Configuration Manual 04/2006 Edition

simodrive

AC Induction Motors
1PH4

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SIMODRIVE 611

AC Induction Motors 1PH4

Configuration Manual

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04.2006 Edition

SIMODRIVE® documentation

Printing history

Brief details of this edition and previous editions are listed below.

The status of each edition is shown by the code in the "Remarks" column.

Status code in the "Remarks" column:

A .... New documentation.
B .... Unrevised reprint with new Order No.
C .... Revised edition with new status.

Edition	Order No.	Remarks
10/03	6SN1197-0AC64-0BP0	**A**
03/06	6SN1197-0AC64-0BP1	**C**
04/06	6SN1197-0AC64-0BP2	**C**

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Foreword

Information on the documentation

This document is part of the Technical Customer Documentation which has been developed for the SIMODRIVE drive converter system. All of the documents are available individually. The documentation list, which includes all Advertising Brochures, Catalogs, Overviews, Short Descriptions, Operating Instructions and Technical Descriptions with Order No., ordering address and price can be obtained from your local Siemens office.

This document does not purport to cover all details or variations in equipment, nor to provide for every possible contingency to be met in connection with installation, operation or maintenance.

We would also like to point out that the contents of this document are neither part of nor modify any prior or existing agreement, commitment or contractual relationship. The sales contract contains the entire obligations of Siemens. The warranty contained in the contract between the parties is the sole warranty of Siemens. Any statements contained herein neither create new warranties nor modify the existing warranty.

Structure of the documentation for 1PH and 1PL motors

The General Section and the individual motor series are separately available.

Title	Order No. (MLFB)	Language
AC Induction Motors, General Section	6SN1197–0AC62–0AP0	German
AC Induction Motors, 1PH2 Motor Section for SIMODRIVE	6SN1197–0AC63–0AP0	German
AC Induction Motors, 1PH4 Motor Section for SIMODRIVE	6SN1197–0AC64–0AP2	German
AC Induction Motors, 1PH7 Motor Section for SIMODRIVE	6SN1197–0AC65–0AP0	German
AC Induction Motors, 1PH7 Motor Section for SIMOVERT MASTERDRIVES VC/MC	6SN1197–0AC66–0AP0	German
AC Induction Motors, 1PL6 Motor Section for SIMOVERT MASTERDRIVES VC/MC	6SN1197–0AC67–0AP0	German

Target group of the Configuration Manual

The Configuration Manual addresses planners and design engineers. It supports you when selecting motors, calculating the drive components, selecting the required accessories as well as when selecting line and motor–side power options.

Commissioning software

Additional commissioning software is available to commission AC induction motors connected to the SIMODRIVE drive converter system.

Order No. [MLFB] for software	6SN1153–2AX10–□AB□5
Order No. [MLFB] for documentation	6SN1197–0AA30–0□B□

Technical Support

Should you have any questions about our products, then please contact the following hotline:

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Internet	http://www.siemens.com/automation/support–request		
E–mail	mailto:adsupport@siemens.com		

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Fax form: Please see the feedback form at the end of this document.

Internet address for products

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Correct usage

Please carefully note the following:
The equipment may only be used for applications described in the catalog or in the Configuration Manual, and only in combination with devices or components from other manufacturers which have been approved or recommended by Siemens.

The successful and safe operation of this equipment and motors is dependent on professional transport, storage, installation and mounting as well as careful operator control, service and maintenance.

Definition of qualified personnel

For the purpose of this document and product labels, a qualified person is a person who is familiar with the installation, mounting, start–up and operation of the equipment and hazards involved. He or she must have the following qualifications:

- Trained and authorized to energize/de–energize, circuits and equipment in accordance with established safety procedures.
- Trained in the proper care and use of protective equipment in accordance with established safety procedures.
- First aid training.

Explanation of symbols

The following danger and warning concept is used in this document:

Danger

This symbol is always used if death, severe personal injury or substantial material damage **will** result if proper precautions are not taken.

Warning

This symbol is always used if death, severe personal injury or substantial material damage **can** result if proper precautions are not taken.

Caution

This symbol is always used if minor personal injury or material damage **can** result if proper precautions are not taken.

Caution

The warning note (without a warning triangle) means that material damage **can** occur if proper precautions are not taken.

Notice

This warning note indicates that an undesirable result or an undesirable status **can** occur if the appropriate information is not observed.

Note

In this document, it can be advantageous to observe the information provided in a Note.

Danger and warning information

Danger

- Start–up/commissioning is absolutely prohibited until it has been completely ensured that the machine, in which the components described here are to be installed, is in full compliance with the specifications of Directive 98/37/EC.
- Only appropriately qualified personnel may commission SIMODRIVE units and AC motors.
- This personnel must carefully observe the technical customer documentation associated with this product and be knowledgeable about and carefully observe the danger and warning information.
- Operational electrical equipment and motors have parts and components which are at hazardous voltage levels.
- When the machine or system is operated, hazardous axis movements can occur.
- All of the work carried–out on the electrical machine or system must be carried–out with it in a no–voltage condition.
- SIMODRIVE drive units are generally designed for operation on low–ohmic, grounded line supplies (TN line supplies). For additional information please refer to the appropriate documentation for the drive converter systems.

Warning

- The successful and safe operation of this equipment and motors is dependent on professional transport, storage, installation and mounting as well as careful operator control, service and maintenance.
- For special versions of the drive units and motors, information and data in the catalogs and quotations additionally apply.
- In addition to the danger and warning information/instructions in the technical customer documentation supplied, the applicable domestic, local and plant–specific regulations and requirements must be carefully taken into account.

Caution

- The motors can have surface temperatures of over +80° C.
- This is the reason that temperature–sensitive components, e.g. cables or electronic components may neither be in contact nor be attached to the motor.
- When handling cables, please observe the following:
  - they may not be damaged,
  - they may not be stressed,
  - they cannot come into contact with rotating parts.

Caution

- Motors should be connected–up according to the circuit diagram provided. They must not be connected directly to the three–phase supply because this will damage them.
- SIMODRIVE drive units with AC motors are subject to a voltage test, in compliance with EN 50178 as part of a routine test. While the electrical equipment of industrial machines is being subject to a voltage test in accordance with EN60204–1, Section 19.4, all SIMODRIVE drive unit connections must be disconnected/withdrawn in order to avoid damaging the SIMODRIVE drive units.

Notes

- SIMODRIVE units with AC motors fulfill, when operational and in dry operating rooms, the Low–Voltage Directive 73/23/EEC.
- SIMODRIVE units with AC motors fulfill, in the configuration specified in the associated EC Declaration of Conformity, the EMC Directive 89/336/EEC.

ESDS information and instructions

Caution

Electro**S**tatic **D**ischarge **S**ensitive Devices (ESDS) are individual components, integrated circuits, or modules that can be damaged by electrostatic fields or discharges.

Handling ESDS boards:

- When handling components, make sure that personnel, workplaces, and packaging are well earthed.
- Personnel in ESDS areas with conductive flooring may only handle electronic components if:
  - They are grounded with an ESDS bracelet, and
  - They are wearing ESDS shoes or ESDS shoe grounding straps
- Electronic boards should only be touched if absolutely necessary.
- Electronic boards must not come into contact with plastics or items of clothing containing synthetic fibers.
- Boards must only be placed on conductive surfaces (work surfaces with ESDS surface, conductive ESDS foam, ESDS packing bag, ESDS transport container).
- Electronic boards may not be brought close to data terminals, monitors or television sets. (Minimum clearance >10 cm).
- Measurements must only be taken on boards when:
  - the measuring unit is grounded (e.g. via a protective conductor) or
  - when floating measuring equipment is used, the probe is briefly discharged before making measurements (e.g. a bare–metal control housing is touched).

Standards, regulations

The motors are developed and designed taking into account the relevant standards and regulations applicable at this time.
The appropriate standards and regulations are directly assigned the functional requirements.

Disposal

Motors must be disposed of carefully taking into account domestic and local regulations in the normal recycling process or by returning to the manufacturer.

The following must be taken into account when disposing of a machine:

- Oil should be disposed of according to the appropriate regulations for disposing of used oil (no mixing with solvents, cold cleaning agents or remains of paint)
- Components that are to be recycled should be separated according to:
  - Electronics to be disposed of (encoder electronics)
  - Iron to be recycled
  - Aluminum
  - Processed metal parts (gearwheels, motor windings)

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■

Space for your notes

Motor Description

1

1.1 Overview

Given the compact design of modern machines, the heat loss from electrical drives can have an adverse effect on the accuracy of machining. The consequential requirement for cold motors at high power densities led to the development of 1PH4 water–cooled motors.

Furthermore, a combination of high torque and small construction volume (low mass inertia) results in short acceleration and braking times and thus in a reduction in non–productive time.

1PH4 motors are robust, 4–pole squirrel–cage induction motors. Power loss and noise emission are reduced to a minimum. Thanks to the compact design of the motors, high maximum speeds can be achieved.

The motors are equipped with an encoder system for sensing the motor speed and indirect position. In machine tools, the encoder system is capable of C–axis operation as standard – that is, an additional encoder is not required for C–axis operation.

Fig. 1-1 1PH4 induction motor

Benefits

- High power density thanks to the small envelope dimensions
- Maximum speeds of up to 7500 rpm (optionally:12000 rpm)
- Full rated torque is continually available – even at standstill
- Cooled flange to prevent thermal stressing of the connected mechanical power train
- Low noise level
- High degree of protection (IP65, shaft exit IP55)
- High rotational accuracy

Fields of application

- All applications in which extreme ambient conditions, such as high temperatures, dust, dirt, or a corrosive atmosphere, do not permit air cooling
- In processes in which the environment must not be heated
- Fully encapsulated milling machines
- High–load milling spindles
- Counterspindles for lathes
- On special machines, when cooling water is an inherent process element

1.2 Technical features

Table 1-1 Standard motor version

Technical feature	Version
Motor type	Induction motor with squirrel–cage rotor
Type of construction (acc. to IEC 60034–7)	IM B35, IM V15, IM V36
Degree of protection (acc. to IEC 60034–5)	IP 65 (shaft exit, IP 55)
Cooling	Water cooling (≤ 30 °C, otherwise, power–de–rating)
Thermal motor protection (acc. to IEC 60034–6)	KTY 84 temperature sensor in stator winding
Winding insulation (acc. to IEC 60034)	Temperature class F for a coolant temperature of +30 °C
Motor voltage	Maximum: 3–ph. 430 V AC
Motor noise (acc. to DIN 45635) tolerance +3 dB	up to SH 132: max. 69 dB (A) SH 160: max. 71 dB (A)
Speed range	> 1: 500 000
Terminal box arrangement	top
Connection type	Motor: via the terminal box encoder: via the signal connector
Encoder system	Integrated optical encoders • Speed sensing • Indirect position sensing (incremental)
Balancing	Standard: Full–key balancing (dynamic) (acc. to DIN ISO 8821)
Shaft end	Cylindrical (acc. to DIN 748, Part 3); with keyway and key (acc. to DIN 6885); solid shaft up to SH 132: Tolerance field k6 SH 160: Tolerance field m6
Bearing version (DE)	Duplex bearing[1)] (deep–groove ball bearing and roller bearing)
Flange adapter, smooth running characteristics	Tolerance N (acc. to DIN 42 955)
Vibration severity (acc. to IEC 60034–14)	Grade R
Paint finish	Anthracite

1) not suitable for coupling operation; minimum cantilever force required.

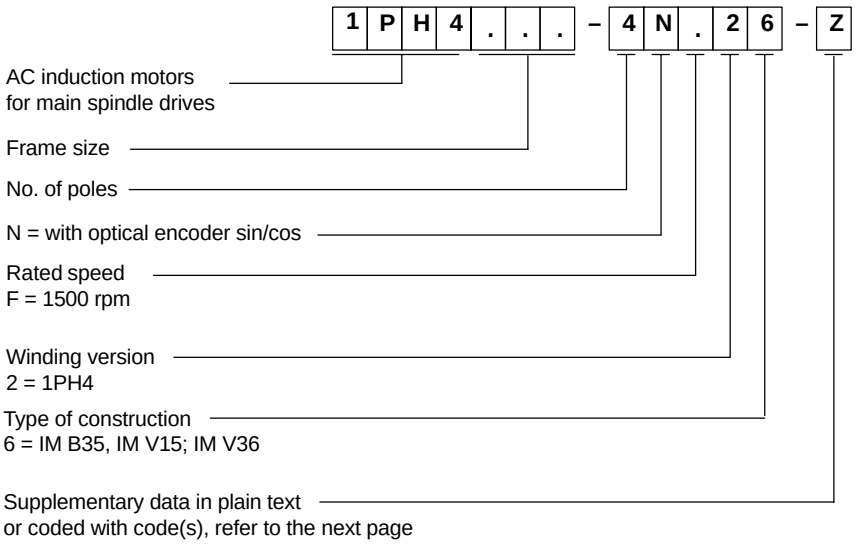
1.3 Technical design, options

Table 1-2 Options

Technical feature	Version
Terminal box arrangement	Terminal box mounted left or right
Balancing	Half–key balancing (dynamic) (acc. to DIN ISO 8821) Marking: ”H” at the shaft face
Shaft end	Cylindrical; without keyway and without key (acc. to DIN 748, Part 3); solid shaft Tolerance field k6 (to SH 132) Tolerance field m6 (to SH 160)
Bearing version (DE)	Single bearing for coupling output or planetary gear mounting; bearing design for increased speeds
Flange adapter, smooth running characteristics	Tolerance R (acc. to DIN 42 955)
Vibration severity (acc. to IEC 60034–14)	Grade S (single/duplex bearing) Grade SR for SH 100 to 160 (single bearing)
Mounted/integrated components	• Selector gearbox • Holding brake
Rating plate	2nd rating plate, supplied loose

1.4 Order designation

Motor type, design features and additional data are coded in the order designation.



Additional data for options

Option	Short designation
Terminal box arrangement (when viewing the DE)	
• On right side	**K09**
• On left side	**K10**
• Small terminal box and signal connector connection turned through 90° (cable entry from DE)	**K83**
• Small terminal box and signal connector connection turned through 90° (cable entry from NDE)	**K84**
• Small terminal box and signal connector connection turned through 180°	**K85**
Bearing version on DE	
• Single bearing for coupling or planetary gear units or low to moderate cantilever forces	**K00**
• Single bearing for increased speeds	**L37**
• Rotary shaft seal, oil–tight	**K18**
Vibration severity (acc. to IEC 34–14, DIN VDE 0530, Part 14)	
• Grade S with duplex bearing	**K05** [1) 4)]
• Grade S with single bearing	**K02** [1) 4)]
• Grade SR with single bearing	**K03** [1) 4)]
Shaft and flange accuracy (acc. to DIN 42955)	
• Tolerance R	**K04** [2)]
DE shaft end	
• NDE shaft end (without keyway)	**K42**
Balancing	
• Half–key balancing	**L69**
Gearbox [5)]	
• Motor prepared for mounting a ZF selector gearbox 2LG43	**K00** [3)]
Holding brake	
• Motor with mounted holding brake (DE)	**G46** [4)]
Miscellaneous	
• 2nd rating plate, supplied loose	**K31**
• No encoder system	**H30**

1) Automatically includes version K04.

2) Increased shaft accuracy

3) For gearboxes 2LG42 (old version), use G97+K00; G97;
G97 = non–standard cylindrical shaft end for SH 100, SE ∅ 28 x 60 mm

4) Cannot be combined with gearbox mounting

5) There must be a seal between motor flange and gearbox flange at SH 132 and SH160 due to the uninterrupted centering shoulder with sealing compound (e.g. Terostat 93, Teroson).

1.5 Rating plate data

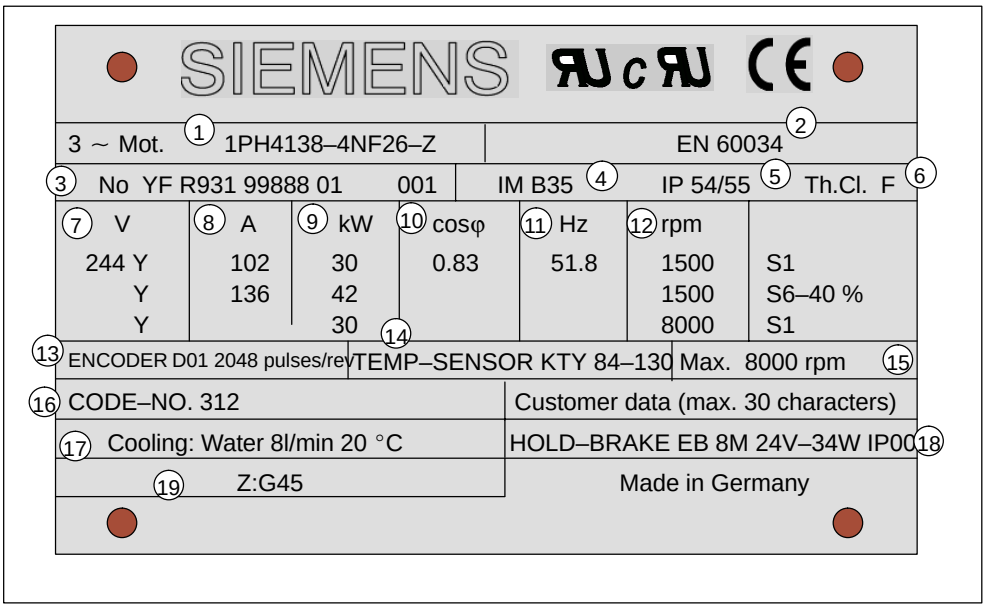


Fig. 1-2 Rating plate (example for 1PH4138), see table 1-3 for description

Table 1-3 Description of the rating plate data

Item	Description/technical data
1	AC induction motor, MLFB No.
2	Standards and regulations
3	Serial number
4	Type of construction
5	Degree of protection
6	Temperature class
7	Rated voltage [V] and winding configuration
8	Rated current [A]
9	Rated output [kW]
10	Power factor [cosφ]
11	Rated frequency [Hz]
12	Rated speed [rpm]
13	Designation of the encoder type
14	Temperature sensor marking
15	Maximum speed [rpm]
16	Code No. for SIMODRIVE 611 drive converter
17	Information on cooling; coolant, flow rate
18	Holding brake marking
19	Additional options

1.6 Cooling

The IPH4 series is water–cooled to achieve a high power density.

The cooling duct geometry is designed so that the stator power losses and part of the rotor losses are dissipated. The geometry is identical for all built–in motors.

Liquid cooling with a cooling system is required for operation.

Coolants

Water or low viscosity oils can be used as coolants.

If water is used as coolant, then the appropriate quantity of additives must be used for anti–corrosion protection and to slow down the growth of algae. The type and quantity of additive should be taken from the manufacturer's specifications for these additives (refer to table 1-4) and the particular ambient conditions.

Table 1-4 Manufacturers of chemical additives

Company	Address	Telephone/URL
Tyforop Chemie GmbH	Hellbrookstr. 5a, D–22305 Hamburg	URL: http://www.tyfo.de
Joh.A. Beckiser Wassertechnik GmbH	Bergstr. 17 D–40699 Erkrath	Tel.: +49 (0)2104 / 40075
CINCINNATI CIMCOOL Cincinnati Milacron b. v./ Cimcool Division	Postfach 98 NL–3031 AB Vlaardingen	Tel.: 003110 / 4600660
Fuchs Petrolub AG	Friesenheimer Strasse 17 D–68169 Mannheim	Tel.: +49 (0)621 / 3802–0 URL: http://www.fuchs–oil.com
Hebro Chemie GmbH	Rostocker Straße D–41199 Mönchengladbach	Tel.: +49 (0)2166 / 6009–0 URL: http://www.hebro–chemie.de
Hoechst	Refer to the Internet address	URL: http://www.hoechst.com
Houghton Lubricor GmbH	Werkstrasse 26 D–52076 Aachen	Tel.: +49 (0)2408 / 14060
Schilling–Chemie GmbH u. Produktions KG	Steinbeißstr. 20 D–71691 Freiberg	Tel.: +49 (0)7141 / 7030

Note

These recommendations involve third–party products which we know to be basically suitable. It goes without saying that similar products with the same quality from other manufacturers can also be used. Our recommendation should only be considered as such and not as a specification. We cannot accept any liability for the quality and properties/features of third–party products.

If, for example, Tyfocor (Tyforop Chemie GmbH) is used, then 75% water and 25% anti–corrosion agent should be used.

When using another coolant (e.g. oil), de–rating may be required so that the thermal motor limit is not exceeded.

To calculate the de–rating, the coolant must have the following properties:

- Specific gravity ρ [kgm^{-3}]
- Specific thermal capacity c_p [$Jkg^{-1}K^{-1}$]
- Kinematic viscosity ν [m^2/s]

Note

The motor power still does not have to be reduced for oil – water mixtures with less than 10 %. The coolant must be pre–cleaned or filtered in order to prevent the cooling circuit from becoming blocked.

For water–cooled motors, the cooling conditions (intake temperature, water flow rate, cooling power) must be maintained. If required, the coolant should be cleaned using a filter before it enters the motor cooling circuit.

Maximum permissible particle size after filtering: 100 µm

Cooling capacities and cooling quantity

Table 1-5 Cooling capacity and cooling quantity

Type	Cooling water flow [l/min] ± 0.75	Cooling capacity [W]	Wiring	Max. permissible pressure [bar]
1PH4103	6	1900	G 1/4	7
1PH4105	6	2600	G 1/4	7
1PH4107	6	3000	G 1/4	7
1PH4133	8	2750	G 3/8	7
1PH4135	8	3500	G 3/8	7
1PH4137	8	4100	G 3/8	7
1PH4138	8	4500	G 3/8	7
1PH4163	10	4600	G 1/2	7
1PH4167	10	5400	G 1/2	7
1PH4168	10	6200	G 1/2	7

Coolant intake temperature

Recommendation: up to 30 °C

When the coolant temperature increases then the rated power P_N (see Table 1-6) decreases.

Table 1-6 Rated power depending on the cooling temperature

Coolant temperature [°C]	Rated power [%]
30	100
40	95
50	90
60	85

Cooling system

A cooling system (i.e. heat exchanger) must be used in order to guarantee a coolant intake temperature of 30 °C. It is possible to operate several motors from a single cooling system.

The cooling system is not part of the motor scope of supply. A list of addresses of cooling system manufacturers is provided in Catalog NC 60.

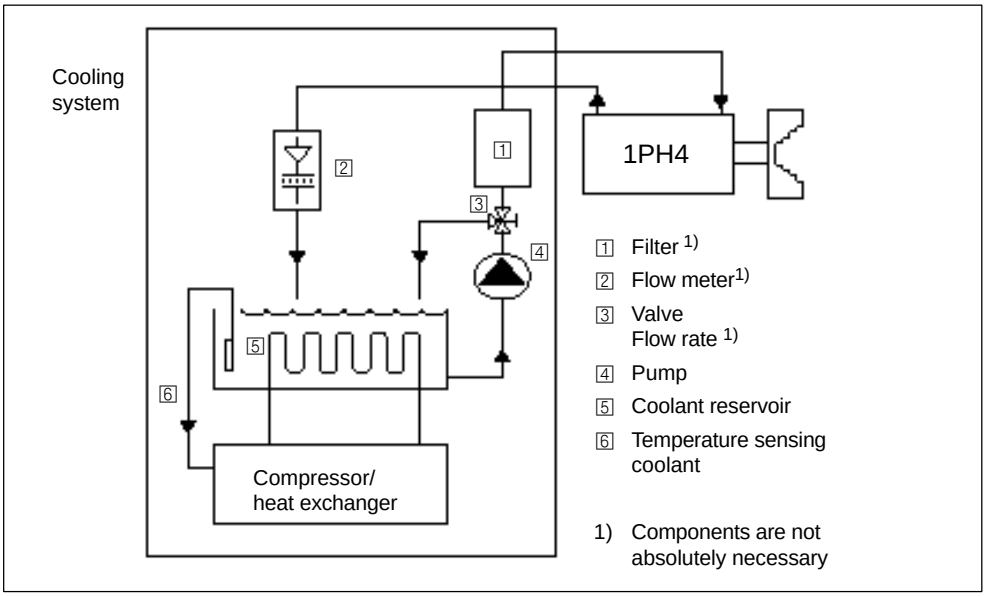


Fig. 1-3 Cooling circuit

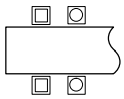
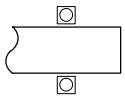
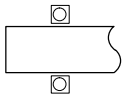
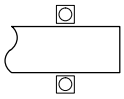
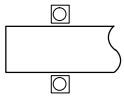
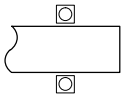
1.7 Bearing design

Standard

Duplex bearing on DE (deep–groove ball bearing and roller bearing).
The duplex bearing is not suitable for a coupling output.

Bearing versions

Table 1-7 Bearing versions

Use case	Bearings	Bearing version at the DE and NDE	
		DE	NDE
Belt drive • Minimum cantilever force required • for high cantilever forces	**Standard** duplex bearing		
Coupling output or planetary gear • Reduced cantilever forces permissible	**Option K00, (K02, K03)** single bearing		
Increased max. speed • Drive with no cantilever force required, e.g. coupling output	**Option L37** Single bearing "spindle bearing"		

Bearing change interval (t_{LW})

For single and duplex bearing, with coolant temperature +25 °C, bearing temperature +85 °C and horizontal mounting position.

Table 1-8 Bearing change interval for shaft heights 100, 132, and 160

Shaft height [mm]	Duplex bearing (standard)		Single bearing (K00)		Bearing for increased speed (L37)	
	Average operating speed n_m [rpm]	Average operating speed n_m [rpm]	Average operating speed n_m [rpm]	Average operating speed n_m [rpm]	Average operating speed n_m [rpm]	Average operating speed n_m [rpm]
100	$n_m < 2500$	$2500 < n_m < 6000$	$n_m < 4000$	$4000 < n_m < 7000$	$n_m \leq 8000$	$8000 < n_m < 12000$
132	$n_m < 2000$	$2000 < n_m < 5500$	$n_m < 3500$	$3500 < n_m < 6500$	$n_m \leq 6000$	$6000 < n_m < 10000$
160	$n_m < 1500$	$1500 < n_m < 4500$	$n_m < 3000$	$3000 < n_m < 5000$	$n_m \leq 5000$	$5000 < n_m < 8000$
t_{LW}[h]	16000	8000	20000	10000	16000	8000

Grease change interval

$0.8 \bullet t_{LW}$ (t_{LW} = bearing change interval)

Continuous operating speed

The max. permissible continuous operating speed n_{S1cont} depends on the bearings and the shaft height.

Table 1-9 Assignment, max. speed/continuous operating speed to shaft height and bearing design

SH [mm]	**Duplex bearing** [rpm]		**Single bearing** [rpm]		**Bearing for increased speed** [rpm]	
	n_{max} 1)	**n_{s1cont}**	**n_{max} 1)**	**n_{s1cont}**	**n_{max} 1)**	**n_{s1cont}**
100	7500	5600	9000	6500	12000	10000
132	6700	5200	8000	6000	10000	9250
160	5300	4000	6500	4500	8000	7000

Important

If the motor is operated at speeds between n_{s1cont} and n_{max}, a speed duty cycle with low speeds and standstill intervals is required in order to reliably guarantee that the grease is well–distributed in the bearings.

1) Mechanical limiting speed (permissible for 10 min. cycle with: 3 min n_{max}, 6 min 2/3 n_{max}, 1 min standstill)

1.8 Electrical connections

Connecting–up AC motors

Note

The motors can be fed from a DC link voltage of up to 700 V DC.

The type of the terminal box used, number of terminals, cross–sections that can be used, number of auxiliary terminals and cross–section for the PE connection are shown in the following tables.

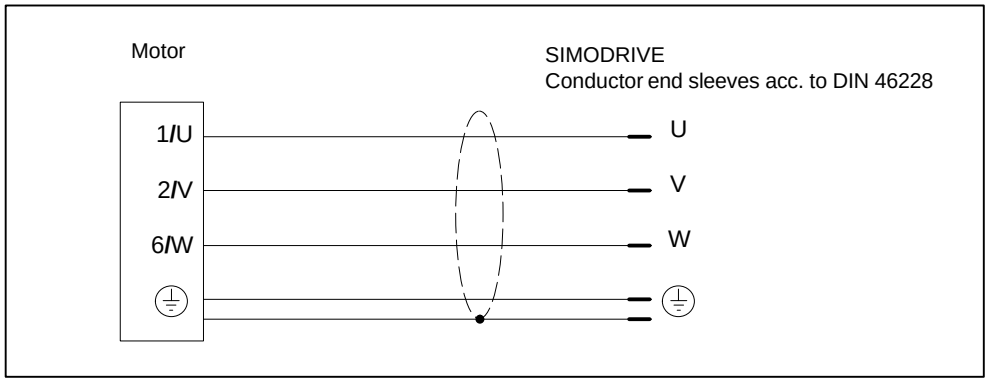
Table 1-10 Overview, connection system for 1PH4 motors

Motor type	Number of main terminals	Max. cross–section that can be connected	Terminal strip for temperature sensor	PE connection size/ cable lug width
SH 100	3xM5	16 mm^2	3 terminals	M4/9 mm
SH 132	3xM5	35 mm^2 with cable lug connection	3 terminals	M5/15 mm
SH 160	3xM10	70 mm^2 with cable lug connection	3 terminals	M6/15 mm

Caution

Carefully observe the current which the motor draws for your particular application! Adequately dimension the connecting cables according to IEC 60204–1.

Power cable



Note

The cables are available in a UL version or for higher mechanical requirements.

Technical data, refer to Catalog NC Z.

Connecting–up information

Note

The overall system compatibility is only guaranteed when using shielded power cables.

Shields must be incorporated in the protective grounding concept. Protective ground should be connected to conductors that are open–circuit and that are not being used and also electrical cables that can be touched. If the brake feeder cables in the SIEMENS cable accessories are not used, then the brake conductor cores and shields must be connected to the cabinet ground (open–circuit cables result in capacitive charges!).

Warning

- Before carrying out any work on the AC motor, please ensure that it is powered–down and the system is locked–out so that the motor cannot re–start!
- Please observe the rating plate data and circuit diagram in the terminal box.

- Twisted or three–core cables with additional ground conductor should be used as motor feeder cables. The insulation should be removed from the ends of the conductors so that the remaining insulation extends up to the cable lug or terminal.
- The connecting cables should be freely arranged in the terminal box so that the protective conductor has an overlength and the cable conductor insulation cannot be damaged. Connecting cables should be appropriately strain relieved.
- Please ensure that the following minimum air distances are maintained: Supply voltages up to 500 V: Minimum air distance 4.5 mm
- After connecting up, the following should be checked:
  - The inside of the terminal box must be clean and free of any cable pieces
  - All of the terminal screws must be tight
  - The minimum air distances must be maintained
  - The cable glands must be reliably sealed

– Unused cable glands must be closed and the plugs must be tightly screwed in place
– All of the sealing surfaces must be in a perfect condition

Press drives

Note

For press drives with acceleration rates > 2 g, special measures are required. Please contact your local Siemens office.

Cross–sections

When connecting cables to the terminal board, the connecting cables must be dimensioned corresponding to the rated current and the size of the cable lugs must match the dimensions of the terminal studs.

Table 1-11 Current load capability acc. to EN 60204–1 for PVC insulated cables with copper conductors for an ambient temperature of 40°C and routing type C (cables and conductors routed along walls/panels and in cable ducts).

I_{rms} at +40 °C [A]	Required cross–section [mm^2]	Comments
11.7	1	Correction factors with reference to the ambient temperature and routing type are specified in EN 60204–1.
15.2	1.5	
21	2.5	
28	4	
36	6	
50	10	
66	16	
84	25	
104	35	
123	50	
155	70	
192	95	
221	120	

1.9 Mounting

Mounting instructions

Warning

These motors are electrically operated. When electrical equipment is operated, certain parts of these motors are at hazardous voltage levels. If this motor is not correctly handled/operated, this can result in death or severe bodily injury as well as significant material damage. Please carefully observe the warning information in this section an on the product itself.

- Only **qualified personnel** may carry–out service or repair work on this motor.
- Before starting any work, the motor must be disconnected from the line supply and grounded.
- Only spare parts, certified by the manufacturer, may be used.
- The specified service/maintenance intervals and measures as well as the procedures for repair and replacement must be carefully maintained and observed.

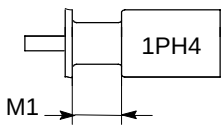
Warning

- When transporting the motors, use all of the hoisting lugs provided!
- All work should be undertaken with the system in a no–voltage condition!
- The motor should be connected up according to the circuit diagram provided.
- In the terminal box it must be ensure that the connecting cables are insulated with respect to the terminal board cover.
- After the motor has been installed, the brake (if one is used) must be checked to ensure that it is functioning perfectly!

Note

Flange mounting is only possible using studs and nuts. Clearance M1 for threading the nut between the motor flange and motor frame acc. to DIN 42677 (refer to Table 1-12).

Table 1-12 Flange mounting with studs and nuts

Shaft height	M1 [mm]	
100	44	
132	50	
160	65	

Cable outlet NDE

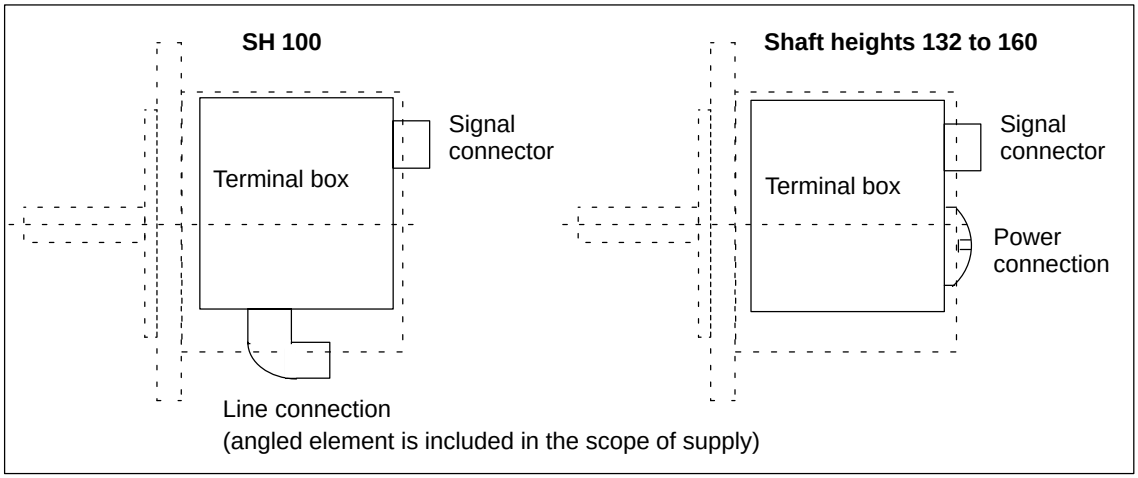


Fig. 1-4 Cable outlet

Mounting information and instructions

The following mounting instructions must be carefully observed:

- For high–speed machines, we recommend that the complete unit is dynamically balanced after couplings or belt pulleys have been mounted.
- Use suitable equipment when mounting drive elements. Use the thread at the shaft end.
- Do not apply any blows or axial pressure to the shaft end.
- Especially for high–speed motors with flange mounting, it is important that the mounting is stiff in order to locate any resonant frequency as high as possible so that it remains above the maximum rotational frequency.
- With flange mounting, the vibration quality of the drive unit can be negatively affected if the mounting is too flexible. For type of construction IM B35, an NDE foot mounting is required to maintain the vibration severity limit values.
- For 1PH4 motors, the screw hole cover plates for the foot mounting should be reattached after mounting the motor.

Caution

Liquid must be prevented from collecting in the flange, both in the vertical as well as horizontal mounting positions. This would have a negative impact on the bearing and bearing grease.

Natural frequency when mounted

The motor is a system which is capable of vibration at its natural frequency. For all 1PH motors, this resonant frequency lies above the specified maximum speed.

When the motor is mounted onto a machine tool, a new system capable of vibration is created with modified natural frequencies. These can lie within the motor speed range.

This can result in undesirable vibrations in the mechanical drive transmission.

Note

Motors must be carefully mounted on adequately stiff foundations or bedplates. Additional elasticities of the foundation/bedplates can result in resonance effects of the natural frequency at the operating speed and therefore result in inadmissibly high vibration values.

The magnitude of the natural frequency when the motor is mounted depends on various factors and can be influenced by the following points:

- Mechanical transmission elements (gearboxes, belts, couplings, pinions, etc.)
- Stiffness of the machine design to which the motor is mounted
- Stiffness of the motor in the area around the foot or customer flange
- Motor weight
- Machine weight and the weight of the mechanical system in the vicinity of the motor
- Damping properties of the motor and the machine tool
- Mounting type, mounting position (IM B5; IM B3; IM B35; IM V1; etc.)
- Motor weight distribution, i.e. length, shaft height

■

Technical Data and Characteristics

2

2.1 Technical data

Table 2-1 Technical data of the 1PH4 series

Motor type	Rated power P_N	Rated speed n_N	n_{max} 1) for duplex bearings (standard)	n_{max} 1) for single bearing (K00)	n_{max} 1) for increased speed (L37)	Rated torque M_N	Moment of inertia J	Rated current I_N	I_0	V_N
	[kW]	rpm]	[rpm]	[rpm]	[rpm]	[Nm]	[kgm^2]	[A]	[A]	[V]
Shaft height 100 mm										
1PH4103–4NF26	7.5	1500	7500	9000	12000	48	0.017	26	12	265
1PH4105–4NF26	11	1500	7500	9000	12000	70	0.024	38	16	263
1PH4107–4NF26	14	1500	7500	9000	12000	90	0.031	46	19	265
Shaft height 132 mm										
1PH4133–4NF26	15	1500	6700	8000	10000	95	0.046	55	17	229
1PH4135–4NF26	22	1500	6700	8000	10000	140	0.071	73	26	251
1PH4137–4NF26	27	1500	6700	8000	10000	170	0.085	85	31	265
1PH4138–4NF26	30	1500	6700	8000	10000	190	0.104	102	34	244
Shaft height 160 mm										
1PH4163–4NF26	37	1500	5300	6500	8000	235	0.17	107	44	286
1PH4167–4NF26	46	1500	5300	6500	8000	293	0.206	120	49	315
1PH4168–4NF26	52	1500	5300	6500	8000	331	0.22	148	59	284

1) Max. speed for S1 and S6 power, refer to P–n diagram; max. continuous operating speed, refer to Table 1-8

Table 2-2 Motor data and selecting converter module for various operating modes (acc. to EN 60034)

Motor type	Motor rated power [kW]			Motor rated current [A]			Converter module [A]		
	S1	S6–60%	S6–40%	S1	S6–60%	S6–40%	S1	S6–60%	S6–40%
Shaft height 100 mm									
1PH4103–4NF26	7.5	8.75	10	26	29	32	24/32 [1)]	24/32	24/32
1PH4105–4NF26	11	12.75	14.75	38	42	47	45/60	45/60	45/60
1PH4107–4NF26	14	16.25	18.75	46	52	58	45/60 [1)]	45/60	45/60
Shaft height 132 mm									
1PH4133–4NF26	15	18	21	55	65	74	60/80	60/80	60/80
1PH4135–4NF26	22	26.5	31	73	86	99	85/110	85/110	85/110
1PH4137–4NF26	27	32.5	38	85	100	114	85/110	85/110	85/110 [1)]
1PH4138–4NF26	30	36	42	102	119	136	120/150	120/150	120/150
Shaft height 160 mm									
1PH4163–4NF26	37	45	52.5	107	125	142	120/150	120/150	120/150
1PH4167–4NF26	46	55	65	120	138	158	120/150	120/150	120/150 [1)]
1PH4168–4NF26	52	62.5	73	148	173	197	200/250	200/250	200/250

1) Larger module may be required

2.2 P/n and M/n diagrams

AC motors for main spindle drives must be continually cooled in operation, independent of the operating mode/duty type.

The dotted lines in the diagrams indicate the power limit of the particular drive converter for the specified AC motor. The power module is specified.

The power values for a relative power–on duration of 25%, 40% and 60% are specified.

Table 2-3 Explanation of the codes used

Abbreviation	Units	Description
P_N	kW	Rated power
n_N	rpm	Rated speed
M_N	Nm	Rated torque
I_N	A	Rated current
n_{max}	rpm	Maximum speed
T_{th}	min	Thermal time constant
J	kgm^2	Moment of inertia
m	kg	Weight

Table 2-4 Main spindle AC motor 1PH4103–4NF2

P_N [kW]	n_N [rpm]	M_N [Nm]	I_N [A]	n_{max} [rpm]	T_{th} [min]	J [kgm^2]	m [kg]
7.5	1500	48	26	9000	6	0.017	52

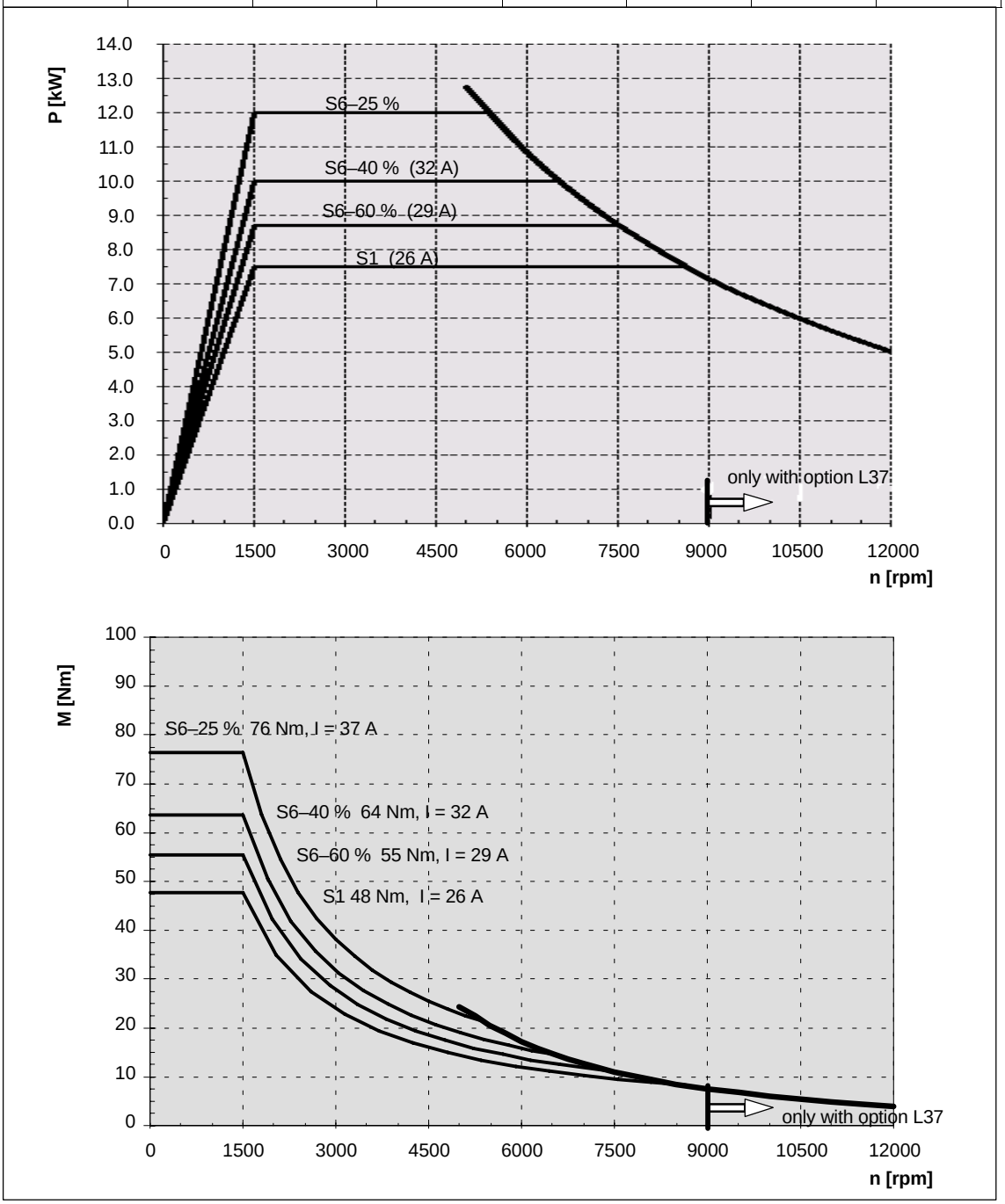


Fig. 2-1 1PH4103–4NF2

Table 2-5 Main spindle AC motor 1PH4105–4NF2

P_N [kW]	n_N [rpm]	M_N [Nm]	I_N [A]	n_{max} [rpm]	T_{th} [min]	J [kgm^2]	m [kg]
11	1500	70	38	9000	6	0.024	67

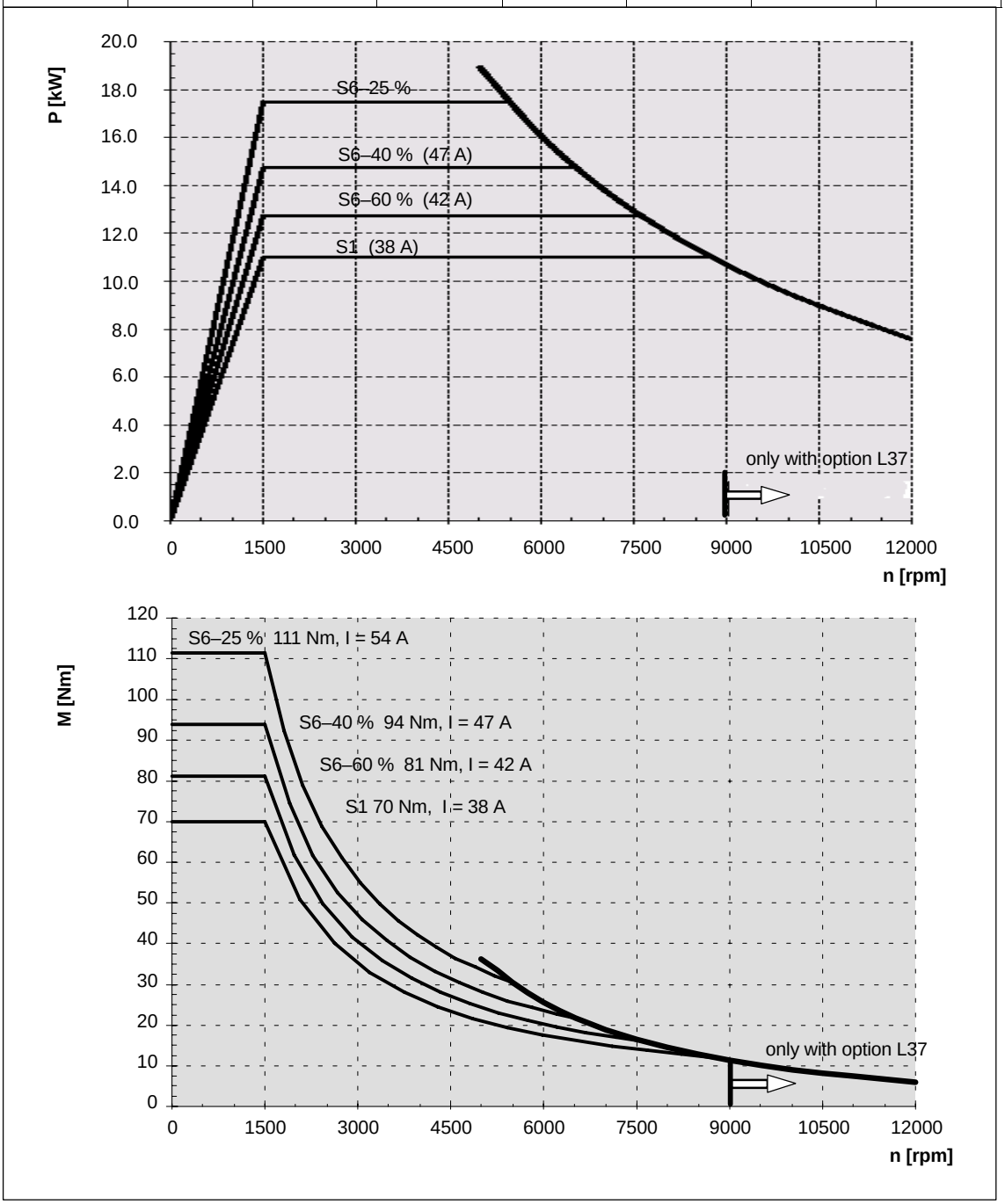


Fig. 2-2 1PH4105–4NF2

Table 2-6 Main spindle AC motor 1PH4107–4NF2

P_N [kW]	n_N [rpm]	M_N [Nm]	I_N [A]	n_{max} [rpm]	T_{th} [min]	J [kgm^2]	m [kg]
14	1500	90	46	9000	6	0.031	80

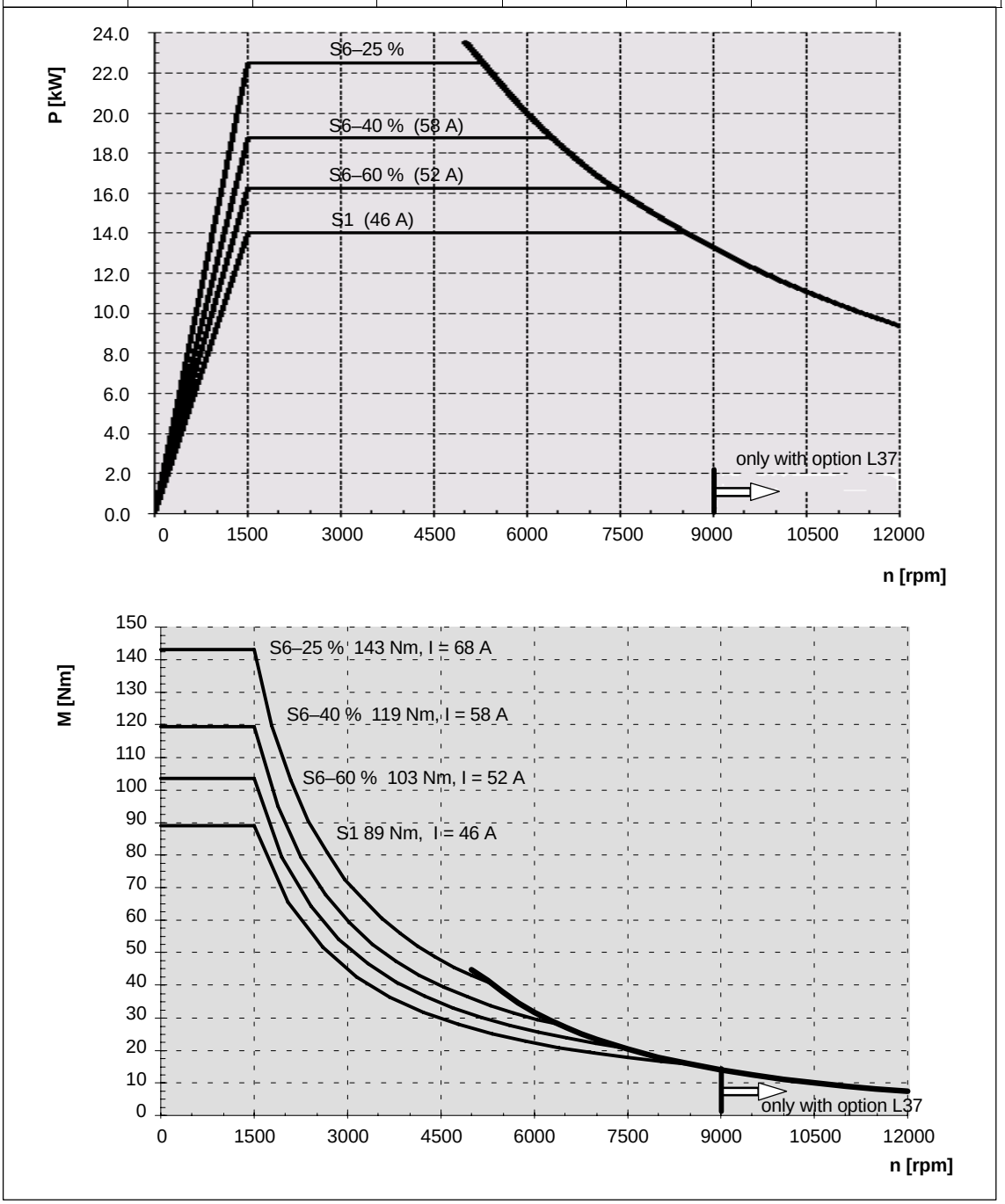


Fig. 2-3 1PH4107–4NF2

Table 2-7 Main spindle AC motor 1PH4133–4NF2

P_N [kW]	n_N [rpm]	M_N [Nm]	I_N [A]	n_{max} [rpm]	T_{th} [min]	J [kgm^2]	m [kg]
15	1500	95	55	8000	11	0.046	90

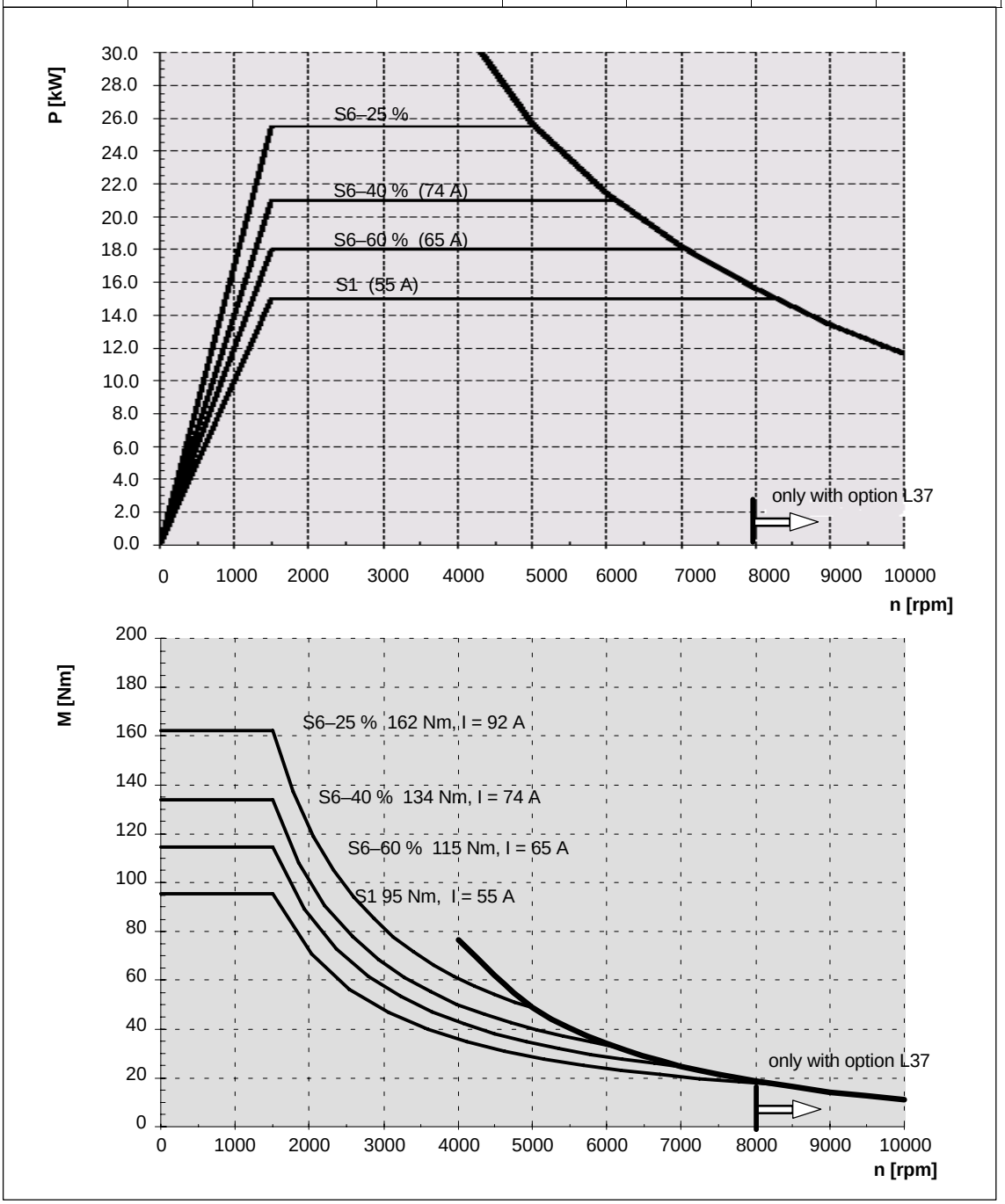


Fig. 2-4 1PH4133–4NF2

Table 2-8 Main spindle AC motor 1PH4135–4NF2

P_N [kW]	n_N [rpm]	M_N [Nm]	I_N [A]	n_{max} [rpm]	T_{th} [min]	J [kgm^2]	m [kg]
22	1500	140	73	8000	11	0.071	112

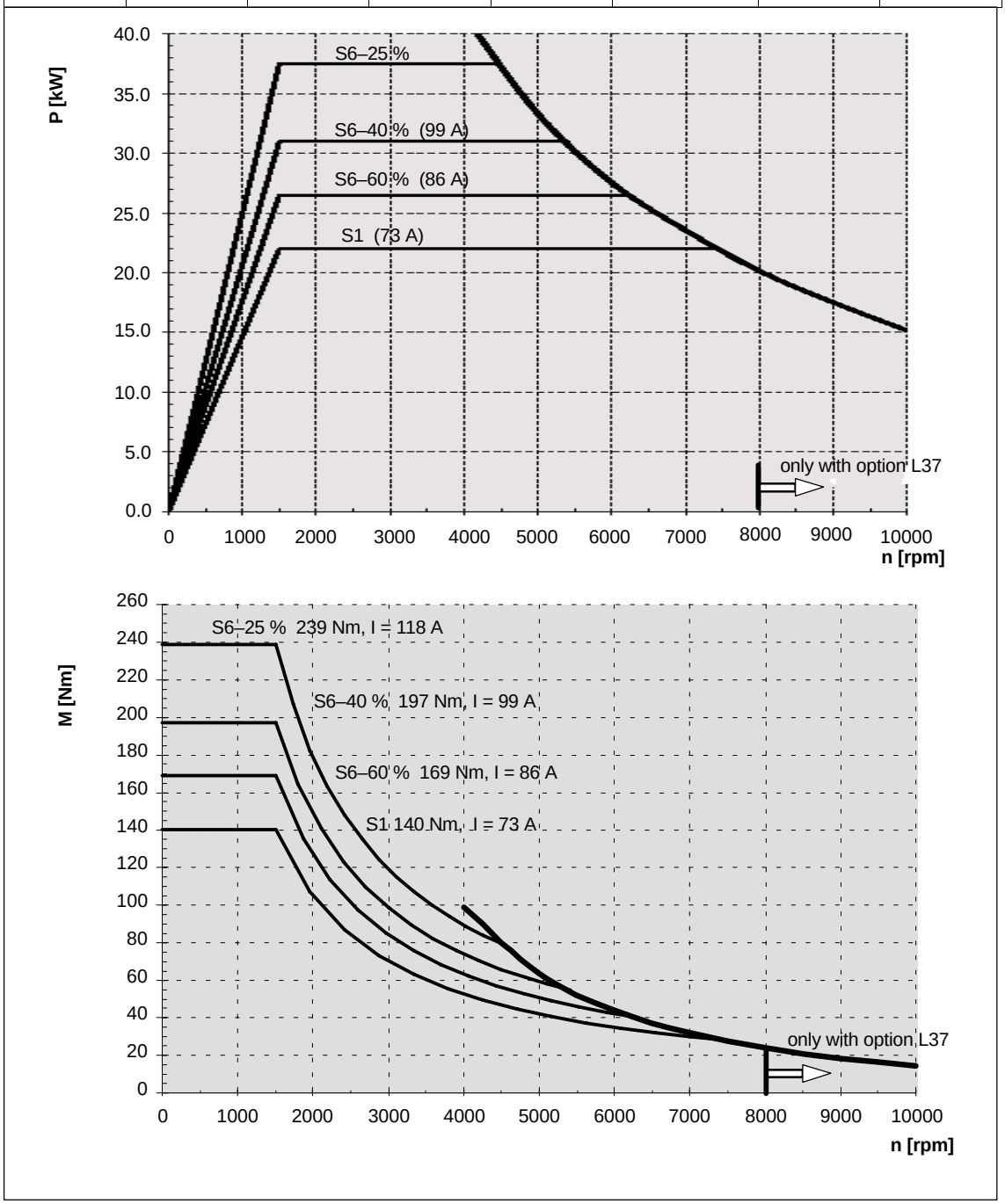


Fig. 2-5 1PH4135–4NF2

Table 2-9 Main spindle AC motor 1PH4137–4NF2

P_N [kW]	n_N [rpm]	M_N [Nm]	I_N [A]	n_{max} [rpm]	T_{th} [min]	J [kgm^2]	m [kg]
27	1500	170	85	8000	11	0.085	130

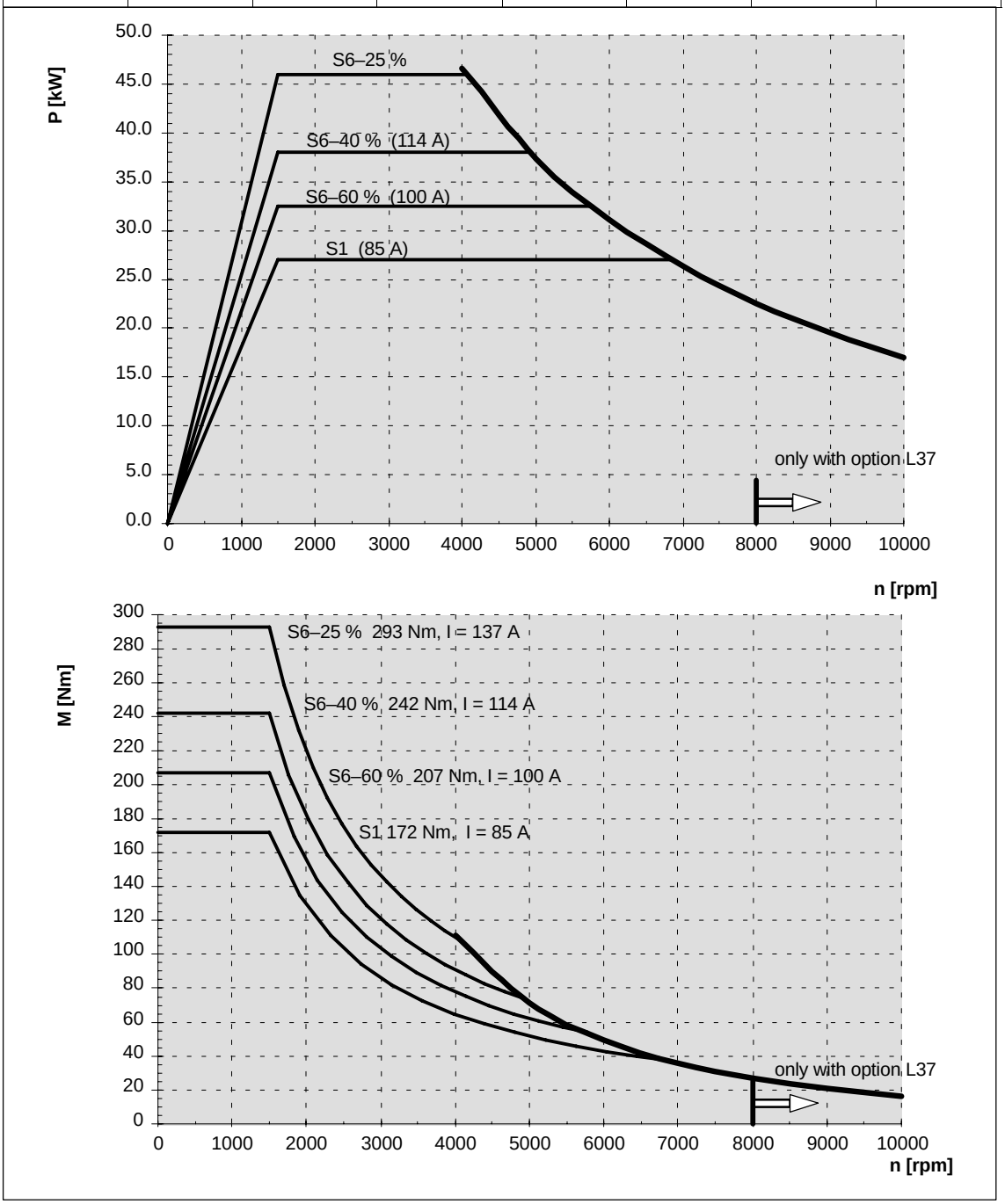


Fig. 2-6 1PH4137–4NF2

Table 2-10 Main spindle AC motor 1PH4138–4NF2

P_N [kW]	n_N [rpm]	M_N [Nm]	I_N [A]	n_{max} [rpm]	T_{th} [min]	J [kgm^2]	m [kg]
30	1500	190	102	8000	11	0.104	150

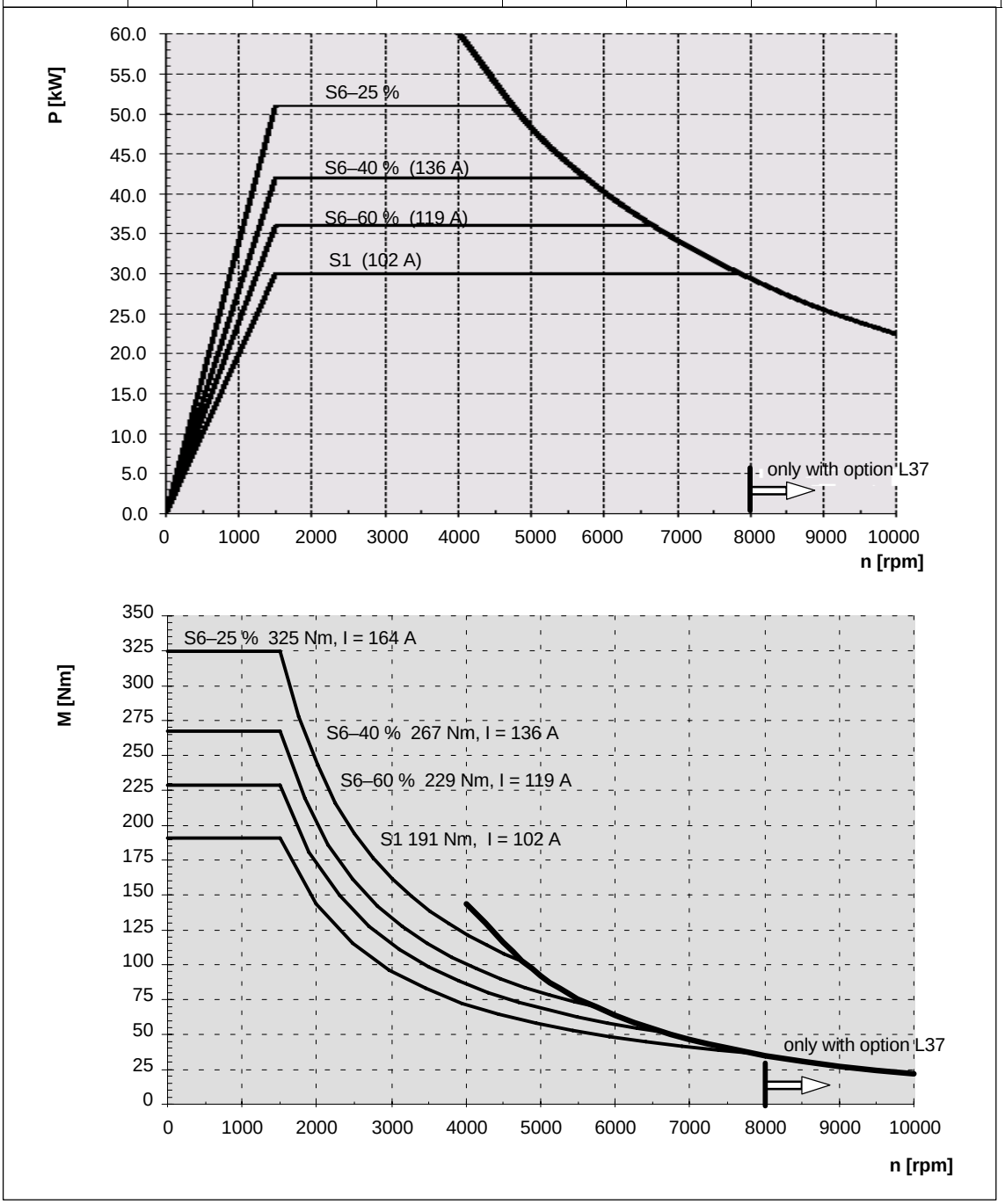


Fig. 2-7 1PH4138–4NF2

Table 2-11 Main spindle AC motor 1PH4163–4NF2

P_N [kW]	n_N [rpm]	M_N [Nm]	I_N [A]	n_{max} [rpm]	T_{th} [min]	J [kgm^2]	m [kg]
37	1500	235	107	6500	14	0.17	175

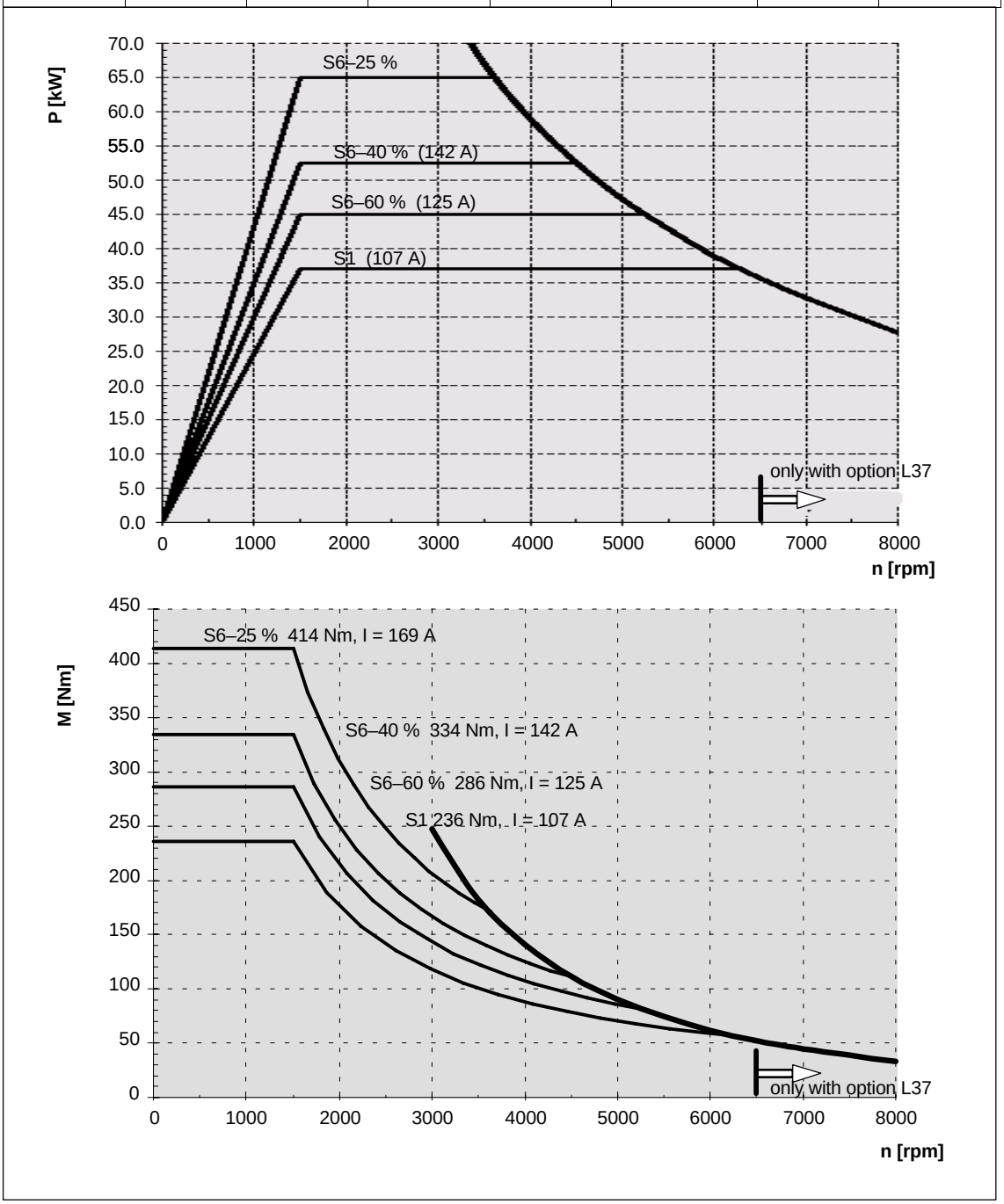


Fig. 2-8 1PH4163–4NF2

Table 2-12 Main spindle AC motor 1PH4167–4NF2

P_N [kW]	n_N [rpm]	M_N [Nm]	I_N [A]	n_{max} [rpm]	T_{th} [min]	J [kgm^2]	m [kg]
46	1500	293	120	6500	14	0.206	210

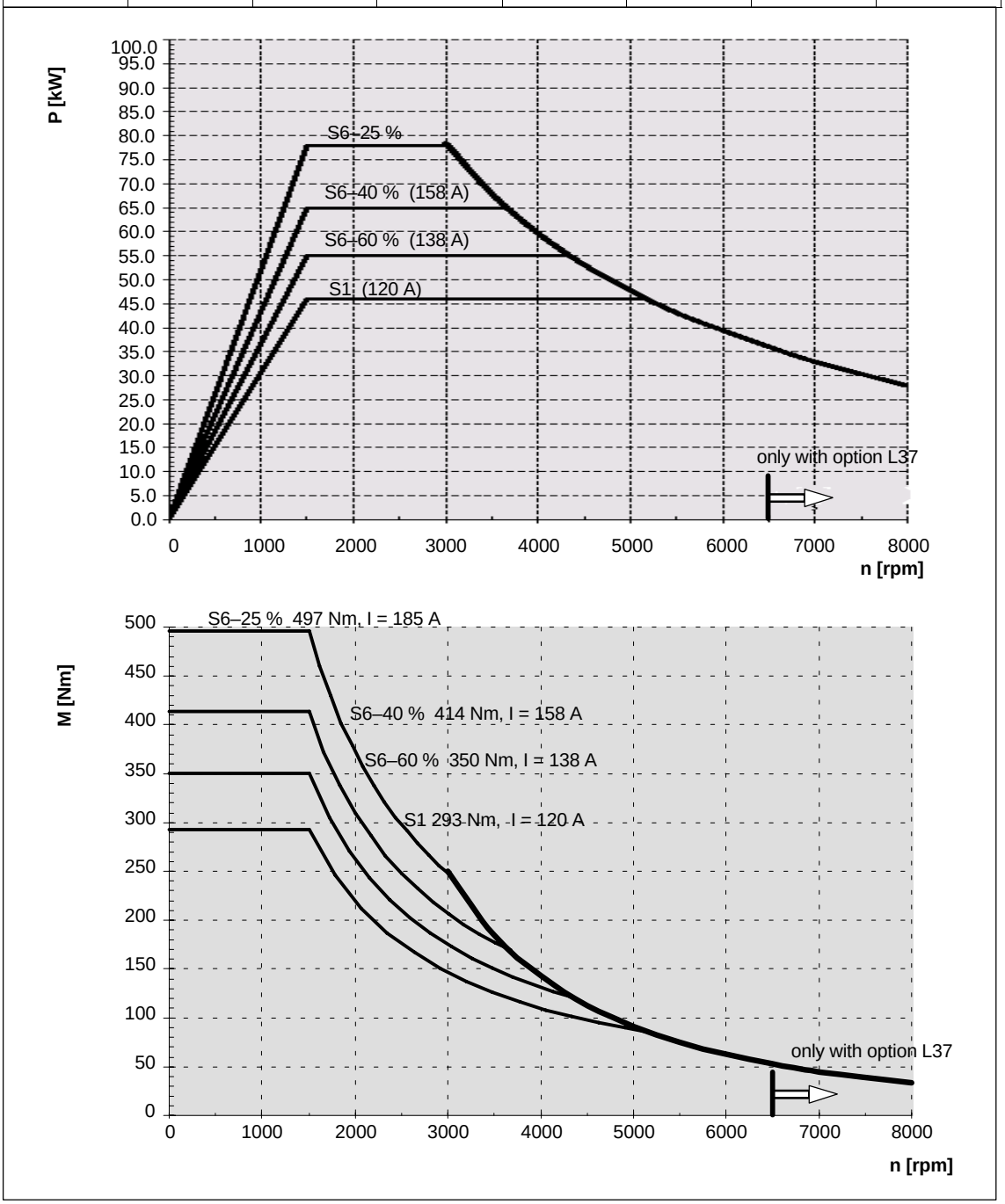


Fig. 2-9 1PH4167–4NF2

Table 2-13 Main spindle AC motor 1PH4168–4NF2

P_N [kW]	n_N [rpm]	M_N [Nm]	I_N [A]	n_{max} [rpm]	T_{th} [min]	J [kgm^2]	m [kg]
52	1500	331	148	6500	14	0.22	240

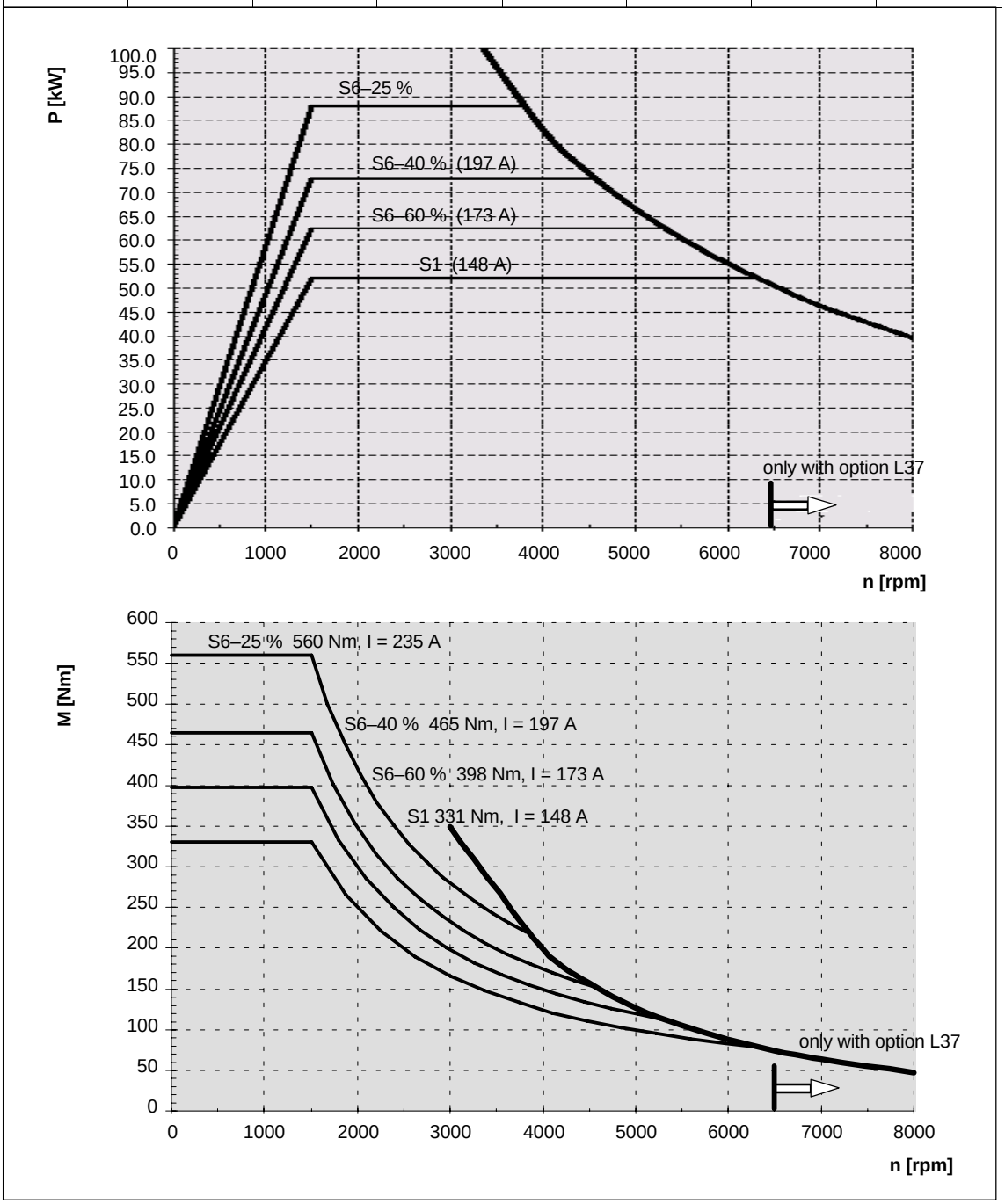


Fig. 2-10 1PH4168–4NF2

2.3 Axial and cantilever force diagram

The 1PH4 main spindle motors are provided with a duplex bearing on the drive end in order to absorb the high cantilever forces from the belt tension.

For a definition, refer to the Configuration Manual ”General Section”.

Axial force

The force diagrams and tables are only valid for standard drive shaft ends; non–standard drive shaft end dimensions are specified for each particular application corresponding to the permissible forces.

For force levels going beyond these, please contact your local Siemens office.

Note

When using option L37 (increased speed), make sure that the motors are only suitable for operation with no cantilever force!

Table 2-14 Axial forces F_A for duplex bearing (standard) depending on speed

Motor type								
1PH410□–4	Speed n in [rpm]	1500	2000	3000	4000	5000	6000	7500
	Axial force FA in [N]	**1440**	**1270**	**1050**	**920**	**830**	**760**	**690**
1PH413□–4	Speed n in [rpm]	1500	2000	3000	4000	5000	6700	–
	Axial force FA in [N]	**1520**	**1330**	**1090**	**950**	**850**	**730**	**–**
1PH416□–4	Speed n in [rpm]	1500	2000	3000	4000	5300	–	–
	Axial force FA in [N]	**2080**	**1830**	**1520**	**1340**	**1180**	**–**	**–**

Forces due to the rotor weight

For an explanation, refer to the Configuration Manual ”General Section”.

Table 2-15 Force due to weight F_L and alignment force F_C of the rotor

Motor type	F_L in [N]	F_C in [N]
1PH4103 1PH4105 1PH4107	125 155 205	320 320 320
1PH4133 1PH4135 1PH4137 1PH4138	215 305 365 445	360 360 360 360
1PH4163 1PH4167 1PH4168	500 590 665	520 520 520

Cantilever force

Caution

When using mechanical transmission elements, which subject the shaft end to a cantilever force, it should be ensured that the **maximum limit values, specified in the cantilever force diagrams, are not exceeded**.

Note

For applications with an extremely low cantilever force load, it should be ensured that the motor shaft is subject to a **minimum cantilever force load as specified in the diagrams**. Low cantilever forces can cause the cylindrical–roller bearing to roll in an undefined fashion that results in increased bearing wear.

For these applications, a single bearing should be selected.

The maximum permissible and the minimum required cantilever forces are shown in the following diagrams.

2.3.1 Cantilever force 1PH410□

Permissible cantilever forces with duplex bearing (standard)

Maximum continuous operating speed	n_{s1max} = 5600 rpm
Mechanical limit speed	n_{max} = 7500 rpm

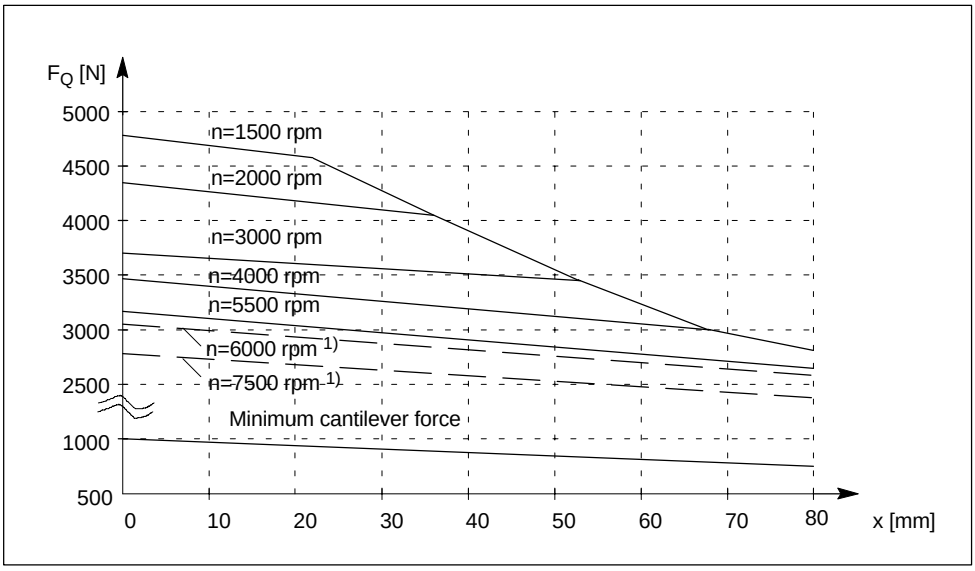


Fig. 2-11 Permissible cantilever force F_Q at a distance x from the shaft shoulder for a nominal bearing lifetime of 20 000 h.

1) Permissible for continuous operation, however with shorter bearing lifetime

Permissible cantilever forces for 1PH410□ with single bearing (option K00)

Maximum continuous operating speed	n_{s1max} = 6500 rpm
Mechanical limit speed	n_{max} = 9000 rpm

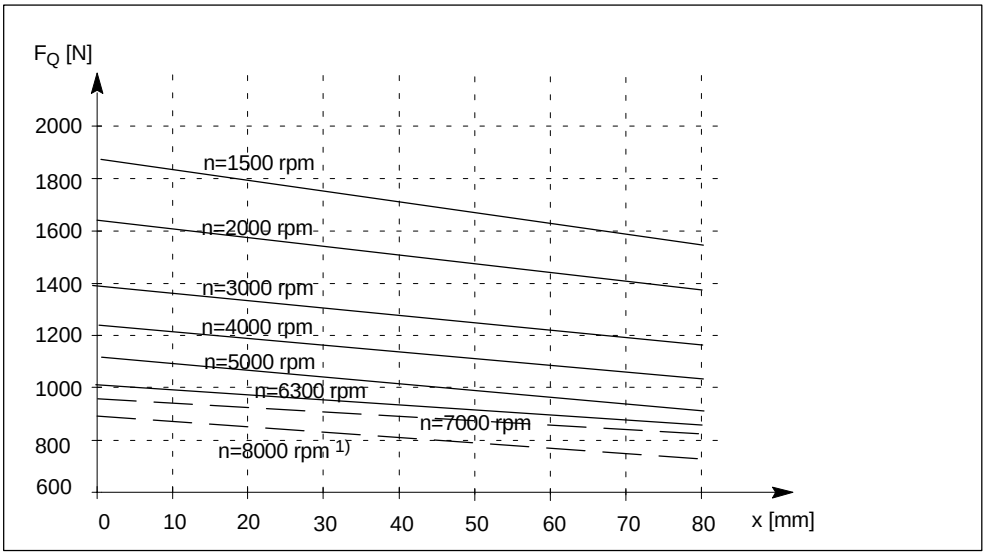


Fig. 2-12 Permissible cantilever force F_Q at a distance x from the shaft shoulder for a nominal bearing lifetime of 20 000 h.[1)]

Permissible cantilever forces for 1PH410□ with single bearing (option K00) depending on axial forces

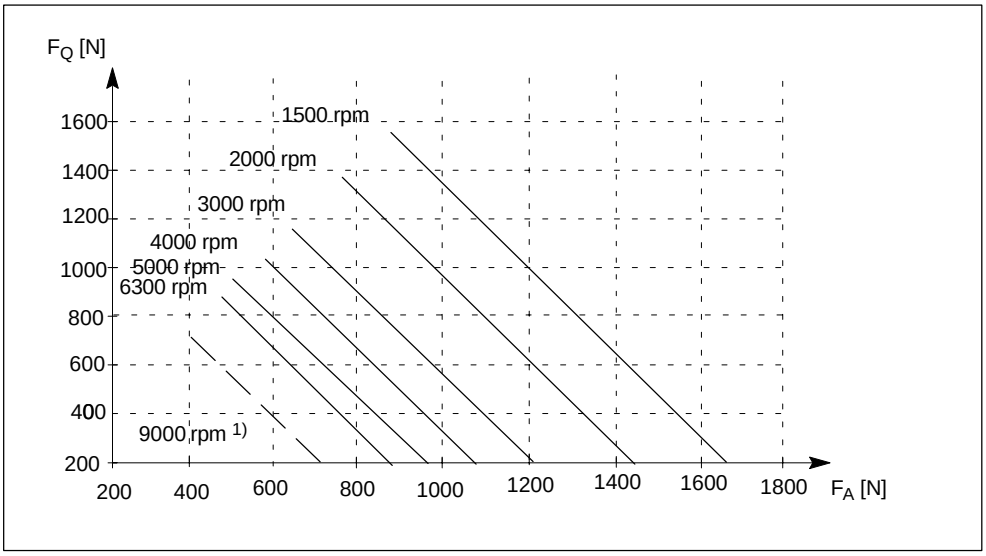


Fig. 2-13 Permissible cantilever force F_Q as a function of axial force F_A for a nominal bearing lifetime of 20 000 h.

1) Permissible for continuous operation, however with shorter bearing lifetime

Permissible cantilever forces for 1PH410□ with single bearing (option K00 with L37)

Maximum continuous operating speed	n_{s1max} = 10000 rpm
Mechanical limit speed	n_{max} = 12000 rpm

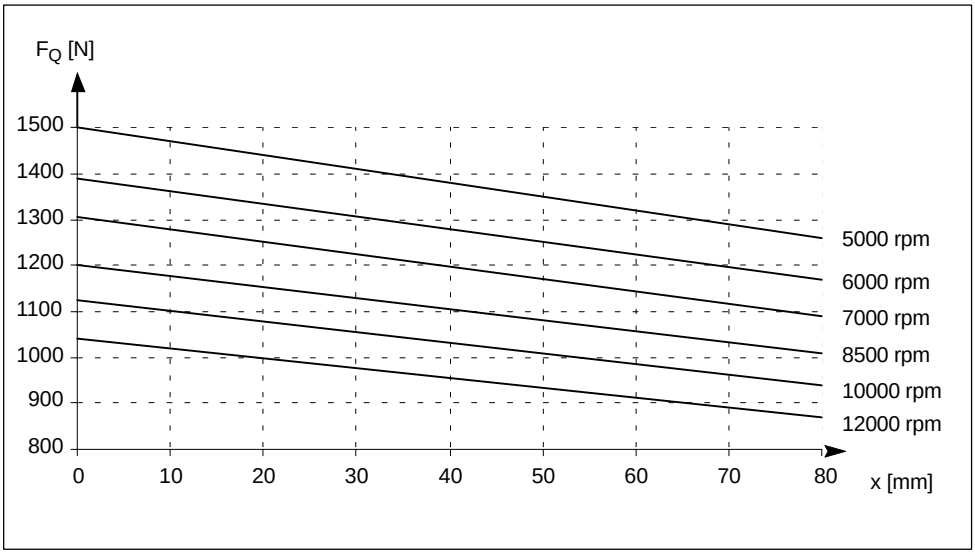


Fig. 2-14 Permissible cantilever force F_Q at a distance x from the shaft shoulder for a nominal bearing lifetime of 10 000 h. [1)]

Permissible cantilever forces for 1PH410□ with single bearing (option K00 with L37) depending on axial forces

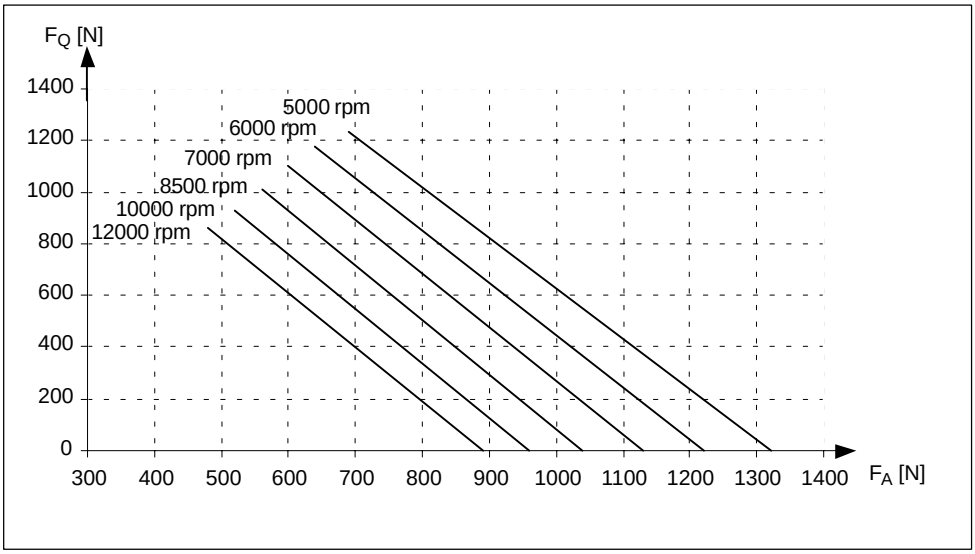


Fig. 2-15 Permissible cantilever force F_Q as a function of axial force F_A for a nominal bearing lifetime of 10 000 h.

2.3.2 Cantilever force 1PH413□

Permissible cantilever forces with duplex bearing (standard)

Maximum continuous operating speed	n_{s1max} = 5200 rpm
Mechanical limit speed	n_{max} = 6700 rpm

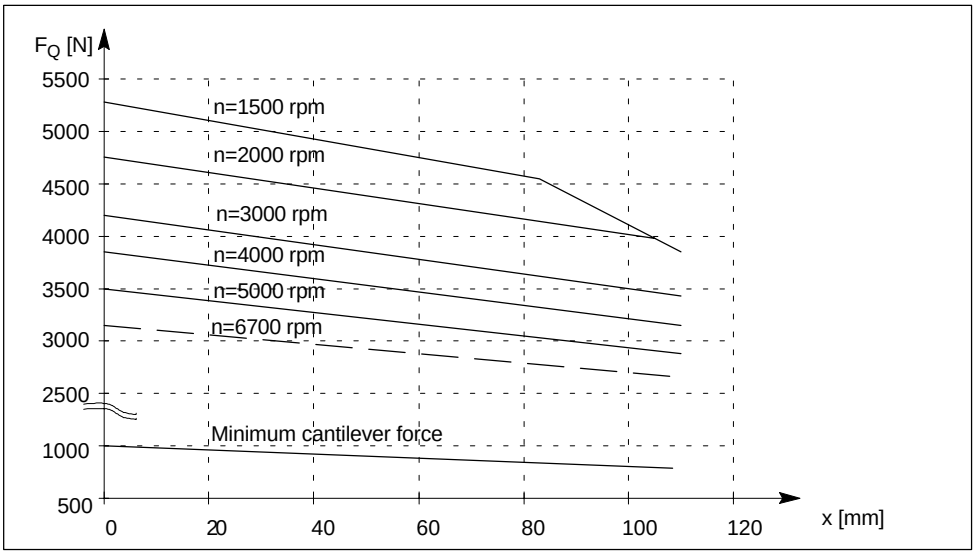


Fig. 2-16 Permissible cantilever force F_Q at a distance x from the shaft shoulder for a nominal bearing lifetime of 20 000 h. [1)]

1) Permissible for continuous operation, however with shorter bearing lifetime

Permissible cantilever forces for 1PH413□ with single bearing (option K00)

Maximum continuous operating speed	n_{s1max} = 6000 rpm
Mechanical limit speed	n_{max} = 8000 rpm

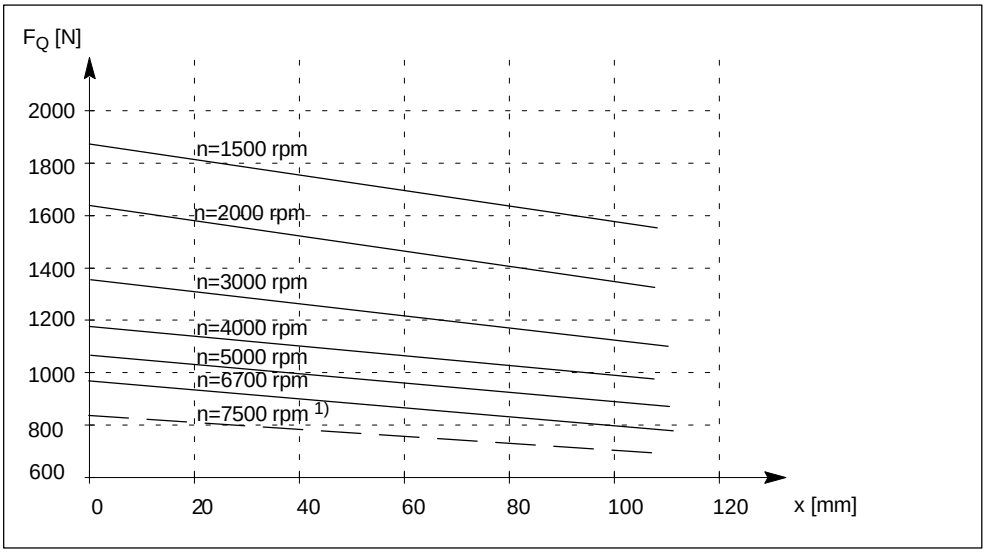


Fig. 2-17 Permissible cantilever force F_Q at a distance x from the shaft shoulder for a nominal bearing lifetime of 20 000 h.[1)]

Permissible cantilever forces for 1PH413□ with single bearing (option K00) depending on axial forces

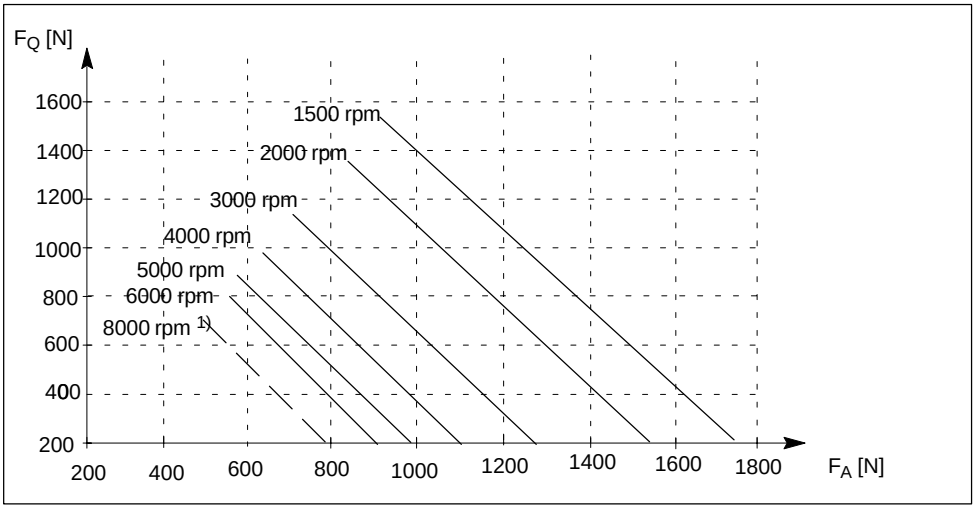


Fig. 2-18 Permissible cantilever force F_Q as a function of axial force F_A for a nominal bearing lifetime of 20 000 h.

1) Permissible for continuous operation, however with shorter bearing lifetime

Permissible cantilever forces for 1PH413□ with single bearing (option K00 with L37)

Maximum continuous operating speed	n_{s1max} = 9250 rpm
Mechanical limit speed	n_{max} = 10000 rpm

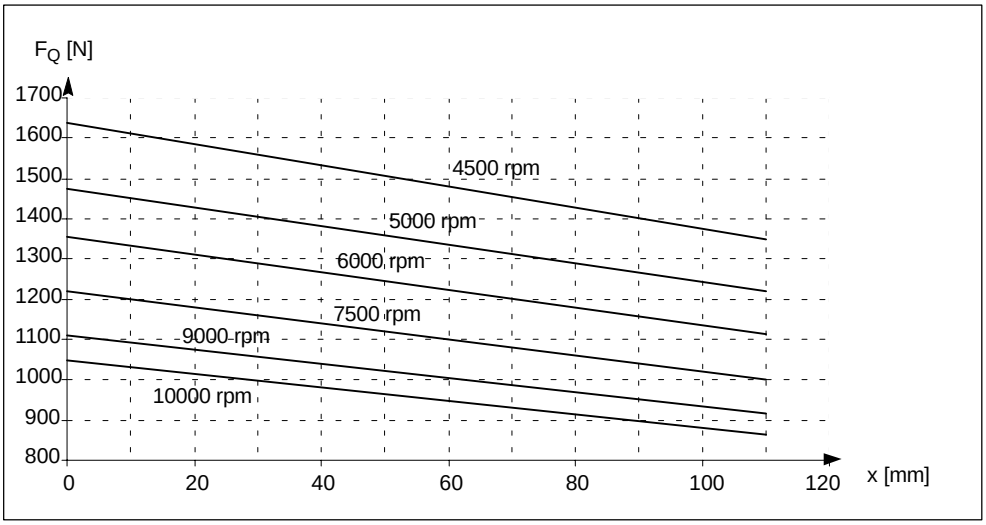


Fig. 2-19 Permissible cantilever force F_Q at a distance x from the shaft shoulder for a nominal bearing lifetime of 10 000 h.[1)]

Permissible cantilever forces for 1PH413□ with single bearing (option K00 with L37) depending on axial forces

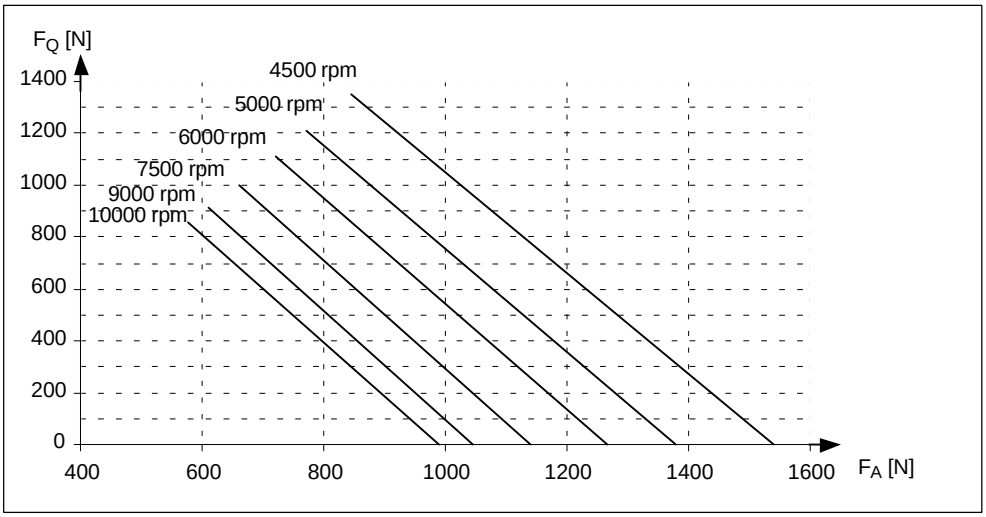


Fig. 2-20 Permissible cantilever force F_Q as a function of axial force F_A for a nominal bearing lifetime of 10 000 h.

1) Permissible for continuous operation, however with shorter bearing lifetime

2.3.3 Cantilever force 1PH416□

Permissible cantilever forces with duplex bearing (standard)

Maximum continuous operating speed	n_{s1max} = 4000 rpm
Mechanical limit speed	n_{max} = 5300 rpm

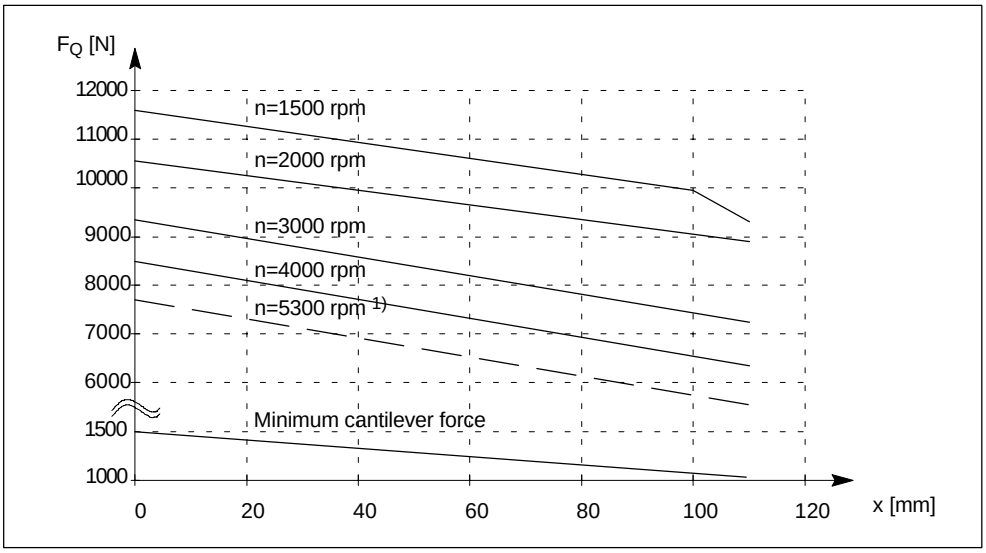


Fig. 2-21 Permissible cantilever force F_Q at a distance x from the shaft shoulder for a nominal bearing lifetime of 20 000 h.

Permissible cantilever forces for 1PH416□ with single bearing (option K00)

Maximum continuous operating speed	n_{s1max} = 4500 rpm
Mechanical limit speed	n_{max} = 6500 rpm

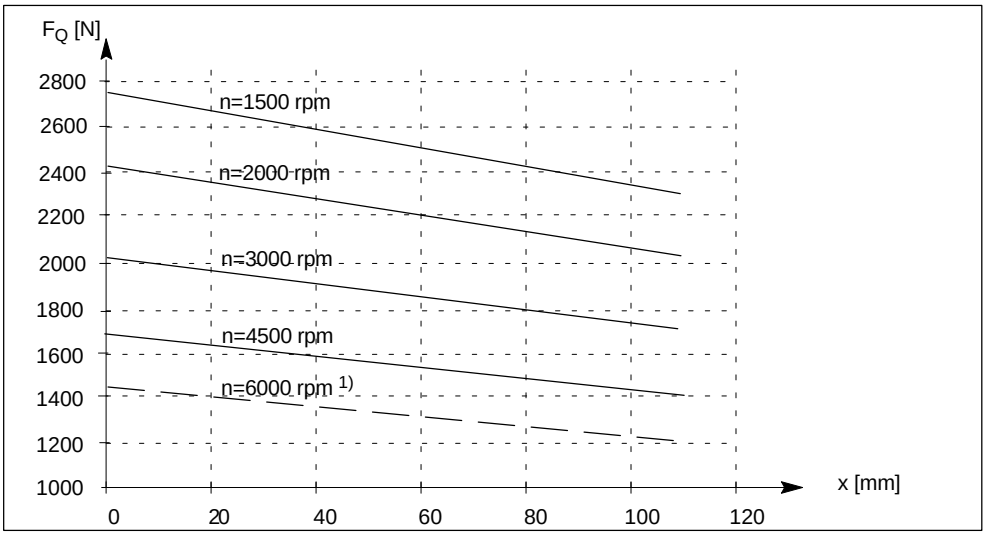


Fig. 2-22 Permissible cantilever force F_Q at a distance x from the shaft shoulder for a nominal bearing lifetime of 20 000 h.[1)]

Permissible cantilever forces for 1PH416□ with single bearing (option K00) depending on axial forces

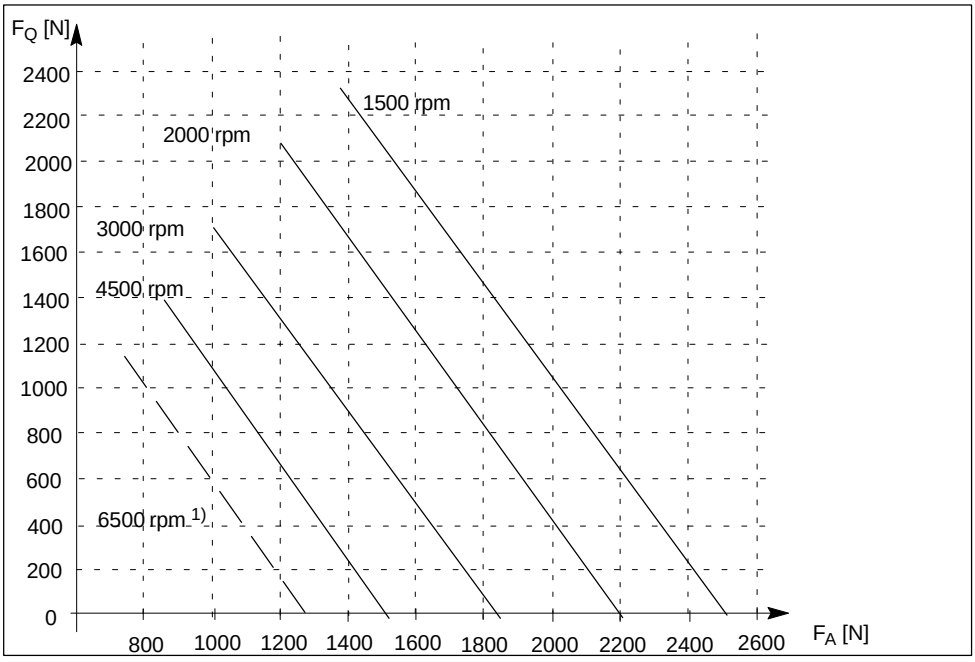


Fig. 2-23 Permissible cantilever force F_Q as a function of axial force F_A for a nominal bearing lifetime of 20 000 h.

1) Permissible for continuous operation, however with shorter bearing lifetime

Permissible cantilever forces for 1PH416□ with single bearing (option K00 with L37)

Maximum continuous operating speed	n_{s1max} = 7000 rpm
Mechanical limit speed	n_{max} = 8000 rpm

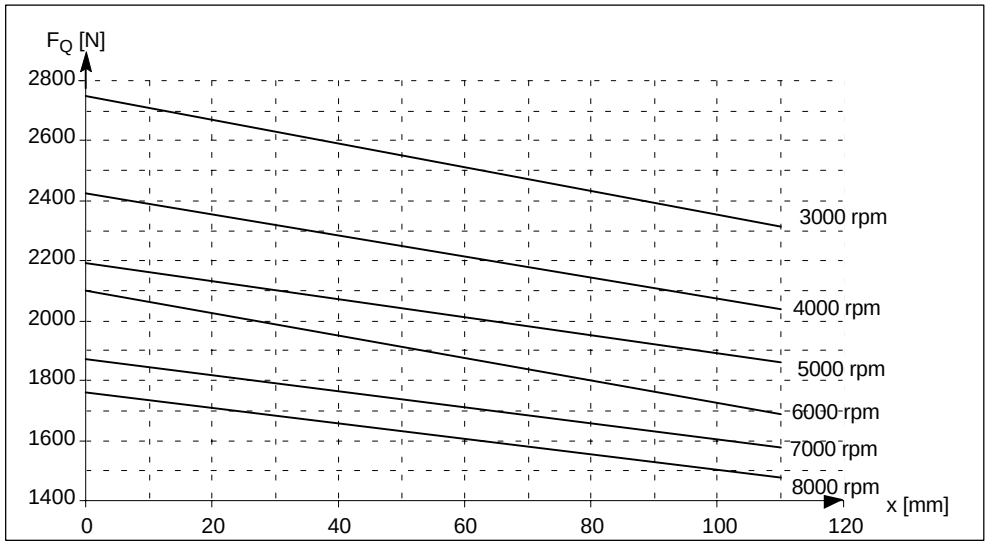


Fig. 2-24 Permissible cantilever force F_Q at a distance x from the shaft shoulder for a nominal bearing lifetime of 10 000 h.[1)]

Permissible cantilever forces for 1PH416□ with single bearing (option K00 with L37) depending on axial forces

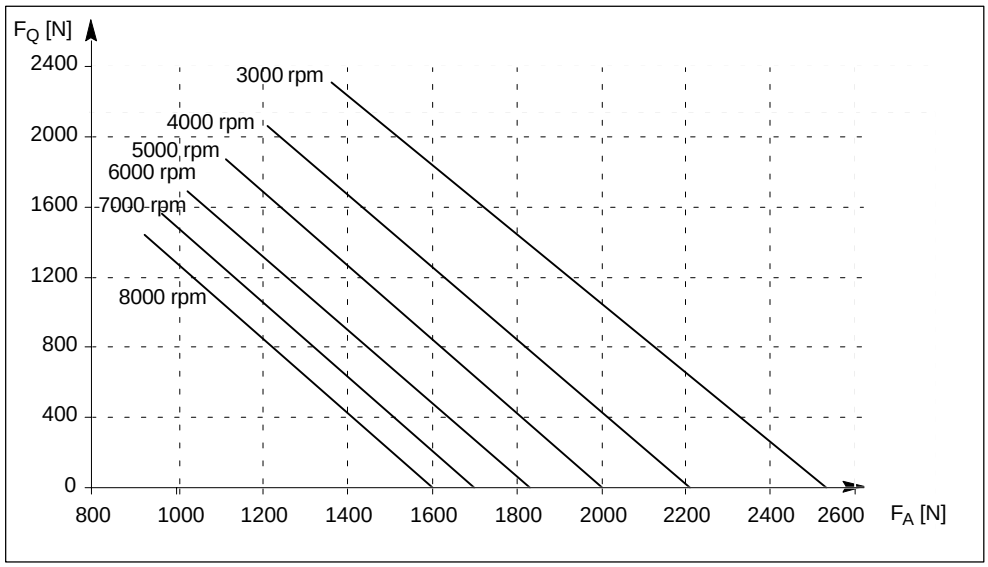


Fig. 2-25 Permissible cantilever force F_Q as a function of axial force F_A for a nominal bearing lifetime of 10 000 h.

1) Permissible for continuous operation, however with shorter bearing lifetime

Motor Components

3

3.1 Thermal motor protection

Table 3-1 Features and technical data

Type	KTY 84
Resistance when cold (20 °C)	Approx. 580 Ohm
Resistance when hot (100 °C)	Approx. 1000 Ohm
Connection	Using the encoder cable
Response temperature	Prewarning at 120 °C Shutdown at 155 °C ± 5 °C

The resistance change is proportional to the winding temperature change. For 1PH motors, the temperature characteristic is taken into account in the closed–loop control.

The prewarning signal from the evaluation circuit in the SIMODRIVE drive converter can be externally evaluated.

High short–time overload conditions require additional protective measures. This is due to the thermal coupling time of the sensor. If the overload condition ($4 \cdot M_0$) lasts longer than 4 s, additional protection should be provided.

The temperature sensor cables are included in the encoder cable.

Warning

If the user carries–out an additional high–voltage test, then the ends of the temperature sensor cables must be short–circuited before the test is carried–out! If the test voltage is connected to only one terminal of the temperature sensor, it will be destroyed.

Warning

The integrated temperature sensor protects the motors against overload conditions up to 4 • $I_{0\ 60K}$ and speed <> 0.

Sufficient protection is no longer provided for thermally critical load situations, e.g. for a high overload condition at motor standstill. In this case, other protective measures must be provided, e.g. a thermal overcurrent relay.

If they exist, reduced data for standstill are specified.

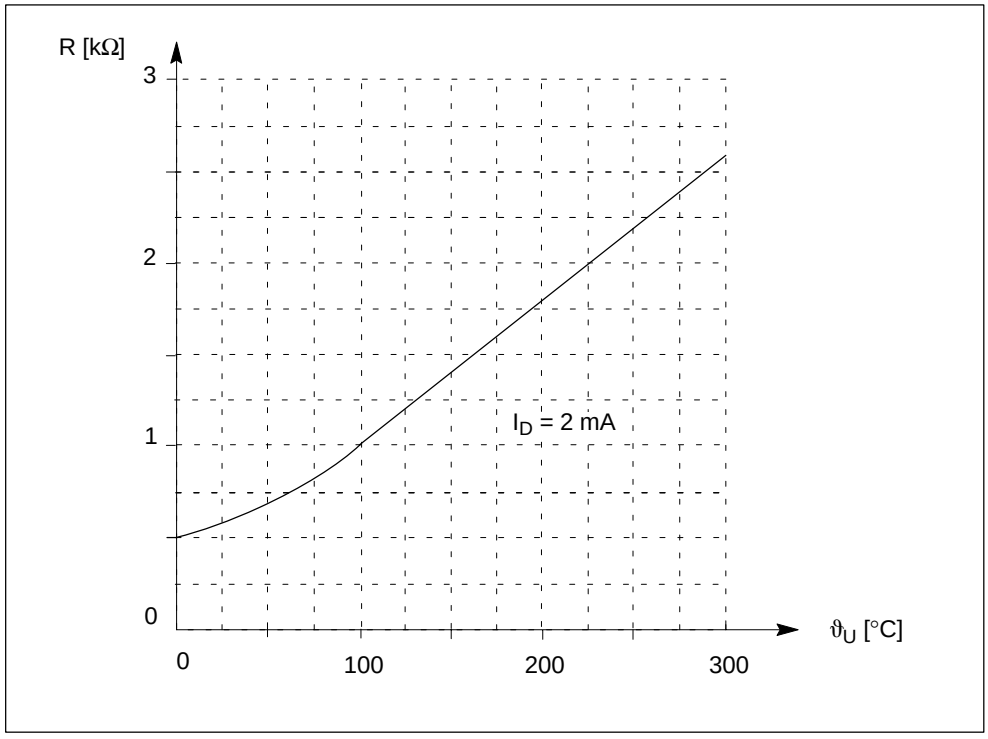


Fig. 3-1 Resistance characteristic as a function of the KTY 84 thermistor temperature

3.2 Encoders

Incremental encoders 1 V_{pp}

Table 3-2 Features and technical data

Version	Optical encoder system
Application	• Tachometer for speed act. value sensing • Indirect meas. system for the position control loop
Coupling	At the NDE, integrated in the motor
Output signals (refer to Fig. 3-2)	• Incremental track, sinusoidal • Reference signal
Connection	Connector
Max. possible connecting cable length	50 m
Operating voltage	+ 5 V ± 5 %
Pulse number per revolution	2048
Incremental signals	1 Vpp
Accuracy	± 40”

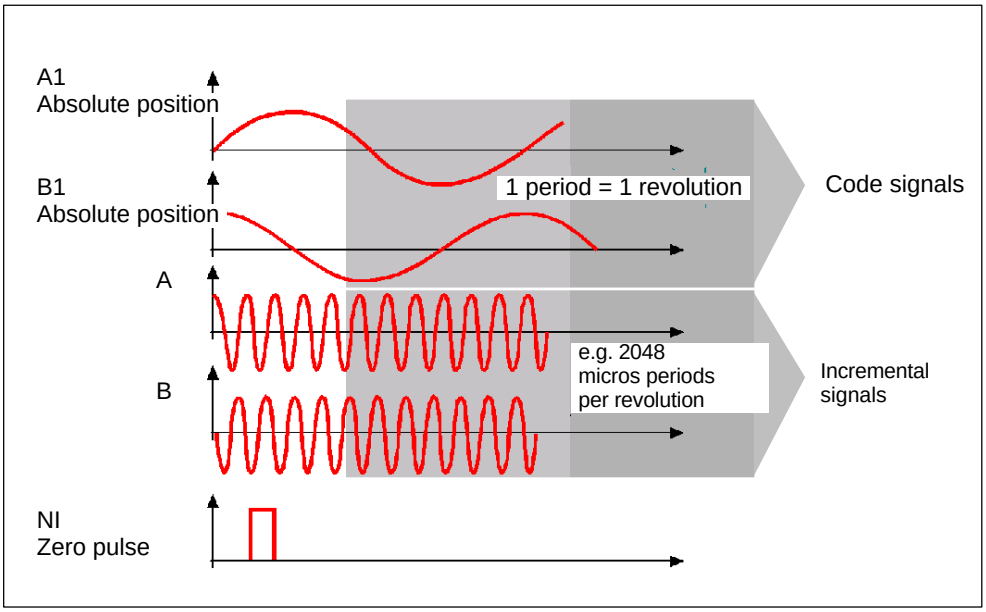
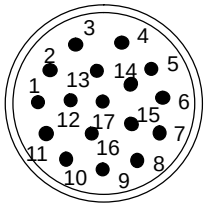


Fig. 3-2 Output signals

Connection: 17 pin flange–mounted socket (pin contacts)

PIN No.	Signal
1	A+
2	A–
3	R+
4	not connected
5	not connected
6	not connected
7	M–Encoder
8	+Temp
9	–Temp
10	P–Encoder
11	B+
12	B–
13	R–
14	not connected
15	0 V Sense
16	5 V Sense
17	not connected



When viewing the plug–in side (pins)

Mating connector: 6FX2003–0CE17 (socket)

Prefabricated cable: 6FX□002–2CA51–□□□0

Length

8 = MOTION–CONNECT 800
5 = MOTION–CONNECT 500

3.3 Holding brake

Application

A single–disk brake can be fitted at the DE to lock the motor rotor without any play at standstill.

Design

The DE bearing end shield is supplied with an external bearing cover (special version) as a fastening part for the magnet block (brake pad). The magnet block can be attached by the customer. The armature disk of the brake is screwed on to the output element (belt pulley or similar).

The brakes are brushless and maintenance free. Both braking surfaces are made of metal. Retrofit is not possible.

Table 3-3 Degree of protection and supply voltage

Degree of protection	IP 00
Supply voltage	24 V DC ±10 %

Principle of operation

The brakes work according to the working principle, i.e. the brake is open when de–energized.

Only apply the brake when the motor is at a standstill.

The holding brake must be released (no current) when changing–over the gearbox ratio and while the motor is running. There is no remaining torque after release.

After mounting the motor, the brake must be checked to ensure that is correctly functioning.

Caution

The holding brake is only designed for a limited number of emergency braking operations. It is not permissible to use the brake as operating brake.

Before removing the magnet block, the holding brake must be under power to prevent the diaphragm spring from overexpanding.

Selection data

The holding brakes described here cannot be used together with the two–speed selector gearbox.

Table 3-4 Holding brake selection

Holding brake for motors, SH 100 to SH 160	Order code
Motor is prepared for mounting a holding brake; holding brake is mounted by the customer.	**G95**
Motor with mounted ZF holding brake	**G46**

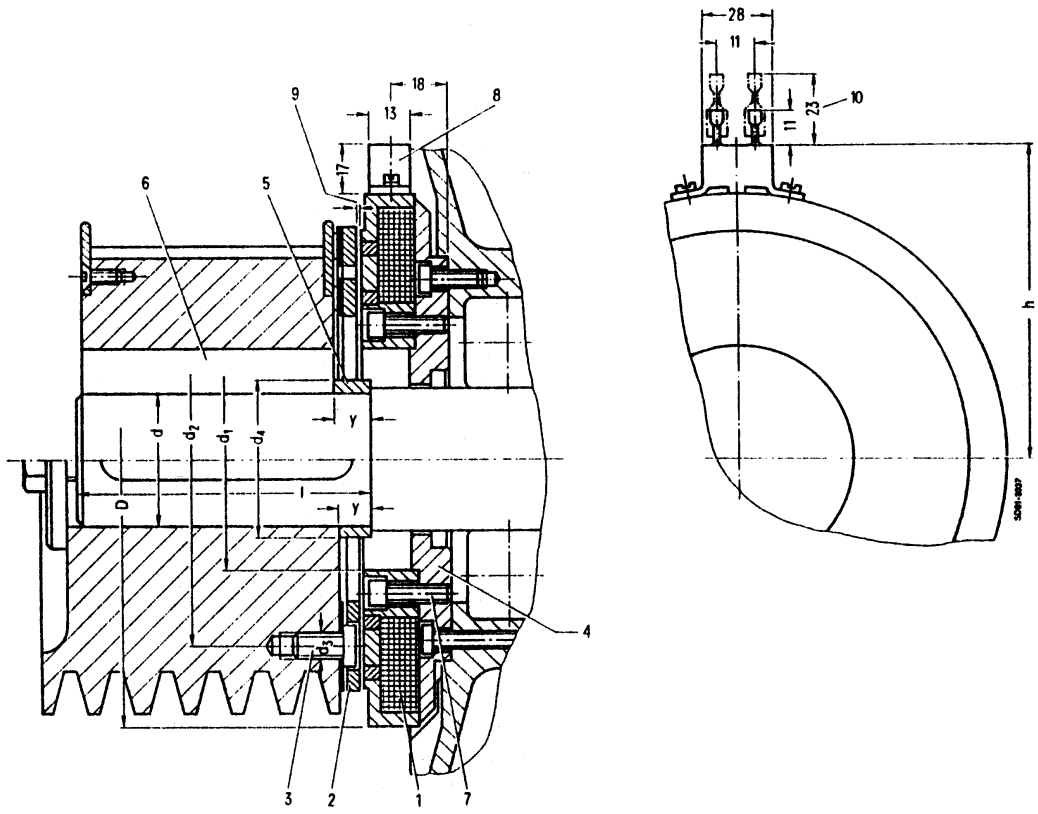
Technical data

Table 3-5 Technical data, holding brake

SH [mm]	ZF type	Order No.	Holding torque [Nm]	Power drain[1)] [W]	Closing time [ms]
100	EB 3M	2LX2 146–0	30	20	100
132	EB 8M	2LX2 145–0	100	34	130
160	EB 8M	2LX2 145–0	100	34	130

1) Coil temperature 20 °C

Dimensions of the single–disk holding brake for motors with shaft heights 100 to 160



1	Electro–magnetic single–disk brake
2	Armature disk of the brake
3	Three cylindrical Allen screws according to DIN 7984 or 6912
4	Outer DE bearing cover, special version
5	Disk or ring to adjust the air gap or as end stop for the tensioning element (variable to equalize tolerance)
6	Space for the tensioning element
7	Four cylindrical Allen screws M 5x15 or M 6x20 acc. to DIN 912
8	Electrical connection: Flat connector DIN 46244 A6, 3–0.8
9	Air gap s = 0.5 mm between the brake assembly and armature disk
10	Removal dimension for the flat connector sleeve, Size 6.3

Fig. 3-3 Mounting a holding brake on the drive end of AC motors 1PH410□ to 1PH416□ as an example: Armature disk mounted to a V–belt pulley with keyway (upper half) or to a toothed–belt pulley for tensioning elements (lower half)

Table 3-6 Dimensions for mounting the single–disk holding brake [mm]

Motor	**Drive shaft end**								
1PH4	**d**	**D**	**l**	**h**	**y**	d_1 H8	d_2 ∅ +/–0.1	d_3 3x offset by max. 120°	d_4
Shaft height 100 1PH4 103 105 107	38	118	80	77	15	45	94	M6	42
Shaft height 132 1PH4 133 135 137 138	42	167	110	100	11	70	118	M8	60
Shaft height 160 1PH4 163 167 168	55	167	110	100	7	70	118	M8	63

3.4 Gearboxes

Prerequisites for mounting a gearbox

- Type of construction IM B5, IM B35 or IM V15
- Shaft with key and full–key balancing
- Degree of protection IP 55, prepared for mounting a ZF gearbox

For questions regarding gearboxes, please directly contact the following:

ZF Friedrichshafen AG
Antriebstechnik Maschinenbau
D–88038 Friedrichshafen
Telephone: +49 (75 41) 77 – 0
Telefax: +49 (75 41) 77 – 34 70
Internet: http://www.ZF–Group.de

3.4.1 Application and features

Application

A gearbox must be mounted, if

- the drive torque is not sufficient at low speeds.
- the constant power range is not sufficient in order to utilize the cutting power over the complete speed range.

Gearbox features

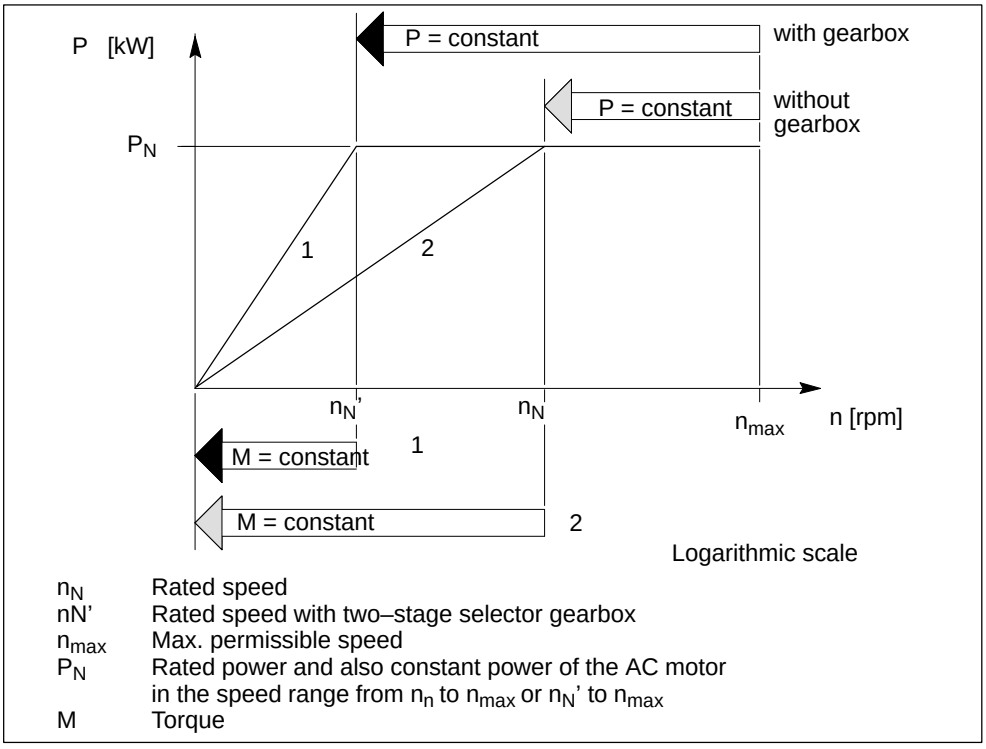
- Version as planetary gear
- Gearbox efficiency: above 95 %
- Gearboxes are available for motors, shaft heights 100 to 160
- Selector gearboxes are available up to a drive output of 100 kW
- Types of construction: IM B35 (IM V15) and IM B5 (IM V1) are possible

Note

1PH4 motors are only designed for stress levels in accordance with the specifications (refer to the cantilever force diagram and maximum torque).

When using force/torque amplifying elements, e.g. a gearbox, the increased mechanical stress (e.g. from heavy belt pre–tension forces) must be absorbed by using the appropriate reinforcing element. The system planner must take this into consideration. For a gearbox, that means that increased belt pre–tension forces must be absorbed by the gearbox, for example, and transferred to the machine.

For drive units where, for example, they are mounted to the gearbox flange or gearbox enclosure, then for motors with type of construction IM B35, they must be supported at the NDE without subjecting the motor frame to any stress.



n_N	Rated speed
nN'	Rated speed with two–stage selector gearbox
n_{max}	Max. permissible speed
P_N	Rated power and also constant power of the AC motor in the speed range from n_n to n_{max} or n_N' to n_{max}
M	Torque

Fig. 3-4 Speed–power diagram when using a two–stage selector gearbox to extend the constant power speed range of AC main spindle drive motors

Example: AC motor without selector gearbox

For P = constant from n_N = 1500 rpm to n_{max} = 6300 rpm a constant power control range greater than 1:4 is possible.

Same AC motor with selector gearbox:

For gearbox stage $i_1 = 4$ and $i_2 = 1$ a constant power control range of greater than 1:16 is possible (n_N' = 375 rpm to n_{max} = 6300 rpm).

Gearbox mounted outside the spindle box

The following advantages are obtained by locating the gearbox outside the spindle box:

- Gearbox vibration is not transferred.
- Separate lubricating systems for the main spindle (grease) and selector gearbox (oil).
- No noise and no temperature fluctuations caused by the gearbox pinion wheels in the spindle box.
- Instead of using belts, the drive power can also be transferred from the gearbox out–drive using pinion (on request) or co–axially through an equalizing coupling.

Vibration severity level

Motor + gearbox: Tolerance level R (acc. to DIN ISO 2373)

This is also valid if motor tolerance level S is ordered.

Seal between motor flange and gearbox flange

There must be a seal between motor flange and gearbox flange for SH 132 and SH 160 due to the uninterrupted centering shoulder with sealing compound (e.g. Terostat 93, Teroson).

3.4.2 Gearbox design

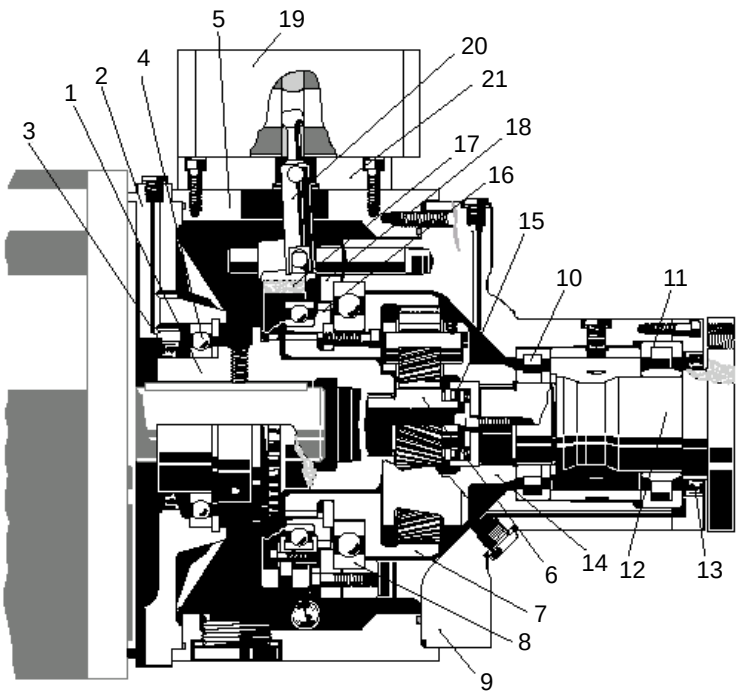


Fig. 3-5 Gearbox design for 1PH4, SH 100–160

For selector gearboxes, the following applies:

Selector position I: $i_1 = 4$
Selector position II: $i_2 = 1$

Both gearbox ratios are electrically selected and the setting is monitored using limit switches.

The gearbox output shaft lies coaxially to the motor shaft.

Torsional play (measured at the gearbox output shaft):
Standard: 30 angular minutes (for SH 100–160)

For milling and machining with interrupted cut, the following special versions are available on request for SH 100–160:

- Lower play: max. 20’
- Lower play for increased requirements: max. 15’

Belt pulley

- The belt pulley should be in the form of a cup wheel.
- The gearbox output shaft has a flange with outer centering and tapped holes to retain the belt pulley.
- The complete drive should be designed to be as stiff as possible using large belt cross–sections. This has a positive impact on the smooth running properties of the drive.

3.4.3 Technical data

Table 3-7 Explanation of the connections

Type	Motor shaft height	Order No.	Max. speed n_{max}	Rated torque (S1 duty)			Max. torque (S6 duty, 10 min. duty cycle, max. 60% power–on duration)			Weight	Drive–out housing a10
				Drive	Drive out		Drive	Drive out			
ZF desig.	[mm]		[rpm]	[Nm]	i=1 [Nm]	i=4 [Nm]	[Nm]	i=1 [Nm]	i=4 [Nm]	[kg]	[mm]
2K120	100	2LG4312–...	8000[2] 9000[3]	120	120	480	140	140	560	30	100
2K250	132	2LG4312–...	6300 8000[3]	250	250	1000	400	400	1600	62	116
2K300	160	2LG4320–...	6300 8000[3]	300	300	1200	400	400	1600	70	140

Important

When designing the complete drive unit (motor with gear) the gearbox data is decisive.

For 1PH4168 AC motors, for example, the rated torque must be reduced to 300 Nm. For motors, shaft heights 100 and 132, the maximum motor speed should be limited to the permissible gearbox speed 2K120 / 2K250.

Other binding technical data and engineering information/instructions (e.g. lubrication, temperature rise, permissible cantilever forces and examples), please refer to Catalog 2K Gearboxes from ZF (Zahnradfabrik Friedrichshafen).

1) Can be supplied with holding brake (option).
2) Higher maximum speed from 8000 ... 9000 rpm for more than 20% power–on duration is only possible with injection lubrication.
3) Permissible with gearbox oil cooling for gearbox stage i = 1.

3.4.4 Electrical connection

Power supply for the selector unit: 24 V DC ±10 %

The mechanical selector unit requires a separate supply.

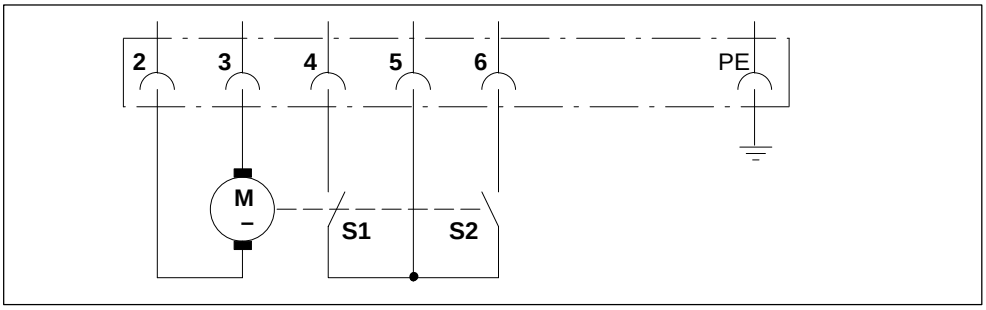


Fig. 3-6 Circuit diagram

Connector (incl. in the scope of supply): Manufacturer, Harting; 7–pin + PE, type HAN 7D

Table 3-8 Explanation of the connections

Connector contact No.	Number and designation	In–put	Out–put	Voltage	Current
2 and 3	1 selector unit	0	–	24 V DC	I_{max} = 5 A (inrush current)
4 and 6	2 limit switches	0	0	24 V DC U_{max} =42 V DC	I_{max} = 5 A

Table 3-9 Control sequence when selecting the gearbox stage

Gearbox stage selection	Connector contact No.			
	2	3	4/5 (S1)	5/6 (S2)
When changing the ratio from stage i_2 to i_1				
a Initial setting (f) b Selection sequence c Mechanical selection carried–out up to endstop [1)]	+24 V DC	0 V	0 0 L	L 0 0
When changing the ratio from stage i_1 to i_2				
d Initial setting (c) e Selection sequence f Mechanical selection carried–out up to endstop [1)]	0 V	+24 V DC	L 0 0	0 0 L

L Contact closed 0 Contact open

1) A limit switch (S1 or S2) sends a signal to the control after selection to switch out the selector unit.

3.4.5 Gearbox stage selection

When changing the gearbox stage, the following information must be carefully observed:

- Only change over the gearbox stage at standstill; e.g. while changing the tool.
- During selection, the direction of rotation should be changed approximately 5 times per second. The gears normally mesh at the first direction of rotation change so that selection times of between 300 and 400 ms can be achieved. The ”oscillation” function is provided in the SIMODRIVE 611 analog drive converter for this purpose.
- The gearbox stage should not be changed without oscillation.
- The motor may only start to accelerate 200 ms after the changeover has been completed.
- The selection must be monitored using a time relay. After 2 s, the selection must be reversed, if the selection command was not able to be executed. A time limit of 10 s should be provided for approx. 4 to 5 additional selection operations.

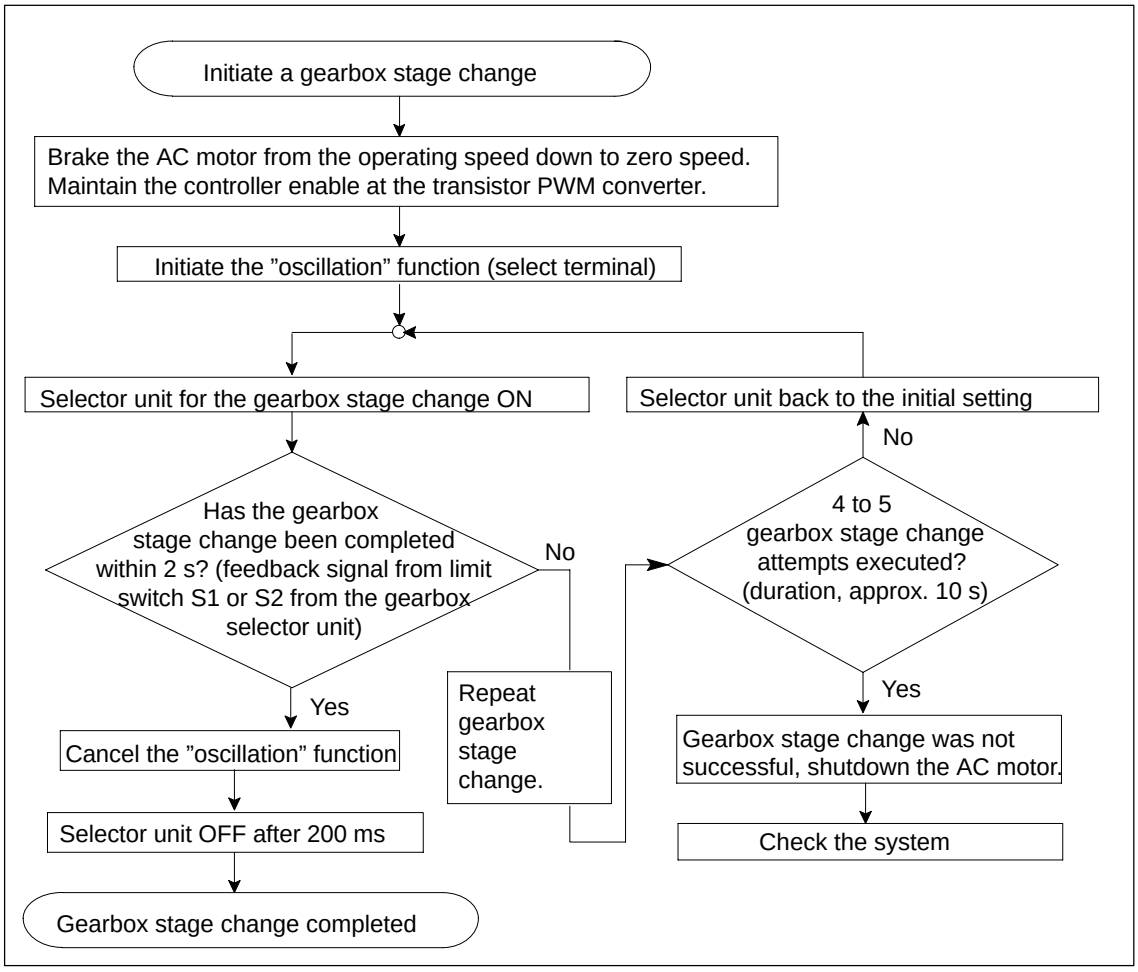


Fig. 3-7 Function sequence when changing the gearbox stage

3.4.6 Lubrication

Splash lubrication

Oil level check:	Visually using a sight glass
The oil level depends on the mounting position:	
Horizontal and vertical:	Center of the sight glass[1)]
For an inclined mounting position:	Mark on the angled oil level indicator (additionally mount)
Oils which can be used:	HLP 32 acc. to ISO–VG 68
Oil drain plugs:	Provided at both sides

Circulating oil lubrication

Circulating oil lubrication is required for the following applications:

- for continuous operation
- for operation over a longer period of time in one gearbox stage
- for intermittent operation with short no–load intervals

The type of circulating oil lubrication depends on which operating temperature level is required in use. Several applications require a low operating temperature level. We recommend, in these cases, circulating oil lubrication. The oil intake quantity is between 1 and 1.5 l/min with an oil pressure of approx. 1.5 bar. The diagrams 3-9 and 3-10 indicate the approximate oil intake and outlet positions on the gearbox. The precise dimensions can be taken from the relevant mounting drawings.

For the following gearboxes, circulating oil lubrication is required for V1 or V3 vertical mounting positions:

- Gearbox 2K120
- Gearbox 2K121
- Gearbox 2K250
- Gearbox 2K300

1) The oil volume data on the rating plate is only an approximate value.

3.4.7 Flange dimensions

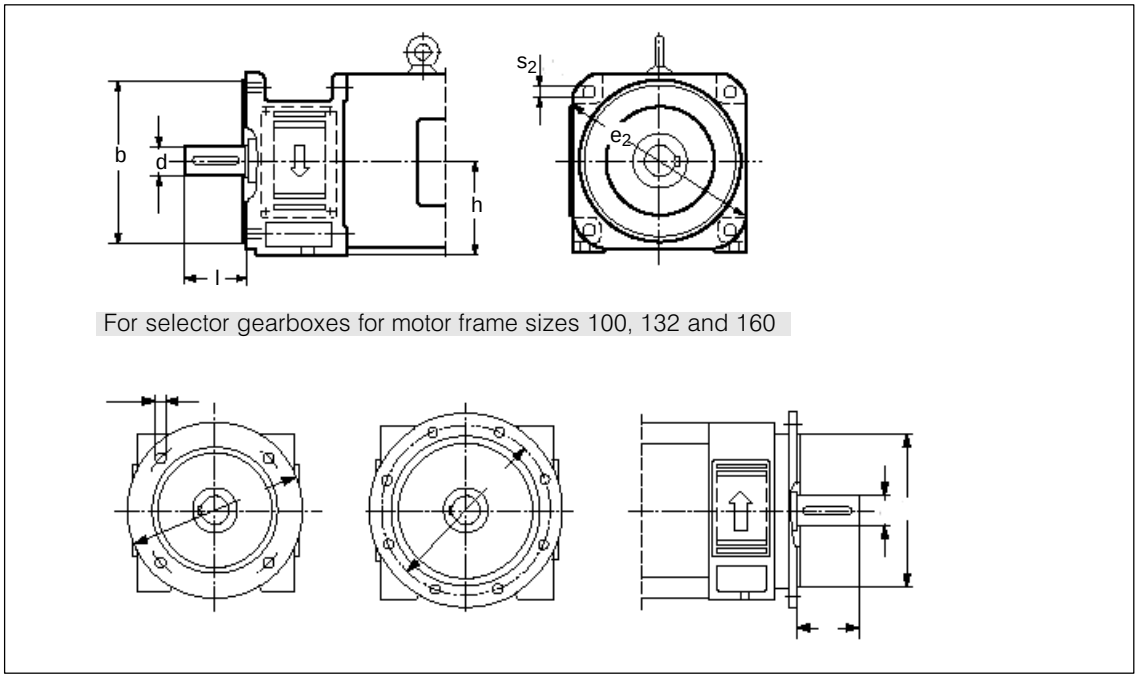


Fig. 3-8 Flange dimension for AC motors (dimensions refer to Table 3-10)

Table 3-10 Flange dimension for AC motors

Two–stage selector gearbox	Motor frame size	Standard motor companion dimensions						
		h	d	l	b_1	e_1	a_1	s_1
2K120	101, 103, 105, 107	100–0.5	38 k_6	80	180 j_6	215 ± 0.5	–	14 ± 0.2
2K250	131, 132, 133, 135, 137	132–0.5	42 k_6	110	250 h_6	300 ± 0.5	–	18 ± 0.2
2K300	163, 167	160–0.5	55 k_6	110	300 h_6	350 ± 0.5	–	18 ± 0.2

3.4.8 Connections for circulating oil lubrication, frame size 100

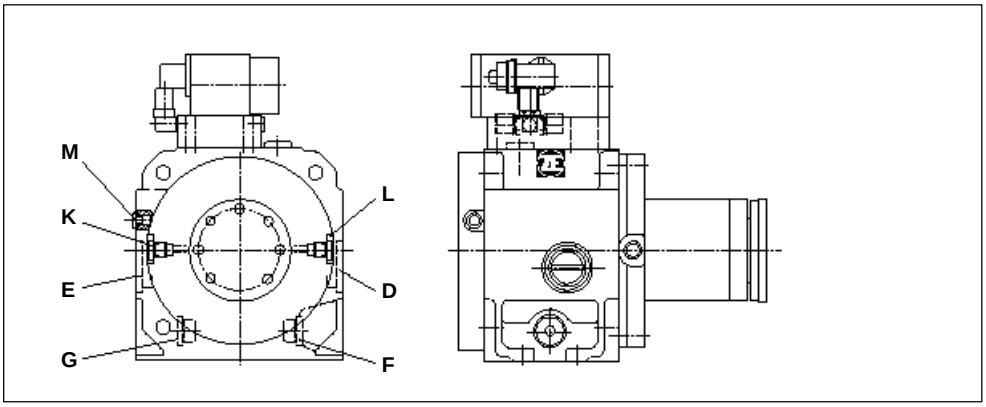


Fig. 3-9 Connections for selector gearbox with selector unit for frame size 100

Table 3-11 Connections for circulating oil lubrication

Max. pressure	Connection, oil return	Connection, oil intake	Mounting position
0.2 bar 1.5 bar	**D** Main direction of rotation, clockwise 1) **E** Main direction of rotation, counter–clockwise1)	**M** (0.5 dm^3/min) **K/L** (1.0 dm^3/min)	V1 (closed version)
1.5 bar			
1.5 bar		**G** (1.5 dm^3/min) main direction of rotation, clockwise **F** (1.5 dm^3/min) main direction of rotation, counter–clockwise	B5 V1
Note: Circulating oil lubrication is required for certain gearboxes and V1 or V3 vertical mounting positions (refer to Chapter 3.4.6)			

1) When viewing the gearbox drive from the motor

3.4.9 Selector gearbox for frame size 132 and 160

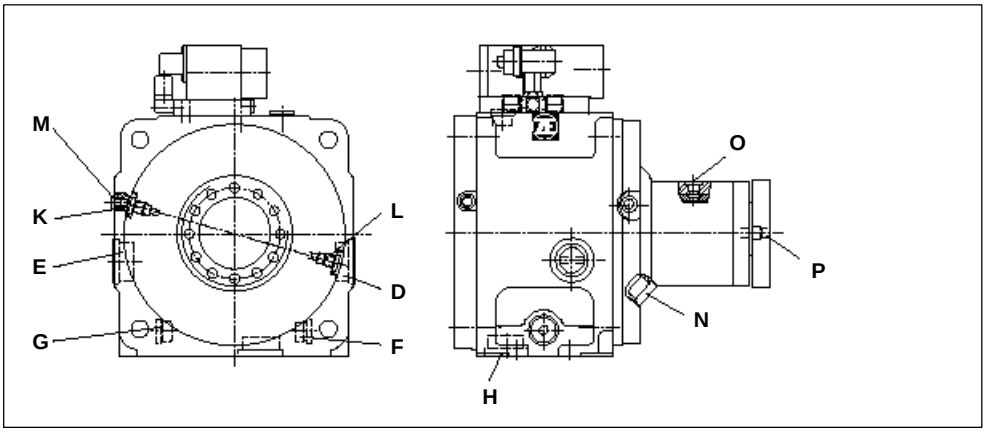


Fig. 3-10 Selector gearbox with selector unit for frame sizes 132 and 160

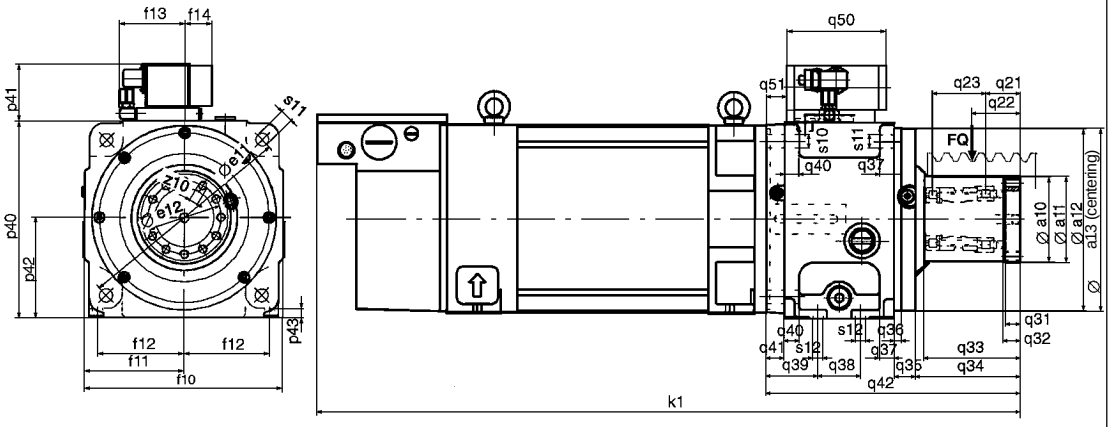
Table 3-12 Connections for circulating oil lubrication

Max. pressure	Connection, oil return	Connection, oil intake	Mounting position
2 bar	**H**	**P** (1.5 dm^3/min)	V3
0.5 bar 1.5 bar	**D** Main direction of rotation, clockwise [1] **E** Main direction of rotation, counter–clockwise[1]	**M** (0.5 dm^3/min) **N** (1.5 dm^3/min)	V1 (closed version)
1.5 bar			
1.5 bar		**G** (1.5 dm^3/min) main direction of rotation, clockwise **F** (1.5 dm^3/min) main direction of rotation, counter–clockwise	B5 V1
Note: Circulating oil lubrication is required for certain gearboxes and V1 or V3 vertical mounting positions (refer to Chapter 3.4.6)			
Connection O is additionally possible (0.5 dm^3/min)			

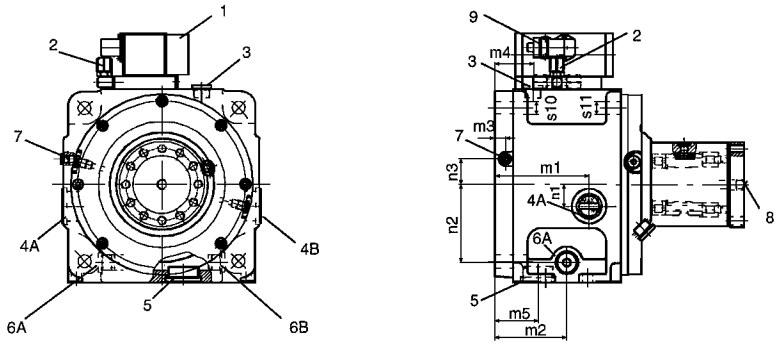
1) When viewing the gearbox drive from the motor

3.4.10 Gearbox dimensions

Gearbox dimensions



Connections for the oil supply



For selector gearbox for motor frame sizes 100 to 160

1 Selector unit (24 V DC, 5 A solenoid)
2 Vent valve
2 Oil filling screw
4A Oil sight glass or oil return for the main direction of rotation, counter–clockwise and circulating oil lubrication
4B Oil sight glass or oil return for the main direction of rotation, clockw. and circulating oil lubrication
5 Oil drain plug for type of construction IM B35
6A Oil intake for the main direction of rotation, clockwise and circulating oil lubrication
6B Oil intake for the main direction of rotation, counter–clockwise and circulating oil lubrication
7 Oil intake for type of construction IM V15 (this must be connected–up)
8 Oil intake for type of construction IM V36
9 Connector, Harting type HAN 8 U

Fig. 3-11 AC motor and gearbox dimensions

Table 3-13 Two–stage selector gearbox (dimensions, overview 1)

Motor		Dimensions in mm (in)																
Frame size	**Type**	∅ **a10** **Drive–out housing**	∅ **a11** **k6**	∅ **a12**	∅ **a13** **g6**	∅ **e11** ±0.2	∅ **e12**	**f10**	**f11**	**f12**	**f13**	**f14**	**h** **Shaft height**	**m1**	**m2**	**m3**	**m4**	**m5**
100	1PH4 105	100	100	188	190	215	80	208	104	92	86.6	42.4	100	107	90.5	15	45	–
	1PH4 107																	
132	1PH4 133	116	118	249	250	300	100	270	135	117	89.5	39.5	132	131	100	15	53	60
	1PH4 135																	
	1PH4 137																	
	1PH4 138																	
160	1PH4 163	140	130	249	250	350	100	326	163	145	89.5	39.5	160	131	100	15	53	60
	1PH4 167																	
	1PH4 168																	

Table 3-14 Two–stage selector gearbox (dimensions, overview 2)

Motor		Dimensions in mm (in)														
Frame size	**Type**	**n1**	**n2**	**n3**	**p40**	**p41**	**p42**	**p43**	**q21**	**q22**	**q23**	**q31**	**q32**	**q33**	**q34**	**q35**	**q36**
100	1PH4 103	17	80	30	209	92	108	12	42	57–67	75	15	17.5	–	116	26	10
	1PH4 105																
	1PH4 107																
132	1PH4 133	30	108	35	268	78	136	12	46.9	57–66	72.1	20	22.5	129.5	142.5	29	10
	1PH4 135																
	1PH4 137																
	1PH4 138																
160	1PH4 163	30	135	35	324	78	164	17	48.2	74–83	69.8	20	22.5	–	142.5	29	10
	1PH4 167																
	1PH4 168																

Table 3-15 Two–stage selector gearbox (dimensions, overview 3)

Motor		Dimensions in mm (in)													
Frame size	**Type**	**q37**	**q38**	**q39**	**q40**	**q41**	**q42**	**q50**	**q51**	**s10**	**s11**	**s12**	**z10 Thread**	**No. of tapped holes**	**Motor with gearbox, total length k1**
100	1PH4 103	18	55	63	18	25	298	136	12	14	14	14	M8	8x45°	714
	1PH4 105														774
	1PH4 107														839
132	1PH4 133	20	58	71	20	25	346.5	136	28	18	18	14	M12	12x30°	805
	1PH4 135														875
	1PH4 137														925
	1PH4 138														960
160	1PH4 163	20	58	71	23	25	346.5	136	28	18	18	14	M12	12x30°	938
	1PH4 167														993
	1PH4 168														1024

■

Notes

Dimension Drawings

4

Note

Siemens AG reserves the right to change the dimensions of the motors as part of mechanical design improvements without prior notice. Dimension drawings can go out–of–date. Updated dimension drawings can be requested at no charge.

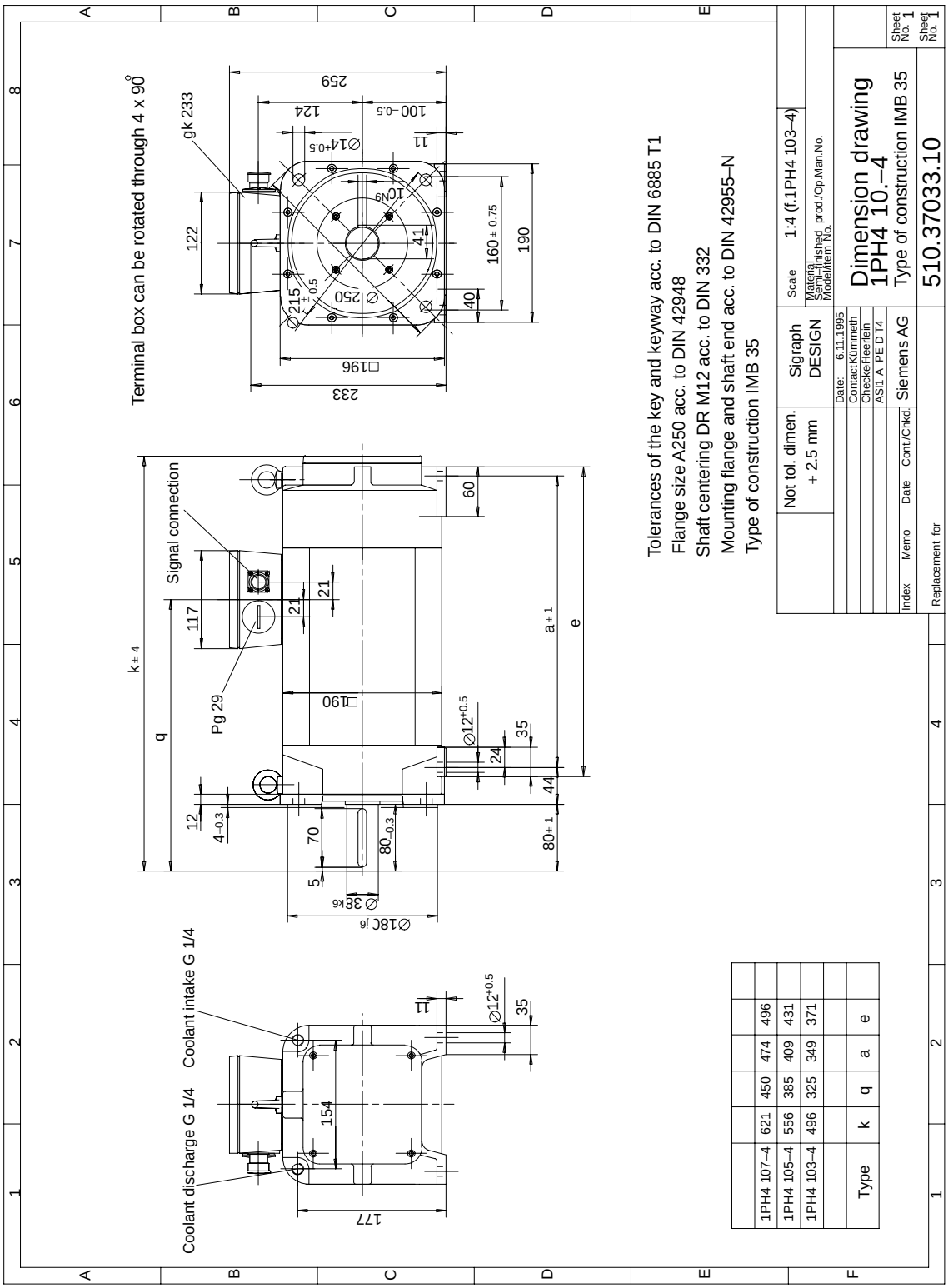
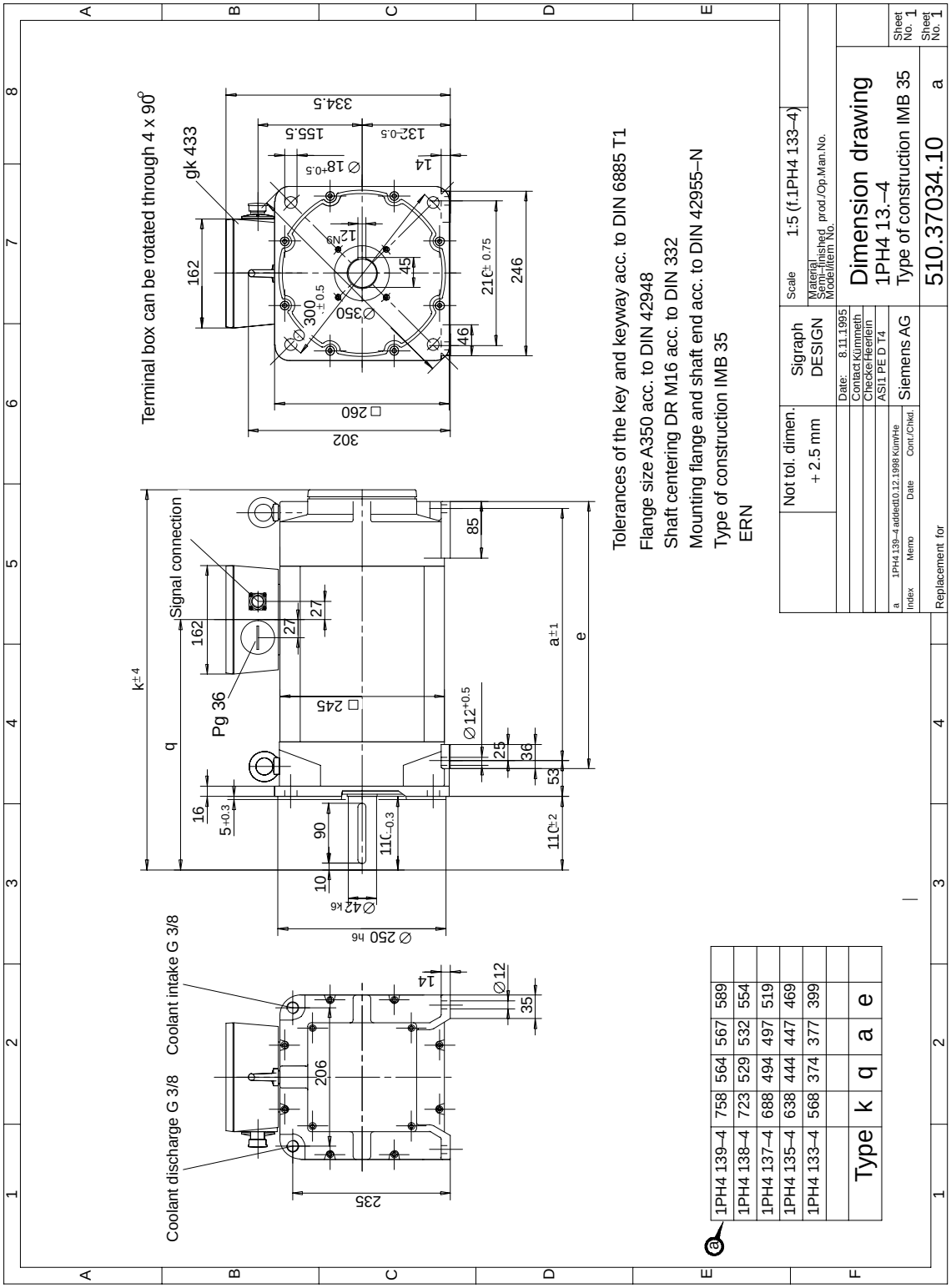


Fig. 4-1 1PH410.–4 in type of construction IM B35



Type	k	q	a	e
1PH4 139–4	758	564	567	589
1PH4 138–4	723	529	532	554
1PH4 137–4	688	494	497	519
1PH4 135–4	638	444	447	469
1PH4 133–4	568	374	377	399

Fig. 4-2 1PH413.–4 in type of construction IM B35

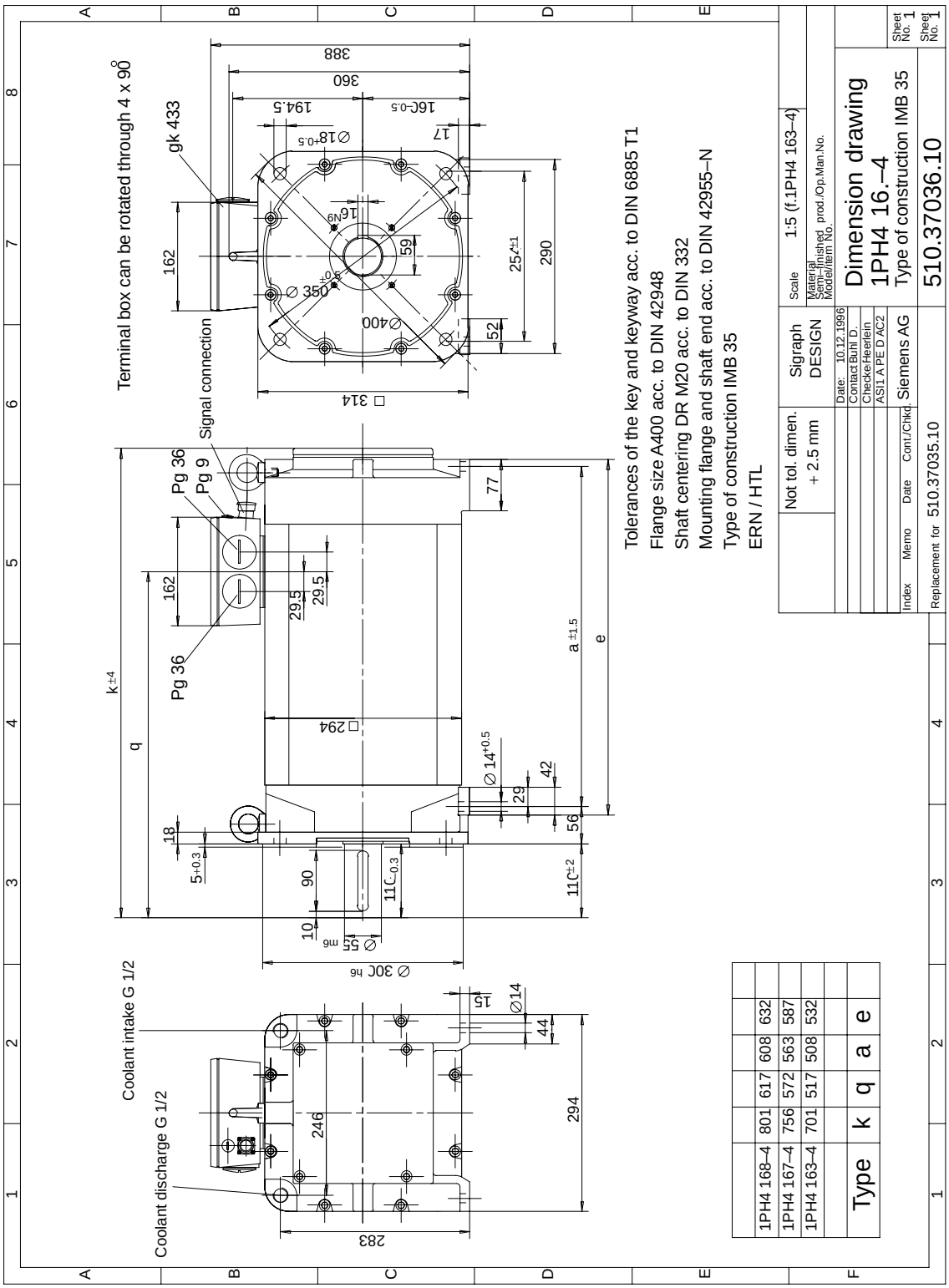


Fig. 4-3 1PH416.–4 in type of construction IM B35

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/BU/ **Catalog NC 60**

Automation Systems for Machine Tools
Ordering documentation
Order No.: E86060–K4460–A101–B1–7600 (English)

Electronic Documentation

/CD1/ **DOC ON CD**

The SINUMERIK System
(includes all SINUMERIK 840D/810D and SIMODRIVE 611D documents)
Order No.: 6FC5 298–6CA00

Manufacturer/Service Documentation

/ASAL/ **Configuration Manual, AC Induction Motors**

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/EMV/ Configuration Manual, EMC Design Guidelines

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Operating Instructions 1PH4

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