\ arith.})$
3) The value may not even be temporarily exceeded, otherwise the magnets may in part be demagnetized (valid for temp. ≥ 0 °C).
4) Other Technical Data on request
5) At 20°C
6) Determination of the permitted friction work (Q_{zul}) depending on the prevailing switching frequency (S_h)
Example: S_h = 100 1/h
$Q_{zul.}(100) = 3000 \times (1 - e^{(-60/100)}) = 1354$ J

tendo®-PM 61/62/63

Designs and Flange Dimensions

B5 flange (FF)

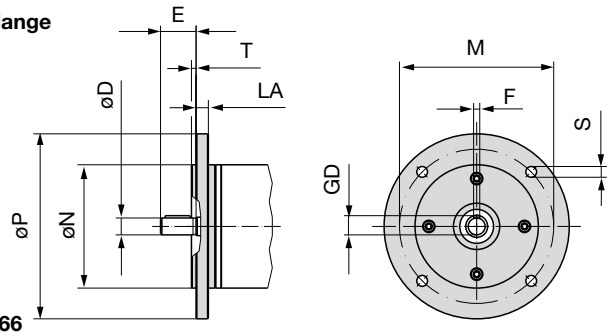


Fig. 66

B14 flange (FT)

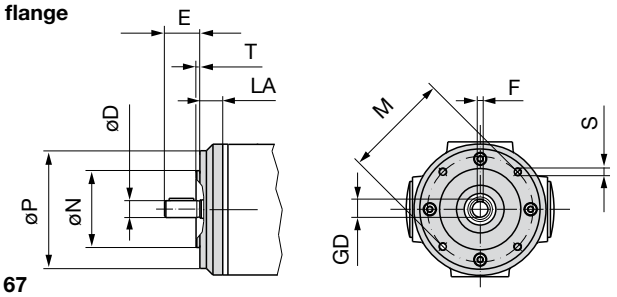


Fig. 67

Four-cornered flange

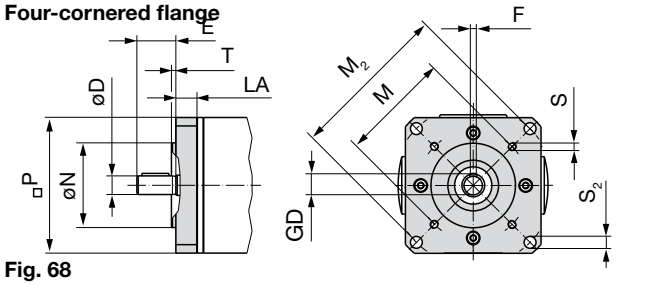


Fig. 68

Base design

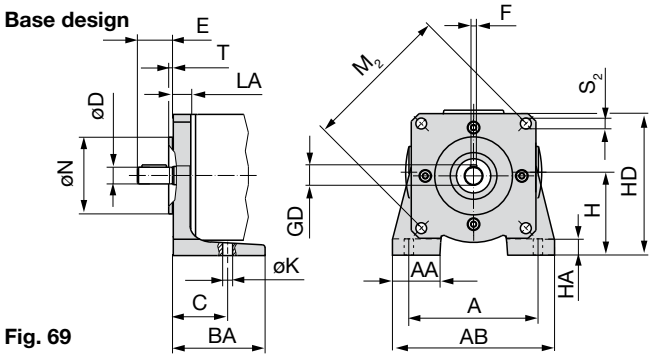


Fig. 69

Dimensions [mm]	DIN EN 50347 (DIN 42939)	A (b)	AA (n)	AB (f)	BA (m)	C (w_1)	D_{k6} (d_{k6})	E (l)	F (u)	GD (t)	H (h)	HA (c)	HD (p)	K (s)	LA (c_1)	M (e_1)	M_2 (e_2)	N_{j6} ($b_{1\ j6}$)	P (a_1)	S (s_1)	S_2 (s_2)	T (f_1)
B5 flange	small / FF 115	-	-	-	-	-	11	23	4	13	-	-	-	-	10	115	-	95	140	9	-	3
	large / FF 130	-	-	-	-	-	14	30	5	16	-	-	-	-	10	130	-	110	160	9	-	3.5
B14 flange	small / FT 75	-	-	-	-	-	11	23	4	13	-	-	-	-	17.5	75	-	60	90	M5	-	2.5
	large / FT 85	-	-	-	-	-	14	30	5	16	-	-	-	-	17.5	85	-	70	105	M6	-	2.5
Four-cornered flange	small shaft	-	-	-	-	-	11	23	4	13	-	-	-	-	17.5	75	115	60	100	M5	9	2.5
	large shaft	-	-	-	-	-	14	30	5	16	-	-	-	-	17.5	75	115	60	100	M5	9	2.5
Base design	small shaft	100	40	125	75	46	11	23	4	13	63	10	113	9	18	-	115	60	100	-	9	2.5
	large shaft	100	40	125	75	46	14	30	5	16	63	10	113	9	18	-	115	60	100	-	9	2.5

Order Number

Connection		Thermal switch		Protection	Speed	Hand release	
Pg with cable	P						
Plug [1) 4)]	S						
Terminal box [5)]	K						
Terminal box + Pg with cable [6)]	KP						
Terminal box + plug [1) 7)]	KS						
Terminal box + Pg + Pg [8)]	KPP	...	without	IP54	2000 rpm	without	...
Terminal box + plug + plug [1) 8)]	KSS	T	with [3)]	IP65	3000 rpm	with [2)]	HL

__ / M 1 0 . 0 __ . __ / __ __ / __ / __ / __ / __ / __ / __

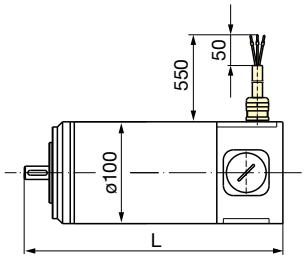
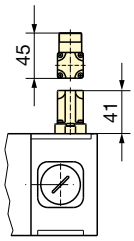
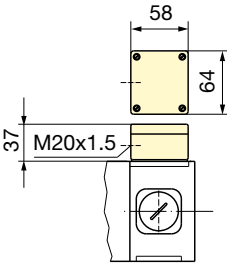
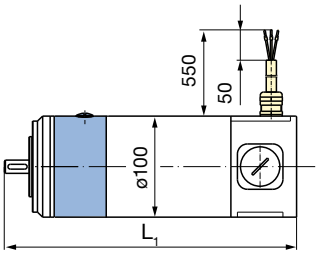
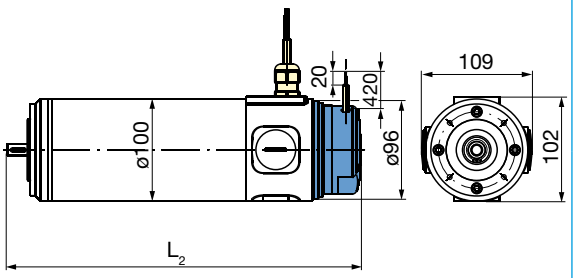
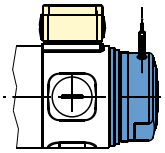
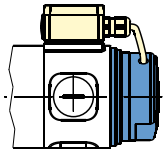
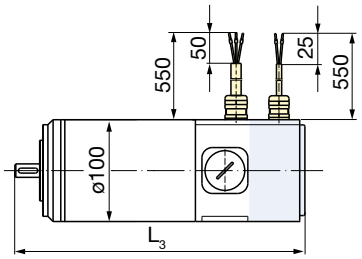
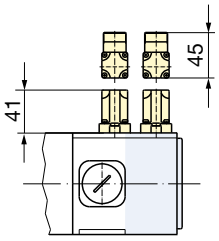
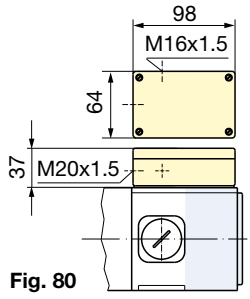
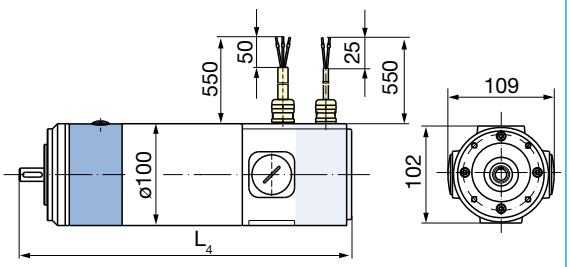
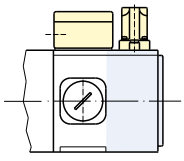
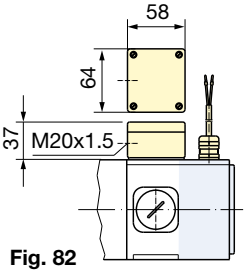
Size	Attachments		Design		Connection position	Armature voltage	Brake voltage
61	without attachment	01	1	B5 small	Only with base designs see page 7	24 V [9)]	24 VDC
62	Holding brake	02	2	B5 large		160 V	207 VDC
63	Positioning brake	04	3	B14 small			
	Tacho	05	4	B14 large			
	Incremental encoder	08	5	Four-cornered flange, small shaft			
	Tacho + incremental encoder	20					
	Holding brake + tacho	30	6	Four-cornered flange, large shaft			
	Holding brake + incremental encoder	41	7	Base design, small shaft			
	Holding brake + tacho + incremental encoder	50	8	Base design, large shaft			

1) Mating plug not included in the standard scope of delivery (on request)
2) Hand release only for positioning brake
3) Thermal switch in combination with cable design available on request
4) Not for Type M10.004._
5) Only Types M10.001._, M10.002._, M10.004._, M10.005._, M10.030._
6) Not for Types M10.001._ and M10.002._
7) Not for Types M10.001._, M10.002._ and M10.004._
8) Only Types M10.020._ and M10.050._
9) Size 63: Not possible in combination with nominal voltage 24V and nominal speed 3000 rpm

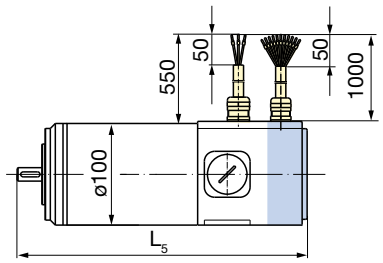
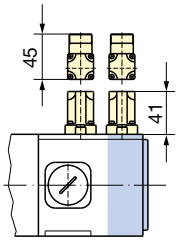
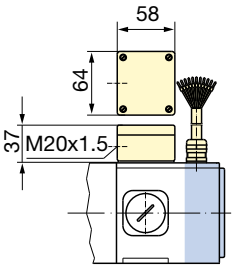
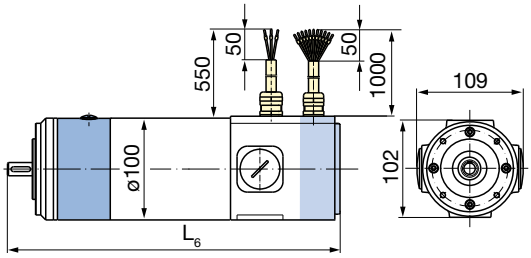
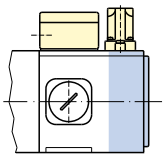
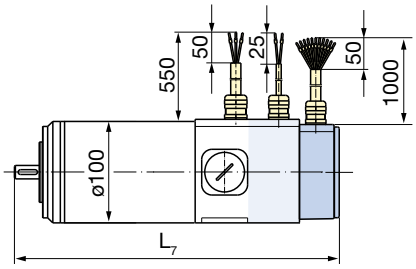
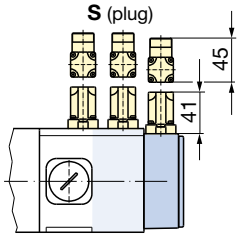
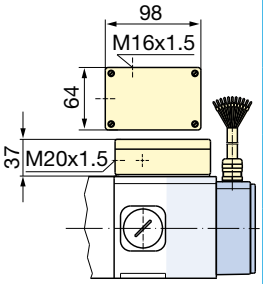
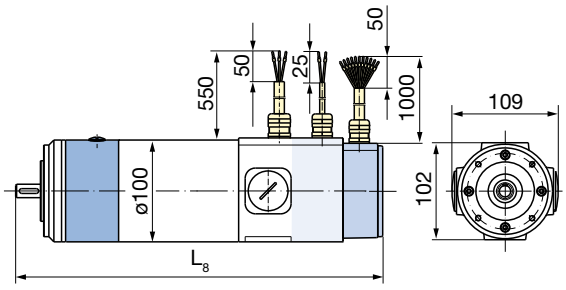
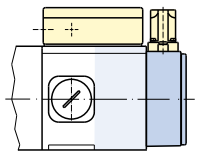
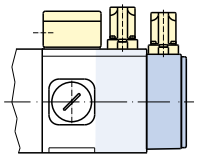
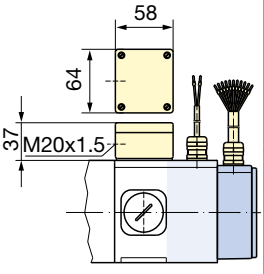
Example: 62 / M10.004.3 / P / IP54 / 160 V / 3000 rpm / 207 VDC / HL

tendo®-PM 61/62/63

Designs and Dimensions

	Standard connection P (Pg with cable)	Further conection possibilities	
Basic motor Type M10.001._	 **Fig. 70**	**S** (plug)  **Fig. 72**	**K** (terminal box)  **Fig. 73**
Brake motor (holding brake in A-bearing shield) Type M10.002._	 **Fig. 71**		
Basic motor with positioning brake Type M10.004._	 **Fig. 74**	**KP** (terminal box + cable)  **Fig. 75**	**K** (terminal box)  **Fig. 76**
Basic motor with tacho Type M10.005._	 **Fig. 77**	**S** (plug)  **Fig. 79**	**K** (terminal box)  **Fig. 80**
Brake motor (holding brake) with tacho Type M10.030._	 **Fig. 78**	**KS** (terminal box + plug)  **Fig. 81**	**KP** (terminal box + Pg with cable)  **Fig. 82**

tendo®-PM 61/62/63

	Standard connection P (Pg with cable)	Further conection possibilities	
Basic motor with incremental encoder Type M10.008._	 **Fig. 83**	**S** (plug)  **Fig. 85**	**KP** (terminal box + Pg with cable)  **Fig. 87**
Brake motor (holding brake) with incremental encoder Type M10.041._	 **Fig. 84**	**KS** (terminal box + plug)  **Fig. 86**	
Basic motor with tacho and incremental encoder Type M10.020._	 **Fig. 88**	**S** (plug)  **Fig. 90**	**KP** (terminal box + Pg with cable)  **Fig. 91**
Brake motor (holding brake) with tacho and incremental encoder Type M10.050._	 **Fig. 89**	**KS** (terminal box + plug)  **Fig. 92** **KSS** (terminal box + plug + plug)  **Fig. 93**	**KPP** (terminal box + Pg with cable + Pg with cable)  **Fig. 94**

Dimensions [mm]		L	L_1	L_2	L_3	L_4	L_5	L_6	L_7	L_8	Shaft øD x E
***tendo*®-PM 61**	small design	209.5	250.5	257	249.5	290.5	249.5	290.5	283.5	324.5	11 x 23
	large design	216.5	257.5	264	256.5	297.5	256.5	287.5	290.5	331.5	14 x 30
***tendo*®-PM 62**	small design	249.5	290.5	297	289.5	330.5	289.5	330.5	323.5	364.5	11 x 23
	large design	256.5	297.5	304	296.5	337.2	296.5	337.5	330.5	371.5	14 x 30
***tendo*®-PM 63**	small design	299.5	340.5	347	339.5	380.5	339.5	380.5	373.5	414.5	11 x 23
	large design	306.5	347.5	354	346.5	387.5	346.5	387.5	380.5	421.5	14 x 30

tendo®-PM with worm gear SG 31

Permanently-excited DC motor sizes 41/42 with single-stage worm gear Type K11.1_ _._

Design B14 – hollow shaft

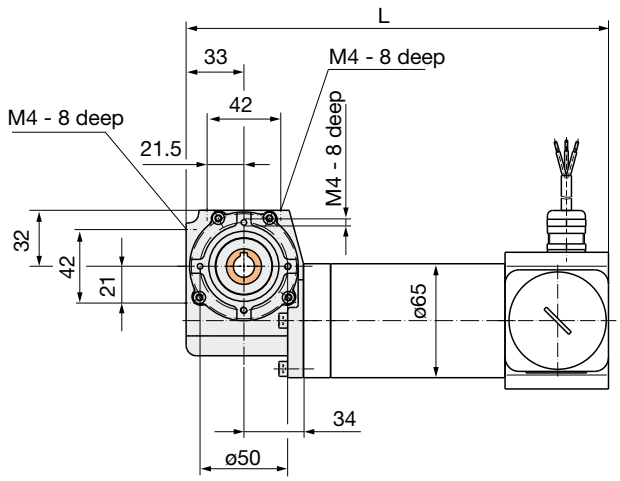


Fig. 95

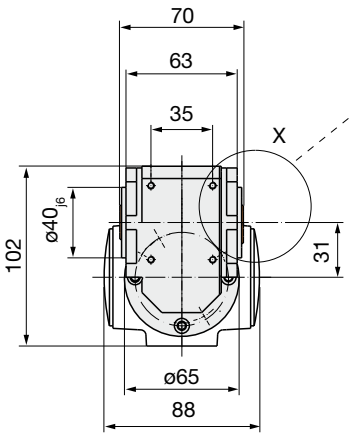


Fig. 96

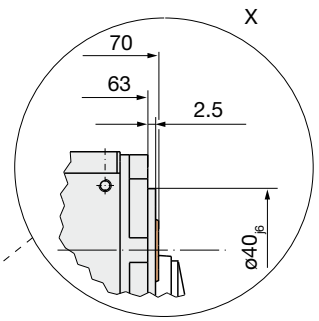


Fig. 97

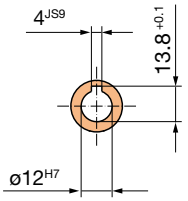


Fig. 98

Design B14 – solid shaft

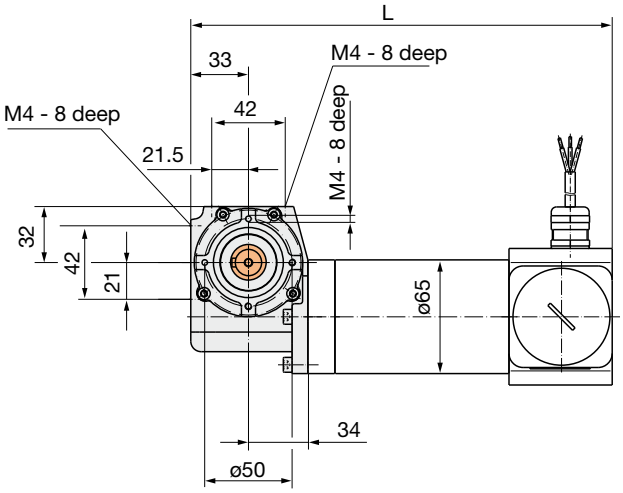


Fig. 99

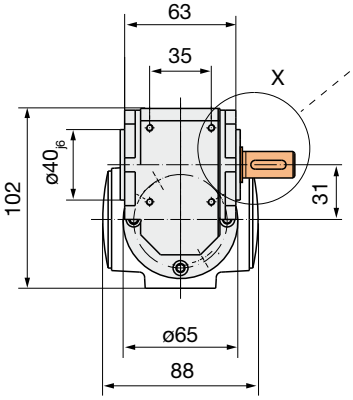


Fig. 100

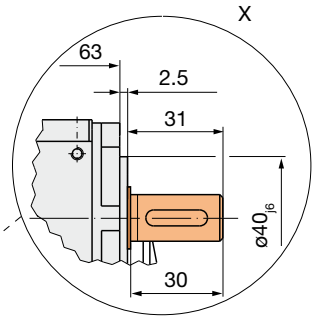


Fig. 101

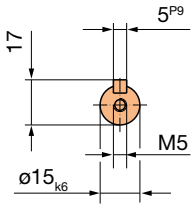


Fig. 102

Dimensions [mm]		L		Further information
		Size 41	Size 42	Sizes 41/42
Attachment B-bearing shield	Motor without attachments	205	241	Page 14
	Motor with positioning brake	242	278	Page 14
	Motor with tacho	251	287	Page 14
	Motor with incremental encoder	251	287	Page 15

tendo®-PM with worm gear SG 31

Selection Table

		Motor	6 : 1	7 : 1	12 : 1	20 : 1	30 : 1 *	50 : 1 *	70 : 1 **
n_2	[rpm]	n_1 = 2000 rpm	333	286	166	100	66	40	28
		n_1 = 3000 rpm	500	429	250	150	100	60	42
M_N [1]	[Nm]	Size 41	0.7	0.9	1.4	2.0	2.7	3.6	4.9
		Size 42	1.5	1.8	3.0	4.2	5.5	[7.1]	[9.7]
$M_{zul.\ 1}$ [2]	[Nm]	typ. operation	7.5	9.6	11.9	8.2	10.1	8.9	8.9
$M_{zul.\ 2}$ [3]	[Nm]	maximum	17.1	21.8	27.2	18.6	23.1	20.3	20.3
$M_{zul.\ therm.}$ [4]	[Nm]	n_1 = 2000 rpm	5.7	7.1	8.9	8.8	9.2	9.3	12.2
		n_1 = 3000 rpm	3.4	4.2	5.4	5.4	5.7	5.8	7.7

Gear backlash <18'

Radial load of output hollow shaft:
1300 N (force application on centre of gear)

Axial load of output hollow shaft: 170 N

Weight of complete gear
(without motor): 0.9 kg

1) With nominal motor speed
If necessary, the motor current must be limited so that the permitted torques are not exceeded!

2) For typical operating conditions: medium impacts; 60 start-ups/h; duty cycle 70 %

3) Permitted acceleration torque

4) Permitted thermal continuous torque

[...] Observe permitted gear torques!

* Statically self-limiting

** Self-limiting

If self-limiting worm gears are to be used in connection with brake motors (mechanical braking procedure) or 4-quadrant drives (electrical braking procedures) please contact us.

Order Number

Connection		Thermal switch		Speed	Installation position	Hand release	
Pg with cable	**P**						
Plug [2) 5)]	**S**						
Terminal box [6)]	**K**						
Terminal box + Pg with cable [7)]	**KP**	**...**	without	**2000 rpm**		without	**...**
Terminal box + plug [2) 8)]	**KS**	**T**	with [4)]	**3000 rpm**	see page 8	with [3)]	**HL**

__ / K 1 1 . 1 __ . __ / __ __ / __ / __ / __ / __ / __ / __ / __

Size	Attachments		Design	Protection [1)]	Armature voltage	Reduction	Brake voltage
41	without attachment	**01**	**1** B14 hollow shaft	**IP54**	**24 V**	**6 : 1**	**24 VDC**
42	Positioning brake [1)]	**04**		**IP65**	**160 V**	**7 : 1**	**104 VDC**
	Tacho	**05**				**12 : 1**	
	Incremental encoder	**08**	**5** B14 solid shaft			**20 : 1**	
						30 : 1	
						50 : 1	
						70 : 1	

Example: 41 / K11.104.1 / KT / IP54 / 160 V / 3000 rpm / 30 : 1 / 104 VDC / HL

1) Positioning brake available on request
2) Mating plug not included in the standard scope of delivery (on request)
3) Hand release only for positioning brake and IP54 on request
4) Thermal switch in combination with cable design available on request
5) Not for Type K11.104._
6) Only Types K11.101._, K11.104._ and K11.105._
7) Not for Type K11.101._
8) Not for Types K11.101._ and K11.104._

tendo®-PM with worm gear SG 35

Permanently-excited DC motor sizes 41/42/52/53 with single-stage worm gear Type K11.2_ _._

Design B14

Stub shaft available on request

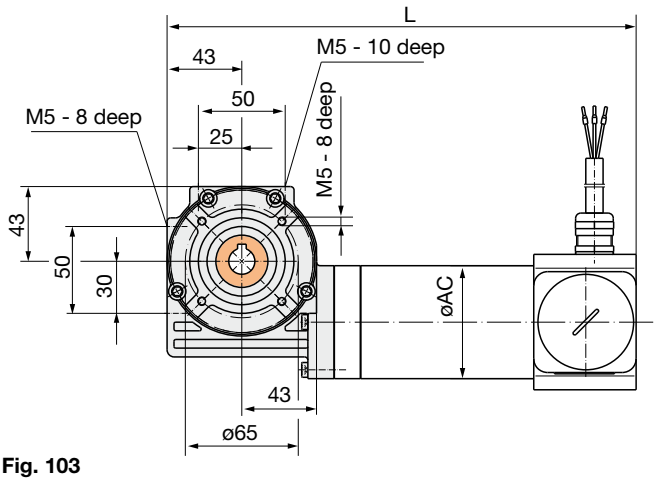


Fig. 103

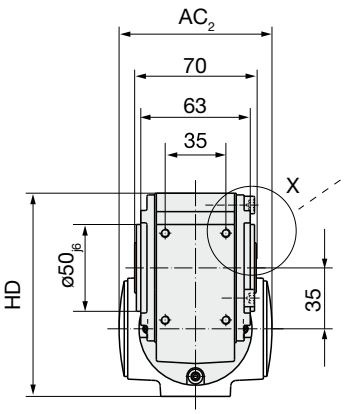


Fig. 104

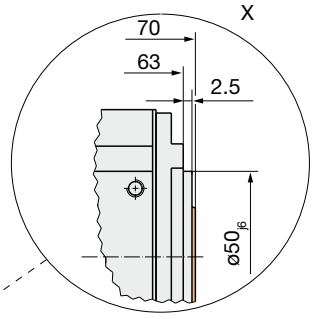


Fig. 105

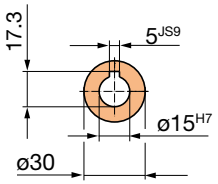


Fig. 106

Design B5

Stub shaft available on request

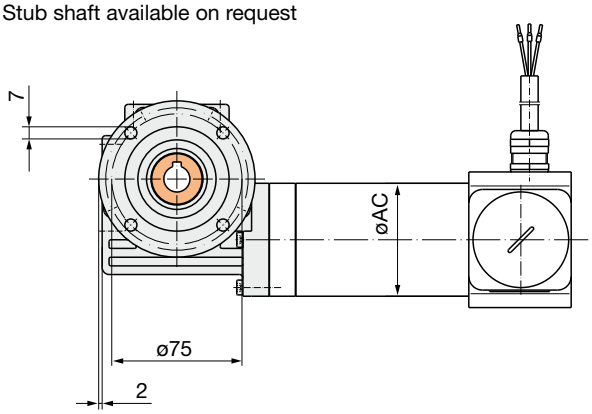


Fig. 107

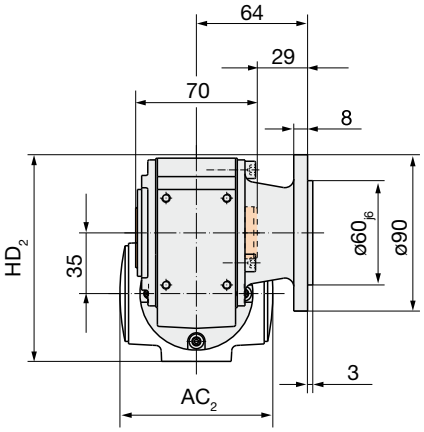


Fig. 108

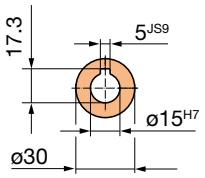


Fig. 109

Dimensions [mm]		AC	AC2	HD	HD2	L*
Motor size	41/42	65	88	117	119	see below
	52/53	80	103	125	127	see below

* Dependent on the attachments

Dimensions [mm]		L				L with holding brake				Further information	
		41	42	52	53	41	42	52	53	41/42	52/53
Attachment B-bearing shield	Motor without attachments	234	270	275.5	310.5	265	301	310	345	Page 14	Page 18
	Motor with positioning brake	271	307	319.5	354.5	-	-	-	-	Page 14	Page 18
	Motor with tacho	280	316	315.5	350.5	311	347	350	385	Page 14	Page 18
	Motor with incremental encoder	280	316	315.5	350.5	311	347	350	385	Page 15	Page 19
	Motor with tacho and incremental encoder	308	344	349.5	384.5	339	375	384	419	Page 15	Page 19

tendo®-PM with worm gear SG 35

Selection Table

		Motor	7,25 : 1	12 : 1	20 : 1	30 : 1 *	50 : 1 *	69 : 1 **
n_2	[rpm]	n_1 = 2000 rpm	276	166	100	66	40	29
		n_1 = 3000 rpm	414	250	150	100	60	43
M_N [1]	[Nm]	Size 41	0.6	1.1	1.6	2.1	3.0	4.3
		Size 42	1.6	2.5	3.7	4.7	6.4	8.9
		Size 52	2.4	3.7	5.3	6,7	[9.0]	[12.4]
		Size 53	3.4	6.0	[9.5]	[11.9]	-	-
$M_{zul.\ 1}$ [2]	[Nm]	typ. operation	14.5	15.8	14.5	14.8	12.7	10.5
$M_{zul.\ 2}$ [3]	[Nm]	maximum	33	36.0	33.0	33.8	29.0	24.0
$M_{zul.\ therm.}$ [4]	[Nm]	n_1 = 2000 rpm	9.9	11.3	11.7	11.4	12.7	17.2
		n_1 = 3000 rpm	5.7	6,7	7.1	6.9	7.9	10.9

Gear backlash <15'

Radial load of output hollow shaft:
1600 N (force application on centre of gear)

Axial load of output hollow shaft: 200 N

Weight of complete gear
(without motor): 1.7 kg

1) With nominal motor speed
If necessary, the motor current must be limited so that the permitted torques are not exceeded!

2) For typical operating conditions: medium impacts; 60 start-ups/h; duty cycle 70 %

3) Permitted acceleration torque

4) Permitted thermal continuous torque

[...] Observe permitted gear torques!

* Statically self-limiting

** Self-limiting

If self-limiting worm gears are to be used in connection with brake motors (mechanical braking procedure) or 4-quadrant drives (electrical braking procedures) please contact us.

Order Number

Connection		Thermal switch	Speed	Installation position	Hand release
Pg with cable	**P**				
Plug [2) 5)]	**S**				
Terminal box [6)]	**K**				
Terminal box + Pg with cable [7)]	**KP**				
Terminal box + plug [2) 8)]	**KS**				
Terminal box + Pg + Pg [9)]	**KPP**	**...** without	**2000 rpm**		without **...**
Terminal box + plug + plug [2) 9)]	**KSS**	**T** with [4)]	**3000 rpm**	see page 8	with [3)] **HL**

__ / K 1 1 . 2 __ . __ / __ __ / __ / __ / __ / __ / __ / __ / __

Size	Attachments		Design	Protection [1)]	Armature voltage	Reduction	Brake voltage
41	without attachment	**01**	**1** B14	**IP54**	**24 V**	**7,25 : 1**	**24 VDC**
42	Holding brake	**02**	**2** B5	**IP65**	**160 V**	**12 : 1**	**104 VDC** (PM 41/42)
52	Positioning brake [1)]	**04**				**20 : 1**	
53	Tacho	**05**				**30 : 1**	**207 VDC** (PM 52/53)
	Incremental encoder	**08**				**50 : 1**	
	Tacho + incremental encoder	**20**				**69 : 1**	
	Holding brake + tacho	**30**					
	Holding brake + incremental encoder	**41**					
	Holding brake + tacho + incremental encoder	**50**					

Example: 42 / K11.220.2 / P / IP54 / 160 V / 3000 rpm / 30 : 1 / 104 VDC

1) Sizes 41/42: IP65 for positioning brake available on request (not in combination with hand release)
2) Mating plug not included in the standard scope of delivery (on request)
3) Hand release only for positioning brake (Sizes 41/42: hand release only for IP54)
4) Thermal switch in combination with cable design available on request
5) Not for Type K11.204._
6) Only Types K11.201._, K11.202._, K11.204._, K11.205._, K11.230._
7) Not for Types K11.201._ and K11.202._
8) Not for Types K11.201._, K11.202._ and K11.204._
9) Only Types K11.220._ and K11.250._

tendo®-PM with worm gear SG 40

Permanently-excited DC motor sizes 52/53/61/62/63 with single-stage worm gear Type K11.3_ _._

Design B14

Stub shaft available on request

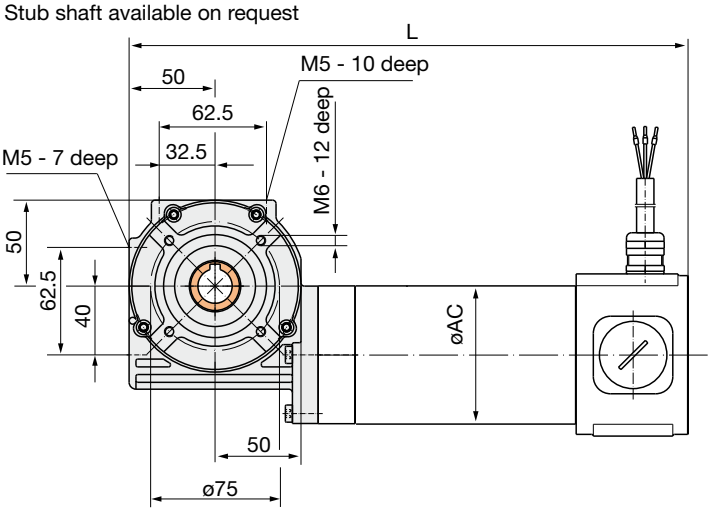


Fig. 110

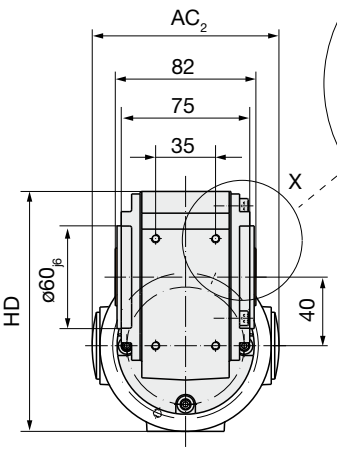


Fig. 111

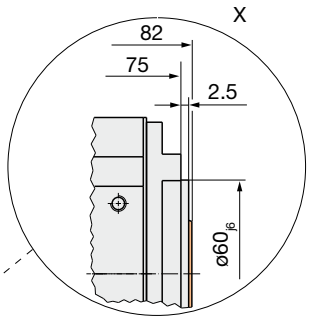


Fig. 112

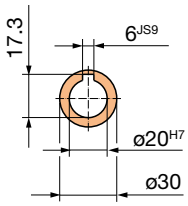


Fig. 113

Design B5

Stub shaft available on request

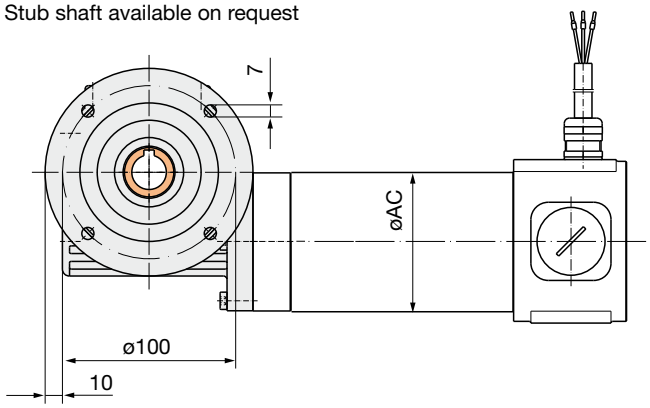


Fig. 114

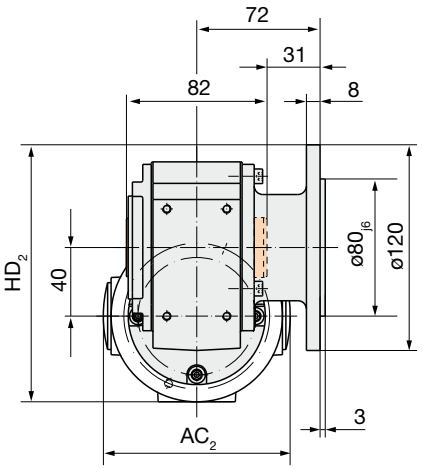


Fig. 115

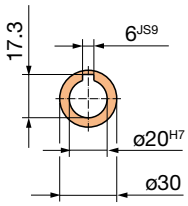


Fig. 116

Dimensions [mm]		AC	AC$_2$	HD	HD$_2$	L*
Motor size	52/53	80	103	137	147	see below
	61/62/63	100	109	140	150	see below

* Dependent on the attachments

Dimensions [mm]		L					L with holding brake					Further information	
		52	53	61	62	63	52	53	61	62	63	52/53	61/62/63
Attachment B-bearing shield	Motor without attachments	289.5	324.5	296.5	336.5	386.5	324	359	337.5	377.5	427.5	Page 18	Page 22
	Motor with positioning brake	333.5	368.5	344	384	434	-	-	-	-	-	Page 18	Page 22
	Motor with tacho	329.5	364.5	336.5	376.5	426.5	364	399	377.5	417.5	467.5	Page 18	Page 22
	Motor with incremental encoder	329.5	364.5	336.5	376.5	426.5	364	399	377.5	417.5	467.5	Page 19	Page 23
	Motor with tacho and incremental encoder	363.5	398.5	370.5	410.5	460.5	398	433	411.5	451.5	501.5	Page 19	Page 23

tendo®-PM with worm gear SG 40

Selection Table

		Motor	6.75 : 1	12 : 1	20 : 1	30 : 1 *	50 : 1 *	70 : 1 **
n_2	[rpm]	n_1 = 2000 rpm	296	166	100	66	40	28
		n_1 = 3000 rpm	444	250	150	100	60	42
M_N [1]	[Nm]	Size 52	2.0	3.6	5.8	7.4	11.6	14.5
		Size 53	3.4	6.0	9.5	11.9	[18.4]	[22.5]
		Size 61	2.6	4.6	7.3	9.2	14.3	17.7
		Size 62	5.4	9.4	[14.7]	[18.2]	[27.8]	-
		Size 63	[8.2]	[14.3]	[22.1]	[27.2]	-	-
$M_{zul.\ 1}$ [2]	[Nm]	typ. operation	29.0	24.9	28.5	29.6	26.7	23.8
$M_{zul.\ 2}$ [3]	[Nm]	maximum	66.0	56.7	65.0	67.5	60.8	54.2
$M_{zul.\ therm.}$ [4]	[Nm]	n_1 = 2000 rpm	13.3	20.2	23.6	19.6	26.7	28.3
		n_1 = 3000 rpm	7.1	11.3	13.7	11.7	16.4	17.9

Gear backlash <12'

Radial load of output hollow shaft:
2400 N (force application on centre of gear)

Axial load of output hollow shaft: 300 N

Weight of complete gear
(without motor): 2.1 kg

1) With nominal motor speed
If necessary, the motor current must be limited so that the permitted torques are not exceeded!
2) For typical operating conditions: medium impacts; 60 start-ups/h; duty cycle 70 %
3) Permitted acceleration torque
4) Permitted thermal continuous torque

[...] Observe permitted gear torques!

* Statically self-limiting

** Self-limiting

If self-limiting worm gears are to be used in connection with brake motors (mechanical braking procedure) or 4-quadrant drives (electrical braking procedures) please contact us.

Order Number

Connection		Thermal switch	Speed	Installation position	Hand release
Pg with cable	**P**				
Plug [1] [4]	**S**				
Terminal box [5]	**K**				
Terminal box + Pg with cable [6]	**KP**				
Terminal box + plug [1] [7]	**KS**				
Terminal box + Pg + Pg [8]	**KPP**	**...** without	**2000 rpm**		without **...**
Terminal box + plug + plug [1] [8]	**KSS**	**T** with [3]	**3000 rpm**	see page 8	with [2] **HL**

__ / K 1 1 . 3 __ . __ / __ __ / __ / __ / __ / __ / __ / __ / __

Size	Attachments		Design	Protection	Armature voltage	Reduction	Brake voltage
52	without attachment	**01**	**1** B14	**IP54**	**24 V** [9]	**6.75 : 1**	**24 VDC**
53	Holding brake	**02**	**2** B5	**IP65**	**160 V**	**12 : 1**	**207 VDC**
61	Positioning brake	**04**				**20 : 1**	
62	Tacho	**05**				**30 : 1**	
63	Incremental encoder	**08**				**50 : 1**	
	Tacho + incremental encoder	**20**				**70 : 1**	
	Holding brake + tacho	**30**					
	Holding brake + incremental encoder	**41**					
	Holding brake + tacho + incremental encoder	**50**					

Example: 53 / K11.304.2 / K / IP54 / 160 V / 3000 rpm / 12 : 1 / H611 / 207 VDC / HL

1) Mating plug not included in the standard scope of delivery (on request)
2) Hand release only for positioning brake
3) Thermal switch in combination with cable design available on request
4) Not for Type K11.304._
5) Only Types K11.301._, K11.302._, K11.304._, K11.305._, K11.330._
6) Not for Types K11.301._ and K11.302._
7) Not for Types K11.301._, K11.302._ and K11.304._
8) Only Types K11.320._ and K11.350._
9) Size 63: Not possible in combination with nominal voltage 24V and nominal speed 3000 rpm

tendo®-PM with worm gear SG 53

Permanently-excited DC motor sizes 61/62/63 with single-stage worm gear Type K11.4_ _._

Design B14

Stub shaft available on request

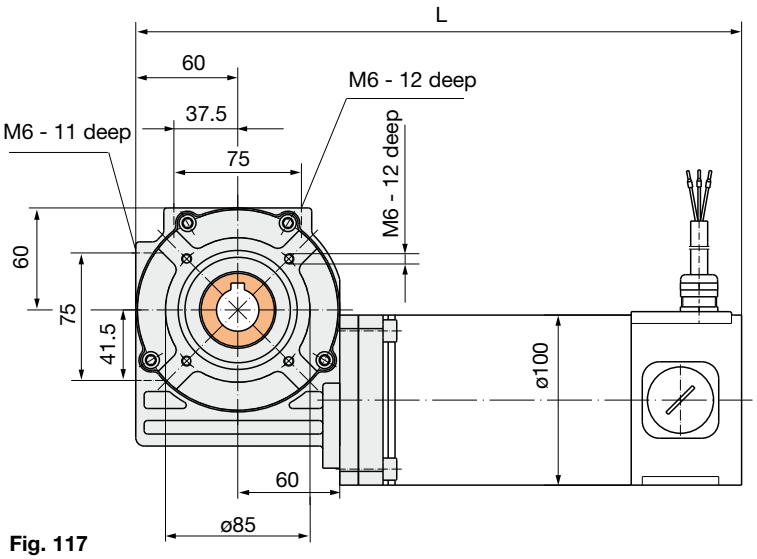


Fig. 117

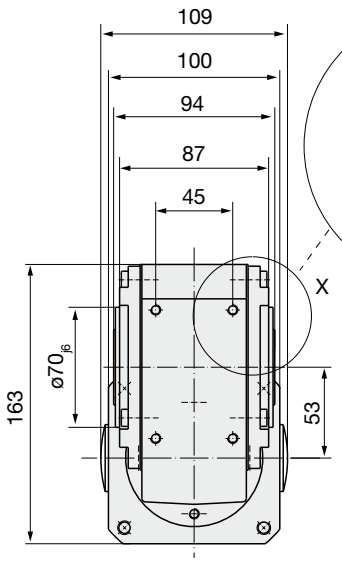


Fig. 118

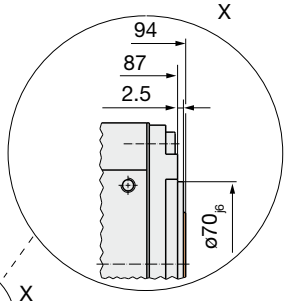


Fig. 119

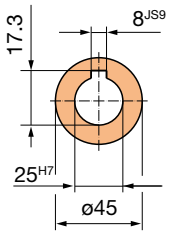


Fig. 120

Design B5

Stub shaft available on request

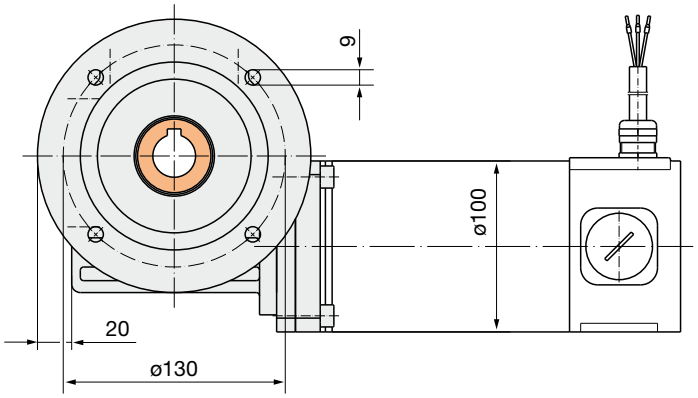


Fig. 121

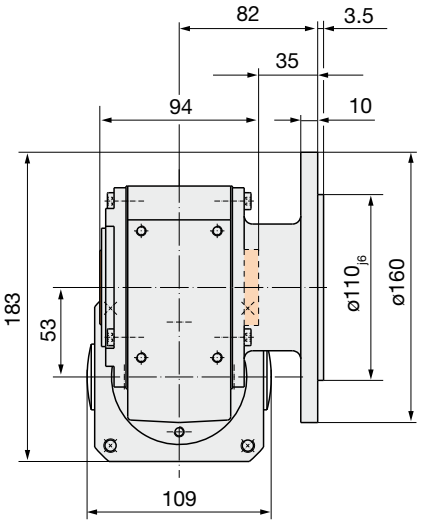


Fig. 122

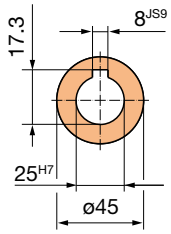


Fig. 123

Dimensions [mm]		L			L with holding brake			Further information
		61	62	63	61	62	63	61/62/63
Attachment B-bearing shield	Motor without attachments	317.5	357.5	407.5	358.5	398.5	448.5	Page 22
	Motor with positioning brake	365	405	455	-	-	-	Page 22
	Motor with tacho	357.5	397.5	447.5	398.5	438.5	488.5	Page 22
	Motor with incremental encoder	357.5	397.5	447.5	398.5	438.5	488.5	Page 23
	Motor with tacho and incremental encoder	391.5	431.5	481.5	432.5	472.5	522.5	Page 23

tendo®-PM with worm gear SG 53

Selection Table

		Motor	6.67 : 1	13.5 : 1	21 : 1	30 : 1 *	50 : 1 *	75 : 1 **
n_2	[rpm]	n_1 = 2000 rpm	300	148	95	66	40	27
		n_1 = 3000 rpm	450	222	143	100	60	40
M_N [1]	[Nm]	Size 61	2.0	4.3	6.9	9.0	13.0	17.0
		Size 62	4.8	9.4	[14.0]	[18.0]	[26.5]	[35.1]
		Size 63	[7.6]	[14.6]	[21.1]	[27.0]	[38.0]	[48.5]
$M_{zul.\ 1}$ [2]	[Nm]	typ. operation	66.5	79.1	92.9	76.4	59.3	48.7
$M_{zul.\ 2}$ [3]	[Nm]	maximum	152	180	212	174	135	111
$M_{zul.\ therm.}$ [4]	[Nm]	n_1 = 2000 rpm	13.0	18.8	22.3	23.4	27.0	30.5
		n_1 = 3000 rpm	5.7	10.0	13.1	14.1	16.7	19.2

Gear backlash <10'

Radial load of output hollow shaft:
3200 N (force application on centre of gear)

Axial load of output hollow shaft: 400 N

Weight of complete gear
(without motor): 3.7 kg

1) With nominal motor speed
If necessary, the motor current must be limited so that the permitted torques are not exceeded!
2) For typical operating conditions: medium impacts; 60 start-ups/h; duty cycle 70 %
3) Permitted acceleration torque
4) Permitted thermal continuous torque

[...] Observe permitted gear torques!

* Statically self-limiting

** Self-limiting

If self-limiting worm gears are to be used in connection with brake motors (mechanical braking procedure) or 4-quadrant drives (electrical braking procedures) please contact us.

Order Number

Connection		Thermal switch	Speed	Installation position	Hand release
Pg with cable	**P**				
Plug [1) 4)]	**S**				
Terminal box [5)]	**K**				
Terminal box + Pg with cable [6)]	**KP**				
Terminal box + plug [1) 7)]	**KS**				
Terminal box + Pg + Pg [8)]	**KPP**	**...** without	**2000 rpm**		without **...**
Terminal box + plug + plug [1) 8)]	**KSS**	**T** with [3)]	**3000 rpm**	see page 8	with [2)] **HL**

__ / K 1 1 . 4 __ . __ / __ __ / __ / __ / __ / __ / __ / __ / __

Size	Attachments		Design	Protection	Armature voltage	Reduction	Brake voltage
61	without attachment	**01**	**1** B14			**6.67 : 1**	
62	Holding brake	**02**	**2** B5	**IP54**	**24 V** [9)]	**13.5 : 1**	**24 VDC**
63	Positioning brake	**04**		**IP65**	**160 V**	**21 : 1**	**207 VDC**
	Tacho	**05**				**30 : 1**	
	Incremental encoder	**08**				**50 : 1**	
	Tacho + incremental encoder	**20**				**75 : 1**	
	Holding brake + tacho	**30**					
	Holding brake + incremental encoder	**41**					
	Holding brake + tacho + incremental encoder	**50**					

Example: 62 / K11.402.1 / P / IP54 / 24 V / 3000 rpm / 21 : 1 / H520 / 207 VDC

1) Mating plug not included in the standard scope of delivery (on request)
2) Hand release only for positioning brake
3) Thermal switch in combination with cable design available on request
4) Not for Type K11.404._
5) Only Types K11.401._, K11.402._, K11.404._, K11.405._, K11.430._
6) Not for Types K11.401._ and K11.402._
7) Not for Types K11.401._, K11.402._ and K11.404._
8) Only Types K11.420._ and K11.450._
9) Size 63: Not possible in combination with nominal voltage 24V and nominal speed 3000 rpm

Hollow shaft worm gear with integrated slip hub

The ***tendo***®-worm gear can be equipped with a slip hub adjustable from the outside. This makes it possible to absorb and damp start-up and operating impacts. But overload protection against blocking can also be guaranteed with this design – in particular in connection with a *mayr*®-speed monitor.

The advantages of the slip hub integrated into the worm gear:

- ❒ Absorbing of start-up and operating impacts
- ❒ Overload protection in case of blockages (in particular using a *mayr*®- speed monitor in order to avoid long slip times and poss. damage to the mechanism, please request separate documents)
- ❒ Simple and continuous adjustment of the slipping torque from the outside
- ❒ Large torque adjustment range
- ❒ Low wear as friction parts run in oil bath
- ❒ Same connection as on standard gears: Hollow shaft with designs B14 and B5
- ❒ Cover possible for the revolving gear parts
- ❒ Inexpensive solution

3 slip hub versions are available			Suitable for: High overload torque	High friction work	Disengaging function
Version characteristics	**RN**	Friction lining friction	+	++	--
	KRN	Cone with metal friction	++	+	--
	FRN	Cone with special cup springs	+	+	++

Design B14

Stub shaft available on request

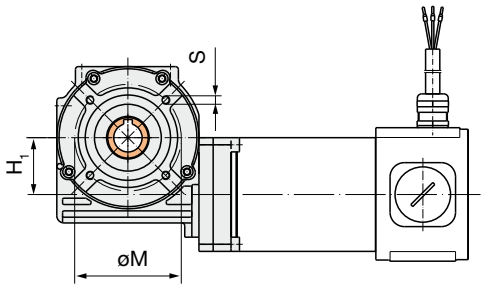


Fig. 124
Worm gear with integrated slip hub SG/RN or SG/KRN

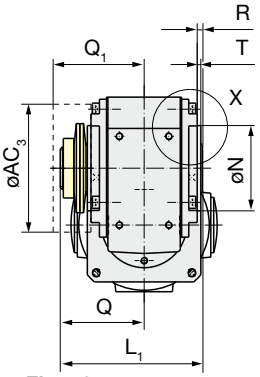


Fig. 125
SG/RN or SG/KRN

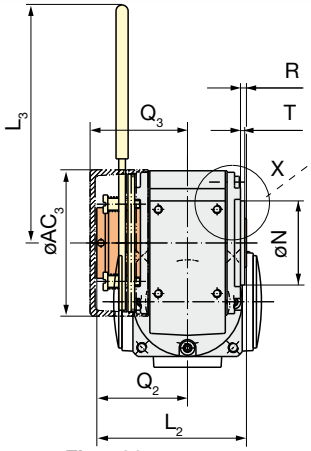


Fig. 126
Worm gear with disengaging device SG/FRN

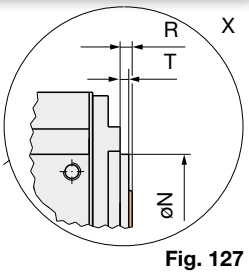


Fig. 127

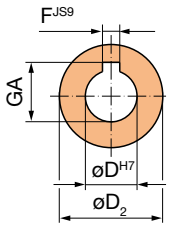


Fig. 128

Design B5

Stub shaft available on request

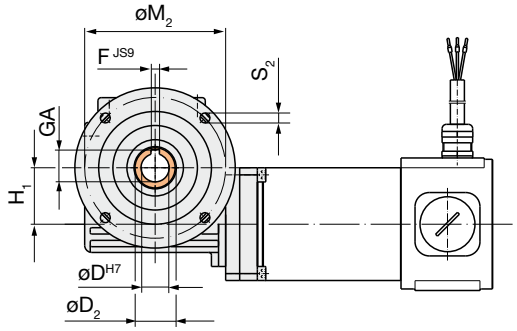


Fig. 129
Worm gear with integrated slip hub SG/RN or SG/KRN

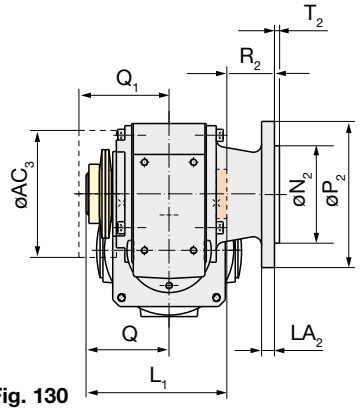


Fig. 130
SG/RN or SG/KRN

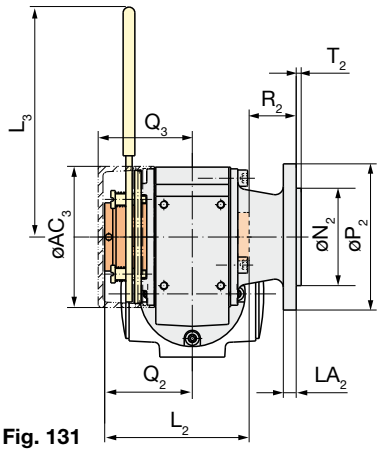


Fig. 131
Worm gear with disengaging device SG/FRN

Dimensions [mm]	DIN EN 50347 / (DIN 42939)	AC_3 (g_3)	D^{H7} (d^{H7})	D_2 (m)	F^{JS9} (u^{JS9})	GA (t)	H_1 (h_1)	L_1 (k_1)	L_2 (k_2)	L_3 (l)	LA_2 (c)	M (e_1)	M_2 (e_2)	N_{j6} ($b_{1\,j6}$)	$N_{2\,j6}$ ($b_{2\,j6}$)	P_2 (a_2)	Q (q)	Q_1 (q_1)	Q_2 (q_2)	Q_3 (q_3)	R (i_1)	R_2 (i_2)	S (s_1)	S_2 (s_2)	T (f_1)	T_2 (f_2)	α α
Gear size **SG 35**		80	15	30	5	17.3	35	85	89	140	8	65	75	50	60	90	50	55	54	59	3.5	29	M5 - 8 deep	7	2.5	3	20°
SG 40		90	20	30	6	22.8	40	100	109	146	8	75	100	60	80	120	59	64	68	72	3.5	31	M6 - 12 deep	7	2.5	3	40°
SG 53		100	25	45	8	28.3	53	114	128	166	10	85	130	70	110	160	67	72	81	86	3.5	35	M6 - 12 deep	9	2.5	3.5	50°

Hollow shaft worm gear with integrated slip hub

Technical Data				Gear size SG 35		Gear size SG 40		Gear size SG 53
Motor size				**PM 41/42**	**PM 52/53**	**PM 52/53**	**PM 61/62/63**	**PM 61/62/63**
Nominal output torque		from – to	[Nm]	1.1 – 11.0	2.8 – 15.0	2.7 – 23.0	5.9 – 27.0	6.0 – 48.8
Adjustable overload torque	**RN**	min. – max.	[Nm]	1.5 – 17.5		2 – 31.5		2.5 – 56.5
	KRN			1.5 – 36.5		2 – 65		2.5 - 120
	FRN			4.5 – 14		18 – 30		36 – 60

- Please state required slipping torque on order.
- Further overload torques and other special requirements available on request!
- The hook wrench required to adjust the overload torque can be supplied.

Order Number

Gear	Connection	Thermal switch	Speed	Installation position	Hand release	Cover
SG 35 **2**	Pg with cable **P**					
SG 40 **3**	Plug [2) 6)] **S**					
SG 53 **4**	Terminal box [5)] **K**					
	Terminal box + Pg with cable [7)] **KP**					
	Terminal box + plug [2) 8)] **KS**					
	Terminal box + Pg + Pg [9)] **KPP**					
	Terminal box + plug + plug [2) 9)] **KSS**	**...** without **T** with [4)]	**2000 rpm** **3000 rpm**	see page 8	without **...** with [3)] **HL**	without **...** with **A**

__ / K 1 1 . __ __ . __ / __ __ / __ / __ / __ / __ / __ / __ / __ / __ / __

Size	Attachments		Design	Motor protection [1)]	Armature voltage	Reduction	Brake voltage	Slip hub
41	without attachment	**01**	**1** B14	**IP54**	**24 V**	**7.25/6.75/ 6.67 : 1**	**24 VDC**	with lever position [10)] and torque
42	Holding brake	**02**	**2** B5	**IP65**	**160 V**	**12/13.5 : 1**	**104 VDC** (PM 41/42)	**RN - ... Nm**
52	Positioning brake [1)]	**04**				**20/21 : 1**	**207 VDC** (PM 52/53, PM 61/62/63)	**KRN - ... Nm**
53	Tacho	**05**				**30 : 1**		**FRN - ... - ... Nm**
61	Incremental encoder	**08**				**50 : 1**		
62	Tacho + incremental encoder	**20**				**69/70/75 : 1**		
63	Holding brake + tacho	**30**						
	Holding brake + incremental encoder	**41**						
	Holding brake + tacho + incremental encoder	**50**						

Example: 53 / K11.304.2 / K / IP54 / 160 V / 3000 rpm / 6.75 : 1 / H311 / 207 VDC / FRN - 4 - 20 Nm / A

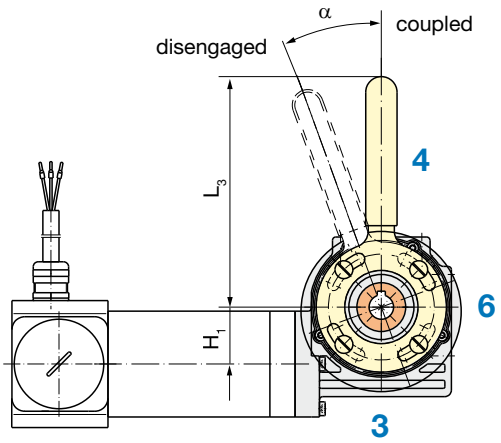


Fig. 132
Worm gear with disengaging device, lever position: 4

1) Sizes 41/42: motor protection IP65 available for positioning brake on request (not available in combination with hand release)
2) Mating plug not included in the standard scope of delivery (on request)
3) Hand release only for positioning brake (Sizes 41/42: hand release only for IP54)
4) Thermal switch in combination with cable design available on request
5) Only Types K11._01._, K11._02._, K11._04._, K11._05._ and K11._30._
6) Not for Type K11._04._
7) Not for Types K11._01._ and K11._02._
8) Not for Types K11._01._, K11._02._ and K11._04._
9) Only Types K11._20._ and K11._50._
10) Possible lever positions: 3, 4 or 6 (see Figure 132, page 33), only with FRN

tendo®-PM with planetary gear REG 42

Permanently-excited DC motor sizes 41/42 with planetary gear Type K13.2_ _._

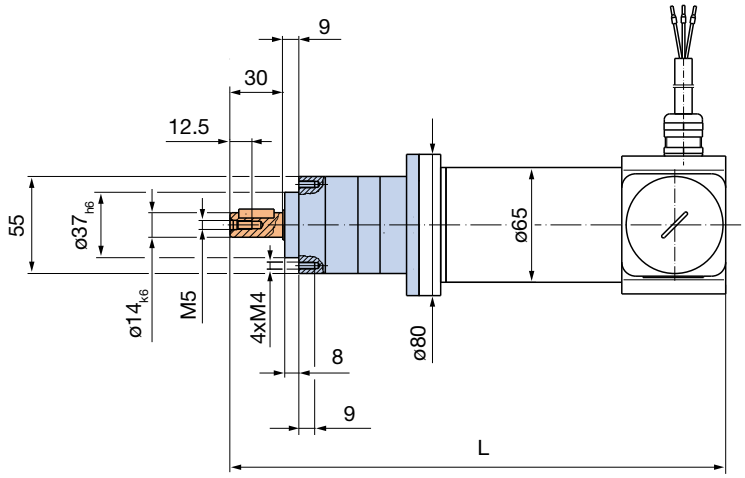


Fig. 133

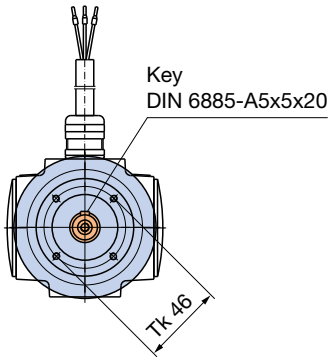


Fig. 134

Can also be supplied in **Direct-mounted** design:
- The appropriate dimension “L” is 32.5 mm smaller than the L value stated in the table below
- Flange ø80 n/a

Dimensions [mm]		Stage count	L		L with holding brake		Further information
			Size 41	Size 42	Size 41	Size 42	Sizes 41/42
Attachment B-bearing shield	Motor without attachments	1-stage	245	281	276	312	Page 14
		2-stage	262	298	293	329	
		3-stage	285	321	316	352	
	Motor with positioning brake	1-stage	282	318	-	-	Page 14
		2-stage	299	335	-	-	
		3-stage	322	358	-	-	
	Motor with tacho	1-stage	291	327	322	358	Page 14
		2-stage	308	344	339	375	
		3-stage	331	367	362	398	
	Motor with incremental encoder	1-stage	291	327	322	358	Page 15
		2-stage	308	344	339	375	
		3-stage	331	367	362	398	
	Motor with tacho and incremental encoder	1-stage	319	355	350	386	Page 15
		2-stage	336	372	367	403	
		3-stage	359	395	390	426	

tendo®-PM with planetary gear REG 42

Selection Table

		Motor	3.83:1	5.25:1	9.5:1	14.68:1	20.1:1	27.56:1	49.87:1	63.27:1	97.79:1	139.34:1	191:1
n_2	[rpm]	n_1 = 2000 rpm	522	381	211	136	100	72.6	40.1	31.6	20.5	14.4	10.5
		n_1 = 3000 rpm	783	571	316	204	149	109	60.2	47.4	30.7	21.5	15.7
M_N [1] Operating mode: S1	[Nm]	Size 41	0.5	0.7	1.3	1.9	2.6	3.5	6.4	8.1	11.7	16.7	[23]
		Size 42	1.1	1.5	2.7	4.0	5.5	7.5	13.6	[17.2]	[25]	[36]	--
M_N [2] Operating mode: S3 - 25 %	[Nm]	Size 41	1.2	1.7	3.0	4.4	6.0	8.2	[14.8]	[18.8]	[27.4]	[39.0]	[53.5]
		Size 42	2.4	3.3	[5.9]	8.6	11.8	[16.2]	[29.2]	[37.1]	[54.0]	[76.9]	--
$M_{zul.\ 1}$ [3]	[Nm]	typ. operation	4.2	4.2	4.2	14	14	14	14	14	21	21	21
$M_{zul.\ 2}$ [4]	[Nm]	maximum	9.0	9.0	9.0	30	30	30	30	30	45	45	45
Mass moment of inertia	[10^{-3} kgm²]		0.0033	0.003	0.0022	0.003	0.0028	0.0026	0.0024	0.0022	0.0032	0.003	0.0026
Stage count			1			2					3		
Gear backlash			<20'			<30'					<45'		
Gear weight (without motor)	[kg]		0.8			1.1					1.3		

Gear protection IP44

Further reductions possible

1) For S1 nominal operation of motor
If necessary, the motor current must be limited so that the permitted torques are not exceeded!

2) For typical intermittent periodic duty S3 - 25 % (I motor = 2 x I nominal)
If necessary, the motor current must be limited so that the permitted torques are not exceeded!

3) For typical operating conditions: medium impacts; 200 start-ups/h; 8h/day

4) Permitted acceleration torque

[...] Observe permitted gear torques!

Order Number

Connection		Thermal switch	Speed	Installation position	Hand release
Pg with cable	P				
Plug [2) 5)]	S				
Terminal box [6)]	K				
Terminal box + Pg with cable [7)]	KP				
Terminal box + plug [2) 8)]	KS				
Terminal box + Pg + Pg [9)]	KPP	... without	2000 rpm	see page 7	without ...
Terminal box + plug + plug [2) 9)]	KSS	T with [4)]	3000 rpm		with [3)] HL

__ / K 1 3 . 2 __ . __ / __ __ / __ / __ / __ / __ / __ / __ / __

Size	Attachments		Design	Motor protection [1)]	Armature voltage	Reduction	Brake voltage
41	without attachment	01	0 B14	IP54	24 V	3.83 : 1	24 VDC
42	Holding brake	02	1 B3 [10)]	IP65	160 V	5.25 : 1	104 VDC
	Positioning brake [1)]	04	2 B5 [10)]			9.50 : 1	
	Tacho	05				14.68 : 1	
	Incremental encoder	08				20.10 : 1	
	Tacho + incremental encoder	20				27.56 : 1	
	Holding brake + tacho	30				49.87 : 1	
	Holding brake + incremental encoder	41				63.27 : 1	
	Holding brake + tacho + incremental encoder	50				97.79 : 1	
						139.34 : 1	
						191.00 : 1	

Example: 42 / K13.202.0 / KPT / IP54 / 24 V / 3000 rpm / 49.87 : 1 / V19 / 104 VDC / HL

1) Motor protection IP65 available for positioning brake available on request (not in combination with hand release)
2) Mating plug not included in the standard scope of delivery (on request)
3) Hand release only for positioning brake and IP54 on request
4) Thermal switch in combination with cable design available on request
5) Not for Type K13.204.0
6) Only Types K13.201.0, K13.202.0, K13.204.0, K13.205.0, K13.230.0
7) Not for Types K13.201.0 and K13.202.0
8) Not for Types K13.201.0, K13.202.0 and K13.204.0
9) Only Types K13.220.0 and K13.250.0
10) On request

tendo®-PM with planetary gear REG 50

Permanently-excited DC motor sizes 52/53 and 61/62/63 with planetary gear Type K13.3_ _._

Motor Sizes 52/53

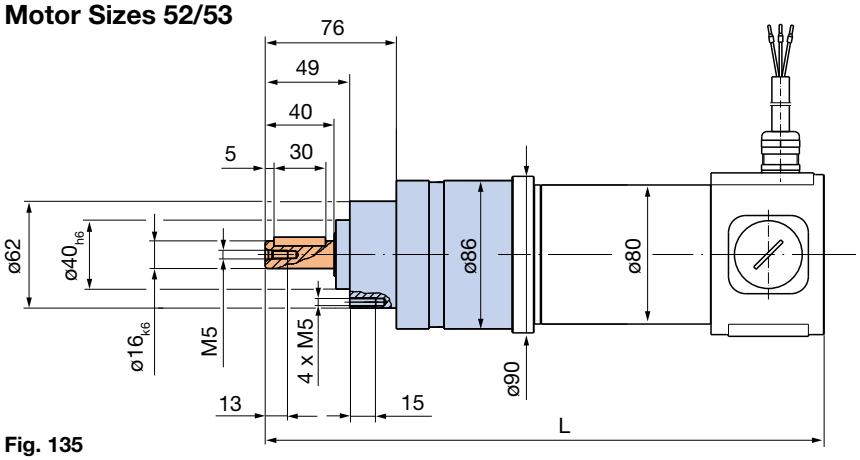


Fig. 135

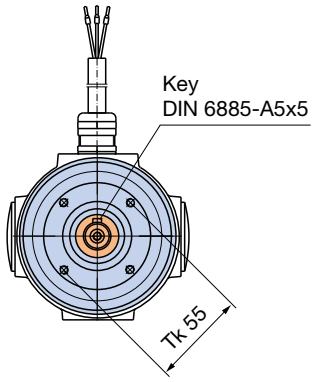


Fig. 136

Motor Sizes 61/62/63

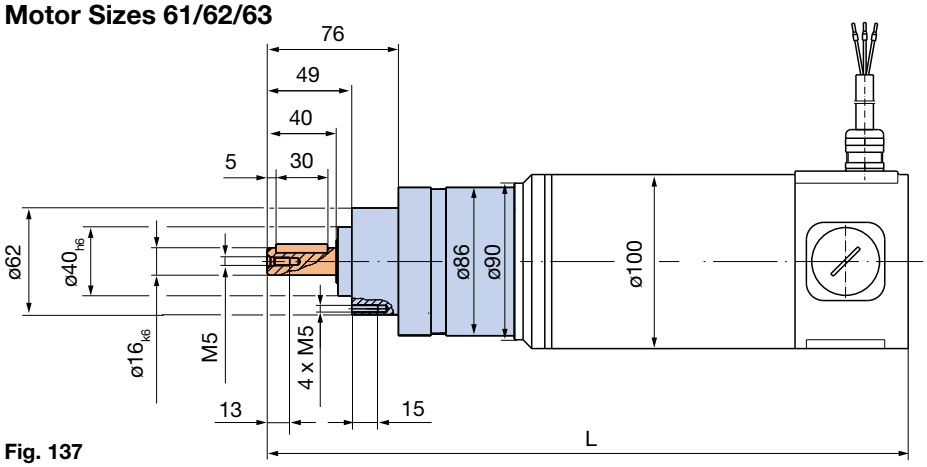


Fig. 137

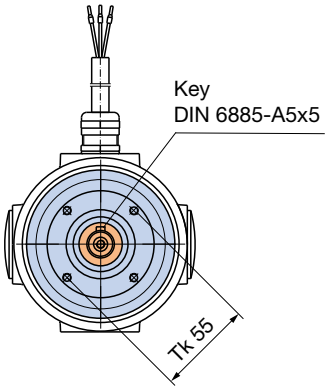


Fig. 138

Can also be supplied in **Direct-mounted** design:
The appropriate dimension “L” is 33 mm smaller than the L value stated in the table below (this applies for all reductions).

Dimensions [mm]		Stage count	L					L with holding brake					Further information	
			52	53	61	62	63	52	53	61	62	63	52/53	61/62/63
Attachment B-bearing shield	Motor without attachments	1-stage	323.5	358.5	330.5	370.5	420.5	358	393	371.5	411.5	461.5	Page 18	Page 22
		2-stage	348.5	383.5	355.5	395.5	445.5	383	418	396.5	436.5	486.5		
		3-stage	373.5	408.5	380.5	420.5	470.5	408	443	421.5	461.5	511.5		
	Motor with positioning brake	1-stage	367.5	402.5	378	418	468	-	-	-	-	-	Page 18	Page 22
		2-stage	392.5	427.5	403	443	493	-	-	-	-	-		
		3-stage	417.5	452.5	428	468	518	-	-	-	-	-		
	Motor with tacho	1-stage	363.5	398.5	370.5	410.5	460.5	398	433	411.5	451.5	501.5	Page 18	Page 22
		2-stage	388.5	423.5	395.5	435.5	485.5	423	458	436.5	476.5	526.5		
		3-stage	413.5	448.5	420.5	460.5	510.5	448	483	461.5	501.5	551.5		
	Motor with incremental encoder	1-stage	363.5	398.5	370.5	410.5	460.5	398	433	411.5	451.5	501.5	Page 19	Page 23
		2-stage	388.5	423.5	395.5	435.5	485.5	423	458	436.5	476.5	526.5		
		3-stage	413.5	448.5	420.5	460.5	510.5	448	483	461.5	501.5	551.5		
	Motor with tacho and incremental encoder	1-stage	397.5	431.5	404.5	444.5	494.5	431	467	445.5	485.5	535.5	Page 19	Page 23
		2-stage	422.5	456.5	429.5	469.5	519.5	456	492	470.5	510.5	560.5		
		3-stage	447.5	481.5	454.5	494.5	544.5	481	517	495.5	535.5	585.5		

tendo®-PM with planetary gear REG 50

Selection Table

		Motor	3.34:1	5.35:1	8.62:1	13.53:1	21.88:1	34.91:1	74.3:1	96.16:1	141.39:1	228.67:1
n_2	[rpm]	n_1 = 2000 rpm	599	374	232	148	91	57	27	21	14.1	8.7
		n_1 = 3000 rpm	898	561	348	222	137	86	40	31	21	13.1
M_N [1] Operating mode: S1	[Nm]	Size 52	1.1	1.8	2.9	4.4	7.1	11.3	24	29	43	[70]
		Size 53	1.9	3.0	4.9	7.2	11.7	18.7	40	48	[71]	--
		Size 61	1.4	2.3	3.7	5.5	8.9	14.2	30	37	54	--
		Size 62	2.9	4.7	7.6	11.3	18.2	29	[62]	[75]	--	--
		Size 63	4.4	7.1	11.5	17.0	28	[44]	--	--	--	--
M_N [2] Operating mode: S3 - 25%	[Nm]	Size 52	2.6	4.2	6.8	10.1	16.4	26	[56]	[68]	[100]	[161]
		Size 53	4.1	6.6	10.7	15.9	26	[41]	[87]	[106]	[156]	--
		Size 61	3.2	5.2	8.4	12.4	20	32	[68]	[83]	[122]	--
		Size 62	6.3	10.0	[16.1]	24	[39]	[62]	[131]	[160]	--	--
		Size 63	9.3	[14.8]	[24]	35	[57]	[91]	--	--	--	--
$M_{zul.\ 1}$ [3]	[Nm]	typ. operation	14.0	14.0	14.0	35.0	35.0	35.0	35.0	55.9	55.9	55.9
$M_{zul.\ 2}$ [4]	[Nm]	maximum	20.0	20.0	20.0	50.0	50.0	50.0	50.0	80.0	80.0	80.0
Mass moment of inertia	[10^{-3} kgm²]		0.20	0.08	0.05	0.17	0.15	0.13	0.12	0.11	0.08	0.06
Stage count			1			2				3		
Gear backlash			<15'			<30'				<45'		
Gear weight (without motor)	[kg]		1.6			2.6				3		

Gear protection IP44

Further reductions possible

1) For S1 nominal operation of motor
If necessary, the motor current must be limited so that the permitted torques are not exceeded!

2) For typical intermittent periodic duty S3 - 25 % (I motor = 2 x I nominal)
If necessary, the motor current must be limited so that the permitted torques are not exceeded!

3) For typical operating conditions: medium impacts; 200 start-ups/h; 8h/day

4) Permitted acceleration torque

[...] Observe permitted gear torques!

Order Number

Connection		Thermal switch		Speed	Installation position	Hand release	
Pg with cable	**P**						
Plug [1) 4)]	**S**						
Terminal box [5)]	**K**						
Terminal box + Pg with cable [6)]	**KP**						
Terminal box + plug [1) 7)]	**KS**						
Terminal box + Pg + Pg [8)]	**KPP**	**...**	without	**2000 rpm**		without	**...**
Terminal box + plug + plug [1) 8)]	**KSS**	**T**	with [3)]	**3000 rpm**	see page 7	with [2)]	**HL**

__ / K 1 3 . 3 __ . __ / __ __ / __ / __ / __ / __ / __ / __ / __

Size	Attachments		Design	Motor protection	Armature voltage	Reduction	Brake voltage
52	without attachment	**01**	**0** B14	**IP54**	**24 V** [10)]	**3.34 : 1**	**24 VDC**
53	Holding brake	**02**	**1** B3 [9)]	**IP65**	**160 V**	**5.35 : 1**	**207 VDC**
61	Positioning brake	**04**	**2** B5 [9)]			**8.62 : 1**	
62	Tacho	**05**				**13.53 : 1**	
63	Incremental encoder	**08**				**21.88 : 1**	
	Tacho + incremental encoder	**20**				**34.91 : 1**	
	Holding brake + tacho	**30**				**74.30 : 1**	
	Holding brake + incremental encoder	**41**				**96.16 : 1**	
						141.39 : 1	
	Holding brake + tacho + incremental encoder	**50**				**228.67 : 1**	

Example: 53 / K13.302.0 / P / IP54 / 24 V / 3000 rpm / 96.16 : 1 / V19 / 207 VDC

1) Mating plug not included in the standard scope of delivery (on request)
2) Hand release only for positioning brake
3) Thermal switch in combination with cable design available on request
4) Not for Type K13.304.0
5) Only Types K13.301.0, K13.302.0, K13.304.0, K13.305.0, K13.330.0
6) Not for Types K13.301.0 and K13.302.0
7) Not for Types K13.301.0, K13.302.0 and K13.304.0
8) Only Types K13.320.0 and K13.350.0
9) On request
10) Size 63: Not possible in combination with nominal voltage 24V and nominal speed 3000 rpm

tendo®-PM with planetary gear EPL 64

Permanently-excited DC motor sizes 41/42 and 52/53 with planetary gear Type K13.5_ _._

Motor Sizes 41/42

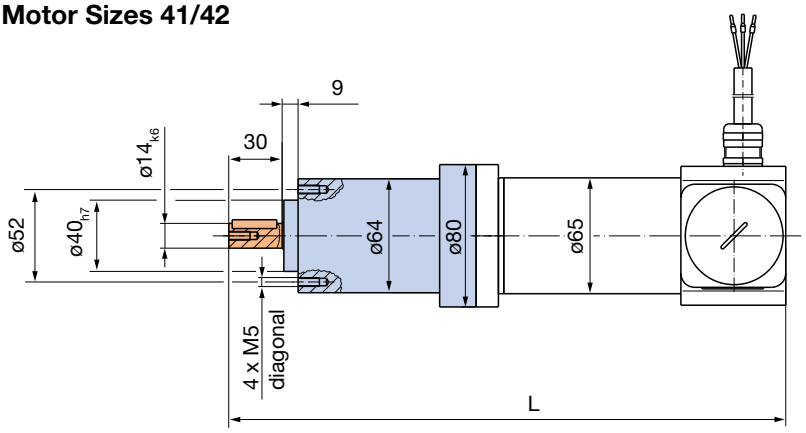


Fig. 139

Motor Sizes 52/53

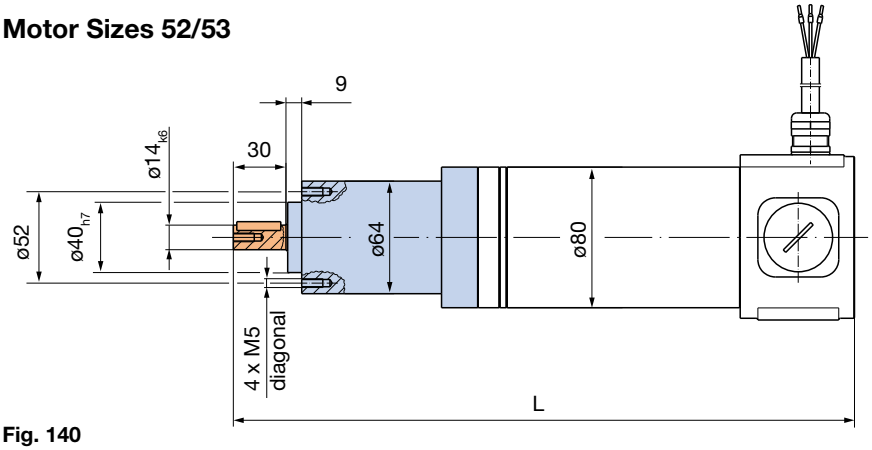


Fig. 140

Can also be supplied in **Direct-mounted** design:
- The appropriate dimension “L” is 39.2 mm smaller than the L value stated in the table below
- Flange ø80 n/a

Dimensions [mm]		Stage count	L				L with holding brake				Further information	
			41	42	52	53	41	42	52	53	41/42	52/53
Attachment B-bearing shield	Motor without attachments	1-stage	255	291	296.5	331.5	286	322	331	366	Page 14	Page 18
		2-stage	277	313	318.5	353.5	308	344	353	388		
		3-stage	299	335	340.5	375.5	330	366	375	410		
	Motor with positioning brake	1-stage	292	328	340.5	375.5	-	-	-	-	Page 14	Page 18
		2-stage	314	350	362.5	397.5	-	-	-	-		
		3-stage	336	372	384.5	419.5	-	-	-	-		
	Motor with tacho	1-stage	301	337	336.5	371.5	332	368	371	406	Page 14	Page 18
		2-stage	323	359	358.5	393.5	354	390	393	428		
		3-stage	345	381	380.5	415.5	376	412	415	450		
	Motor with incremental encoder	1-stage	301	337	336.5	371.5	332	368	371	406	Page 15	Page 19
		2-stage	323	359	358.5	393.5	354	390	393	428		
		3-stage	345	381	380.5	415.5	376	412	415	450		
	Motor with tacho and incremental encoder	1-stage	329	365	370.5	405.5	360	402	405	440	Page 15	Page 19
		2-stage	351	387	392.5	427.5	382	424	427	462		
		3-stage	373	409	414.5	449.5	404	446	449	484		

tendo®-PM with planetary gear EPL 64

Selection Table

		Motor	3:1	5:1	10:1	12:1	20:1	35:1	70:1	100:1	160:1	250:1	490:1	1000:1
n_2	[rpm]	n_1 = 2000 rpm	667	400	200	167	100	57	29	20	12.5	8.0	4.1	2.0
		n_1 = 3000 rpm	1000	600	300	250	150	86	43	30	18.8	12.0	6.1	3.0
M_N [1] Operating mode: S1	[Nm]	Size 41	0.2	0.4	0.7	0.8	1.4	2.4	4.8	6.8	10.2	16.0	[31]	[64]
		Size 42	0.7	1.1	2.3	2.6	4.3	7.4	14.9	[21]	[32]	[50]	--	--
		Size 52	1.0	1.7	3.4	3.9	6.5	11.3	23	--	--	--	--	--
		Size 53	1.7	2.8	5.7	6.4	10.7	18.7	[37]	--	--	--	--	--
M_N [2] Operating mode: S3 - 25 %	[Nm]	Size 41	0.8	1.3	2.5	2.9	4.8	8.3	16.7	[24]	[36]	[56]	--	--
		Size 42	1.7	2.8	5.6	6.3	10.5	18.4	[37]	[53]	[79]	[124]	--	--
		Size 52	2.4	4.0	7.9	9.0	15.0	26	[52]	--	--	--	--	--
		Size 53	3.7	6,2	[12.4]	14.1	23	[41]	[82]	--	--	--	--	--
$M_{zul.\ 1}$ [3]	[Nm]	typ. operation	14.0	18.2	9.8	25	29	31	25	11.2	29	31	25	10.5
$M_{zul.\ 2}$ [4]	[Nm]	maximum	40	52	28	50	59	62	50	22	59	62	50	21
Mass moment of inertia	[10^{-3} kgm²]		0.0178	0.0150	0.0136	0.0173	0.0156	0.0143	0.0136	0.0136	0.0136	0.0136	0.0136	0.0136
Stage count			1			2					3			
Gear backlash			<15'			<20'					<25'			
Gear weight (without motor)	[kg]		1.0			1.3					1.6			

Gear protection IP44

Further reductions possible

1) For S1 nominal operation of motor
If necessary, the motor current must be limited so that the permitted torques are not exceeded!

2) For typical intermittent periodic duty S3 - 25 % (I motor = 2 x I nominal)
If necessary, the motor current must be limited so that the permitted torques are not exceeded!

3) For typical operating conditions: medium impacts; 200 start-ups/h; 8h/day

4) Permitted acceleration torque

[...] Observe permitted gear torques!

Order Number

Connection		Thermal switch	Speed	Installation position	Hand release
Pg with cable	**P**				
Plug [2) 5)]	**S**				
Terminal box [6)]	**K**				
Terminal box + Pg with cable [7)]	**KP**				
Terminal box + plug [2) 8)]	**KS**				
Terminal box + Pg + Pg [9)]	**KPP**				
Terminal box + plug + plug [2) 9)]	**KSS**				
		... without	**2000 rpm**		without **...**
		T with [4)]	**3000 rpm**	see page 7	with [3)] **HL**

__ / K 1 3 . 5 __ . __ / __ __ / __ / __ / __ / __ / __ / __ / __

Size	Attachments		Design	Motor protection [1)]	Armature voltage	Reduction	Brake voltage
41	without attachment	**01**	**0** B14	**IP54**	**24 V**	**3 : 1**	**24 VDC**
42	Holding brake	**02**	**2** B5 [10)]	**IP65**	**160 V**	**5 : 1**	**104 VDC** (PM 41/42)
52	Positioning brake [1)]	**04**				**10 : 1**	
53	Tacho	**05**				**12 : 1**	**207 VDC** (PM 52/53)
	Incremental encoder	**08**				**20 : 1**	
	Tacho + incremental encoder	**20**				**35 : 1**	
	Holding brake + tacho	**30**				**70 : 1**	
	Holding brake + incremental encoder	**41**				**100 : 1**	
						160 : 1	
	Holding brake + tacho + incremental encoder	**50**				**250 : 1**	
						490 : 1	
						1000 : 1	

Example: 42 / K13.502.0 / P / IP54 / 24 V / 3000 rpm / 160 : 1 / V19 / 104 VDC

1) Sizes 41/42: Motor protection IP65 available for positioning brake available on request (not in combination with hand release)
2) Mating plug not included in the standard scope of delivery (on request)
3) Hand release only for positioning brake (Sizes 41/42: hand release only for IP54)
4) Thermal switch in combination with cable design available on request
5) Not for Type K13.504.0
6) Only Types K13.501.0, K13.502.0, K13.504.0, K13.505.0, K13.530.0
7) Not for Types K13.501.0 and K13.502.0
8) Not for Types K13.501.0, K13.502.0 and K13.504.0
9) Only Types K13.520.0 and K13.550.0
10) On request

tendo®-PM with planetary gear EPL 84

Permanently-excited DC motor sizes 52/53 and 61/62/63 with planetary gear Type K13.6_ _._

Motor Sizes 52/53

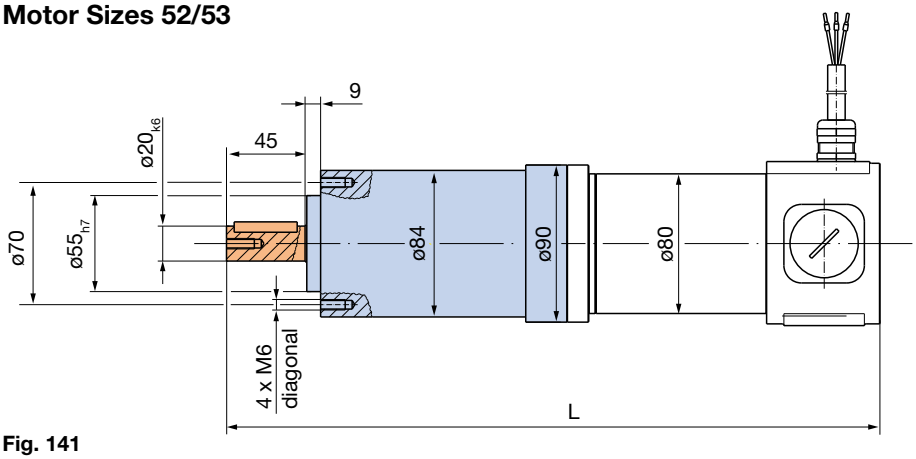


Fig. 141

Motor Sizes 61/62/63

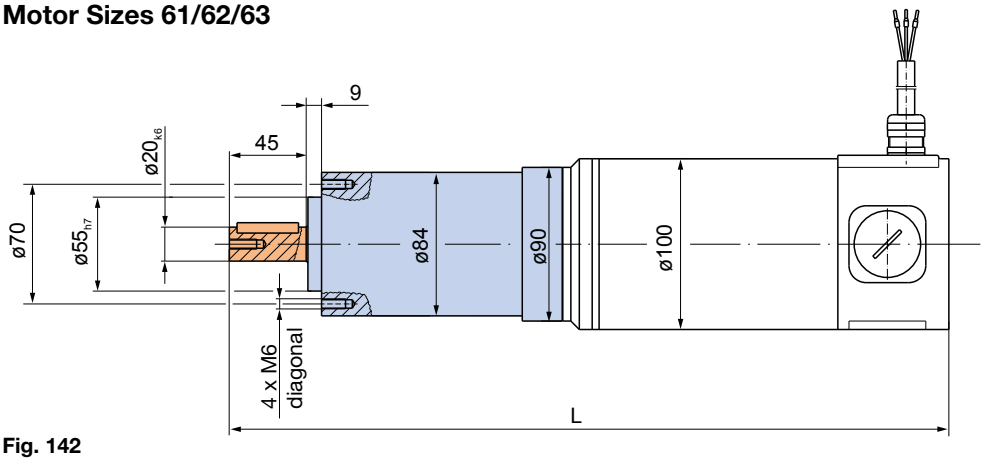


Fig. 142

Can also be supplied in **Direct-mounted** design:
The appropriate dimension “L” is 46.5 mm smaller than the L value stated in the table below.

Dimensions [mm]		Stage count	L					L with holding brake					Further information	
			52	53	61	62	63	52	53	61	62	63	52/53	61/62/63
Attachment B-bearing shield	Motor without attachments	1-stage	341.5	376.5	348.5	388.5	438.5	376	411	389.5	429.5	479.5	Page 18	Page 22
		2-stage	374.5	409.5	381.5	421.5	471.5	409	444	422.5	462.5	512.5		
		3-stage	407.5	442.5	414.5	454.5	504.5	442	477	455.5	495.5	545.5		
	Motor with positioning brake	1-stage	385.5	420.5	396	436	486	-	-	-	-	-	Page 18	Page 22
		2-stage	418.5	453.5	429	469	519	-	-	-	-	-		
		3-stage	451.5	486.5	462	502	552	-	-	-	-	-		
	Motor with tacho	1-stage	381.5	416.5	388.5	428.5	478.5	416	451	429.5	469.5	519.5	Page 18	Page 22
		2-stage	414.5	449.5	421.5	461.5	511.5	449	484	462.5	502.5	552.5		
		3-stage	447.5	482.5	454.5	494.5	544.5	482	517	495.5	535.5	585.5		
	Motor with incremental encoder	1-stage	381.5	416.5	388.5	428.5	478.5	416	451	429.5	469.5	519.5	Page 19	Page 23
		2-stage	414.5	449.5	421.5	461.5	511.5	449	484	462.5	502.5	552.5		
		3-stage	447.5	482.5	454.5	494.5	544.5	482	517	495.5	535.5	585.5		
	Motor with tacho and incremental encoder	1-stage	415.5	450.5	422.5	462.5	512.5	450	485	463.5	503.5	553.5	Page 19	Page 23
		2-stage	448.5	483.5	455.5	495.5	545.5	483	518	496.5	436.5	586.5		
		3-stage	481.5	516.5	488.5	528.5	578.5	516	551	529.5	569.5	619.5		

tendo®-PM with planetary gear EPL 84

Selection Table

		Motor	3:1	5:1	10:1	12:1	20:1	35:1	70:1	100:1	160:1	250:1	490:1	1000:1
n_2	[rpm]	n_1 = 2000 rpm	667	400	200	167	100	57	29	20	12.5	8.0	4.1	2.0
		n_1 = 3000 rpm	1000	600	300	250	150	86	43	30	18.8	12.0	6.1	3.0
M_N [1] Operating mode: S1	[Nm]	Size 52	0.8	1.4	2.7	3.1	5.1	8.9	17.9	26	38	60	[118]	[240]
		Size 53	1.5	2.5	5.0	5.6	9.4	16.4	33	47	70	[110]		--
		Size 61	1.1	1.8	3.6	4.1	6.8	11.9	24	34	51	--	--	--
		Size 62	2.4	4.1	8.1	9.2	15.3	27	54	[77]	[115]	--	--	--
		Size 63	3.8	6.3	12.6	14.3	24	42	[83]	--	--	--	--	--
M_N [2] Operating mode: S3 - 25 %	[Nm]	Size 52	2.2	3.6	7.2	8.2	13.6	24	48	[68]	[102]	[160]	[314]	[640]
		Size 53	3.5	5.9	11.7	13.3	22.1	39	[77]	[111]	[166]	[260]	--	--
		Size 61	2.7	4.5	9.0	10.2	17.0	30	60	[85]	[128]	--	--	--
		Size 62	5.4	9.0	18.0	20	34	60	[119]	[170]	--	--	--	--
		Size 63	8.1	13.5	27	31	51	[89]	[179]	--	--	--	--	--
$M_{zul.\ 1}$ [3]	[Nm]	typ. operation	28	38	28	56	70	70	63	45	70	70	63	45
$M_{zul.\ 2}$ [4]	[Nm]	maximum	80	108	80	112	140	140	126	90	140	140	126	90
Mass moment of inertia	[10^{-3} kgm²]		0.0542	0.0379	0.0322	0.0473	0.0407	0.0356	0.0327	0.0327	0.0327	0.0327	0.0327	0.0327
Stage count			1			2					3			
Gear backlash			<15'			<20'					<25'			
Gear weight (without motor)	[kg]		2.3			3.1					3.9			

Gear protection IP44

Further reductions possible

1) For S1 nominal operation of motor
If necessary, the motor current must be limited so that the permitted torques are not exceeded!

2) For typical intermittent periodic duty S3 - 25 % (I motor = 2 x I nominal)
If necessary, the motor current must be limited so that the permitted torques are not exceeded!

3) For typical operating conditions: medium impacts; 200 start-ups/h; 8h/day

4) Permitted acceleration torque

[...] Observe permitted gear torques!

Order Number

Connection		Thermal switch	Speed	Installation position	Hand release
Pg with cable	**P**				
Plug [1) 4)]	**S**				
Terminal box [5)]	**K**				
Terminal box + Pg with cable [6)]	**KP**				
Terminal box + plug [1) 7)]	**KS**				
Terminal box + Pg + Pg [8)]	**KPP**	**...** without	**2000 rpm**		without **...**
Terminal box + plug + plug [1) 8)]	**KSS**	**T** with [3)]	**3000 rpm**	see page 7	with [2)] **HL**

__ / K 1 3 . 6 __ . __ / __ __ / __ / __ / __ / __ / __ / __ / __

Size	Attachments		Design	Motor protection	Armature voltage	Reduction	Brake voltage
52	without attachment	**01**	**0** B14	**IP54**	**24 V** [10)]	**3 : 1**	**24 VDC**
53	Holding brake	**02**	**2** B5 [9)]	**IP65**	**160 V**	**5 : 1**	**207 VDC**
61	Positioning brake	**04**				**10 : 1**	
62	Tacho	**05**				**12 : 1**	
63	Incremental encoder	**08**				**20 : 1**	
	Tacho + incremental encoder	**20**				**35 : 1**	
	Holding brake + tacho	**30**				**70 : 1**	
	Holding brake + incremental encoder	**41**				**100 : 1**	
						160 : 1	
	Holding brake + tacho + incremental encoder	**50**				**250 : 1**	
						490 : 1	
						1000 : 1	

Example: 61 / K13.602.0 / PT / IP54 / 24 V / 3000 rpm / 250 : 1 / V18 / 207 VDC / HL

1) Mating plug not included in the standard scope of delivery (on request)
2) Hand release only for positioning brake
3) Thermal switch in combination with cable design available on request
4) Not for Type K13.604.0
5) Only Types K13.601.0, K13.602.0, K13.604.0, K13.605.0, K13.630.0
6) Not for Types K13.601.0 and K13.602.0
7) Not for Types K13.601.0, K13.602.0 and K13.604.0
8) Only Types K13.620.0 and K13.650.0
9) On request
10) Size 63: Not possible in combination with nominal voltage 24V and nominal speed 3000 rpm

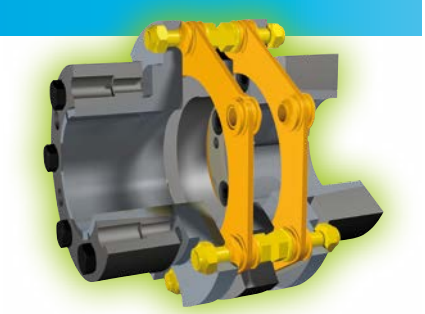
Space for your notes:

Product Summary

Safety Clutches/Overload Clutches

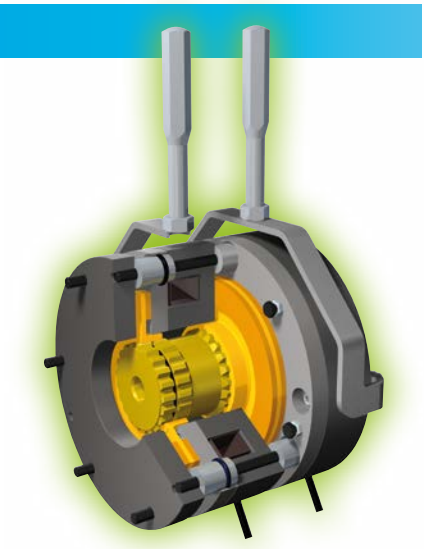
- **EAS®-Compact®/EAS®-NC**
  Positive locking and completely backlash-free torque limiting clutches
- **EAS®-smartic®**
  Cost-effective torque limiting clutches, quick installation
- **EAS®-element clutch/EAS®-elements**
  Load-disconnecting protection against high torques
- **EAS®-axial**
  Exact limitation of tensile and compressive forces
- **EAS®-Sp/EAS®-Sm/EAS®-Zr**
  Load-disconnecting torque limiting clutches with switching function
- **ROBA®-slip hub**
  Load-holding, frictionally locked torque limiting clutches
- **ROBA®-contitorque**
  Magnetic continuous slip clutches
- **EAS®-HSC/EAS®-HSE**
  High-speed safety clutches for high-speed applications

Shaft Couplings



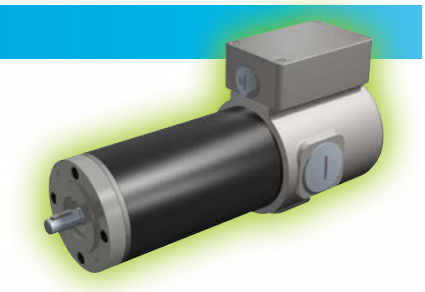
- **smartflex®/primeflex®**
  Perfect precision couplings for servo and stepping motors
- **ROBA®-ES**
  Backlash-free and damping for vibration-sensitive drives
- **ROBA®-DS/ROBA®-D**
  Backlash-free, torsionally rigid all-steel couplings
- **ROBA®-DSM**
  Cost-effective torque-measuring couplings

Electromagnetic Brakes/Clutches



- **ROBA-stop® standard**
  Multifunctional all-round safety brakes
- **ROBA-stop®-M motor brakes**
  Robust, cost-effective motor brakes
- **ROBA-stop®-S**
  Water-proof, robust monoblock brakes
- **ROBA-stop®-Z/ROBA-stop®-silenzio®**
  Doubly safe elevator brakes
- **ROBA®-diskstop®**
  Compact, very quiet disk brakes
- **ROBA®-topstop®**
  Brake systems for gravity loaded axes
- **ROBA®-linearstop**
  Backlash-free brake systems for linear motor axes
- **ROBA®-guidestop**
  Backlash-free holding brake for profield rail guides
- **ROBATIC®/ROBA®-quick/ROBA®-takt**
  Electromagnetic clutches and brakes, clutch brake units

DC Drives



- **tendo®-PM**
  Permanent magnet-excited DC motors

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