Configuration Manual 08/2008

1PH4 induction motors
SINAMICS S120

sinamics

SIEMENS

SIEMENS

SINAMICS S120

1PH4 Induction Motors

Configuration Manual

(APH4S), 08/2008
6SN1197-0AD64-0BP1

Legal information

Warning notice system

This manual contains notices you have to observe in order to ensure your personal safety, as well as to prevent damage to property. The notices referring to your personal safety are highlighted in the manual by a safety alert symbol, notices referring only to property damage have no safety alert symbol. These notices shown below are graded according to the degree of danger.

⚠DANGER
indicates that death or severe personal injury **will** result if proper precautions are not taken.

⚠WARNING
indicates that death or severe personal injury **may** result if proper precautions are not taken.

⚠CAUTION
with a safety alert symbol, indicates that minor personal injury can result if proper precautions are not taken.

CAUTION
without a safety alert symbol, indicates that property damage can result if proper precautions are not taken.

NOTICE
indicates that an unintended result or situation can occur if the corresponding information is not taken into account.

If more than one degree of danger is present, the warning notice representing the highest degree of danger will be used. A notice warning of injury to persons with a safety alert symbol may also include a warning relating to property damage.

Qualified Personnel

The device/system may only be set up and used in conjunction with this documentation. Commissioning and operation of a device/system may only be performed by **qualified personnel**. Within the context of the safety notes in this documentation qualified persons are defined as persons who are authorized to commission, ground and label devices, systems and circuits in accordance with established safety practices and standards.

Proper use of Siemens products

Note the following:

⚠WARNING
Siemens products may only be used for the applications described in the catalog and in the relevant technical documentation. If products and components from other manufacturers are used, these must be recommended or approved by Siemens. Proper transport, storage, installation, assembly, commissioning, operation and maintenance are required to ensure that the products operate safely and without any problems. The permissible ambient conditions must be adhered to. The information in the relevant documentation must be observed.

Trademarks

All names identified by ® are registered trademarks of the Siemens AG. The remaining trademarks in this publication may be trademarks whose use by third parties for their own purposes could violate the rights of the owner.

Disclaimer of Liability

We have reviewed the contents of this publication to ensure consistency with the hardware and software described. Since variance cannot be precluded entirely, we cannot guarantee full consistency. However, the information in this publication is reviewed regularly and any necessary corrections are included in subsequent editions.

Siemens AG
Industry Sector
Postfach 48 48
90026 NÜRNBERG
GERMANY

Ordernumber: 6SN1197-0AD64-0BP1
℗ 09/2008

Preface

Information on the documentation

You will find an overview of the documentation, which is updated on a monthly basis, in the available languages in the Internet under: http://www.siemens.com/motioncontrol

Follow menu items "Support" → "Technical Documentation" → "Ordering Documentation" → "Printed Documentation".

The Internet version of DOConCD (DOConWEB) is available at:

http://www.automation.siemens.com/doconweb

Information on the range of training courses and FAQs (frequently asked questions) are available on the Internet under:

http://www.siemens.com/motioncontrol under the menu item "Support"

Target group

Planners and project engineers

Benefits

The Configuration Manual supports you when selecting motors, calculating the drive components, selecting the required accessories as well as when selecting line and motor-side power options.

Standard scope

The scope of the functionality described in this document can differ from the scope of the functionality of the drive system that is actually supplied. Other functions not described in this documentation might be able to be executed in the drive system. This does not, however, represent an obligation to supply such functions with a new control or when servicing. Extensions or changes made by the machine manufacturer are documented by the machine manufacturer.

For the sake of simplicity, this documentation does not contain all detailed information about all types of the product and cannot cover every conceivable case of installation, operation, or maintenance.

Technical Support

If you have any technical questions, please contact our hotline:

	Europe / Africa	Asia / Australia	America
Phone	+49 (0) 180 5050 – 222	+86 1064 719 990	+1 423 262 2522
Fax	+49 (0) 180 5050 – 223	+86 1064 747 474	+1 423 262 2289
Internet	http://www.siemens.com/automation/support-request		
E-mail	mailto:adsupport@siemens.com		

Note

For technical support telephone numbers for different countries, go to:
http://www.siemens.com/automation/service&support

Calls are subject to charge (e.g. € 0.14/min from fixed lines within Germany). Tariffs of other telephone providers may differ.

Questions about this documentation

If you have any questions (suggestions, corrections) regarding this documentation, please fax or e-mail us at:

Fax	+49 (0) 9131 / 98-2176
E-mail	E-mail to: docu.motioncontrol@siemens.com

A fax form is available in the appendix of this document.

Internet address for SINAMICS

http://www.siemens.com/sinamics

EC Declarations of Conformity

The EC Declaration of Conformity for the EMC Directive can be found/obtained:

- in the Internet:

  http://support.automation.siemens.com

  under the Product Order No. 15257461 or
- at the relevant regional office of the A&D MC Group of Siemens AG.

The EC Declaration of Conformity for the EMC Directive can be found/obtained

- in the Internet:

  http://support.automation.siemens.com

  under the Product Order No. 22383669 or
- at the relevant regional office of the A&D MC Group of Siemens AG.

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 the motor:

- Oil according to the regulations for disposing of old oil (e.g. gear oil when a gearbox is mounted)
- Not mixed with solvents, cold cleaning agents of remains of paint
- Components that are to be recycled should be separated according to:
  - Electronics waste (e.g. sensor electronics, sensor modules)
  - Iron to be recycled
  - Aluminum
  - Non-ferrous metal (gearwheels, motor windings)

Danger and warning information

⚠ DANGER

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 provisions of the EC Machinery Directive.

Only appropriately qualified personnel may commission the SINAMICS units and the motors.

This personnel must carefully observe the technical customer documentation associated with this product and be familiar with 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.

In combination with the drive system, the motors are generally approved for operation on TN and TT systems with **grounded neutral** and on IT systems.

In operation on IT systems, the occurrence of a first fault between an active part and ground must be signaled by a monitoring device. In accordance with IEC 60364-4-41 it is recommended that the first fault should be eliminated as quickly as practically possible.

In systems with a **grounded external conductor**, an isolating transformer with grounded neutral (secondary side) must be connected between the supply and the drive system to protect the motor insulation from excessive stress. The majority of TT systems have a grounded external conductor, so in this case an isolating transformer must be used.

⚠ 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 +100 °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 connecting up cables, please observe that they
– are not damaged
– are not subject to tensile stress
– cannot be touched by rotating components.

CAUTION

Motors should be connected up according to the operating instructions provided. They must not be connected directly to the three-phase supply because this will damage them.

SINAMICS units with motors are voltage-tested as part of routine testing. It is not permissible to perform an additional high-voltage test on the motor; such a test can destroy electronic components such as the temperature sensor or encoder.

CAUTION

The DRIVE-CLiQ interface contains motor and encoder-specific data as well as an electronic rating plate. This is the reason that this Sensor Module may only be operated on the original motor - and may not be mounted onto other motors or replaced by a Sensor Module from other motors.

The DRIVE-CLiQ interface has direct contact to components that can be damaged/destroyed by electrostatic discharge (ESDS). Neither hands nor tools that could be electrostatically charged should come into contact with the connections.

Note

When operational and in dry operating rooms, SINAMICS units with motors fulfill the Low-Voltage Directive.

In the configurations specified in the associated EC Declaration of Conformity, SINAMICS units with motors fulfill the EMC Directive.

ESDS instructions and electromagnetic fields

⚠ CAUTION

An **e**lectrostatic-**s**ensitive **d**evice (ESDS) is an individual component, integrated circuit, or module that can be damaged by electrostatic fields or discharges.

ESDS regulations for handling boards and equipment:

When handling components that can be destroyed by electrostatic discharge, it must be ensured that personnel, the workstation and packaging are well grounded!

Personnel in ESD zones with conductive floors may only touch electronic components if they are
– grounded through an ESDS bracelet and
– wearing ESDS shoes or ESDS shoe grounding strips.

Electronic boards may only be touched when absolutely necessary.

Electronic boards may 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 to screens > 10 cm).

Measurements may only be carried-out on electronic boards and modules if
– the measuring instrument is grounded (e.g. via a protective conductor) or
– before making measurements with a potential-free measuring device, the measuring head is briefly discharged (e.g. by touching an unpainted blank piece of metal on the control cabinet).

Information regarding third-party products

NOTICE

This document contains recommendations relating to third-party products. This involves third-party products whose fundamental suitability is familiar to us. It goes without saying that equivalent products from other manufacturers may be used. Our recommendations are to be seen as helpful information, not as requirements or regulations. We cannot accept any liability for the quality and properties/features of third-party products.

Residual risks of power drive systems

When carrying out a risk assessment of the machine in accordance with the EU Machinery Directive, the machine manufacturer must consider the following residual risks associated with the control and drive components of a power drive system (PDS).

1. Unintentional movements of driven machine components during commissioning, operation, maintenance, and repairs caused by, for example:
   - Hardware defects and/or software errors in the sensors, controllers, actuators, and connection technology
   - Response times of the controller and drive
   - Operating and/or ambient conditions not within the scope of the specification
   - Parameterization, programming, cabling, and installation errors
   - Use of radio devices / cellular phones in the immediate vicinity of the controller
   - External influences / damage
2. Exceptional temperatures as well as emissions of light, noise, particles, or gas caused by, for example:
   - Component malfunctions
   - Software errors
   - Operating and/or ambient conditions not within the scope of the specification
   - External influences / damage
3. Hazardous shock voltages caused by, for example:
   - Component malfunctions
   - Influence of electrostatic charging
   - Induction of voltages in moving motors
   - Operating and/or ambient conditions not within the scope of the specification
   - Condensation / conductive contamination
   - External influences / damage
4. Electrical, magnetic and electromagnetic fields generated in operation that can pose a risk to people with a pacemaker, implants or metal replacement joints, etc. if they are too close.
5. Release of environmental pollutants or emissions as a result of improper operation of the system and/or failure to dispose of components safely and correctly.

For more information about residual risks of the power drive system components, see the relevant chapters in the technical user documentation.

Table of contents

1 Description of the motors

1.1 Properties

Overview

The AC motors in the 1PH4 series are compact, water-cooled squirrel-cage induction motors with a high degree of protection.

They have been designed specifically for use in conjunction with the SINAMICS S120 drive system, allowing power losses and noise levels to be reduced to a minimum. Depending on the control requirements, the appropriate encoder systems are available for the motors. These encoders are used to sense the motor speed and indirect position.

In machine tools, the encoder system is capable of C-axis operation as standard - i.e. an additional encoder is not required for C-axis operation.

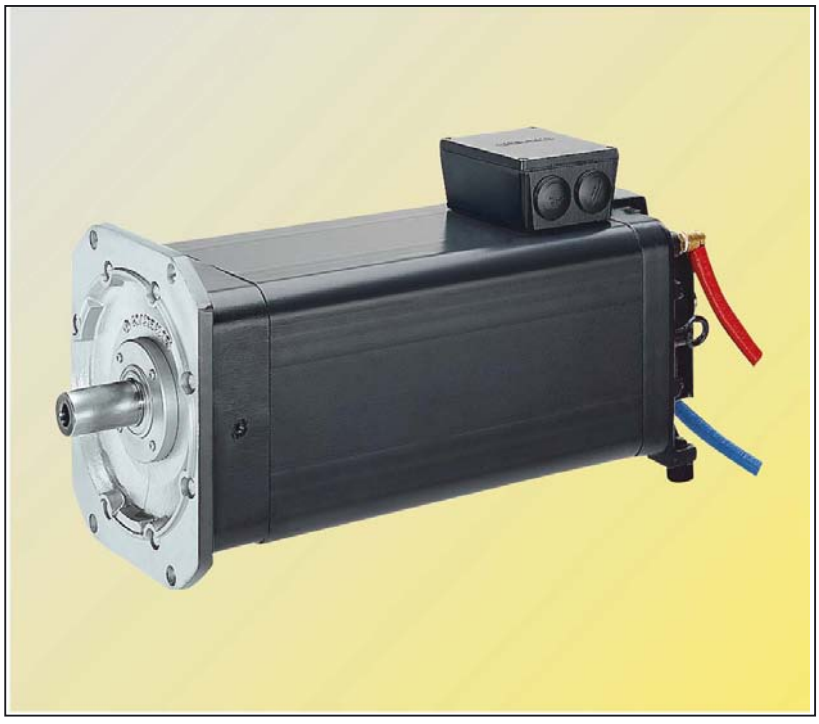


Figure 1-1 1PH4 AC motor

Benefits

- High power density with small motor dimensions
- High degree of protection (IP65, shaft exit IP55)
- Speed down to zero without reducing the torque
- Cooled flange to prevent thermal stressing of the connected mechanical power train
- Low noise level
- High radial force loading
- Ruggedness
- Essentially maintenance-free
- High rotational accuracy
- Integrated encoder system to sense the motor speed, connected using a connector
- Terminal box to connect the power cable
- Motor temperature monitoring with KTY 84
- Maximum permissible water pressure 6 bar

Application area

- All applications in which extreme ambient conditions, such as dust, dirt, or a corrosive atmosphere, do not permit air cooling
- In processes in which the environment must not be heated
- On special machines, when cooling water is an inherent process element
- Milling machines with full enclosure
- High-load milling spindles
- Counterspindles or rotating tools for turning machines

NOTICE
Not approved for use in potentially explosive areas.

1.2 Technical features

Table 1- 1 Technical features on standard design

Technical feature	Version
Insulation of the stator winding in accordance with EN 60034-1 (IEC 60034-1)	Temperature class 155 (F) for a coolant intake temperature of up to +30 °C
Type of construction according to EN 60034-7 (IEC 60034-7)	IM B35 (IM V15, IM V36)
Degree of protection to EN 60034-5 (IEC 60034-5)	IP65 (IP55 on shaft exit)
Cooling according to EN 60034-6 (IEC 60034-6)	Water cooling
Temperature monitoring according to EN 60034-11 (IEC 60034-11)	KTY 84 temperature sensor in the stator winding
Drive shaft end according to DIN 748-3 (IEC 60072-1)	Cylindrical with keyway and fitted key, full-key balancing;
Rotational accuracy, concentricity, and linear movement to DIN 42955 (IEC 60072-1)	Tolerance class N (at normal running temperature)
Vibration severity according to EN 60034-14 (IEC 60034-14)	Vibration corresponds to grade A up to rated speed
Sound pressure level according to DIN EN ISO 1680, tolerance +3 dB(A)	1PH410❑: 69 dB(A) 1PH413❑: 69 dB(A) 1PH416❑: 71 dB(A)
Bearing designs	Duplex bearing 1) at drive end for belt drive (minimum radial force required)
Built-in encoder system for motors without DRIVE-CLiQ interface	• Absolute encoder 2048 S/R singleturn, 4096 revolutions multiturn, with EnDat interface (AM2048S/R encoder) • Incremental encoder HTL 1024 S/R (encoder HTL1024S/R) • Incremental encoder HTL 2048 S/R (encoder HTL2048S/R) • Incremental encoder sin/cos 1 V_{pp}, 2048 S/R with C and D track (encoder IC2048S/R) • Incremental encoder sin/cos 1 V_{pp}, 2048 S/R without C and D track (encoder IN2048S/R)
Built-in encoder system for motors with DRIVE-CLiQ interface	• Absolute encoder 22 bit singleturn (resolution 4194304, 2048 S/R internal) + 12 bit multiturn (traversing range 4096 revolutions) (encoder AM22DQ) • Incremental encoder 22 bit (resolution 4194304, internal 2048 S/R) + commutating position 11 bit (encoder IC22DQ) • Incremental encoder 22 bit (resolution 4194304, internal 2048 S/R), without commutating position (encoder IN19DQ)
Connection	Connector for signals (mating connector not supplied) Terminal box for power; terminal box at top (can be rotated 4 x 90°)
Paint finish	Anthracite, RAL 7016
Options	Refer to Options and Selection and ordering data

S/R = signals per revolution

1) Not suitable for coupling output

Table 1- 2 Options

Option	Order code	Description
Bearing version (view of DE)	K00	Single bearing • for coupling 1) • for planetary gearbox, e.g. ZF gearbox 2LG43❑❑❑, types IM B35, IM V15 1) 2) • for low to moderate radial forces
Vibration severity grade according to EN 60034-14 (IEC 60034-14)	K05 K02 K03	• Grade S with duplex bearing 3) • Grade S with single bearing 3) • Grade SR with single bearing 3)
Radial eccentricity, concentricity and axial eccentricity according to DIN 42955 (IEC 60072-1)	K04	Tolerance R 4)
Shaft end (DE)	K42 L69	• Plain shaft • Half-key balancing
Shaft seal (DE) 5)	K18	Radial shaft seal, oil-tight, IP65
Holding brake 1)	G46 G95	• With holding brake mounted on DE • Motor is prepared for a holding brake
Terminal box arrangement (view of DE)	K09 K10	• Right-hand side • Left-hand side
Terminal box rotation	K83 K84 K85	• by 90°, cable entry from drive end • by 90°, cable entry from non-drive end • by 180°
Speed 6)	L37	Increased maximum speed and half-key balancing
Rating plate (type plate)	K31	Second rating plate (type plate), separately packed
Encoder system	H30	Without encoder

1) Options mutually exclude each other.

2) Vibration severity grades S/SR are not achievable for models with built-in gearboxes. Use order code **K00 + G97** for old ZF gearbox 2LG42❑❑❑ (for selecting gearing, see chapter "Gearboxes").

3) Automatically includes version **K04**.

4) Increased shaft accuracy.

5) Only recommended if oil spray/mist occasionally gets onto the sealing ring.

6) Version for increased maximum speed includes vibration severity grade SR and half-key balancing. The following options are not possible:

- Prepared for ZF gearbox mounting
- Shaft seal

1.3 Specifications

Table 1- 3 Technical data of the 1PH4 series

Motor type	P_N [kW]	n_N [rpm]	n_{max} 1) with duplex bearing [rpm]	n_{max} 1) with K00 Single bearing [rpm]	n_{max} 1) with L37 [rpm]	M_N [Nm]	J [kgm²]	I_N [A]	I_0 [A]	V_N [V]
Shaft height 100 mm										
1PH4103-4❑F26	7,5	1500	7500	9000	12000	48	0,017	26	12	265
1PH4103-4❑F56	7,5	1500	7500	9000	-	48	0,017	20,5	11	350
1PH4105-4❑F26	11	1500	7500	9000	12000	70	0,024	38	16	263
1PH4105-4❑F56	11	1500	7500	9000	-	70	0,024	28	13	350
1PH4107-4❑F26	14	1500	7500	9000	12000	90	0,031	46	19	265
1PH4107-4❑F56	14	1500	7500	9000	-	89	0,031	35,5	17	350
Shaft height 132 mm										
1PH4133-4❑F26	15	1500	6700	8000	11000	95	0,046	55	17	229
1PH4133-4❑F56	15	1500	6700	8000	-	95	0,046	35	11	350
1PH4135-4❑F26	22	1500	6700	8000	10000	140	0,071	73	26	251
1PH4135-4❑F56	22	1500	6700	8000	-	140	0,071	52	21	350
1PH4137-4❑F26	27	1500	6700	8000	10000	170	0,085	85	31	265
1PH4137-4❑F56	27	1500	6700	8000	-	172	0,085	62	21	350
1PH4138-4❑F26	30	1500	6700	8000	10000	190	0,104	102	34	244
Shaft height 160 mm										
1PH4163–4❑F26	37	1500	5300	6500	8000	235	0,17	107	44	286
1PH4163-4❑F56	37	1500	5300	6500	-	236	0,17	89	43	350
1PH4167–4❑F26	46	1500	5300	6500	8000	293	0,206	120	49	315
1PH4167-4❑F56	46	1500	5300	6500	-	293	0,206	107	46	350
1PH4168–4❑F26	52	1500	5300	6500	8000	331	0,22	148	59	284
1PH4168-4❑F56	52	1500	5300	6500	-	331	0,22	117	44	350

1) Max. speed for S1 and S6 power, refer to P-n graph; max. continuous operating speed, refer to table "Bearing change interval"

1.4 Selection and ordering data

1.4.1 Selection and ordering data for production machines

1PH4 400 V 3 AC line voltage, Servo Control

Rated speed n_{rated} rpm	Shaft height SH	Rated power P_{rated} kW/HP	Rated torque M_{rated} Nm/lb$_f$-ft	Rated current I_{rated} A	Rated voltage V_{rated} V	Speed during field weakening [1] n_2 rpm	Max. permissible continuous speed [2] n_{S1} rpm	Max. speed [3] n_{max} rpm	1PH4 asynchronous motor [4] Order No.
400 V 3 AC line voltage, Servo Control									
1500	100	7.5/10.1	48/35.4	20.5	350	3200	5600	7500 [6]	1PH4103- 4 ■ F 5 6
		11/14.8	70/51.6	28	350	2900	5600	7500 [6]	1PH4105- 4 ■ F 5 6
		14/18.8	89/65.6	35.5	350	3150	5600	7500 [6]	1PH4107- 4 ■ F 5 6
	132	15/20.1	95/70	35	350	2200	5200	6700	1PH4133- 4 ■ F 5 6
		22/29.5	140/103.2	52	350	2600	5200	6700	1PH4135- 4 ■ F 5 6
		27/36.2	172/126.8	62	350	2450	5200	6700	1PH4137- 4 ■ F 5 6
	160	37/49.6	236/173.9	89	350	3000	4000	5300	1PH4163- 4 ■ F 5 6
		46/61.7	293/215.9	107	350	2850	4000	5300	1PH4167- 4 ■ F 5 6
		52/69.7	331/243.9	117	350	2700	4000	5300	1PH4168- 4 ■ F 5 6

Encoder systems for motors without DRIVE-CLiQ interface:	Absolute encoder EnDat 2048 pulses/revolution (Encoder AM2048S/R)	E
	Incremental encoder HTL 1024 pulses/revolution (Encoder HTL1024S/R)	H
	Incremental encoder HTL 2048 pulses/revolution (Encoder HTL2048S/R)	J
	Incremental encoder sin/cos 1 V_{pp} with C and D tracks (Encoder IC2048S/R)	M
	Incremental encoder sin/cos 1 V_{pp} without C and D tracks (Encoder IN2048S/R)	N
Encoder systems for motors with DRIVE-CLiQ interface:	Absolute encoder EnDat 2048 pulses/revolution (Encoder AM22DQ)	F
	Incremental encoder sin/cos 1 V_{pp} with C and D tracks (Encoder IC22DQ)	D
	Incremental encoder sin/cos 1 V_{pp} without C and D tracks (Encoder IN22DQ)	Q

1PH4 400 V 3 AC line voltage, Servo Control

Power factor	Magnetizing current	Efficiency	Rated frequency	Moment of inertia of	Weight, approx.	1PH4 asynchronous motor [4]	SINAMICS S120 Motor Module Rated output current	
	I_μ	η_{rated}	f_{rated}	J			I_{rated}	
cos φ	A		Hz	kgm^2/ lb_f-in-s^2	kg/lb	Order No.	A	Order No.
400 V 3 AC line voltage, Servo Control								
0.74	12	0.820	52.8	0.017/0.15	52/114.66	1PH4103- 4 . F 5 6	18 [5]	6SL3120- ■T E21-8AA ■
0.78	13.5	0.836	52.9	0.024/0.212	67/147.74	1PH4105- 4 . F 5 6	30	6SL3120- 1 T E23-0AA 1
0.77	18.5	0.851	52.5	0.031/0.274	80/176.4	1PH4107- 4 . F 5 6	45	6SL3120- 1 T E24-5AA 1
0.81	13	0.877	51.8	0.046/0.407	90/198.45	1PH4133- 4 . F 5 6	45	6SL3120- 1 T E24-5AA 1
0.79	24	0.890	51.4	0.071/0.628	112/246.96	1PH4135- 4 . F 5 6	60	6SL3120- 1 T E26-0AA 1
0.81	24	0.895	51.5	0.085/0.752	130/286.65	1PH4137- 4 . F 5 6	60 [5]	6SL3120- 1 T E26-0AA 1
0.77	45	0.905	50.9	0.10/1.505	175/385.88	1PH4163- 4 . F 5 6	85 [5]	6SL3120- 1 T E28-5AA 1
0.79	48	0.910	51.0	0.206/1.823	210/463.05	1PH4167- 4 . F 5 6	132	6SL3120- 1 T E31-3AA 0
0.81	48	0.913	51.0	0.220/1.947	240/529.2	1PH4168- 4 . F 5 6	132	6SL3120- 1 T E31-3AA 0
Special versions:		Specify supplementary order code and plain text if applicable (see Options).				–Z		
Motor Module:		Single Motor Module Double Motor Module						1 2

1) n_2: Max. permissible thermal speed at constant output or speed, which is at the voltage limit when $P = P_{rated}$.

2) n_{S1}: Max. permissible speed that is continuously permitted without speed duty cycles.

3) n_{max}: Maximum speed which must not be exceeded.

4) Standard design with duplex bearing.

5) The rated output current of the Motor Module is lower than the motor rated current.

6) Speed is limited to lower values in some cases. The following restriction applies: Max. output frequency < 5 × motor rated frequency.

1PH4 400 V 3 AC line voltage, Vector Control

Rated speed	Shaft height SH	Rated power	Rated torque	Rated current	Rated voltage	Speed during field weakening [1]	Max. permissible continuous speed [2]	Max. speed [3]	1PH4 asynchronous motor [4]
n_{rated}		P_{rated}	M_{rated}	I_{rated}	V_{rated}	n_2	n_{S1}	n_{max}	
rpm		kW/HP	Nm/lb_f-ft	A	V	rpm	rpm	rpm	Order No.
400 V 3 AC line voltage, Vector Control									
1750	100	8.8/11.8	48/35.4	20.5	400	3750	5600	7500 [6]	1PH4103- 4 ■ F 5 6
		12.8/17.2	70/51.6	28	400	3450	5600	7500 [6]	1PH4105- 4 ■ F 5 6
		16.3/21.9	89/65.6	35.5	400	3700	5600	7500 [6]	1PH4107- 4 ■ F 5 6
	132	17.5/23.5	96/70.8	35.5	400	2550	5200	6700	1PH4133- 4 ■ F 5 6
		25.5/34.2	139/102.4	52	400	3000	5200	6700	1PH4135- 4 ■ F 5 6
		31.5/42.2	172/126.8	63	400	2800	5200	6700	1PH4137- 4 ■ F 5 6
	160	43/57.7	235/173.2	88	400	3400	4000	5300	1PH4163- 4 ■ F 5 6
		54/72.4	295/217.4	107	400	3200	4000	5300	1PH4167- 4 ■ F 5 6
		61/81.8	333/245.4	117	400	3050	4000	5300	1PH4168- 4 ■ F 5 6

Encoder systems for motors without DRIVE-CLiQ interface:	Absolute encoder EnDat 2048 pulses/revolution (Encoder AM2048S/R)	E
	Incremental encoder HTL 1024 pulses/revolution (Encoder HTL1024S/R)	H
	Incremental encoder HTL 2048 pulses/revolution (Encoder HTL2048S/R)	J
	Incremental encoder sin/cos 1 V_{pp} with C and D tracks (Encoder IC2048S/R)	M
	Incremental encoder sin/cos 1 V_{pp} without C and D tracks (Encoder IN2048S/R)	N
Encoder systems for motors with DRIVE-CLiQ interface:	Absolute encoder EnDat 2048 pulses/revolution (Encoder AM22DQ)	F
	Incremental encoder sin/cos 1 V_{pp} with C and D tracks (Encoder IC22DQ)	D
	Incremental encoder sin/cos 1 V_{pp} without C and D tracks (Encoder IN22DQ)	Q

1PH4 400 V 3 AC line voltage, Vector Control

Power factor	Magnetizing current	Efficiency	Rated frequency	Moment of inertia of	Weight, approx.	1PH4 asynchronous motor 1PH4 [4]	SINAMICS S120 Motor Module Rated output current	
	I_μ	η_{rated}	f_{rated}	J			I_{rated}	
cos φ	A		Hz	kgm^2/ lb_f-in-s^2	kg/lb	Order No.	A	Order No.
400 V 3 AC line voltage, Vector Control								
0.75	11.5	0.841	61.2	0.017/0.15	52/114.66	1PH4103- 4 . F 5 6	18 [5]	6SL3120- ■ T E21-8AA ■
0.78	13.5	0.854	61.3	0.024/0.212	67/147.74	1PH4105- 4 . F 5 6	30	6SL3120- 1 T E23-0AA 1
0.78	18	0.867	61.0	0.031/0.274	80/176.4	1PH4107- 4 . F 5 6	45	6SL3120- 1 T E24-5AA 1
0.82	12	0.887	60.2	0.046/0.407	90/198.45	1PH4133- 4 . F 5 6	45	6SL3120- 1 T E24-5AA 1
0.79	22	0.901	59.8	0.071/0.628	112/246.96	1PH4135- 4 . F 5 6	60	6SL3120- 1 T E26-0AA 1
0.81	23	0.905	59.9	0.085/0.752	130/286.65	1PH4137- 4 . F 5 6	60 [5]	6SL3120- 1 T E26-0AA 1
0.78	42	0.914	59.3	0.170/1.505	175/385.88	1PH4163- 4 . F 5 6	85 [5]	6SL3120- 1 T E28-5AA 1
0.80	44	0.920	59.4	0.206/1.823	210/463.05	1PH4167- 4 . F 5 6	132	6SL3120- 1 T E31-3AA 0
0.82	43	0.921	59.4	0.220/1.947	240/529.2	1PH4168- 4 . F 5 6	132	6SL3120- 1 T E31-3AA 0
Special versions:		Specify supplementary order code and plain text if applicable (see Options).				–Z		
Motor Module:		Single Motor Module Double Motor Module					1 2	1 0

1) n_2: Max. permissible thermal speed at constant output or speed, which is at the voltage limit when $P = P_{rated}$.

2) n_{S1}: Max. permissible speed that is continuously permitted without speed duty cycles.

3) n_{max}: Maximum speed which must not be exceeded.

4) Standard design with duplex bearing.

5) The rated output current of the Motor Module is lower than the motor rated current.

6) Speed is limited to lower values in some cases. The following restriction applies: Max. output frequency < 5 × motor rated frequency.

1PH4 480 V 3 AC line voltage, Servo/Vector Control

Rated speed	Shaft height SH	Rated power	Rated torque	Rated current	Rated voltage	Speed during field weakening [1]	Max. permissible continuous speed [2]	Max. speed [3]	1PH4 asynchronous motor [4]
n_{rated}		P_{rated}	M_{rated}	I_{rated}	V_{rated}	n_2	n_{S1}	n_{max}	
rpm		kW/HP	Nm/lb_f-ft	A	V	rpm	rpm	rpm	Order No.
480 V 3 AC line voltage, Servo/Vector Control									
2000	100	9.5/12.7	45/33.2	19.5	450	4850	5600	7500 [6]	1PH4103- 4 ■ F 5 6
		14/18.8	67/49.4	26.5	450	4450	5600	7500 [6]	1PH4105- 4 ■ F 5 6
		18/24.1	86/63.4	34.5	450	4700	5600	7500 [6]	1PH4107- 4 ■ F 5 6
	132	19/25.5	91/67.1	33.5	450	3300	5200	6700	1PH4133- 4 ■ F 5 6
		28/37.6	134/98.8	50	450	3720	5200	6700	1PH4135- 4 ■ F 5 6
		34/45.6	162/119.4	59	450	3600	5200	6700	1PH4137- 4 ■ F 5 6
	160	47/63.0	224/165.1	84	450	4300	4000	5300	1PH4163- 4 ■ F 5 6
		58/77.8	277/204.1	101	450	3980	4000	5300	1PH4167- 4 ■ F 5 6
		65/87.2	310/228.5	110	450	3750	4000	5300	1PH4168- 4 ■ F 5 6

Encoder systems for motors without DRIVE-CLiQ interface:	Absolute encoder EnDat 2048 pulses/revolution (Encoder AM2048S/R)	E
	Incremental encoder HTL 1024 pulses/revolution (Encoder HTL1024S/R)	H
	Incremental encoder HTL 2048 pulses/revolution (Encoder HTL2048S/R)	J
	Incremental encoder sin/cos 1 V_{pp} with C and D tracks (Encoder IC2048S/R)	M
	Incremental encoder sin/cos 1 V_{pp} without C and D tracks (Encoder IN2048S/R)	N
Encoder systems for motors with DRIVE-CLiQ interface:	Absolute encoder EnDat 2048 pulses/revolution (Encoder AM22DQ)	F
	Incremental encoder sin/cos 1 V_{pp} with C and D tracks (Encoder IC22DQ)	D
	Incremental encoder sin/cos 1 V_{pp} without C and D tracks (Encoder IN22DQ)	Q

1PH4 480 V 3 AC line voltage, Servo/Vector Control

Power factor	Magnetizing current	Efficiency	Rated frequency	Moment of inertia of	Weight, approx.	1PH4 asynchronous motor 1PH4 [4]	SINAMICS S120 Motor Module Rated output current	
	I_μ	η_{rated}	f_{rated}	J			I_{rated}	
cos φ	A		Hz	$kgm^2/lb_f\text{-}in\text{-}s^2$	kg/lb	Order No.	A	Order No.
480 V 3 AC line voltage, Servo/Vector Control								
0.74	11.2	0.856	69.3	0.017/0.15	52/114.66	1PH4 103- 4 . F 5 6	18 [5]	6SL3120- ■T E21-8AA ■
0.79	12.9	0.870	69.4	0.024/0.212	67/147.74	1PH4 105- 4 . F 5 6	30	6SL3120- 1 T E23-0AA 1
0.78	17.1	0.879	69.1	0.031/0.274	80/176.4	1PH4 107- 4 . F 5 6	45	6SL3120- 1 T E24-5AA 1
0.83	11.9	0.899	68.4	0.046/0.407	90/198.45	1PH4 133- 4 . F 5 6	45	6SL3120- 1 T E24-5AA 1
0.80	21.5	0.909	68.1	0.071/0.628	112/246.96	1PH4 135- 4 . F 5 6	60	6SL3120- 1 T E26-0AA 1
0.83	22.1	0.914	68.1	0.085/0.752	130/286.65	1PH4 137- 4 . F 5 6	60	6SL3120- 1 T E26-0AA 1
0.79	39.7	0.923	67.6	0.170/1.505	175/385.88	1PH4 163- 4 . F 5 6	85	6SL3120- 1 T E28-5AA 1
0.81	42.6	0.926	67.6	0.206/1.823	210/463.05	1PH4 167- 4 . F 5 6	132	6SL3120- 1 T E31-3AA 0
0.83	41	0.928	67.6	0.220/1.947	240/529.2	1PH4 168- 4 . F 5 6	132	6SL3120- 1 T E31-3AA 0
Special versions:		Specify supplementary order code and plain text if applicable (see Options).				–Z		
Motor Module:		Single Motor Module Double Motor Module					1 2	1 0

1) n_2: Max. permissible thermal speed at constant output or speed, which is at the voltage limit when $P = P_{rated}$.

2) n_{S1}: Max. permissible speed that is continuously permitted without speed duty cycles.

3) n_{max}: Maximum speed which must not be exceeded.

4) Standard design with duplex bearing.

5) The rated output current of the Motor Module is lower than the motor rated current.

6) Speed is limited to lower values in some cases. The following restriction applies: Max. output frequency < 5 × motor rated frequency.

1.4.2 Selection and ordering data for machine tools

Shaft height	Rated speed	Continuous speed, max.			Speed, max.[1]			Rated power for duty type in accordance with IEC 60034-1			**1PH4 asynchronous motor with solid shaft Water cooling**
SH	n_{rated}	$n_{S1\ cont.}$[2]	$n_{S1\ cont.}$[3]	$n_{S1\ cont.}$[4]	n_{max}[2]	n_{max}[3]	n_{max}[4]	P_{rated} S1	S6-60%	S6-40%	Order No. **Standard type**
	rpm	rpm	rpm	rpm	rpm	rpm	rpm	kW (HP)	kW (HP)	kW (HP)	
100	1500	5600	6500	10000	7500	9000	12000	7.5 (10.1)	8.75 (11.7)	10 (13.4)	**1PH4103 - 4 ■ F26**
								11 (14.8)	12.75 (17.1)	14.75 (19.8)	**1PH4105 - 4 ■ F26**
								14 (18.8)	16.25 (21.8)	18.75 (25.1)	**1PH4107 - 4 ■ F26**
132	1500	5200	6000	9250	6700	8000	10000	15 (20.1)	18 (24.1)	21 (28.2)	**1PH4133 - 4 ■ F26**
								22 (29.5)	26.5 (35.5)	31 (41.6)	**1PH4135 - 4 ■ F26**
								27 (36.2)	32.5 (43.6)	38 (51.0)	**1PH4137 - 4 ■ F26**
								30 (40.2)	36 (48.3)	42 (56.3)	**1PH4138 - 4 ■ F26**
160	1500	4000	4500	7000	5300	6500	8000	37 (49.6)	45 (60.3)	52.5 (70.4)	**1PH4163 - 4 ■ F26**
								46 (61.7)	55 (73.8)	65 (87.2)	**1PH4167 - 4 ■ F26**
								52 (69.7)	62.5 (83.8)	73 (97.9)	**1PH4168 - 4 ■ F26**

Encoder systems for motors without DRIVE-CLiQ interface:	Absolute encoder EnDat, 2048 S/R (Encoder AM2048S/R) Incremental encoder sin/cos 1 V_{pp} 2048 S/R with C and D track (Encoder IC2048S/R) Incremental encoder sin/cos 1 V_{pp} 2048 S/R without C and D track (Encoder IN2048S/R)	**E M N**
Encoder systems for motors with DRIVE-CLiQ interface:	Absolute encoder 22 bit single-turn + 12 bit multi-turn (Encoder AM22DQ) Incremental encoder 22 bit with 11 bit commutation position (Encoder IC22DQ) Incremental encoder 22 bit (Encoder IN22DQ)	**F D Q**

[1] For continuous duty (with 30% n_{max}, 60% $^2/_3$ n_{max}, 10% standstill) for a duty cycle time of 10 min.

[2] Bearing version for duplex bearing.

[3] Bearing version for single bearing.

[4] Bearing version for increased speed using option L37.

Motor type (continued)	Rated torque	Moment of inertia	Weight, approx.	Rated current for duty type in accordance with IEC 60034-1			SINAMICS S120 Motor Module	
							Required rated output current	**Booksize format**
	M_{rated}	J	m	I_{rated}			I_{rated}	Order No.
				S1	S6-60%	S6-40%	S1	
	Nm (lb_f-ft)	kgm^2 (lb_f-in-s^2)	kg (lb)	A	A	A		
1PH4103 - ...	48 (35.4)	0.017 (0.15)	52 (115)	26	29	32	30	**6SL312■ - 1TE23-0AA3**
1PH4105 - ...	70 (51.6)	0.024 (0.21)	67 (148)	38	42	47	45	**6SL312■ - 1TE24-5AA3**
1PH4107 - ...	90 (66.4)	0.031 (0.27)	80 (176)	46	52	58	60	**6SL312■ - 1TE26-0AA3**
1PH4133 - ...	95 (70.1)	0.046 (0.41)	90 (198)	55	65	74	60	**6SL312■ - 1TE26-0AA3**
1PH4135 - ...	140 (103)	0.071 (0.63)	112 (247)	73	86	99	85	**6SL312■ - 1TE28-5AA3**
1PH4137 - ...	170 (125)	0.085 (0.75)	130 (287)	85	100	114	85	**6SL312■ - 1TE28-5AA3**
1PH4138 - ...	190 (140)	0.097 (0.86)	150 (331)	102	119	136	132	**6SL312■ - 1TE31-3AA3**
1PH4163 - ...	235 (173)	0.17 (1.50)	175 (386)	107	125	142	132	**6SL312■ - 1TE31-3AA3**
1PH4167 - ...	293 (216)	0.206 (1.82)	210 (463)	120	138	158	132	**6SL312■ - 1TE31-3AA3**
1PH4168 - ...	331 (244)	0.22 (1.95)	240 (529)	148	173	197	200	**6SL312■ - 1TE32-0AA3**

Cooling:	
Internal air cooling	**0**
External air cooling	**1**
Motor Module:	
Single Motor Module	**1**

Notes on water cooling

Motor type	Coolant flow rate (water)	Connecting thread on non-drive end (NDE)
1PH410	6 l/min	G 1/4
1PH413	8 l/min	G 3/8
1PH416	10 l/min	G 1/2

1.5 Rating plate (type plate)

The rating plate (type plate) shows the technical specifications applicable to the supplied motor.

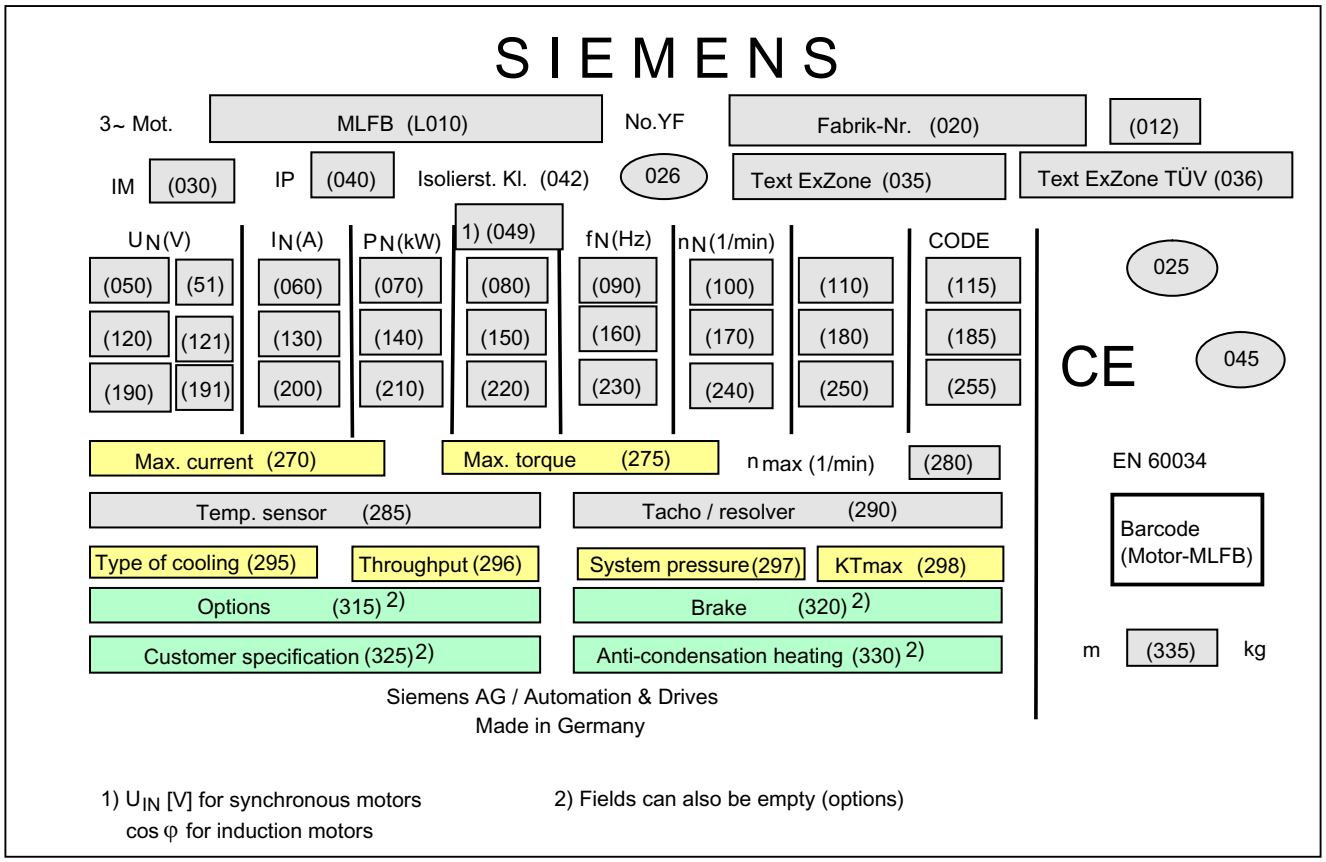


Figure 1-2 Schematic layout of rating plate

Table 1- 4 Elements on the rating plate

No.	Description	No.	Description
010	Order number	170	Rated speed n_N (2)
012	Consecutive number, part of serial number	180	Operating mode (2)
020	Serial number	185	Code for operating point 2
025	UL approval	190	Rated voltage V_N (3)
026	Graphical symbol zone 2	191	Switching mode 3
030	Type of construction	200	Rated current I_N (3)
035	Identification code zone 2	210	Rated power P_N (3)
036	Protection against explosion	220	cos φ (3)
040	Degree of protection	230	Rated frequency f_N (3)
045	Type of balancing	240	Rated speed n_N (3)
049	for induction motors: cos φ	250	Operating mode (3)
	for synchronous motors: induced voltage V_{IN}	255	Code for operating point 3
050	Rated voltage V_N (1)		Maximum current I_{max}
051	Switching mode 1	270	Maximum torque M_{max}
060	Rated current I_N (1)	275	Maximum speed n_{max}
070	Rated power P_N (1)	280	Temperature sensor
080	cos φ (1)	285	Tachometer/resolver
090	Rated frequency f_N (1)	290	Cooling method
100	Rated speed n_N (1)	295	Throughput l/min (m^3/s)
110	Operating mode (1)	296	System pressure
115	Code for operating point 1	297	Maximum coolant temperature
120	Rated voltage V_N (2)	298	Options (I)
121	Switching mode 2	315	Options (II)
130	Rated current I_N (2)	320	Optional customer information
140	Rated power P_N (2)	325	Anti-condensation heating
150	cos φ (2)	330	Weight
160	Rated frequency f_N (2)	335	

Configuring

2

2.1 Configuring software

2.1.1 SIZER engineering tool

Overview

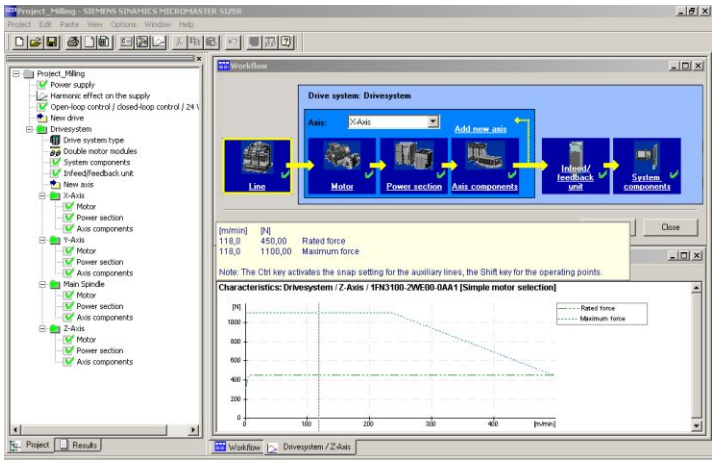


Figure 2-1 SIZER

The SIZER configuration tool provides an easy-to-use means of configuring the SINAMICS and MICROMASTER 4 drive families, as well as the SINUMERIK solution line CNC control and SIMOTION Motion Control system. It provides support for the technical planning of the hardware and firmware components required for a drive task. SIZER supports the complete configuration of the drive system, from simple individual drives to complex multi-axis applications.

SIZER supports all of the engineering steps in a workflow:

- Configuring the power supply
- Designing the motor and gearbox, including calculation of mechanical transmission elements
- Configuring the drive components
- Compiling the required accessories
- Selection of the line-side and motor-side power options

When SIZER was being designed, particular importance was placed on a high degree of usability and a universal, function-based approach to the drive application. The extensive user navigation makes it easy to use the tool. Status information keeps you continually informed about how engineering is progressing.

The SIZER user interface is available in German and English. The drive configuration is saved in a project. In the project, the components and functions used are displayed in a hierarchical tree structure. The project view permits the configuration of drive systems and the copying/inserting/modifying of drives already configured.

The configuration process produces the following results:

- Parts list of components required (Export to Excel)
- Technical specifications of the system
- Characteristics
- Comments on system reactions
- Location diagram of drive and control components and dimension drawings

These results are displayed in a results tree and can be reused for documentation purposes. User support is provided by technological online help, which provides the following information:

- Detailed technical data
- Information about the drive systems and their components
- Decision-making criteria for the selection of components.

Minimum system requirements

- PG or PC with Pentium™ II 400 MHz (Windows™ 2000), Pentium™ III 500 MHz (Windows™ XP)
- 256 MB RAM (512 MB recommended)
- At least 1.7 GB of free hard disk space
- An additional 100 MB of free hard disk space on Windows system drive
- Monitor resolution, 1024×768 pixels
- Windows™ 2000 SP2, XP Professional SP1, XP Home Edition SP1
- Microsoft Internet Explorer 5.5 SP2

Order number for SIZER

Engineering tool	Order number (MLFB)
SINAMICS MICROMASTER SIZER German/English	6SL3070-0AA00-0AG0

2.1.2 STARTER drive/commissioning software

The easy-to-use STARTER drive/commissioning tool can be used for:

- Commissioning,
- Optimization, and
- Diagnostics

You will find a description in the Intranet under the following address:

http://mall.automation.siemens.com

Select the country and then in the menu bar "Products".

In the navigator, set "Drive Technology" → "Engineering software" → "STARTER drive/commissioning software"

Download, refer under http://support.automation.siemens.com

2.1.3 SinuCom commissioning tool

The simple-to-use commissioning software for PC/PG serves to ensure optimum commissioning of drives with SINAMICS S120/SIMODRIVE 611 digital. You will find a description in the Intranet under the following address:

https://mall.automation.siemens.com

Select your country and then in the menu bar "Products".

In the navigator, select "Automation Systems" → "SINUMERIK CNC automation systems" → HMI software for CNC controls" → "Tools" → "SinuCom".

2.2 Configuring procedure

Motion control

Servo drives are optimized for motion control applications. They execute linear or rotary movements within a defined movement cycle. All movements should be optimized in terms of time.

As a result of these considerations, servo drives must meet the following requirements:

- High dynamic response, i.e. short rise times
- Capable of overload, i.e. a high acceleration reserve
- Wide control range, i.e. high resolution for precise positioning.

The following table "Configuring procedure" is valid for synchronous and induction motors.

General configuring procedure

The function description of the machine provides the basis when configuring the drive application. The definition of the components is based on physical interdependencies and is usually carried out as follows:

step	Description of the configuring activity	
1.	Clarification of the type of drive	Refer to the next chapter
2.	Definition of supplementary conditions and integration into an automation system	
3.	Definition of the load, calculation of the maximum load torque and selection of the motor	
4.	Selection of the SINAMICS Motor Module	Refer to catalog
5.	Steps 3 and 4 are repeated for additional axes	
6.	Calculation of the required DC link power and selection of the SINAMICS Line Module	
7.	Selection of the line-side options (main switch, fuses, line filters, etc.)	
8.	Specification of the required control performance and selection of the Control Unit, definition of component cabling	
9.	Definition of other system components (e.g. braking resistors)	
10.	Calculation of the current demand of the 24 V DC supply for the components and specification of the power supplies (SITOP devices, Control Supply Modules)	
11.	Selection of the components for the connection system	
12.	Configuration of the drive line-up components	
13.	Calculation of the required cable cross sections for power supply and motor connections	
14.	Inclusion of mandatory installation clearances	

2.3 Selecting and dimensioning induction motors

2.3.1 Clarification of the type of drive

The motor is selected on the basis of the required torque, which is defined by the application, e.g. traveling drives, hoisting drives, test stands, centrifuges, paper and rolling mill drives, feed drives or main spindle drives. Gearboxes to convert motion or to adapt the motor speed and motor torque to the load conditions must also be considered.

As well as the load torque, which is determined by the application, the following mechanical data is among those required to calculate the torque to be provided by the motor:

- Masses to be moved
- Diameter of the drive wheel
- Leadscrew pitch, gear ratios
- Frictional resistance
- Mechanical efficiency
- Traversing paths
- Maximum velocity
- Maximum acceleration and maximum deceleration
- Cycle time

2.3.2 Defining the supplementary conditions and integration into an automation system

You must decide whether synchronous or induction motors are to be used.

Synchronous motors are the best choice if it is important to have low envelope dimensions, low rotor moment of inertia and therefore maximum dynamic response ("Servo" control type).

Induction motors can be used to increase maximum speeds in the field weakening range. Induction motors for higher power ratings are also available.

The following factors are especially important when engineering a drive application:

- The line system configuration, when using specific types of motor and/or line filters on IT systems (non-grounded systems)
- The utilization of the motor in accordance with rated values for winding temperatures of 60 K or 100 K.
- The ambient temperatures and the installation altitude of the motors and drive components.
- Heat dissipation from the motors through natural ventilation, forced ventilation or water cooling

Other supplementary conditions apply when integrating the drives into an automation environment such as SIMATIC or SIMOTION.

For motion control and technology functions (e.g. positioning), as well as for synchronous functions, the corresponding automation system, e.g. SIMOTION D, is used.

The drives are interfaced to the higher-level automation system via PROFIBUS.

2.3.3 Selecting induction motors

A differentiation must be made between 3 applications when selecting a suitable induction motor:

Case 1: The motor essentially operates in continuous duty.

Case 2: A periodic duty cycle determines how the drive is dimensioned.

Case 3: A high field weakening range is required.

The objective is to identify characteristic torque and speed operating points, on the basis of which the motor can be selected depending on the particular application.

Once the application has been defined and specified, the maximum motor torque is calculated. Generally, the maximum motor torque is required when accelerating. The load torque and the torque required to accelerate the motor are added.

The maximum motor torque is then verified with the limiting characteristic curves of the motors.

The following criteria must be taken into account when selecting the motor:

- The dynamic limits must be adhered to, i.e., all speed-torque points of the relevant load event must lie below the relevant limiting characteristic curve.
- The thermal limits must be adhered to, i.e. the rms motor torque at the average motor speed resulting from the duty cycle must lie below the S1 characteristic curve (continuous duty). The rms value of the motor current within a duty cycle must be less than the rated motor current.
- In the field-weakening range, the permissible motor torque is restricted by the voltage limit characteristic (stability limit). A margin of 30 % should be observed.

2.3.4 Motor operates continuously

The following motor must be selected: $P_{N,\ Motor} \geq P_{required}$

An overload is dimensioned for transient overloads (e.g. when accelerating). The peak torque must lie below the stability limit.

It must then be verified that the selected motor can supply the necessary output over the desired speed range. If this is not the case, a larger motor or a different winding variant must be selected.

2.3.5 Motor operates with a periodic duty cycle

The duty cycle determines how the drive is dimensioned. It is assumed that the speeds during the duty cycle lie below the rated speed.

If the power is known, but the torques during the duty cycle are unknown, then the power must be converted to a torque:

$M = P \bullet 9550 / n$ M in [Nm], P in [kW], n in [rpm]

The torque to be generated by the motor comprises the frictional torque $M_{friction}$, the load torque of the driven machine M_{load} and the accelerating torque M_B:

$M = M_{friction} + M_{load} + M_B$

The accelerating torque M_B is calculated as follows:

$$M_B = \frac{\pi}{30} \bullet J_{Motor + load} \bullet \frac{\Delta n}{t_B} = \frac{J_{Motor + load} \bullet \Delta n}{9.55 \bullet t}$$

M_B	Acceleration torque in Nm referred to the motor shaft (on the motor side)
$J_{motor+load}$	Total moment of inertia in kgm^2 (on the motor side)
Δn	Speed variation in rpm
t_B	Acceleration time, in s

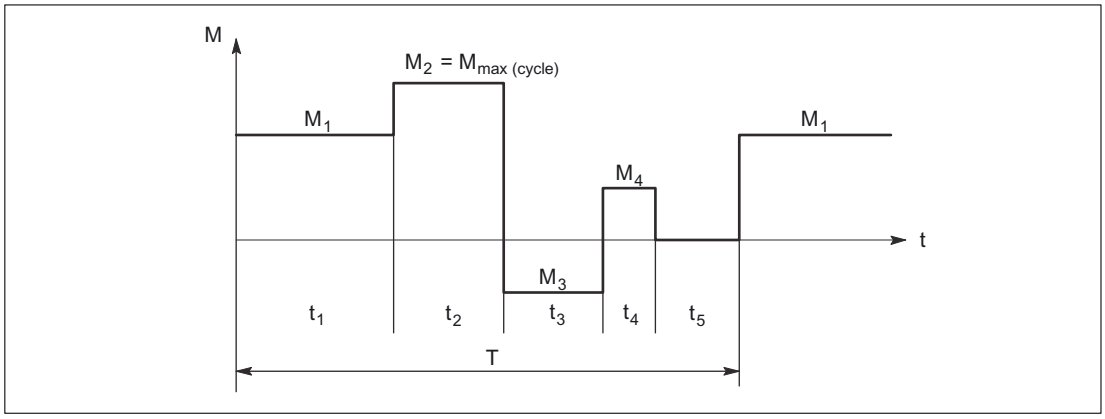


Figure 2-2 Periodic duty cycle (example)

The M_{rms} torque must be calculated from the load cycle:

$$M_{rms} = \sqrt{\frac{M_1^2 \bullet t_1 + M_2^2 \bullet t_2 \ldots}{T}}$$

A differentiation should be made depending on the period T and the thermal time constant T_{th} of the motor that is dependent on the shaft height:

- $T/T_{th} \leq 0.1$ (for a cycle duration of 2 to 4 min)
- $0.1 \leq T/T_{th} \leq 0.1$ (for a cycle duration of 3 to 20 min)
- $T/T_{th} > 0.5$ (for a cycle duration of approx. 15 min)

Motor selection

Table 2- 1 The motor is selected depending on the cycle duration and the thermal time constant

Cycle duration	Motor selection
$T/T_{th} \leq 0.1$ (cycle duration of 2 to 4 min)	A motor with the following rated torque M_N should be selected: $M_N > M_{rms}$ and $M_{max\ (cycle)} < 2\ M_N$
$0.1 \leq T/T_{th} \leq 0.5$ (cycle duration of approx. 3 to approx. 20 min)	A motor with the following rated torque M_N should be selected: $M_N > \frac{M_{rms}}{1.025 - 0.25 \cdot \frac{T}{T_{th}}}$ and $M_{max\ (cycle)} < M_N$
$T/T_{th} > 0.5$ (for a cycle duration of approx. 15 min)	If, for duty cycles, torques occur above M_N for longer than 0.5 T_{th}, then a motor with the following rated torque should be selected: $M_N > M_{max\ (cycle)}$.

Selecting Motor Module

The required currents for overload are specified in the power-speed characteristics (powers for S6-25 %, S6-40 %, S6-60 %). Intermediate values can be interpolated.

2.3.6 A high field weakening range is required

Proceed as follows for applications with a field-weakening range greater than for standard induction motors:

Starting from the max. speed n_{max} and the power P_{max} required at maximum speed, a motor must be selected which provides the required power P_{max} at this operating point (n_{max}, P_{max}).

Finally, a check should be made as to whether the motor can generate the torque or the power at the transition speed required by the application (n_N, P_N).

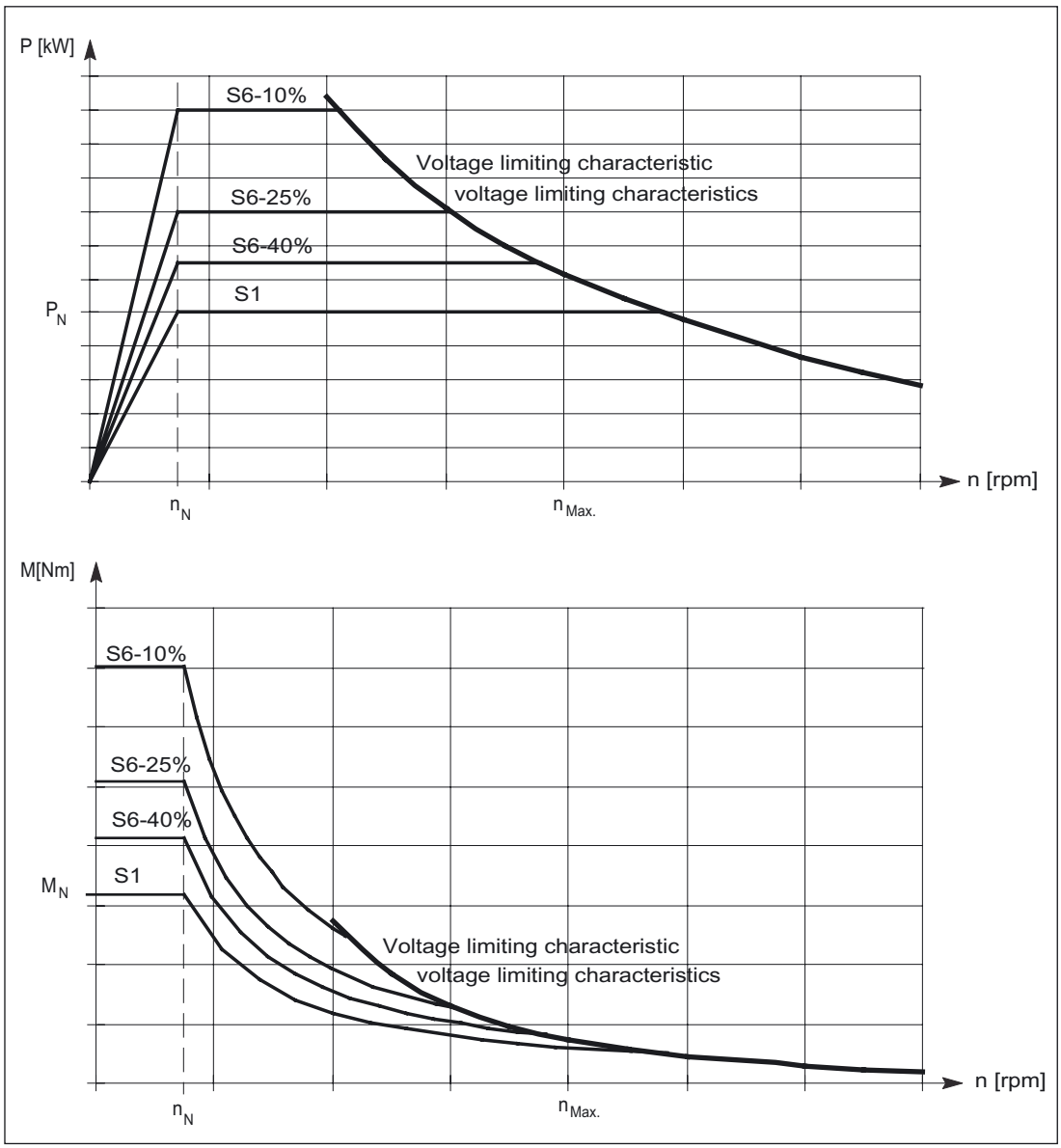


Figure 2-3 Motor selection based on power-speed and torque-speed diagrams

Example of the calculation of n_N

A specific power of P_{max} = 8 kW is required at n_{max} = 5250 rpm.
The field weakening range should be 1 : 3.5.

Calculation of the required rated speed n_N: 5250 / 3.5 rpm = 1500 rpm.

Mechanical properties of the motors

3

3.1 Cooling

An extremely high power density is achieved with water-cooled motors.

The cooling duct geometry is designed to achieve optimum dissipation of the stator power losses and part of the rotor losses.

Water cooling with a cooling system is required for operation.

Coolants

Water or low-viscosity oils can be used as coolants (carefully observe any derating required).

The coolant should fulfill the following prerequisites: Water which is chemically neutral and free of solids (tap water). For additional requirements, refer to the following table.

Table 3- 1 Chemical requirements placed on the coolant

Contents and chemical composition	Value
pH value	6.0 to 8.0
Chloride ions	< 40 ppm
Sulfate ions	< 50 ppm
Nitrate ions	< 50 ppm
Dissolved solids	< 340 ppm
Total hardness	< 170 ppm
Electrical conductivity	< 500 µS/cm
Size of any particles in the coolant	max. 100 µm

Additives must be mixed with the cooling water in appropriate quantities to protect against corrosion and the growth of algae. The type and quantity of additive should be taken from the manufacturer's specifications for these additives (refer to table) and the particular ambient conditions.

If Tyfocor (Tyforop Chemie GmbH) or Antifrogen N (Clariant Produkte GmbH Deutschland) is used, for example, 75% water and 25% anti-corrosion agent should be used.

Table 3- 2 Manufacturers of chemical additives

Company	Tel. / Telefax	Internet / E-mail
Tyforop Chemie GmbH Anton-Rée-Weg 7, D-20537 Hamburg, Germany	Tel.: +49 (0)40 / 20 94 97-0 Fax: +49 (0)40 / 61 52 99	www.tyfo.de info@tyfo.de
Clariant Produkte Deutschland GmbH Werk Gendorf, Hr. Dr. Michael Waidelich, R&D, Bau 300, D-84504 Burgkirchen, Germany	Tel.: +49 (0)8679 / 7-2272 Fax: +49 (0)8679 / 7-5085	www.antifrogen.de
Cimcool Industrial Products Schiedamsedijk 20, 3134 KK Vlaardingen, Netherlands	Tel.: +31 10 / 460 06 60 Fax: +31 10 / 460 32 40	www.cimcool.net info.nl@cimcool.net
FUCHS PETROLUB AG Friesenheimer Str. 17, D-68169 Mannheim, Germany	Tel.: +49 (0)621 / 38 02-0 Fax: +49 (0)621 / 3802 - 190	www.fuchs–oil.com contact-de.fpoc@fuchs-oil.de
hebro chemie GmbH Rostocker Strasse 40, D-41199 Mönchengladbach, Germany	Tel.: +49 (0)2166 / 6009–0 Fax: +49 (0)621 / 3802	www.hebro–chemie.de info@hebro-chemie.de
HOUGHTON Deutschland GmbH Werkstrasse 26, D-52076 Aachen-Oberforstbach, Germany	Tel.: +49 (0)2408 / 1406 - 0 Fax: +49 (0)2408 / 1406 - 20	www.houghton.de
Nalco Deutschland GmbH Steinbeisstrasse. 20-22, D-71691 Freiberg, Germany	Tel.: +49 (0)7141 / 70 30 Fax: +49 (0)7141 / 178	www.nalco.com

Note

These recommendations involve third-party products which we know to be basically suitable. It goes without saying that equivalent products from other manufacturers may be used. Our recommendations should be considered as such. We cannot accept any liability for the quality and properties/features of third-party products.

If other coolants (e.g. oil) are used, the following data must be determined and the motor derating (reduced output) clarified with your local Siemens office:

Density	ρ	[kg/m^3]
Specific thermal capacitance	c_ρ	[J/(kg•K)]
Kinematic viscosity	v	[m^2/s]
Flow rate	v	[rpm]

Note

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

Coolant intake temperature

In order to prevent moisture condensation, the coolant intake temperature must be greater than the ambient temperature.

Coolant intake temperature (recommended): $T_{cool} \geq T_{ambient} - 2$ K

Minimum coolant intake temperature: $T_{cool} > T_{ambient} - 5$ K

The motors are designed in accordance with EN 60034-1 for operation up to 30 °C coolant temperature, maintaining all of the motor data. If the motors are operated at higher coolant temperatures, the derating factors in the following table must be taken into account:

Table 3- 3 Derating factors for rated power

Coolant intake temperature	≤ 30 °C	40 °C	50 °C	60 °C
Derating factor	1,0	0,95	0,90	0,85

Coolant pressure

Maximum static coolant pressure:	0.6 MPa (6.0 bar)
Pressure drop (this occurs naturally)	max. approx. 0.01 MPa (0.1 bar)

Cooling power to be dissipated and cooling volumetric flow

Table 3- 4 Cooling power to be dissipated and cooling volumetric flow

Motor	Cooling volumetric flow [l/min] ± 0.75	Cooling power to be dissipated [W]	Connection	max. permissible Pressure [MPa]
1PH4103	6	1900	G 1/4"	0,6
1PH4105	6	2600	G 1/4"	0,6
1PH4107	6	3000	G 1/4"	0,6
1PH4133	8	2750	G 3/8"	0,6
1PH4135	8	3500	G 3/8"	0,6
1PH4137	8	4100	G 3/8"	0,6
1PH4138	8	4500	G 3/8"	0,6
1PH4163	10	4600	G 1/2"	0,6
1PH4167	10	5400	G 1/2"	0,6
1PH4168	10	6200	G 1/2"	0,6

Materials used in the cooling circuit

EN-GJL-200 and aluminum alloy are used in the cooling circuit.

The cooling circuit does not contain any non-ferrous metals.

⚠ CAUTION

The heatsink material is not resistant to seawater. It is not permissible to directly cool the motors using seawater.

If there is a danger of frost, the appropriate anti-freeze measures are required for operation, storage and transport. For example, emptying and blowing out with air, supplementary heating system for the cooling ducts.

Cooling system

A heat-exchanger unit must be used to ensure 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. For the addresses of cooling system manufacturers, please refer to the relevant catalog.

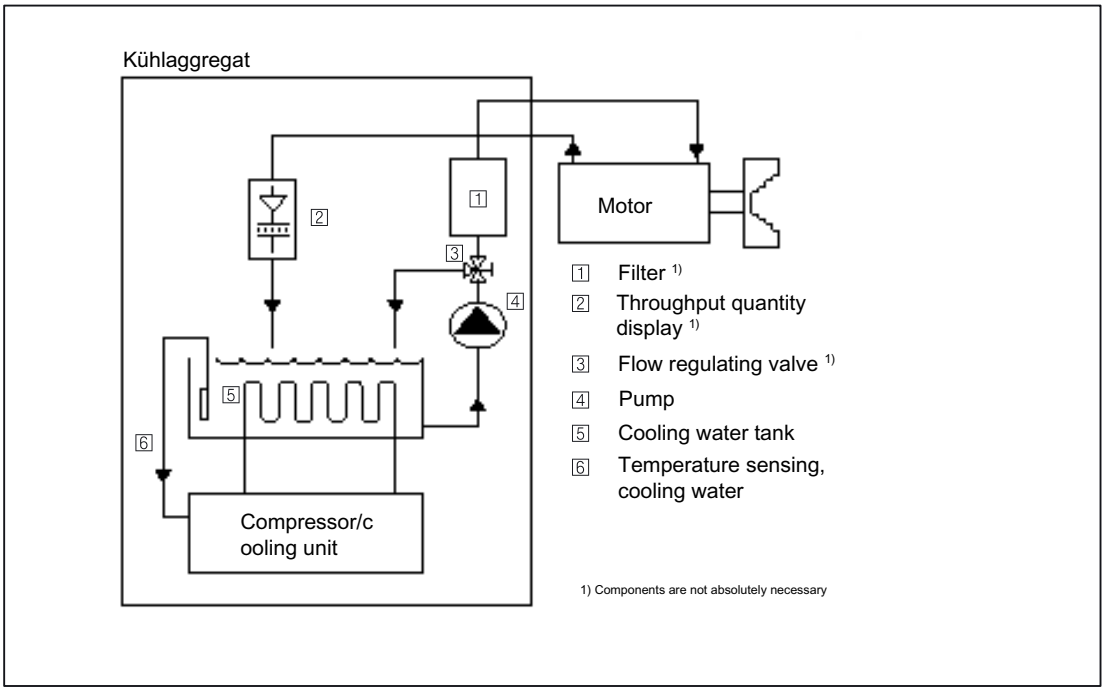


Figure 3-1 Cooling circuit

3.2 Degree of protection

The degree of protection designation in accordance with EN 60034-5 (IEC 60034-5) is described using the letters "IP" and two digits (e.g. IP64).

IP = International Protection
1. digit = Protection against the ingress of foreign bodies
2. digit = Protection against ingress of water

Since most coolants used in machine tools and transfer machines are oily, creep-capable, and/or corrosive, protection against water alone is insufficient. The motors must be protected by suitable covers.

Attention must be paid to providing suitable sealing of the motor shaft for the selected degree of protection of the motor.

1PH4 motors have degree of protection IP65. The motors have degree of protection IP55 at the shaft exit.

3.3 Bearing design and service life

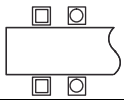
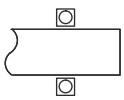
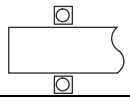
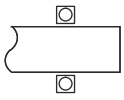
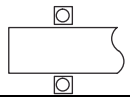
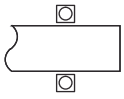
Standard

Duplex bearing on DE (deep-groove ball bearing and roller bearing).

NOTICE
The duplex bearing is not suitable for coupling output.

Bearing versions

Table 3- 5 Bearing versions

Application	Bearing	DE	NDE
Belt drive • Minimum radial force required • for high radial forces	**Standard:** Duplex bearing		
Coupling output or planetary gear • Reduced radial forces permitted	**Option K00, (K02, K03):** Single bearing		
Increased max. speed • Output with no radial force required, e.g. coupling output	**Option L37:** Single bearing "Spindle bearing"		

Bearing change interval (t_{LW}) and grease change interval

The values specified in the following table are valid for:

- Single and duplex bearings
- Cooling water temperature +30 °C
- Horizontal mounting position

Table 3- 6 Bearing change interval

SH	Duplex bearing (standard)		Single bearing (option K00)		Bearing for increased speed (option L37)	
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
n_m = average operating speed [rpm] t_{LW} = bearing change interval; grease change interval = 0.8 • t_{LW}						

Maximum speed n_{max} and maximum continuous speed n_{s1}

The motor must not exceed the maximum speed n_{max}, nor may it operate at n_{max} continuously. The speed must be reduced in accordance with the following duty cycle:

Duty cycle for a 10-minute cycle

3 min	n_{max}
6 min	2/3 n_{max}
1 min	Standstill

⚠ CAUTION

If the speed n_{max} is exceeded, this can result in damage to the bearings, short-circuit end rings, press fits etc. It should be ensured that higher speeds are not possible by appropriately designing the control or by activating the speed monitoring in the drive system.

The motor may operate at the maximum permissible continuous speed n_{S1} continuously without speed duty cycles. This speed depends on the bearings and shaft height.

Table 3- 7 Maximum permissible speed and maximum permissible continuous speed

SH	Duplex bearing [rpm]		Single bearing (option K00) [rpm]		Bearing for increased speeds (option L37) [rpm]	
	n_{max}	n_{s1}	n_{max}	n_{s1}	n_{max}	n_{s1}
100	7500	5600	9000	6500	12000	10000
132	6700	5200	8000	6000	10000	9250
160	5300	4000	6500	4500	8000	7000

Note

If the motor is operated at speeds between n_{s1} 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.

3.4 Radial force (transverse force)

Specific radial forces may not be exceeded in order to guarantee perfect operation. The radial force must not drop below a minimum value on certain shaft heights. This is indicated in the radial force diagrams.

The radial force diagrams show the radial force F_R

- at various operating speeds
- as a function of the bearing lifetime

The force diagrams and tables only apply to standard drive shaft ends. If smaller shaft diameters are used, only reduced radial forces may be transmitted or none at all. With forces in excess of these values, please contact your local Siemens office.

NOTICE
Motors with option L37 (increased speed) are suitable only for operation without radial force. When using elements which increase the force/torque (e.g. gearboxes, brakes), it must be ensured that the higher forces are not absorbed through the motor. When using mechanical transmission elements which subject the shaft end to a radial force, it must be ensured that the **maximum limit values specified in the radial force diagrams are not exceeded**. For applications with an extremely low radial force load, it must be ensured that the motor shaft is subject to the minimum radial force specified in the diagrams. Low radial forces can cause the cylindrical-roller bearing to roll in an undefined manner, thereby reducing the service life of the bearing. For these applications, a single bearing should be selected.

Dimensioning and calculation of the radial force F_R for a belt output

Note

The radial forces at the shaft end must be precisely dimensioned according to the guidelines specified by the belt manufacturer. The belt tension is set by means of appropriate measuring instruments.

If the belt manufacturer has not provided accurate radial force data, then this can be appropriately determined using the following formula:

$F_R = c \cdot F_U$ $\qquad$ $F_U = 2 \cdot 10^7 \cdot P / (n \cdot D)$

Table 3- 8 Explanation of the formula abbreviations

Formula abbreviation	Unit	Description
c	---	Pre-tensioning factor: The pre-tensioning factor is an empirical value provided by the belt manufacturer. The following value can be assumed: for V belts: c = 1.5 to 2.5 for special plastic belts (flat belts) depending on the type of load and belt: c = 2.0 to 2.5
F_R	N	Radial force
F_U	N	Circumferential force
P	kW	Motor output
n	rpm	Motor speed
D	mm	Diameter of belt pulley

1PH410□, duplex bearing (standard)

Maximum continuous speed	n_{s1} = 5600 rpm
Max. speed	n_{max} = 7500 rpm

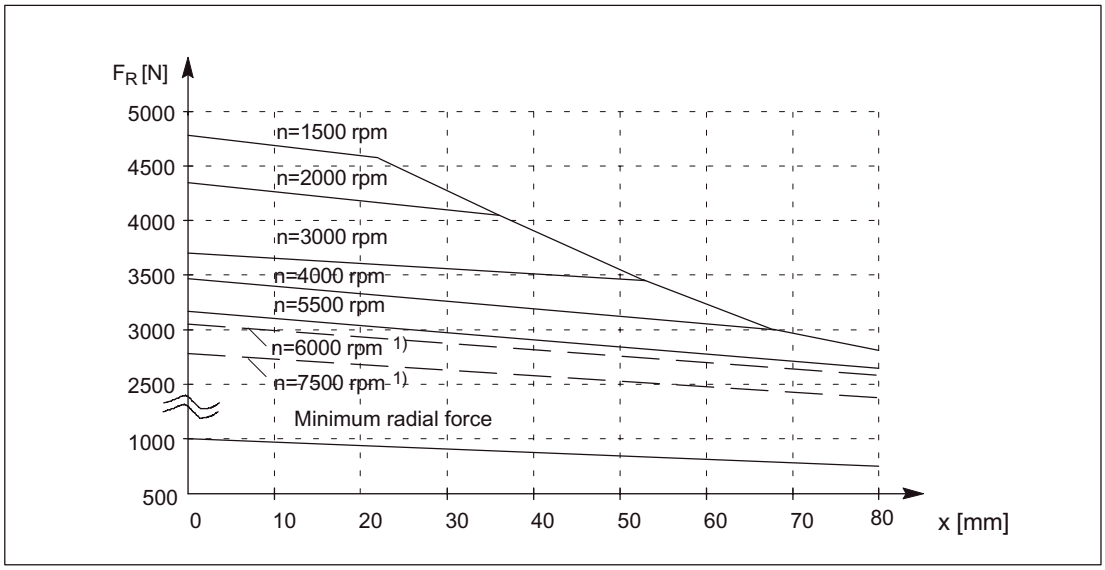


Figure 3-2 Permissible radial force F_R at a distance x from the shaft shoulder for a nominal bearing lifetime of 20 000 h.

1) Permissible for continuous operation with shorter bearing lifetime

1PH410□, single bearing (option K00)

Maximum continuous speed	n_{s1} = 6500 rpm
Max. speed	n_{max} = 9000 rpm

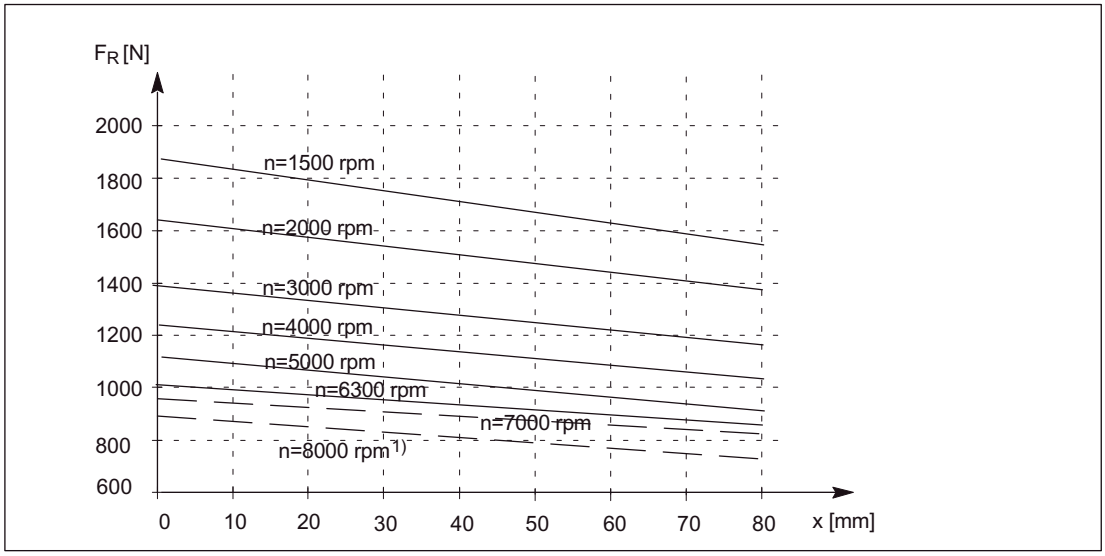


Figure 3-3 Permissible radial force F_R at a distance x from the shaft shoulder for a nominal bearing lifetime of 20 000 h. 1)

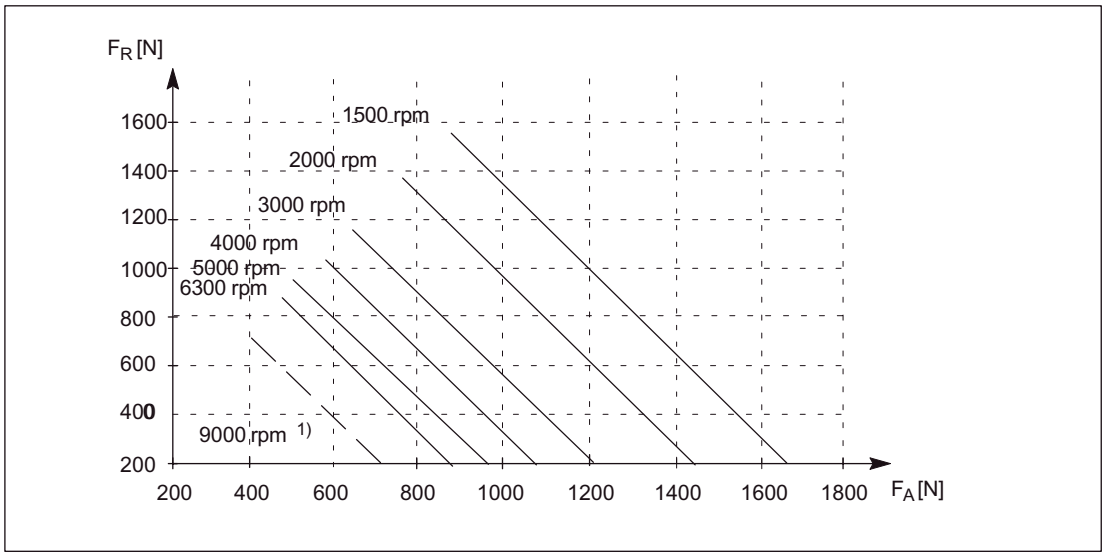


Figure 3-4 Permissible radial force F_R as a function of axial force F_A for a nominal bearing lifetime of 20 000 h.

1) Permissible for continuous operation with shorter bearing lifetime

1PH410□, single bearing (option K00 with L37)

Maximum continuous speed	n_{s1max} = 10000 rpm
Max. speed	n_{max} = 12000 rpm

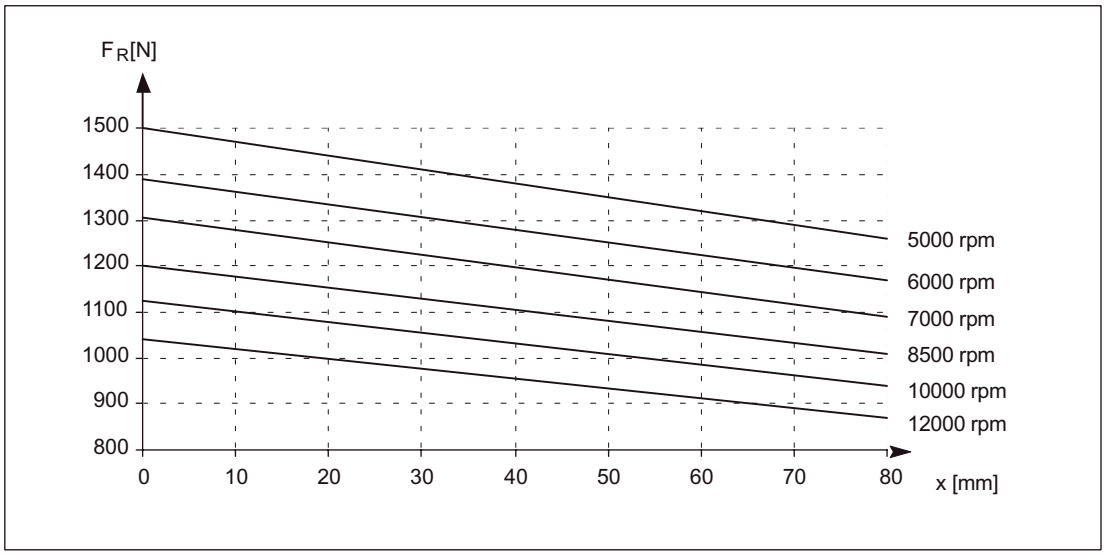


Figure 3-5 Permissible radial force F_R at a distance x from the shaft shoulder for a nominal bearing lifetime of 10 000 h. [1)]

[1)] Permissible for continuous operation with shorter bearing lifetime

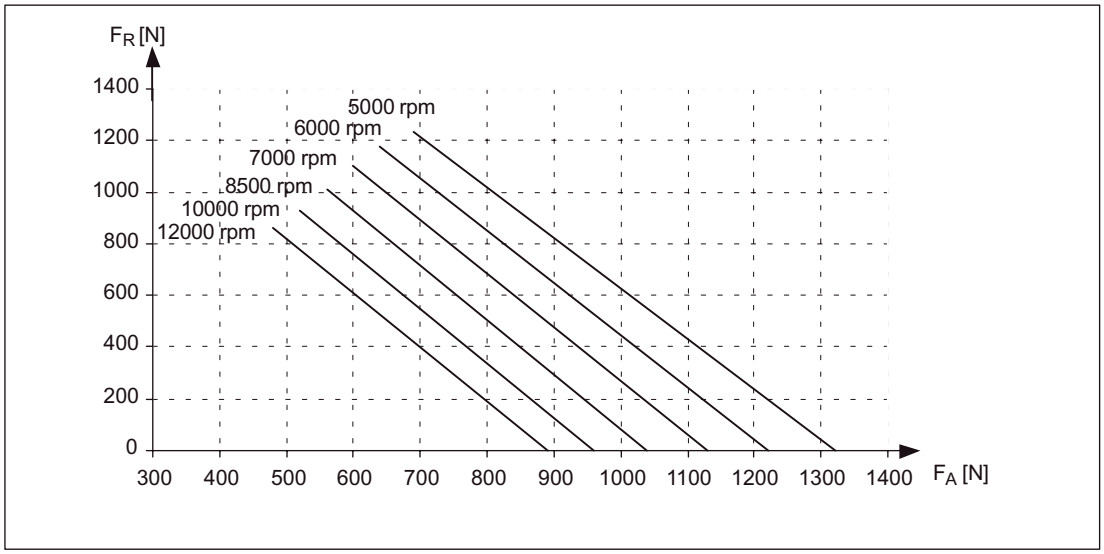


Figure 3-6 Permissible radial force F_R as a function of axial force F_A for a nominal bearing lifetime of 10 000 h.

1PH413□, duplex bearing (standard)

Maximum continuous speed	n_{s1} = 5200 rpm
Max. speed	n_{max} = 6700 rpm

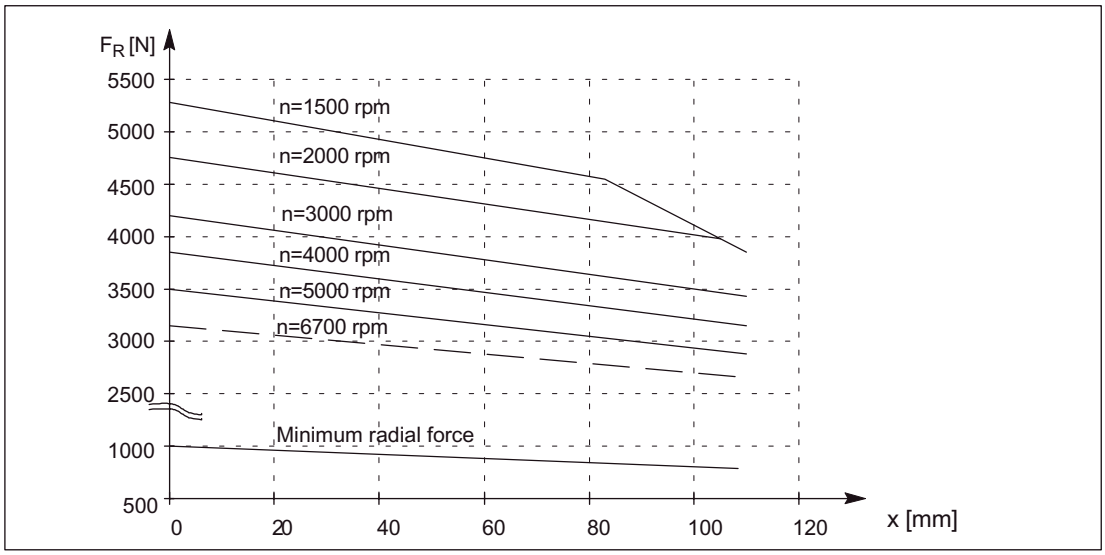


Figure 3-7 Permissible radial force F_R at a distance x from the shaft shoulder for a nominal bearing lifetime of 20 000 h. [1)]

[1)] Permissible for continuous operation with shorter bearing lifetime

1PH413□, single bearing (option K00)

Maximum continuous speed	n_{s1} = 6000 rpm
Max. speed	n_{max} = 8000 rpm

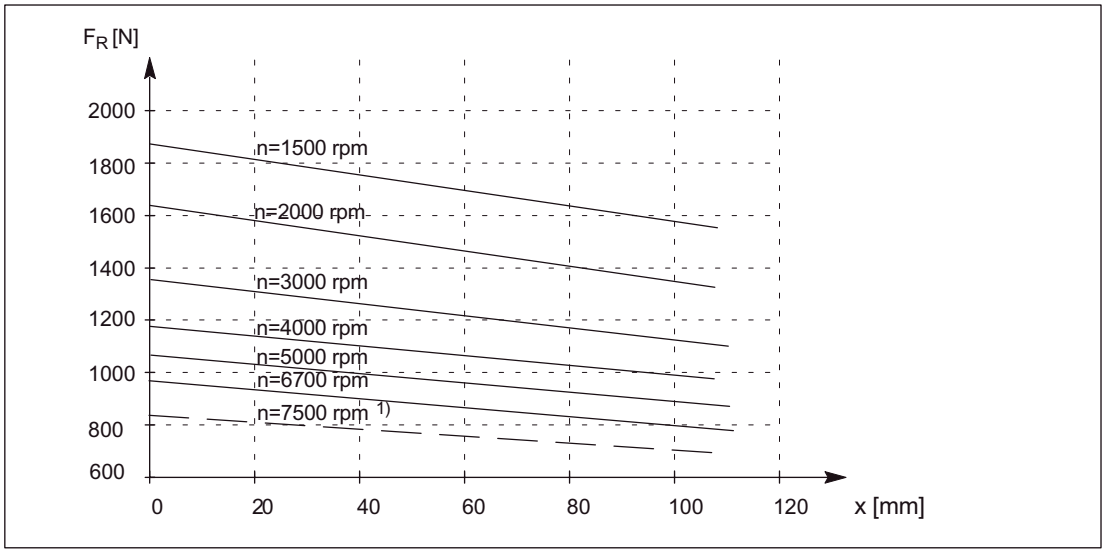


Figure 3-8 Permissible radial force F_R at a distance x from the shaft shoulder for a nominal bearing lifetime of 20 000 h. 1)

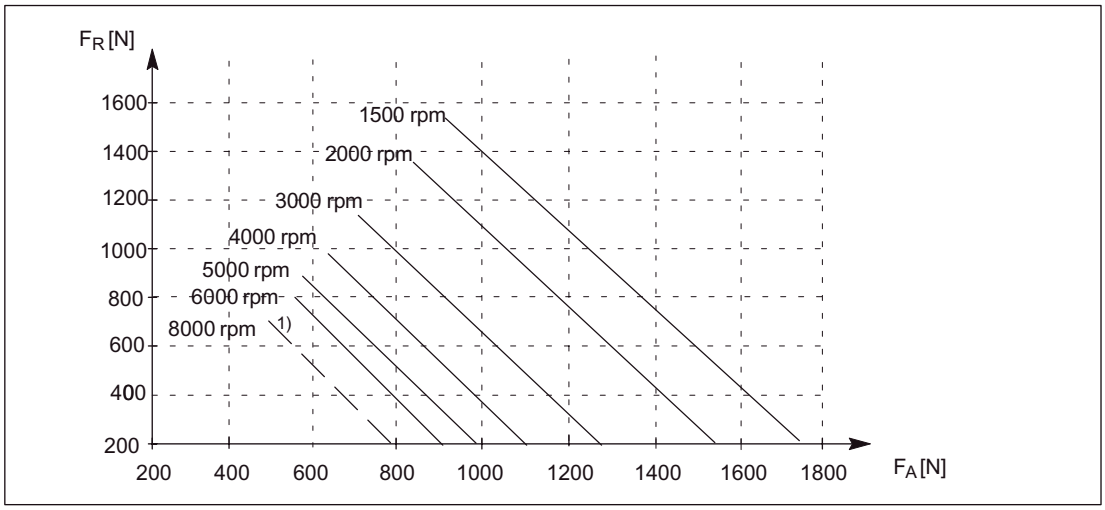


Figure 3-9 Permissible radial force F_R as a function of axial force F_A for a nominal bearing lifetime of 20 000 h.

1) Permissible for continuous operation with shorter bearing lifetime

1PH413□, single bearing (option K00 with L37)

Maximum continuous speed	n_{s1} = 9250 rpm
Max. speed	n_{max} = 10000 rpm

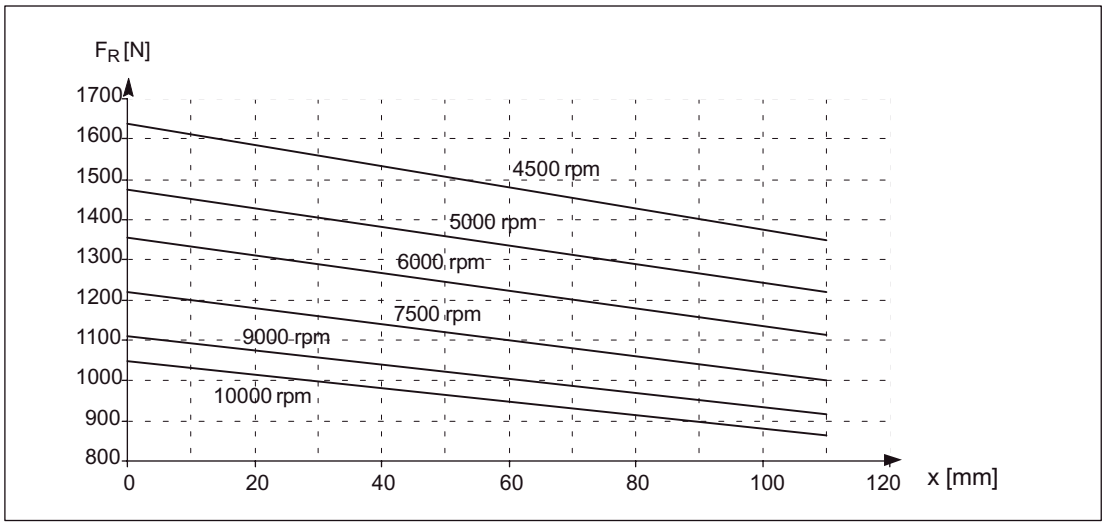


Figure 3-10 Permissible radial force F_R at a distance x from the shaft shoulder for a nominal bearing lifetime of 10 000 h. [1)]

[1)] Permissible for continuous operation with shorter bearing lifetime

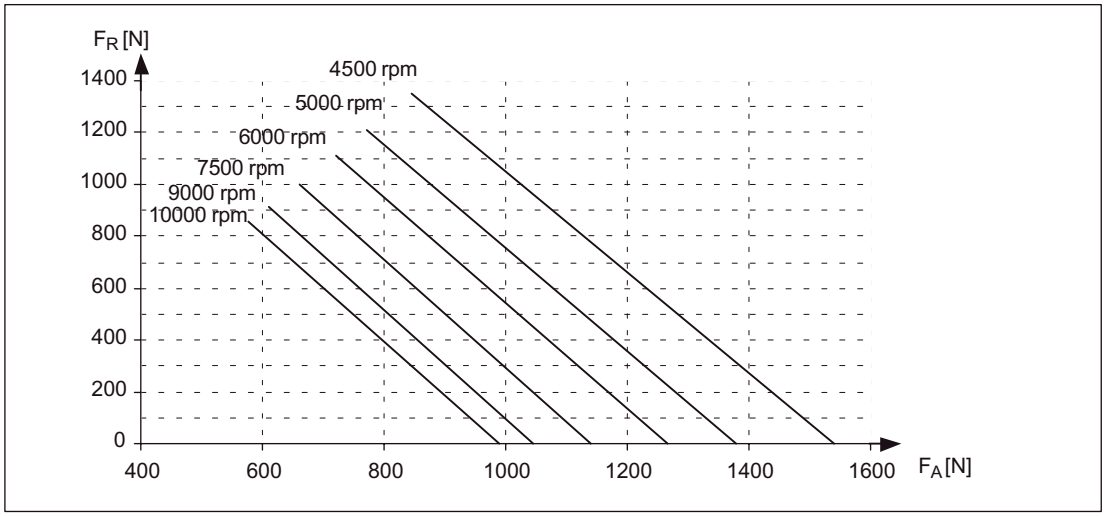


Figure 3-11 Permissible radial force F_R as a function of axial force F_A for a nominal bearing lifetime of 10 000 h.

1PH416□, duplex bearing (standard)

Maximum continuous speed	n_{s1} = 4000 rpm
Max. speed	n_{max} = 5300 rpm

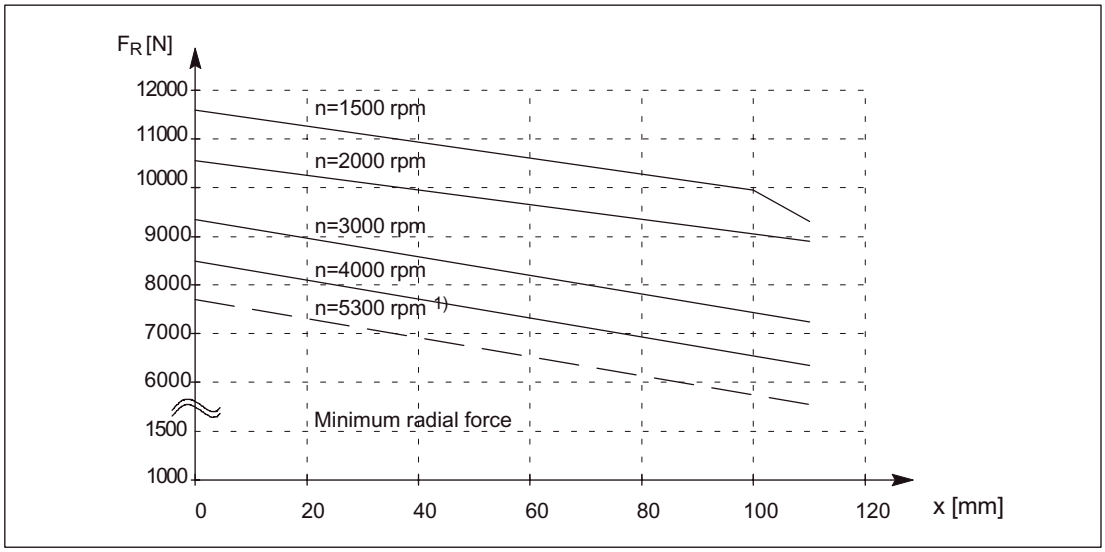


Figure 3-12 Permissible radial force F_R at a distance x from the shaft shoulder for a nominal bearing lifetime of 20 000 h.

1) Permissible for continuous operation with shorter bearing lifetime

1PH416□, single bearing (option K00)

Maximum continuous speed	n_{s1} = 4500 rpm
Max. speed	n_{max} = 6500 rpm

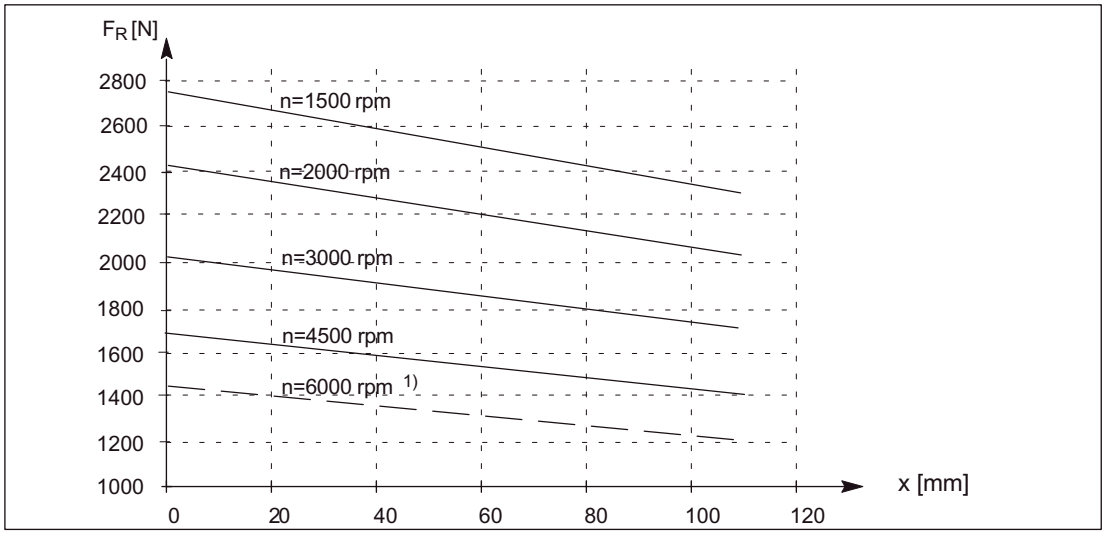


Figure 3-13 Permissible radial force F_R at a distance x from the shaft shoulder for a nominal bearing lifetime of 20 000 h. 1)

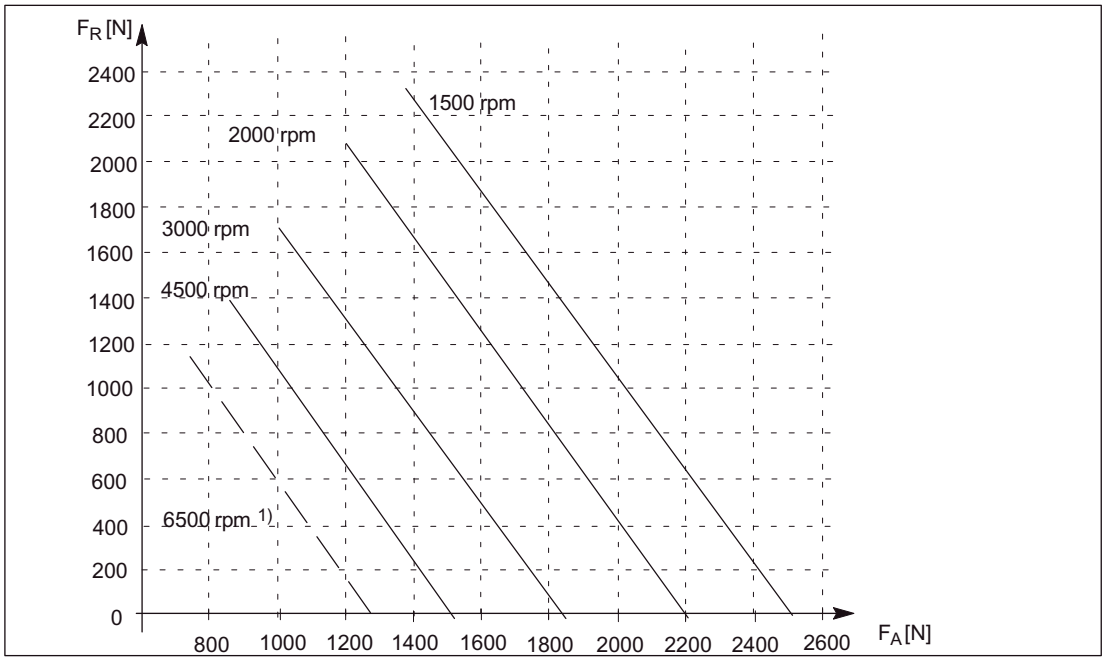


Figure 3-14 Permissible radial force F_R as a function of axial force F_A for a nominal bearing lifetime of 20 000 h.

1) Permissible for continuous operation with shorter bearing lifetime

1PH416□, single bearing (option K00 with L37)

Maximum continuous speed	n_{s1} = 7000 rpm
Max. speed	n_{max} = 8000 rpm

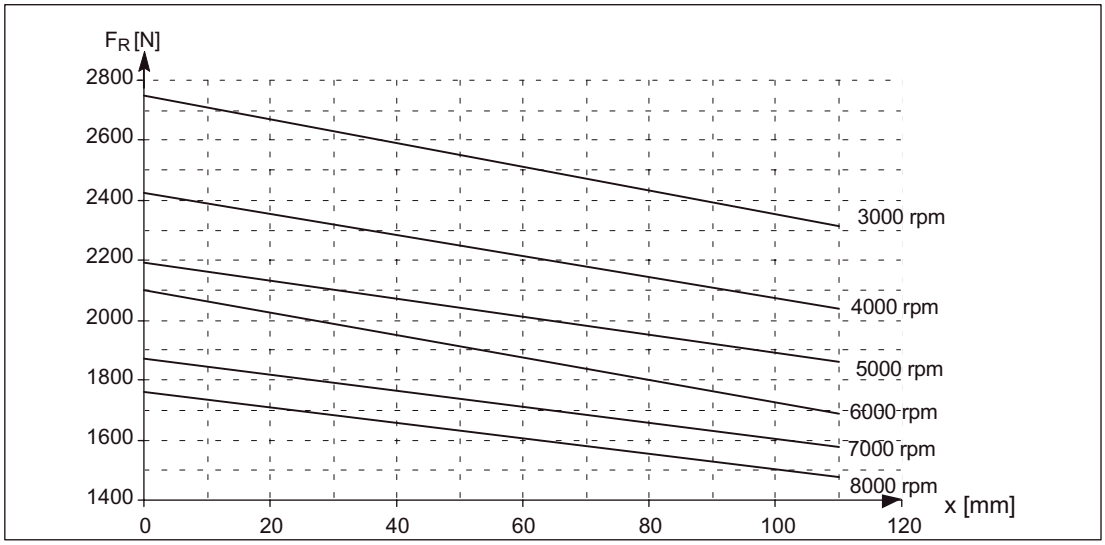


Figure 3-15 Permissible radial force F_R at a distance x from the shaft shoulder for a nominal bearing lifetime of 10 000 h. [1)]

[1)] Permissible for continuous operation with shorter bearing lifetime

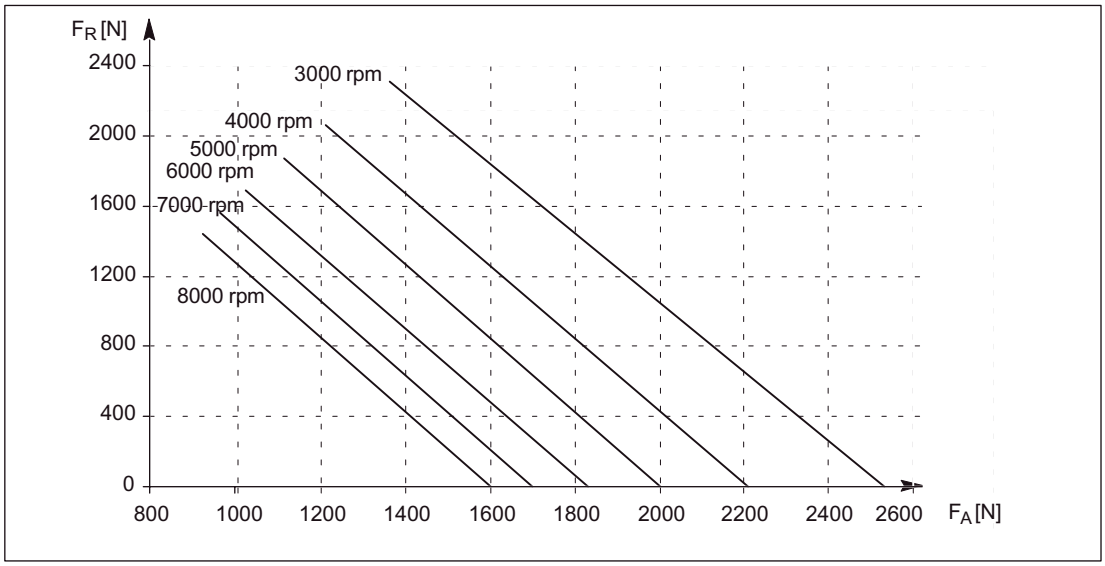


Figure 3-16 Permissible radial force F_R as a function of axial force F_A for a nominal bearing lifetime of 10 000 h.

3.5 Axial force

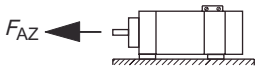
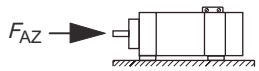
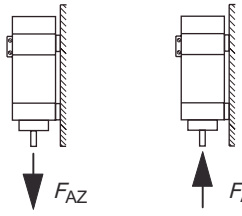
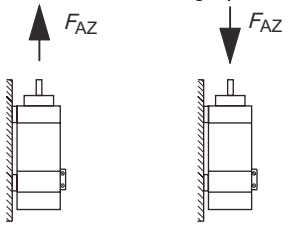
The axial force acting on the locating bearings comprises an external axial force (e.g. gearbox with helical gearing, machining forces through the tool), a bearing pre-load force and possibly the force due to the weight of the rotor when the motor is vertically mounted. This results in a maximum axial force that is a function of the direction.

When helical toothed wheels, for example, are used as the drive element, in addition to the radial force there is also an axial force on the motor bearings. For axial forces in the direction of the motor, the spring-loading of the bearing can be overcome. This must be prevented, as under certain circumstances, the bearing pre-loading is cancelled which means that the bearing lifetime could be reduced.

Calculating the permissible axial force F_{AZ}

The permissible axial force F_{AZ} in operation depends on the motor mounting position.

Table 3- 9 Calculating the permissible axial force

Horizontal arrangement	Shaft end facing downwards	Shaft end facing upwards
 $F_{AZ} = F_A - F_C$  $F_{AZ} = F_A + F_C$	 $F_{AZ} = F_A - F_L - F_C$ $F_{AZ} = F_L + F_C$	 $F_{AZ} = F_A + F_L - F_C$ $F_{AZ} = F_C - F_L$

F_{AZ}	Permissible axial force in operation
F_A	Permissible axial force as a function of the average speed
F_C	Force due to spring-loaded bearing
F_L	Force due to weight of rotor

Forces due to the rotor weight

Table 3- 10 Force due to weight of the rotor and force due to spring-loaded 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

The values specified apply to standard drive shaft ends; the permissible force loads are separately specified depending on the individual application for non-standard drive shaft end dimensions. With forces in excess of these values, please contact your local Siemens office.

Table 3- 11 Axial forces for duplex bearing (standard)

Motor type		Max. permissible axial force as a function of speed						
1PH410□-4	Speed n [rpm]	1500	2000	3000	4000	5000	6000	7500
	Axial force F_A [N]	**1440**	**1270**	**1050**	**920**	**830**	**760**	**690**
1PH413□-4	Speed n [rpm]	1500	2000	3000	4000	5000	6700	–
	Axial force F_A [N]	**1520**	**1330**	**1090**	**950**	**850**	**730**	**–**
1PH416□-4	Speed n [rpm]	1500	2000	3000	4000	5300	–	–
	Axial force F_A [N]	**2080**	**1830**	**1520**	**1340**	**1180**	**–**	**–**

3.6 Shaft end and balancing

The drive shaft end is cylindrical in accordance with DIN 748 Part 3, IEC 60072-1. The friction-locked shaft-hub coupling is the preferred option for fast acceleration and reversing operation of the drives.

Standard:	With keyway and fitted key (full-key balancing)
	Solid shaft SH 100 Tolerance field k6
	Solid shaft SH 132 Tolerance field k6
	Solid shaft SH 160 Tolerance field m6
Options:	K42 = plain shaft
	L69 = half-key balancing

The motor balance quality is certified in accordance with DIN ISO 8821.

3.7 Smooth running, concentricity and axial eccentricity

Radial eccentricity, shaft and flange accuracy (concentricity and axial eccentricity) in accordance with IEC 60072.

Table 3- 12 Radial eccentricity tolerance of the shaft to the frame axis (referred to cylindrical shaft ends)

Shaft height [mm]	Tolerance class N	Tolerance class R
100	0.05 mm	0.025 mm
132	0.05 mm	0.025 mm
160	0.06 mm	0.03 mm

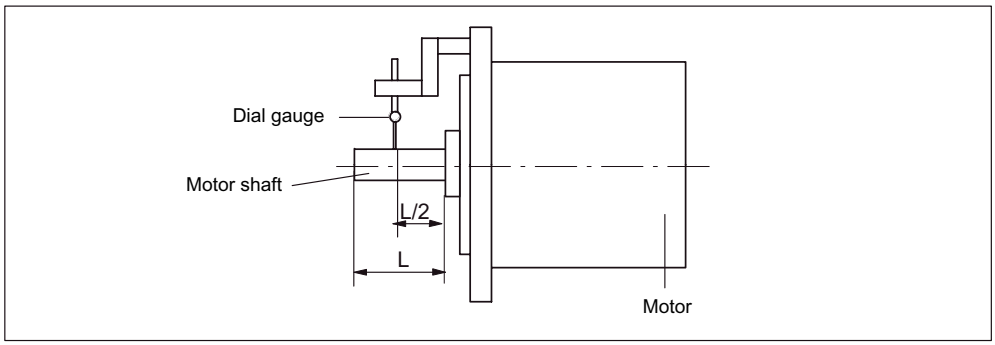


Figure 3-17 Checking the radial eccentricity

Table 3- 13 Concentricity and axial eccentricity tolerance of the flange surface to the shaft axis (referred to the centering diameter of the mounting flange)

Shaft height [mm]	Tolerance class N	Tolerance class R
100	0.1 mm	0.05 mm
132	0.125 mm	0.063 mm
160	0.125 mm	0.063 mm

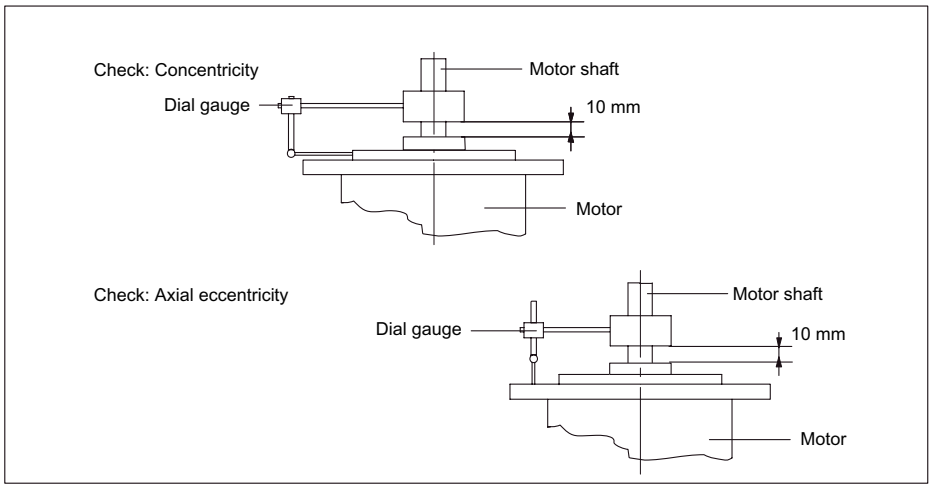


Figure 3-18 Checking the concentricity and axial eccentricity

3.8 Vibration severity grade

The 1PH4 motors conform to vibration severity Grade A in accordance with EN 60034-14 (IEC 60034-14).

The values indicated refer only to the motor. These values can be increased at the motor due to the overall vibration characteristics of the complete system after the drive has been mounted.

The motors comply with the vibration severity grade up to rated speed n_N.

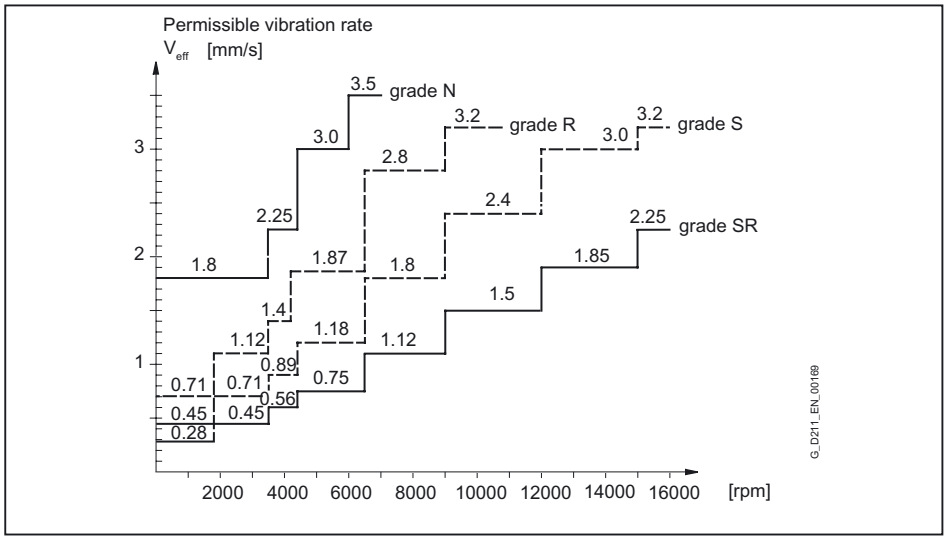


Figure 3-19 Vibration severity grades for shaft heights 100 to 132

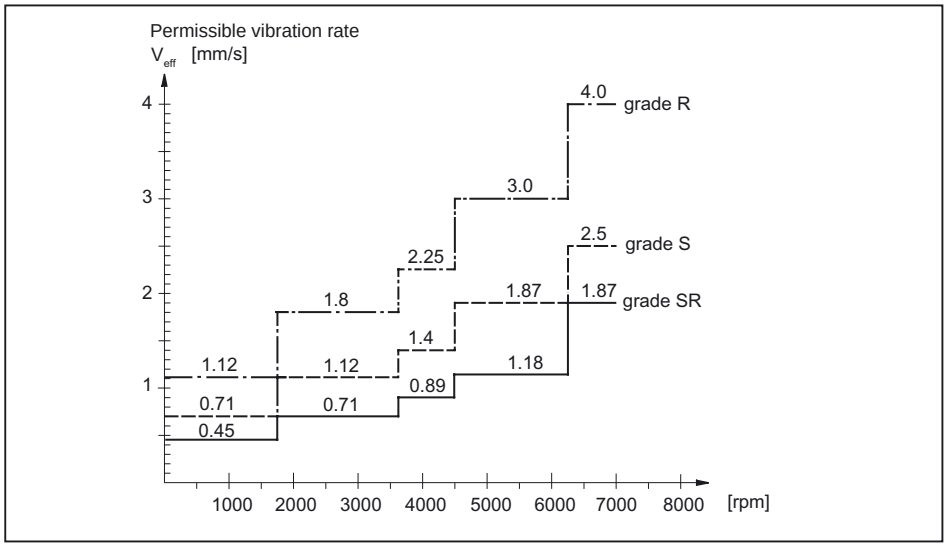


Figure 3-20 Vibration severity grades for shaft height 160

3.9 Paint finish

The motors are shipped with the standard paint finish RAL 7016 (anthracite).

Technical data and characteristics

4

4.1 Mode of operation and characteristics

A constant torque M_N is available from standstill up to the rated operating point. The constant-power range begins from the rated operating point (see P/n characteristic). Induction motors have a high overload capacity in the constant power range. For some induction motors, the overload capacity is reduced in the highest speed range.

At higher speeds, i.e. in the constant power range, the maximum available torque M_{max} at a specific speed n is approximated according to the following formula:

$$M_{max}\ [Nm] < \frac{P_{max}\,[kW] \bullet 9550}{n\ [rpm]} \qquad P_{max}\,[kW] = 2 \bullet P_N$$

For main spindle applications, the constant power range used to machine a workpiece with constant cutting power is extremely important. The required drive converter power can be reduced by optimally utilizing the constant power range.

The following limits and characteristics apply as basis for all induction motors fed from drive converters.

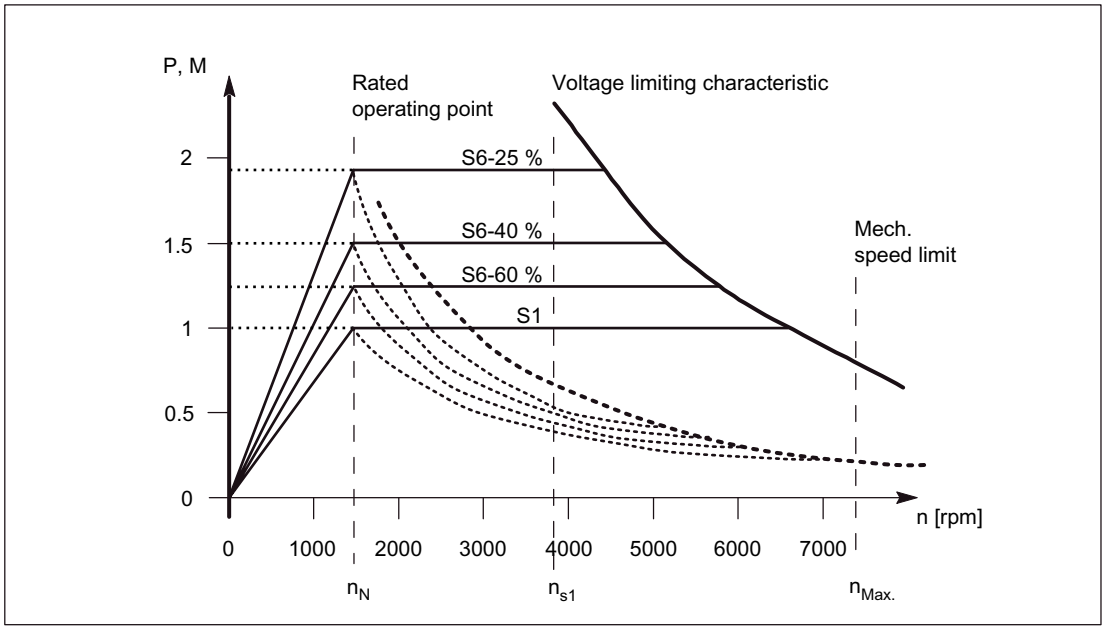


Figure 4-1 Power characteristics, limits and curves; torque-speed diagram

Power rating data for duty types S1 and S6

All power rating data of induction motors refer to continuous operation and the appropriate duty type S1.

However, for many applications, duty type S1 does not apply, if e.g. the load varies as a function of time. For this particular case, an equivalent sequence can be specified which represents, as a minimum, the same load for the motor.

For shorter accelerating times, torque surges or drives which have to handle overload conditions, short-time or peak currents are available in a 60 second cycle. The magnitude and precise engineering of these currents are described in the documentation for the relevant converter power units or Motor Modules.

The characteristics for continuous duty S1 and intermittent operation S6-60 %, S6-40 % and S6-25 % describe the permissible power values for an ambient temperature of up to 40 °C. A winding temperature rise of approx. 105 K can occur.

Speed limit

The maximum permissible speed n_{max} is determined by mechanical factors. The maximum speed n_{max} may not be exceeded and may not be continually used.

⚠ CAUTION

If the speed n_{max} is exceeded, then this can result in damage to the bearings, short-circuit end rings, press fits etc. It should be ensured that higher speeds are not possible by appropriately designing the control or by activating the speed monitoring in the drive.

Output voltages

The converter output voltages differ according to the converter type and supply voltage.

Converter type	Infeed module	Mains voltage	DC link voltage	Output voltage
		U_{supply}	U_{ZK}	U_{mot}
SINAMICS S120 380 - 480 V 3 AC	Active Line Module	400 V	600 V	425 V
	Smart Line Module	400 V	528 V	380 V
	Smart Line Module	480 V	634 V	460 V

4.2 Offset of the voltage limit characteristic

The characteristics in chapter "P/n and M/n characteristics" refer to the Active Line Module, U_{supply} = 400 V. The output voltage U_{mot} is 425 V.

In order to identify the motor limits with an output voltage other than 425 V, the plotted voltage limiting characteristic must be shifted accordingly for the new output voltage.

NOTICE
The offset in the voltage limiting characteristic is only valid for linear characteristics.

Calculating the new voltage limiting characteristic

$$\text{Calculation } P_{new} = P_{\text{Characteristic curve}} \cdot \left(\frac{U_{mot,\,new}}{U_{Mot}}\right)^2$$

$$\text{Calculation } n_{new} = n_{\text{Characteristic curve}} \cdot \left(\frac{U_{mot,\,new}}{U_{Mot}}\right)^2$$

U_{Mot} = output voltage

$U_{mot,\,new}$ = new output voltage

Example: Calculating the new voltage limiting characteristic for operation on an SLM, U_{supply} = 400 V, output voltage U_{mot} = 380 V

Voltage limiting characteristic at 425 V	New voltage limiting characteristic at 380 V
$P_{\text{Characteristic curve}}$ at n = 6000 rpm = 22.6 kW	$P_{new} = 22.6\text{ kW} \cdot \left(\frac{380\text{ V}}{425\text{ V}}\right)^2 = 18.0\text{ kW}$
$P_{\text{Characteristic curve}}$ at n = 9000 rpm = 14.0 kW	$P_{new} = 14.0\text{ kW} \cdot \left(\frac{380\text{ V}}{425\text{ V}}\right)^2 = 11.3\text{ kW}$
$P_{\text{Characteristic curve}}$ at n = 15000 rpm = 4.7 kW	$P_{new} = 4.7\text{ kW} \cdot \left(\frac{380\text{ V}}{425\text{ V}}\right)^2 = 3.7\text{ kW}$

The result are the points of intersection in the new voltage limiting characteristic for 380 V.

The new speed up to which power remains constant is: $n_{new} = 8000\text{ rpm} \cdot \left(\frac{380\text{ V}}{425\text{ V}}\right)^2 = 6400\text{ rpm}$

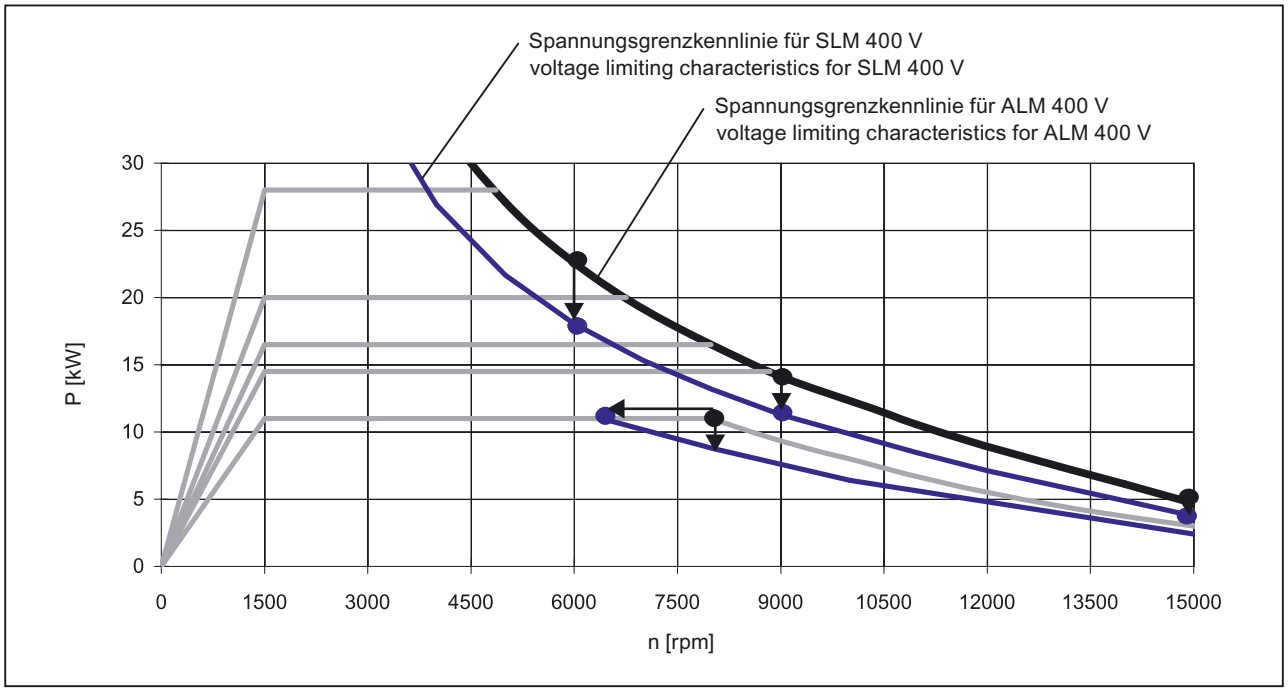


Figure 4-2 An example of the offset in the voltage limiting characteristic

4.3 P/n and M/n characteristics

Irrespective of the operating mode, running motors must be cooled continuously.

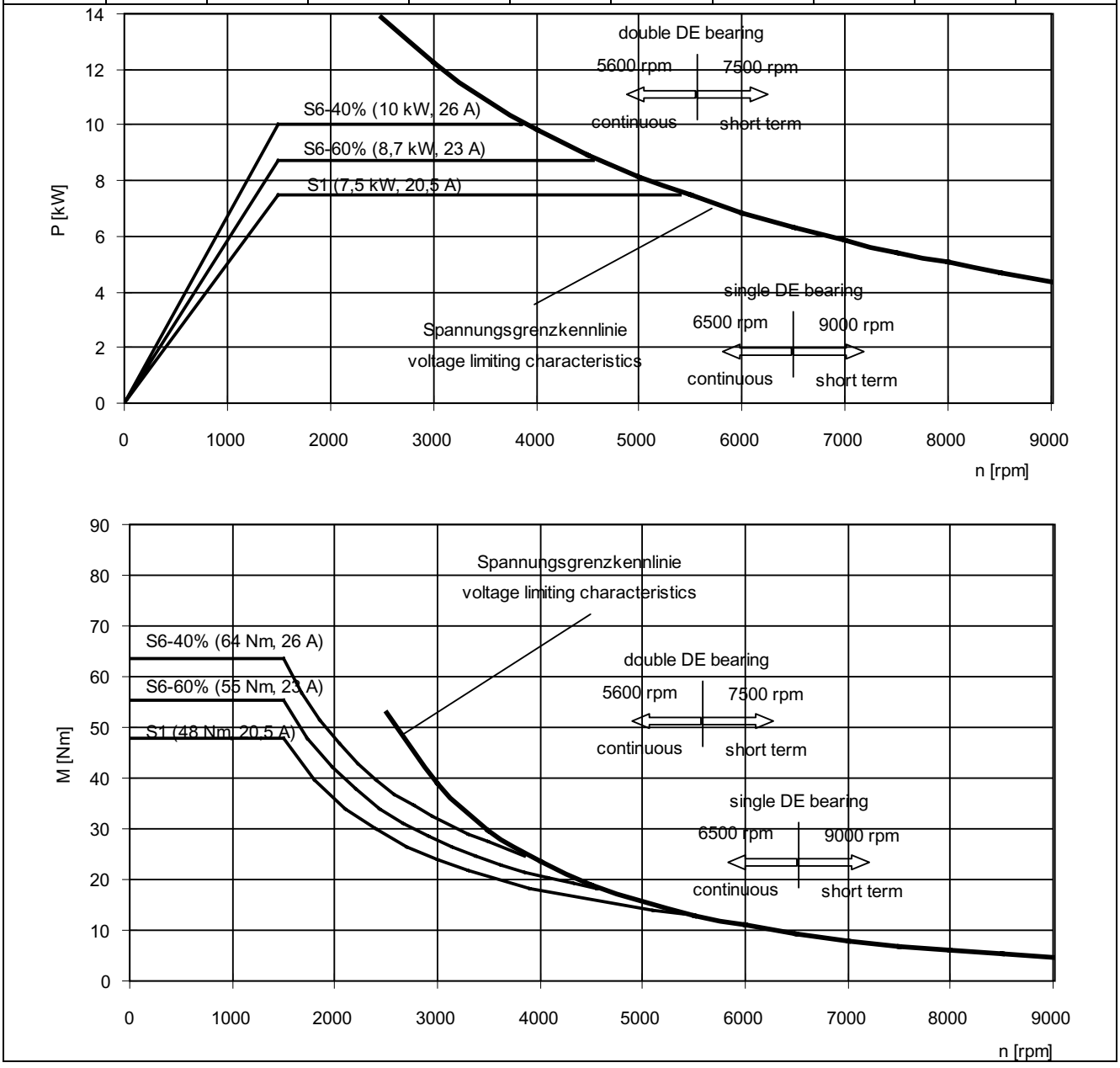
Table 4- 1 Explanation of abbreviations in the following tables

Abbreviation	Unit	Description
n_N	rpm	Rated speed
P_N	kW	Rated power
M_N	Nm (lb-in)	Rated torque
I_N	A	Rated current
U_N	V	Rated voltage
f_N	Hz	Rated frequency
n_2	rpm	Speed for field weakening with constant power
n_{max}	rpm	Maximum speed
T_{th}	min	Thermal time constant
I_μ	A	No-load current
I_{max}	A	Maximum current

4.3.1 Characteristics for production machines

Table 4- 2 1PH4103-❑❑F5

n_N [rpm]	P_N [kW]	M_N [Nm]	I_N [A]	U_N [V]	f_N [Hz]	n_2 [rpm]	n_{max} [rpm]	T_{th} [min]	I_μ [A]	I_{max} [A]
1500	7,5	48,0	20,5	350	52,8	5400	9000	6	12,0	26,0

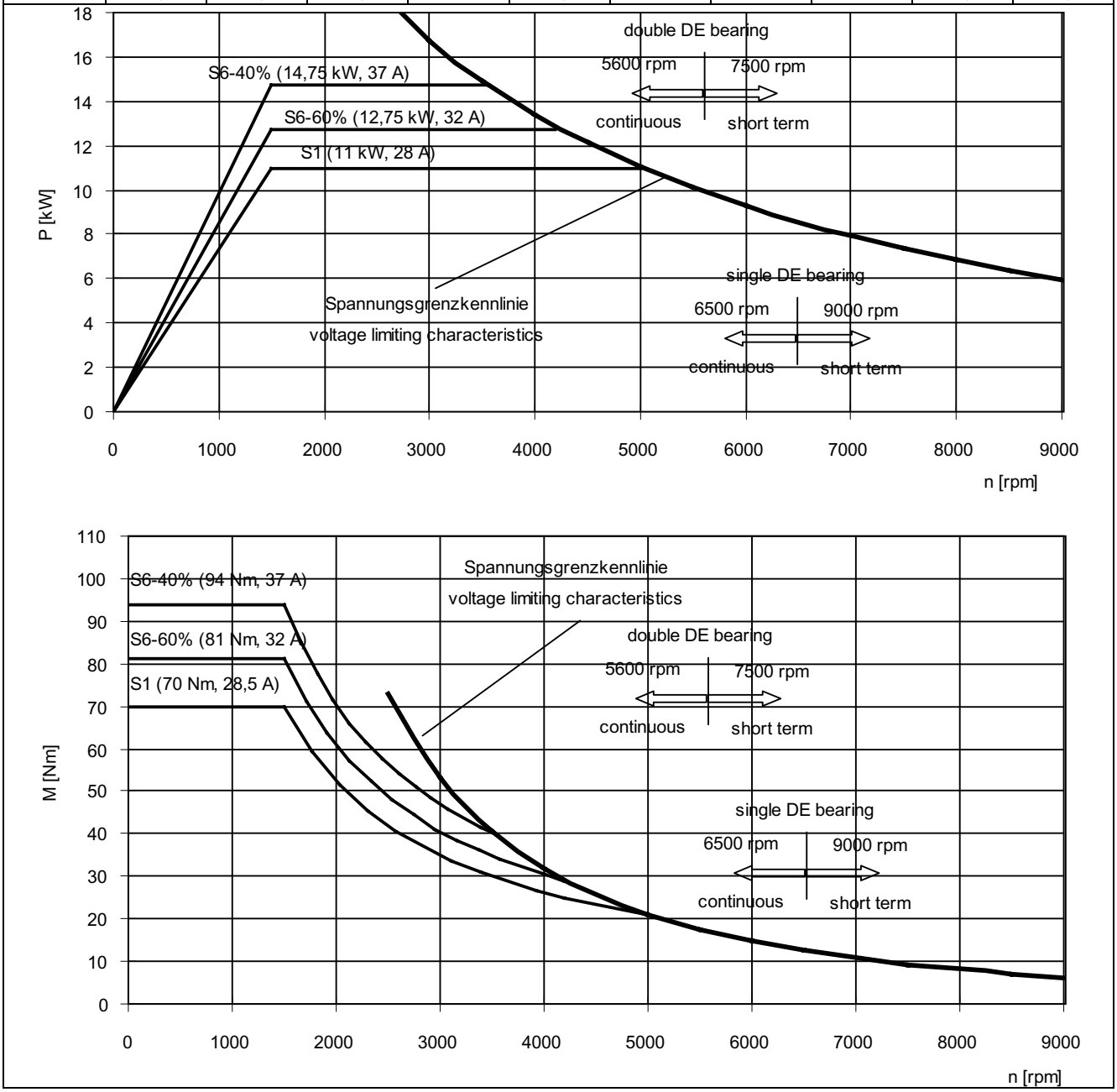


SINAMICS S120 Active Line Module, $U_{supply\ rms}$ = 400 V

The characteristics apply in the case of optimized drive parameters

Table 4- 3 1PH4105-❑❑F5

n_N [rpm]	P_N [kW]	M_N [Nm]	I_N [A]	U_N [V]	f_N [Hz]	n_2 [rpm]	n_{max} [rpm]	T_{th} [min]	I_μ [A]	I_{max} [A]
1500	11,0	70,0	28,0	350	52,9	5000	9000	6	13,5	37,0

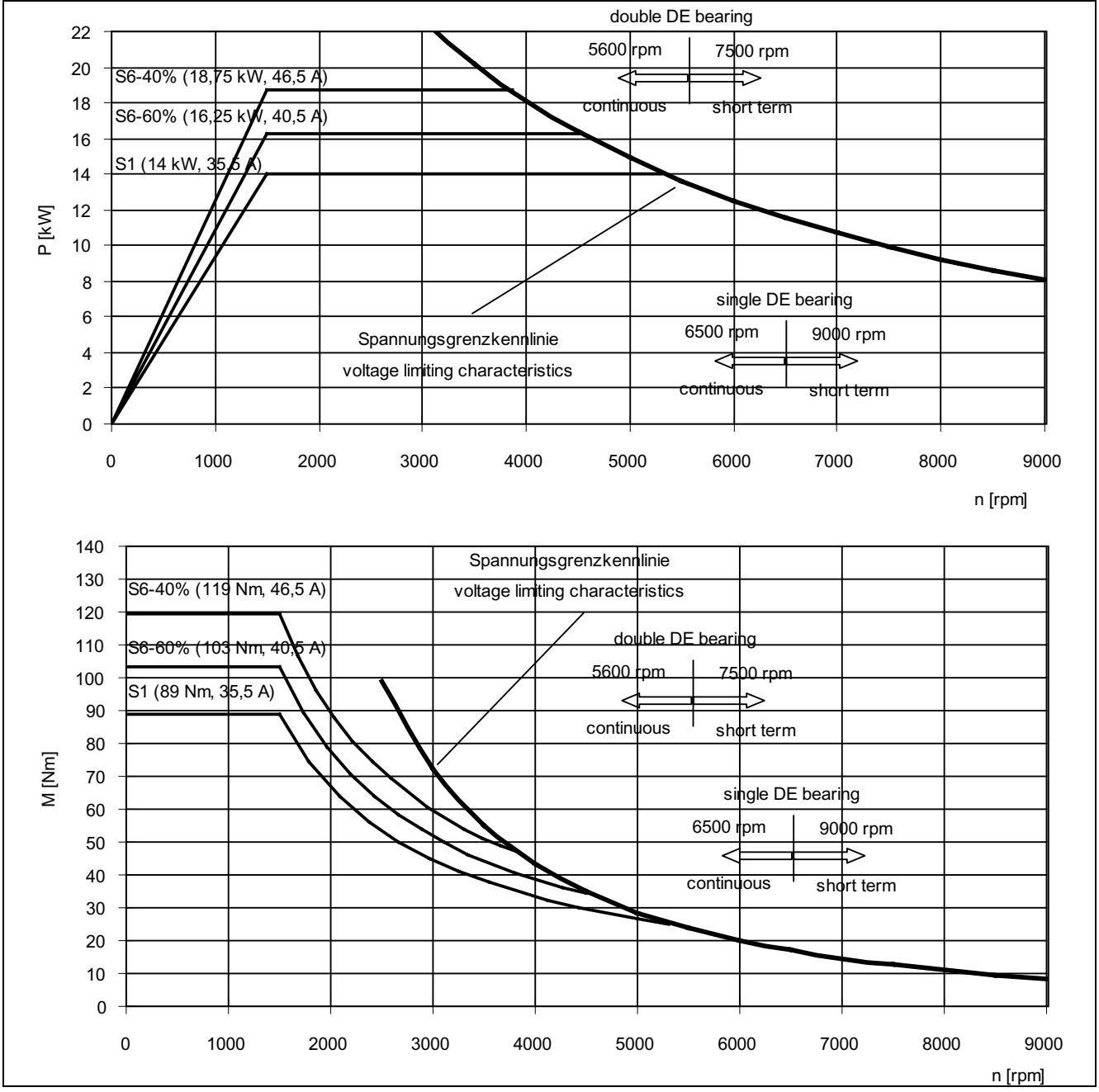


SINAMICS S120 Active Line Module, $U_{supply\ rms}$ = 400 V

The characteristics apply in the case of optimized drive parameters

Table 4- 4 1PH4107-❑❑F5

n_N [rpm]	P_N [kW]	M_N [Nm]	I_N [A]	U_N [V]	f_N [Hz]	n_2 [rpm]	n_{max} [rpm]	T_{th} [min]	I_μ [A]	I_{max} [A]
1500	14,0	89,0	35,5	350	52,2	5300	9000	6	18,5	46,5

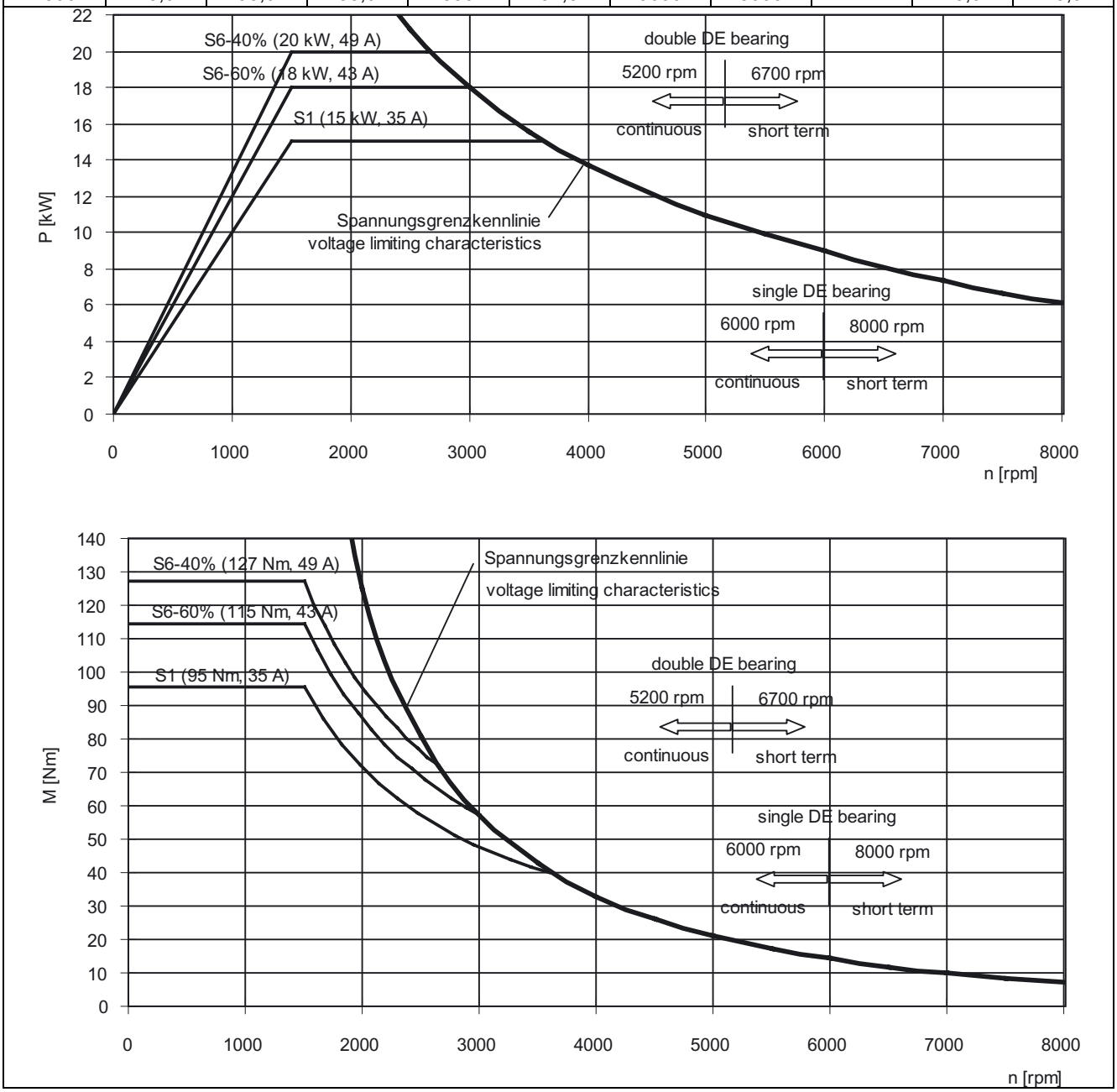


SINAMICS S120 Active Line Module, $U_{supply\ rms}$ = 400 V

The characteristics apply in the case of optimized drive parameters

Table 4- 5 1PH4133-❑❑F5

n_N [rpm]	P_N [kW]	M_N [Nm]	I_N [A]	U_N [V]	f_N [Hz]	n_2 [rpm]	n_{max} [rpm]	T_{th} [min]	I_μ [A]	I_{max} [A]
1500	15,0	95,0	35,0	350	51,8	3600	8000	11	13,0	49,0

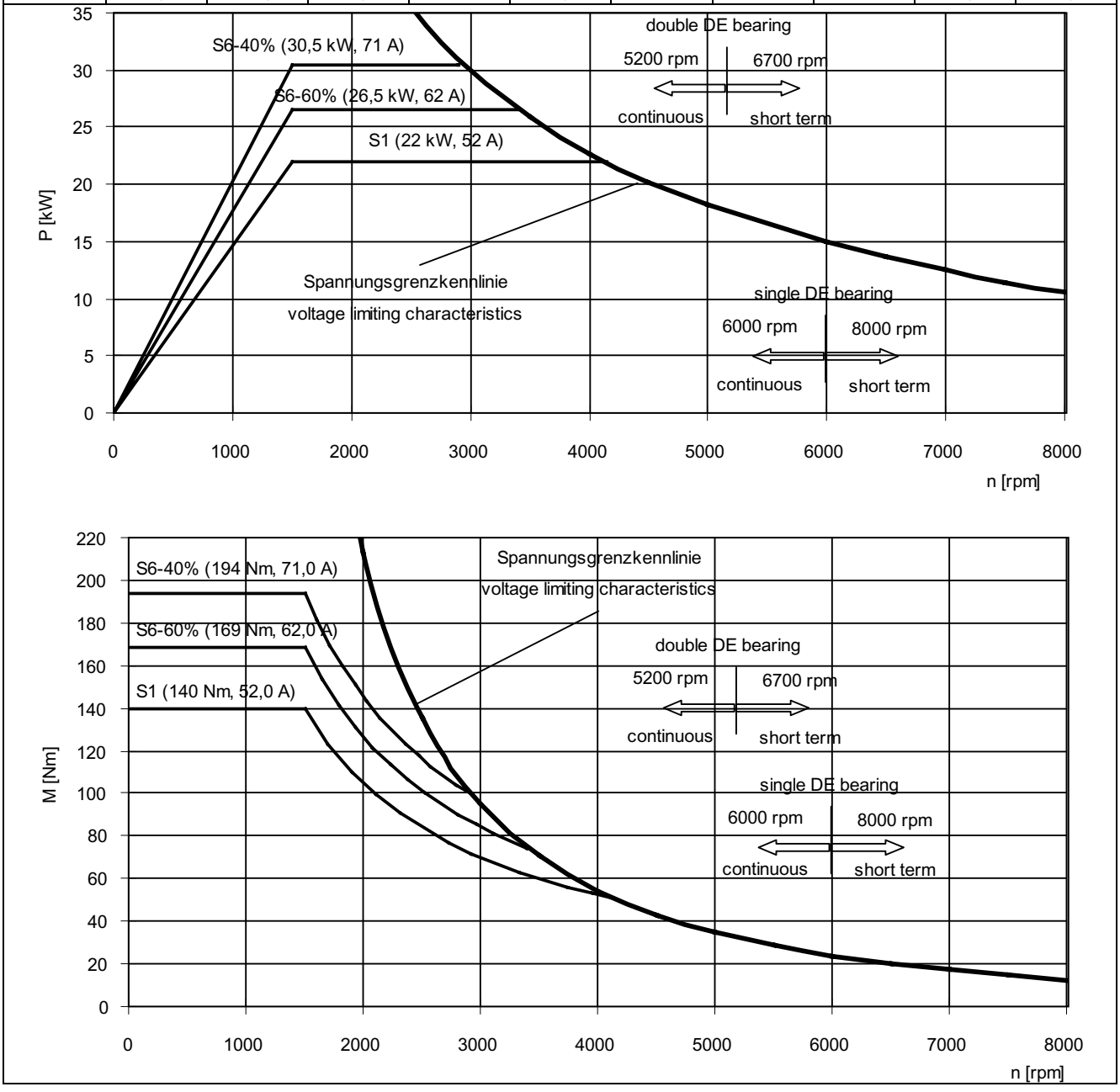


SINAMICS S120 Active Line Module, $U_{supply\ rms}$ = 400 V

The characteristics apply in the case of optimized drive parameters

Table 4- 6 1PH4135-❑❑F5

n_N [rpm]	P_N [kW]	M_N [Nm]	I_N [A]	U_N [V]	f_N [Hz]	n_2 [rpm]	n_{max} [rpm]	T_{th} [min]	I_μ [A]	I_{max} [A]
1500	22,0	140,0	52,0	350	51,4	4150	8000	11	24,0	71,0

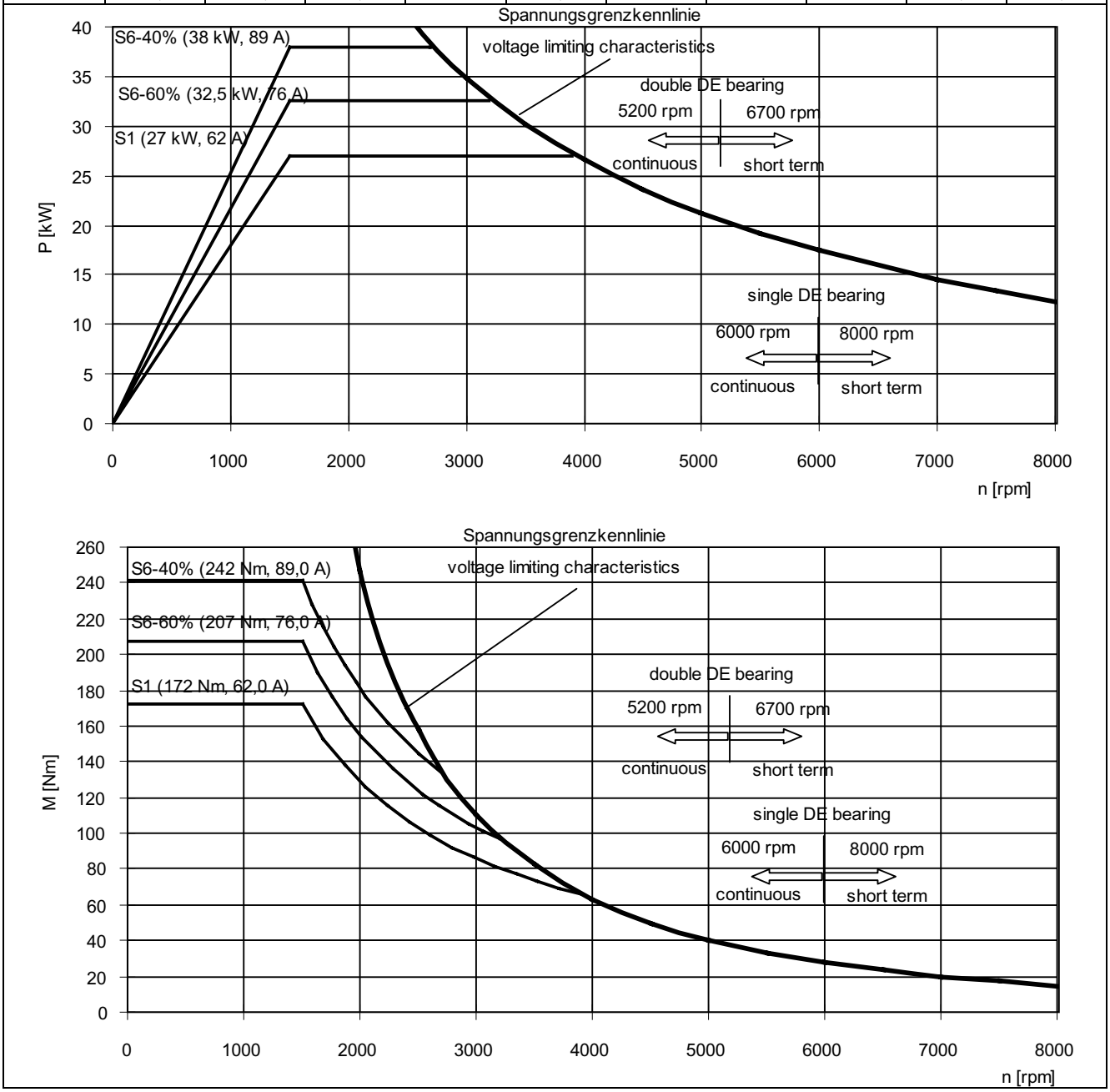


SINAMICS S120 Active Line Module, $U_{supply\ rms}$ = 400 V

The characteristics apply in the case of optimized drive parameters

Table 4- 7 1PH4137-❑❑F5

n_N [rpm]	P_N [kW]	M_N [Nm]	I_N [A]	U_N [V]	f_N [Hz]	n_2 [rpm]	n_{max} [rpm]	T_{th} [min]	I_μ [A]	I_{max} [A]
1500	27,0	172,0	62,0	350	51,5	3900	8000	11	24,0	89,0

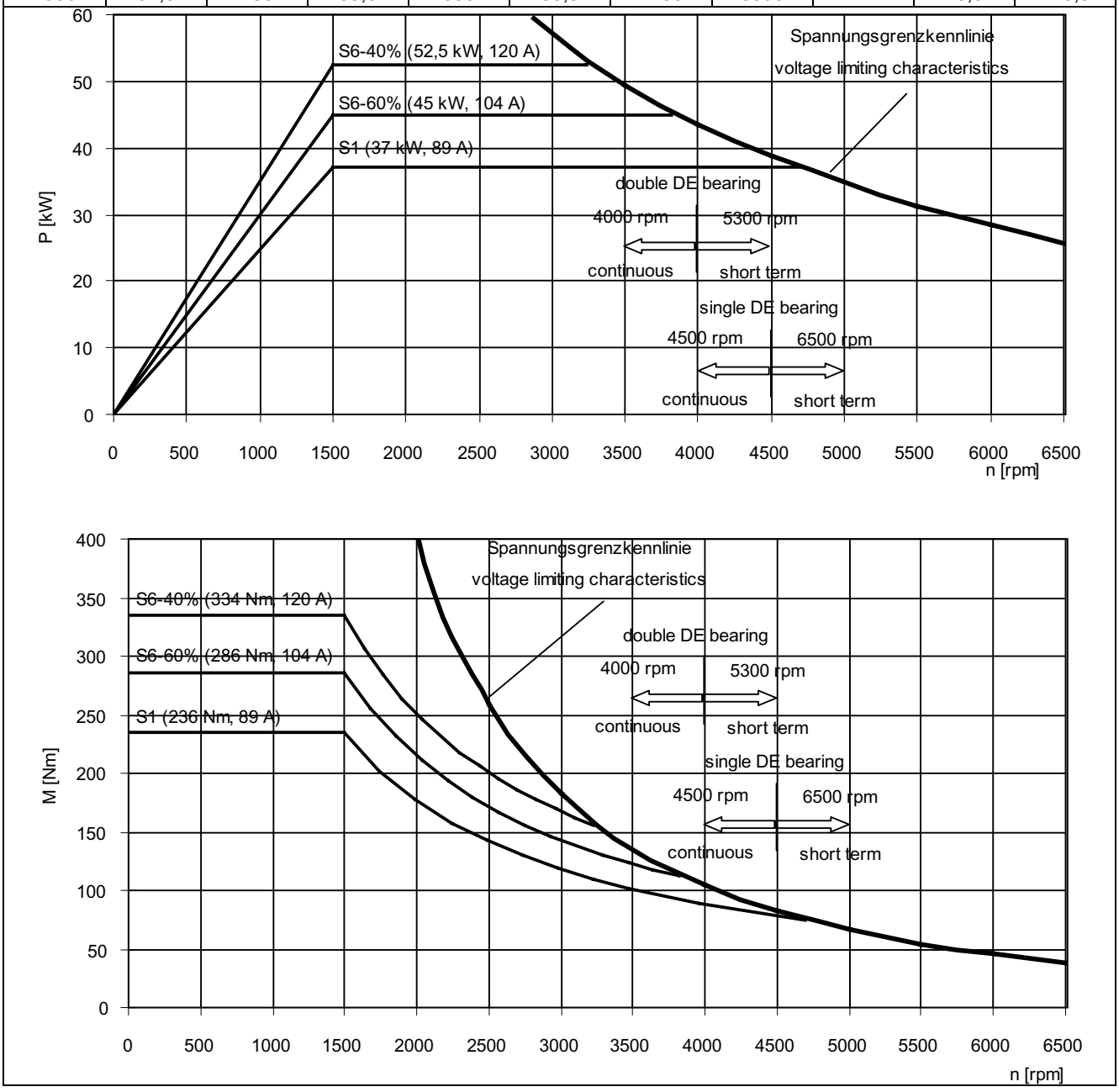


SINAMICS S120 Active Line Module, $U_{supply\ rms}$ = 400 V

The characteristics apply in the case of optimized drive parameters

Table 4- 8 1PH4163-❑❑F5

n_N [rpm]	P_N [kW]	M_N [Nm]	I_N [A]	U_N [V]	f_N [Hz]	n_2 [rpm]	n_{max} [rpm]	T_{th} [min]	I_μ [A]	I_{max} [A]
1500	37,0	236	89,0	350	50,9	4700	6500	14	45,0	120,0

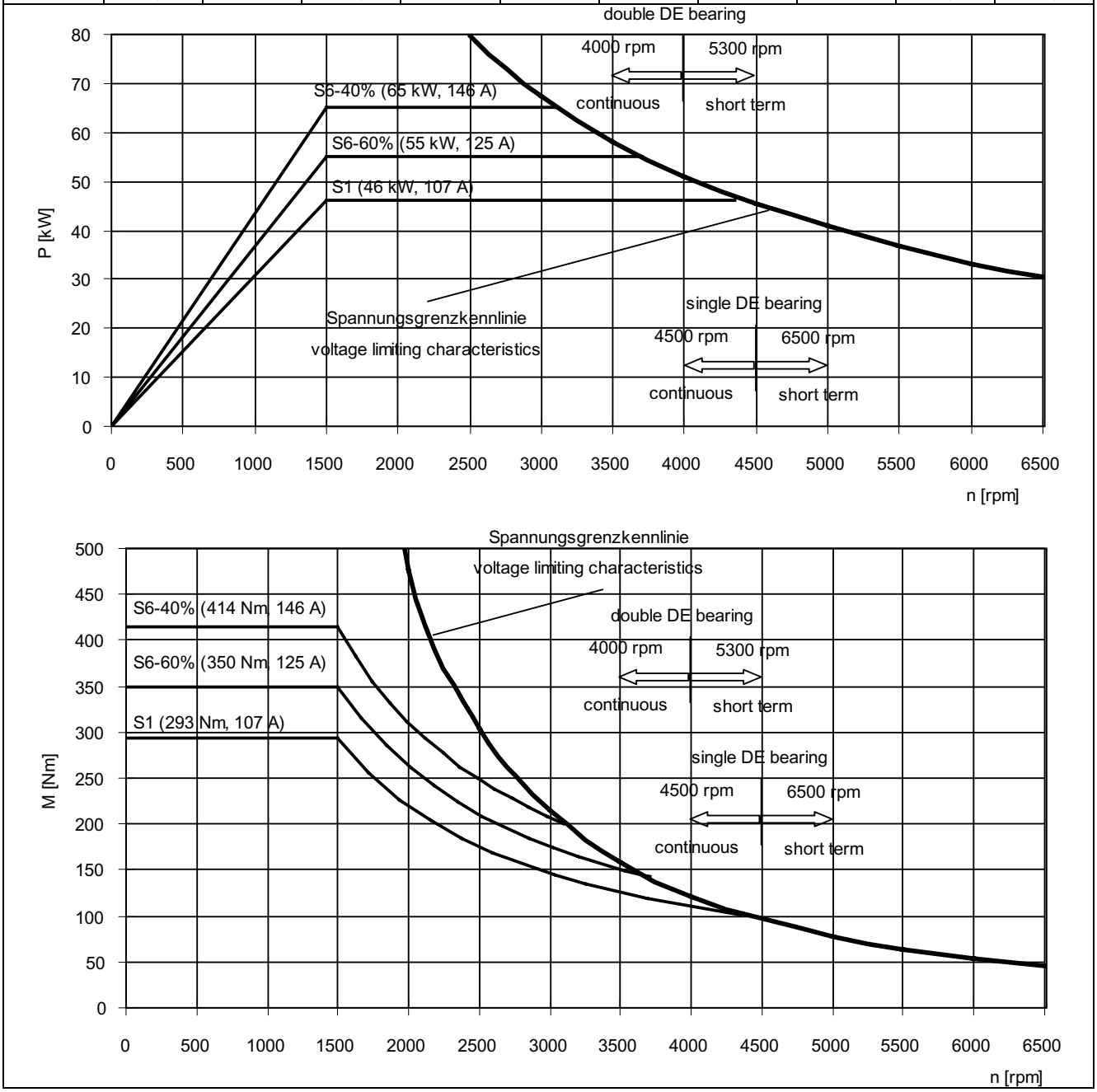


SINAMICS S120 Active Line Module, $U_{supply\ rms}$ = 400 V

The characteristics apply in the case of optimized drive parameters

Table 4- 9 1PH4167-❑❑F5

n_N [rpm]	P_N [kW]	M_N [Nm]	I_N [A]	U_N [V]	f_N [Hz]	n_2 [rpm]	n_{max} [rpm]	T_{th} [min]	I_μ [A]	I_{max} [A]
1500	46,0	293	107,0	350	51,0	4350	6500	14	48,0	146,0

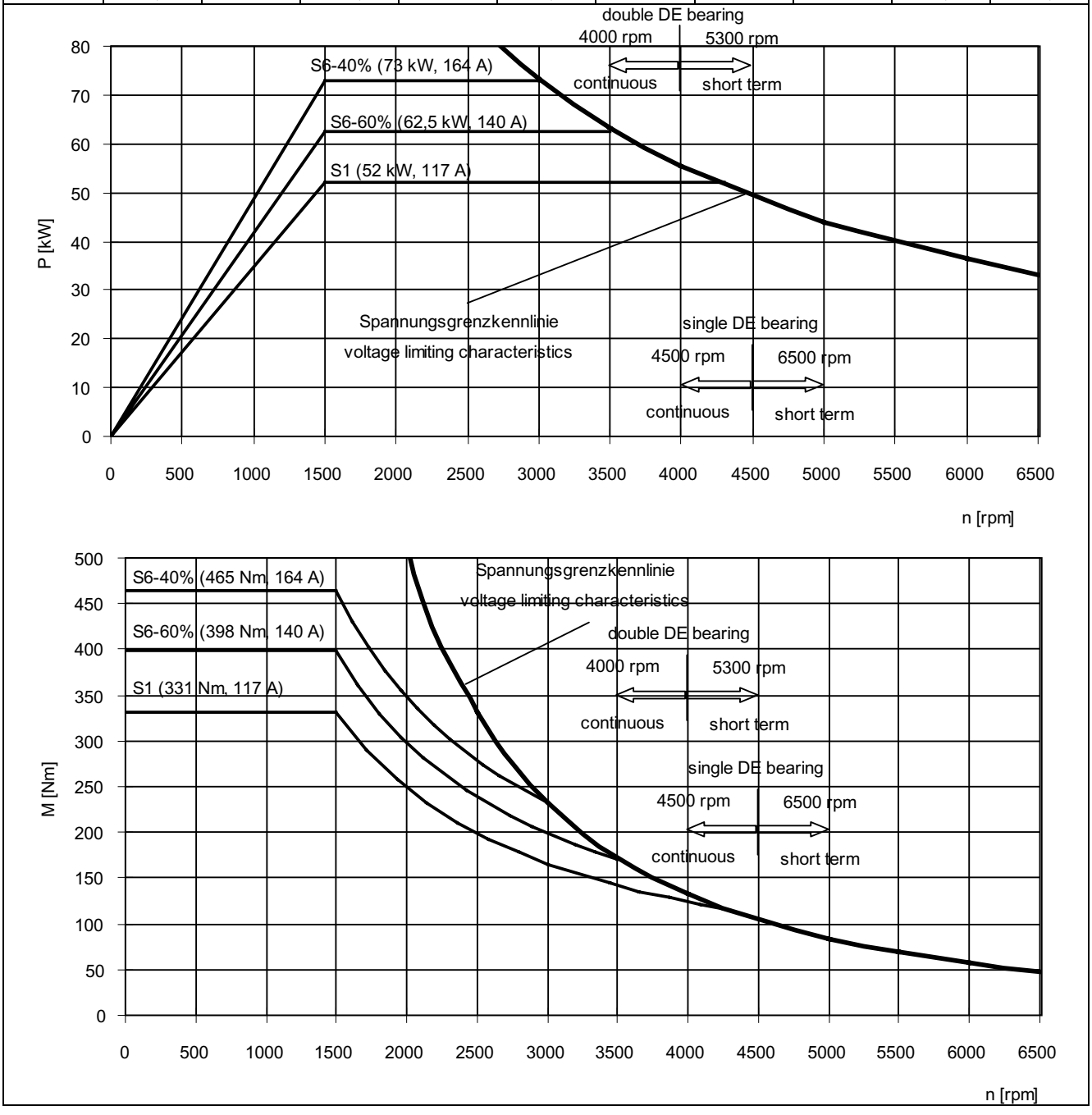


SINAMICS S120 Active Line Module, $U_{supply\ rms}$ = 400 V

The characteristics apply in the case of optimized drive parameters

Table 4- 10 1PH4168-❑❑F5

n_N [rpm]	P_N [kW]	M_N [Nm]	I_N [A]	U_N [V]	f_N [Hz]	n_2 [rpm]	n_{max} [rpm]	T_{th} [min]	I_μ [A]	I_{max} [A]
1500	52,0	331	117,0	350	51,0	4300	6500	14	46,0	164,0



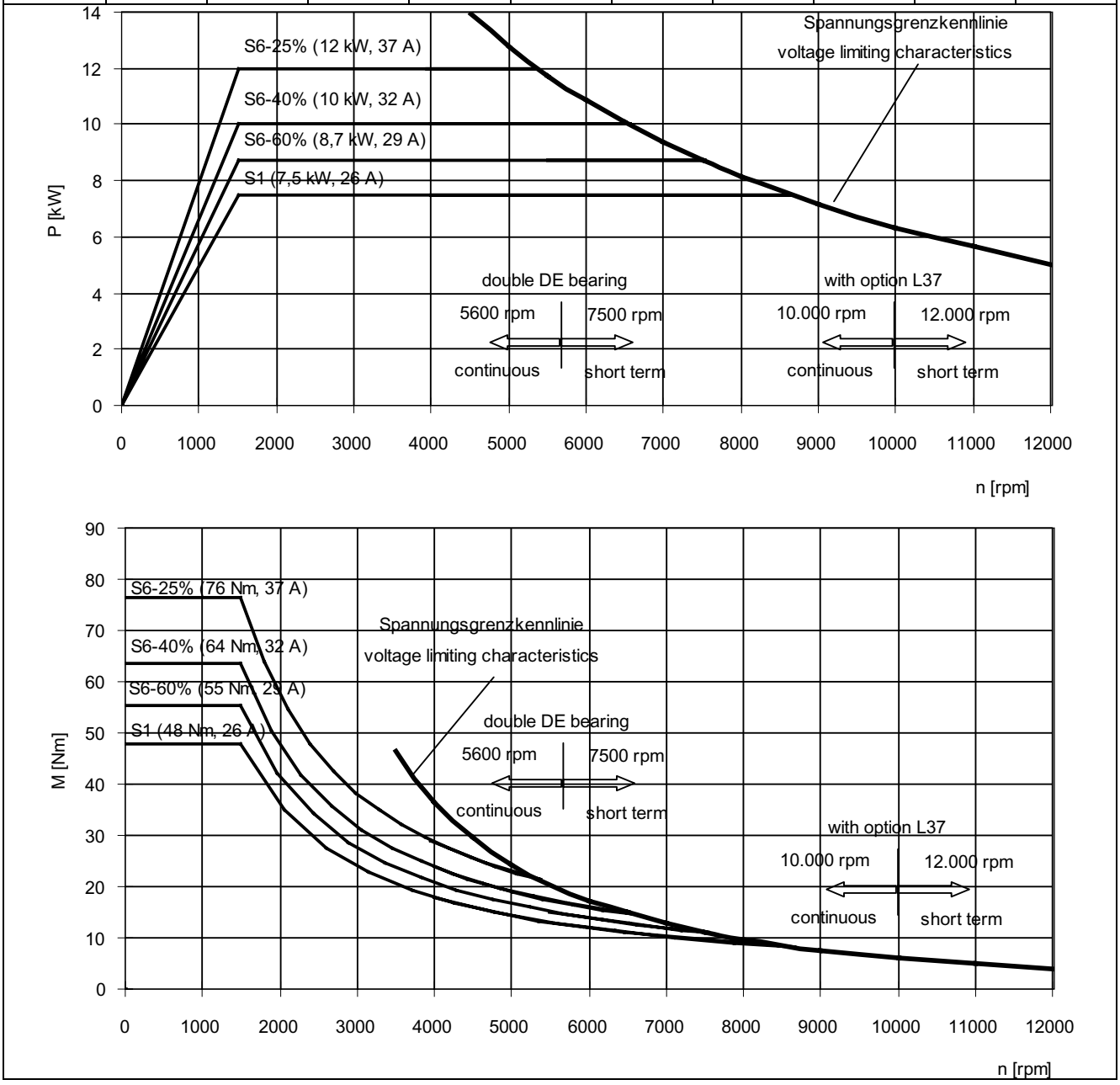
SINAMICS S120 Active Line Module, $U_{supply\ rms}$ = 400 V

The characteristics apply in the case of optimized drive parameters

4.3.2 Characteristics for machine tools

Table 4- 11 1PH4103-❑❑F2

n_N [rpm]	P_N [kW]	M_N [Nm]	I_N [A]	U_N [V]	f_N [Hz]	n_2 [rpm]	n_{max} [rpm]	T_{th} [min]	I_μ [A]	I_{max} [A]
1500	7,5	48,0	26,0	265	53,3	8664	12000	6	11,7	37,0

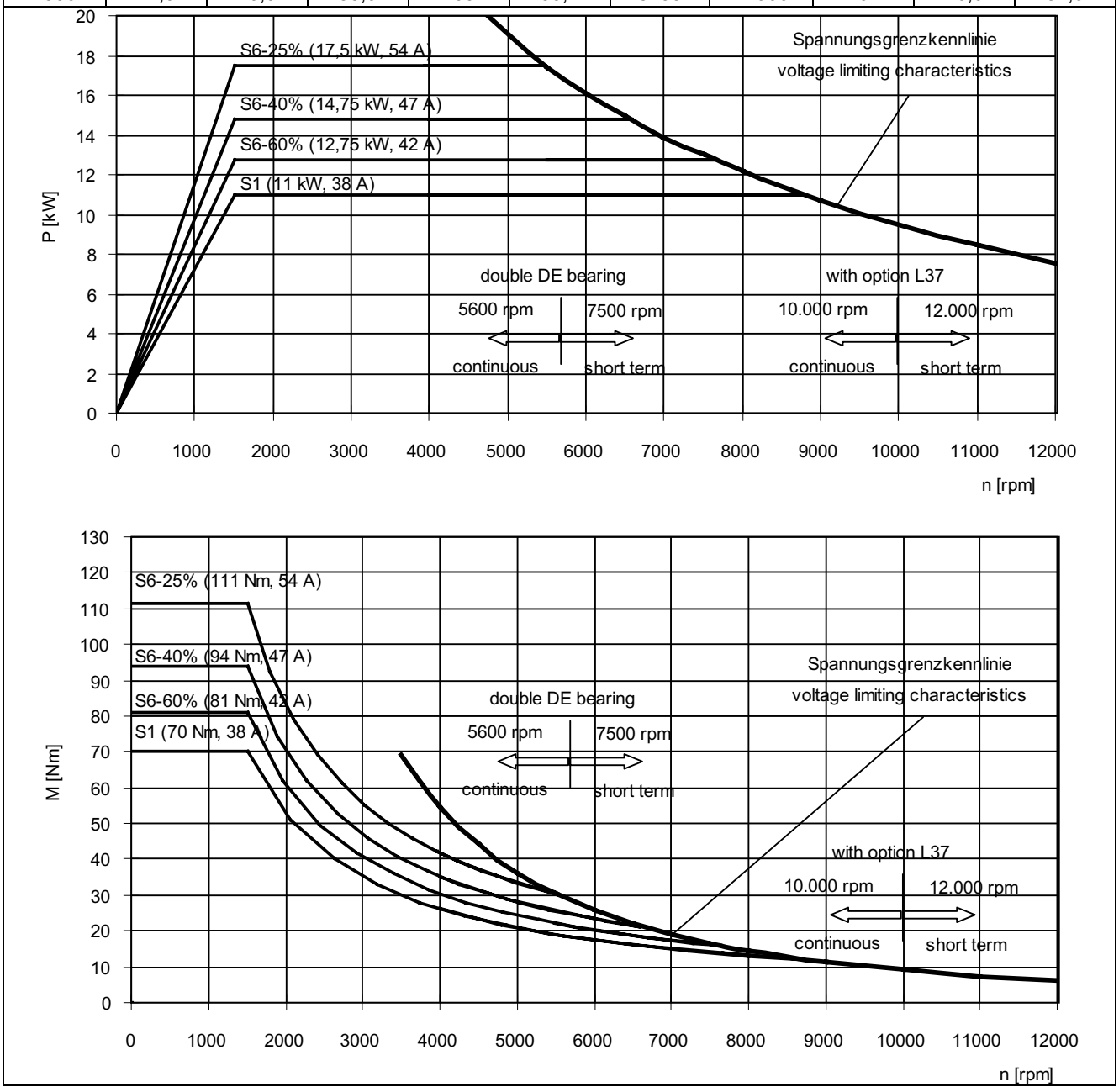


SINAMICS S120 Active Line Module, $U_{supply\ rms}$ = 400 V

The characteristics apply in the case of optimized drive parameters

Table 4- 12 1PH4105-❑❑F2

n_N [rpm]	P_N [kW]	M_N [Nm]	I_N [A]	U_N [V]	f_N [Hz]	n_2 [rpm]	n_{max} [rpm]	T_{th} [min]	I_μ [A]	I_{max} [A]
1500	11,0	70,0	38,0	263	53,2	8799	12000	6	16,6	54,0

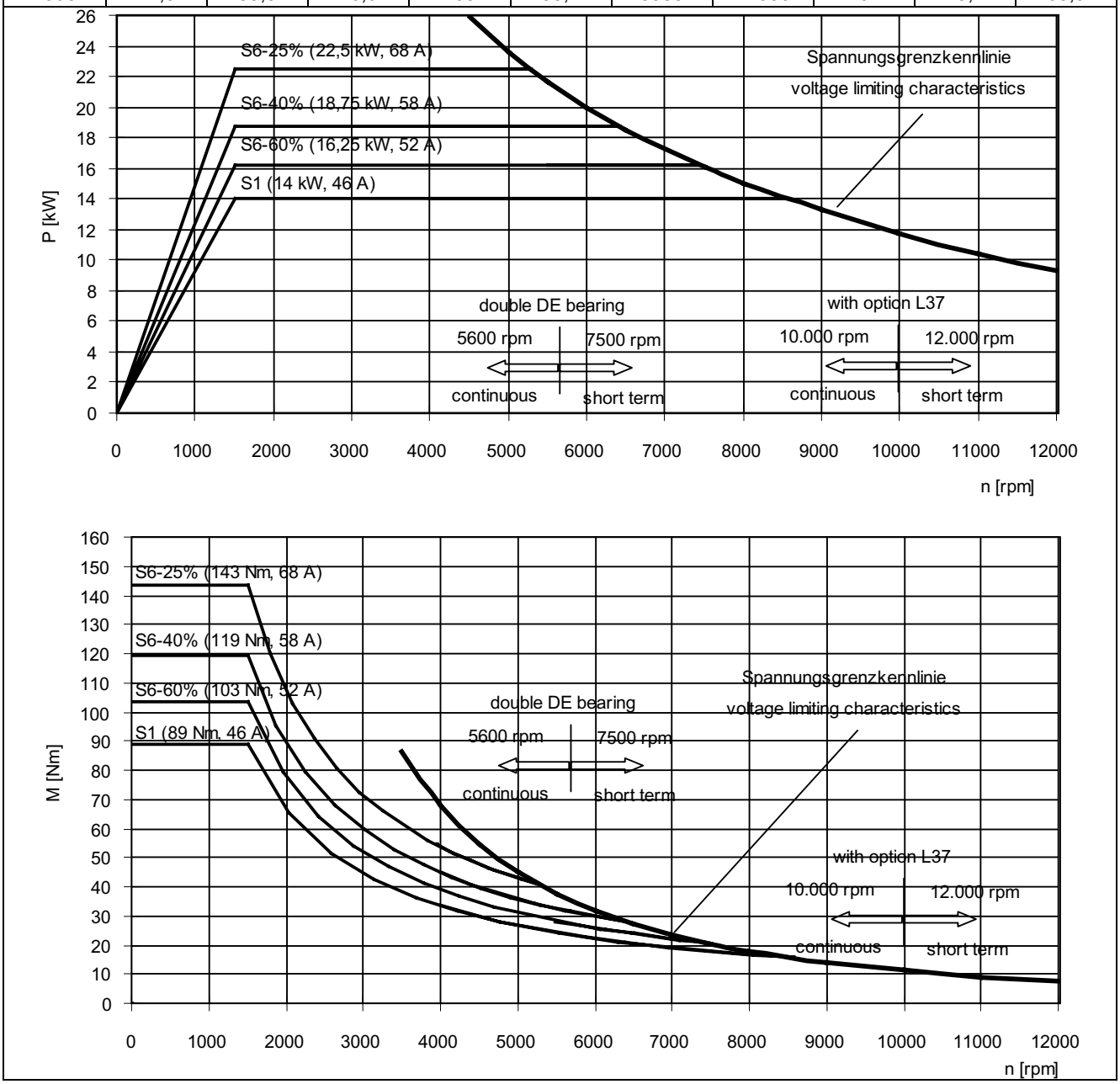


SINAMICS S120 Active Line Module, $U_{supply\ rms}$ = 400 V

The characteristics apply in the case of optimized drive parameters

Table 4- 13 1PH4107-❑❑F2

n_N [rpm]	P_N [kW]	M_N [Nm]	I_N [A]	U_N [V]	f_N [Hz]	n_2 [rpm]	n_{max} [rpm]	T_{th} [min]	I_μ [A]	I_{max} [A]
1500	14,0	89,0	46,0	265	53,1	8585	12000	6	19,1	68,0

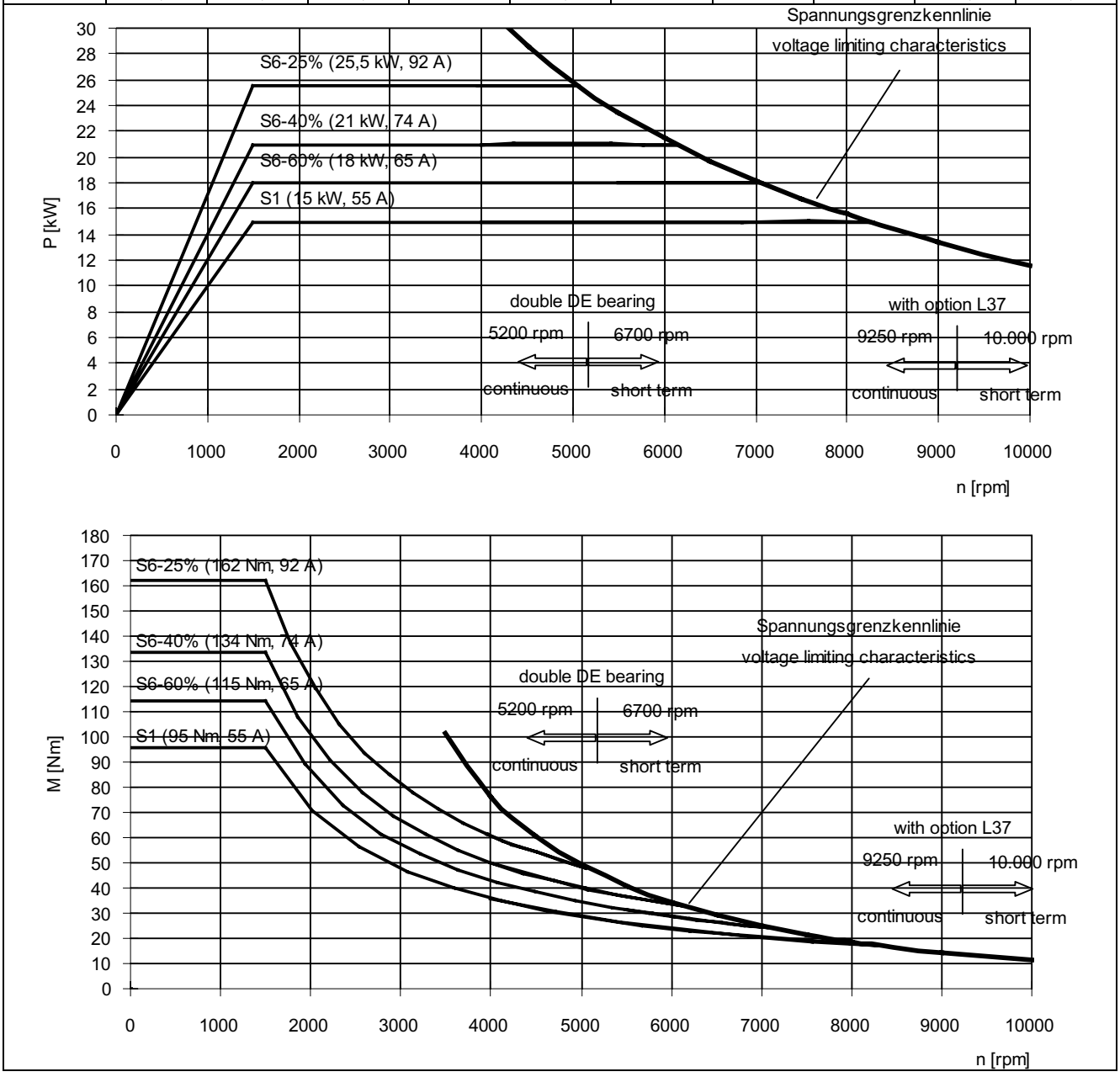


SINAMICS S120 Active Line Module, $U_{supply\ rms}$ = 400 V

The characteristics apply in the case of optimized drive parameters

Table 4- 14 1PH4133-❑❑F2

n_N [rpm]	P_N [kW]	M_N [Nm]	I_N [A]	U_N [V]	f_N [Hz]	n_2 [rpm]	n_{max} [rpm]	T_{th} [min]	I_μ [A]	I_{max} [A]
1500	15,0	95,0	55,0	229	51,9	8290	11000	11	18,8	92,0

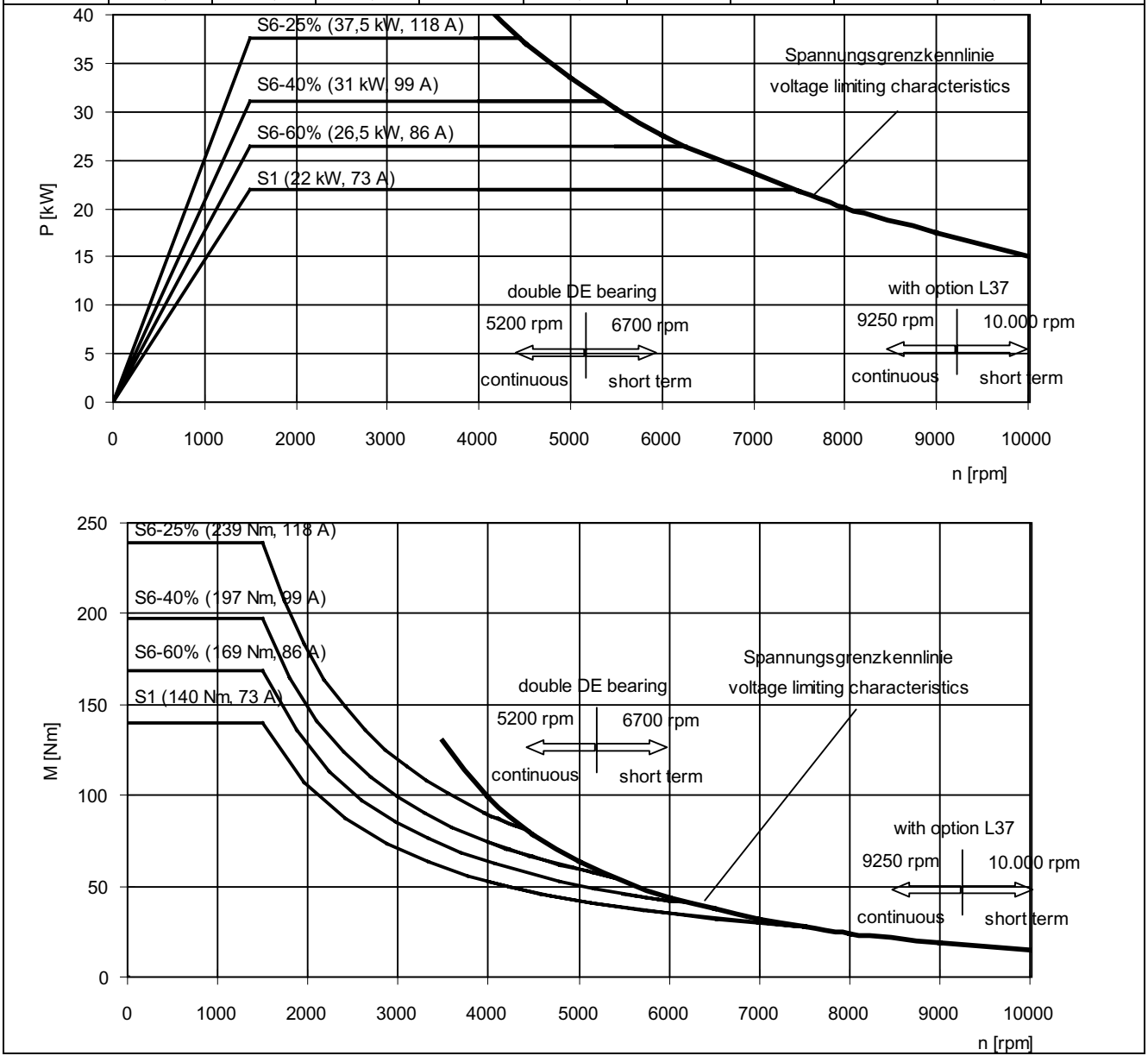


SINAMICS S120 Active Line Module, $U_{supply\ rms}$ = 400 V

The characteristics apply in the case of optimized drive parameters

Table 4- 15 1PH4135-❑❑F2

n_N [rpm]	P_N [kW]	M_N [Nm]	I_N [A]	U_N [V]	f_N [Hz]	n_2 [rpm]	n_{max} [rpm]	T_{th} [min]	I_μ [A]	I_{max} [A]
1500	22,0	140,0	73,0	251	51,7	7433	10000	11	27,5	118

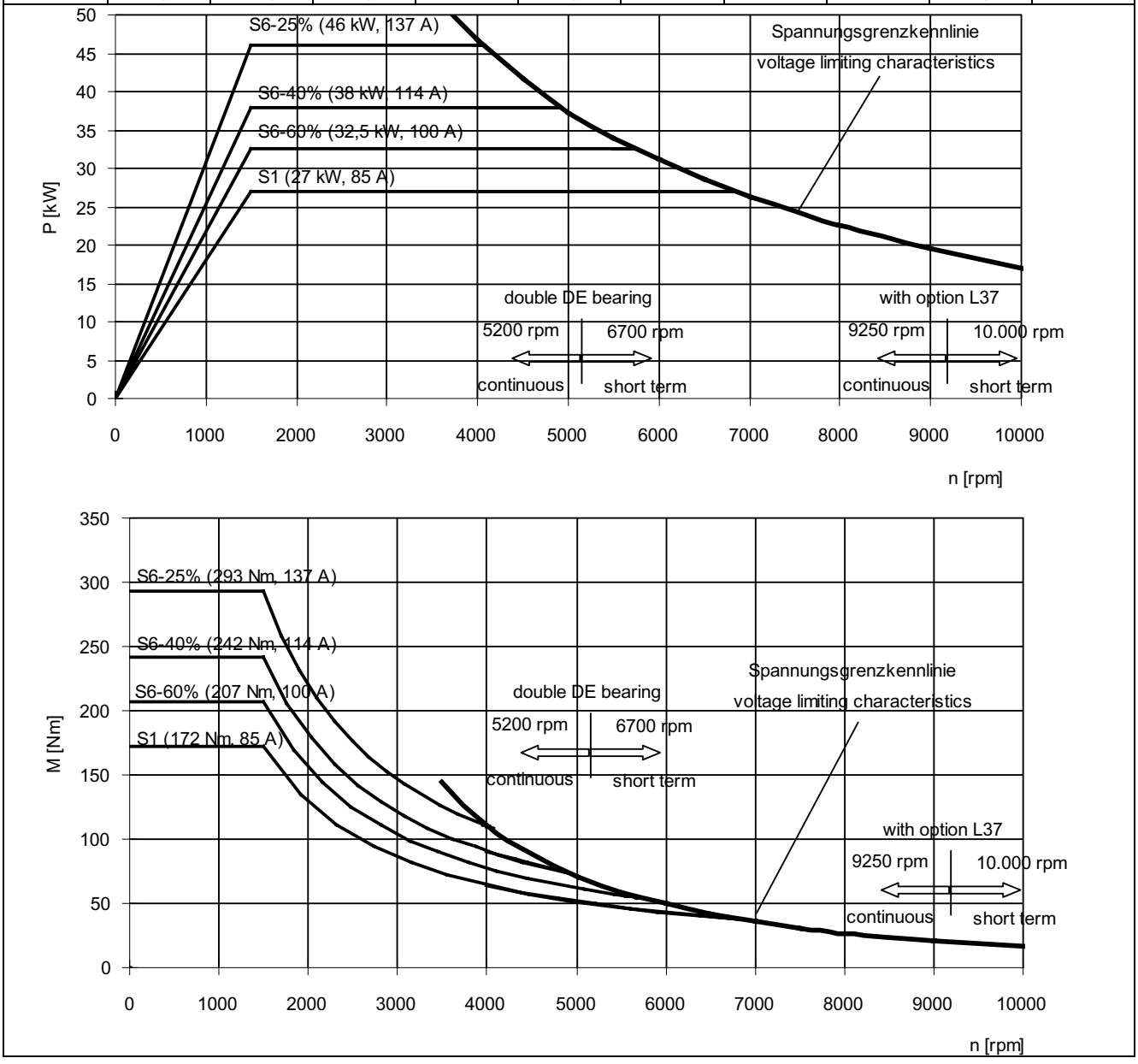


SINAMICS S120 Active Line Module, $U_{supply\ rms}$ = 400 V

The characteristics apply in the case of optimized drive parameters

Table 4- 16 1PH4137-❑❑F2

n_N [rpm]	P_N [kW]	M_N [Nm]	I_N [A]	U_N [V]	f_N [Hz]	n_2 [rpm]	n_{max} [rpm]	T_{th} [min]	I_μ [A]	I_{max} [A]
1500	27,0	172,0	85,0	265	51,6	6853	10000	11	32,7	137

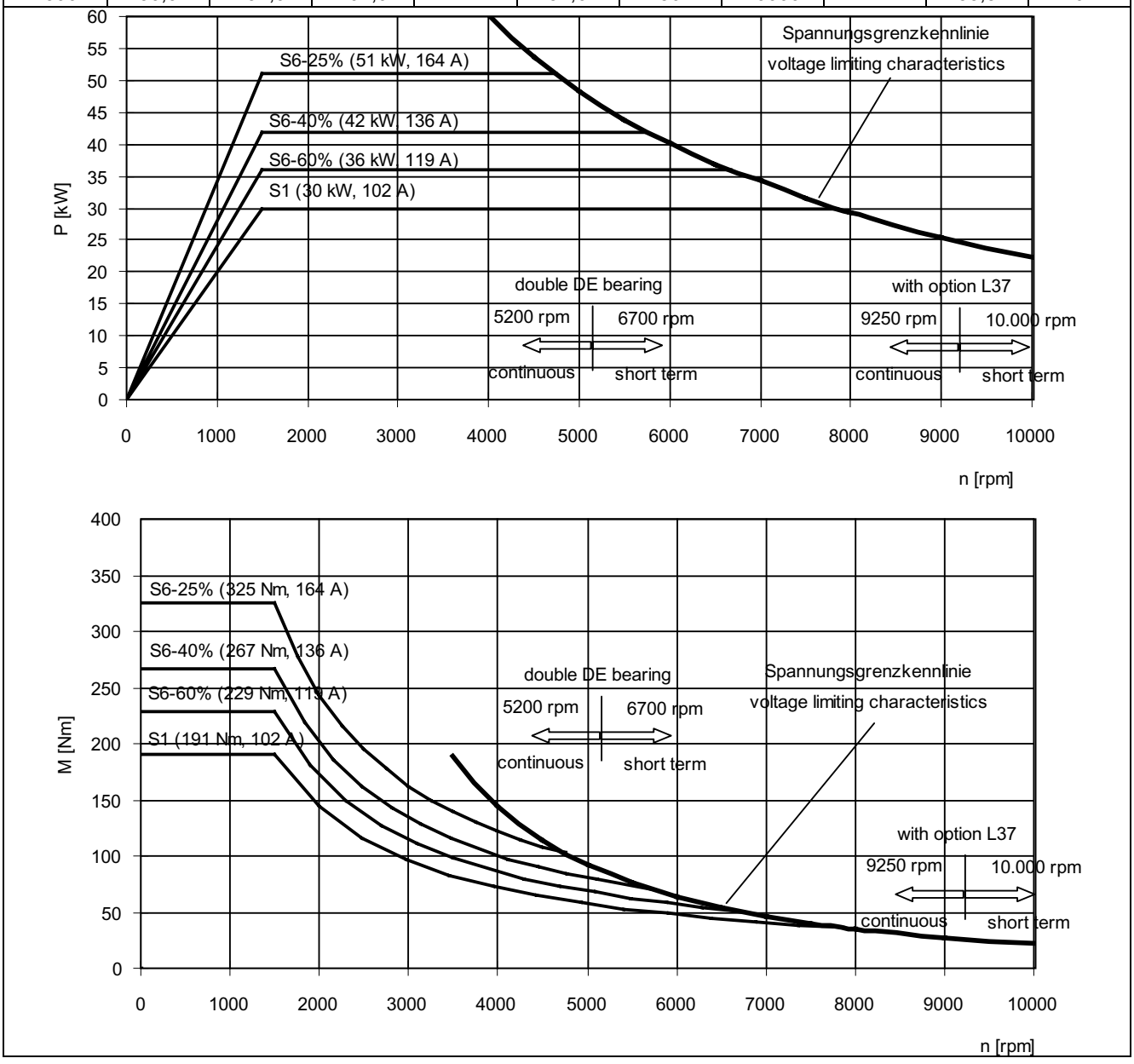


SINAMICS S120 Active Line Module, $U_{supply\ rms}$ = 400 V

The characteristics apply in the case of optimized drive parameters

Table 4- 17 1PH4138-❑❑F2

n_N [rpm]	P_N [kW]	M_N [Nm]	I_N [A]	U_N [V]	f_N [Hz]	n_2 [rpm]	n_{max} [rpm]	T_{th} [min]	I_μ [A]	I_{max} [A]
1500	30,0	191,0	102,0	244	51,6	7861	10000	11	35,8	164

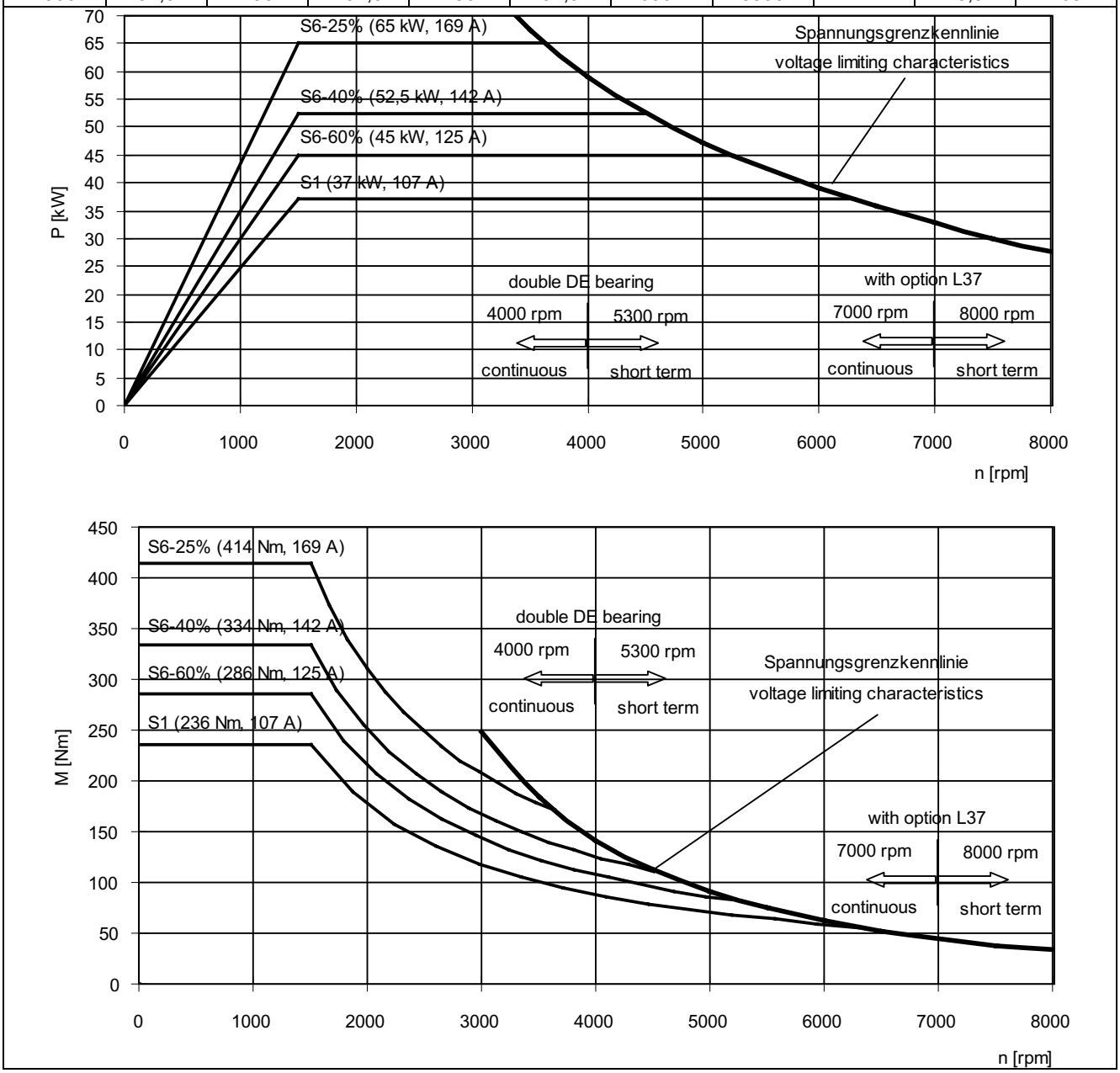


SINAMICS S120 Active Line Module, $U_{supply\ rms}$ = 400 V

The characteristics apply in the case of optimized drive parameters

Table 4- 18 1PH4163-❑❑F2

n_N [rpm]	P_N [kW]	M_N [Nm]	I_N [A]	U_N [V]	f_N [Hz]	n_2 [rpm]	n_{max} [rpm]	T_{th} [min]	I_μ [A]	I_{max} [A]
1500	37,0	236	107,0	286	51,0	6307	8000	14	43,9	169

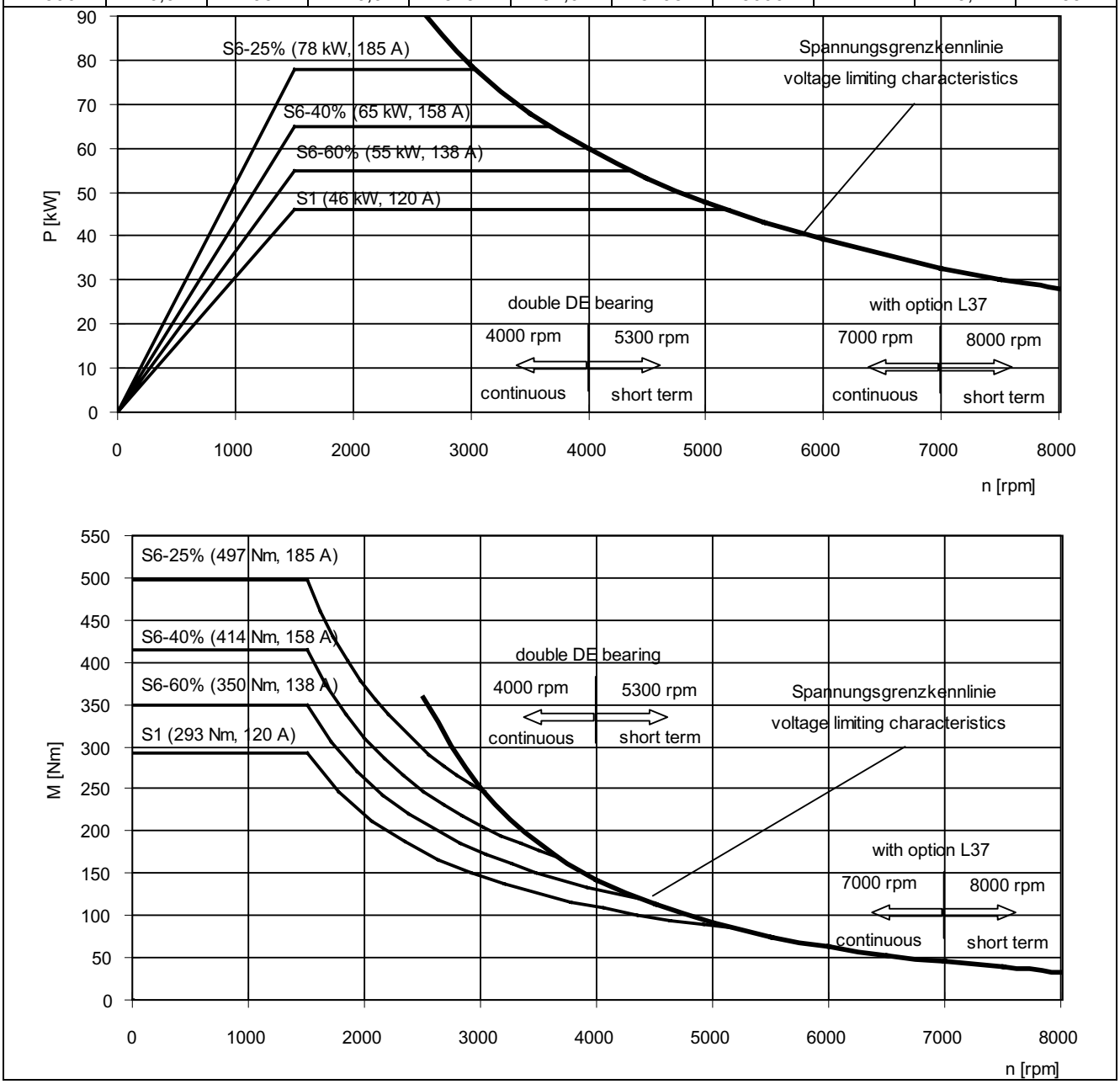


SINAMICS S120 Active Line Module, $U_{supply\ rms}$ = 400 V

The characteristics apply in the case of optimized drive parameters

Table 4- 19 1PH4167-❑❑F2

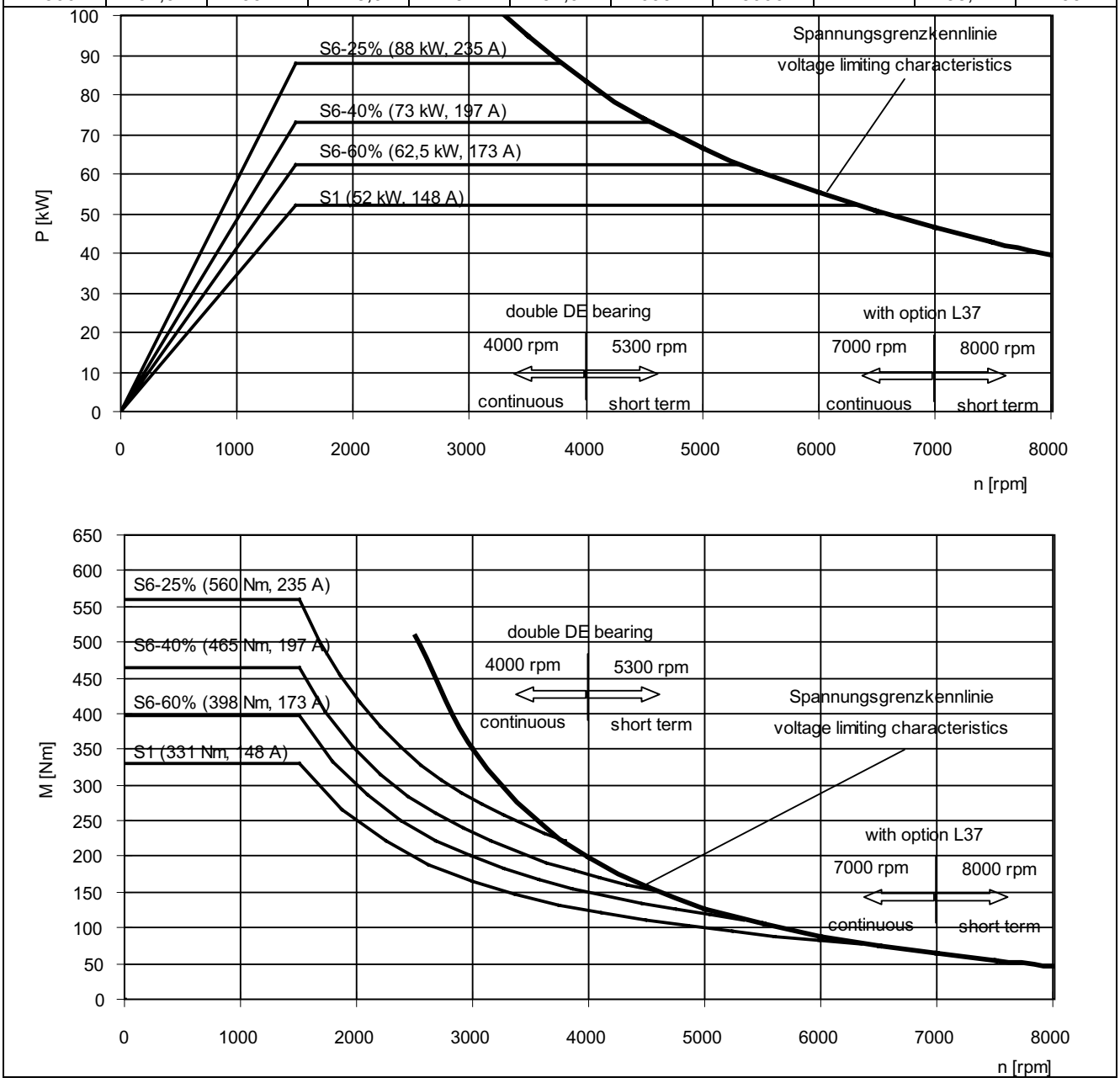
n_N [rpm]	P_N [kW]	M_N [Nm]	I_N [A]	U_N [V]	f_N [Hz]	n_2 [rpm]	n_{max} [rpm]	T_{th} [min]	I_μ [A]	I_{max} [A]
1500	46,0	293	120,0	315	51,0	5198	8000	14	49,1	185



SINAMICS S120 Active Line Module, $U_{supply\ rms}$ = 400 V
The characteristics apply in the case of optimized drive parameters

Table 4- 20 1PH4168-❑❑F2

n_N [rpm]	P_N [kW]	M_N [Nm]	I_N [A]	U_N [V]	f_N [Hz]	n_2 [rpm]	n_{max} [rpm]	T_{th} [min]	I_μ [A]	I_{max} [A]
1500	52,0	331	148,0	284	51,0	6351	8000	14	58,4	235



SINAMICS S120 Active Line Module, $U_{supply\ rms}$ = 400 V

The characteristics apply in the case of optimized drive parameters

4.4 Dimension sheets

CAD CREATOR

Using a configuration interface that is very easy to understand, CAD CREATOR allows you to quickly find

- technical data
- dimension drawings
- 2D/3D CAD data

and supports you when generating plant/system documentation regarding project-specific information and parts lists.

In the online version the data for motors, drives and CNC controllers are currently available to you. On the Intranet at http://www.siemens.com/cad-creator

Motors

- 1FK7, 1FT6, 1FT7, 1FE1 synchronous motors
- 1FW3 complete torque motors
- 1FK7, 1FK7 DYA, 1FT6, 1FT7 geared motors
- 1PH7, 1PH4, 1PL6, 1PH8 SH 355 induction motors
- 1PM4, 1PM6 induction motors
- 2SP1 spindle motors

SINAMICS S120

- Control Units
- Booksize Line Modules
- Line-side components
- Booksize Motor Modules
- DC link components
- Additional system components
- Encoder system connection
- MOTION-CONNECT connection system

SIMOTION D

- SIMOTION D410 DP, D410 PN, D425. D435, D445

SINUMERIK solution line

- Controllers
- Operator components for CNC controls

How up-to-date are the dimension drawings

Note

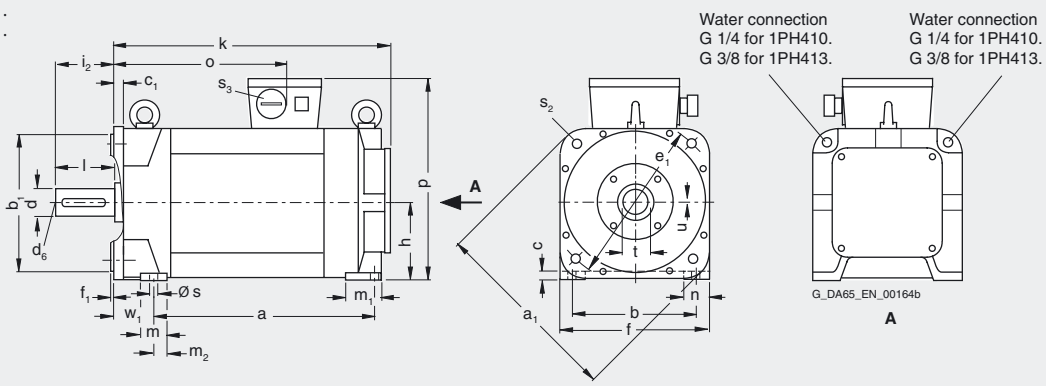
Siemens AG reserves the right to change the dimensions of the motors as part of mechanical design improvements without prior notice. This means that dimensions drawings can go out-of-date. Up-to-date dimension drawings can be requested at no charge from your local SIEMENS representative.

1PH4 water cooling IM B35

For motor		Dimensions in mm (in)																
Shaft height	Type	DIN IEC	a B	a_1 P	b A	b_1 N	c LA	c_1 –	e_1 –	f AB	f_1 T	h H	i_2 –	k LB	m BA	m_1 –	m_2 –	n AA
1PH4, type IM B35, water cooling																		
100	1PH4103 1PH4105 1PH4107		349 (13.74) 409 (16.10) 474 (18.66)	250 (9.84)	160 (6.30)	180 (7.09)	11 (0.43)	12 (0.47)	215 (8.46)	190 (7.48)	4 (0.16)	100 (3.94)	80 (3.15)	416 (16.38) 476 (18.74) 541 (21.30)	35 (1.38)	60 (2.36)	24 (0.94)	40 (1.57)
132	1PH4133 1PH4135 1PH4137		377 (14.84) 447 (17.60) 497 (19.57)	350 (13.78)	216 (8.50)	250 (9.84)	14 (0.55)	16 (0.63)	300 (11.81)	245 (9.65)	5 (0.20)	132 (5.20)	110 (4.33)	458 (18.03) 528 (20.79) 578 (22.76)	36 (1.42)	85 (3.35)	24 (0.94)	43 (1.69)

									DE shaft extension				
Shaft height	Type	DIN IEC	o –	p HD	s K	s_2 K	s_3 –	w_1 C	d D	d_6 –	l E	t GA	u F
100	1PH4103 1PH4105 1PH4107		244 (9.61) 304 (11.97) 369 (14.53)	259 (10.20)	12 (0.47)	14 (0.55)	Pg 29	44 (1.73)	**38 (1.50)**	M12	80 (3.15)	41 (1.61)	10 (0.39)
132	1PH4133 1PH4135 1PH4137		264 (10.39) 334 (13.15) 384 (15.12)	334.5 (13.17)	12 (0.47)	18 (0.71)	Pg 36	53 (2.09)	**42 (1.77)**	M16	110 (4.33)	45 (1.77)	12 (0.47)

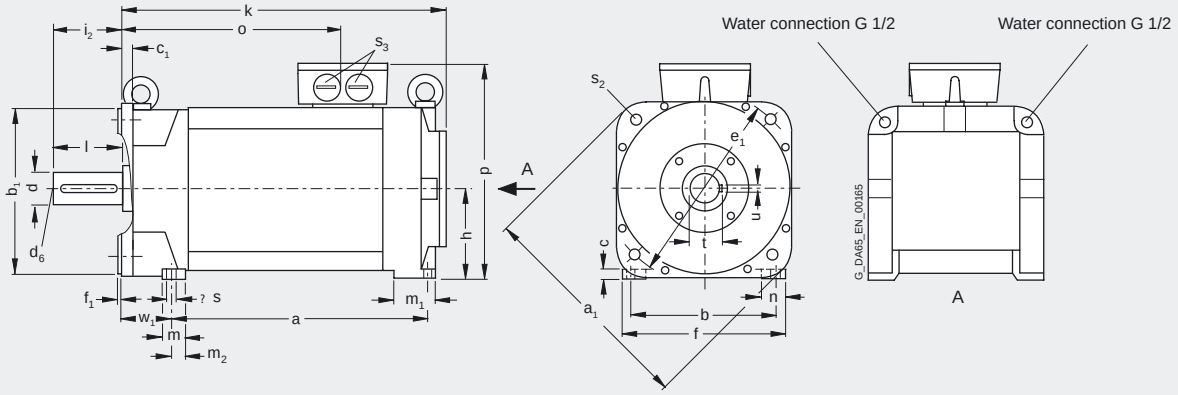
1PH410 .
1PH413 .



For motor		Dimensions in mm (in)																
Shaft height	Type	DIN IEC	a B	a_1 P	b A	b_1 N	c LA	c_1 –	e_1 –	f AB	f_1 T	h H	i_2 –	k LB	m BA	m_1 –	m_2 –	n AA
1PH4, type IM B35, water cooling																		
160	1PH4163 1PH4167 1PH4168		508 (20.00) 563 (22.17) 608 (23.94)	400 (15.75)	254 (10.00)	300 (11.81)	15 (0.59)	18 (0.71)	350 (13.78)	294 (11.57)	5 (0.20)	160 (6.30)	110 (4.33)	591 (23.27) 646 (25.43) 691 (27.20)	44 (1.73)	77 (3.03)	29 (1.14)	49 (1.93)

									DE shaft extension					
Shaft height	Type	DIN IEC	o –	p HD	s K	s_2 K	s_3 –	w_1 C	d D	d_6 –	l E	t GA	u F	
160	1PH4163 1PH4167 1PH4168		407 (16.02) 462 (18.19) 507 (19.96)	388 (15.28)	14 (0.55)	18 (0.71)	Pg 36	56 (2.20)	55 (2.17)	M20	110 (4.33)	59 (2.32)	16 (0.63)	

1PH416 .



Motor components

5

5.1 Thermal motor protection

A temperature-dependent resistor is integrated in the stator winding to monitor the motor temperature.

Table 5- 1 Properties and technical specifications

Designation	Description
Type	KTY 84 (PTC thermistor)
Resistance when cold (20 °C)	approx. 580 Ω
Resistance when warm (100 °C)	approx. 1000 Ω
Response temperature	Alarm at 120 °C ± 5 °C Trip at 155 °C ± 5 °C
Connection	via signal cable

NOTICE
The polarity must be observed.

The resistance of the KTY 84 thermistor changes proportionally to the winding temperature change (refer to the following diagram).

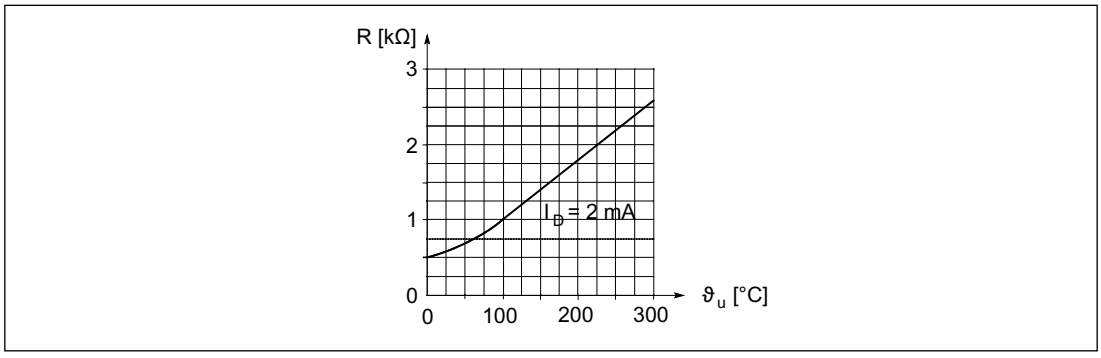


Figure 5-1 Resistance characteristic of the KTY 84 as a function of the temperature

The KTY 84 is evaluated in the converter whose closed-loop control takes into account the temperature characteristic of the motor winding. When a fault occurs, an appropriate message is output on the drive converter. When the motor temperature increases, a message "Alarm motor overtemperature" is output; this can be externally evaluated. If this signal is ignored, the drive converter shuts down after a preset time period or, when the motor limit temperature or shutdown temperature is exceeded, the converter shuts down with an appropriate fault message.

⚠ WARNING

The built-in KTY temperature sensor protects the motors against overload up to I_{max}.

There is no adequate protection for thermally critical load situations, e.g. a high overload at motor standstill. For this reason, additional protection in the form, for example, of a thermal overcurrent relay must be provided.

The temperature sensor is designed so that the DIN/EN requirement for "protective separation" is fulfilled.

⚠ 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 temperature sensor terminal, then it will be destroyed.

5.2 Encoder

NOTICE
When the encoder is replaced, the position of the encoder system with respect to the motor EMF must be adjusted. Only qualified personnel may replace an encoder. If the encoder to the motor EMF is incorrectly adjusted, this can result in uncontrolled motion.

The encoder is selected in the motor Order No. (MLFB) using the appropriate letter at the 9th position. The letter ID at the 9th position of the Order No. (MLFB) differs for motors with and without DRIVE-CLiQ.

Table 5- 2 ID for encoder selection in the order number (MLFB)

Encoder type	ID for 9th position in the MLFB
Motors without DRIVE-CLiQ interface	
Absolute encoder 2048 S/R singleturn, 4096 revolutions multiturn, with EnDat interface (AM2048S/R encoder)	E
Incremental encoder HTL 1024 S/R (encoder 1024S/R)	H
Incremental encoder HTL 2048 S/R (encoder 2048S/R)	J
Incremental encoder sin/cos 1 Vpp 2048 S/R with C and D track (encoder IC2048S/R)	M
Incremental encoder sin/cos 1 Vpp 2048 S/R with C and D track (encoder IN2048S/R)	N
Motors with DRIVE-CLiQ interface	
Absolute encoder 22 bit singleturn (resolution 4194304, internal (2048 S/R) + 12 bit multiturn (traversing range 4096 revolutions) (encoder AM22DQ)	F
Incremental encoder 22 bit (resolution 4194304, internal 2048 S/R) + commutating position 11 bit (encoder IC22DQ)	D
Incremental encoder 22 bit (resolution 4194304, internal 2048 S/R), without commutating position (encoder IN19DQ)	Q

5.2.1 Encoder connection for motors with DRIVE-CLiQ

Motors with DRIVE-CLiQ have a sensor module that includes the encoder evaluation, the motor temperature sensing and an electronic rating plate.

This sensor module instead of the signal connector and has a 10-pin RJ45-plus socket.

⚠ WARNING

The sensor module contains motor and encoder-specific data as well as an electronic rating plate. This is the reason that this sensor module may only be operated on the original motor - and may not be mounted onto other motors or replaced by a sensor module from other motors.

The sensor module has direct contact to components that can be destroyed by electrostatic discharge (ESDS). Neither hands nor tools that could be electrostatically charged may come into contact with the connections.

5.2.2 Encoder connection for motors without DRIVE-CLiQ

Motors without DRIVE-CLiQ are connected using the 17-pin flange socket.

5.2.3 Incremental encoder HTL

Function:

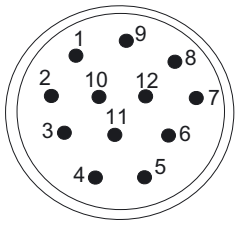
- Angular measuring system for the commutation
- Speed actual value sensing
- Indirect incremental measuring system for the position control loop
- One zero pulse (reference mark) per revolution

Table 5- 3 Properties and technical data

Properties	Incremental encoder HTL 1024 S/R (encoder HTL1024S/R)	Incremental encoder HTL 2048 S/R (encoder HTL2048S/R)
Coupling	on NDE	on NDE
Operating voltage	+10 ... +30 V	+10 ... +30 V
Current consumption	max. 150 mA	max. 150 mA
Incremental resolution (periods per revolution)	1024	2048
Incremental signals	HTL Track A, track B, zero pulse and inverted signals	HTL Track A, track B, zero pulse and inverted signals
Angular error	±1'	±1'

Connection

Table 5- 4 Connection assignment, 12-pin flange-mounted socket

PIN No.	Signal	
1	B*	 When viewing the plug-in side (pins)
2	+1R1	
3	R	
4	R*	
5	A	
6	A*	
7	CTRL TACH	
8	B	
9	not connected	
10	M encoder	
11	-1R2	
12	P encoder	

Cables

Mating connector: 6FX2003-0SU12

Table 5- 5 Pre-fabricated cable for SINAMICS:

6FX	□	002	-	2AH00	-	□□□	0
	↓ ↓ 5 MOTION-CONNECT®500 8 MOTION-CONNECT®800					↓↓↓ Length Max. cable lengths: without transfer of inverted signals,150 m with transfer of inverted signals, 300 m	

For other technical data and length code, refer to catalog, Chapter "MOTION-CONNECT connection system"

5.2.4 Incremental encoder sin/cos 1Vpp

Function:

- Angular measuring system for the commutation
- Speed actual value sensing
- Indirect incremental measuring system for the position control loop
- One zero pulse (reference mark) per revolution

Table 5- 6 Properties and technical data

Properties	Incremental encoder sin/cos 1 Vpp 2048 S/R with C and D track (encoder IC2048S/R)	Incremental encoder sin/cos 1 Vpp 2048 S/R without C and D track (encoder IN2048S/R)
Coupling	on NDE	on NDE
Operating voltage	+5 V ±5 %	+5 V ±5 %
Current consumption	max. 150 mA	max. 150 mA
A-B track: resolution, incremental (sin/cos periods per revolution)	2048 S/R (1 Vpp)	2048 S/R (1 Vpp)
C-D track: rotor position (sin/cos periods per revolution)	1 S/R (1 Vpp)	---
Reference signal	1 per revolution	1 per revolution
Angular error	±40"	±40"

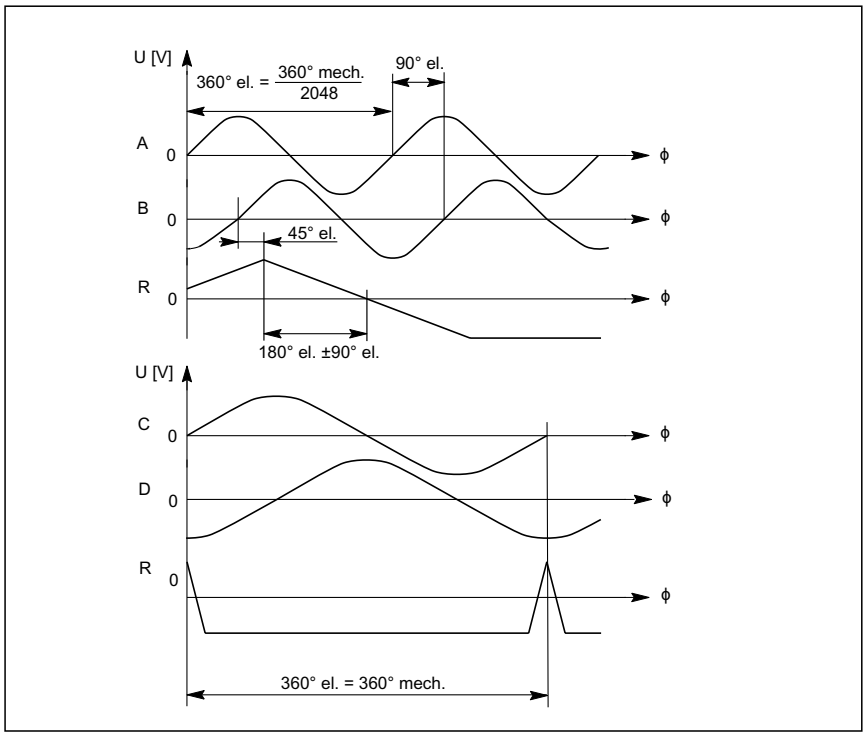
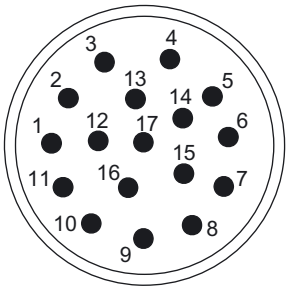


Figure 5-2 Signal sequence and assignment for a positive direction of rotation (clockwise direction of rotation when viewing the drive end)

Connection

Table 5- 7 Connection assignment, 17-pin flange-mounted socket

PIN No.	Signal	
1	A	 When viewing the plug-in side (pins)
2	A*	
3	R	
4	D*	
5	C	
6	C*	
7	M encoder	
8	+1R1	
9	-1R2	
10	P encoder	
11	B	
12	B*	
13	R*	
14	D	
15	0 V sense	
16	5 V sense	
17	not connected	

Cables

Mating connector: 6FX2003-0SU17

Table 5- 8 Pre-fabricated cable for SINAMICS

6FX	□	002	-	2CA31	-	□□□	0
	↓ ↓ 5 MOTION-CONNECT®500 8 MOTION-CONNECT®800					↓↓↓ Length Max. cable length 100 m	

For other technical data and length code, refer to catalog, Chapter "MOTION-CONNECT connection system"

5.2.5 Absolute encoder (EnDat)

Function:

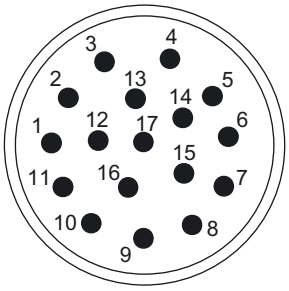
- Angular measuring system for the commutation
- Speed actual value sensing
- Indirect measuring system for absolute position determination within a revolution
- Indirect measuring system for absolute position determination within a traversing range of 4096 revolutions
- Indirect incremental measuring system for the position control loop

Table 5- 9 Properties and technical data

Properties	Absolute encoder EnDat 2048 S/R (AM2048S/R encoder)
Coupling	on NDE
Operating voltage	+5 V ±5 %
Current consumption	max. 300 mA
Absolute resolution (singleturn)	8192
Multiturn traversing range	4096 revolutions
A-B track: resolution, incremental (sin/cos periods per revolution)	2048 S/R (1 Vpp)
Angular error	±40"
Serial absolute position interface	EnDat 2.1

Connection

Table 5- 10 Connection assignment, 17-pin flange-mounted socket

PIN No.	Signal	
1	A	 When viewing the plug-in side (pins)
2	A*	
3	data	
4	not connected	
5	clock	
6	not connected	
7	M encoder	
8	+1R1	
9	-1R2	
10	P encoder	
11	B	
12	B*	
13	data*	
14	clock*	
15	0 V sense	
16	5 V sense	
17	not connected	

Cables

Mating connector: 6FX2003-0SU17

Table 5- 11 Pre-fabricated cable for SINAMICS

6FX	□	002	-	2EQ10	-	□□□	0
	↓ ↓ 5 MOTION-CONNECT®500 8 MOTION-CONNECT®800					↓↓↓ Length Max. cable length 100 m	

For other technical data and length code, refer to catalog, Chapter "MOTION-CONNECT connection system"

5.3 Holding brake

The motor can be ordered with a single-disc holding brake fitted at the drive end in order to hold the motor shaft without play at standstill.

Note

The holding brake cannot be retrofitted!

The holding brake cannot be combined with the two-speed selector gearbox.

Table 5- 12 Order codes for the holding brake

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

Design

The drive shaft 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.

Table 5- 13 Degree of protection and supply voltage

Degree of protection	IP00
Supply voltage	24 VDC ±10 %

Mode of operation

The brake works according to the open-circuit principle, i.e. the brake is open when de-energized.

⚠ CAUTION

Only turn brakes on with motor at standstill.

The holding brake must be released when switching the gearbox and when the motor is running (no current). There is no remaining torque after release.

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.

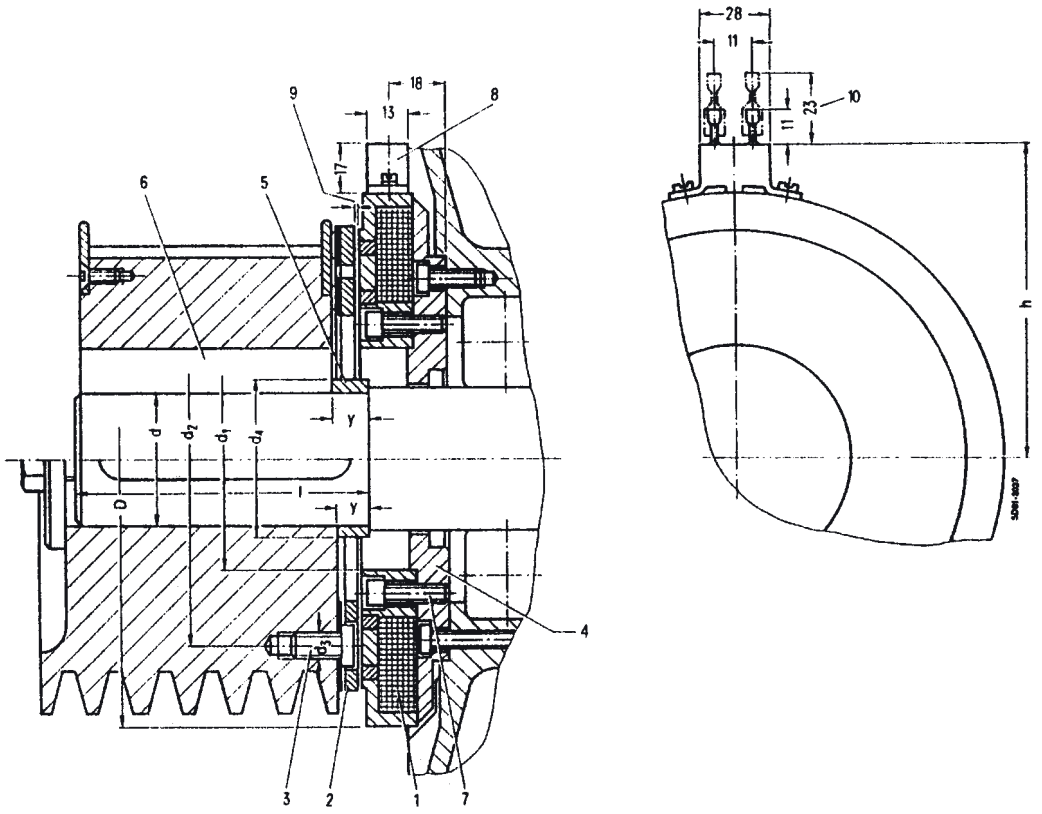
After mounting the motor, the brake must be checked for proper function.

Technical data of the holding brake

Table 5- 14 Technical data of the holding brake

Shaft height [mm]	ZF type	Order No.	Holding torque [Nm]	Power intake 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-disc holding brake for motors with shaft heights 100 to 160



1 Electromagnetic single-disc brake
2 Armature plate of the brake
3 3 cylinder head screws with hexagon socket head to DIN 7984 or DIN 6912
4 External DE bearing cover (special version)
5 Adjusting disc or ring for air gap adjustment or as stop for clamping elements (variable for tolerance compensation)
6 Space for clamping element
7 4 cylinder head screws with hexagon socket head M5 x 15 or M6 x 20 to DIN 912
8 Electrical connection: Flat connector DIN 46244 A6, 3-0.8
9 Air gap s = 0.5 mm between brake pad and armature plate
10 Removal dimension for push-on receptacle size 6.3

Figure 5-3 Mounting a holding brake on the drive end of motors 1PH410□ to 1PH416□ as an example: Armature disk mount to a V-belt pulley with key (upper half) or to a toothed-belt pulley for tensioning elements (lower half)

Table 5- 15 Dimensions for mounting the single-disc holding brake

Shaft height [mm]	Drive shaft end, dimensions in [mm]								
	d	D	l	h	y	d1	d2	d3	d4
					H8			3 x offset by 120°	
100	38	118	80	77	15	45	94 ± 0,1	M6	42
132	42	167	110	100	11	70	118 ± 0,1	M8	60
160	55	167	110	100	7	70	118 ± 0,1	M8	63

5.4 Gear

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.

For questions regarding gearboxes, please directly contact the following:

Company ZF Friedrichshafen AG, Antriebstechnik Maschinenbau
D-88038 Friedrichshafen, Germany
Phone: 07541/77-0
Fax: 07541/77-3470
Internet: http://www.ZF-Group.de

The following requirements must be fulfilled in order to mount a gearbox:

Table 5- 16 Prerequisites for mounting a gearbox

Prerequisites for mounting a gearbox for shaft height 100 to 160	
	Type of construction IM B5, IM B35 or IM V15
	Shaft with key and full-key balancing

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 stressing in accordance with the specifications (refer to the radial force diagram and maximum torque).

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

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

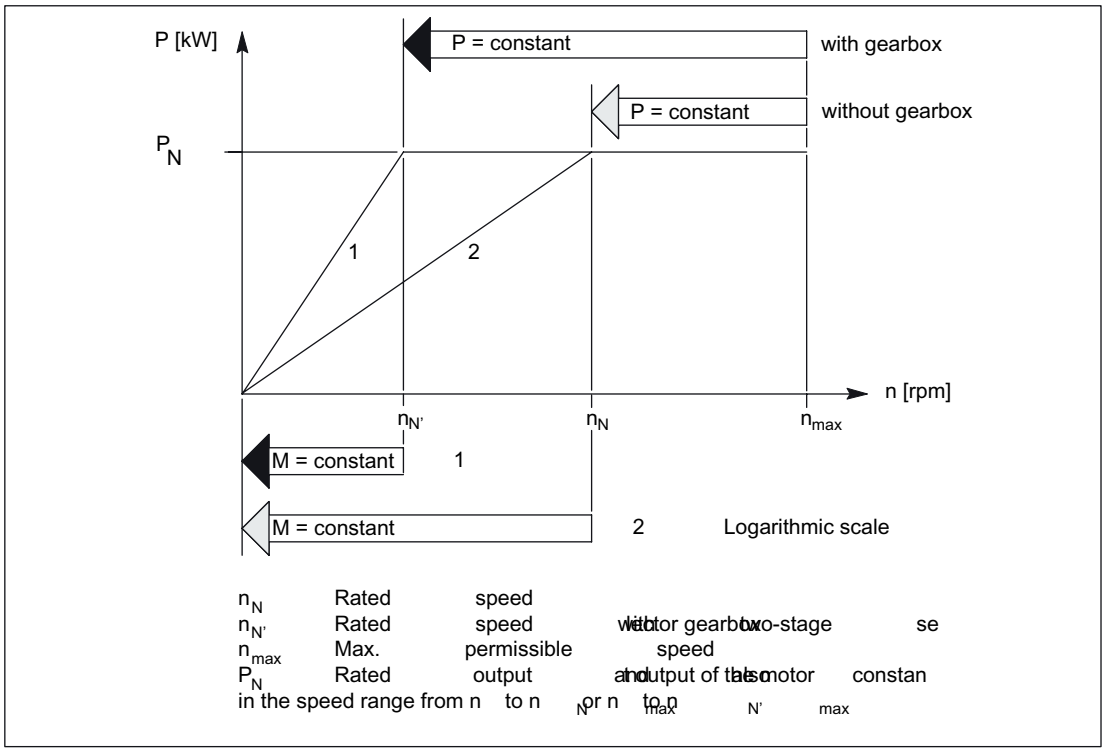


Figure 5-4 Speed-power diagram when using a two-stage selector gearbox to extend the constant power speed range of main spindle drive motors

Example: 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 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 output using pinion (on request) or co-axially through an equalizing coupling.

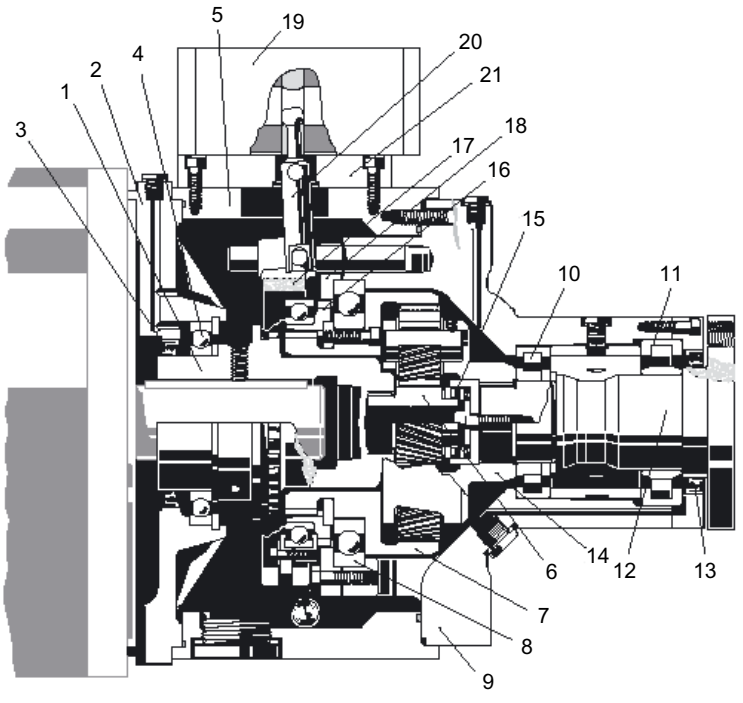
Vibration magnitudes

Motor + gearbox: Tolerance grade R (acc. to DIN ISO 2373)
This also applies if motor tolerance level S is ordered.

Seal between motor flange and gearbox flange

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

5.4.1 Gearbox design



1 Drive hub
2 Adapter plate
3 Radial shaft sealing ring
4 Hub bearings
5 Gearbox housing
6 Sun wheel
7 Hollow wheel
8 Hollow wheel bearings
9 Bearing housing
10 Output bearings
11 Output bearings
12 Drive shaft
13 Radial shaft sealing ring
14 Planetary carrier
15 Axial bearings with plate-type springs
16 Sliding coupling
17 Shift fork
18 Brake disk
19 Solenoid
20 Switching shaft
21 Connection plate

Figure 5-5 Gearbox design

The following applies to the selector gearbox:	Switch position I:	$i_1 = 4$
	Switch position II:	$i_2 = 1$

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

The gearbox output lies coaxially to the motor shaft.

Circumferential backlash (measured on gearbox output): 30'

For milling and machining with interrupted cut, the following special versions are available on request:

- 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.

5.4.2 Specifications

Table 5- 17 Technical data for gearbox

Type ZF identifier	SH	Order No.	Maximum speed n_{max}	Rated torque (S1 duty)			Maximum torque (S6 duty, 10 min duty cycle, max. 60% load duration)			Weight	Output housing
				Drive	Output		Drive	Output			
			[rpm]	[Nm]	i = 1 [Nm]	i = 4 [Nm]	[Nm]	i = 1 [Nm]	i = 4 [Nm]	[kg]	[mm]
2K120	100	2LG4312-...	8000 1) 9000 2)	120	120	480	140	140	560	30	100
2K250	132	2LG4315-...	6300 8000 2)	250	250	1000	400	400	1600	62	116
2K300	160	2LG4320-...	6300 8000 2)	300	300	1200	400	400	1600	70	140

1) Higher maximum speed from 8000 ... 9000 rpm for more than 20% load duration is only possible with injection lubrication.

2) Permissible with gearbox oil cooling for gearbox stage i = 1.

NOTICE
When designing the complete drive unit (motor with gear) the gearbox data is decisive. With 1PH4168 motors, for example, the 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. For other binding technical data and engineering information/instructions (e.g. lubrication, temperature rise, permissible radial forces and examples), please refer to Catalog 2K Gearboxes from ZF (Zahnradfabrik Friedrichshafen).

5.4.3 Electrical connection

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

The mechanical selector unit requires a separate supply.

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

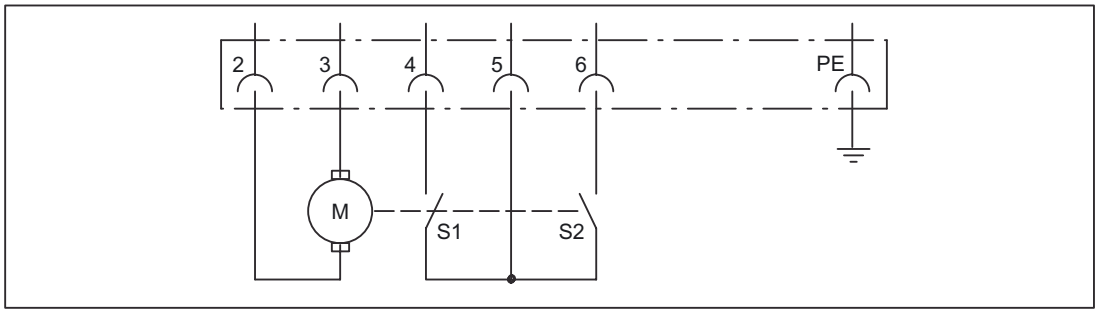


Figure 5-6 Circuit diagram

Table 5- 18 Explanation of the connections

Connector contact no.	Number and Designation	Input	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

5.4.4 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 gearbox stage should not be changed without oscillation.
- The motor may only start to accelerate 200 ms after the gear stage has been changed.
- The selection must be monitored using a time relay.
  If the selection command was not able to be executed, the selection must be reversed after 2 s. A time limit of 10 s should be provided for approx. 4 to 5 additional selection operations.

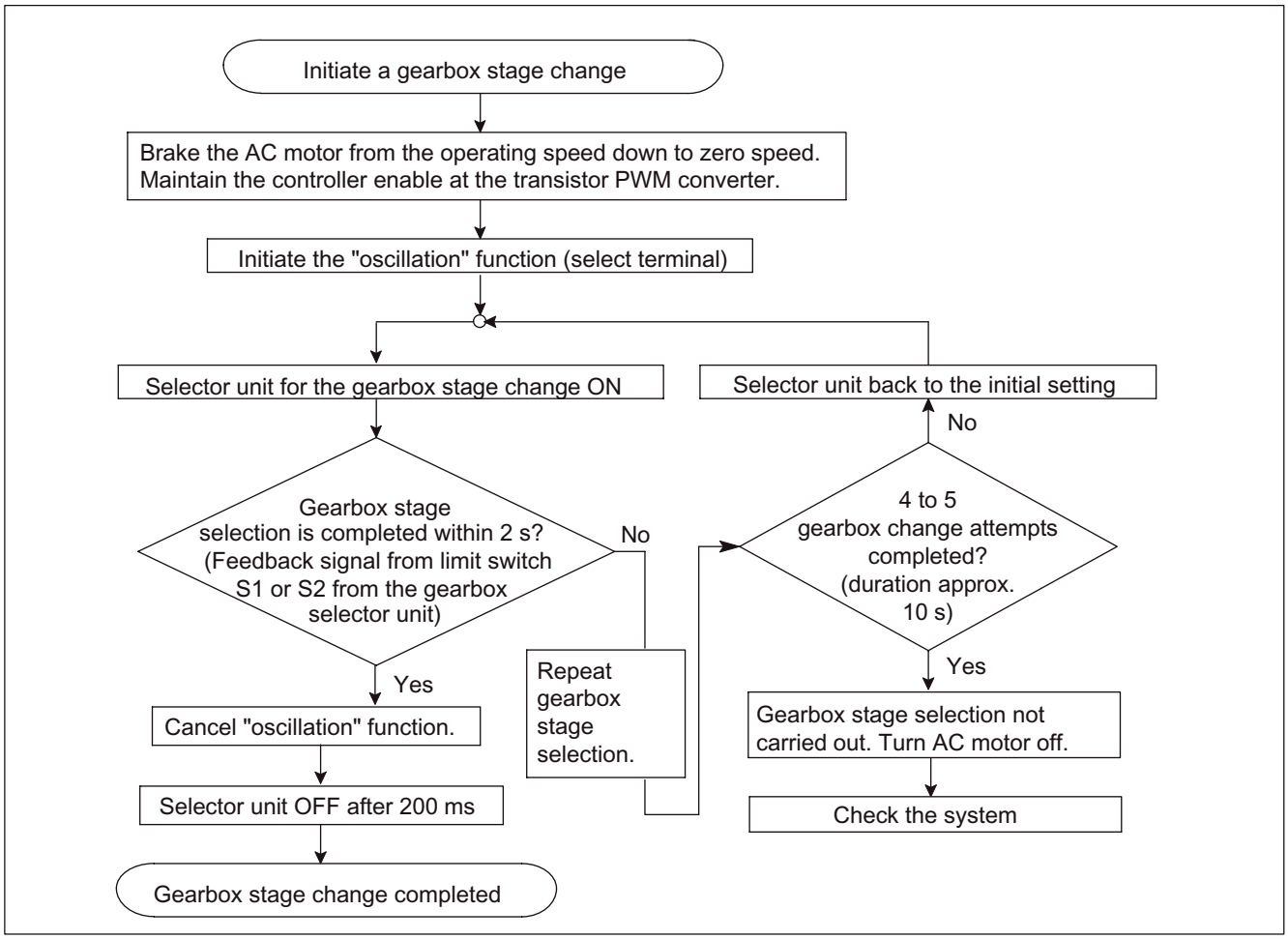


Figure 5-7 Function sequence when changing the gearbox stage

Table 5- 19 Control sequence when selecting the gearbox stage

Gearbox stage selection	Connector contact No.			
	2	3	4/5 (S1)	5/6 (S2)
On ratio changeover 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
On ratio changeover 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.

5.4.5 Lubrication

Splash lubrication

Oil level check:	Visually using a sight glass
The oil level depends on the	mounting position:
horizontally and vertically:	Middle of sight glass[1)]
For an inclined mounting position:	Mark on the angled oil level indicator (mount additionally)
Oils which can be used:	HLP 32 acc. to ISO-VG 68
Oil drain bolts:	on both sides

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

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 images of the selector gearbox (see below) show 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

5.4.6 Connections for circulating oil lubrication, shaft height 100

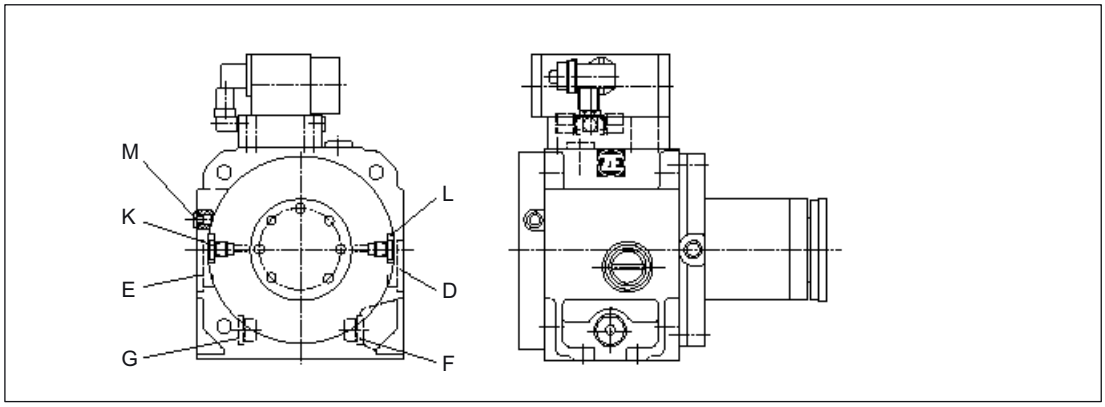


Figure 5-8 Connections for selector gearbox with selector unit for frame size 100

Table 5- 20 Connections for circulating oil lubrication

Max. pressure	Wiring Oil return	Wiring Oil inlet	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 V1 or V3 vertical mounting positions:			

[1] When viewing the gearbox drive from the motor

5.4.7 Connections for circulating oil lubrication, shaft heights 132 and 160

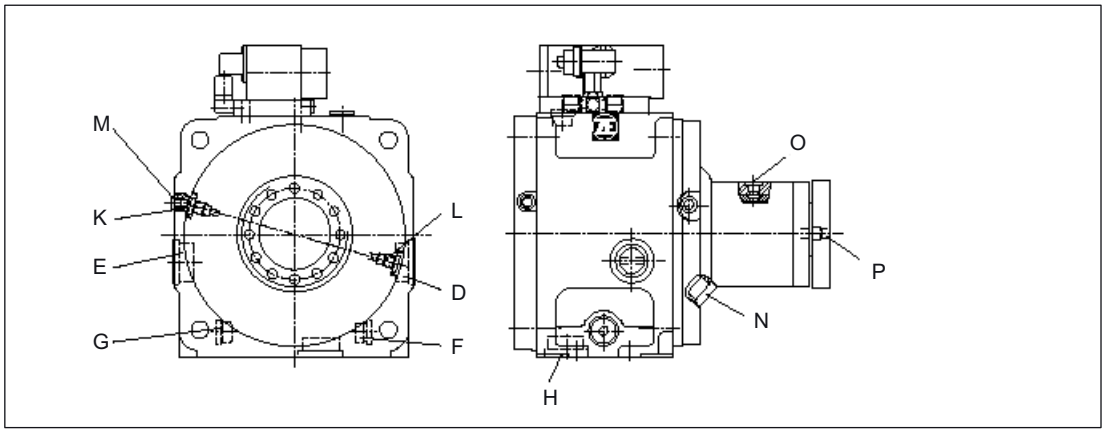


Figure 5-9 Selector gearbox with selector unit for frame sizes 132 and 160

Table 5- 21 Connections for circulating oil lubrication

Max. pressure	Connection Oil return	Connection Oil inlet	Mounting position
2 bar	**H**	**P** (1.5 dm³/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 dm³/min) **N** (1.5 dm³/min)	V1 (closed version)
1.5 bar			
1.5 bar		**G** (1.5 dm³/min) Main direction of rotation clockwise **F** (1.5 dm³/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:			
Connection O is also possible (0.5 dm³/min)			

1) When viewing the gearbox drive from the motor

5.4.8 Flange dimensions

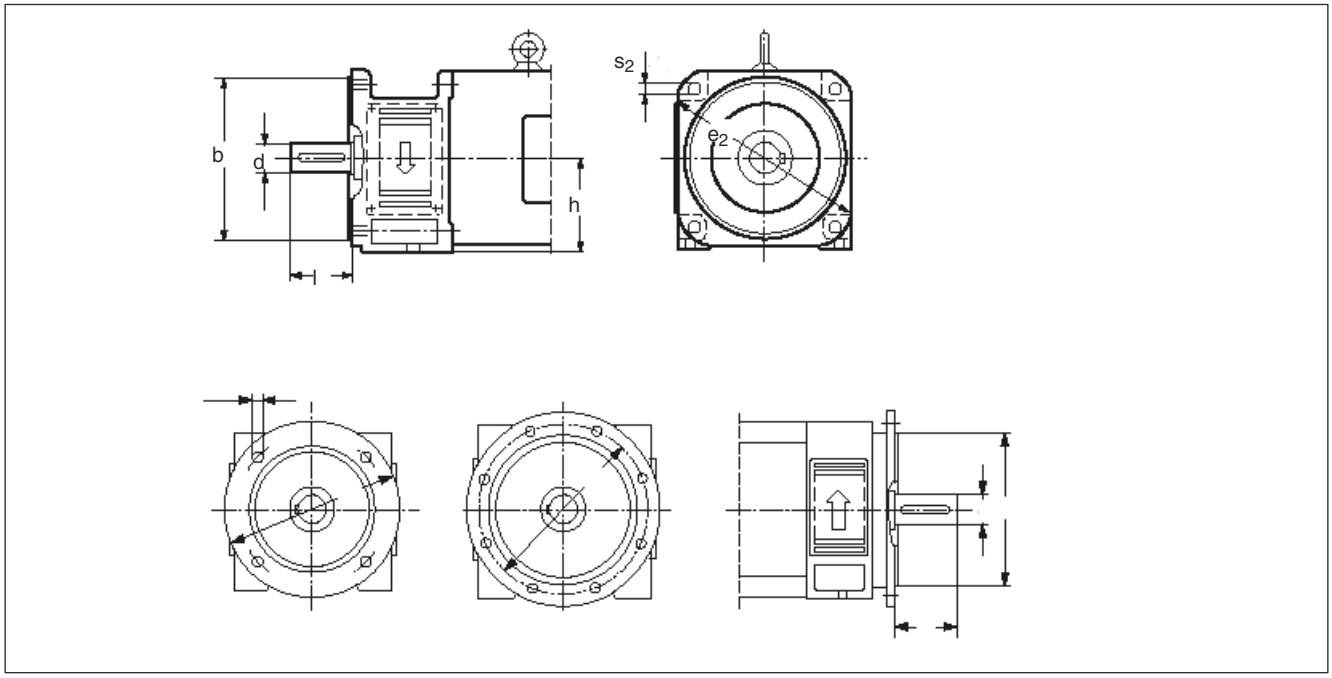


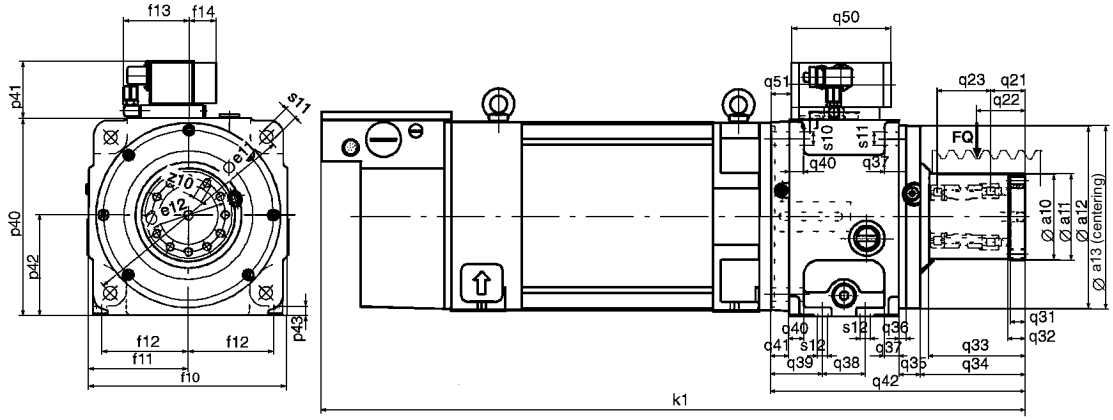
Figure 5-10 Flange dimensions

Table 5- 22 Flange dimensions

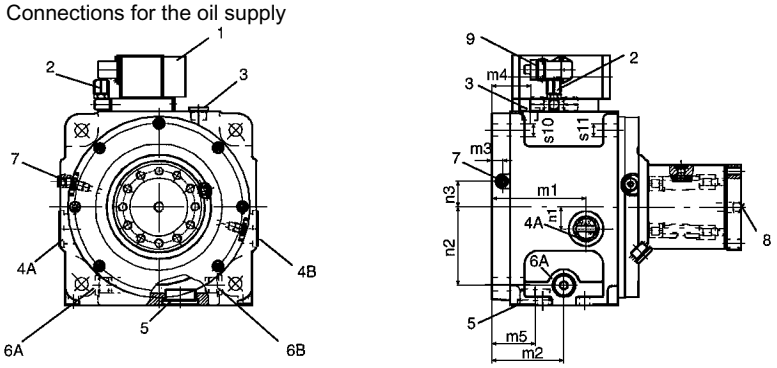
Two-stage Selector gearbox	Shaft height	Standard motor companion dimensions						
		h	d	l	b_1	e_1	a_1	s_1
2K120	100	100–0,5	38 k_6	80	180 j_6	215 ± 0,5	–	14 ± 0,2
2K250	132	132–0,5	42 k_6	110	250 h_6	300 ± 0,5	–	18 ± 0,2
2K300	160	160–0,5	55 k_6	110	300 h_6	350 ± 0,5	–	18 ± 0,2

5.4.9 Gearbox dimensions

Gearbox dimensions



Connections for the oil supply



For selector gearboxes for motor frame sizes 100 to 160

1 Selelctor unit (solenoid 24 V DC, 5 A)
2 Vent valve
3 Oil filling plug
4A Oil sight glass and oil return for CCW main direction of rotation and circulating-oil lubrication
4B Oil sight glass and oil return for CW main direction of rotation and circulating-oil lubrication
5 Oil drain plug for type of construction IM B35
6A Oil intake for main direction of rotation CW and circulating oil lubrication
6B Oil intake for main direction of rotation CCW and circulating oil lubrication
7 Oil intake for type construction IM V15 (must be connected)
8 Oil intake for type of construction IM V36
9 Harting connector, type HAN 8 U

Figure 5-11 Motor and gearbox dimensions

Two-stage selector gearbox (dimensions, overview 1)

Motor		Dimensions in mm															
Size	Type	a10 Output enclosure	a11 k6	a12	a13 g6	e11 0,2	e12	f10	f11	f12	f13	f14	m1	m2	m3	m4	m5
100	1PH4 105 1PH4 107	100	100	188	190	215	80	208	104	92	86,6	42,4	107	90,5	15	45	–
132	1PH4 133 1PH4 135 1PH4 137 1PH4 138	116	118	249	250	300	100	270	135	117	89,5	39,5	131	100	15	53	60
160	1PH4 163 1PH4 167 1PH4 168	140	130	249	250	350	100	326	163	145	89,5	39,5	131	100	15	53	60

Two-stage selector gearbox (dimensions, overview 2)

Motor		Dimensions in mm														
Frame size	Type	n1	n2	n3	p40	p41	p42	p43	q21	q22	q23	q31	q32	q33	q34	q35	q36
100	1PH4 103 1PH4 105 1PH4 107	17	80	30	209	92	108	12	42	57–67	75	15	17,5	–	116	26	10
132	1PH4 133 1PH4 135 1PH4 137 1PH4 138	30	108	35	268	78	136	12	46,9	57–66	72,1	20	22,5	129,5	142,5	29	10
160	1PH4 163 1PH4 167 1PH4 168	30	135	35	324	78	164	17	48,2	74–83	69,8	20	22,5	–	142,5	29	10

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	Number of threaded holes	Motor with gearbox total length k1
100	1PH4 103 1PH4 105 1PH4 107	18	55	63	18	25	298	136	12	14	14	14	M8	8x45°	714 774 839
132	1PH4 133 1PH4 135 1PH4 137 1PH4 138	20	58	71	20	25	346,5	136	28	18	18	14	M12	12x30°	805 875 925 960
160	1PH4 163 1PH4 167 1PH4 168	20	58	71	23	25	346,5	136	28	18	18	14	M12	12x30°	938 993 1024

Figure 5-12 Two-speed gearbox

5.4.10 Permissible dimension deviations

Table 5- 23 Permissible dimension deviations

Dim.	permissible deviations		
a, b	up to 250 mm from 250 mm to 500 mm from 500 mm to 750 mm		±0.75 mm ±1.0 mm ±1.5 mm
b_1	up to 230 mm over 230 mm	DIN 7160	j6 h6
d, d_1	up to 11 mm from 11 mm to 50 mm over 50 mm	DIN 7160	j6 k6 m6
e_1	up to 200 mm from 200 mm to 500 mm		±0.25 mm ±0.5 mm
h	from 50 mm to 250 mm DIN 747 from 250 mm to 500 mm		–0.5 mm –1.0 mm
i, i_1, i_2	up to 85 mm from 85 mm to 130 mm from 130 mm to 240 mm		±0.75 mm ±1.0 mm ±1.5 mm
u, t, u_1, t_1	acc. to DIN 6885 Sheet 1		

Connection methods

6

6.1 SINAMICS drive I/O

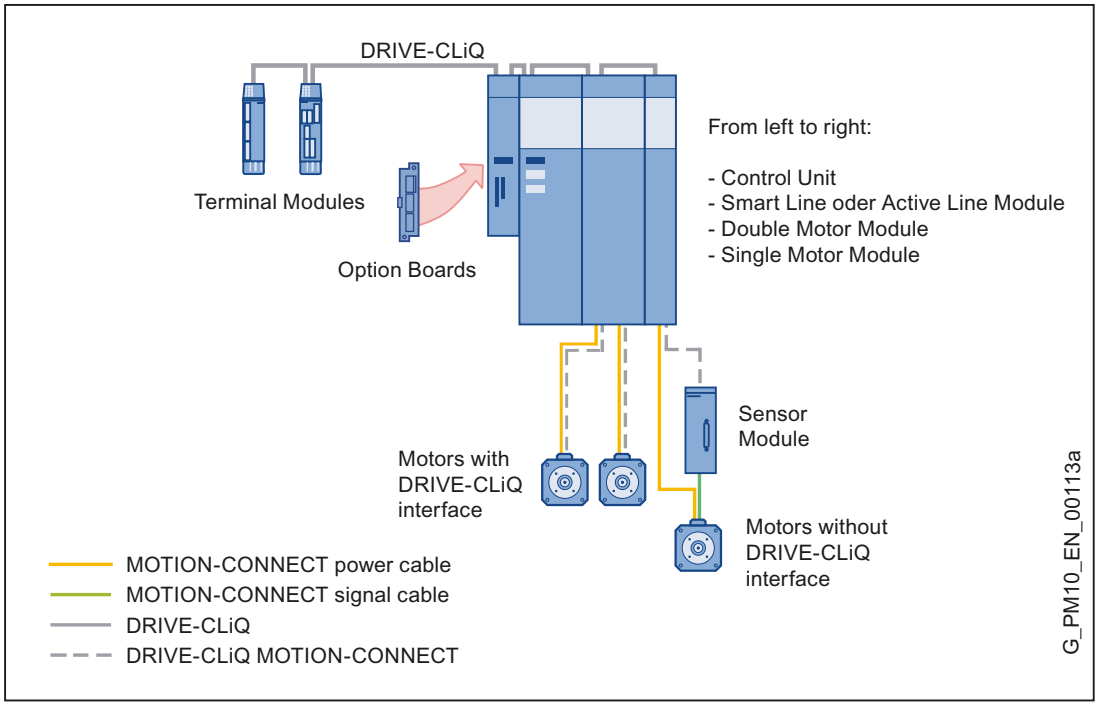


Figure 6-1 SINAMICS drive I/O

6.2 Power connection

Connecting motors

Note

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

Table 6- 1 Overview, connection system for 1PH4 motors

SH	Number Main terminals	Max. cross-section that can be connected	Terminal strip for temperature sensor	PE connection size/ cable lug width
100	3 x M5	16 mm^2	3 terminals	M4/9 mm
132	3 x M5	35 mm^2 with cable lug connection	3 terminals	M5/15 mm
160	3 x M10	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

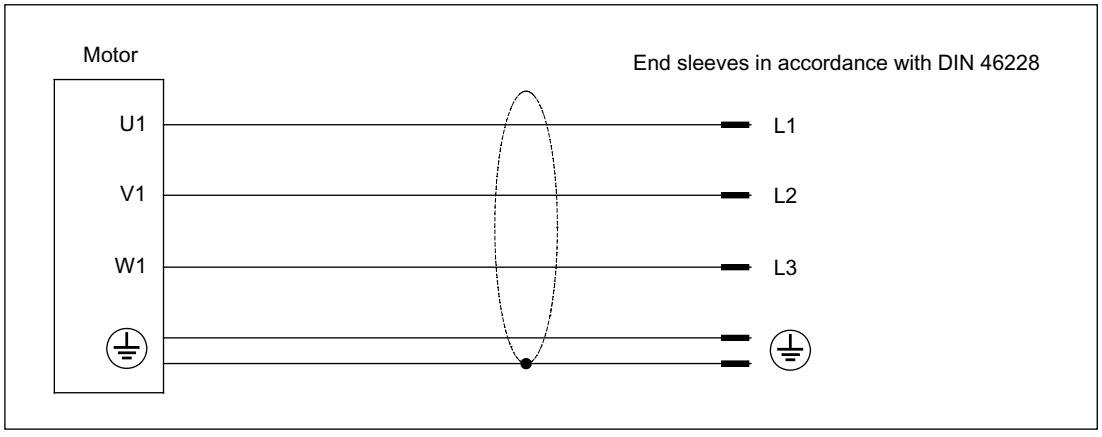


Figure 6-2 Power cable

Note

The cables are available in a UL version or for higher mechanical requirements.
For technical data, see Catalog.

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

Current-carrying capacity for power and signal cables

The current-carrying capacity of PVC/PUR-insulated copper cables is specified for routing types B1, B2 and C under continuous operating conditions in the table with reference to an ambient air temperature of 40 °C. For other ambient temperatures, the values must be corrected by the factors from the "Derating factors" table.

Table 6- 2 Cable cross section and current-carrying capacity

Cross section	Current-carrying capacity rms; AC 50/60 Hz or DC for routing type		
[mm²]	B1 [A]	B2 [A]	C [A]
Electronics (according to EN 60204-1)			
0,20	-	4,3	4,4
0,50	-	7,5	7,5
0,75	-	9	9,5
Power (according to EN 60204-1)			
0,75	8,6	8,5	9,8
1,00	10,3	10,1	11,7
1,50	13,5	13,1	15,2
2,50	18,3	17,4	21
4	24	23	28
6	31	30	36
10	44	40	50
16	59	54	66
25	77	70	84
35	96	86	104
50	117	103	125
70	149	130	160
95	180	165	194
120	208	179	225
Power (according to IEC 60364-5-52)			
150	-	-	344
185	-	-	392
> 185	Values must be taken from the standard		

Table 6- 3 Derating factors for power and signal cables

Ambient air temperature [°C]	Derating factor according to EN 60204-1 Table D1
30	1,15
35	1,08
40	1,00
45	0,91
50	0,82
55	0,71
60	0,58

6.3 Signal connection

DRIVE-CLiQ is the preferred method for connecting the encoder systems to SINAMICS.

Motors with a DRIVE-CLiQ interface can be ordered for this purpose. Motors with a DRIVE-CLiQ interface can be directly connected to the associated motor module via the available MOTION-CONNECT DRIVE-CLiQ cables. The MOTION-CONNECT DRIVE-CLiQ cable is connected to the motor in degree of protection IP67. The DRIVE-CLiQ interface supplies power to the motor encoder via the integrated 24 VDC supply and transfers the motor encoder and temperature signals and the electronic type plate data, e.g. a unique identification number, rating data (voltage, current, torque) to the control unit. The MOTION-CONNECT DRIVE-CLiQ cable is used universally for connecting the various encoder types. These motors simplify commissioning and diagnostics, as the motor and encoder type are identified automatically.

Encoder connection on motors with DRIVE-CLiQ

Motors with DRIVE-CLiQ interfaces can be directly connected to the corresponding Motor Module via the available MOTION-CONNECT DRIVE-CLiQ cables. This data is transferred directly to the Control Unit.

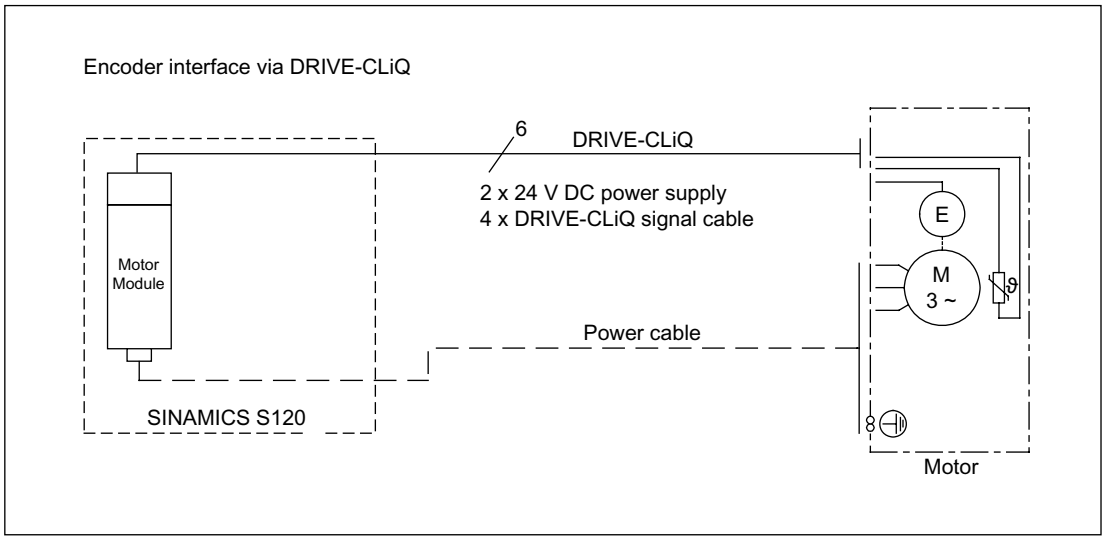


Figure 6-3 Encoder connection on motors with DRIVE-CLiQ

Cables on motors with DRIVE-CLiQ

With DRIVE-CLiQ, the same cable is used for all encoder types. Only pre-assembled cables from Siemens (MOTION-CONNECT) may be used.

Table 6- 4 Pre-assembled cable

6FX	□	002	-	□DC□□	-	□□□	0
	↓					↓ ↓ ↓	
	↓					Length	
	5 MOTION-CONNECT®500					max. cable length 100 m	
	8 MOTION-CONNECT®800					max. cable length 50 m	

For other technical data and length code, refer to Catalog, Chapter "MOTION-CONNECT connection system"

Encoder connection on motors without DRIVE-CLiQ

Motors without DRIVE-CLiQ require a Sensor Module Cabinet-Mounted or operation with SINAMICS S120. The Sensor Modules evaluate the signals from the connected motor encoders or external encoders and convert them to DRIVE-CLiQ. In conjunction with motor encoders, the motor temperature can also be evaluated using Sensor Modules. For additional information, refer to the SINAMICS Equipment Manual.

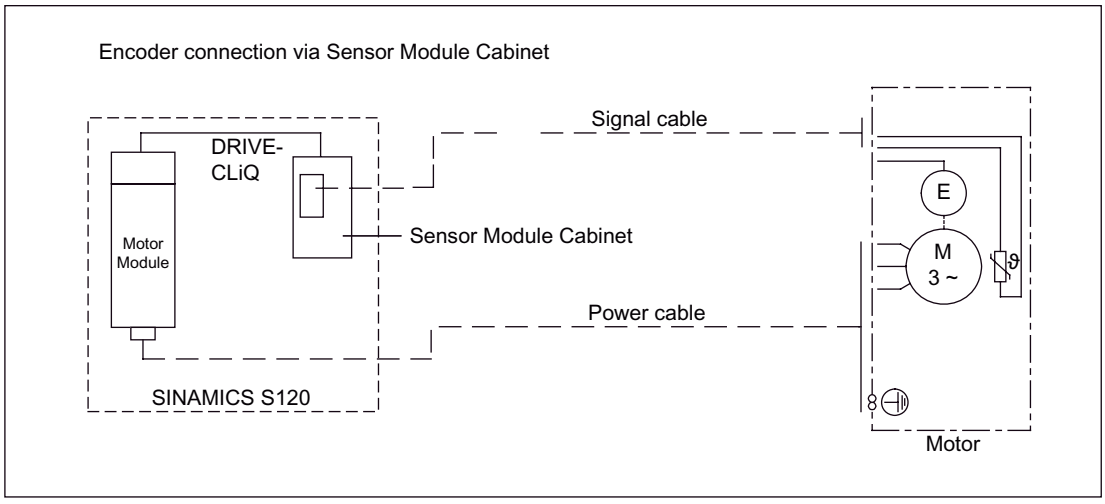


Figure 6-4 Encoder connection on motors without DRIVE-CLiQ

Cables on motors without DRIVE-CLiQ

Only pre-assembled cables from Siemens (MOTION-CONNECT) may be used.

Table 6- 5 Pre-assembled cable

6FX	□	002	-	2AC31	-	□□□	0
	↓					↓ ↓ ↓	
	↓					Length	
	5 MOTION-CONNECT®500					max. cable length 100 m	
	8 MOTION-CONNECT®800					max. cable length 50 m	

For other technical data and length code, refer to Catalog, Chapter "MOTION-CONNECT connection system"

Information on the application of motors

7

7.1 Transportation / storage before use

During transportation and if the motors are out of operation for a long period of time, the cooling circuit must be completely emptied to protect against frost damage and corrosion.

The motors should be stored indoors in dry, low-dust and low-vibration (v_{rms} < 0.2 mm/s) rooms. The motors should not be stored longer than two years at room temperature (+5° C to +40° C) to retain the service life of the grease.

Read the additional notes regarding transportation and storage in the operating instructions.

7.2 Ambient conditions

The bearings are sealed at both ends and designed for a minimum ambient temperature in operation of -15° C.

7.3 Routing cables in a wet/moist environment

NOTICE
If the motor is mounted in a humid environment, the power and signal cables must be routed as shown in the following figure.

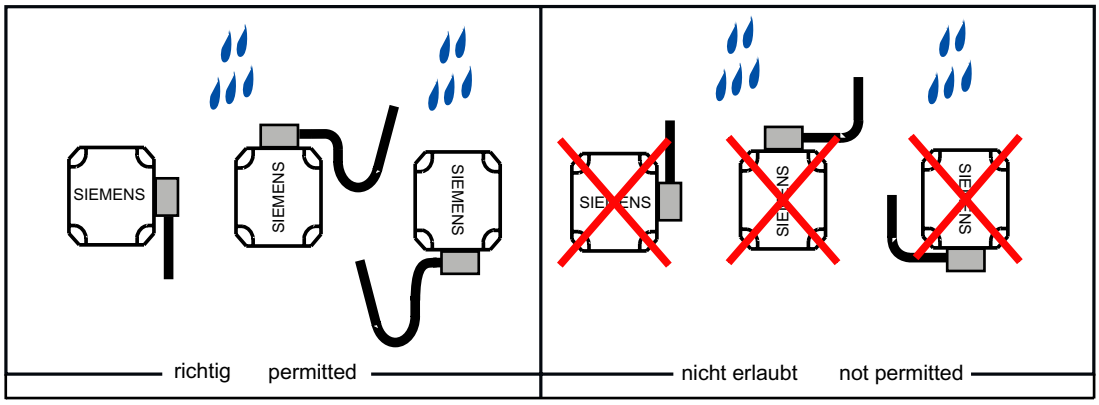
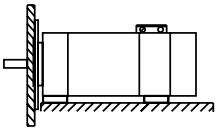
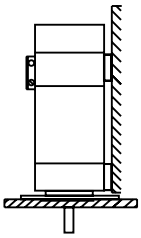
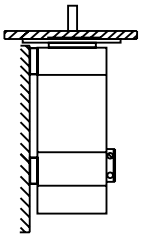


Figure 7-1 Principle of cable routing in a wet/moist environment

7.4 Mounting position/types of construction

Table 7- 1 Designation of types of construction (accdg. to IEC 60034-7)

Type of construction	Representation	Description
IM B35		Standard
IM V15		Special construction types Observe the special conditions applicable to vertical axes! Note that a special seal is required for IM V36!
IM V36		

⚠ CAUTION
Liquid must not be allowed to build up on the flange on vertically or horizontally mounted motors. Failure to protect the flange against liquid build-up may damage the bearing and/or the bearing grease.

7.5 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.

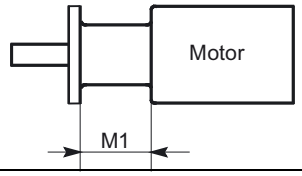
In the terminal box it must be ensure that the connecting cables are insulated with respect to the terminal board cover.

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 (see table).

Table 7- 2 Flange mounting with threaded studs and nuts

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

Outgoing feeder on NDE

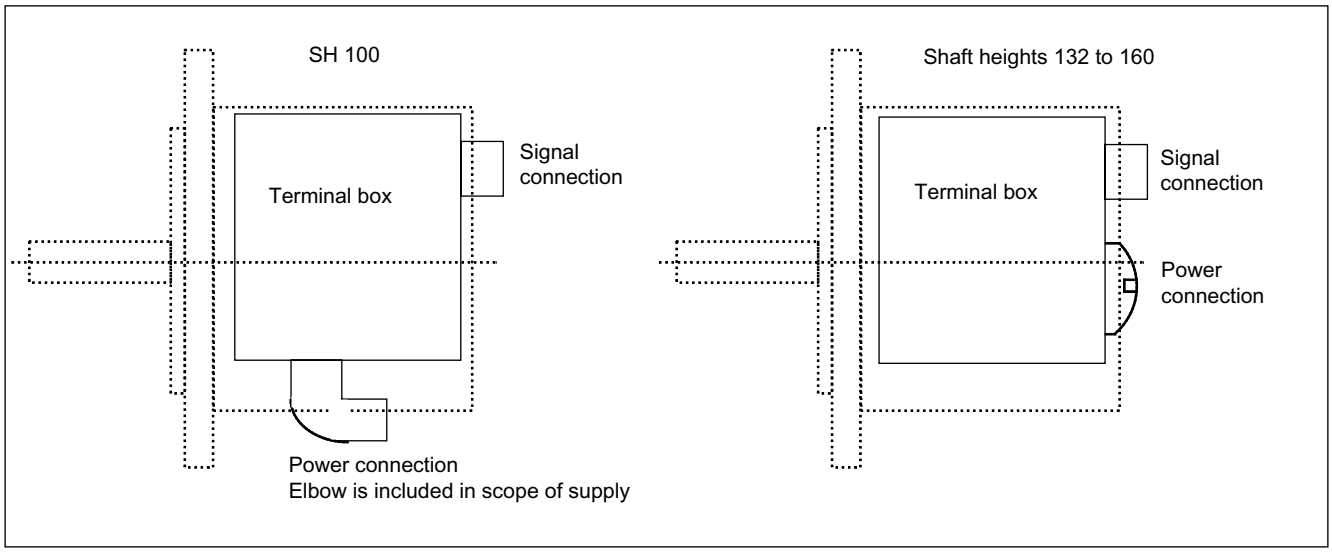


Figure 7-2 Outgoing feeder

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, a foot fastening at the non-drive end is required to adhere to the vibration severity limit values.
- For 1PH4 motors, the screw hole cover plates for the foot fastening 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 driven machine, 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 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
- Mounting type, mounting position (IM B5; IM B3; IM B35; IM V1; etc.)
- Motor weight distribution, i.e. length, shaft height

Permissible induced vibrations

External vibrations are introduced into the motor through the motor foundation and/or the drive mechanical transmission through the motor frame and/or through the rotor. In order to ensure perfect functioning of the drive as well as a long motor lifetime, these types of vibrations, introduced into the drive system, should not exceed the specific limit values of the motor. Vibrations caused by the rotor must be minimized by appropriately balancing the motor.

Table 7- 3 Vibration values

Vibration frequency	Vibration values for SH 100 to 160	
< 6.3 Hz	Vibration displacement s	≤ 0.16 mm
6,3 ... 63 Hz	Vibration velocity v_{rms}	≤ 4.5 mm/s
> 63 Hz	Vibration acceleration a	≤ 2.55 m/s^2

Appendix

A

A.1 Description of terms

DE

Drive end

Maximum continuous speed n_{S1}

The maximum permissible speed that is continuously permitted without speed duty cycles.

Max. current I_{max}

This is the maximum current (rms phase value) that can briefly flow for dynamic operations (e.g. when accelerating) without damaging the motor.

Maximum speed n_{max}

The maximum permissible speed n_{max} is determined by mechanical factors. The maximum speed n_{max} must not be exceeded.

⚠ CAUTION

If the speed n_{max} is exceeded, this can result in damage to the bearings, short-circuit end rings, press fits etc. It should be ensured that higher speeds are not possible by appropriately designing the control or by activating the speed monitoring in the drive system.

The motor may not operate continuously at maximum speed n_{max}. Unless a different duty cycle is specified, the speed must be reduced as stated below:

Duty cycle for a 10-minute cycle	
3 min	n_{max}
6 min	2/3 n_{max}
1 min	Standstill

Maximum torque M_{max}

Torque which is briefly available for dynamic operations (e.g. when accelerating).
$M_{max} = 2 \bullet M_N$

Modes

The operating modes (duty types) are defined in IEC 60034, Part 1. The maximum duty cycle duration for duty types S1 and S6 is 10 minutes unless otherwise specified.

NDE

Non-drive end

No-load current I_μ

This is the current (rms phase current) that is required in order to operate the motor under no-load conditions at rated speed without load torque. The no-load current defines the motor magnetization in the base speed range (low speed at the start of field weakening).

Rated current I_N

This is the the current (rms phase value) that flows at the rated speed and rated torque and can be thermally provided according to the specified operating mode (duty type) according to IEC 60034-1.

Rated frequency f_N

Frequency required to obtain the performance ratings (P_N, n_N, etc.).

Rated power P_N

The rated power is the power that is mechanically available at the shaft that can be thermally provided corresponding to the specified operating mode (duty type) according to IEC 60034-1.

Rated speed n_N

This is the speed for which the rated power and the rated torque are defined corresponding to the specified operating mode (duty type) according to IEC 60034-1.

Rated torque M_N

The rated torque is the torque that is mechanically available at the shaft that can be thermally provided corresponding to the specified operating mode (duty type) according to IEC 60034-1.

Rated voltage V_N

Voltage between two motor phases for which the rating data (P_N, n_N, etc.) are defined. The rated voltage definition takes into account magnetic (iron saturation) and thermal factors.

S1 duty (continuous operation)

Operation with a constant load, the duration of which is sufficient that the motor goes into a thermal steady-state condition.

S6 duty (intermittent operation)

S6 duty is operation which comprises a sequence of identical duty cycles; each of these duty cycles comprises a time with constant motor load and a no-load time. Unless otherwise specified, the load period refers to a duty cycle of 10 min.

S6-40 % =	4 min load operation, 6 min no-load operation
S6-60 % =	6 min load operation, 4 min no-load operation

Speed for field weakening with constant power n_2

Maximum achievable speed at rated power corresponding to the specified operating mode (duty type) according to IEC 60034-1.

Thermal time constant T_{th}

The thermal time constant defines the temperature rise of the motor winding when the motor load is suddenly increased (step increase) up to the permissible S1 torque. The motor has reached 63% of its S1 final temperature after T_{th}.

A.2 References

Overview of publications of planning manuals

An updated overview of publications is available in a number of languages on the Internet at:
www.siemens.com/motioncontrol
Select "Support" → "Technical Documentation" → "Ordering Documentation" → "Printed Documentation".

Catalogs

Abbreviations	Catalog name
NC 61	SINUMERIK & SINAMICS
NC 60	SINUMERIK & SIMODRIVE
PM 21	SIMOTION & SINAMICS
DA 65.3	Servo motors
DA 65.4	SIMODRIVE 611 universal and POSMO
DA 65.10	SIMOVERT MASTERDRIVES VC
DA 65.11	SIMOVERT MASTERDRIVES MC

Electronic Documentation

Abbreviations	DOC ON CD
CD1	The SINUMERIK System (includes all SINUMERIK 840D/810D and SIMODRIVE 611D)
CD2	The SINAMICS System

A.3 Suggestions/corrections

Should you come across any printing errors when reading this publication, please notify us on this sheet. We would also be grateful for any suggestions and recommendations for improvement.

To: SIEMENS AG I DT MC MS1 P.O. Box 3180 D-91050 Erlangen, Federal Republic of Germany Fax: +49 (0) 9131 / 98 - 2176 (documentation) mailto:docu.motioncontrol@siemens.com http://www.siemens.com/automation/service&support	From Name: Address of your Company/Dept. Street: Postal code: Location: Phone: / Fax: /

Suggestions and/or corrections

Index

Siemens AG

Industry Sector
Motion Control Systems
P.O. Box 3180
91050 ERLANGEN
GERMANY

www.siemens.com/motioncontrol