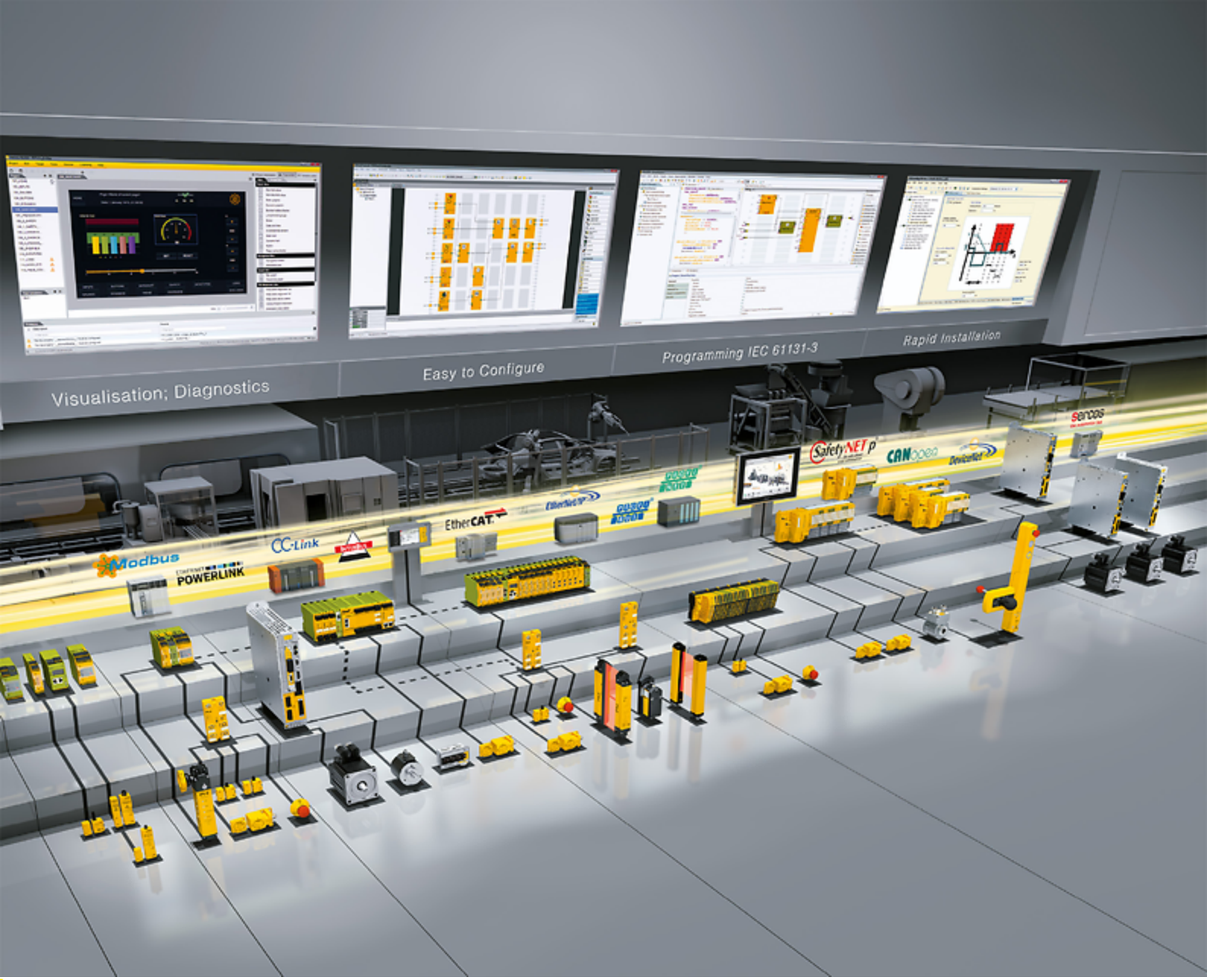

Synchronous servo motors PMC EZ

Pilz

Operating manual-1005461-en-US-01

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1 Introduction

1.1 Purpose of the manual

This operating manual describes PMC EZ synchronous servo motors. It contains information about transport, storage, installation, connection, commissioning, service and disposal.

1.2 Additional support

If you have questions that are not answered in this document, additional support is available at http://www.pilz.com.

2 Safety instructions

2.1 Warranty and liability

These devices can pose certain risks. For this reason, always comply with the safety information listed in the following sections and points and with the technical rules and regulations.

Warranty and liability claims are voided if:

- The product was not used as intended
- Damage can be traced back to noncompliance with the operating manual
- Operating personnel are not properly trained
- Changes of any kind have been made

2.2 Part of the product

The technical documentation is part of a product.

Always keep these operating instructions at hand in the area of the device until disposal of the product because it contains important information.

Hand over this operating manual in case of sale, transfer or rental of the product.

2.3 Intended use

The PMC EZ synchronous servo motors are intended for installation in machines or systems or for assembly with other components into a machine or system. They must be operated in connection with appropriate, correctly configured drive controllers (e.g. PMC SC6, PMC SI6 or PMC SD6 series drive controllers).

The thermal winding protection integrated in the motor winding must be monitored and evaluated.

The following are considered non-intended use:

- Direct connection to the supply grid
- Any structural, technical or electrical change
- Use outside of the areas described in these operating instructions
- Use deviating from the specified technical data

2.4 Qualified personnel

These devices can pose certain residual risks. Therefore all work on the device, as well as its operation and disposal, may be performed only by qualified personnel who are aware of the potential risks. Qualified personnel are persons who have acquired the authorization to perform these tasks through professional training and/or instruction by specialists.

In addition, applicable regulations, legal provisions, technical standards, this technical documentation and especially the safety information contained within it must be read carefully, understood and observed.

2.5 Working on the machine

Apply the 5 safety rules in the order stated before performing any work on the machine:

1. Disconnect. Also make sure to disconnect the auxiliary circuits.
2. Protect against being turned on again.
3. Check that voltage is not present.
4. Ground and short circuit.
5. Cover adjacent live parts.

2.6 Disposal

Observe the current national and regional regulations! Dispose of individual parts separately depending on their condition and the currently applicable regulations, e.g. as electronic waste (circuit boards), plastic, sheet metal, copper or aluminum.

2.7 Directives and standards

Pilz synchronous servo motors meet the requirements of the following directives and standards:

- (Low Voltage) Directive 2014/35/EU
- EN 60034-1:2010 + Cor.:2010
- EN 60034-5:2001 + A1:2007
- EN 60034-6:1993

2.8 Use of symbols

Safety instructions are identified with the following symbols. They indicate special risks when handling the product and are accompanied by relevant signal words that express the extent of the risk. Furthermore, useful tips and recommendations for efficient, error-free operation are specially highlighted.

DANGER!

Danger with a warning triangle indicates that there is a considerable risk of fatal injury

- if the stated precautionary measures are not taken.

WARNING!

Warning with a warning triangle means there may be a considerable risk of fatal injury

- if the stated precautionary measures are not taken.

ATTENTION!

Attention indicates that damage to property may occur

- if the stated precautionary measures are not taken.

IMPORTANT

Important indicates relevant information about the product or serves to emphasize a section in the documentation that deserves special attention from the reader.

3 Product description

The PMC EZ synchronous servo motors have a very short design made possible by using optimal winding technology. This allows for the stator windings to be manufactured with the highest possible copper fill factor. This technology and other optimizations of the mechanics make it possible to shorten the motor length by roughly half without negatively impacting performance.

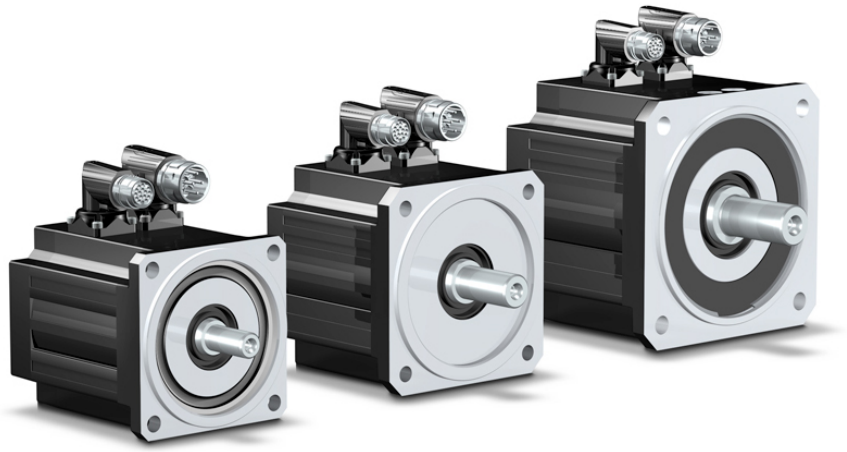
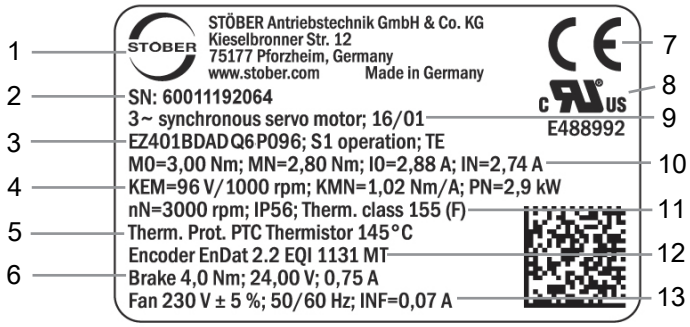


Fig. 1: PMC EZ synchronous servo motors

3.1 PMC EZ synchronous servo motors

3.1.1 Nameplate

An example nameplate of an EZ401 synchronous servo motor is explained in the figure below.



Line	Value	Description
1	STÖBER Antriebstechnik GmbH & Co. KG	Logo and address of the manufacturer
2	SN: 60011192064	Serial number of the motor
3	EZ401BDADQ6P096 S1 operation	Type designation according to the manufacturer Operating mode
4	KEM=96 V/1000 rpm KMN=1.02 Nm/A PN=2.9 kW	Voltage constant Torque constant Nominal power
5	Therm. prot. of PTC thermistor 145 °C	Type of temperature sensor
6	Brake 4.0 Nm 24.00 V 0.75 A	Holding brake (optional) Static braking torque at 100 °C Nominal voltage (DC) of the holding brake Nominal current of the holding brake at 20 °C
7	CE	CE mark
8	cURus E488992	cURus test symbol, registered under UL number E488992 (optional)
9	3~ synchronous servo motor 16/01	Motor type: Three-phase synchronous servo motor Date of manufacture (year/calendar week)
10	M0=3.00 Nm MN=2.80 Nm I0=2.88 A IN=2.74 A	Stall torque Nominal torque Stall current Nominal current
11	nN=3000 rpm IP56 Therm. class 155 (F)	Nominal speed Protection class Thermal class
12	Encoder EnDat 2.2 EQI 1131 MT	Encoder model
13	Fan 230 V ± 5%; 50/60 Hz INF = 0.07 A	Forced ventilation unit (optional) Nominal voltage of the forced ventilation unit Nominal current of the forced ventilation unit

3.1.2 Type designation

EZ	4	0	1	U	D	AD	Q6	O	096

Explanation

Code	Designation	Design
EZ	Type	Synchronous servo motor
4	Size	4 (example)
0	Generation	0
1	Length	1 (example)
U B	Cooling[1]	Convection cooling Forced ventilation
D	Design	Dynamic
AD	Drive controller	PMC SD6 (example)
Q6	Encoder	EQI 1131 EnDat 2.2 (example)
O P	Brake	Without holding brake Permanent magnet holding brake
096	Voltage constant K_{EM}	96 V/1000 rpm (example)

3.1.3 Material variant

In addition to the nameplate, there is another sticker with the material variant (MV) and serial number (SN) on the motor.

Fig. 2: Sticker with MV and serial number

Value in example	Meaning
PMC EZ401BDADQ6P0P096	Pilz type designation
ID No. 8G123456	Identification number
MV0000012345	MV number
SN 60011192064	Serial number
1000914812 / 001100	Order number/order item

Meaning of the specifications on the sticker

[1] EZ3 motors only available with convection cooling

3.2 Drive controllers

The PMC EZ synchronous servo motors have to be operated with speed, torque or position regulation using drive controllers, such as the PMC SC6, PMC SI6 or PMC SD6 series.

The most important selection criteria for the appropriate drive controllers and associated cables are:

- Stall torque M_0 [Nm]
- Stall current I_0 [A]
- Nominal speed n_N [rpm]
- Mass moments of inertia for the motor and load J [$kgcm^2$]
- Effective torque of the motor M_{eff} [Nm]
- Regeneration energy in braking operation
- Overload capacity
- EMC

When selecting the drive controller, also keep static and dynamic loading in mind (acceleration and braking).

3.3 Encoders

The PMC EZ synchronous servo motors can be equipped with the following encoder systems:

- EnDat 2.2 single-turn, inductive (ECI 1118-G2)
- EnDat 2.2 single-turn, optical (ECN 1123)
- EnDat 2.2 multi-turn, inductive (EQI 1131)
- EnDat 2.2 multi-turn, optical (EQN 1135)

Single-turn encoder systems deliver an absolute position within one revolution; multi-turn encoder systems provide an absolute position over a number of revolutions.

3.4 Dynamics

The PMC EZ synchronous servo motors are designed for applications with high dynamics by default. This means that they have the lowest possible mass inertia.

3.5 Operating mode

PMC EZ synchronous servo motors are designed for continuous operation. This corresponds to the S1 operating mode (in accordance with DIN EN 60 034-1).

3.6 Thermal winding protection

The PMC EZ synchronous servo motors have thermal winding protection that protects the stator winding from damage during constant overload.

The PMC EZ motors are equipped with a PTC triplet. If the motor temperature reaches a critical value, the resistance of the PTC resistors increases abruptly and thereby indicates the overload of the motor.

As an alternative, the motors can be implemented with a Pt1000 temperature sensor on request for operation connected to PMC SD6 series drive controllers.

IMPORTANT

Every thermal winding protection has to be monitored and evaluated by a drive controller or an external triggering device.

3.7 Cooling

PMC EZ synchronous servo motors are sized for convection cooling by default.

In order to increase the performance of the motors, they can optionally be equipped or upgraded with external forced ventilation systems (IP44 protection class).

3.8 Holding brake

DANGER!

Risk of fatal injury!

The motor brake is not a safety brake.

- Check whether additional protective measures have to be taken, such as when stopping or standing under suspended loads.

For holding the motor shaft in place without any backlash, the synchronous servo motors can be delivered with a built-in permanent magnet holding brake. It blocks the rotor when de-energized.

Since the synchronous servo motors can be braked actively and quickly using corresponding set value specifications on the drive controller, the built-in brakes have the function of a holding brake.

Unlike working brakes, which are used to brake drives under load cyclically, holding brakes are designed for dynamic applications in which the drive is stopped and regulated, and the brake is not subject to considerable wear.

Observe the detailed information in the technical data of the brake; see the chapter Holding brake [📖 32].

An electro-mechanical method is used to release the brake. The applied voltage generates an electromagnetic field that counteracts the field from the permanent magnet and neutralizes its effect.

IMPORTANT

The air gap in the holding brake cannot be adjusted later.

ATTENTION!

Damage to the motor or motor components due to electrical connection errors!

- Observe the motor nameplate and the connection plan. Contact Technical Support in case of questions.

DANGER!

Risk of fatal injury due to gravity-loaded vertical axes!

Unsecured gravity-loaded vertical axes can drop unexpectedly due to defective or released brakes.

- Follow the requirements and protective measures for gravity-loaded vertical axes from the DGUV, special area information sheet No. 005, 09/2012 edition.

3.9 Motor shaft and bearing

PMC EZ synchronous servo motors have a smooth shaft end on the drive side (DIN 6885). Surface pressure needs to be achieved for torque transfer in the case of a positive connection. This ensures a reliable transfer of force free of backlash.

The bearings are designed as ball bearings with lifetime lubrication and with non-contact sealing.

4 Transport and storage

4.1 Transport

Secure the shafts and bearings of a synchronous servo motor against impacts during transport. During transport, use the corresponding eyebolts (if present) and a suitable fastening element.

IMPORTANT

Lift the synchronous servo motor by the eyebolts exclusively without additional attachments. Never transport the motor by the fan hoods or plug connectors.

4.2 Storage

Store synchronous servo motors in enclosed, dry spaces. Storage on the fan hoods is not permitted. If the motors are protected against all damaging environmental influences and mechanical damage, short-term storage in outdoor areas with roofing is permitted.

Make sure that no condensate forms during storage, such as due to extreme temperature fluctuations with high humidity.

Be sure to protect the motor shaft against corrosion in the case of long-term storage. Be aware that the insulation resistance of the winding must be tested after long-term storage.

5 Installation

DANGER!

Electric shock!

Serious injuries due to contact with live parts!

- Carry out all work on a de-energized motor!
- Make sure that the motor shaft is stationary during all work. A rotating rotor can cause high voltages at the connections.
- Disconnect the supply voltage. Be aware that there may still be dangerously high voltages at the drive controller, even up to 15 minutes after switching off the supply voltage, due to the residual charge of the link capacitors. Observe the discharge time specification of the drive controller.
- Cover all open electrical connections, e.g. using protective caps.
- Secure the installation location as per regulations, e.g. using locks or warning signs.

DANGER!

Burns!

The surface temperature of a synchronous servo motor can significantly exceed 65 °C through operation.

- Take suitable protective measures against unintentional and intentional contact with the motor.

5.1 Installation location

The following requirements apply to the installation location:

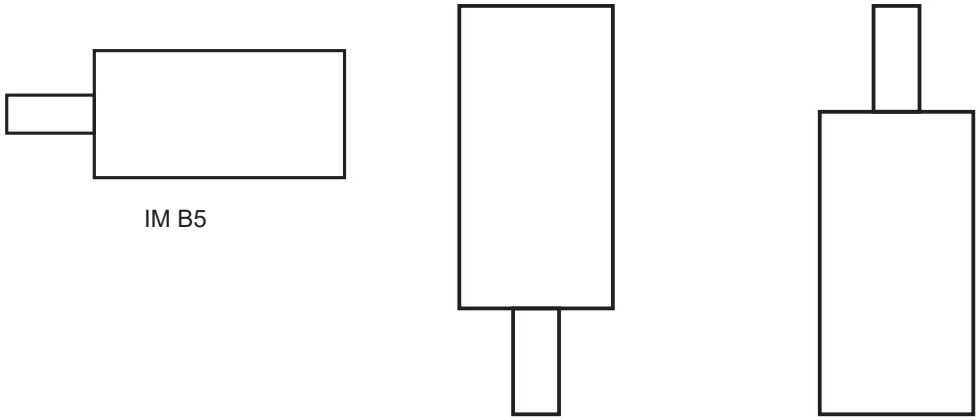
- The installation location must be free of any aggressive substances and any electrically conductive atmosphere
- The substructure must be even, free of vibrations and resistant to warpage
- Sufficient heat dissipation must be ensured; for this purpose, ensure compliance with the permitted surrounding temperature and, as needed, provide additional cooling for the motor, such as by using a forced ventilation unit
- If using a forced ventilation unit, ensure compliance with the minimum clearance of the air intake

Minimum clearance of the air intake for PMC EZ motors with forced ventilation

Type	Forced ventilation unit	Minimum clearance [mm]
EZ4	FL4	20
EZ5	FL5	20
EZ7	FL7	30
EZ8	FL8	30

Permissible mounting positions for PMC EZ synchronous servo motors

The following graphics show permitted mounting positions IM B5, IM V1 and IM V3.



In mounting position IM V3, take special care that no fluid from attachments can get into the motor bearings.

5.2 Motor installation

ATTENTION!

Material damage!

Impacts or other uses of force cause damage to the bearings, feedback system and motor shaft.

- Do not hit the motor shaft or motor housing with a hammer or other tools.
- Do not expose the motor to any compressive stress, impacts or high acceleration.
- Use backlash-free, frictional collets or couplings.
- For attaching and releasing couplings, gears or belt drives, always use the intended draw bar thread in the motor shaft. Use a suitable tool!

ATTENTION!

Material damage!

Solvents damage the sealing lips of the shaft seal rings.

- Make sure that substances containing solvents do not come in contact with the sealing lips of the shaft seal rings.

5.2.1 Preparing the motor for installation

1. Check the motor for transport damage. Never install a motor with obvious damage!
2. Check the insulation resistance of the motor winding after storage.
3. Thoroughly remove any corrosion protection agent and/or dirt from the motor shaft. Use commercially available solvents to do so. Make sure that solvent does not come in contact with the sealing lips of the shaft seal rings. Otherwise, material damage may occur.
4. If possible, warm the drive elements, e.g. belt drive.
5. Be aware that damage to the finish on the synchronous servo motor is never permitted.

5.2.2 Installing the motor

1. Align the coupling correctly. Misalignment leads to impermissible vibrations and to the destruction of ball bearings and coupling!
2. Avoid mechanically constrained motor shaft mounting. A rigid coupling and/or additional external bearings (e.g. in the gear unit) can put excessive stress on the motor shaft.
3. Prevent contact between temperature-sensitive parts and the motor. The surface of the motor can reach temperatures that are significantly above 65 °C through operation.
4. If you remove the eyebolts after installation, you must seal the tapped hole in a durable way according to the protection class of the motor.

6 Electrical installation

Observe the 5 safety rules in the chapter Working on the machine [📖 6]!

DANGER!

Electric shock!

Serious injuries due to contact with live parts!

- Carry out all work on a de-energized motor!
- Make sure that the motor shaft is stationary during all work. A rotating rotor can cause high voltages at the connections.
- Disconnect the supply voltage. Be aware that there may still be dangerously high voltages at the drive controller, even up to 15 minutes after switching off the supply voltage, due to the residual charge of the link capacitors. Observe the discharge time specification of the drive controller.
- Cover all open electrical connections, e.g. using protective caps.
- Secure the installation location as per regulations, e.g. using locks or warning signs.

WARNING!

Injury to persons and damage to property due to faulty wiring!

Faulty wiring of the motor and/or encoder can lead to uncontrolled movements and to personal injury or damage to property as a result.

- Observe the specifications in this operating manual and in the documentation of the drive controller used.
- Make sure that components attached to the motor, such as feather keys and coupling elements, are sufficiently secured against centrifugal forces.

6.1 Forced ventilation unit

PMC EZ synchronous servo motors offer the option of being cooled with a forced ventilation unit in order to increase performance data while maintaining the same size.

Retrofitting with a forced ventilation unit is also possible in order to optimize the drive at a later date. When retrofitting, check whether the conductor cross-section of the power cable of the motor must be increased.

The following plug connection for the connection of the forced ventilation unit is included in the scope of delivery.

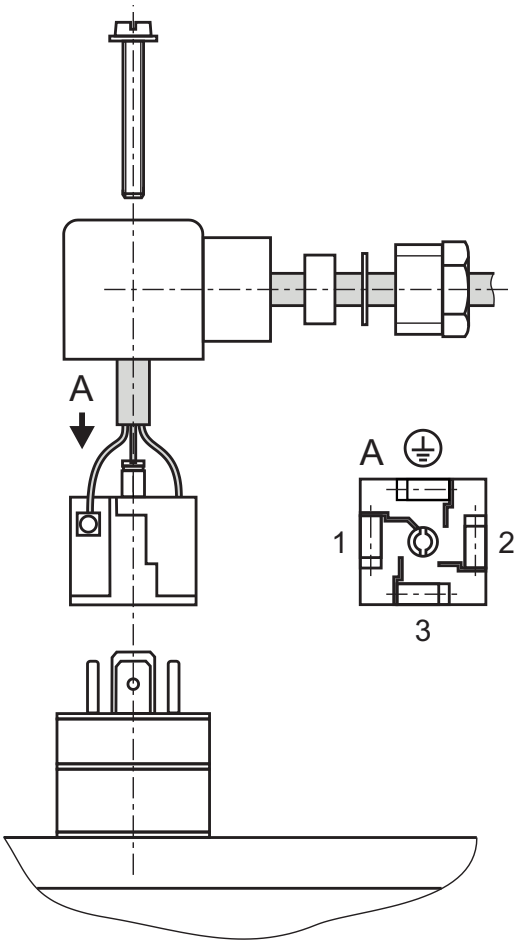


Fig. 3: Forced ventilation unit

Pin	Signal
1	L1 (phase)
2	N (neutral conductor)
3	—
⏚	PE

6.2 General information

6.2.1 Line routing

Observe the valid provisions for your machine or system, e.g. DIN IEC 60364 or DIN EN 50110, during the installation of electrical equipment.

6.2.2 Grounding, shielding and EMC

Observe the following factors for grounding, shielding and EMC.

- For synchronous servo motors, the connection to PE is made using the cable for the supply voltage (see the chapter Connection method [23]). For additional grounding, the motors have an externally attached and marked grounding connection.
- Use a ring core or a motor throttle near the drive controller for the power supply cable as needed. Observe the specifications in the operating manual of the drive controller used.
- You need shielded cables for power cables.
  - Apply inner and outer shielding on both sides (e.g. at a shield wire bus bar).
- You need shielded cables for data and control cables.
  - Apply the outer shielding on both sides (e.g. at a shield wire bus bar).
  - Apply the inner shielding on the side of the drive controller (e.g. at a shield wire bus bar).
  - If equalizing current is expected when using longer cables, it can be prevented with voltage-equalizing cables.
- Apply (low-impedance) shielding extensively over metallized connector housings or EMC-compatible cable glands.
- Use a suitable connection material to apply the cable shield to the ground rail or shield cable bus bar (e.g. shield clamps, see the following graphic).

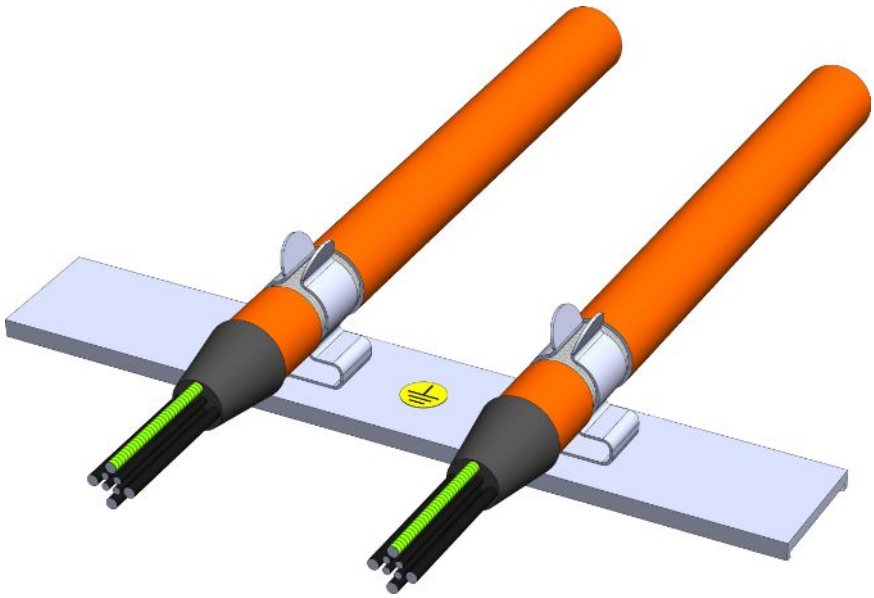


Fig. 4: Shielded connection of the power cable (graphic: icotek GmbH)

6.2.3 Cable selection

Note that the motor, cables and drive controller each have electrical properties which influence one another. Failure to coordinate them properly can lead to impermissibly high voltage peaks at the motor and drive controller.
Also observe the following factors.

- Select the conductor cross-sections based on the permissible stall current of the motor. Also observe the documentation for the drive controller.
- Pay attention to the trailing and torsional strength of the cables as necessary.
- Plug connectors are used to connect the cables to the synchronous servo motor. Cables are available as accessories.
- Observe the chapter Connection method [23] when selecting the cross-sections.
- When using a motor brake, especially with longer cables, observe the drop in the supply voltage on the line.
- Observe the legal requirements for EMC.

6.2.4 Plug connectors

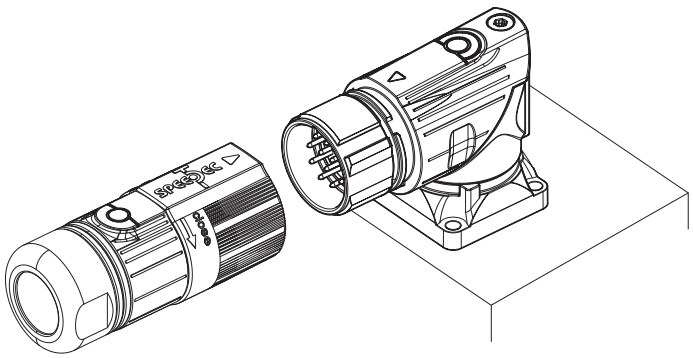
The synchronous servo motors are equipped with angled, round plug connectors for the encoder and power connections.

The cables are connected as described below.

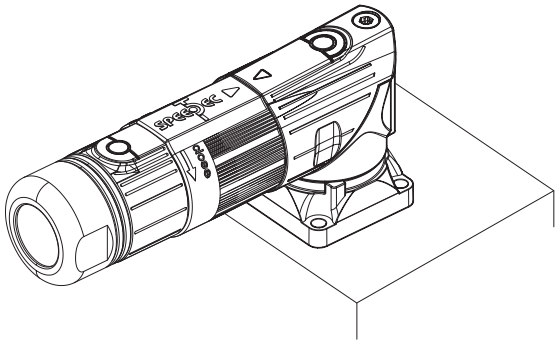
6.2.4.1 Connecting cables using speedtec plug connectors to PMC EZ4 – PMC EZ8

✓ You have removed the protective caps from the plug connectors.

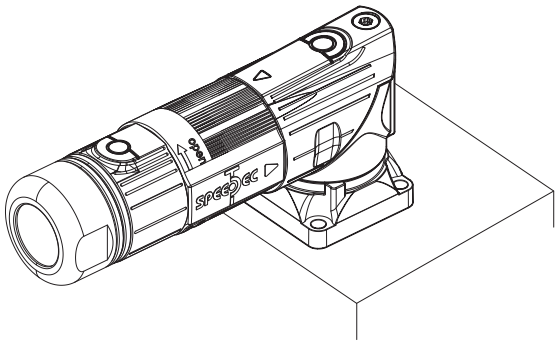
1. Align the cap nut so that the arrows on the cap nut and plug connector are across from each other:



2. Insert the cap nut straight onto the plug connector:



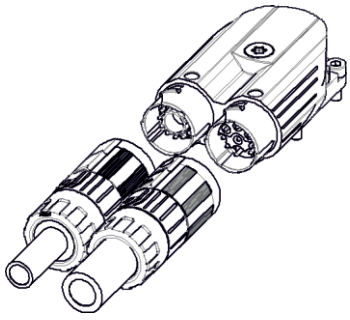
3. Turn the screw closure of the cap nut as far as it will go in the **close** direction:



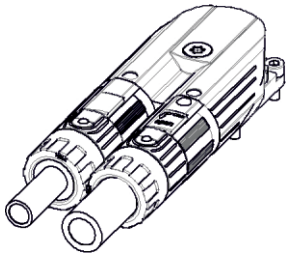
6.2.4.2 Connecting cables using plug connectors to PMC EZ3

✓ You have removed the protective caps from the plug connectors.

1. Align the respective cap nuts of the green encoder and orange power plug connectors so that the points on the cap nuts and plug connectors are across from each other:



2. Insert the cap nuts straight onto the plug connectors:



6.3 Connection method

6.3.1 Connection of the motor housing to the grounding conductor system

Connect the motor housing to the grounding conductor system of the machine in order to prevent personal injury and faulty triggering of residual current protective devices.

All attachment parts required for the connection of the grounding conductor to the motor housing are delivered with the motor. The grounding screw of the motor is identified with the symbol ⏚ in accordance with IEC 60417-DB. The cross-section of the grounding conductor has to be at least as large as the cross-section of the lines in the power connection.

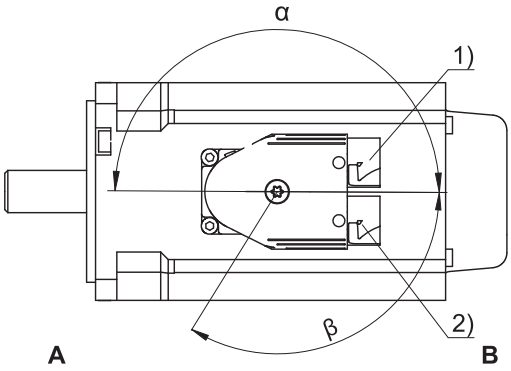
6.3.2 Plug connectors

Pilz synchronous servo motors are equipped with twistable quick-lock plug connectors in the standard version (except for plug connector size con.58). Details can be found in this chapter.

For motors with forced ventilation, avoid collisions between the motor connection cables and the plug connector of the forced ventilation unit. In the event of a collision, turn the motor plug connectors accordingly. Details regarding the position of the plug connector for the forced ventilation unit can be found in the "Dimensional drawings" chapter.

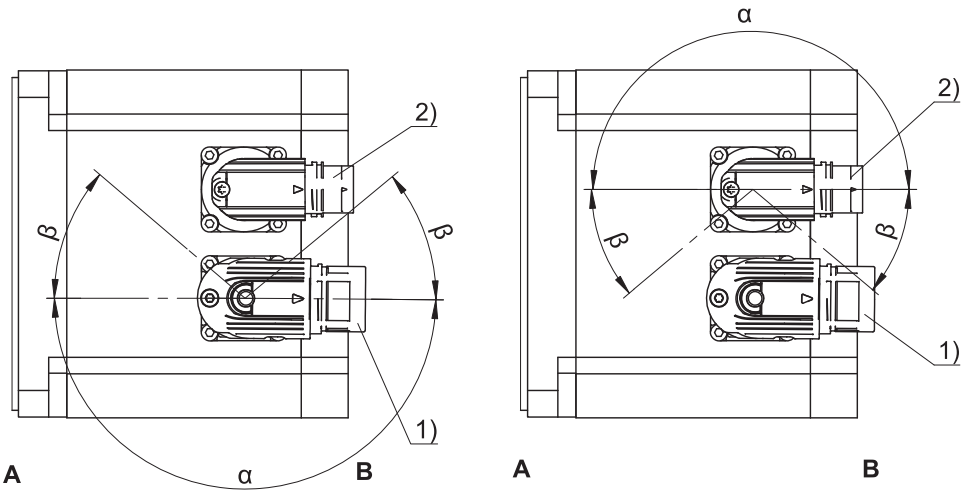
The figures represent the position of the plug connectors upon delivery.

Turning ranges of plug connectors (PMC EZ3 motors)



1	Power plug connector	2	Encoder plug connector
A	Attachment or output side of the motor	B	Rear side of the motor

Turning ranges of plug connectors (PMC EZ4 – PMC EZ8 motors)



1	Power plug connector	2	Encoder plug connector
A	Attachment or output side of the motor	B	Rear side of the motor

Power plug connector features

Motor type	Size	Connection	Turning range	
			α	β
EZ3	con.15	Quick lock	180°	120°
EZ4, EZ5, EZ701, EZ702, EZ703	con.23	Quick lock	180°	40°
EZ705, EZ802, EZ803, EZ805U	con.40	Quick lock	180°	40°
EZ805B	con.58	Screw thread[2]	0°	0°

Encoder plug connector features

Motor type	Size	Connection	Turning range	
			α	β
EZ3	con.15	Quick lock	180°	120°
EZ4, EZ5, EZ7, EZ802, EZ803, EZ805U	con.17	Quick lock	180°	20°
EZ805B	con.17	Quick lock	180°	0°

Notes

- The number after "con." indicates the approximate external thread diameter of the plug connector in mm (for example, con.23 designates a plug connector with an external thread diameter of about 23 mm).
- In turning range β, the power or encoder plug connectors can be turned only if doing so does not cause them to collide.
- For the PMC EZ3 motor, the power and encoder plug connectors are mechanically connected and can only be turned together.

[2] Specify alignment on side A or B in the purchase order.

7 Commissioning

Observe the 5 safety rules in the chapter Dimensional drawings [43]!

DANGER!

Electric shock!

Serious injuries due to contact with live parts!

- Carry out all work on a de-energized motor!
- Make sure that the motor shaft is stationary during all work. A rotating rotor can cause high voltages at the connections.
- Disconnect the supply voltage. Be aware that there may still be dangerously high voltages at the drive controller, even up to 15 minutes after switching off the supply voltage, due to the residual charge of the link capacitors. Observe the discharge time specification of the drive controller.
- Cover all open electrical connections, e.g. using protective caps.
- Secure the installation location as per regulations, e.g. using locks or warning signs.

IMPORTANT

Be aware that synchronous servo motors may be repaired only by Pilz GmbH & Co. KG. Unauthorized opening of a synchronous servo motor and improper handling will void the warranty.

7.1 Checking the motor installation

DANGER!

Burns!

The surface temperature of a synchronous servo motor can significantly exceed 65 °C through operation.

- Take suitable protective measures against unintentional and intentional contact with the motor.

✓ You have installed a synchronous servo motor as described in the chapter Installation [15].

1. Check the general installation and alignment of the synchronous servo motor.
2. Check the drive elements (coupling, gear unit, belt drive) for firm placement and correct setting.
3. Check whether the motor surface is protected against unintentional or intentional contact.
4. Check whether measures have been taken to prevent possible contact with temperature-sensitive motor parts.
5. Check whether the rotor of the synchronous servo motor can turn freely.
   ⇨ If a motor brake is present, it must be released before inspection. Also note the polarity of the connections!

7.2 Checking the motor connection

WARNING!

Risk of injury due to moving parts!

Make sure that:

- No one is put at risk by starting up the motor.
- All protective and safety devices are properly installed, even in test operation.
- Components attached to the drive are sufficiently secured against centrifugal forces (feather keys, coupling elements, etc.).

✓ You have connected a synchronous servo motor as described in the chapter Connection method [23].

1. Check whether the grounding was established properly.
2. Check whether all live parts are protected against unintentional or intentional contact.
3. Check whether the rotor of the synchronous servo motor can turn freely.
4. Check the direction of rotation of the synchronous servo motor by actuating it using the corresponding drive controller (also observe the documentation of the drive controller).
5. Check the function of the motor brake by applying control voltage to it (note the polarity). The motor brake must be released.

7.3 Putting the motor into operation

WARNING!

Injury to persons and damage to property due to faulty wiring!

Faulty wiring of the motor and/or encoder can lead to uncontrolled movements and to personal injury or damage to property as a result.

- Observe the specifications in this operating manual and in the documentation of the drive controller used.
- Make sure that components attached to the motor, such as feather keys and coupling elements, are sufficiently secured against centrifugal forces.

Only put the synchronous servo motor into operation if you have reviewed its installation and connection in accordance with this documentation as well as all other necessary requirements specific to your system. In addition, follow the instructions for commissioning your drive controller. In multi-unit systems, every drive must be put into operation individually.

7.4 Testing and bedding in the brakes

If a brake does not perform any work by friction over a prolonged period, its friction factor can change due to rust deposition or vapors created by high motor temperatures. In the same way, it is possible that slight material deformation becomes noticeable due to high temperature fluctuations. Regular brake tests must be performed to assess the effective braking torque.

Observe the detailed information in the technical data of the brake; see the chapter Holding brake [32].

Testing the brakes

Load the brake with 1.3x the load torque. When energizing the motor, ensure that the suspended load of a vertical axis exerts a torque on the motor even at a standstill.

Brake re-bedding

If the tested brake torque deviates from the required value, a brake can be bedded again. To perform this action, drive the motor at a maximum of 20 rpm.

Release and close the brake once per second so that the motor has to act against the closed brake for approximately 0.7 seconds. Repeat these steps in the other direction of rotation after approximately 20 cycles.

If the brake's nominal holding torque is still not correct after this bedding in process, perform the entire process again.

If the brake torque still has not been set after performing the bedding in process four times, check for additional factors that could cause the deviating nominal holding torque, such as reaching the wear limit.

Depending on the specific drive controller type, the bed-in routine can also be automated. Refer to the associated documentation on this topic.

8 Service

Observe the 5 safety rules in the chapter Working on the machine [📖 6]!

DANGER!

Electric shock!

Serious injuries due to contact with live parts!

- Carry out all work on a de-energized motor!
- Make sure that the motor shaft is stationary during all work. A rotating rotor can cause high voltages at the connections.
- Disconnect the supply voltage. Be aware that there may still be dangerously high voltages at the drive controller, even up to 15 minutes after switching off the supply voltage, due to the residual charge of the link capacitors. Observe the discharge time specification of the drive controller.
- Cover all open electrical connections, e.g. using protective caps.
- Secure the installation location as per regulations, e.g. using locks or warning signs.

IMPORTANT

Be aware that synchronous servo motors may be repaired only by Pilz GmbH & Co. KG. Unauthorized opening of a synchronous servo motor and improper handling will void the warranty.

8.1 Maintenance

With proper installation, the synchronous servo motors are largely maintenance-free. Since operating conditions vary greatly, maintenance intervals must be adapted to the local conditions (e.g. pollution degree, activation frequency, load).

Maintenance – Regular

- Cleaning the synchronous servo motor
  The cleaning intervals depend on the local pollution degree; note that the original finish must be preserved. Let the motor cool before cleaning; do not use solvents; select the individual cleaning methods based on the protection class of the motor.

Maintenance – Every 500 operating hours, or at least once per quarter

- Inspect the electrical and mechanical connections and retighten as needed.
- Check for smooth operation of the synchronous servo motor and check the installation as needed; if necessary, replace the motor (see the chapter Motor replacement [📖 29]).
- Check the ball bearings for noise and, in the case of deterioration, send in the synchronous servo motor in order to replace the ball bearings.
  Be aware that the ball bearings may be replaced only by Pilz GmbH & Co. KG!

8.2 Procedure in case of faults

Make all personnel working on the machine or motor (machine operators, users, service staff, etc.) aware of any deviations from normal operation. They indicate that function is impaired.
These include:

- Increased power consumption, higher temperatures or increased vibrations.
- Unusual noises or smells.
- (Frequent) triggering of monitoring systems.

In this case, power down the machine and immediately notify the responsible specialist personnel. Check the protective measures that must be taken when in the movement range of a motor, e.g. in the machine/system, especially under raised loads.

8.3 Motor replacement

ATTENTION!

Material damage!

Impacts or other uses of force cause damage to the bearings, feedback system and motor shaft.

- Do not hit the motor shaft or motor housing with a hammer or other tools.
- Do not expose the motor to any compressive stress, impacts or high acceleration.
- Use backlash-free, frictional collets or couplings.
- For attaching and releasing couplings, gears or belt drives, always use the intended draw bar thread in the motor shaft. Use a suitable tool!

Observe the following when replacing the motor:

- If synchronous servo motors with motor brakes have been stored for longer period, the motor brake must be bedded in again before using the motor.
- Check the insulation resistance of the motor winding after long-term storage.
- Observe the information on the motor installation (see the chapter Installation [15]).
- Reestablish the data reference for the machine coordinate system after replacement.

9 Technical data

9.1 General features

Feature	Description
Design	IM B5, IM V1, IM V3 in accordance with EN 60034-7
Protection class	IP56 / IP66 (option)
Thermal class	155 (F) in accordance with EN 60034-1 (155 °C, heating $\Delta\vartheta$ = 100 K)
Surface	Matte black as per RAL 9005
Cooling	IC 410 convection cooling (IC 416 convection cooling with forced ventilation units, optional)
Bearing	Rolling bearing with lifetime lubrication and non-contact sealing
Sealing	Radial shaft seal rings made of FKM (A side)
Shaft	Shaft without feather key, diameter quality k6
Radial runout	Normal tolerance class in accordance with IEC 60072-1
Concentricity	Normal tolerance class in accordance with IEC 60072-1
Axial runout	Normal tolerance class in accordance with IEC 60072-1
Vibration intensity	A in accordance with EN 60034-14
Noise level	Limit values in accordance with EN 60034-9

9.2 Electrical features

General electrical features of the motor are described in this chapter.

Feature	Description
DC link voltage	DC 540 V (max. 620 V) on Pilz drive controllers
Winding	Three-phase, single-tooth coil design
Circuit	Star, center not led through
Protection class	I (protective grounding) in accordance with EN 61140
Number of pole pairs	5 (EZ3) 7 (EZ4/EZ5/EZ7) 8 (EZ8)

9.3 Ambient conditions

Standard ambient conditions for transport, storage and operation of the motor are described in this chapter. Information about differing ambient conditions can be found in section Derating [37].

Feature	Description
Surrounding temperature for transport/storage	−30 °C to +85 °C
Surrounding temperature for operation	−20 °C to +40 °C
Relative humidity	5% to 95%, no condensation
Installation altitude	≤ 1000 m above sea level
Shock load	≤ 50 m/s² (5 g), 6 ms in accordance with EN 60068-2-27

Notes

- Pilz synchronous servo motors are not suitable for potentially explosive atmospheres.
- Secure the power cables close to the motor so that vibrations of the cable do not place impermissible loads on the motor plug connector.
- Note that the braking torques of the holding brake (optional) may be reduced by shock loading.
- At operating temperatures below 0 °C, note that the discs of the holding brake (optional) may ice up.
- Also take into consideration the shock load of the motor due to output units (such as gear units and pumps) which are coupled with the motor.

9.4 Forced ventilation unit

Technical data

Motor	Forced ventilation unit	$U_{N,F}$ [V]	$I_{N,F}$ [A]	$P_{N,F}$ [W]	$q_{v,F}$ [m³/h]	$L_{p(A)}$ [dBA]	m_F [kg]	Protection class
EZ4_B	FL4	230 V ± 5%, 50/60 Hz	0.07	10	59	41	1.4	IP44
EZ5_B	FL5		0.10	14	160	45	1.9	IP54
EZ7_B	FL7		0.10	14	160	45	2.9	IP54
EZ8_B	FL8		0.20	26	420	54	5.0	IP55

9.5 Encoders

EnDat 2.2

Encoder model	Code	Measuring method	Recordable revolutions	Resolution	Position values per revolution
ECI 1118-G2	C5	Inductive	–	18 bit	262144
ECN 1123	C7	Optical	–	23 bit	8388608
EQI 1131	Q6	Inductive	4096	19 bit	524288
EQN 1135	Q5	Optical	4096	23 bit	8388608

9.6 Holding brake

Pilz synchronous servo motors can be equipped with a backlash-free holding brake using permanent magnets in order to secure the motor shaft when at a standstill. The holding brake engages automatically if the voltage drops.

The holding brake is designed for a high number of operations (B_{10} = 10 million operations, B_{10d} = 20 million operations).

Nominal voltage of permanent magnet holding brake: DC 24 V ± 5%, smoothed.

Observe the following during project configuration:

- The holding brake is designed to keep the motor shaft from moving. Activate braking processes during operation using the corresponding electrical functions of the drive controller. In exceptional circumstances, the holding brake can be used for braking from full speed (following a power failure or when setting up the machine). The maximum permitted work done by friction $W_{B,Rmax/h}$ may not be exceeded.
- Note that the braking torque M_{Bdyn} may initially be up to 50% less when braking from full speed. As a result, the braking effect has a delayed action and braking distances become longer.
- Regularly perform a brake test to ensure the functional safety of the brakes.
- The holding brake of the motor does not offer adequate safety for persons in the hazardous area of gravity-loaded vertical axes. Therefore take additional measures to minimize risk, e.g. by providing a mechanical substructure for maintenance work.
- Take into consideration voltage losses in the connection cables that connect the voltage source to the holding brake connections.
- The holding torque of the brake can be reduced by shock loading. Information about shock loading can be found in the "Ambient conditions" chapter.
- At operating temperatures from −15 °C to 0 °C, a cold holding brake in the released state may cause operating noises. As the temperature of the holding brake increases, these noises decrease such that operating noises are not heard when using holding brake at operating temperature in the released state.

Calculation of work done by friction per braking process

$$W_{B,R/B} = \frac{J_{tot} \cdot n^2}{182.4} \cdot \frac{M_{Bdyn}}{M_{Bdyn} \pm M_L}, \; M_{Bdyn} > M_L$$

The sign of M_L is positive if the movement runs vertically upwards or horizontally and it is negative if the movement runs vertically down.

Calculation of the stop time

$$t_{dec} = 2.66 \cdot t_{1B} + \frac{n \cdot J_{tot}}{9.55 \cdot M_{Bdyn}}$$

Switching behavior

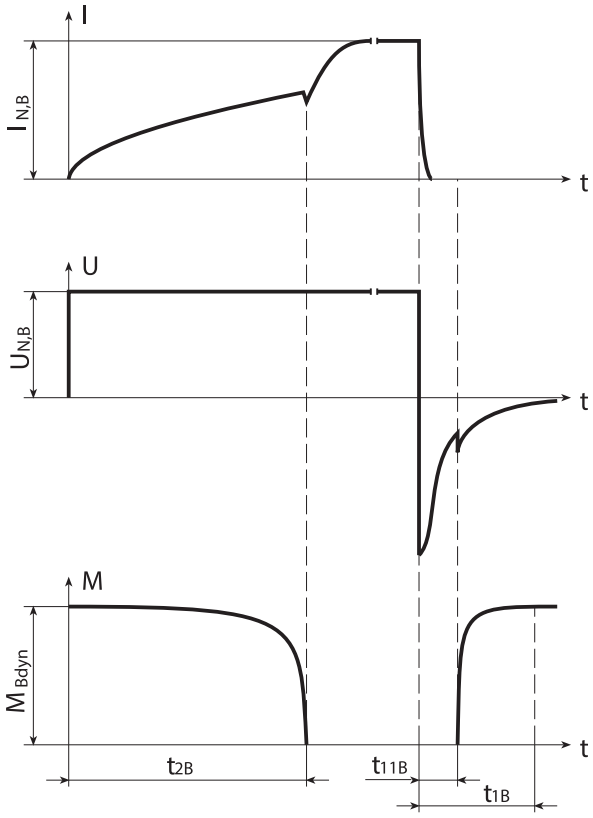


Fig. 5: Holding brake – Switching behavior

9.6.1 Technical data – Holding brake

Type	M_{Bstat}	M_{Bdyn}	$I_{N,B}$	$W_{B,Rmax/h}$	N_{Bstop}	J_{Bstop}	$W_{B,Rlim}$	t_{2B}	t_{11B}	t_{1B}	$x_{B,N}$	ΔJ_B	Δm_B
	[Nm]	[Nm]	[A]	[kJ]		[kgcm²]	[kJ]	[ms]	[ms]	[ms]	[mm]	[kgcm²]	[kg]
EZ301	2.5	2.3	0.51	6.0	48000	0.752	180	25	3.0	20	0.2	0.186	0.55
EZ302	4.0	3.8	0.50	8.5	38000	0.952	180	44	4.0	26	0.3	0.186	0.55
EZ303	4.0	3.8	0.50	8.5	30000	1.17	180	44	4.0	26	0.3	0.186	0.55
EZ401	4.0	3.8	0.50	8.5	16000	2.24	180	44	4.0	26	0.3	0.192	0.76
EZ402	8.0	7.0	0.75	8.5	13500	4.39	300	40	2.0	20	0.3	0.566	0.97
EZ404	8.0	7.0	0.75	8.5	8500	7.09	300	40	2.0	20	0.3	0.566	0.97
EZ501	8.0	7.0	0.75	8.5	8700	6.94	300	40	2.0	20	0.3	0.571	1.19
EZ502	8.0	7.0	0.80	8.5	5200	11.5	300	40	2.0	20	0.3	0.571	1.19
EZ503	15	12	1.0	11.0	5900	18.6	550	60	5.0	30	0.3	1.721	1.62
EZ505	15	12	1.0	11.0	4000	27.8	550	60	5.0	30	0.3	1.721	1.62
EZ701	15	12	1.0	11.0	5400	20.5	550	60	5.0	30	0.3	1.743	1.94
EZ702	15	12	1.0	11.0	3600	30.9	550	60	5.0	30	0.3	1.743	1.94
EZ703	32	28	1.1	25.0	5200	54.6	1400	100	5.0	25	0.4	5.680	2.81
EZ705	32	28	1.1	25.0	3500	79.4	1400	100	5.0	25	0.4	5.680	2.81
EZ802	65	35	1.7	45.0	6000	149	2250	200	10	50	0.4	16.460	5.40
EZ803	65	35	1.7	45.0	4500	200	2250	200	10	50	0.4	16.460	5.40
EZ805	115	70	2.1	65.0	7000	376	6500	190	12	65	0.5	55.460	8.40

9.7 Thermal winding protection

The PMC EZ motors are equipped with a PTC triplet. As an alternative, the motors can be implemented with a Pt1000 temperature sensor on request for operation connected to PMC SD6 series drive controllers.

9.7.1 PTC thermistor

The PMC EZ motors are equipped with a PTC triplet.

The PTC thermistor is a triple thermistor in accordance with DIN 44082 that can be used for monitoring the temperature of each winding phase. The resistance values in the following table and curve refer to a single thermistor in accordance with DIN 44081. These values must be multiplied by 3 for a triple thermistor in accordance with DIN 44082.

Feature	Description
Nominal response temperature ϑ_{NAT}	145 °C ± 5 K
Resistance R −20 °C up to ϑ_{NAT} − 20 K	≤ 250 Ω
Resistance R with ϑ_{NAT} − 5 K	≤ 550 Ω
Resistance R with ϑ_{NAT} + 5 K	≥ 1330 Ω
Resistance R with ϑ_{NAT} + 15 K	≥ 4000 Ω
Operating voltage	≤ DC 7.5 V
Thermal response time	< 5 s
Thermal class	155 (F) in accordance with EN 60034-1 (155 °C, heating $\Delta\vartheta$ = 100 K)

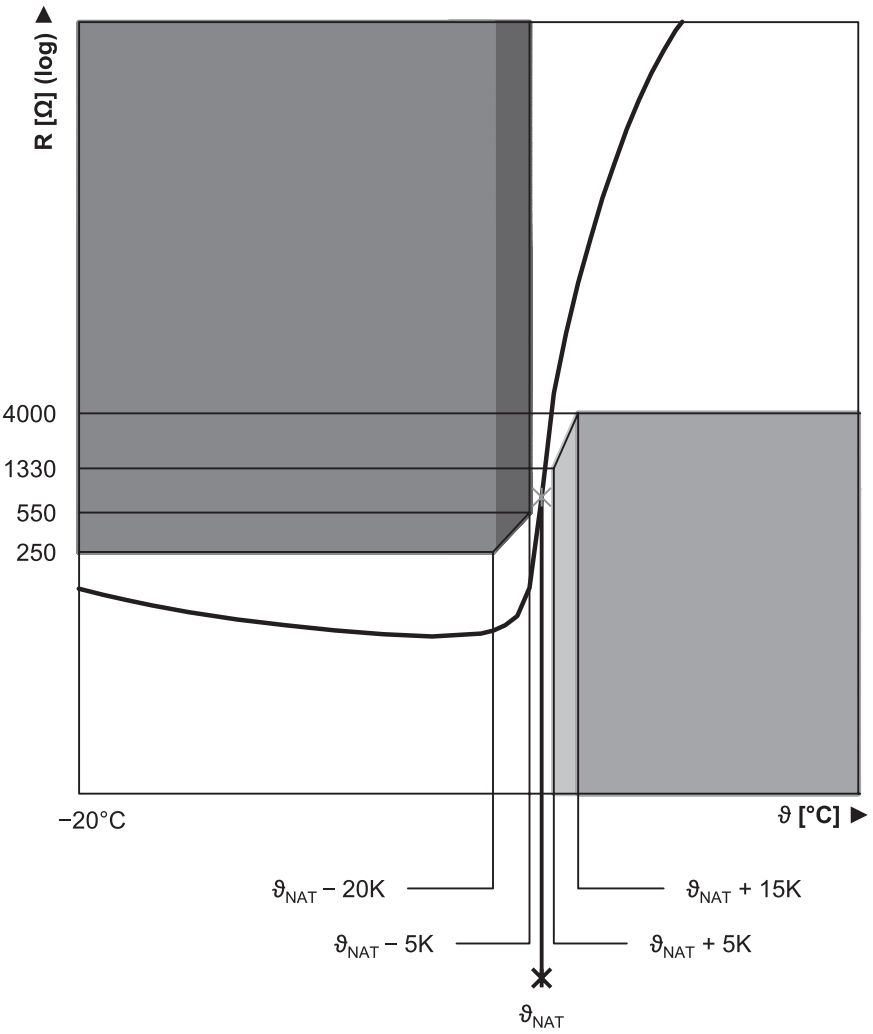


Fig. 6: PTC thermistor curve (single thermistor)

9.7.2 Pt1000 temperature sensor

On request, PMC EZ motors can be implemented with a Pt1000 temperature sensor.

The Pt1000 is a temperature-dependent resistor that has a resistance curve with a linear relationship with temperature. As a result, the Pt1000 allows for measurements of the winding temperature. These measurements are limited to one phase of the motor winding, however. In order to adequately protect the motor from exceeding the maximum permitted winding temperature, use a i^2t model in the drive controller to monitor the winding temperature.

Avoid exceeding the specified measurement current so that the measured values are not falsified due to self-heating of the temperature sensor.

Feature	Description
Measurement current (constant)	2 mA
Resistance R for ϑ = 0 °C	1000 Ω
Resistance R for ϑ = 80 °C	1300 Ω
Resistance R for ϑ = 150 °C	1570 Ω

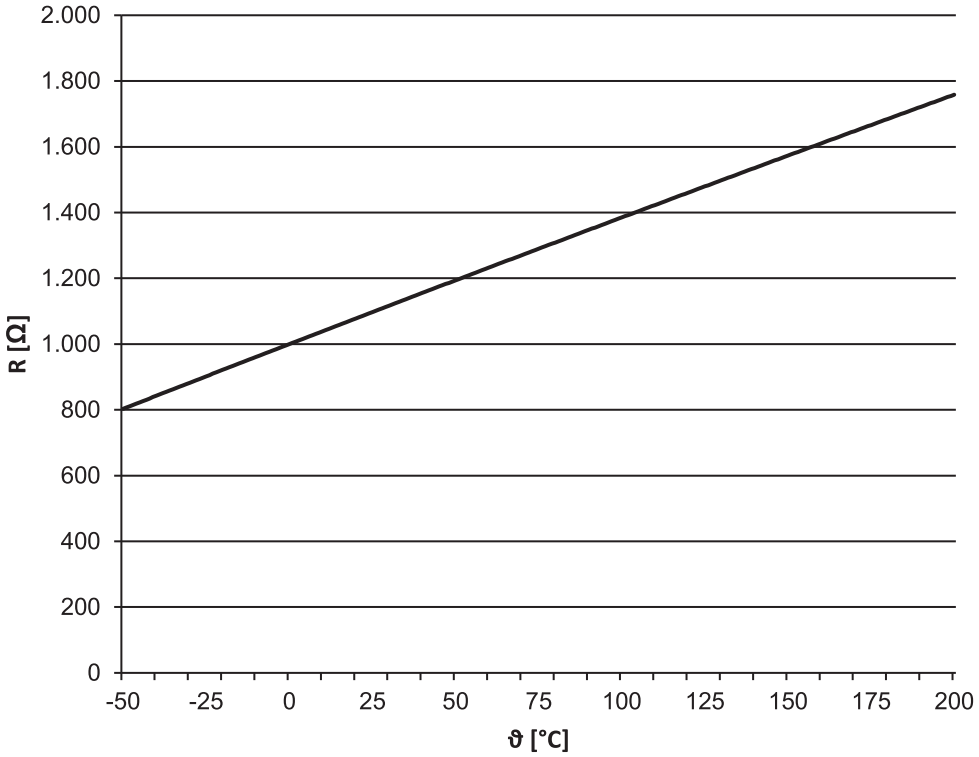


Fig. 7: Pt1000 temperature sensor characteristic curve

9.8 Derating

If you use the motor under ambient conditions that differ from the standard ambient conditions, the nominal torque M_N of the motor is reduced. In this chapter, you can find information for calculating the reduced nominal torque.

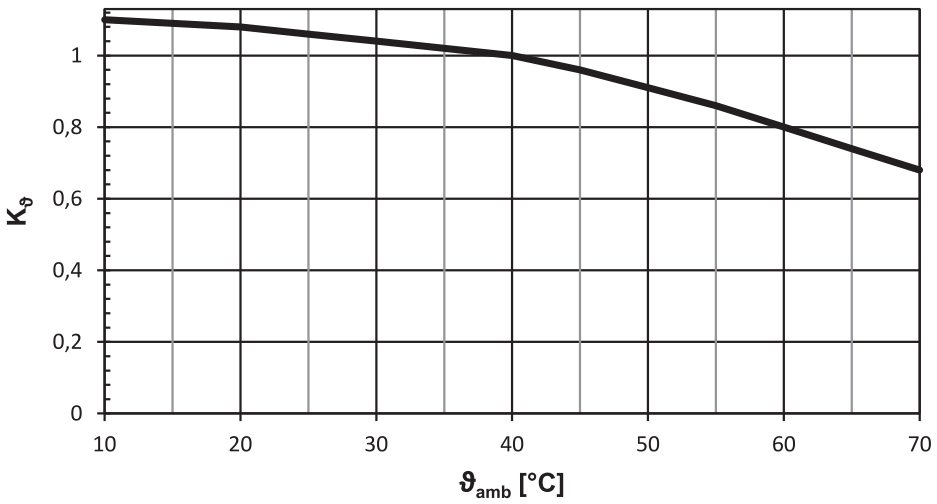


Fig. 8: Derating depending on the surrounding temperature

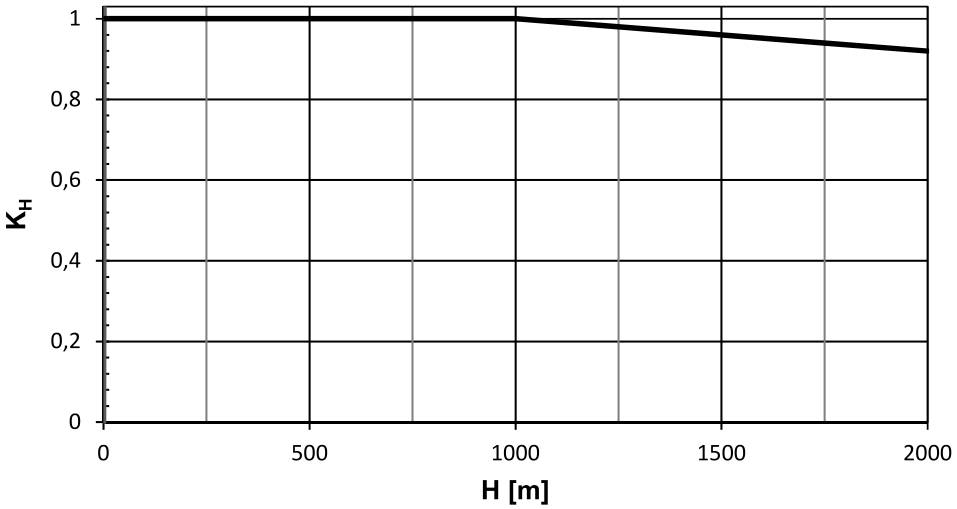


Fig. 9: Derating depending on the installation height

Calculation

If surrounding temperature ϑ_{amb} > 40 °C:

$M_{Nred} = M_N \cdot K_\vartheta$

If installation altitude H > 1000 m above sea level:

$M_{Nred} = M_N \cdot K_H$

If the surrounding temperature ϑ_{amb} > 40 °C and installation altitude H > 1000 m above sea level:

$M_{Nred} = M_N \cdot K_H \cdot K_\vartheta$

9.9 Type-specific data

9.9.1 Attachment conditions

ATTENTION!

Overheating!

Repainting the motor changes its thermal properties. The motor cannot be operated with the nominal data.

- Preserve the finish of the motor (RAL 9005 jet black, matte).

The following technical data applies to the ideal energy configuration of a drive controller and was determined under the following thermal attachment conditions:

- Attachment of the synchronous servo motor with a steel bracket to a base plate
- Minimum attachment surfaces between synchronous servo motor and steel bracket and base plate in accordance with the subsequent table.

Type	Dimensions of steel mounting flange (thickness x width x height)	Convection surface area Steel mounting flange
EZ3 − EZ5	23 x 210 x 275 mm	0.16 m^2
EZ7 − EZ8	28 x 300 x 400 mm	0.3 m^2

Note the differing ambient conditions in the chapter Derating [📖 37].

9.9.2 PMC EZ motors with convection cooling

Type	K_{EM}	n_N	M_N	I_N	$K_{M,N}$	P_N	M_0	I_0	K_{M0}	M_R	M_{max}	I_{max}	R_{U-V}	L_{U-V}	T_{el}	J_{dyn}	m_{dyn}
	[V/1000 rpm]	[rpm]	[Nm]	[A]	[Nm/A]	[kW]	[Nm]	[A]	[Nm/A]	[Nm]	[Nm]	[A]	[Ω]	[mH]	[ms]	[kgcm²]	[kg]
EZ301U	40	6000	0.89	1.93	0.46	0.56	0.95	2.02	0.49	0.04	2.80	12.7	11.70	39.80	3.40	0.19	1.50
EZ301U	40	3000	0.93	1.99	0.47	0.29	0.95	2.02	0.49	0.04	2.80	12.7	11.70	39.80	3.40	0.19	1.50
EZ302U	42	6000	1.50	3.18	0.47	0.94	1.68	3.48	0.49	0.04	5.00	17.8	4.50	18.70	4.16	0.29	2.10
EZ302U	86	3000	1.59	1.60	0.99	0.50	1.68	1.67	1.03	0.04	5.00	8.55	17.80	75.00	4.21	0.29	2.10
EZ303U	55	6000	1.96	3.17	0.62	1.2	2.25	3.55	0.65	0.04	7.00	16.9	4.90	21.10	4.31	0.40	2.60
EZ303U	109	3000	2.07	1.63	1.27	0.65	2.19	1.71	1.30	0.04	7.00	8.25	20.30	68.70	5.24	0.40	2.60
EZ401U	47	6000	2.30	4.56	0.50	1.4	2.80	5.36	0.53	0.04	8.50	33.0	1.94	11.52	5.94	0.93	4.00
EZ401U	96	3000	2.80	2.74	1.02	0.88	3.00	2.88	1.06	0.04	8.50	16.5	6.70	37.70	5.63	0.93	4.00
EZ402U	60	6000	3.50	5.65	0.62	2.2	4.90	7.43	0.66	0.04	16.0	43.5	1.20	8.88	7.40	1.63	5.10
EZ402U	94	3000	4.70	4.40	1.07	1.5	5.20	4.80	1.09	0.04	16.0	26.5	3.00	21.80	7.26	1.63	5.10
EZ404U	78	6000	5.80	7.18	0.81	3.6	8.40	9.78	0.86	0.04	29.0	51.0	0.89	7.07	7.94	2.98	7.20
EZ404U	116	3000	6.90	5.80	1.19	2.2	8.60	6.60	1.31	0.04	29.0	35.0	1.85	15.00	8.11	2.98	7.20
EZ501U	68	6000	3.40	4.77	0.71	2.1	4.40	5.80	0.77	0.06	16.0	31.0	2.10	12.10	5.76	2.90	5.00
EZ501U	97	3000	4.30	3.74	1.15	1.4	4.70	4.00	1.19	0.06	16.0	22.0	3.80	23.50	6.18	2.90	5.00
EZ502U	72	6000	5.20	7.35	0.71	3.3	7.80	9.80	0.80	0.06	31.0	59.0	0.76	5.60	7.37	5.20	6.50
EZ502U	121	3000	7.40	5.46	1.36	2.3	8.00	5.76	1.40	0.06	31.0	33.0	2.32	16.80	7.24	5.20	6.50
EZ503U	84	6000	6.20	7.64	0.81	3.9	10.6	11.6	0.92	0.06	43.0	63.5	0.62	5.00	8.06	7.58	8.00
EZ503U	119	3000	9.70	6.90	1.41	3.1	11.1	7.67	1.46	0.06	43.0	41.0	1.25	10.00	8.00	7.58	8.00
EZ505U	103	4500	9.50	8.94	1.06	4.5	15.3	13.4	1.15	0.06	67.0	73.0	0.50	4.47	8.94	12.2	10.9

Type	K_{EM}	n_N	M_N	I_N	$K_{M,N}$	P_N	M_0	I_0	K_{M0}	M_R	M_{max}	I_{max}	R_{U-V}	L_{U-V}	T_{el}	J_{dyn}	m_{dyn}
	[V/1000 rpm]	[rpm]	[Nm]	[A]	[Nm/A]	[kW]	[Nm]	[A]	[Nm/A]	[Nm]	[Nm]	[A]	[Ω]	[mH]	[ms]	[kgcm²]	[kg]
EZ505U	141	3000	13.5	8.80	1.53	4.2	16.0	10.0	1.61	0.06	67.0	52.0	0.93	8.33	8.96	12.2	10.9
EZ701U	76	6000	5.20	6.68	0.78	3.3	7.90	9.38	0.87	0.24	20.0	31.0	0.87	8.13	9.34	8.50	8.30
EZ701U	95	3000	7.40	7.20	1.03	2.3	8.30	8.00	1.07	0.24	20.0	25.0	1.30	12.83	9.87	8.50	8.30
EZ702U	82	6000	7.20	8.96	0.80	4.5	14.3	16.5	0.88	0.24	41.0	60.5	0.34	3.90	11.47	13.7	10.8
EZ702U	133	3000	12.0	8.20	1.46	3.8	14.4	9.60	1.53	0.24	41.0	36.0	1.00	11.73	11.73	13.7	10.8
EZ703U	99	4500	12.1	11.5	1.05	5.7	20.0	17.8	1.14	0.24	65.0	78.0	0.36	4.42	12.28	21.6	12.8
EZ703U	122	3000	16.5	11.4	1.45	5.2	20.8	14.0	1.50	0.24	65.0	62.0	0.52	6.80	13.08	21.6	12.8
EZ705U	106	4500	16.4	14.8	1.11	7.7	30.0	25.2	1.20	0.24	104	114	0.22	2.76	12.55	34.0	18.3
EZ705U	140	3000	21.3	14.2	1.50	6.7	30.2	19.5	1.56	0.24	104	87.0	0.33	4.80	14.55	34.0	18.3
EZ802U	90	4500	10.5	11.2	0.94	5.0	34.5	33.3	1.05	0.30	100	135	0.13	1.90	14.60	58.0	26.6
EZ802U	136	3000	22.3	13.9	1.60	7.0	37.1	22.3	1.68	0.30	100	84.0	0.30	5.00	16.66	58.0	26.6
EZ803U	131	3000	26.6	17.7	1.50	8.4	48.2	31.1	1.56	0.30	145	124	0.18	2.79	15.50	83.5	32.7
EZ805U	142	2000	43.7	25.9	1.69	9.2	66.1	37.9	1.75	0.30	205	155	0.13	2.22	17.08	133	45.8

9.9.3 PMC EZ motors with forced ventilation

Type	K_{EM}	n_N	M_N	I_N	$K_{M,N}$	P_N	M_0	I_0	K_{M0}	M_R	M_{max}	I_{max}	R_{U-V}	L_{U-V}	T_{el}	J_{dyn}	m_{dyn}
	[V/1000 rpm]	[rpm]	[Nm]	[A]	[Nm/A]	[kW]	[Nm]	[A]	[Nm/A]	[Nm]	[Nm]	[A]	[Ω]	[mH]	[ms]	[kgcm²]	[kg]
EZ401B	47	6000	2.90	5.62	0.52	1.8	3.50	6.83	0.52	0.04	8.50	33.0	1.94	11.52	5.94	0.93	5.40
EZ401B	96	3000	3.40	3.40	1.00	1.1	3.70	3.60	1.04	0.04	8.50	16.5	6.70	37.70	5.63	0.93	5.40
EZ402B	60	6000	5.10	7.88	0.65	3.2	6.40	9.34	0.69	0.04	16.0	43.5	1.20	8.88	7.40	1.63	6.50
EZ402B	94	3000	5.90	5.50	1.07	1.9	6.30	5.80	1.09	0.04	16.0	26.5	3.00	21.80	7.26	1.63	6.50
EZ404B	78	6000	8.00	9.98	0.80	5.0	10.5	12.0	0.88	0.04	29.0	51.0	0.89	7.07	7.94	2.98	8.60
EZ404B	116	3000	10.2	8.20	1.24	3.2	11.2	8.70	1.29	0.04	29.0	35.0	1.85	15.00	8.11	2.98	8.60
EZ501B	68	6000	4.50	6.70	0.67	2.8	5.70	7.50	0.77	0.06	16.0	31.0	2.10	12.10	5.76	2.90	7.00
EZ501B	97	3000	5.40	4.70	1.15	1.7	5.80	5.00	1.17	0.06	16.0	22.0	3.80	23.50	6.18	2.90	7.00
EZ502B	72	6000	8.20	11.4	0.72	5.2	10.5	13.4	0.79	0.06	31.0	59.0	0.76	5.60	7.37	5.20	8.50
EZ502B	121	3000	10.3	7.80	1.32	3.2	11.2	8.16	1.38	0.06	31.0	33.0	2.32	16.80	7.24	5.20	8.50
EZ503B	84	6000	10.4	13.5	0.77	6.5	14.8	15.9	1.07	0.06	43.0	63.5	0.62	5.00	8.06	7.58	10.0
EZ503B	119	3000	14.4	10.9	1.32	4.5	15.9	11.8	1.35	0.06	43.0	41.0	1.25	10.00	8.00	7.58	10.0
EZ505B	103	4500	16.4	16.4	1.00	7.7	22.0	19.4	1.14	0.06	67.0	73.0	0.50	4.47	8.94	12.2	12.9
EZ505B	141	3000	20.2	13.7	1.47	6.4	23.4	14.7	1.60	0.06	67.0	52.0	0.93	8.33	8.96	12.2	12.9
EZ701B	76	6000	7.50	10.6	0.71	4.7	10.2	12.4	0.84	0.24	20.0	31.0	0.87	8.13	9.34	8.50	11.2
EZ701B	95	3000	9.70	9.50	1.02	3.1	10.5	10.0	1.07	0.24	20.0	25.0	1.30	12.83	9.87	8.50	11.2
EZ702B	82	6000	12.5	16.7	0.75	7.9	19.3	22.1	0.89	0.24	41.0	60.5	0.34	3.90	11.47	13.7	13.7
EZ702B	133	3000	16.6	11.8	1.41	5.2	19.3	12.9	1.51	0.24	41.0	36.0	1.00	11.73	11.73	13.7	13.7
EZ703B	99	4500	19.8	20.3	0.98	9.3	27.2	24.2	1.13	0.24	65.0	78.0	0.36	4.42	12.28	21.6	15.7

Type	K_{EM}	n_N	M_N	I_N	$K_{M,N}$	P_N	M_0	I_0	K_{M0}	M_R	M_{max}	I_{max}	R_{U-V}	L_{U-V}	T_{el}	J_{dyn}	m_{dyn}
	[V/1000 rpm]	[rpm]	[Nm]	[A]	[Nm/A]	[kW]	[Nm]	[A]	[Nm/A]	[Nm]	[Nm]	[A]	[Ω]	[mH]	[ms]	[kgcm²]	[kg]
EZ703B	122	3000	24.0	18.2	1.32	7.5	28.0	20.0	1.41	0.24	65.0	62.0	0.52	6.80	13.08	21.6	15.7
EZ705B	106	4500	27.7	25.4	1.09	13	39.4	32.8	1.21	0.24	104	114	0.22	2.76	12.55	34.0	21.2
EZ705B	140	3000	33.8	22.9	1.48	11	41.8	26.5	1.59	0.24	104	87.0	0.33	4.80	14.55	34.0	21.2
EZ802B	90	4500	30.6	30.5	1.00	14	47.4	45.1	1.06	0.30	100	135	0.13	1.90	14.60	58.0	31.6
EZ802B	136	3000	34.3	26.5	1.29	11	47.9	28.9	1.67	0.30	100	84.0	0.30	5.00	16.66	58.0	31.6
EZ803B	131	3000	49.0	35.9	1.37	15	66.7	42.3	1.58	0.30	145	124	0.18	2.79	15.50	83.5	37.7
EZ805B	142	2000	77.2	45.2	1.71	16	94.0	53.9	1.75	0.30	205	155	0.13	2.22	17.08	133	51.8

9.9.4 Dimensional drawings

Dimensions can exceed the specifications of ISO 2768-mK due to casting tolerances or accumulation of individual tolerances.

We reserve the right to make dimensional changes due to ongoing technical development.

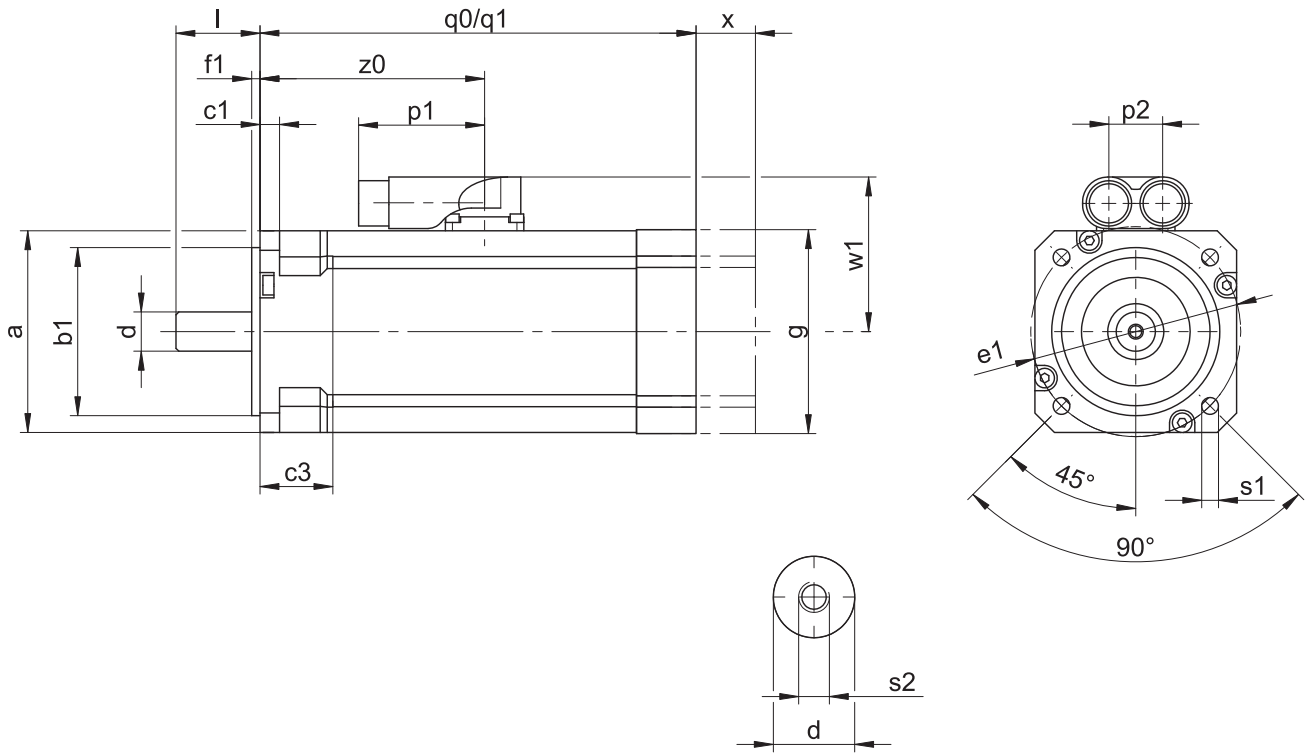
You can find CAD drawings and models at http://www.pilz.com or receive them by request.

Solid shaft	Tolerance
Shaft ∅ fit ≤ 50 mm	DIN 748-1, ISO k6
Shaft ∅ fit > 50 mm	DIN 748-1, ISO m6

Centering holes in solid shafts in accordance with DIN 332-2, DR shape

Thread size	M4	M5	M6	M8	M10	M12	M16	M20	M24
Thread depth [mm]	10	12.5	16	19	22	28	36	42	50

9.9.4.1 PMC EZ3 motors



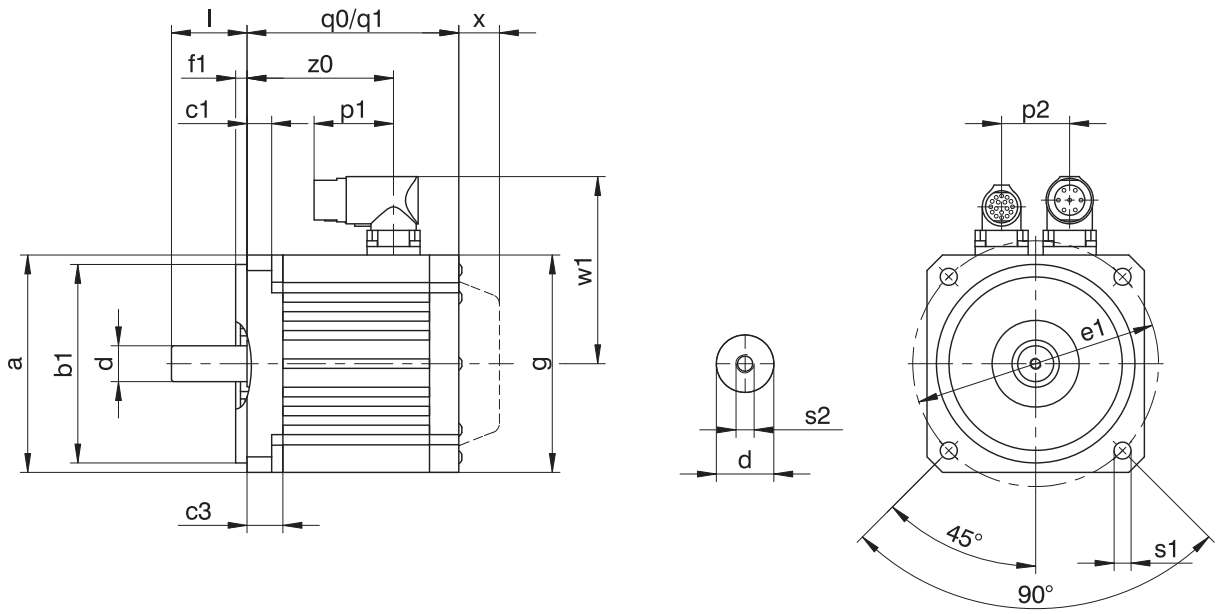
q0 Applies to motors without holding brake

q1 Applies to motors with holding brake

x Applies to encoders based on an optical measuring method

Type	□a	Ø$b1_{j6}$	c1	c3	Ød_{k6}	Øe1	f1	□g	l	p1	p2	q0	q1	Øs1	s2	w1	x	z0
EZ301U	72	60_{j6}	7	26	14_{k6}	75	3	72	30	45	19	116	156	6	M5	55.5	21	80.5
EZ302U	72	60_{j6}	7	26	14_{k6}	75	3	72	30	45	19	138	178	6	M5	55.5	21	102.5
EZ303U	72	60_{j6}	7	26	14_{k6}	75	3	72	30	45	19	160	200	6	M5	55.5	21	124.5

9.9.4.2 PMC EZ4 – PMC EZ8 motors with convection cooling



q0 Applies to motors without holding brake

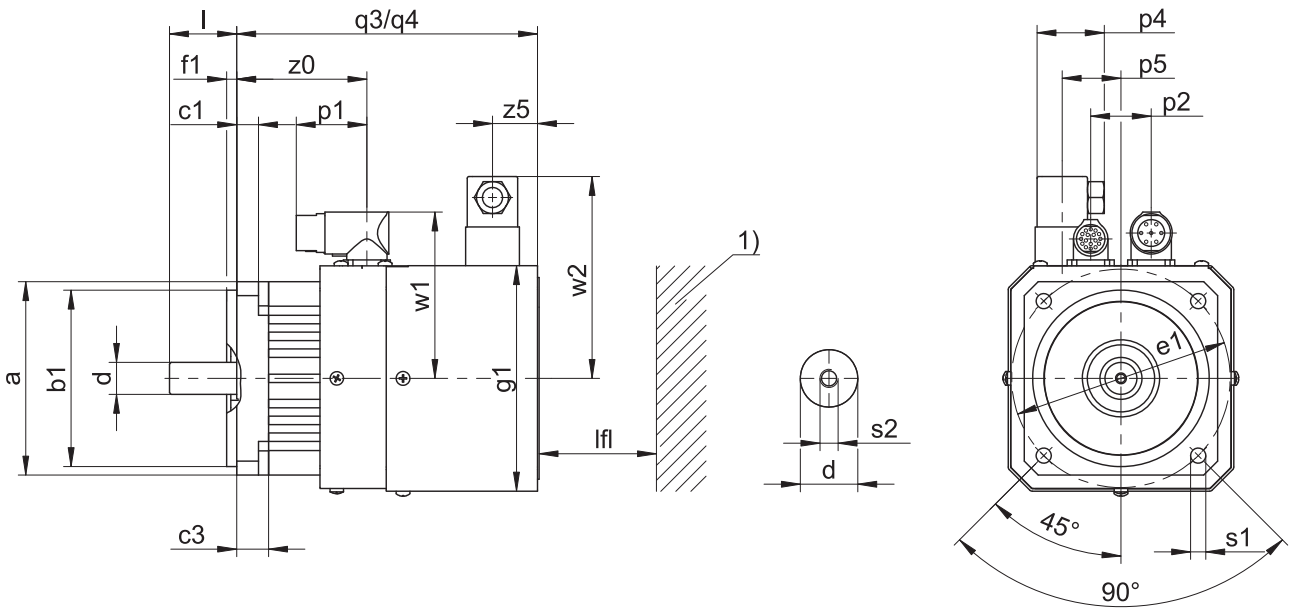
q1 Applies to motors with holding brake

x Applies to encoders based on an optical measuring method

Type	□a	Ød1	c1	c3	Ød	Øe1	f1	□g	l	p1	p2	q0	q1	Øs1	s2	w1	x	z0
EZ401U	98	95_{j6}	9.5	20.5	14_{k6}	115	3.5	98	30	40	32	118.5	167.0	9	M5	91.0	22	76.5
EZ402U	98	95_{j6}	9.5	20.5	19_{k6}	115	3.5	98	40	40	32	143.5	192.0	9	M6	91.0	22	101.5
EZ404U	98	95_{j6}	9.5	20.5	19_{k6}	115	3.5	98	40	40	32	193.5	242.0	9	M6	91.0	22	151.5
EZ501U	115	110_{j6}	10.0	16.0	19_{k6}	130	3.5	115	40	40	36	109.0	163.5	9	M6	100.0	22	74.5
EZ502U	115	110_{j6}	10.0	16.0	19_{k6}	130	3.5	115	40	40	36	134.0	188.5	9	M6	100.0	22	99.5
EZ503U	115	110_{j6}	10.0	16.0	24_{k6}	130	3.5	115	50	40	36	159.0	213.5	9	M8	100.0	22	124.5
EZ505U	115	110_{j6}	10.0	16.0	24_{k6}	130	3.5	115	50	40	36	209.0	263.5	9	M8	100.0	22	174.5

Type	□a	Øb1	c1	c3	Ød	Øe1	f1	□g	l	p1	p2	q0	q1	Øs1	s2	w1	x	z0
EZ701U	145	130_{j6}	10.0	19.0	24_{k6}	165	3.5	145	50	40	42	121.0	180.0	11	M8	115.0	22	83.0
EZ702U	145	130_{j6}	10.0	19.0	24_{k6}	165	3.5	145	50	40	42	146.0	205.0	11	M8	115.0	22	108.0
EZ703U	145	130_{j6}	10.0	19.0	24_{k6}	165	3.5	145	50	40	42	171.0	230.0	11	M8	115.0	22	133.0
EZ705U	145	130_{j6}	10.0	19.0	32_{k6}	165	3.5	145	58	71	42	226.0	285.0	11	M12	134.0	22	184.0
EZ802U	190	180_{j6}	15.0	25.0	32_{k6}	215	3.5	190	58	71	60	222.0	299.0	13.5	M12	156.5	22	168.0
EZ803U	190	180_{j6}	15.0	25.0	38_{k6}	215	3.5	190	80	71	60	263.0	340.0	13.5	M12	156.5	22	209.0
EZ805U	190	180_{j6}	15.0	25.0	38_{k6}	215	3.5	190	80	71	60	345.0	422.0	13.5	M12	156.5	22	277.0

9.9.4.3 PMC EZ4 – PMC EZ8 motors with forced ventilation



q3 Applies to motors without holding brake

q4 Applies to motors with holding brake

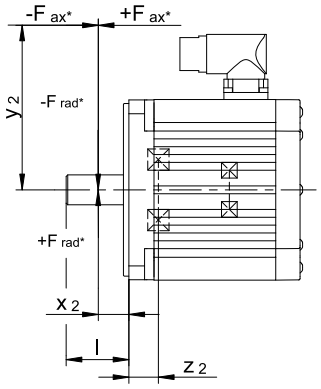
1) Machine wall

Type	□a	Ød1	c1	c3	Ød	Øe1	f1	□g1	l	lfl_{min}	p1	p2	p4	p5	q3	q4	Øs1	s2	w1	w2	z0	z5
EZ401B	98	95_{j6}	9.5	20.5	14_{k6}	115	3.5	118	30	20	40	32	37.5	0	175	224	9.0	M5	91.0	111	76.5	25
EZ402B	98	95_{j6}	9.5	20.5	19_{k6}	115	3.5	118	40	20	40	32	37.5	0	200	249	9.0	M6	91.0	111	101.5	25
EZ404B	98	95_{j6}	9.5	20.5	19_{k6}	115	3.5	118	40	20	40	32	37.5	0	250	299	9.0	M6	91.0	111	151.5	25
EZ501B	115	110_{j6}	10.0	16.0	19_{k6}	130	3.5	135	40	20	40	36	37.5	0	179	234	9.0	M6	100.0	120	74.5	25
EZ502B	115	110_{j6}	10.0	16.0	19_{k6}	130	3.5	135	40	20	40	36	37.5	0	204	259	9.0	M6	100.0	120	99.5	25
EZ503B	115	110_{j6}	10.0	16.0	24_{k6}	130	3.5	135	50	20	40	36	37.5	0	229	284	9.0	M8	100.0	120	124.5	25
EZ505B	115	110_{j6}	10.0	16.0	24_{k6}	130	3.5	135	50	20	40	36	37.5	0	279	334	9.0	M8	100.0	120	174.5	25

Type	□a	Ø$b1_{j6}$	c1	c3	Ød_{k6}	Ø$e1_{k6}$	f1	□g1	l	lfl_{min}	p1	p2	p4	p5	q3	q4	Ø$s1_{k6}$	s2	w1	w2	z0	z5
EZ701B	145	130_{j6}	10.0	19.0	24_{k6}	165	3.5	165	50	30	40	42	37.5	0	213	272	11.0	M8	115.0	134	83.0	40
EZ702B	145	130_{j6}	10.0	19.0	24_{k6}	165	3.5	165	50	30	40	42	37.5	0	238	297	11.0	M8	115.0	134	108.0	40
EZ703B	145	130_{j6}	10.0	19.0	24_{k6}	165	3.5	165	50	30	40	42	37.5	0	263	322	11.0	M8	115.0	134	133.0	40
EZ705B	145	130_{j6}	10.0	19.0	32_{k6}	165	3.5	165	58	30	71	42	37.5	0	318	377	11.0	M12	134.0	134	184.0	40
EZ802B	190	180_{j6}	15.0	25.0	32_{k6}	215	3.5	215	58	30	71	60	37.5	62	322	399	13.5	M12	156.5	160	168.0	40
EZ803B	190	180_{j6}	15.0	25.0	38_{k6}	215	3.5	215	80	30	71	60	37.5	62	363	440	13.5	M12	156.5	160	209.0	40
EZ805B	190	180_{j6}	15.0	25.0	38_{k6}	215	3.5	215	80	30	71	60	37.5	62	445	522	13.5	M12	178.0	160	277.0	40

9.9.5 Permitted shaft loads

This chapter contains information about the maximum permitted shaft loads of the output shaft of the motor.



Type	z_2	F_{ax100}	F_{rad100}	M_{k100}
	[mm]	[N]	[N]	[Nm]
EZ301	24.0	350	1000	39
EZ302	24.0	350	1000	39
EZ303	24.0	350	1000	39
EZ401	19.5	550	1800	62
EZ402	19.5	550	1800	71
EZ404	19.5	550	1800	71
EZ501	19.5	750	2000	79
EZ502	19.5	750	2400	95
EZ503	19.5	750	2400	107
EZ505	19.5	750	2400	107
EZ701	24.5	1300	3500	173
EZ702	24.5	1300	4200	208
EZ703	24.5	1300	4200	208
EZ705	24.5	1300	4200	225
EZ802	28.5	1750	5600	384
EZ803	28.5	1750	5600	384
EZ805	28.5	1750	5600	384

The values for permitted shaft loads specified in the table apply:

- For shaft dimensions in accordance with the catalog
- A force applied at the center of the output shaft: $x_2 = l / 2$ (shaft dimensions can be found in the chapter Dimensional drawings)
- Output speeds $n_{m^*} \leq 100$ rpm ($F_{ax} = F_{ax100}$; $F_{rad} = F_{rad100}$; $M_k = M_{k100}$)

The following applies to output speeds n_{m^*} > 100 rpm:

$$F_{ax} = \frac{F_{ax100}}{\sqrt[3]{\frac{n_{m^*}}{100\ rpm}}} \qquad F_{rad} = \frac{F_{rad100}}{\sqrt[3]{\frac{n_{m^*}}{100\ rpm}}} \qquad M_k = \frac{M_{k100}}{\sqrt[3]{\frac{n_{m^*}}{100\ rpm}}}$$

The following applies to other force application points:

$$M_{k^*} = \frac{2 \cdot F_{ax^*} \cdot y_2 + F_{rad^*} \cdot (x_2 + z_2)}{1000} \leq M_{k100}$$

$$F_{rad^*} \leq F_{rad100}$$

$$F_{ax^*} \leq F_{ax100}$$

For applications with multiple axial and/or radial forces, you must add the forces as vectors.

9.9.6 Torque/speed curves

Torque/speed curves depend on the nominal speed and/or winding design of the motor and the DC link voltage of the drive controller that is used. The following torque/speed curves apply to the DC link voltage DC 540 V.

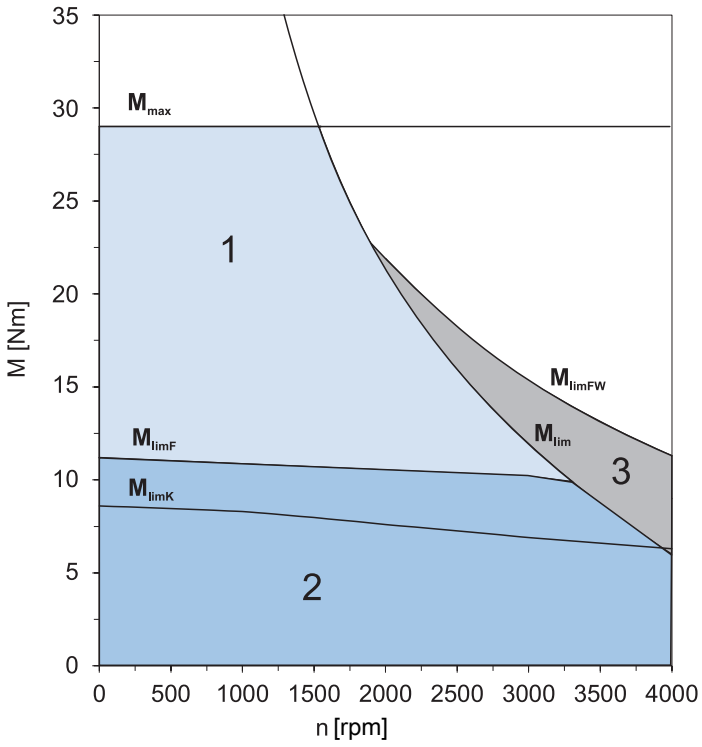
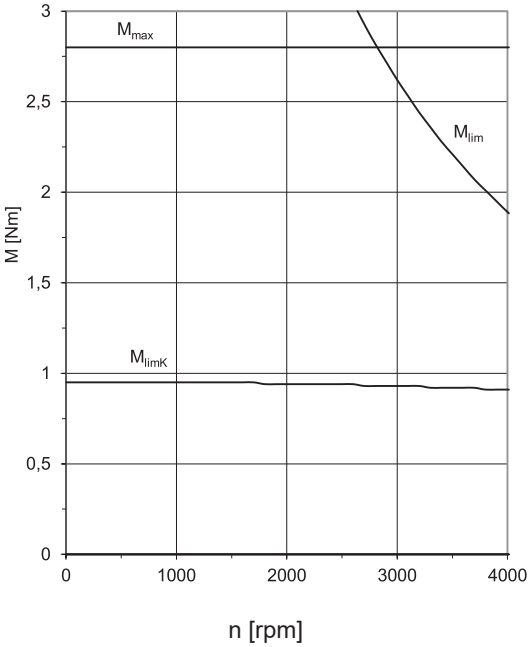


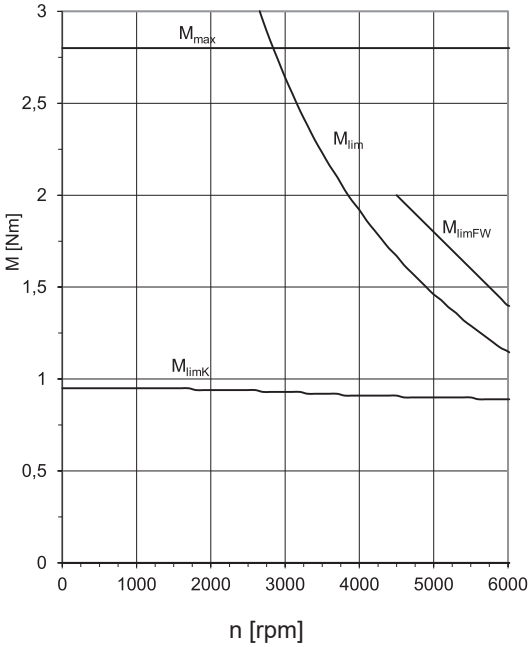
Fig. 10: Explanation of a torque/speed curve

1	Torque range for brief operation (ED_{10} < 100%) with $\Delta\vartheta$ = 100 K	2	Torque range for continuous operation with constant load (S1 mode, ED_{10} = 100%) with $\Delta\vartheta$ = 100 K
3	Field weakening range (can be used only with operation on Pilz drive controllers)		

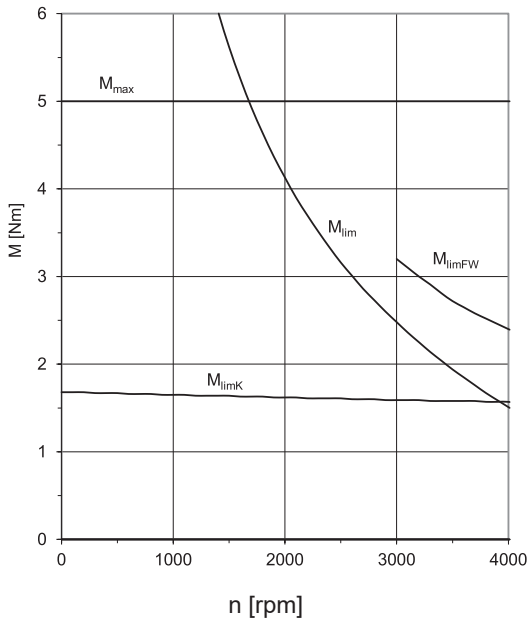
EZ301 (n_N=3000 rpm)



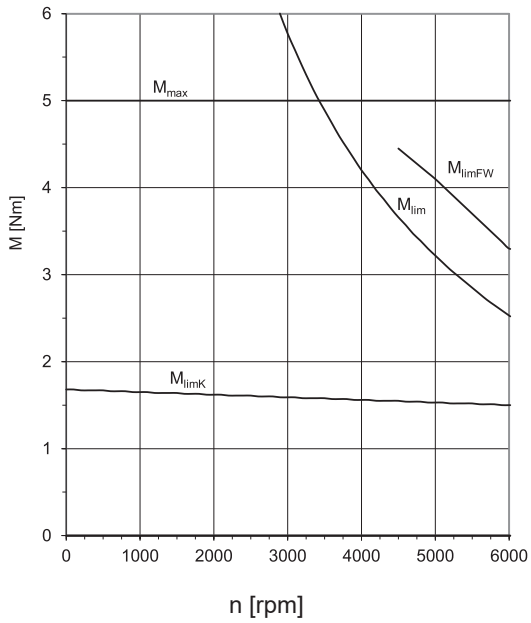
EZ301 (n_N=6000 rpm)



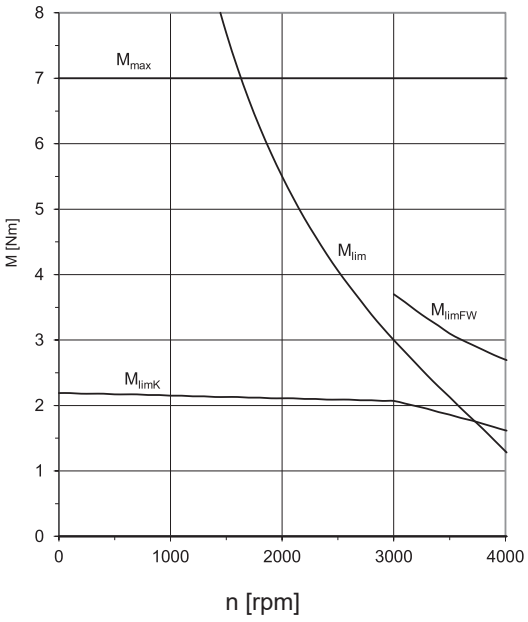
EZ302 (n_N=3000 rpm)



EZ302 (n_N=6000 rpm)



EZ303 (n_N=3000 rpm)



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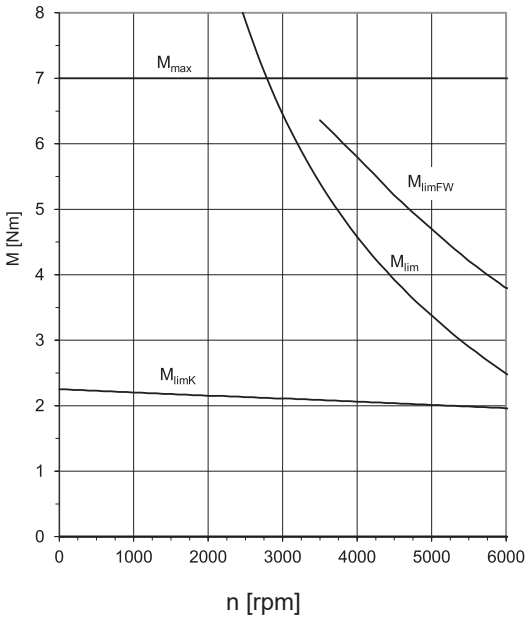

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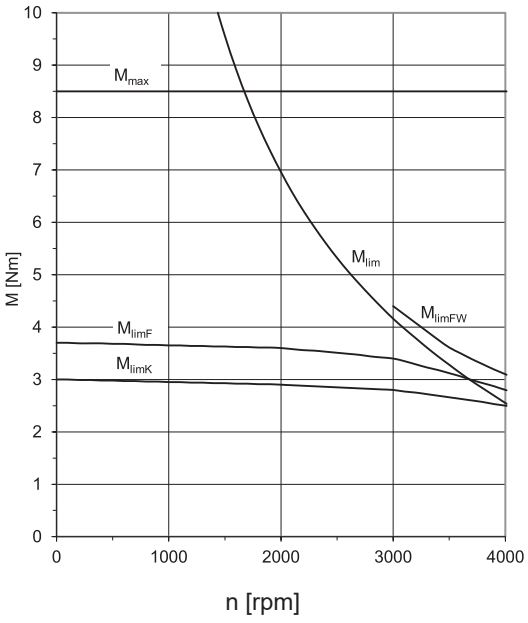

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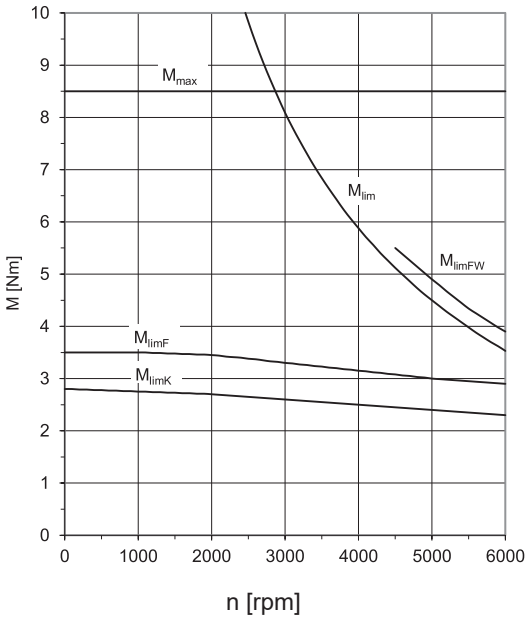

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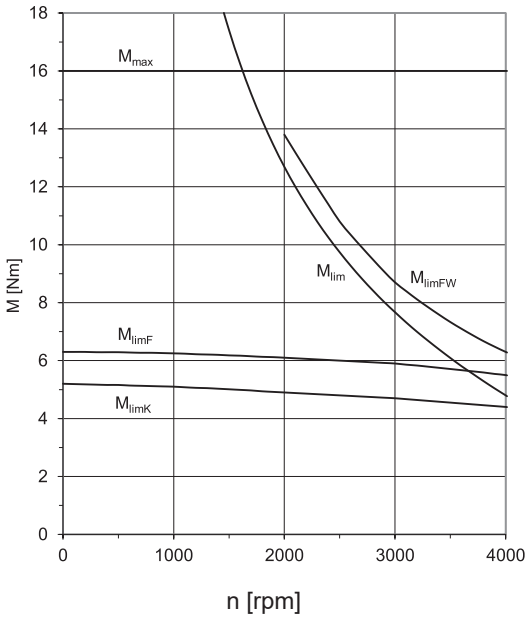

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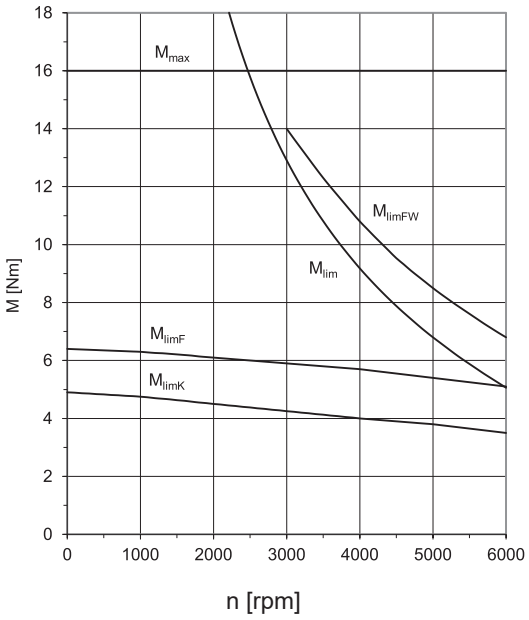

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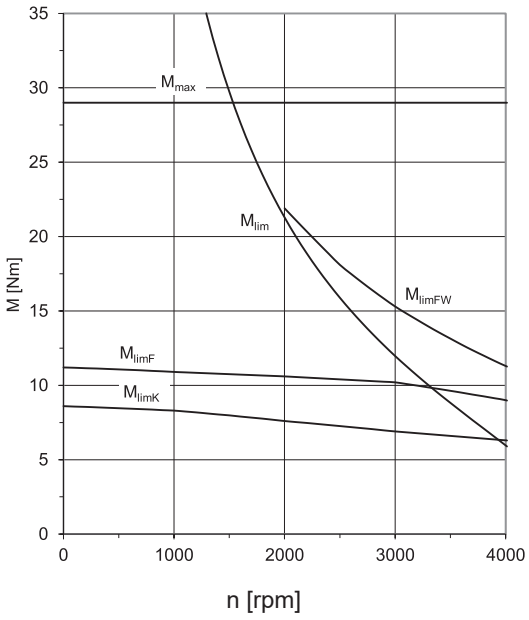

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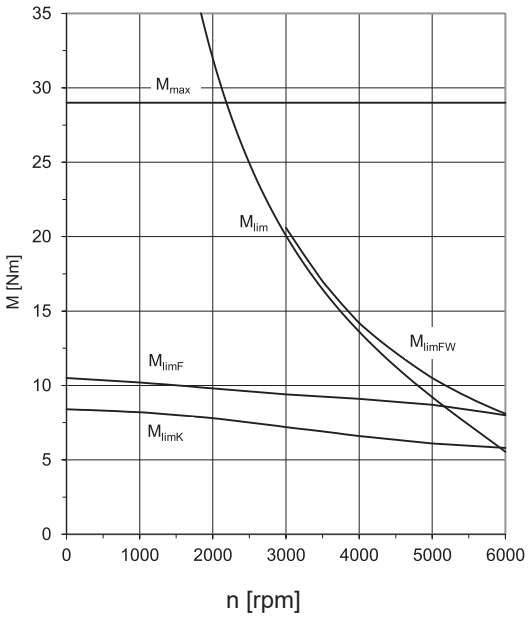

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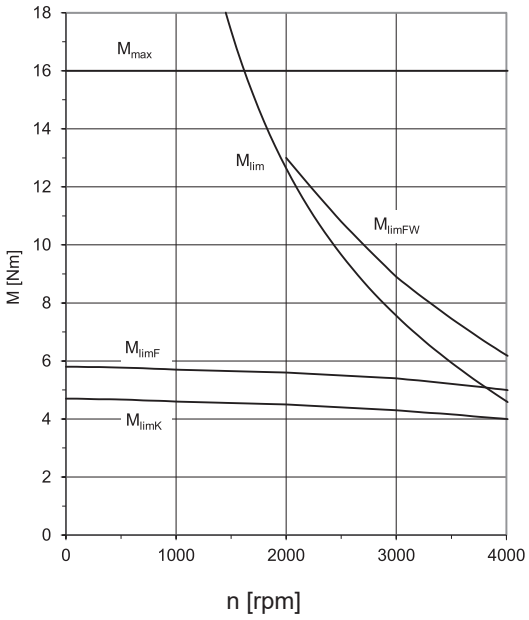

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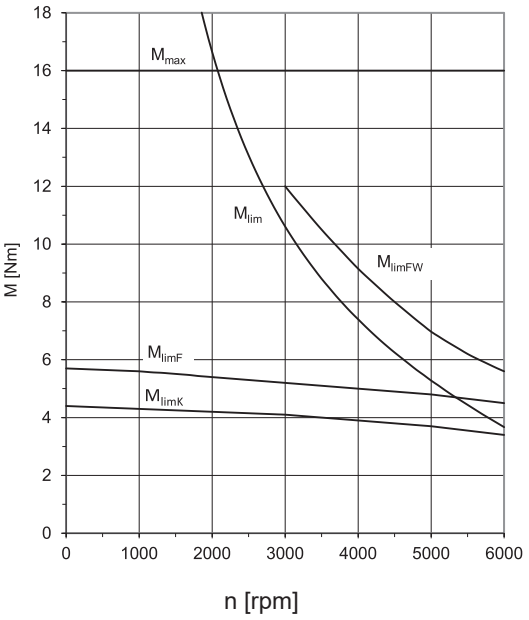

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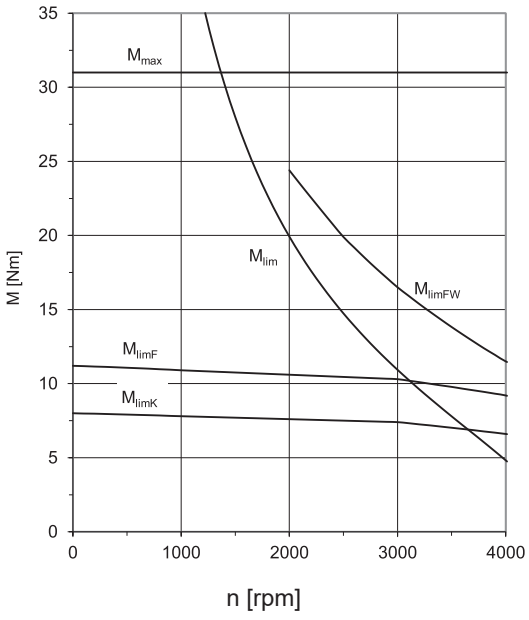

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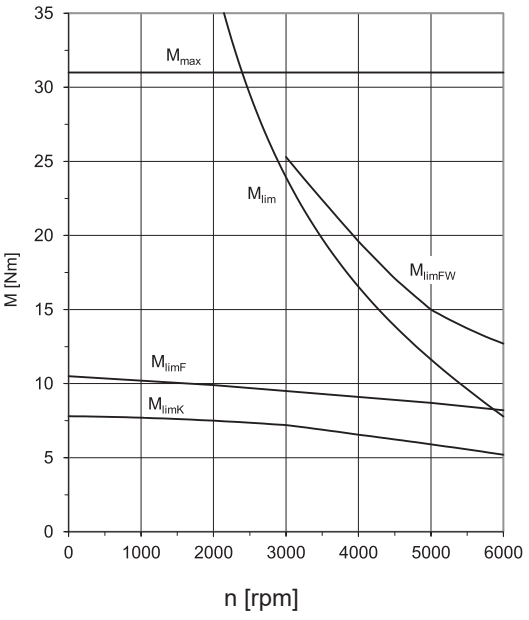

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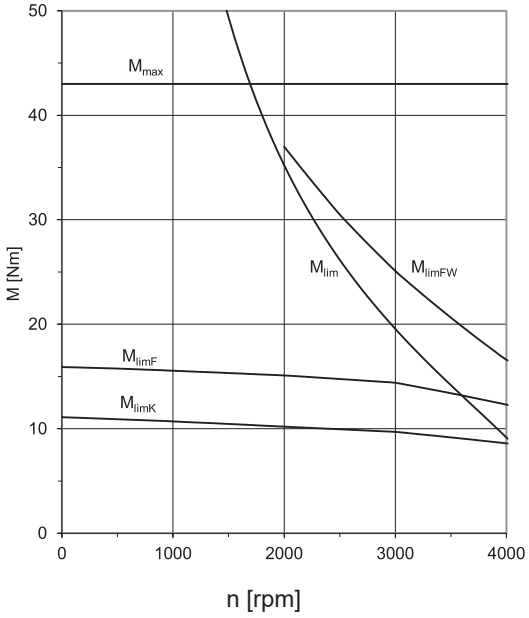

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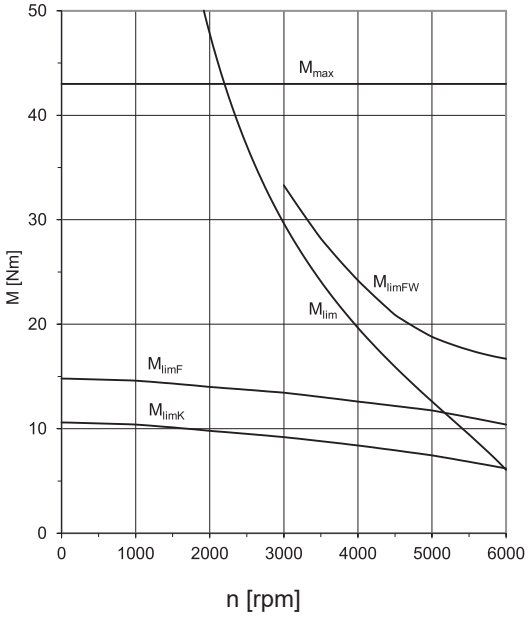

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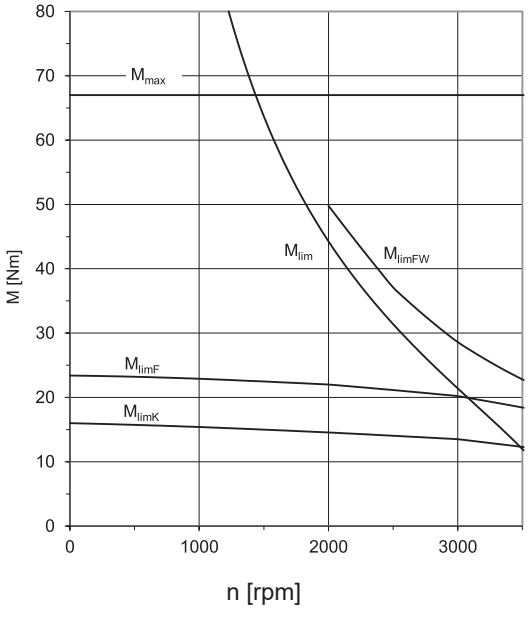

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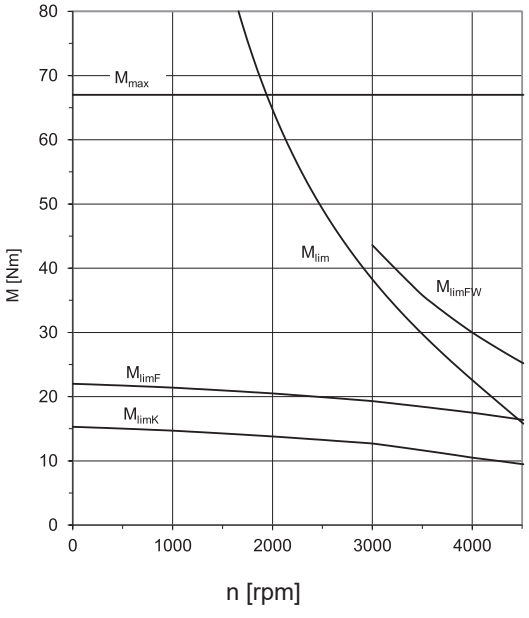

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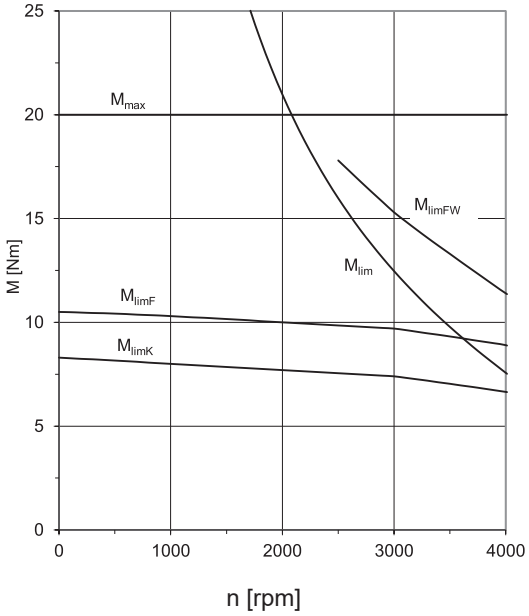

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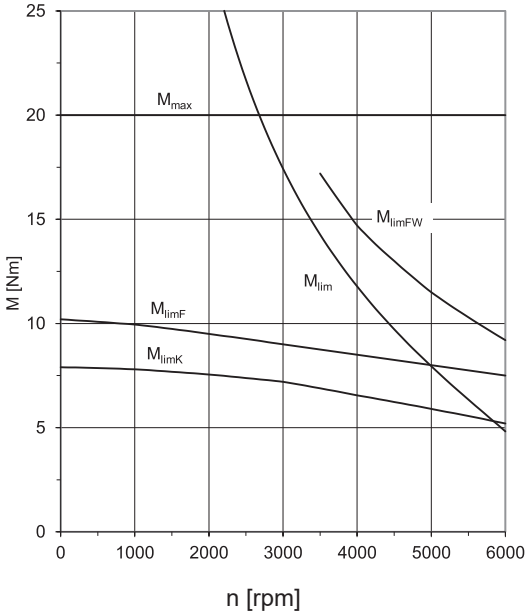

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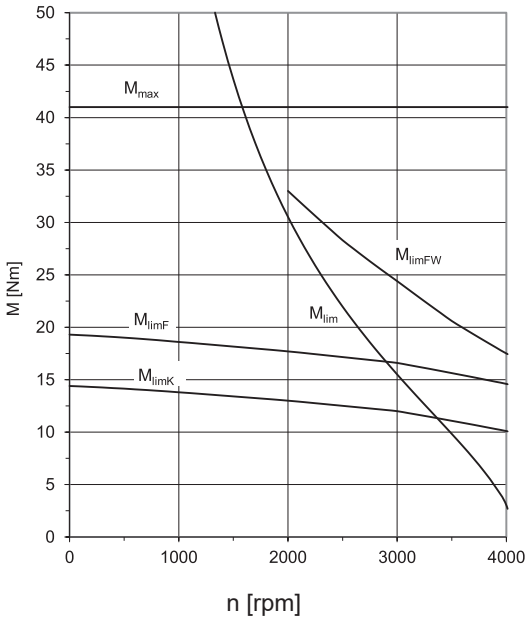

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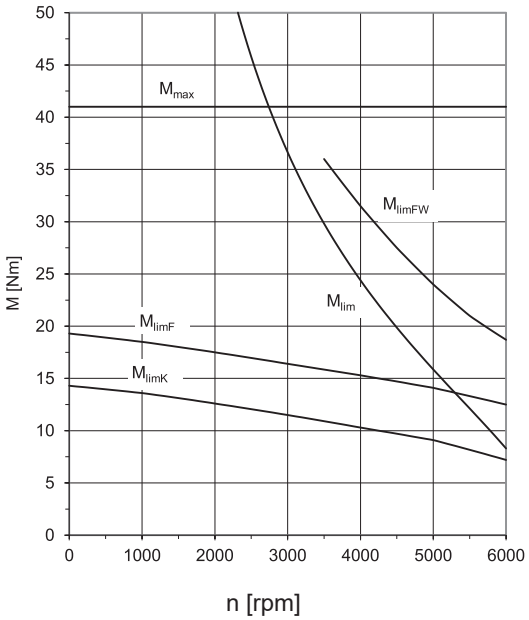

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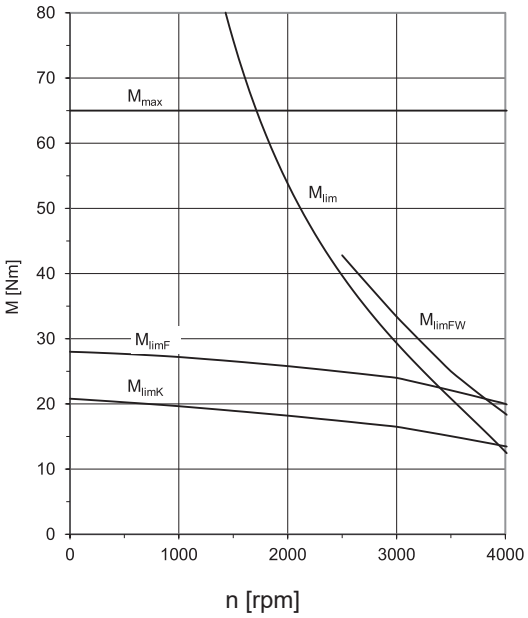

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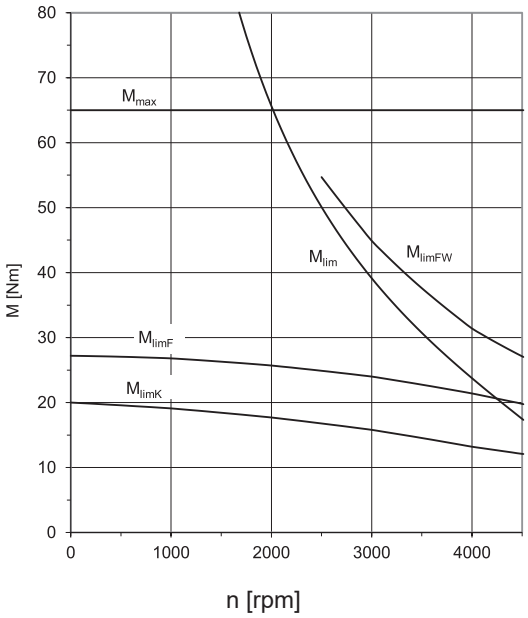

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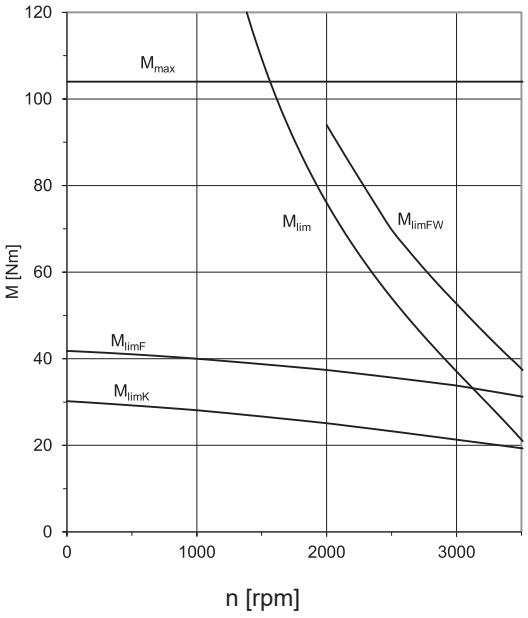

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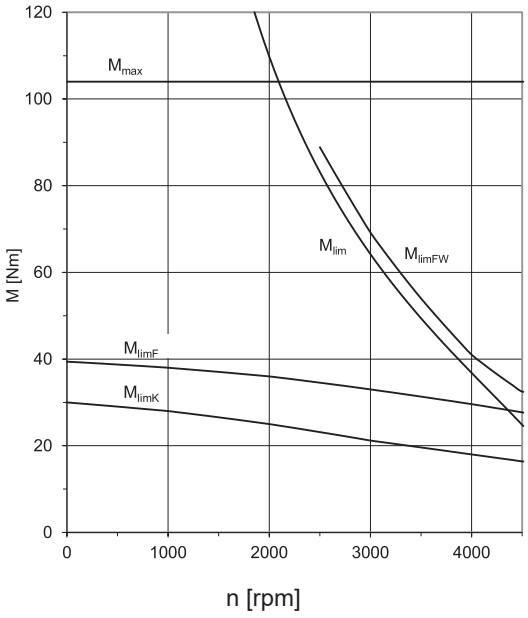

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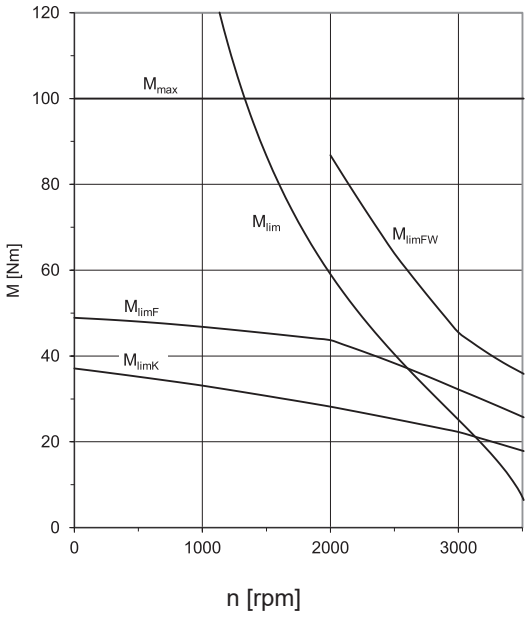

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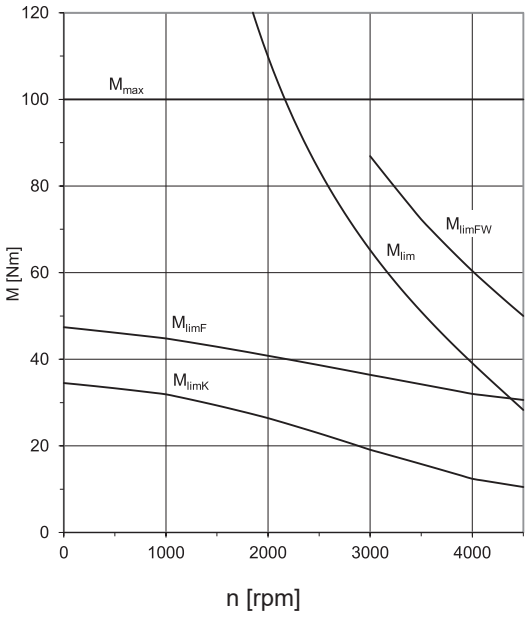

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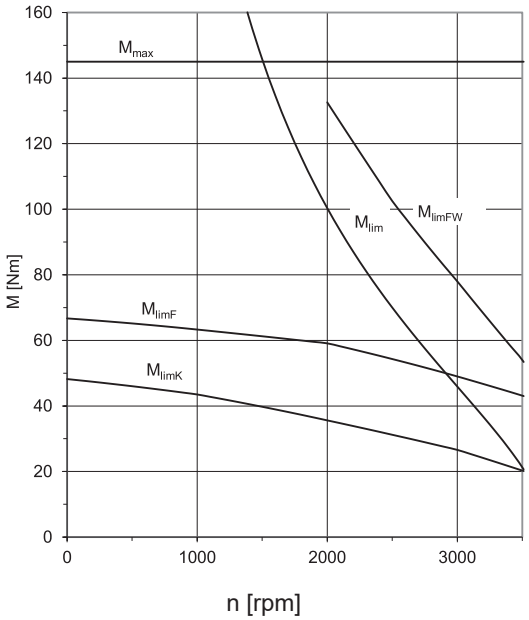
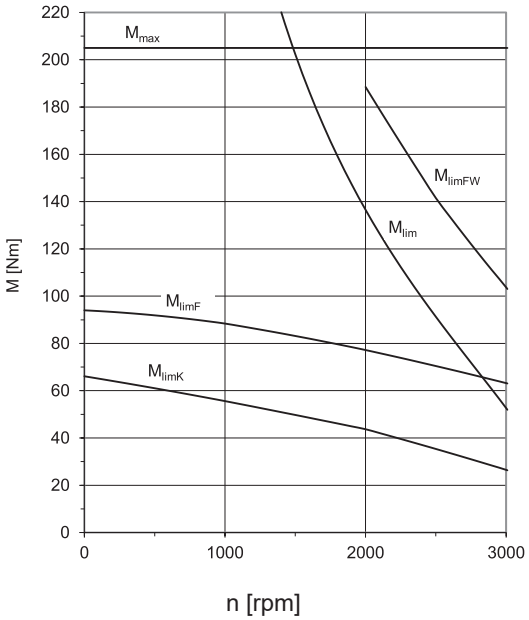


EZ805 (n_N=2000 rpm)



9.9.7 Key safety-related figures

Safety figures – Encoder

The safety figures apply to the intended use of the encoder. This includes failsafe attachment, use of suitable cables and evaluation of failsafe frames. You can find all necessary information about the intended use in the documentation of the encoder manufacturer.

Type	PFH_D [h^{-1}]
EnDat 2.2 single-turn, inductive (ECI 1118-G2)	—
EnDat 2.2 single-turn, optical (ECN 1123)	≤ 15×10^{-9}
EnDat 2.2 multi-turn, inductive (EQI 1131)	SIL 2: ≤ 15×10^{-9} SIL 3: ≤ 2×10^{-9}
EnDat 2.2 multi-turn, optical (EQN 1135)	≤ 15×10^{-9}

Safety figures – Brake

Type	B_{10D}
Permanent magnet holding brake	20 million operations

10 Appendix

10.1 Abbreviations

Abbreviation	Meaning
CSA	Canadian Standards Association
DC	Direct Current
DGUV	Deutsche Gesetzliche Unfallversicherung (en.: German Social Accident Insurance organization)
DIN EN	German acceptance of a European standard
DIN IEC	German standard based on the International Electrotechnical Commission
EMC	Electromagnetic Compatibility
FKM	Fluororubber
IEC	International Electrotechnical Commission
IP	International Protection
MTTP, $MTTF_D$	Mean Time To (dangerous) Failure
PE	Protective Earth (i.e. grounding conductor)
PFH, PFH_D	Probability of a (dangerous) Failure per Hour
UL	Underwriters Laboratories

10.2 Formula symbols

Symbol	Unit	Explanation
ΔJ_B	$kgcm^2$	Additive mass moment of inertia of a motor with brake
Δm_B	kg	Additive weight of a motor with brake
$\Delta\vartheta$	K	Temperature difference
B_{10D}	–	Number of cycles until 10% of components have failed dangerously
ED_{10}	%	Duty cycle based on 10 minutes
F_{ax100}	N	Permitted axial force on the output for $n_{m^*} \leq 100$ rpm
F_{rad}	N	Permitted radial force on the output
F_{rad100}	N	Permitted radial force on the output for $n_{m^*} \leq 100$ rpm
H	m	Installation altitude above sea level
I_0	A	Stall current
I_{max}	A	Maximum current
I_N	A	Nominal current
$I_{N,B}$	A	Nominal current of the brake at 20 °C
$I_{N,F}$	A	Nominal current of the forced ventilation unit
J	$kgcm^2$	Mass moment of inertia
J_{Bstop}	$kgcm^2$	Reference mass moment of inertia when braking from full speed: $J_{Bstop} = J \times 2$

Symbol	Unit	Explanation
J_{dyn}	$kgcm^2$	Mass moment of inertia of a motor in dynamic operation
J_{tot}	$kgcm^2$	Total mass moment of inertia (based on the motor shaft)
K_{EM}	V/1000 rpm	Voltage constant: Peak value of the induced motor voltage at a speed of 1000 rpm and a winding temperature $\Delta\vartheta$ = 100 K (tolerance ±10%)
K_H	–	Derating factor for installation altitude
$K_{M,N}$	Nm/A	Torque constant: ratio of the nominal torque M_N to the nominal current I_N; $K_{M,N} = M_N / I_N$ (tolerance ±10%)
K_{M0}	Nm/A	Torque constant: ratio of the stall torque and frictional torque to the stall current; $K_{M0} = (M_0 + M_R) / I_0$ (tolerance ±10%)
K_ϑ	–	Derating factor for surrounding temperature
$L_{pA,F}$	dBA	Noise level of the forced ventilation unit in the optimal operating range
L_{U-V}	mH	Winding inductance of a motor between two phases (determined in a resonant circuit)
M_0	Nm	Stall torque: The continuous torque the motor is able to deliver at a speed of 10 rpm (tolerance ±5%)
M_{Bdyn}	Nm	Dynamic braking torque at 100 °C (Tolerance +40%, −20%)
M_{Bstat}	Nm	Static braking torque at 100 °C (Tolerance +40%, −20%)
m_{dyn}	kg	Weight of a motor in dynamic operation
M_{eff}	Nm	Actual effective torque of the motor
m_F	kg	Weight of the forced ventilation unit
M_k	Nm	Permitted tilting torque on the output
M_{k100}	Nm	Permitted tilting torque on the output for $n_{m*} \leq 100$ rpm
M_L	Nm	Load torque
M_{max}	Nm	Maximum torque: the maximum permitted torque the motor is able to deliver over a short period (when accelerating or decelerating) (tolerance ±10%)
M_N	Nm	Nominal torque: the maximum torque of a motor in S1 mode at nominal speed n_N (tolerance ±5%)
M_{Nred}	Nm	Reduced nominal torque of the motor
M_R	Nm	Frictional torque (of the bearings and seals) of a motor at winding temperature $\Delta\vartheta$ = 100 K
n	rpm	Speed
N_{Bstop}	–	Permitted number of braking processes from full speed (n = 3000 rpm) with J_{Bstop} (M_L = 0). The following applies if the values of n and J_{Bstop} differ: $N_{Bstop} = W_{B,Rlim} / W_{B,R/B}$.
n_m	rpm	Actual average motor speed
n_{mot}	rpm	Speed of the motor
n_N	rpm	Nominal speed: The speed for which the nominal torque M_N is specified
P_N	kW	Nominal power: the power the motor is able to deliver long term in S1 mode at the nominal point (tolerance ±5 %)
$P_{N,F}$	W	Nominal output of the forced ventilation unit
PFH_D	1/h	Average probability of a dangerous failure per hour
q_{vF}	m^3/h	Delivery capacity of the forced ventilation unit in open air

Symbol	Unit	Explanation
R_{U-V}	Ω	Winding resistance of a motor between two phases at a winding temperature of 20 °C
t_{1B}	ms	Linking time: time from when the current is turned off until the nominal braking torque is reached
t_{11B}	ms	Response delay: time from when the current is turned off until the torque increases
t_{2B}	ms	Disengagement time: time from when the current is turned on until the torque begins to drop
t_{dec}	ms	Stop time
T_{el}	ms	Electrical time constant: ratio of the winding inductance to the winding resistance of a motor: $T_{el} = L_{U-V} / R_{U-V}$
$\vartheta_{amb,max}$	°C	Maximum surrounding temperature
ϑ_{NAT}	°C	Nominal response temperature
$U_{N,B}$	V	Nominal voltage of brake
$U_{N,F}$	V	Nominal voltage of the forced ventilation unit
$W_{B,R/B}$	J	Work done by friction for braking
$W_{B,Rlim}$	J	Work done by friction until wear limit is reached
$W_{B,Rmax/h}$	J	Maximum permitted work done by friction per hour with individual braking
x_2	mm	Distance of the shaft shoulder to the force application point
$x_{B,N}$	mm	Nominal air gap of brake
y_2	mm	Distance of the shaft axis to the axial force application point
z_2	mm	Distance of the shaft shoulder to the middle of the output bearing

10.3 Trademarks

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10.4 Marks and test symbols

Pilz synchronous servo motors have the following marks and test symbols:

CE mark: The product meets the requirements of EU directives.

cURus test symbol "Servo and Stepper Motors – Component"; registered under UL number E488992 with Underwriters Laboratories USA.

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Support

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