Planning Guide 10/2003 Edition

simodrive

AC Induction Motors
1PH4
SIMODRIVE 611

SIEMENS

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SIMODRIVE 611

AC Induction Motors 1PH4

Planning Guide

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10.2003 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

If factual changes have been made on the page since the last edition, this is indicated by a new edition coding in the header on that page.

Edition	Order No. for 1PH4	Remarks
10.03	6SN1197–0AC64–0BP0	**A**

This manual is part of the documentation on CD–ROM **(DOCONCD)**

Edition	Order No.	Remarks
03.04	6FC5 298–7CA00–0BG0	**C**

Additional information is available in the Internet under:
http://www.ad.siemens.de/mc

This documentation was produced with Interleaf V 7

Other functions not described in this documentation might be executable in the control. This does not, however, represent an obligation to supply such functions with a new control or when servicing.

We have checked that the contents of this publication agree with the hardware and software described herein. Nonetheless, differences might exist and therefore we cannot guarantee that they are completely identical. The information given in this publication is reviewed at regular intervals and any corrections that might be necessary are made in the subsequent printings. Suggestions for improvement are welcome at all times.

Subject to change without prior notice.

Order No.6SN1197-0AC64-0BP0
Printed in the Federal Republic of Germany

Siemens–Aktiengesellschaft

Foreword

Information on the documentation

This document is part of the technical customer documentation developed for the SIMODRIVE drive converter system. All publications are available individually. The documentation list, which includes all Advertising Brochures, Catalogs, Overview, Short Descriptions, Operating Instructions and Technical Descriptions with order number, 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.

Furthermore, the contents of this document shall neither become part of nor modify any prior or existing agreement, commitment or 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 complete Planning Guides for 1PH and 1PL motors can be ordered in paper form.

Table 1-1 Planning Guide with General Section and 1PH and 1PL6 motors

Title	Order No. (MLFB)	Lan-guage
AC Induction Motors, 1PH and 1PL6	6SN1197–0AC61–0**A**P0	German
AC Induction Motors, 1PH and 1PL6	6SN1197–0AC61–0**B**P0	English

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

Table 1-2 Planning Guide, individual section

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

Start–up software

Start–up software is also available to start–up (commission) AC induction motors when connected to the SIMODRIVE drive converter system.

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

Hotline

If you have any questions please contact the following Hotline:

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	Fax: +49 (180) 5050–223
	eMail: adsupport@siemens.com

Please send any questions regarding the documentation (suggestions, corrections) to the following fax number:

+49 (9131) 98–2176

Fax form: Refer to the response sheet at the end of the document

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, ground and tag 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.
- Trained in rendering first aid.

Explanation of the symbols

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

Danger

This symbol is used in the document to indicate that death, severe personal injury or substantial property damage **will** result if proper precautions are not taken.

Warning

This symbol is used in the document to indicate that death, severe personal injury or property damage **can** result if proper precautions are not taken.

Caution

This symbol is used in the document to indicate that minor personal injury or material damage **can** result if proper precautions are not taken.

Caution

This warning (without warning triangle) indicates that material damage **can** result if proper precautions are not taken.

Notice

This warning indicates that an undesirable situation or condition **can** occur if the appropriate instructions/information are 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, fully corresponds to the specifications of Directive 98/37/EC.
- Only appropriately qualified personnel may commission/start–up the SIMODRIVE drive units and the AC motors.
- This personnel must carefully observe the technical customer documentation belonging to 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.
- Hazardous axis motion can occur when working with the equipment.
- All work must be undertaken with the system in a no–voltage condition (powered–down).
- SIMODRIVE drive units are designed for connection to line supplies that are grounded through a low–ohmic connection (TN line supplies). For additional information please refer to the appropriate documentation for the drive converter systems.

Warning

- Perfect and safe operation of these units and motors assumes professional transport, storage, mounting and installation as well as careful operator control and servicing.
- The information provided in catalogs and quotations additionally applies to special versions of units and motors.
- 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 no temperature–sensitive components, e.g. cables or electronic components may be in contact or be attached to the motor.
- When handling cables, please observe the following
  - They may not be damaged
  - They may not be stressed
  - They may not come into contact with rotating components**.**

Caution

- Motors should be connected up according to the circuit diagram provided. It is not permissible to directly connect the motors to the three–phase line supply as this will destroy the motors.
- SIMODRIVE drive units with AC motors are subject, as part of the routine test, to a voltage test in accordance with EN 50178. 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.

Note

- 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, EMC Directive 89/336/EEC.

ESDS information

Caution

Electro**S**tatic **D**ischarge **S**ensitive devices (ESDS) are individual components, integrated circuits or boards which, when handled, tested or transported, could be destroyed by electrostatic fields or electrostatic discharge.

Handling ESDS boards:

- When handling components which can be destroyed by electrostatic discharge, it must be ensured that personnel, the workstation and packaging are well grounded!
- Electronic boards may only be touched by personnel in ESDS areas with conductive flooring if
  - they are grounded with an ESDS bracelet
  - they are wearing ESDS shoes or ESDS shoe grounding strips.
- Electronic boards should only be touched when absolutely necessary.
- Electronic boards would not be brought into contact with plastics and articles of clothing manufactured from man–made fibers.
- Electronic boards may only be placed on conductive surfaces (table with ESDS surface, conductive ESDS foam rubber, ESDS packing bag, ESDS transport containers).
- Electronic boards may not be brought close to data terminals, monitors or television sets. Minimum clearance > 10 cm).
- Measuring work may only be carried–out on the electronic boards, if
  - the measuring unit is grounded (e.g. via a protective conductor) or
  - for floating measuring equipment, the probe is briefly discharged before making measurements (e.g. a bare–metal control housing is touched).

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■

Space for your notes

Motor Description

1

1.1 Applications and features

Applications

The 1PH4 series is suitable for the closed–loop speed controlled operation of main spindles on machine tools, transfer lines and special–purpose machines.

For compact machine tool designs, the power loss from the electrical drives can have a negative impact on the machining precision. The resulting requirement for cold–running motors resulted in the development of the water–cooled 1PH4 AC main spindle motors.

Features

1PH4 motors are water–cooled squirrel–cage induction motors. As a result of the compact design, high maximum speeds (up to 12000 RPM) can be reached.

Depending on the shaft height, the 1PH4 series of motors has rated outputs of between 7.5 and 52 kW at rated speeds of 1500 RPM.

The power of these water–cooled motors can be increased by up to 40 % over the power of air–cooled motors.

The 1PH4 series has compatible flange and shaft dimensions to the air–cooled 1PH7 AC motors.

Standards, regulations

The appropriate standards and regulations are directly assigned to the functional requirements.

1.2 Technical design

Table 1-1 Standard motors

Technical features	Design
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 gland IP 55)
Cooling	Water cooling (≤ 25 °C, otherwise de–rating)
Thermal motor protection (acc. to IEC 60034-6)	KTY 84 temperature sensor in the stator winding
Winding insulation (acc. to IEC 60034)	Temperature rise class F for a cooling medium temperature of +25 °C
Motor voltage	Max.: 3–ph. 430 V AC
Motor noise (acc. to DIN 45635) Tolerance +3 dB	up to shaft height 132: max. 69 dB (A) shaft height 160: max. 71 dB (A)
Speed control range	> 1: 500 000
Terminal box arrangement	Top
Connection type	Motor: via terminal box Encoder: via signal connector
Encoder system	Integrated optical encoder • 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 to shaft height 132: Tolerance zone k6 shaft height 160: Tolerance zone m6
Bearing design (A side)	Double–bearing design[1)] (deep–groove ball bearings and roller bearings)
Flange version, radial eccentricity	Tolerance N (acc. to DIN 42 955)
Vibration severity (acc. to IEC 60034-14)	Level R
Paint finish	Anthracite

1.3 Technical version, options

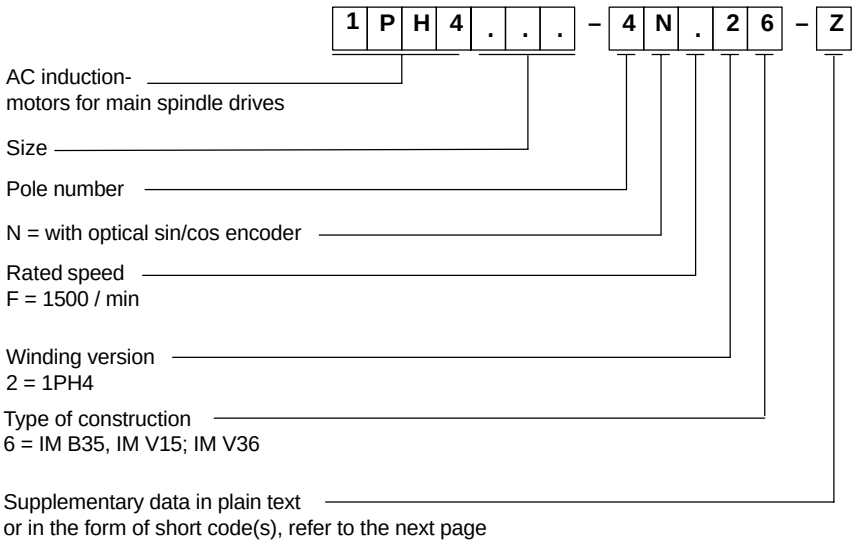
Table 1-2 Option

Technical feature	Design
Terminal box arrangement	Terminal box, mounted on the left or right
Balancing	Half–key balancing (dynamic) (acc. to DIN ISO 8821) Code: ”H” at the shaft face
Shaft end	Cylindrical; without keyway and without key (acc. to DIN 748, Part 3); solid shaft Tolerance zone k6 (up to shaft height 132) Tolerance zone m6 (up to shaft height 160)
Bearing design (A side)	Single–bearing design for coupling outdrive or planetary gear mounting; bearing design for increased speeds
Flange version, radial eccentricity	Tolerance R (acc. to DIN 42 955)
Vibration severity (acc. to IEC 60034-14)	Level S (single/double–bearing design) Level SR for shaft heights 100 to 160 (single–bearing design)
Mounted/integrated components	• Selector gearbox • Holding brake
Rating plate	2nd rating plate, supplied loose

1) Not suitable for use with couplings; minimum cantilever force required.

1.4 Order designation

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



Supplementary data for options

Option	Brief designation
Terminal box arrangement (when viewing the A side)	
• Mounted on the righthand side	**K09**
• Mounted on the lefthand side	**K10**
• The small terminal box and signal connector connections rotated through 90° (cable entry from the A side)	**K83**
• The small terminal box and signal connector connections rotated through 90°(cable entry from the B side)	**K84**
• The small terminal box and signal connector connections rotated through 180°	**K85**
Bearing design on the DE	
• Single bearing design for coupling, planetary gear or for low up to average cantilever forces	**K00**
• Single bearing design for increased speeds	**L37**
• Radial shaft sealing ring; oiltight	**K18**
Vibration severity (acc. to IEC 34–14, DIN VDE 0530, Part 14)	
• Level S for double bearing designs	**K05** [1) 4)]
• Level S for single bearing designs	**K02** [1) 4)]
• Level SR for single bearing designs	**K03** [1) 4)]
Shaft and flange accuracy (acc. to DIN 42955)	
• Tolerance R	**K04** [2)]
Shaft end DE	
• Shaft end ”B” (without keyway)	**K42**
Balancing	
• Half key balancing	**L69**
Gearbox [5)]	
• The motor is prepared for mounting a 2LG43 ZF selector gearbox	**K00** [3)]
Holding brake	
• Motor with mounted holding brake (A side)	**G46** [4)]
Others	
• 2nd rating plate, supplied loose	**K31**
• Without encoder system	**H30**

1) Automatically includes version K04
2) Increased shaft precision
3) For 2LG42 gearboxes (old version), use G97+K00;
G97 = non–standard cylindrical shaft end for shaft height 100, WE ∅ 28 x 60 mm
4) Cannot be combined with a mounted gearbox
5) For shaft heights 32 and 160, a sealing compound (e.g. Terostat 93, from Terosan) must be used to establish a seal between the motor and gearbox flanges due to the interrupted sealing edge.

1.5 Rating plate data

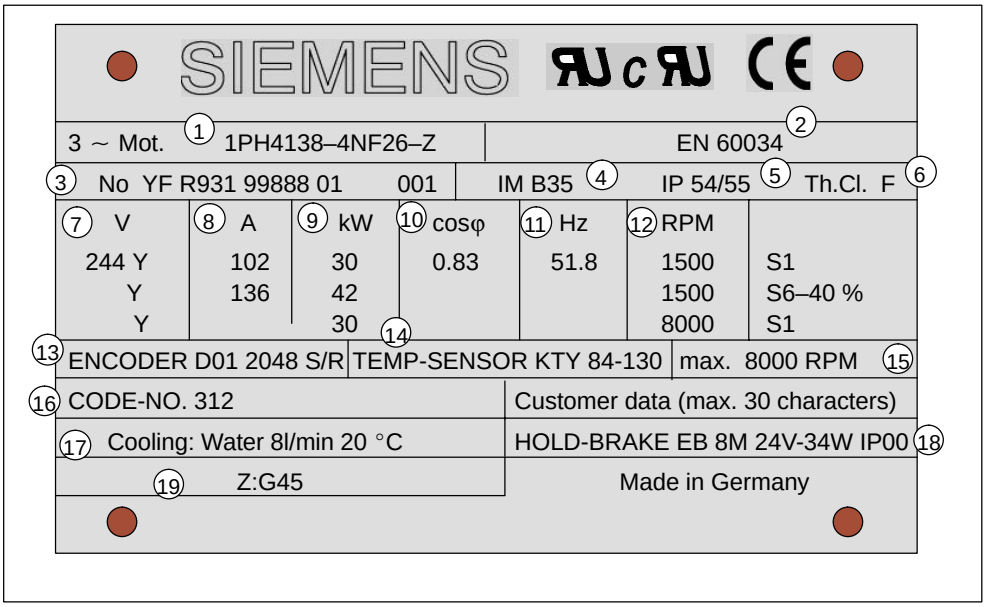


Fig. 1-1 Rating plate (example for 1PH4138), for a description, refer to Table 1-3

Table 1-3 Description of the rating plate data

Position	Description / Technical data
1	AC induction motor Order No.
2	Standards and Regulations
3	Serial No.
4	Type of construction
5	Degree of protection
6	Temperature rise class
7	Rated voltage [V] and winding configuration
8	Rated current [A]
9	Rated power [kW]
10	Power factor [cosφ]
11	Rated frequency [Hz]
12	Rated speed [RPM]
13	Designation, encoder type
14	Designation, temperature sensor
15	Maximum speed [RPM]
16	Code No. for SIMODRIVE 611 drive converters
17	Cooling data; cooling medium, flow rate
18	Designation, holding brake
19	Supplementary options

1.6 Cooling

The 1PH4 series is water–cooled in order to achieve a high power density.

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

Liquid cooling with a cooling unit is required for operation.

Cooling medium

Water or a low viscosity oil can be used as cooling medium.

If water is used as cooling medium, 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: www.tyfo.de
Joh. A. Beckiser Wassertechnik GmbH	Bergstr. 17 D-40699 Erkrath	Tel.: 02104 / 40075
CINCINATI CIMCOOL Cincinati Milacron b. v. / Cimcool Division	Postfach 98 NL–3031 AB Vlaardingen	Tel.: 003110 / 4600660
Fuchs Petrolub AG	Friesenheimer Strasse 17 D-68169 Mannheim	Tel.: 0621 / 3802–0 URL: www.fuchs–oil.com
Hebro Chemie GmbH	Rostocker Straße D-41199 Mönchengladbach	Tel.: 02166 / 6009–0 URL: www.hebro–chemie.de
Hoechst	Refer to the Internet address	URL: www.hoechst.com
Houghton Lubricor GmbH	Werkstrasse 26 D-52076 Aachen	Tel.: 02408 / 14060
Schilling–Chemie GmbH u. Produktions KG	Steinbeißstr. 20 D-71691 Freiberg	Tel.: 07141 / 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 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/characteristics of third–party products.

If e.g. Tyfocor is used (Tyforop Chemie GmbH), then 75% water and 25% anti–corrosion additive should be used.

When using another cooling medium (e.g. oil) it may be necessary to de–rate the motor so that the thermal motor limit is not exceeded.

The following properties of the cooling medium must be known in order to calculate the de–rating:

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

Note

For oil–water mixtures with less than 10% oil, the motor power does not have to be reduced. The cooling medium 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, liquid quantity, cooling power) must be maintained. If required, the cooling medium should be cleaned using a filter before it is fed to the motor cooling circuit.

Maximum permissible particle size after filtering: 100 µm

Cooling power and cooling quantity

Table 1-5 Cooling power and cooling quantity

Type	Cold water flow [l/min] ± 0.75	Cooling power [W]	Connection	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

Cooling medium intake temperature

Recommendation: up to 25 °C

In order to avoid moisture condensation, depending on the ambient temperature, the cooling medium intake temperature can be up to 40 °C.

The rated power P_N is reduced for increased cooling medium temperatures (refer to the Table 1-6).

Table 1-6 Rated power as a function of the cooling temperature

Cooling medium 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 cooling medium intake temperature of 25 °C. It is possible to operate several motors from a single cooling system.

The cooling system is not included in the scope of supply of the motors. You will find addresses of cooling system manufacturers in Catalog NC 60.

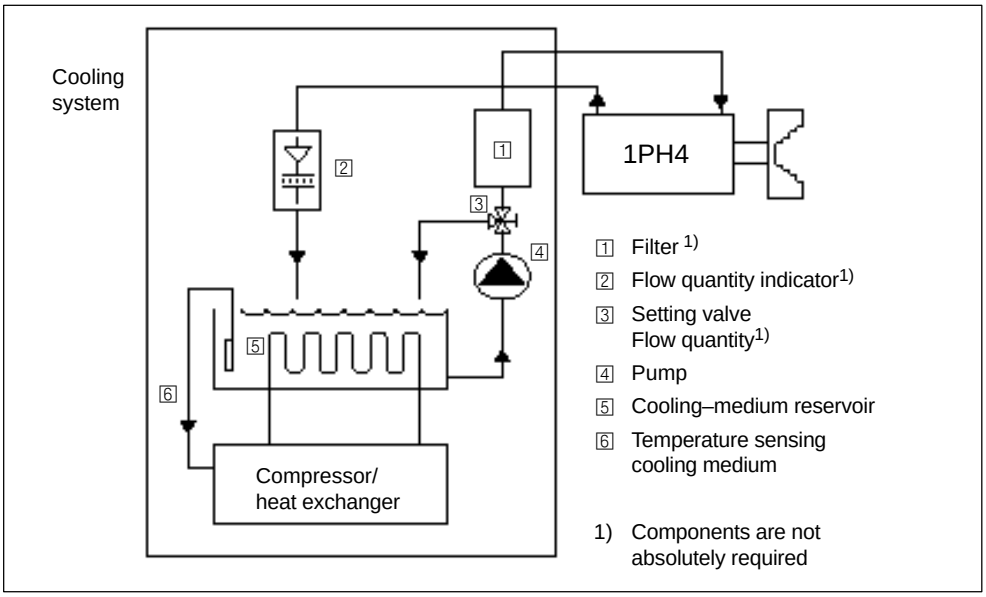


Fig. 1-2 Cooling circuit

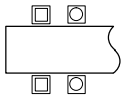
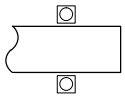
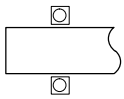
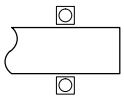
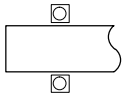
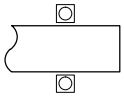
1.7 Bearing design

Standard

Double–bearing design on the A side (deep–groove ball bearings and roller bearings).
The double–bearing design is not suitable for a coupling outdrive.

Bearing versions

Table 1-7 Bearing versions

Applications	Bearing/option	Bearing/option	
		Drive end	Non–drive end
Belt drive • Minimum cantilever force required • For high cantilever forces	**Standard** double–bearing design		
Coupling outdrive or planetary gear • Reduced cantilever forces permissible	**K00, (K02, K03)** single–bearing design		
Increased max. speed • Outdrive without cantilever force required, e.g. coupling outdrive	**L37** single–bearing design ”spindle bearings”		

Bearing change intervals (t_{LW})

For single and double bearing designs, for a cooling medium temperature of +25 °C, bearing temperature of +85 °C and horizontal mounting.

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

Shaft height [mm]	Double–bearing design (standard)		Single–bearing design (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 intervals

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

Continuous operating speed

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

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

SH [mm]	**Double–bearing design** [RPM]		**Single–bearing design** [RPM]		**Bearings for increased speeds** [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 limit 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 terminal box, number of terminals, cross–sections which can be connected, number of auxiliary terminals and the cross–section for the PE connection are listed in the following tables.

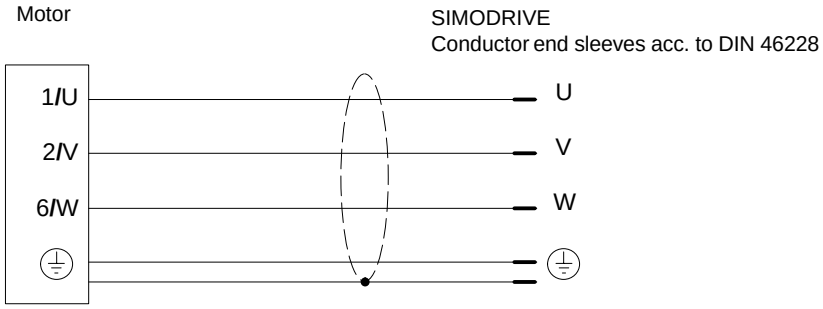
Table 1-10 Overview, 1PH4 connection system

Motor type	Number of main terminals	Max. cross–section which can be connected	Terminal strip for temperature sensor	PE connection size/ cable lug width
Shaft height 100	3xM5	16 mm^2	3 terminals	M4/9 mm
Shaft height 132	3xM5	35 mm^2 with cable lug connection	3 terminals	M5/15 mm
Shaft height 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 in compliance with 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 open conductors or conductors which are not being used or electrical cables which can be touched. If the brake feeder cables from the SIEMENS range of 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 locked–out so that it cannot be accidentally re–started!
- Please observe the rating plate data and the circuit diagram in the terminal box.

- Twisted or three–core cables with additional ground conductor should be used as motor cables. Only as much insulation should be removed from the ends of the conductors so that the insulation remains up to the cable lug or the terminal.
- The connecting cables must be freely arranged in the terminal box so that the protective conductor has a certain amount of excess length and so that the cable conductor insulation cannot be damaged. The connecting cables must be strain–relieved.
- Please ensure that the following minimum air clearances are maintained: Supply voltages up to 500 V: Minimum air distance 4.5 mm
- After the motor has been connected–up, the following must be checked:
  - the inside of the terminal box must clean and free of any pieces of conductor
  - all of the terminal screws must be tight
  - the minimum air distances must be maintained
  - the cable glands must be reliably sealed
  - unused cable entry glands must be closed–off and the sealing elements (e.g. plugs) tightly screwed in
  - all of the sealing surfaces must be in a perfect condition

Press drive

Note

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

Cross–sections

When making connections at the terminal board, the connecting cables must be dimensioned corresponding to the rated current. The size of the cable lugs must be selected to match the dimensions of the terminal studs.

Table 1-11 Current load capacity according to EN 60204–1 for PVC–insulated cables with copper conductors at an ambient temperature 40°C and routing type C (cables and conductors routed along walls and in cable trays)

I_{rms} at +40 °C [A]	Required cross–section [mm^2]	Comments
11.7	1	Correction factors regarding the ambient temperature and routing type should be taken from 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 and installation

Mounting instructions

Warning

This is an electric motor. 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 all of the warning information and instructions provided in this Chapter and 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.

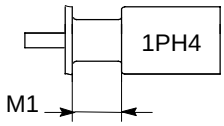
Warning

- 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 ensured 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 to insert the nut between the motor flange and motor frame acc. to DIN 42677 (refer to Table 1-1).

Table 1-12 Flange mounting with threaded studs and nut

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

Cable outlet NDE

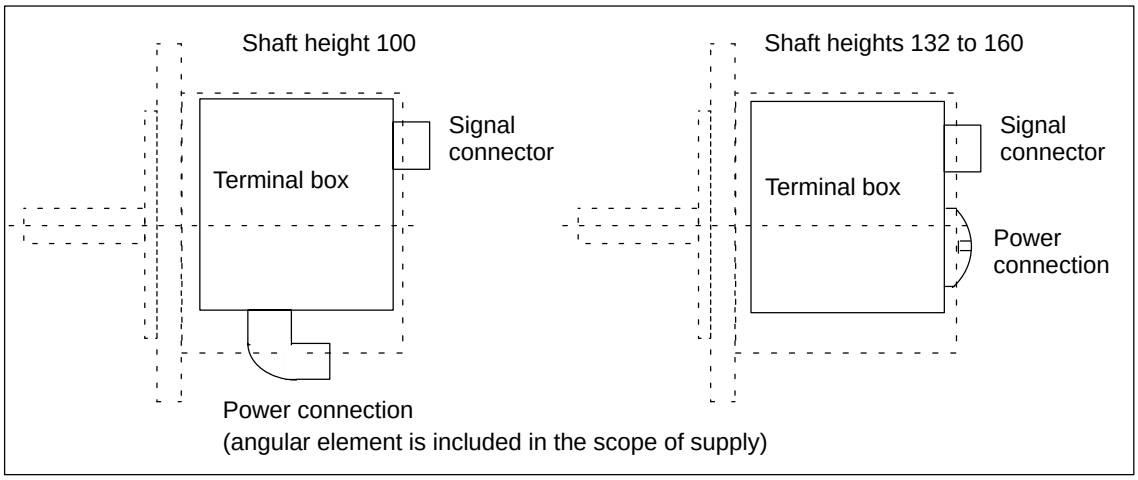


Fig. 1-3 Cable outlet

Mounting 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 that any resonant frequency is positioned as high as possible and it remains above the maximum rotational frequency.
- When motors are flange mounted, if the mounting is too ”soft”, then this can have a negative impact on the vibration quality of the drive unit. Foot mounting is required on the B side for type of construction IM B35 in order to maintain the vibration severity limit values.
- The sealing caps for the screw holes used to foot–mount 1PH4 motor must be re–located after the motor has been mounted.

Caution

Liquid must be prevented from collecting at the flange – for both vertical and horizontal mounting. If this is not observed, this can have a negative impact on the bearings 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, which is 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 to which the motor is mounted
- Stiffness of the motor in the area around the foot or customer flange
- Motor weight
- Weight of the machine 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

■

Space for your notes

Technical Data and Characteristics

2

2.1 Technical data

Table 2-1 Technical data of the 1PH4 series

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

Technical data

Table 2-2 Technical data – drive converter assignment, 1PH4

Motor type 1PH4...	n_N	n_{max} 2)	M_N	n_{max} with L37 2)	I_0	U_N	Rated motor power for duty type (acc. to EN 60 034) P_N [kW]			Rated motor current for duty type (acc. to EN 60 034) I_N [A]			Drive converter module for the motor duty type (acc. to EN 60 034) [A]		
	(RPM)	(RPM)	(Nm)	(RPM)	(A)	(V)	S1	S6–60 %	S6–40 %	S1	S6–60 %	S6–40 %	S1	S6–60 %	S6–40 %
Shaft height 100 mm															
103–4NF26	1500	9000	48	12 000	12	265	7.5	8.75	10	26	29	32	24/32 1)	24/32	24/32
105–4NF26			70		16	263	11	12.75	14.75	38	42	47	45/60	45/60	45/60
107–4NF26			90		19	265	14	16.25	18.75	46	52	58	45/60 1)	45/60	45/60
Shaft height 132 mm															
133–4NF26	1500	8000	95	10 000	17	229	15	18	21	55	65	74	60/80	60/80	60/80
135–4NF26			140		26	251	22	26.5	31	73	86	99	85/110	85/110	85/110
137–4NF26			170		31	265	27	32.5	38	85	100	114	85/110	85/110	85/110 1)
138–4NF26			190		34	244	30	36	42	102	119	136	120/150	120/150	120/150
Shaft height 160 mm															
163–4NF26	1500	6500	235	8000	44	286	37	45	52.5	107	125	142	120/150	120/150	120/150
167–4NF26			293		49	315	46	55	65	120	138	158	120/150	120/150	120/150 1)
168–4NF26			331		59	284	52	62.5	73	148	173	197	200/250	200/250	200/250

1) If required, use a larger module; refer to the diagram

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

2.2 P/n and M/n diagrams

Independent of the duty type, the main spindle AC motors must be continuously cooled in operation.

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

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

Table 2-3 Explanation of the codes

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 AC main spindle 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

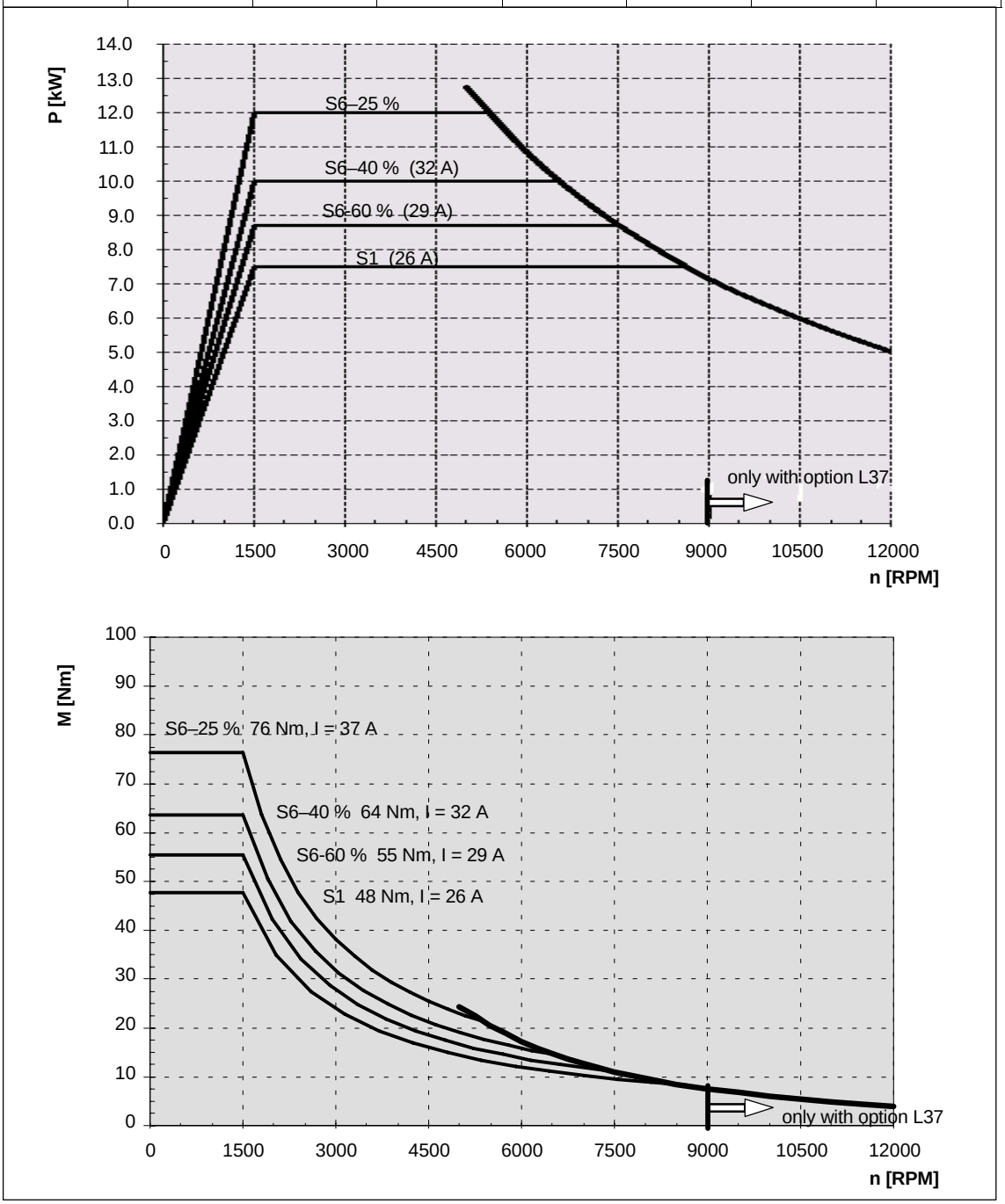


Fig. 2-1 1PH4103–4NF2

Table 2-5 AC main spindle 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

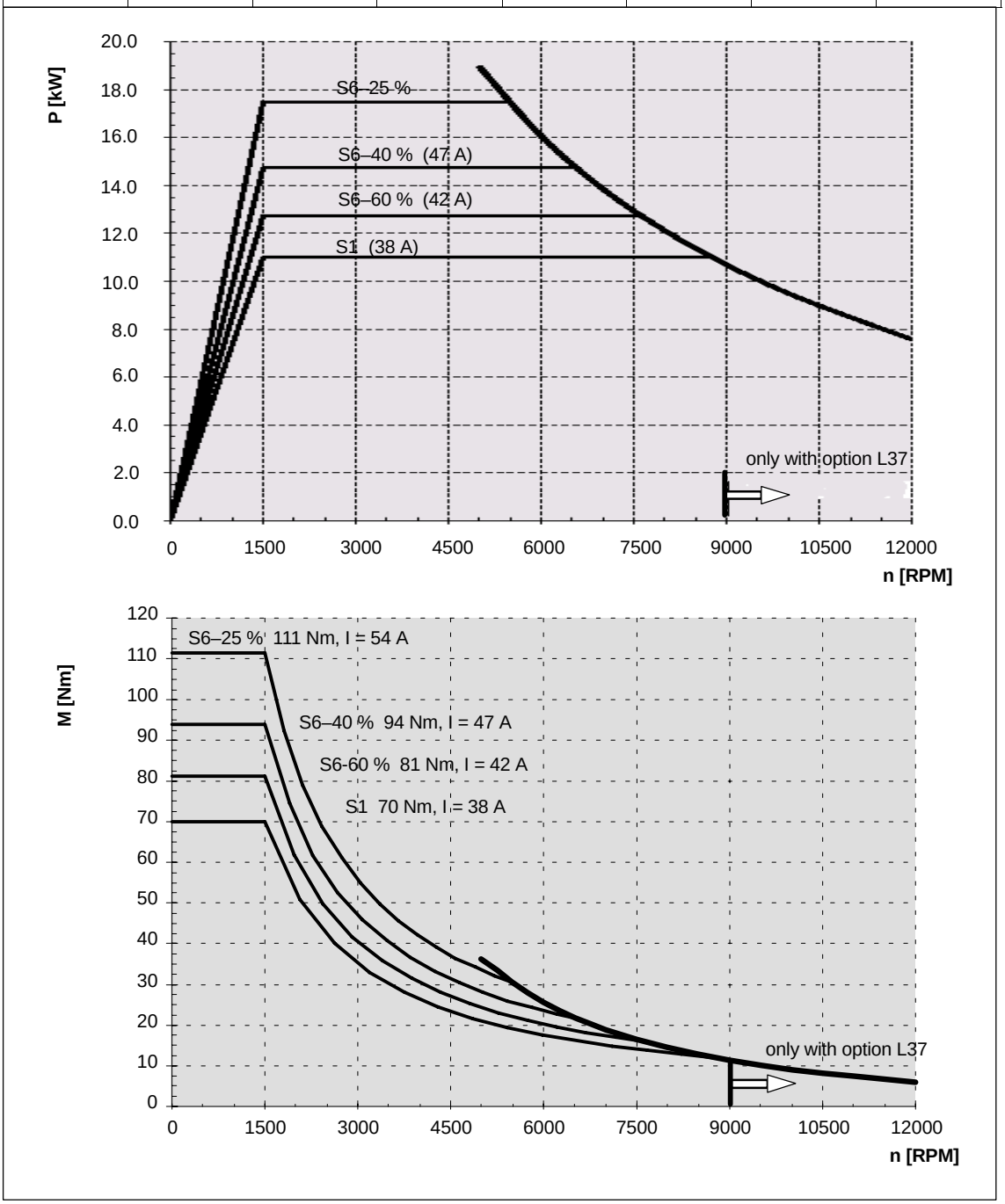


Fig. 2-2 1PH4105–4NF2

Table 2-6 AC main spindle 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

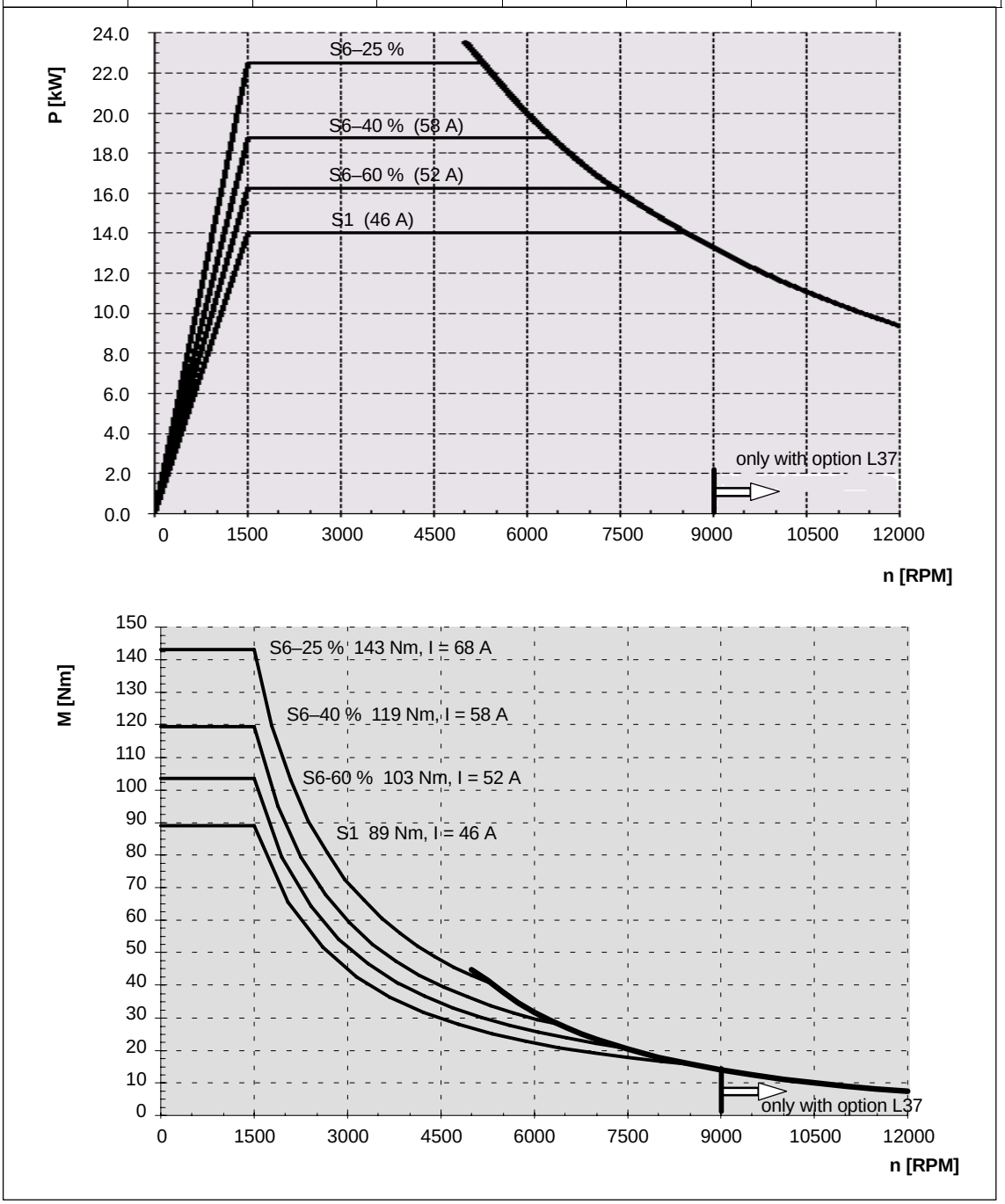


Fig. 2-3 1PH4107–4NF2

Table 2-7 AC main spindle 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

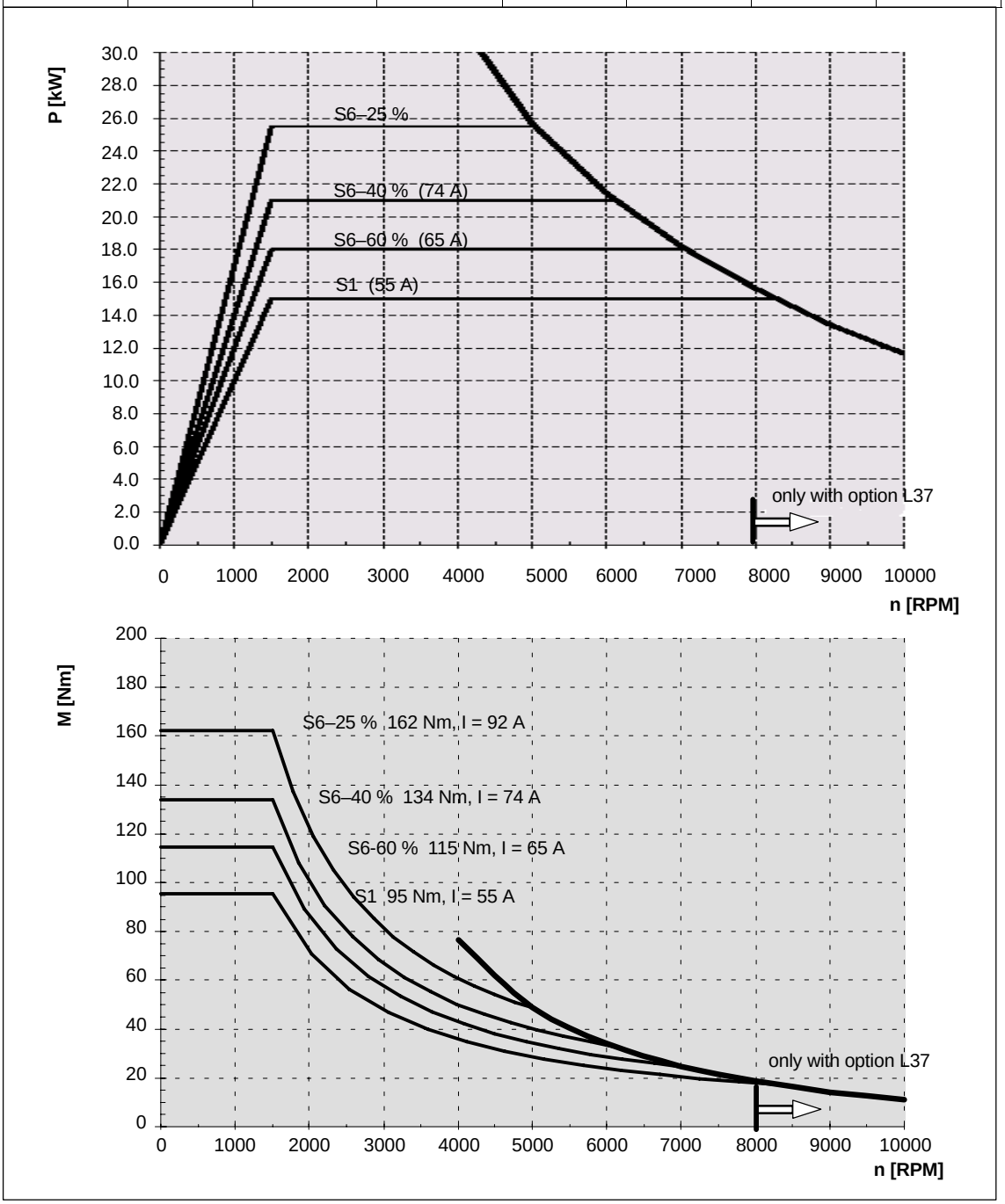


Fig. 2-4 1PH4133–4NF2

Table 2-8 AC main spindle 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

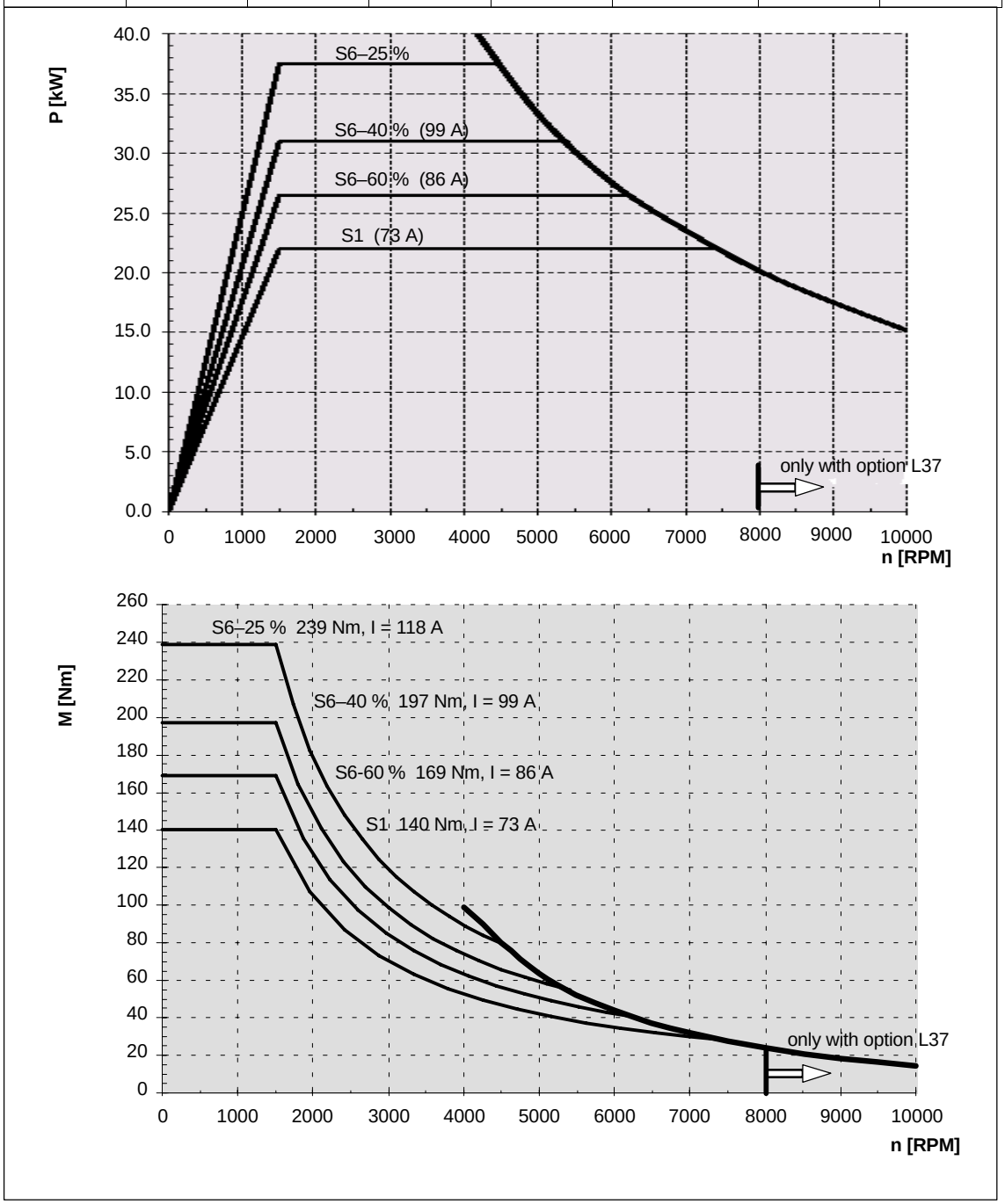


Fig. 2-5 1PH4135–4NF2

Table 2-9 AC main spindle 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

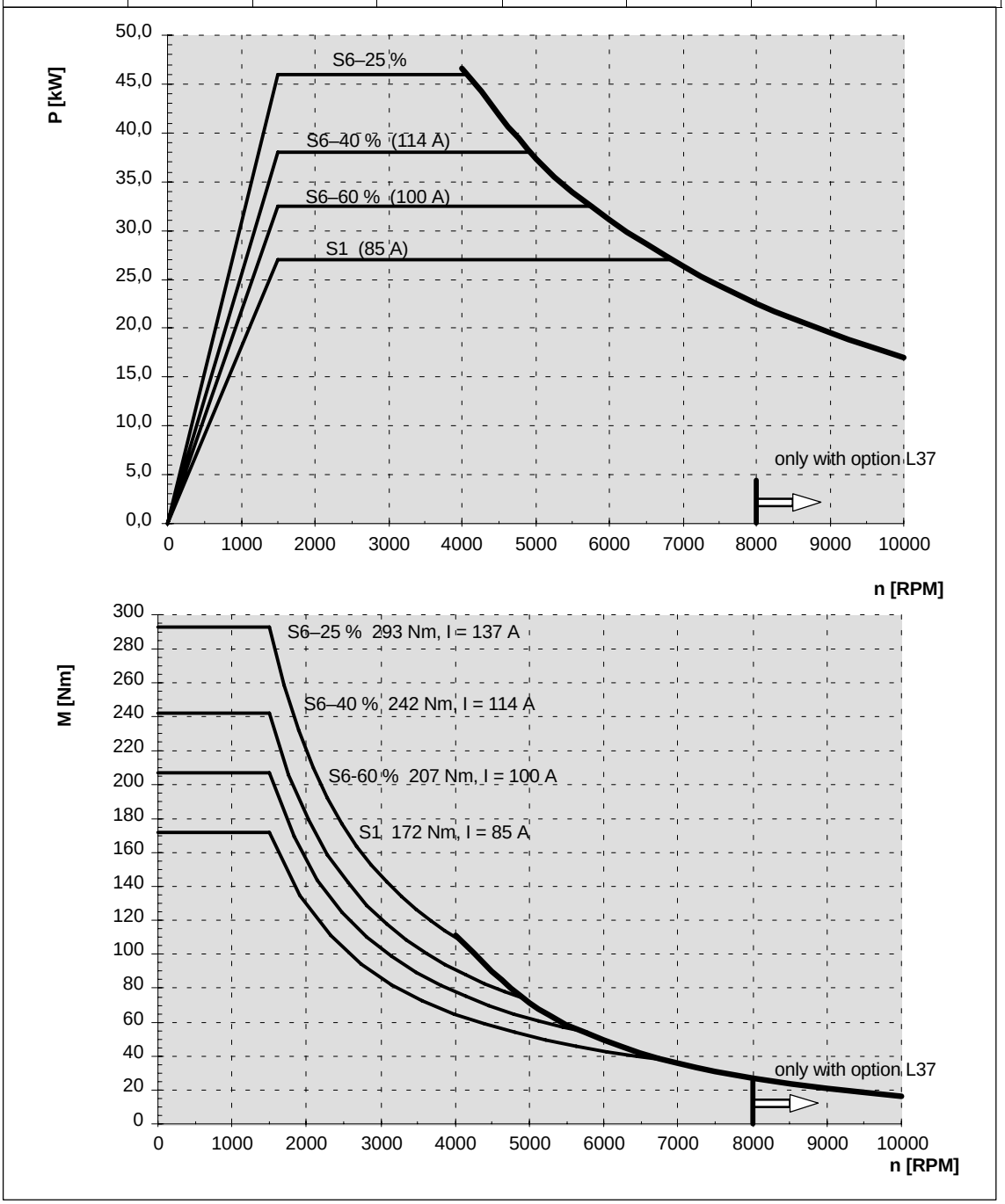


Fig. 2-6 1PH4137–4NF2

Table 2-10 AC main spindle 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

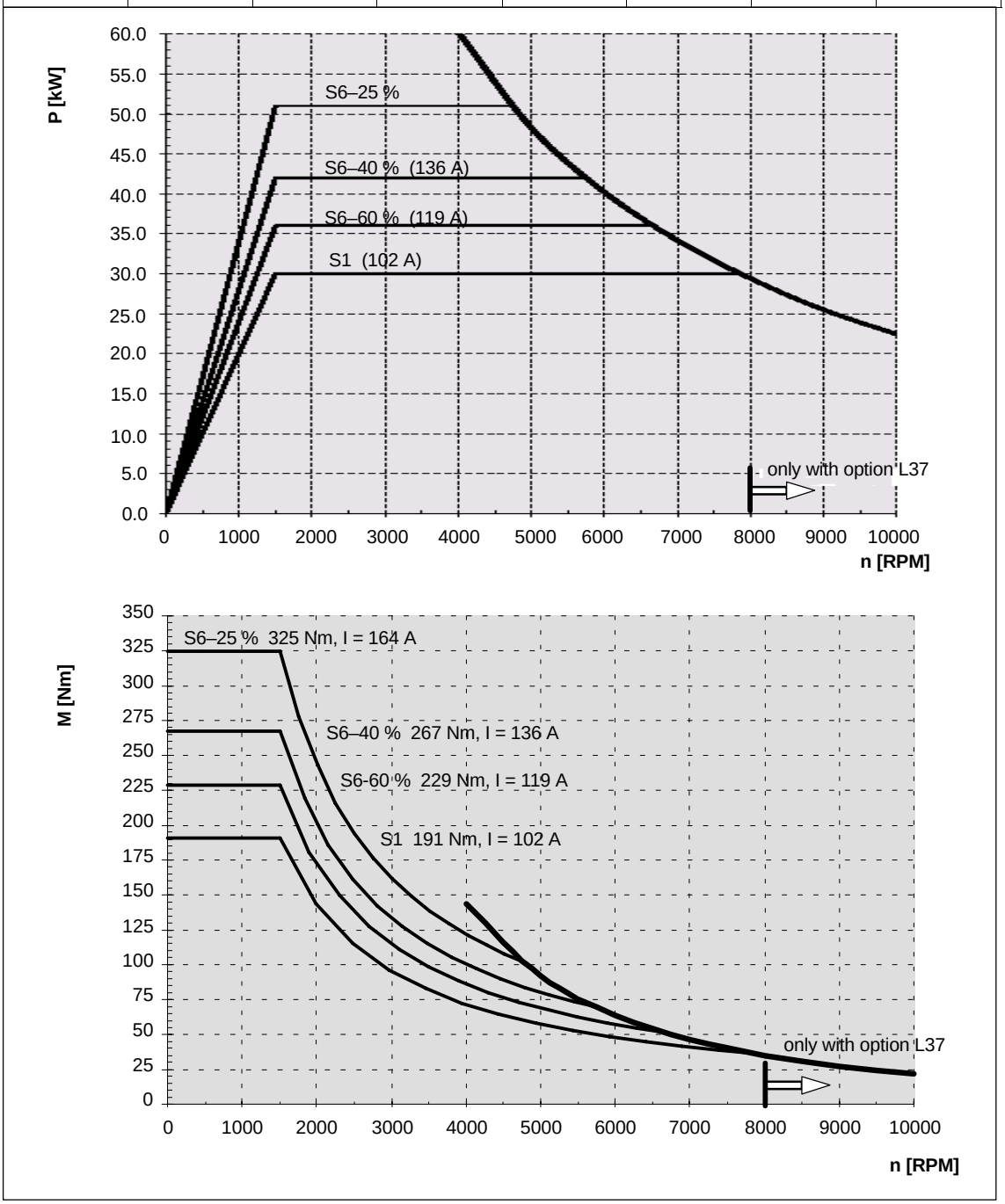


Fig. 2-7 1PH4138–4NF2

Table 2-11 AC main spindle 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

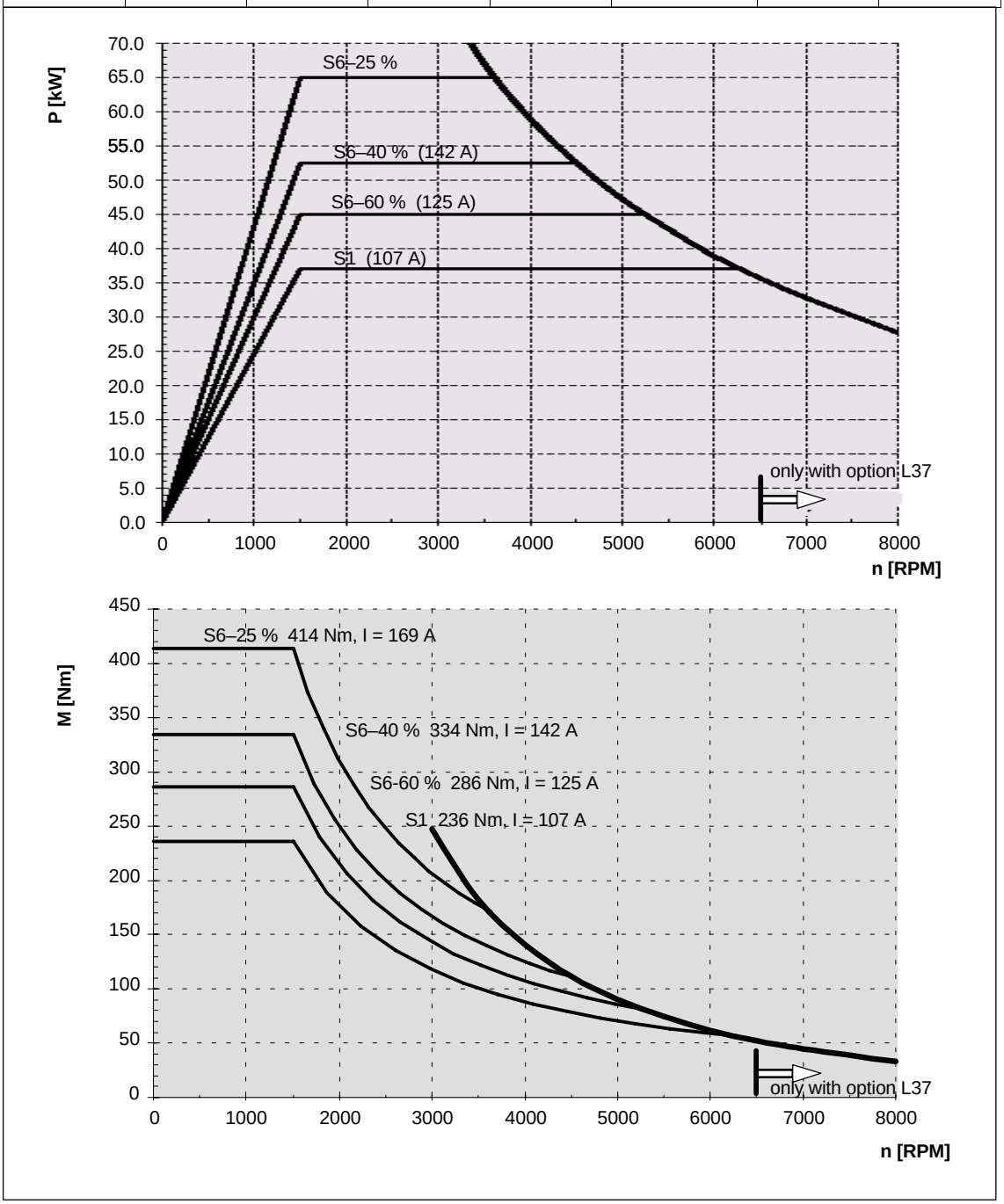


Fig. 2-8 1PH4163–4NF2

Table 2-12 AC main spindle 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

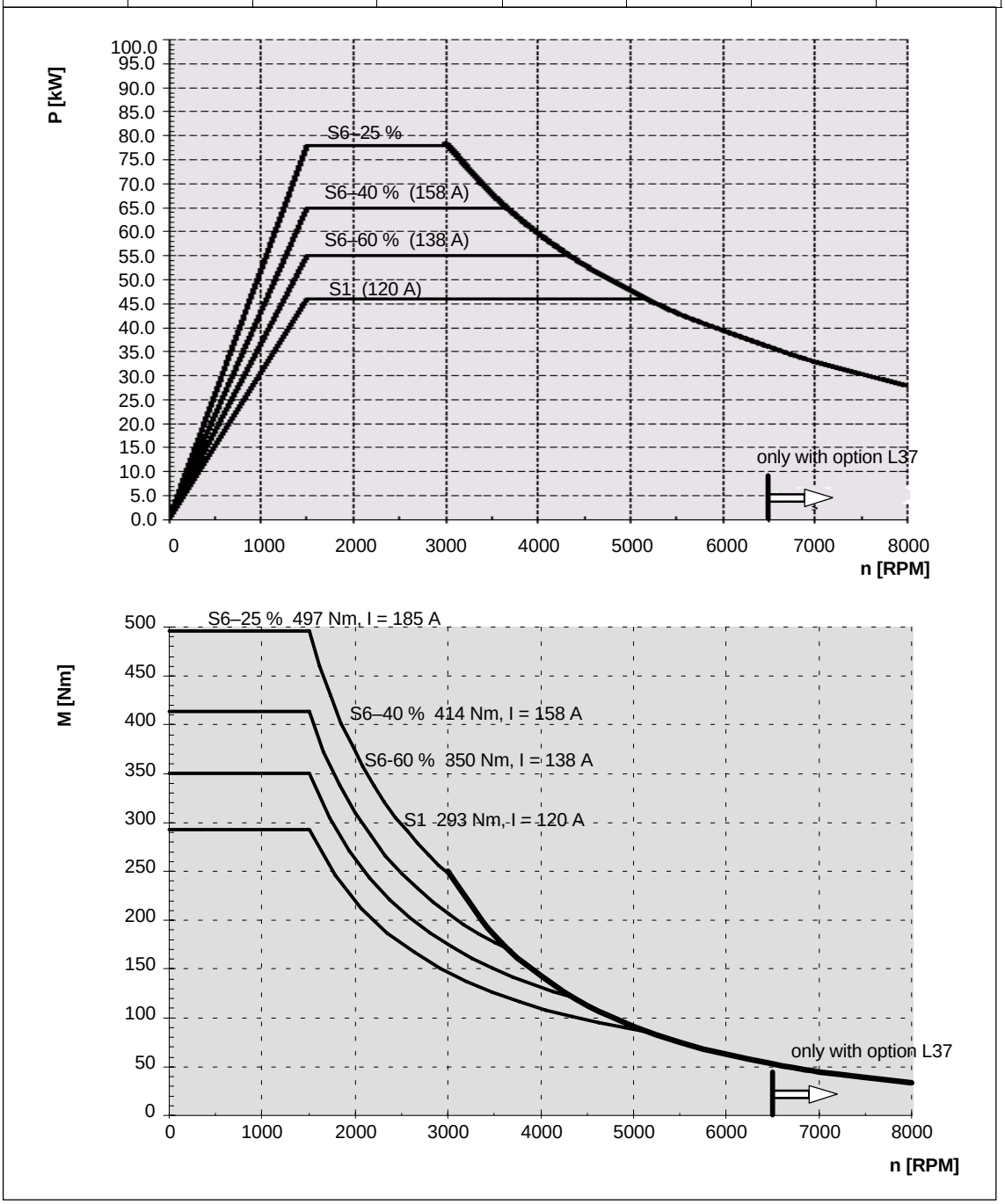


Fig. 2-9 1PH4167–4NF2

Table 2-13 AC main spindle 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

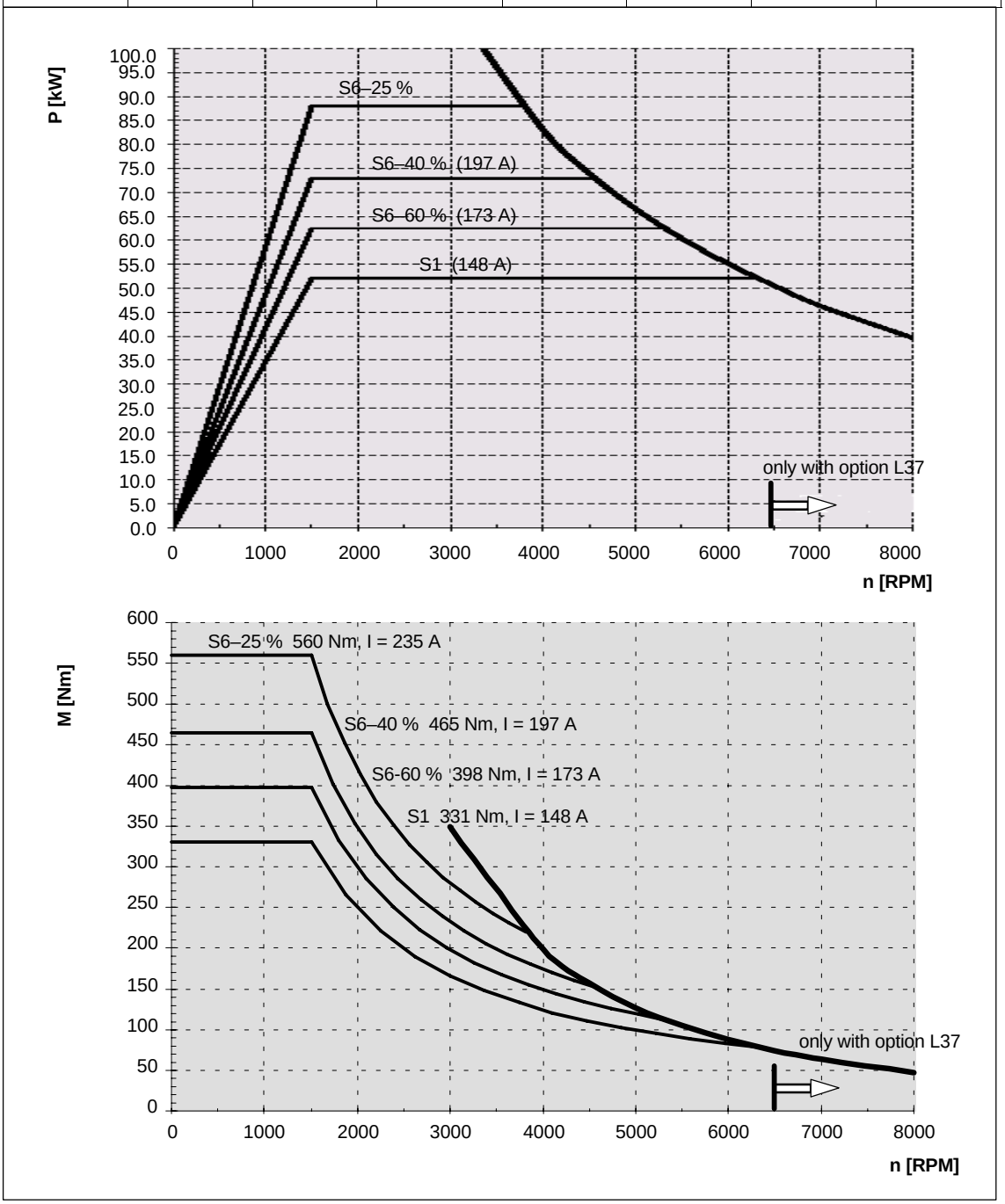


Fig. 2-10 1PH4168–4NF2

2.3 Axial and cantilever force diagrams

1PH4 main spindle motors are provided with double bearings on the A side in order to accept high cantilever forces due to belt tension.

For a definition, refer to the Planning Guide ”General Section”.

Axial force

The force diagrams and tables only apply for standard drive shaft ends; for non–standard drive shaft ends, the dimensions will be specified corresponding to the permissible force load for each application.

For forces which go beyond these values, please contact your local Siemens office.

Note

When using option L37 (increased speed), it must be ensured that the motors are only suitable for operation without any cantilever force!

Table 2-14 Axial forces F_A for double bearing designs (standard) as a function of the 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 Planning Guide ”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 force 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 extremely low cantilever force loads, it must be observed, that the **minimum cantilever force is applied to the motor shaft as specified in the diagrams**. Low cantilever forces can result in the cylindrical roller bearings rolling in an undefined fashion which would result in increased bearing wear.

For these particular applications, single bearing designs should be selected.

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

2.3.1 Cantilever force 1PH410□

Permissible cantilever forces for double–bearing designs (standard).

Max. continuous operating speed	n_{s1max} = 5600 RPM
Mechanical limit speed	n_{max} = 9000 RPM

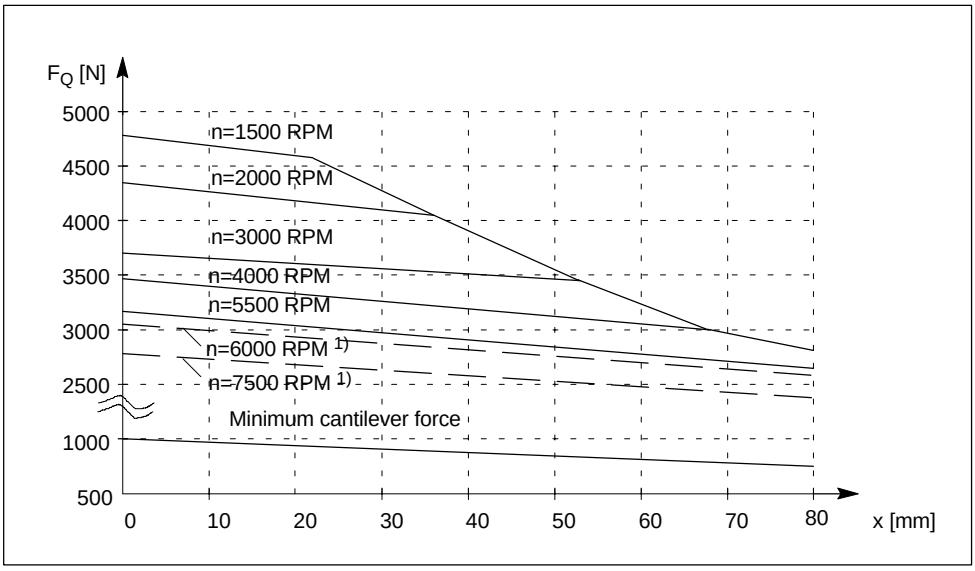


Fig. 2-11 Permissible cantilever force F_Q at a distance x from the shaft shoulder for a nominal bearing lifetime of 20 000 h.

1) Permissible for continuous duty, however with a reduced bearing lifetime

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

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

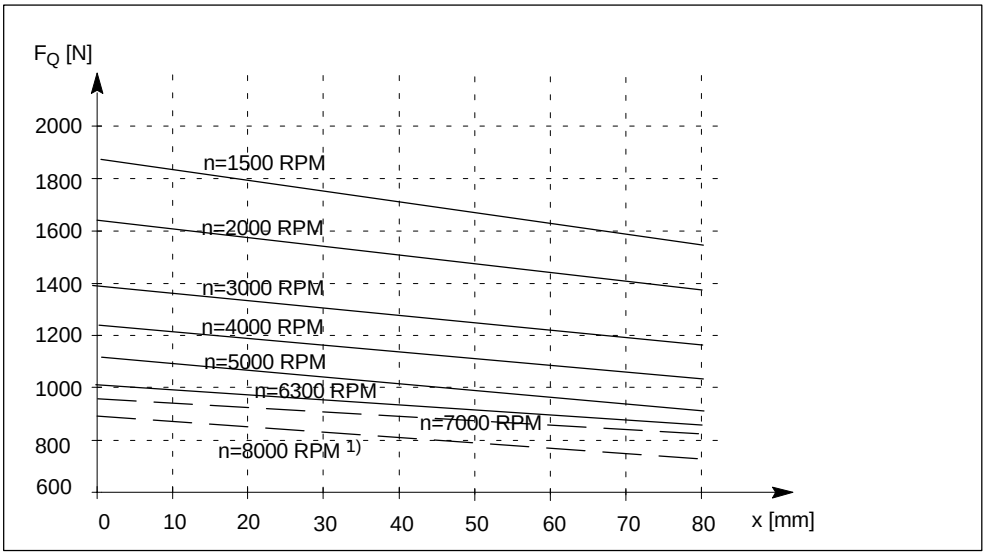


Fig. 2-12 Permissible cantilever force F_Q at a distance x from the shaft shoulder for a nominal bearing lifetime of 20 000 h. 1)

Permissible cantilever forces for 1PH410□, single bearing designs (option K00) as a function of the axial forces

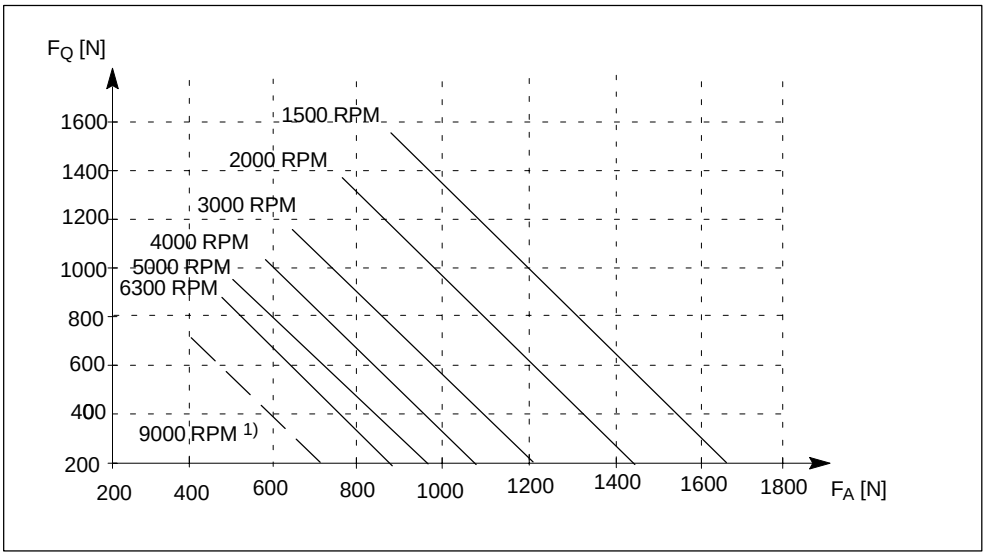


Fig. 2-13 Permissible cantilever force F_Q as a function of the axial force F_A for a nominal bearing lifetime of 20 000 h.

1) Permissible for continuous duty, however with a reduced bearing lifetime

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

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

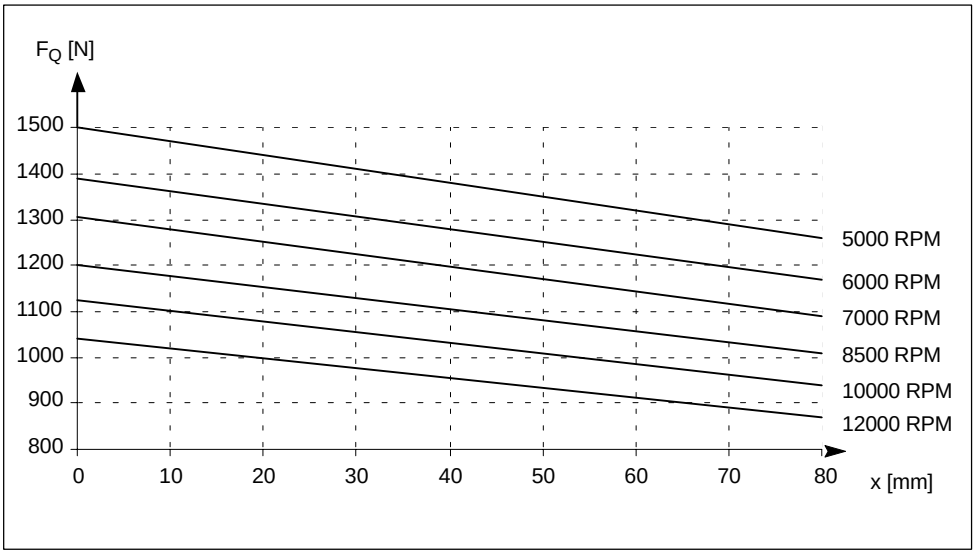


Fig. 2-14 Permissible cantilever force F_Q at a distance x from the shaft shoulder for a nominal bearing lifetime of 10 000 h [1)]

Permissible cantilever forces for 1PH410□, single bearing designs (option K00 with L37) as a function of the axial forces

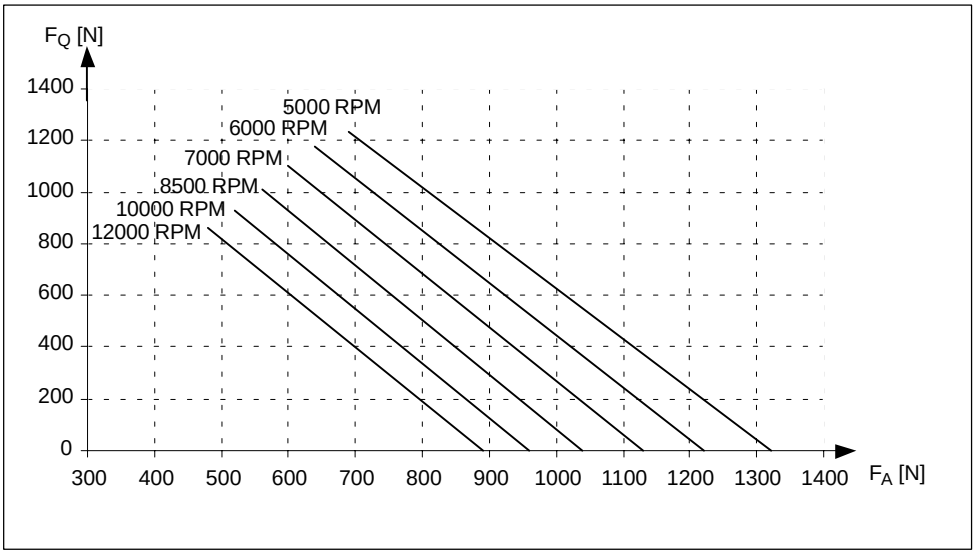


Fig. 2-15 Permissible cantilever force F_Q as a function of the axial force F_A for a nominal bearing lifetime of 10,000 h.

2.3.2 Cantilever force 1PH413□

Permissible cantilever forces for double–bearing designs (standard).

Maximum continuous operating speed	n_{s1max} = 5200 RPM
Mechanical limit speed	n_{max} = 8000 RPM

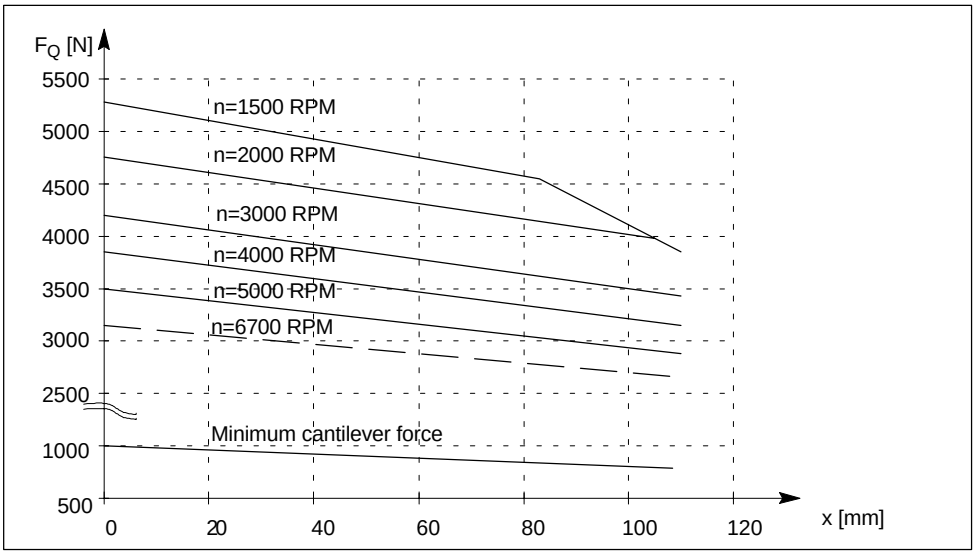


Fig. 2-16 Permissible cantilever force F_Q at a distance x from the shaft shoulder for a nominal bearing lifetime of 20,000 h [1)]

1) Permissible for continuous duty, however with a reduced bearing lifetime

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

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

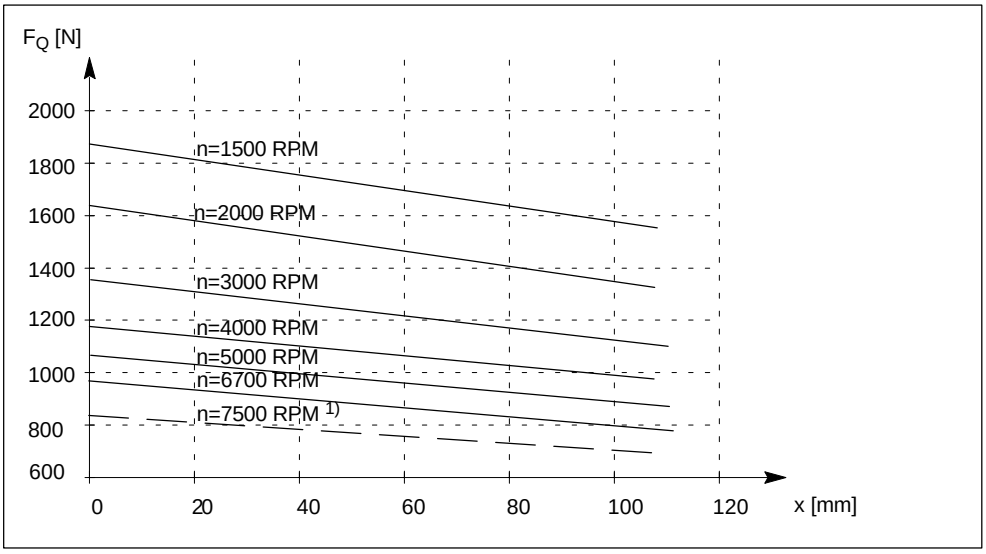


Fig. 2-17 Permissible cantilever force F_Q at a distance x from the shaft shoulder for a nominal bearing lifetime of 20 000 h. 1)

Permissible cantilever forces for 1PH413□, single bearing designs (option K00) as a function of the axial forces

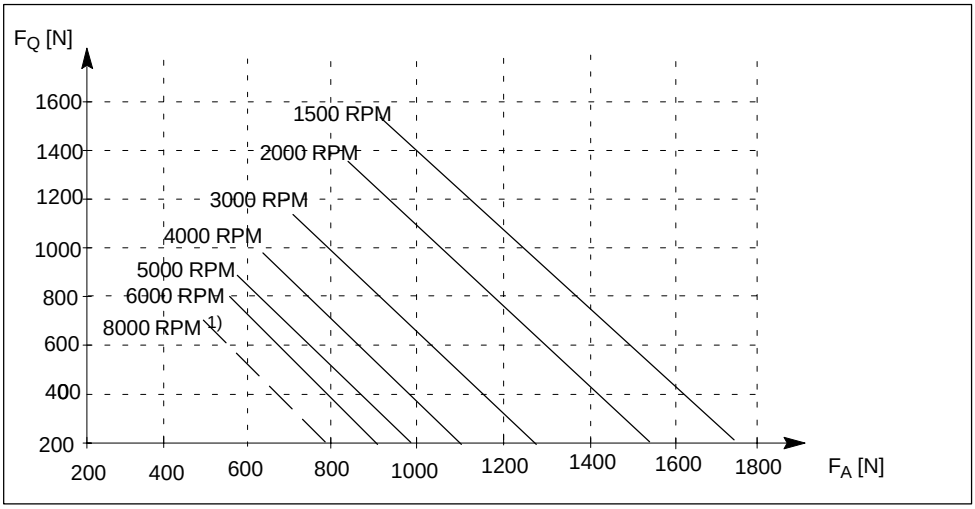


Fig. 2-18 Permissible cantilever force F_Q as a function of the axial force F_A for a nominal bearing lifetime of 20 000 h.

1) Permissible for continuous duty, however with a reduced bearing lifetime

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

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

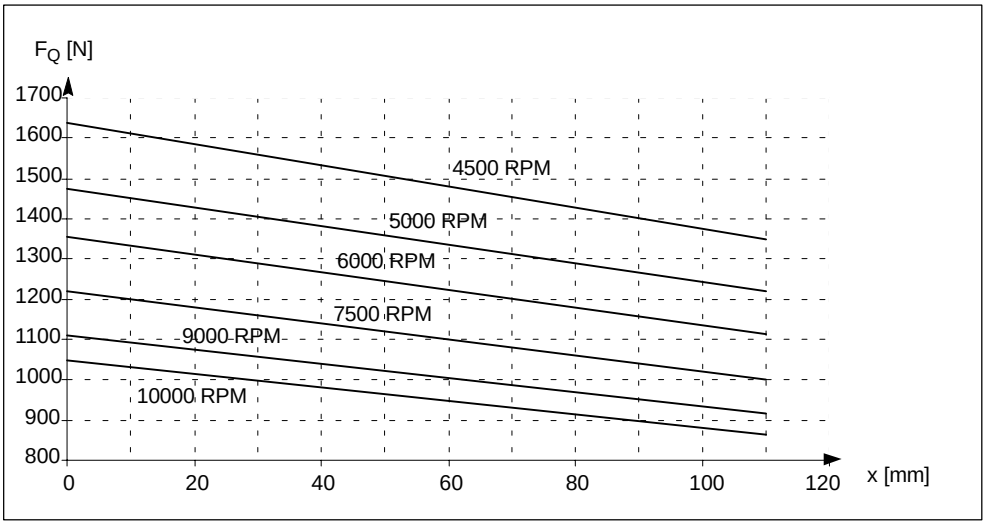


Fig. 2-19 Permissible cantilever force F_Q at a distance x from the shaft shoulder for a nominal bearing lifetime of 10,000 h. [1)]

Permissible cantilever forces for 1PH413□, single bearing designs (option K00 with L37) as a function of the axial forces

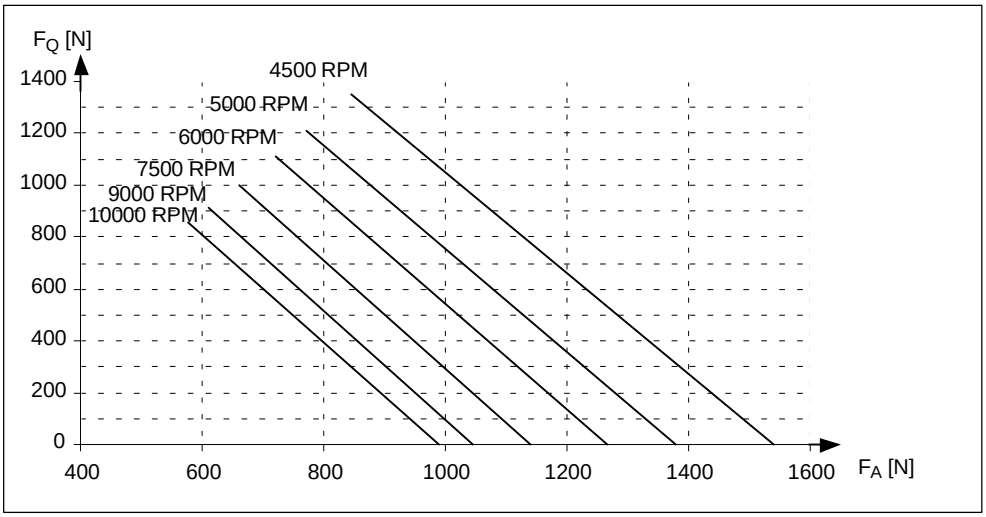


Fig. 2-20 Permissible cantilever force F_Q as a function of the axial force F_A for a nominal bearing lifetime of 10,000 h.

1) Permissible for continuous operation, however with a reduced bearing lifetime

2.3.3 Cantilever force 1PH416□

Permissible cantilever forces for double–bearing designs (standard).

Maximum continuous operating speed	n_{s1max} = 4000 RPM
Mechanical limit speed	n_{max} = 6500 RPM

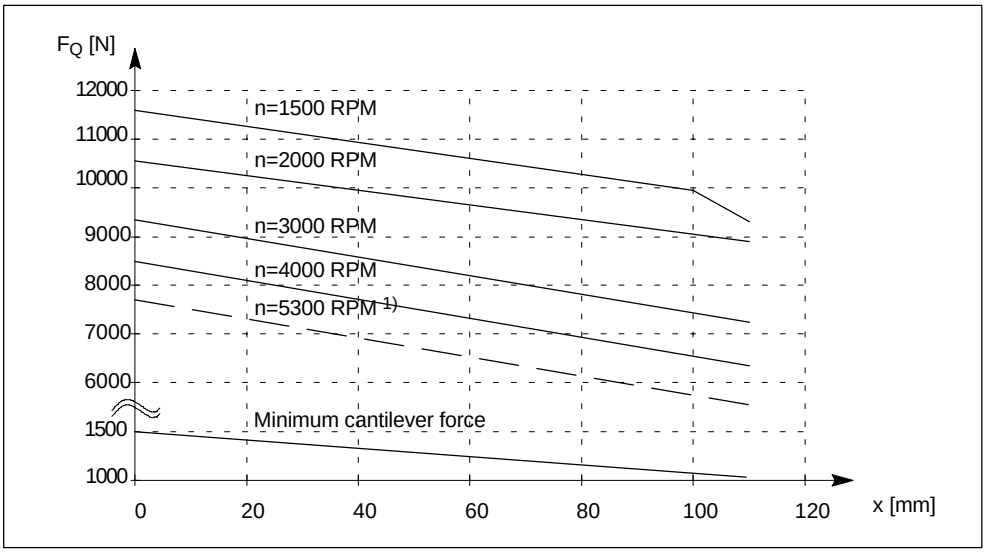


Fig. 2-21 Permissible cantilever force F_Q at a distance x from the shaft shoulder for a nominal bearing lifetime of 20 000 h.

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

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

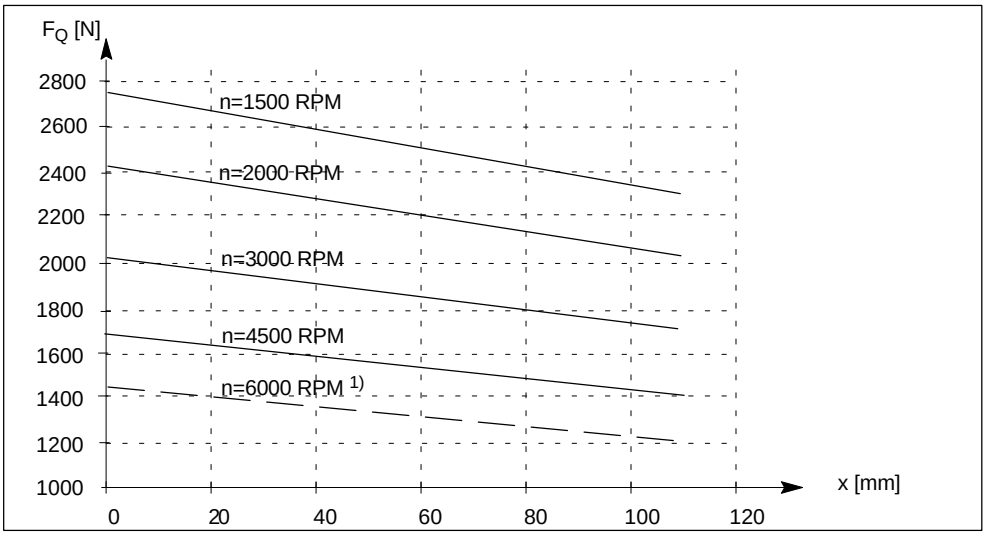


Fig. 2-22 Permissible cantilever force F_Q at a distance x from the shaft shoulder for a nominal bearing lifetime of 20 000 h. 1)

Permissible cantilever forces for 1PH416□, single bearing designs (option K00) as a function of the axial forces

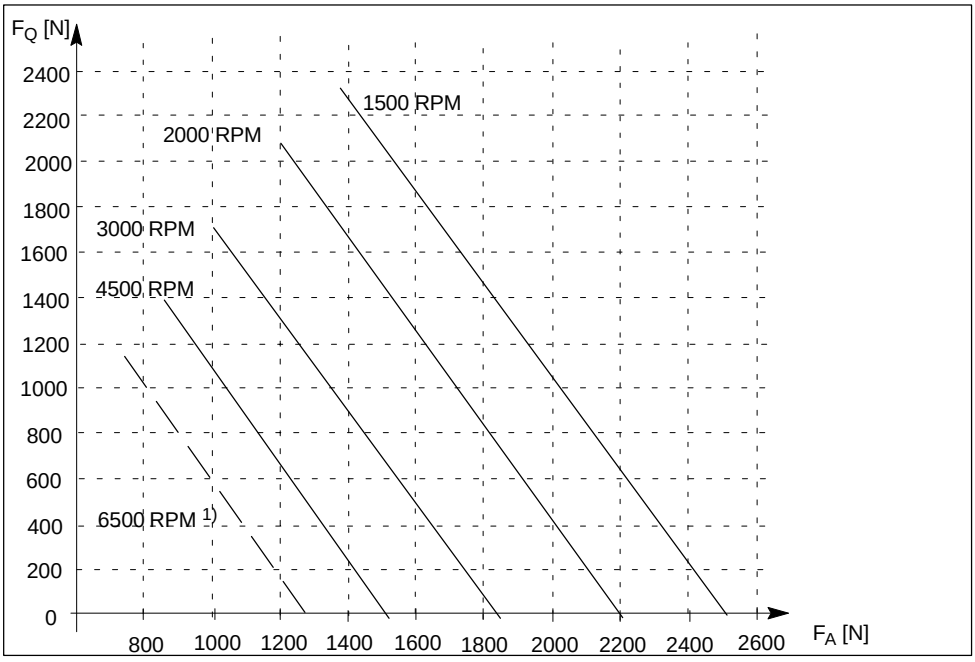


Fig. 2-23 Permissible cantilever force F_Q as a function of the axial force F_A for a nominal bearing lifetime of 20 000 h.

1) Permissible for continuous duty, however with a reduced bearing lifetime

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

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

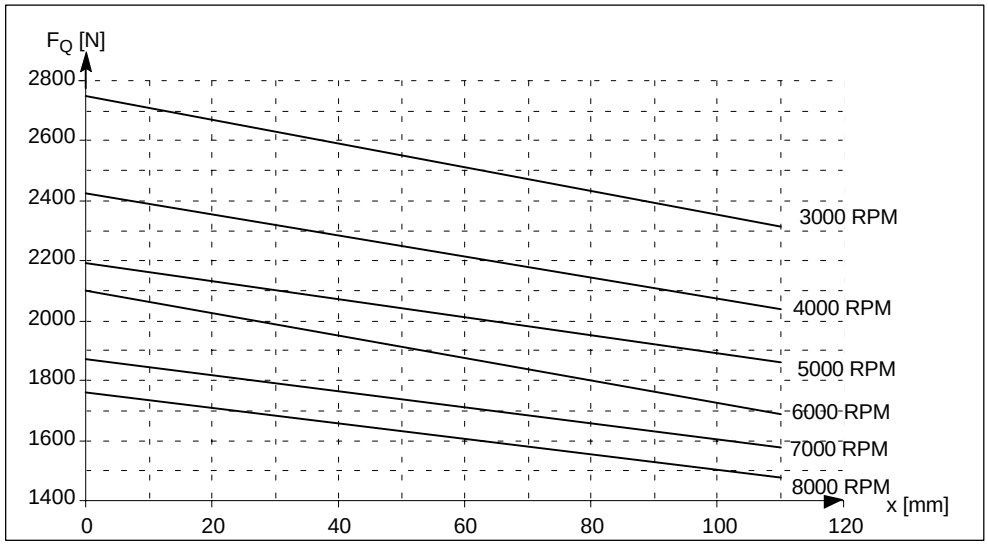


Fig. 2-24 Permissible cantilever force F_Q at a distance x from the shaft shoulder for a nominal bearing lifetime of 10,000 h. [1)]

Permissible cantilever forces for 1PH416□, single bearing designs (option K00 with L37) as a function of the axial forces

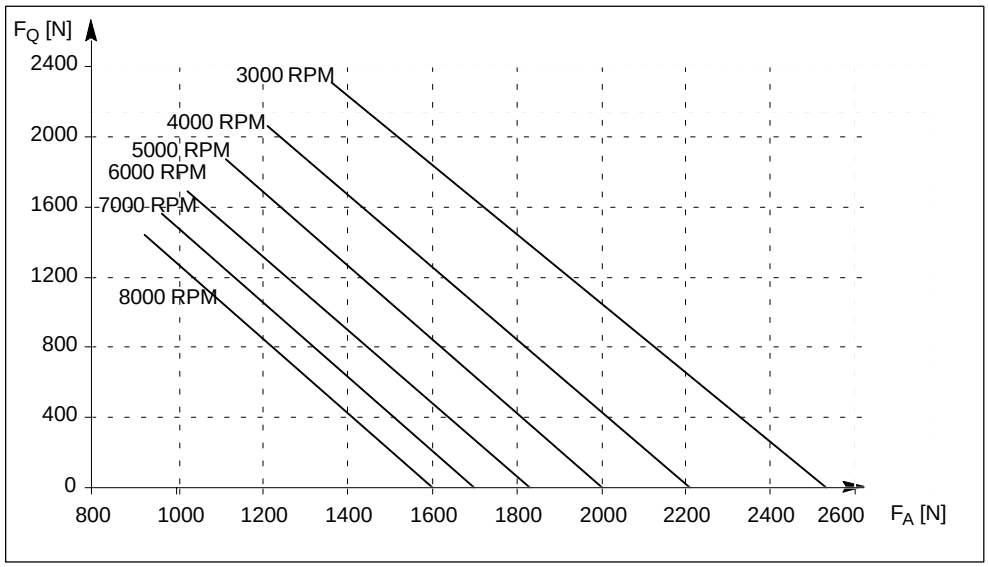


Fig. 2-25 Permissible cantilever force F_Q as a function of the axial force F_A for a nominal bearing lifetime of 10,000 h.

1) Permissible for continuous duty, however with a reduced bearing lifetime

Motor Components

3

3.1 Thermal motor protection

Table 3-1 Characteristics and technical data

Type	KTY 84
Resistance when cold (20 °C)	approx. 580 Ohm
Resistance when warm (100 °C)	approx. 1000 Ohm
Connection	Through the encoder cable
Response temperature	Alarm at 120 °C Shutdown at 155 °C ± 5 °C

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

The pre–alarm 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 would be connected to only one temperature sensor terminal, then it would be destroyed.

Warning

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

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

If available, reduced data for standstill is specified.

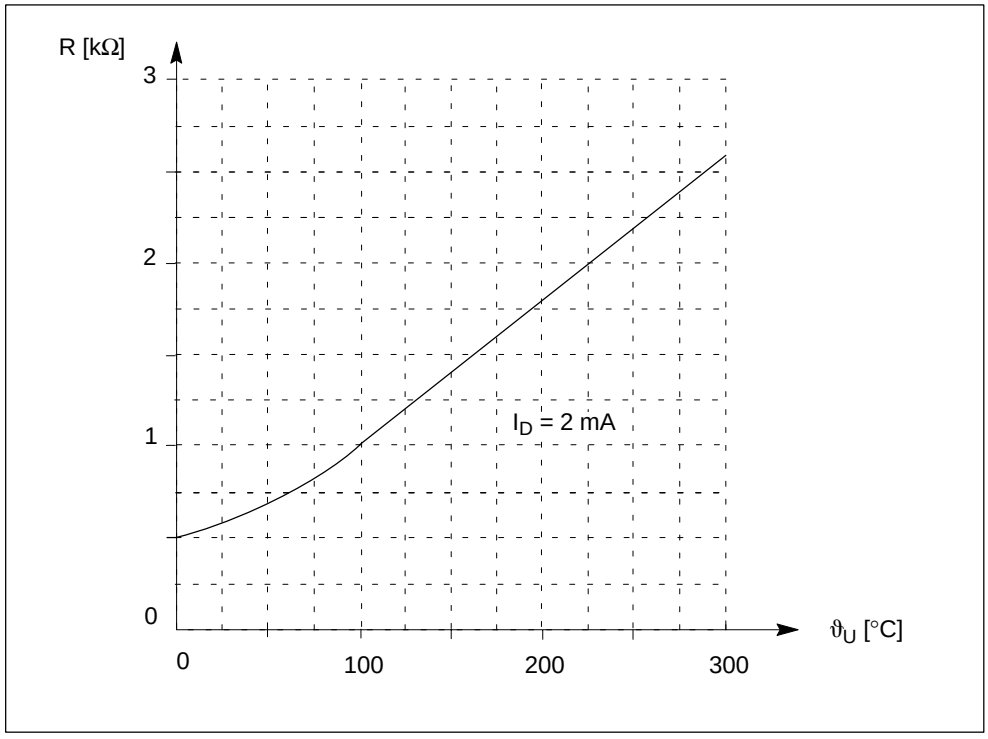


Fig. 3-1 Resistance characteristic as a function of the KTY 84 temperature

3.2 Encoder

Incremental encoders 1 V_{pp}

Table 3-2 Characteristics and technical data

Design	Optical encoder system
Use	• Tachometer for speed actual value sensing • Indirect measuring system for the position control loop
Coupling	On the non–drive end, 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	2048
Incremental signals	1 Vpp incremental encoder
Accuracy	± 40”

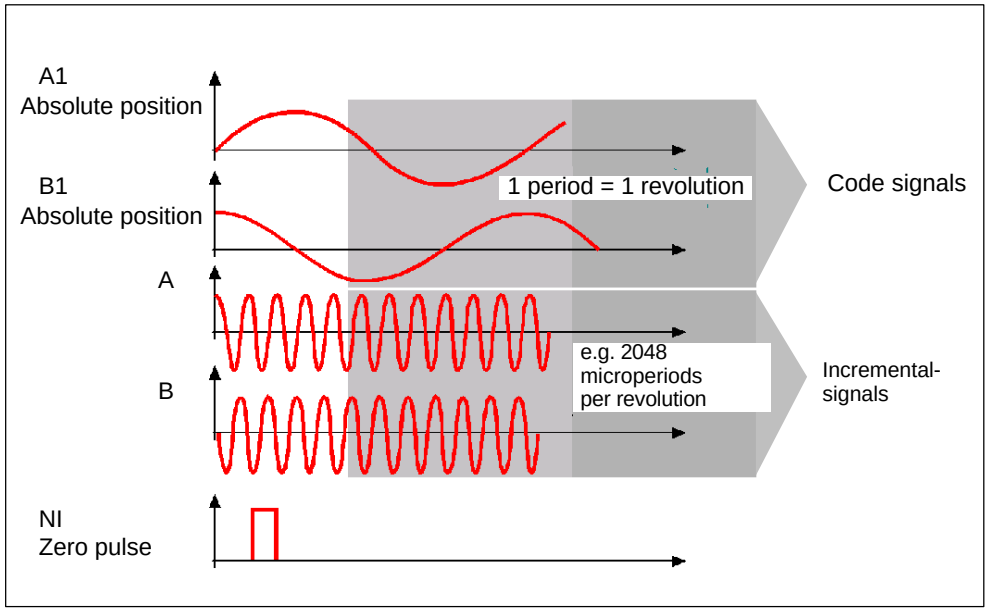
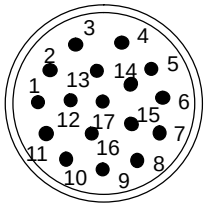


Fig. 3-2 Output signals

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 connector side
(plug contacts)

Mating connector: 6FX2003–0CE17 (socket)

Pre–assembled cable: 6FX□002–2CA51–□□□0

Length

8 = MOTION-CONNECT 800
5 = MOTION-CONNECT 500

3.3 Holding brake

Use

A single–disk brake can be mounted on the A side to hold the motor shaft, without any play, at standstill.

Design

The drive end bearing endshield is supplied with a special output bearing cover as retaining element for the solenoid assembly (brake assembly). Customers can bolt–on the solenoid assembly. The armature disk of the brake should be bolted to the drive–out element (pulley or similar).

The brakes do not have any slip rings and are maintenance–free. Both of the friction surfaces are metallic. Brakes cannot be retrofitted.

Table 3-3 Degree of protection and supply voltage

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

Mode of operation

The brake operates according to the open–circuit principle. This means that the brake is open when it is in a no–current state.

Only switch in the brake when the motor is at a standstill.

When changing–over the gear ratio, and when the motor is running, the holding brake must be released (no current condition). There is no residual torque after the brake has been released.

After the motor has been mounted, the brake must be checked to ensure that it is functioning perfectly.

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.

Voltage must be connected to the holding brake before the solenoid assembly is withdrawn. This prevents the membrane spring from being overextended.

Selection data

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

Table 3-4 Selecting the holding brake

Holding brake for motors, shaft heights 100 to 160	**Brief data**
The motor is prepared for mounting a holding brake; customers mount the holding brake	**G95**
Motor with mounted ZF holding brake	**G46**

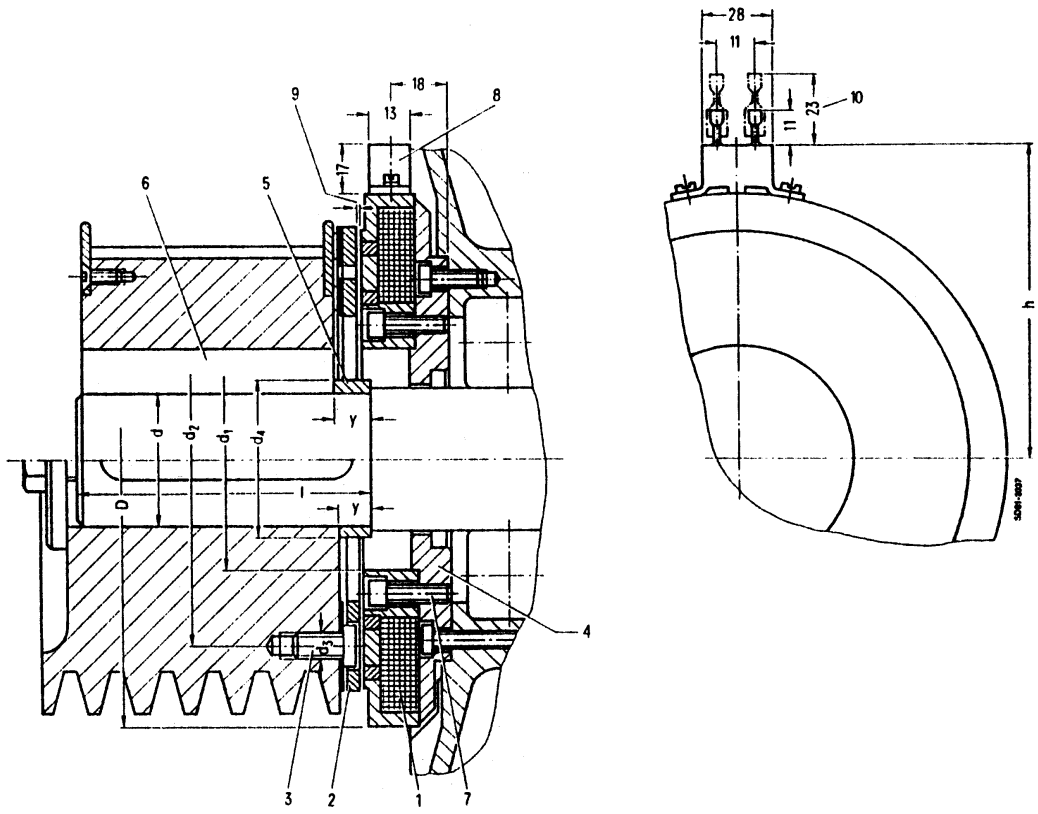
Technical data

Table 3-5 Technical data, holding brake

Shaft height [mm]	**ZF type**	**Order No.**	**Holding torque [Nm]**	**Power consumption[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–surface holding brake for motors, shaft heights 100 to 160



1	Electromagnetic single–disk brake
2	Armature disk of the brake
3	Three Allen screws acc. to DIN 7984 or 6912
4	External special drive end bearing endshield
5	Adjustment screw or ring to adjust the air gap or as endstop for the tensioning elements Tensioning elements (variable to compensate for the tolerance)
6	Space for the tensioning element
7	Four Allen screws M 5x15 or M 6x20 acc. to DIN 912
8	Electr. connection: Flat connector DIN 46244 A6, 3–0.8
9	Air gap s = 0.5 mm between the braking assembly and armature disk
10	Disassembly dimensions for the flat connector sleeve, Size 6.3

Fig. 3-3 Mounting a holding brake on the A side of 1PH410□ up to 1PH416□ AC motors as example: The armature disk is mounted to a belt with key (upper half) and 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 Gearbox

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

Please contact the gearbox manufacturer if you have questions about gearboxes:

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 Applications and features

Use

A gearbox has to be mounted if

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

Gearbox features

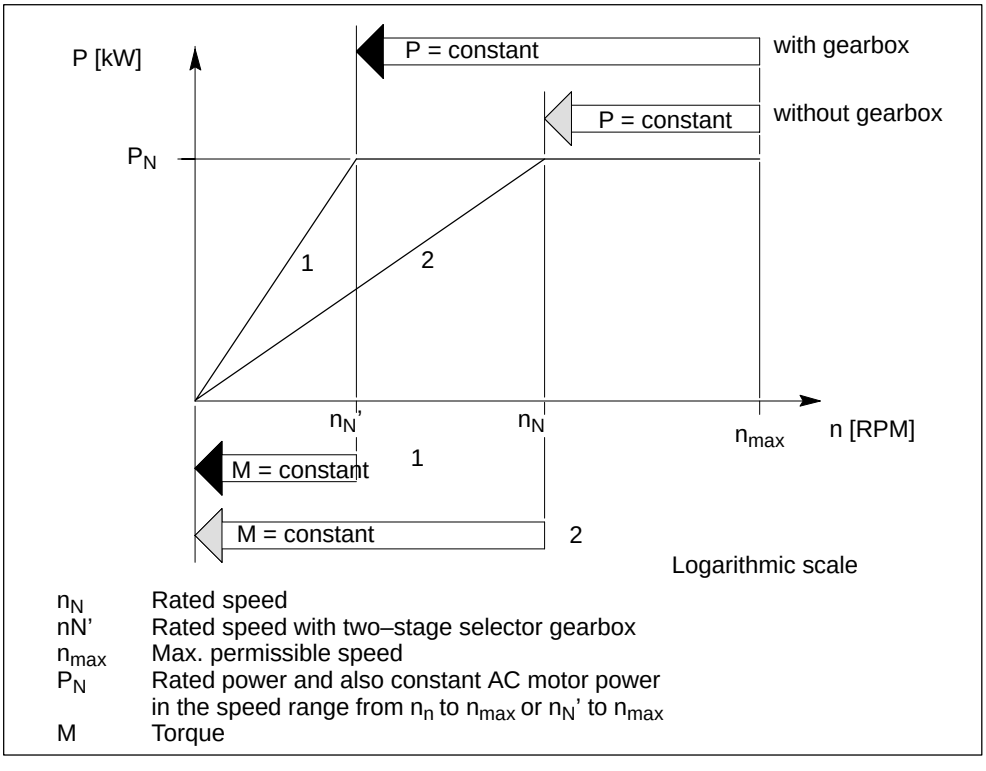
- Version as planetary gear
- Gearbox efficiency: Above 95 %
- Gearboxes are available for motors, shaft heights 100 to 160
- Selector gearboxes are available up to a drive output of 100 kW
- Types of construction: IM B35 (IM V15) and IM B5 (IM V1) are possible

Note

The 1PH4 motor series is only designed for load levels in accordance with the specifications (refer to the cantilever force diagrams and maximum torque).

When using elements to increase the force/torque, for example, a gearbox, then the increased mechanical load (e.g. as a result of significant belt tensioning forces) must be able to be handled by the appropriate element. This must be taken into account by the plant/system design engineers. For a gearbox this means that, for example, the gearbox must be able to handle increased belt pre–tensioning forces and transfer them to the machine.

For drive units which are, for example, retained to the gearbox flange or gearbox enclosure, then motors with type of construction IM B35 must be supported on the B side (non–drive end). This support must be tension–free.



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

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

Example: AC motor without selector gearbox

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

The 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 up 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 vibrations are 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 a compensating coupling.

Vibration severity level

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

This also applies if motor tolerance level S is ordered.

Sealing between the motor flange and gearbox flange

For shaft heights 132 and 160, a sealing compound must be used because of the interrupted centering edge (e.g. Terostat 93 from the Teroson company).

3.4.2 Mounting a gearbox

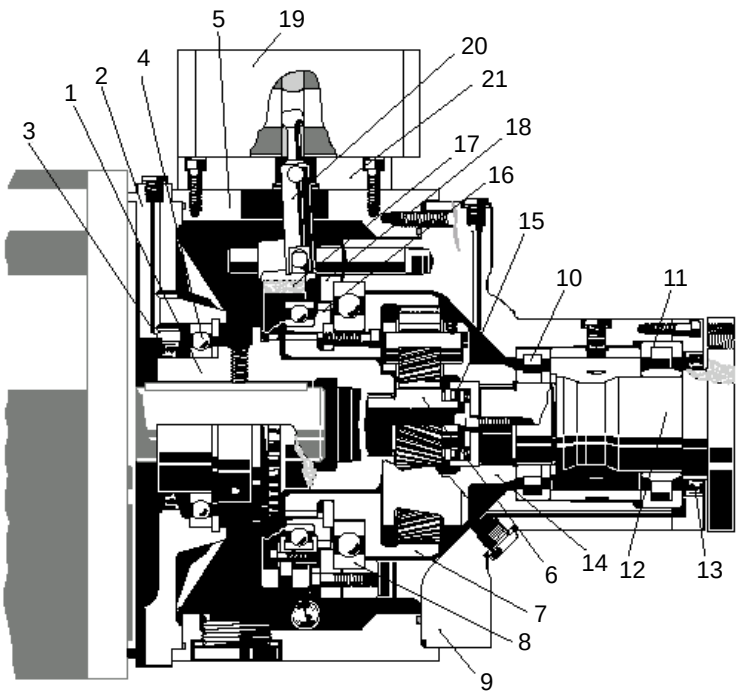


Fig. 3-5 Mounting a gearbox for 1PH4, shaft heights 100-160

The following applies for the selector gearbox:

Stage I: $i_1 = 4$
Stage II: $i_2 = 1$

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

The gearbox out drive lies coaxially to the motor shaft.

Torsional play (measured at the gearbox out–drive):
Standard: 30 angular minutes (for shaft heights 100-160)

For milling and machining with interrupted cutting, the following special versions are available on request for shaft heights 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 drive out 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.	Maximum 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	2LG4315-...	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 torque should be reduced to 300 Nm. For motors, shaft heights 100 and 132, the maximum motor torque 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 of 8000 ... 9000 RPM for more than 20 % power–on duration is only possible using injection lubrication.
3) Permissible with gearbox oil cooling for gearbox stage i = 1.

3.4.4 Electrical connection

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

The mechanical selector unit requires a separate supply.

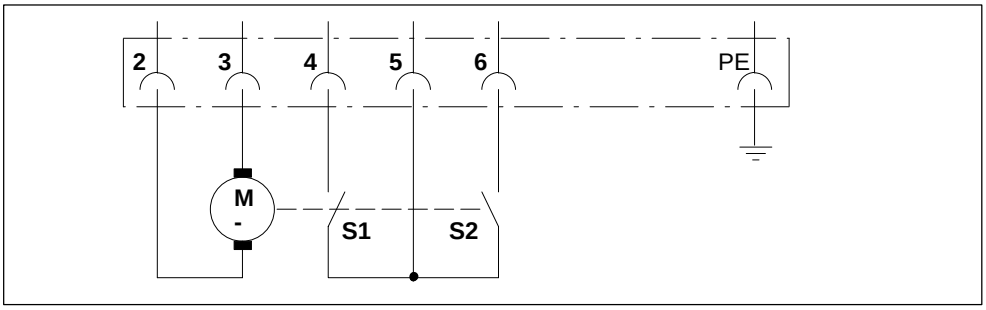


Fig. 3-6 Circuit diagram

Connector (included with the gearbox): 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 (pick–up current)
4 and 6	2 limit switches	0	0	24 V DC V_{max} =42 V DC	I_{max} = 5 A

Table 3-9 Control sequence when changing–over the gearbox ratios

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 c Mechanical selection executed up to the 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 f Mechanical selection executed up to the endstop[1)]	0 V	+24 V DC	L 0 0	0 0 L

L Contact closed 0 Contact open

1) After the switching operation, the limit switch (S1 or S2) outputs a signal to the control to switch–out the selector unit.

3.4.5 Gearbox stage changeover

The following information should be carefully observed when selecting a gearbox stage:

- The gearbox stage may only be changed when the motor/gearbox is at a complete standstill. For example while a tool is being changed.
- 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 changeover times of between 300 and 400 ms can be achieved. An ”oscillation” function is provided in the SIMODRIVE 611 drive converter.
- The gearbox stage should not be changed without using the oscillation function.
- The motor may only accelerate 200 ms after the changeover has been completed.
- The changeover operation must be monitored using a time relay. The switching operation must be reversed after 2 s if the switching command was not able to be executed. A time limit of 10 s should be provided for approx. 4 to 5 additional selection operations.

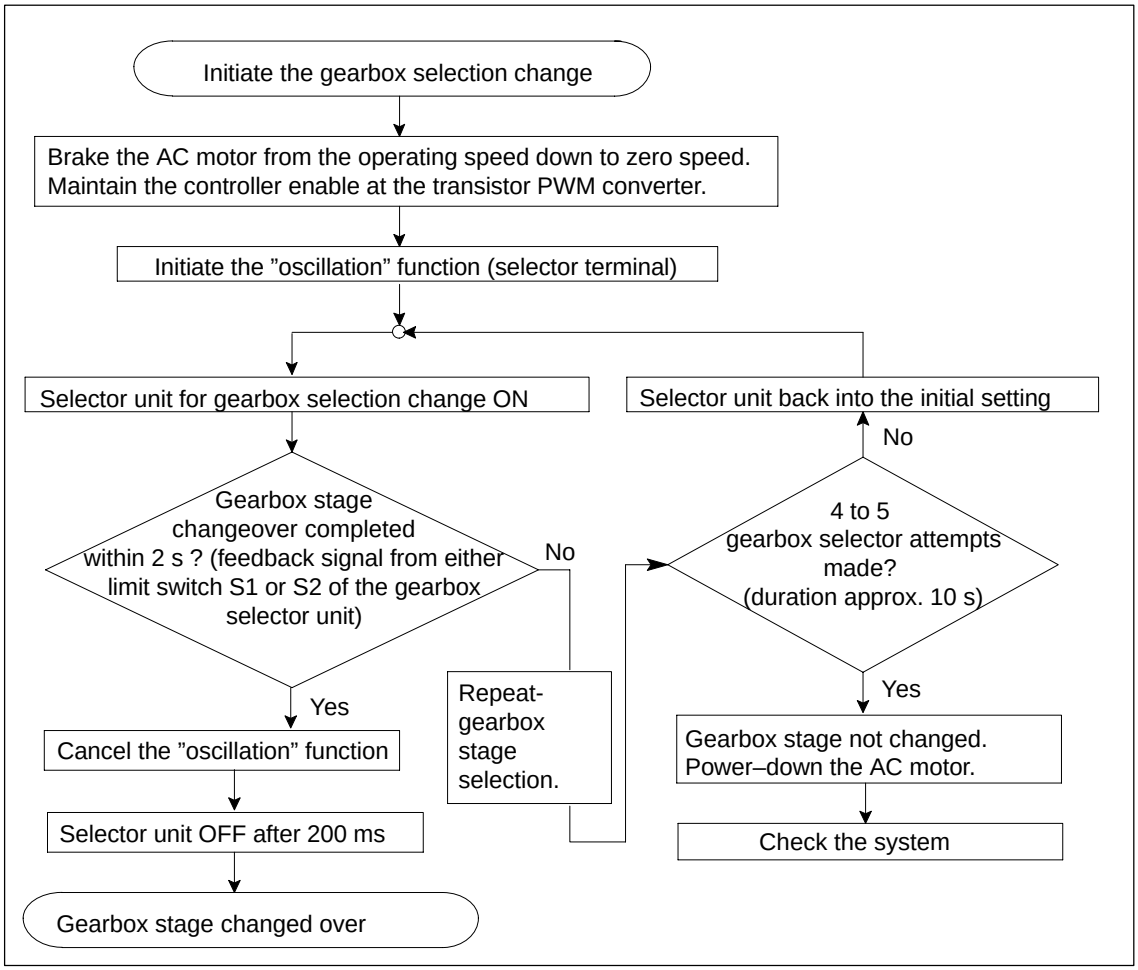


Fig. 3-7 Functional sequence of a gearbox stage changeover

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)]
When inclined:	Provide an appropriate mark on the angled oil level indicator (additionally mounted)
Oil which can be used:	HLP 32 acc. to ISO-VG 68
Oil drain plugs:	Located at both sides

Circulating oil lubrication

Circulating lubrication is required in the following cases:

- for continuous duty
- for duty over a longer period of time in one gearbox stage
- for intermittent duty with shorter standstill times

The type of circulating lubrication used depends on which operating temperature level is required in use. Several applications require a low operating temperature level. We recommend, in these cases, circulating 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 lubrication is required when mounted vertically in positions V1 or V3:

- 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

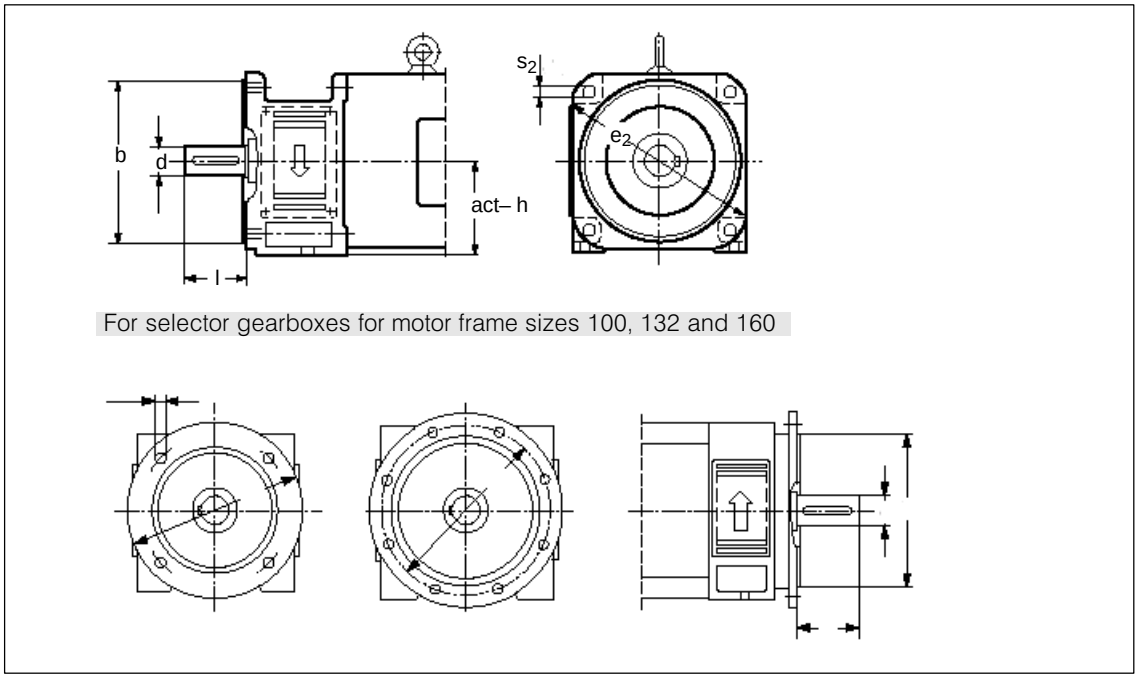


Fig. 3-8 Flange dimensions for AC motors (dimensions refer to the Table 3-10)

Table 3-10 Flange dimension for AC motors

Two–stage selector gearbox	Motor size	Standard motor companion dimensions						
		act– 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 oil circulating lubrication, frame size 100

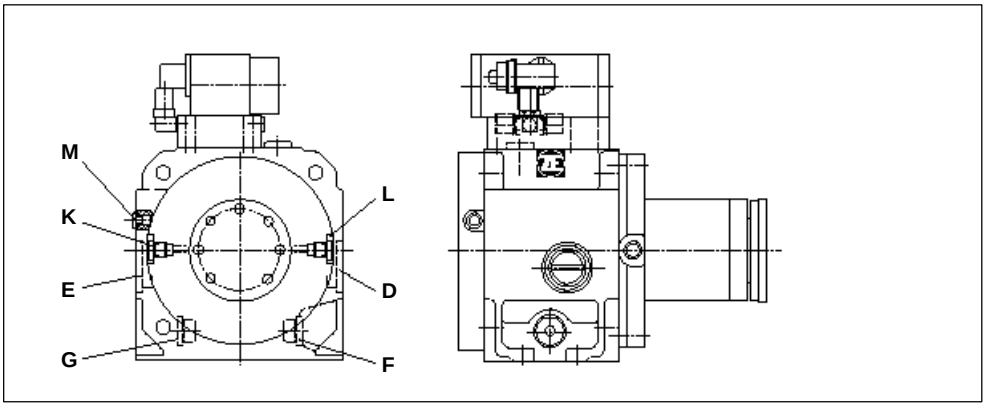


Fig. 3-9 Connections for selector gearbox with selector unit for frame size 100

Table 3-11 Connections for circulating 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–clockwise [1]	**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 mounting positions vertical V1 or V3 (refer to Chapter 3.4.6)			

1) View from the motor to the gearbox drive

3.4.9 Selector gearbox for frame sizes 132 and 160

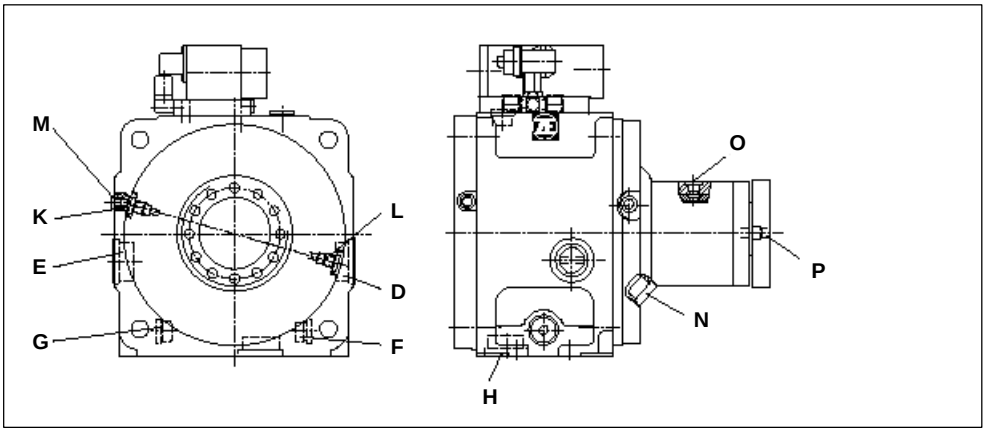


Fig. 3-10 Selector gearbox with selector unit for frame sizes 132 and 160

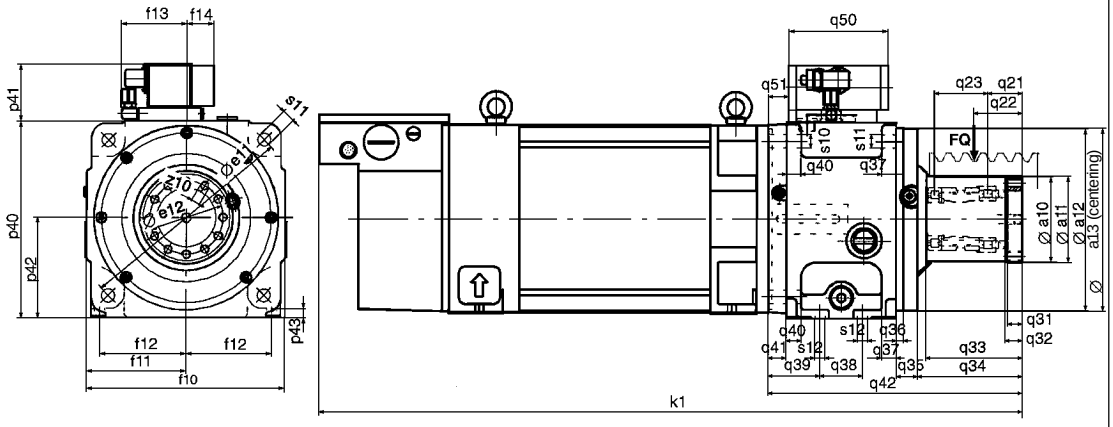
Table 3-12 Connections for circulating lubrication

Max. pressure	Connection oil return	Connection oil intake	Mounting position
2 bar	**H**	**P** (1.5 dm^3/min)	3 V
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 vertical V1 or V3 mounting position (refer to Chapter 3.4.6)			
O connection additionally possible (0.5 dm^3/min)			

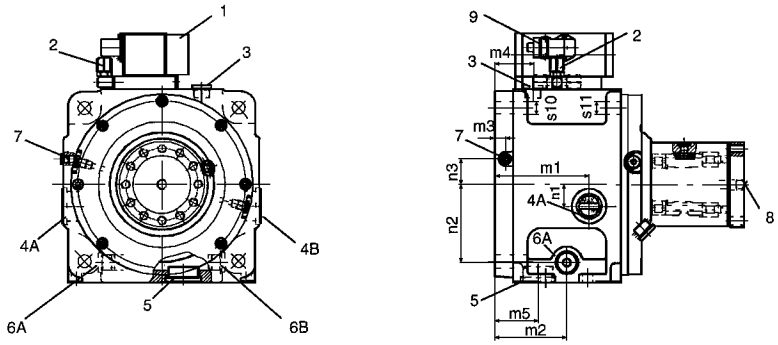
1) View from the motor to the gearbox drive

3.4.10 Gearbox dimensions

Gearbox dimensions



Connections for the oil supply



for selector gearboxes for motor frame sizes 100 to 160

1 Selector unit (24 V DC, 5 A solenoid)
2 Vent valve
2 Oil filling plug
4A Oil level sight glass or oil return for counter–clockwise main direction of rotation and circulating oil lubrication
4B Oil level sight glass or oil return for clockwise main direction of rotation and circulating oil lubrication
5 Oil drain plug for type of construction IM B35
6A Oil feed for clockwise main direction of rotation and circulating lubrication
6B Oil feed for counter–clockwise main direction of rotation and circulating oil lubrication
7 Oil feed for type of construction IM V15 (this must be connected)
8 Oil feed 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															
Size	**Type**	∅ **a10** **Drive–out housing**	∅ **a11** **k6**	∅ **a12**	∅ **a13** **g6**	∅ **e11** ±0.2	∅ **e12**	**f10**	**f11**	**f12**	**f13**	**f14**	**act– 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														
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												
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

■

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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.

1PH410.-4 in type of construction IM B35	1PH4/4-78
1PH413.-4 in type of construction IM B35	1PH4/4-79
1PH416.-4 in type of construction IM B35	1PH4/4-80

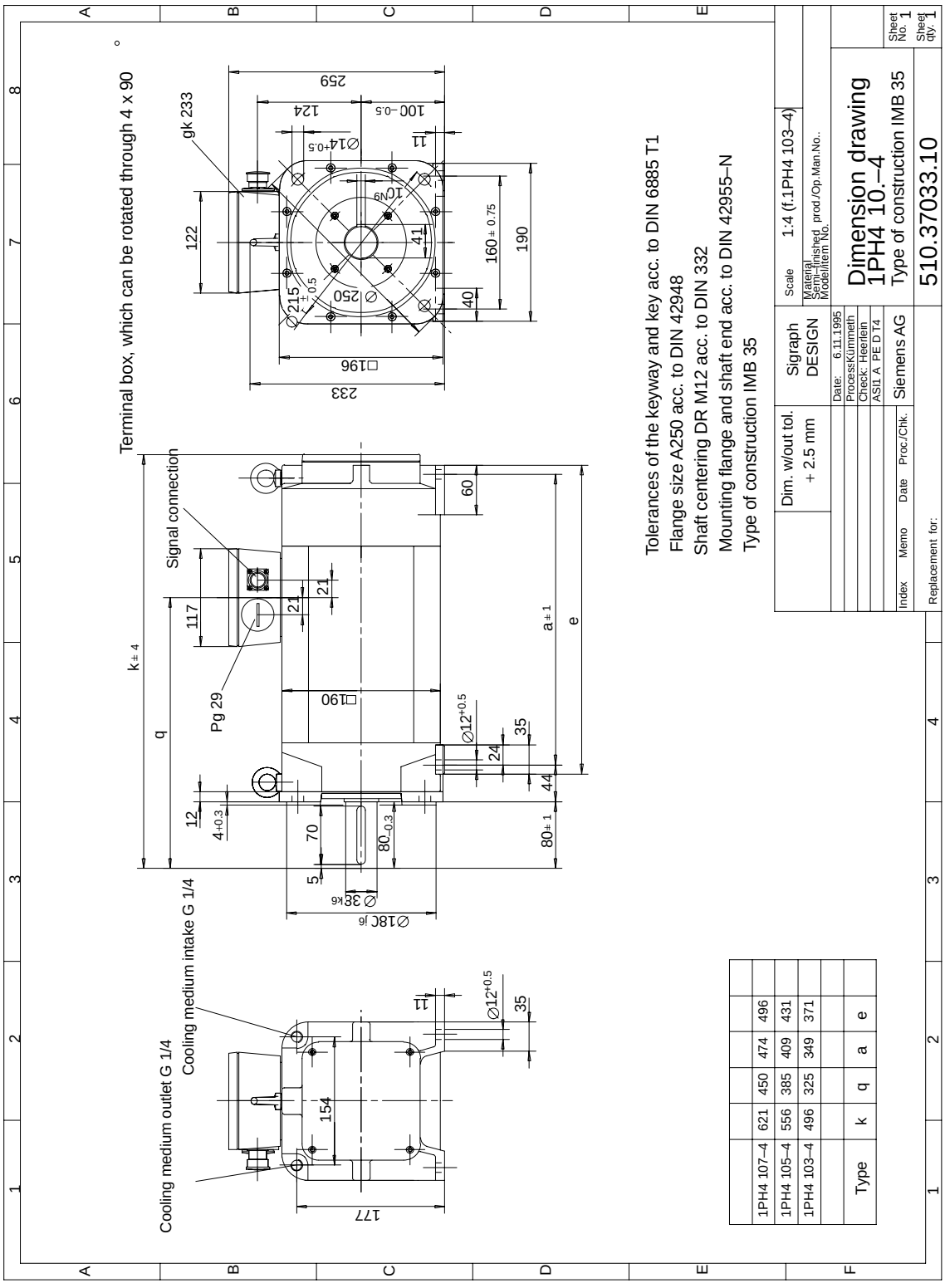
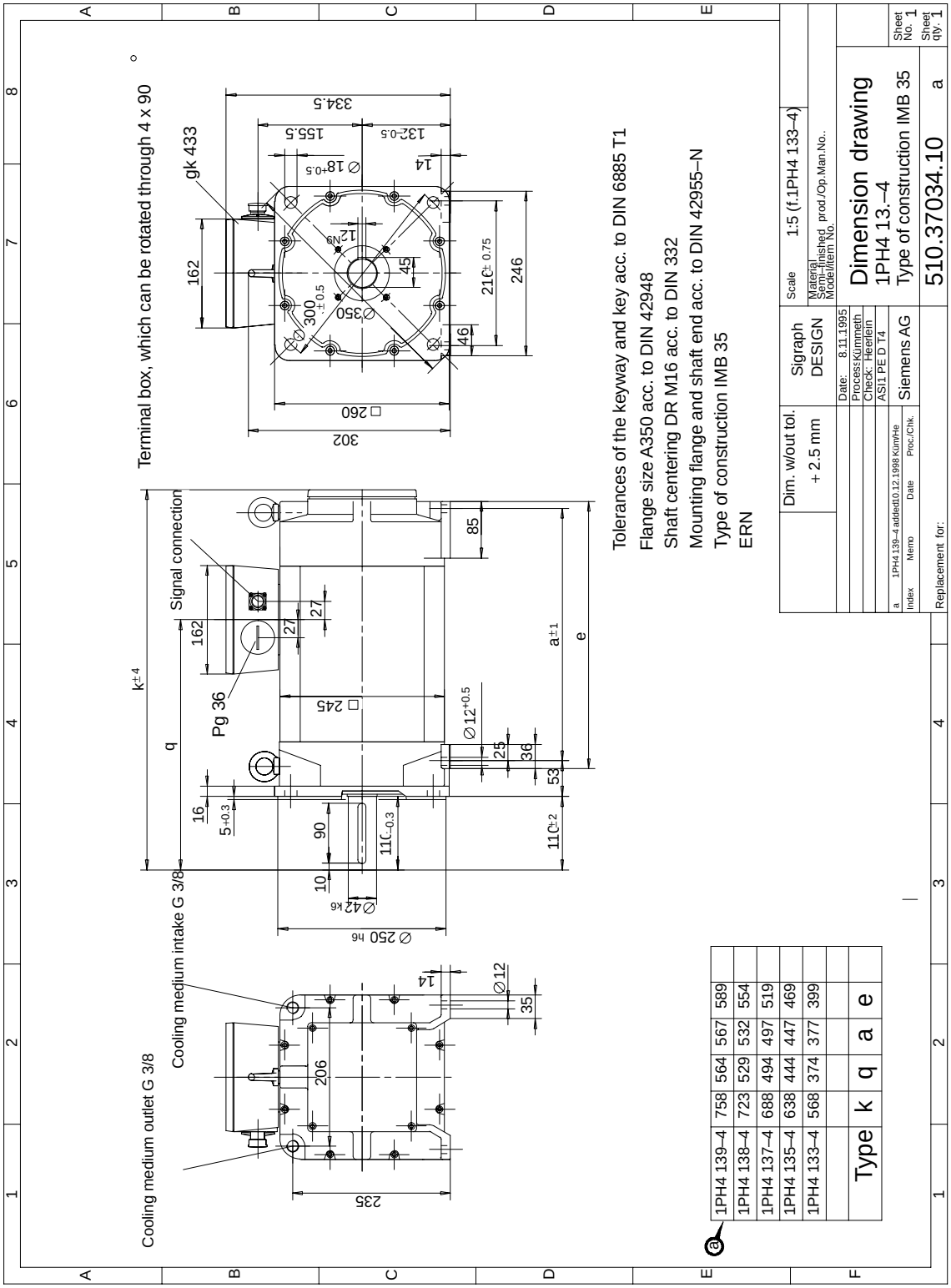


Fig. 4-1 1PH410.-4 in type of construction IM B35



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

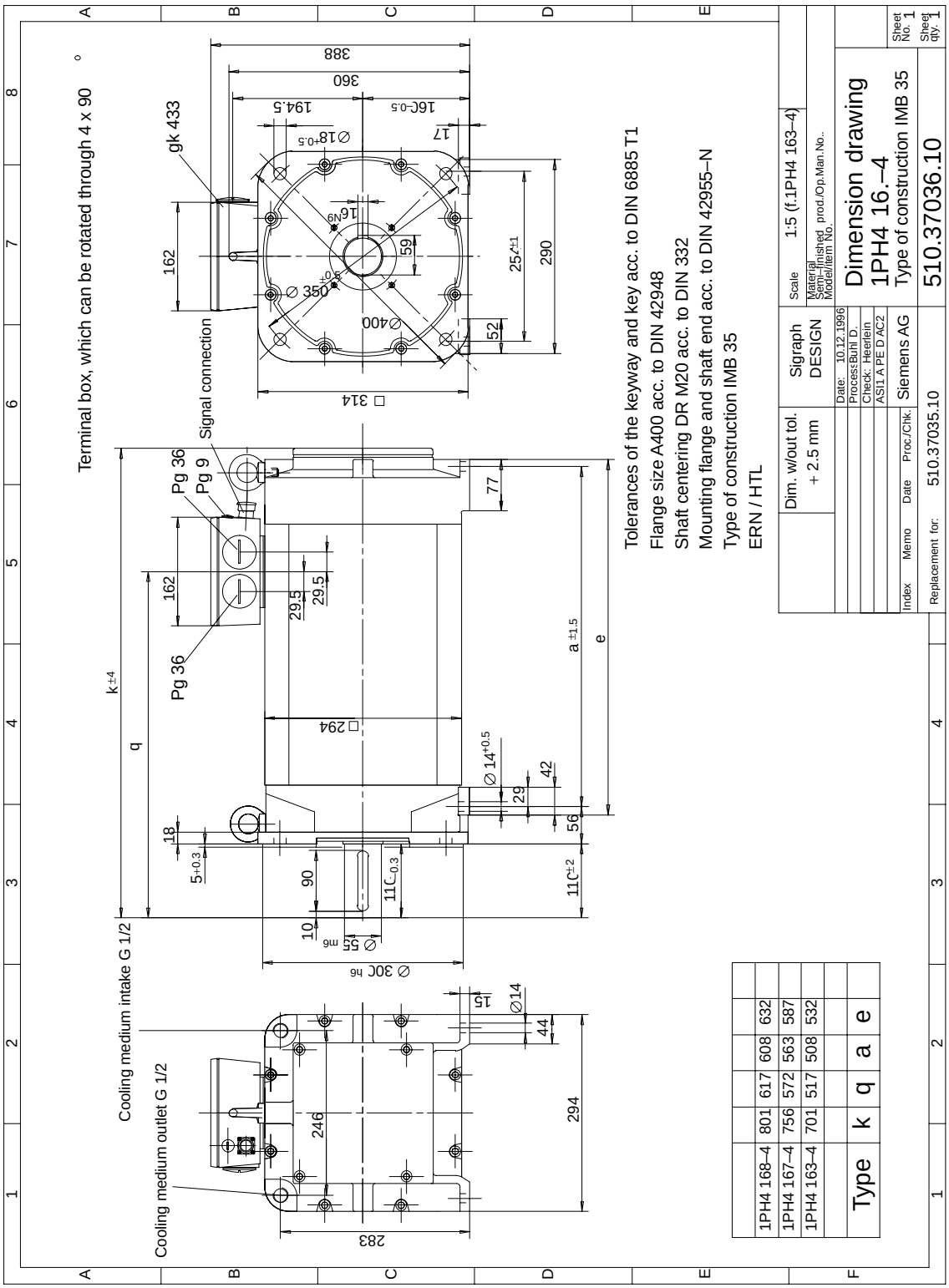


Fig. 4-3 1PH416.-4 in type of construction IM B35

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/BU/ **Catalog NC 60**

Automation Systems for Machine Tools
Ordering document
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Order No.: E86060–K4460–A101–A8–7600 (English)

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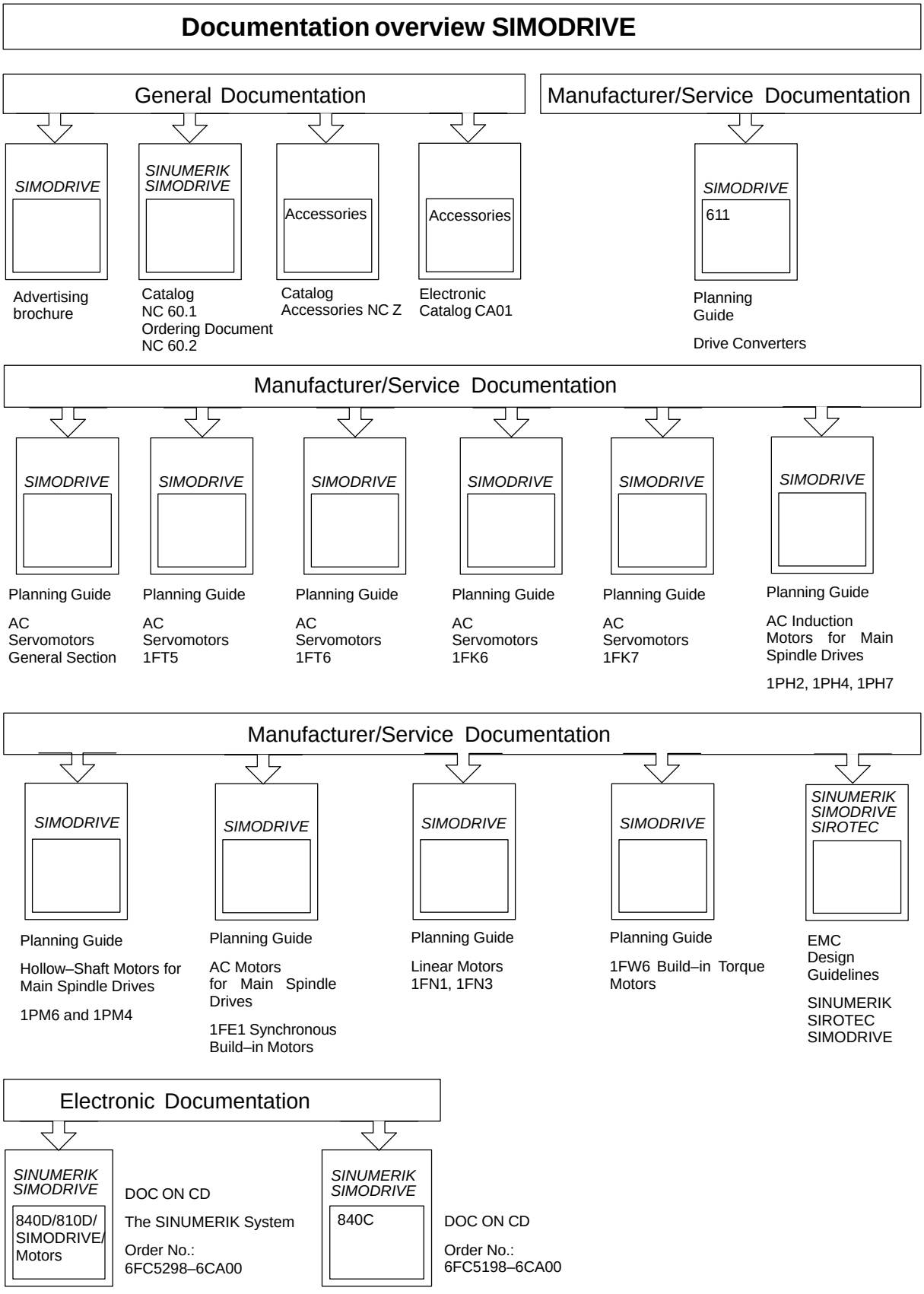

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