Configuration Manual 04/2008

Hollow-shaft motors for 1PM6 1PM4 ma in spindle drives

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SINAMICS S120

1PM6/1PM4 Hollow-Shaft Motors for Main Spindle Drives

Configuration Manual

PPMS, 04/2008
6SN1197-0AD23-0BP0

Safety Guidelines

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.

Prescribed Usage

Note the following:

⚠WARNING
This device may only be used for the applications described in the catalog or the technical description and only in connection with devices or components from other manufacturers which have been approved or recommended by Siemens. Correct, reliable operation of the product requires proper transport, storage, positioning and assembly as well as careful operation and maintenance.

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.

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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

Select the menu items "Support" → "Technical Documentation" → "Overview of Publications".

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 9131 98 63315
E-mail	mailto: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. Protective equipment which will shut down the drive system in the event of a ground fault must be provided for motors operated on IT systems.

In operation 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.

⚠ 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.

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

⚠ 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.

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Description of the motor

1

1.1 Features of the 1PM6

Overview

The air-cooled 1PM6 motors have been specially designed for direct mounting on mechanical spindles. The hollow shaft permits the passage of coolant for tools with internal cooling.

The shaft is prepared on the non-drive end of the motor for connection of a rotary gland for input of the coolant.

The 1PM6 motors are rugged and maintenance-free 4-pole induction motors with squirrel-cage rotors. They have been designed specifically for use in conjunction with the SINAMICS S drive system.

A fan for providing forced ventilation is mounted either radially or axially (depending on the version) on the rear of the motor. The direction of air flow is from the drive end to the non-drive end to keep the exhaust heat of the motor away from the machine tool.

The motors have a built-in hollow shaft measuring system for recording the motor speed and indirect position.

Figure 1-1 1PM6 motors with radial and axial fans

Benefits

- Hollow shaft for passage of coolant with direct spindle mounting
- Maximum speeds up to 12000 rpm (option: 18000 rpm)
- Full rated torque is continuously available, even during idle times
- Axial or radial fans
- High rotational accuracy
- Short acceleration and braking times

Area of application

- Compact machining centers
- Directly driven tools with internal cooling
- Customized machines

1.2 Features of the 1PM4

Overview

Liquid-cooled 1PM4 motors have been specially designed for direct mounting on mechanical spindles. The hollow shaft permits the passage of coolant for tools with internal cooling.

The shaft is prepared on the non-drive end of the motor for connection of a rotary gland for input of the coolant.

Given the compact design of modern machines, the heat loss from electrical drives can have an adverse effect on the accuracy of machining, especially when they are directly mounted on the spindle. The resulting demand for cold motors with a high power density has led to the development of the 1PM4 liquid-cooled motors.

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

The motors have a built-in hollow shaft measuring system for recording the motor speed and indirect position.

Figure 1-2 1PM4 series motor, liquid-cooled

Benefits

- Hollow shaft for passage of coolant with direct spindle mounting
- Maximum speeds up to 12000 rpm (option: 18000 rpm)
- Full rated torque is continuously available, even during idle times
- Cooled flange to prevent thermal stressing of the mechanical power train
- Low noise level
- High rotational accuracy
- Short acceleration and braking times

Area of application

- Compact machining centers
- Directly driven tools with internal cooling
- Customized machines

1.3 Technical features

Table 1-1 Technical features

Technical feature	Version	
	1PM6	1PM4
Insulation of the stator winding in acc. with EN 60035 (IEC 60034-1)	Temperature class 155 (F) for a coolant temperature of up to +40 °C	Temperature class 155 (F) for a coolant temperature of up to +30 °C
Installation altitude according to EN 60034-1 (IEC 60034-1)	≤ 1000 m above sea level, otherwise power derating	
Type of construction according to EN 60034-7 (IEC 60034-7)	IM B5 (IM V1, IM V3)	IM B35 (IM V15, IM V36)
Degree of protection to EN 60034-5 (IEC 60034-5)	IP55, fan IP54	IP65, IP55 on shaft exit
Permissible coolant temperature	-15 ... +40 °C	
Coolant intake temperature		Due to the risk of condensate formation, a coolant intake temperature of up to +30 °C is recommended depending on the prevailing ambient conditions.
Temperature monitoring acc. to EN 60034-11 (IEC 60034-11)	2 temperature sensors KTY 84 in the stator winding, 1 as reserve	
Paint finish	Anthracite, similar to RAL 7016	
2. rating plate	Enclosed separately	
Drive shaft end according to DIN 748-3 (IEC 60072-1)	Plain shaft, without fitted key	
Hollow-shaft bore	∅ 11.5 mm	
Radial eccentricity, concentricity and axial eccentricity acc. to DIN 42955 (IEC 60072-1)	Tolerance R (reduced)	
Vibration severity according to EN 60034-14 (IEC 60034-14)	Grade A is observed up to rated speed	
Sound pressure level according to DIN EN ISO 1680	From drive end to non-drive end (when fan is operating on a 50 Hz supply) 70 dB(A) +3 dB(A) 2)	 69 dB(A) +3 dB(A) 2)
Built-in encoder systems for motors without DRIVE-CLiQ interface	Incremental encoder, sin/cos 1 Vpp, 256 S/R 1) without C and D tracks (IN256S/R encoder)	
Built-in encoder systems for motors with DRIVE-CLiQ interface	Incremental encoder, 19-bit (resolution 524288, internal 256 S/R), without commutating position (Encoder IN19DQ)	
Terminal box arrangement (when viewing the DE)	For axial fan: Top, rotatable 4 x 90° For radial fan: On right side, rotatable 4 x 90°	Top, rotatable 4 x 90°
Terminal box connection type		
• Motor	Terminals in terminal box	Terminals in terminal box
• Fan (1PM6 only)	Terminals in terminal box	---
• Encoder system and temperature sensor	17-pin circular socket (without mating connector or DRIVE-CLiQ)	17-pin circular socket (without mating connector or DRIVE-CLiQ)
Options	L37 = higher maximum speed	

1) S/R = signals/revolution

2) With option L37: 72 dB(A) +3 dB(A)

1.4 Motor data

	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]
1PM6, force-ventilated											
1PM6101, Y circuit	1500	3.7	24	13.5	278	52.7	9711	18000	25	6.8	28
1PM6101, Δ circuit	4000	3.7	9	14	336	134.7	12000	18000	25	9.6	26
1PM6105, Y circuit	1500	7.5	48	23	300	52.2	9008	18000	25	12.3	52
1PM6105, Δ circuit	4000	7.5	18	24	375	134.4	12000	18000	25	17.9	47
1PM6133, Y circuit	1500	11.0	70	41	222	51.4	8000	15000	30	17.0	101
1PM6133, Δ circuit	4000	11.0	26.3	41	295	133.9	10500	15000	30	26.5	86
1PM6137, Y circuit	1500	18.5	118	56	271	51.2	7000	12000	30	24.5	132
1PM6137, Δ circuit	4000	18.5	44	56	366	133.8	10500	12000	30	37.0	114
1PM6138, Y circuit	1500	22.0	140	58	316	51.0	4000	11000	30	26.9	132
1PM6138, Δ circuit	4000	22.0	53	57	400	133.9	6000	11000	30	36.1	123
1PM4, oil-cooled											
1PM4101, Y circuit	1500	3.7	24	13.5	278	52.7	9711	18000	25	6.8	28
1PM4101, Δ circuit	4000	3.7	9	14	336	134.7	12000	18000	25	9.6	26
1PM4105, Y circuit	1500	7.5	48	23	300	52.2	9008	18000	25	12.3	52
1PM4105, Δ circuit	4000	7.5	18	24	375	134.4	12000	18000	25	17.9	47
1PM4133, Y circuit	1500	11.0	70	41	222	51.4	8000	15000	30	17.0	101
1PM4133, Δ circuit	4000	11.0	26.3	41	295	133.9	10500	15000	30	26.5	86
1PM4137, Y circuit	1500	18.5	118	56	271	51.2	7000	12000	30	24.5	132
1PM4137, Δ circuit	4000	18.5	44	56	366	133.8	10500	12000	30	37.0	114
1PM4, water-cooled											
1PM4101, Y circuit	1500	5.0	32	18	259	53.6	9665	18000	6	8.1	36.5
1PM4105, Y circuit	1500	11.0	70	38	263	53.2	9460	18000	6	16.4	72.0
1PM4133, Y circuit	1500	15.0	95.5	55	229	51.9	8290	15000	11	17.4	116
1PM4137, Y circuit	1500	27.0	172	85	265	51.6	6863	12000	11	30.3	170

1.5 Selection and ordering data

Shaft height	Rated speed		Contin-uous speed, max.	Speed, max.[1]	Rated power for star n_{ratedY} = 1500 rpm		Rated power for delta $n_{rated\Delta}$ = 4000 rpm		1PM4 asynchronous motor with hollow shaft	1PM6 asynchronous motor with hollow shaft
SH	star	delta	n_{S1cont}	n_{max}	P_{rated}		P_{rated}			
					S1	S6-40%	S1	S6-40%	Order No. **Standard type**	Order No. **Standard type**
	rpm	rpm	rpm	rpm	kW (HP)	kW (HP)	kW (HP)	kW (HP)		
									Oil cooling[2]	***Forced ventilation***
100	1500	4000	12000	12000	3.7 (4.96)	5.25 (7.04)	3.7 (4.96)	6 (8.05)	**1PM4101 - 27 F86 - 17 S1**	**1PM6101 - 27 F87 - 17 7 1**
	1500	4000	18000	18000	3.7 (4.96)	5.25 (7.04)	3.7 (4.96)	6 (8.05)	**1PM4101 - 2L F86 - 17 S1**[3]	**1PM6101 - 2L F87 - 17 7 1**[3]
	1500	4000	12000	12000	7.5 (10.1)	11 (14.8)	7.5 (10.1)	13 (17.4)	**1PM4105 - 27 F86 - 17 S1**	**1PM6105 - 27 F87 - 17 7 1**
	1500	4000	18000	18000	7.5 (10.1)	11 (14.8)	7.5 (10.1)	13 (17.4)	**1PM4105 - 2L F86 - 17 S1**[3]	**1PM6105 - 2L F87 - 17 7 1**[3]
132	1500	4000	10000	10500	11 (14.8)	16.5 (22.1)	11 (14.8)	19.5 (26.1)	**1PM4133 - 27 F86 - 17 S1**	**1PM6133 - 27 F87 - 17 7 1**
	1500	4000	15000	15000	11 (14.8)	16.5 (22.1)	11 (14.8)	19.5 (26.1)	**1PM4133 - 2L F86 - 17 S1**[3]	**1PM6133 - 2L F87 - 17 7 1**[3]
	1500	4000	10000	10500	18.5 (24.8)	28 (37.5)	18.5 (24.8)	32 (42.9)	**1PM4137 - 27 F86 - 17 S1**	**1PM6137 - 27 F87 - 17 7 1**
	1500	4000	12000	12000	18.5 (24.8)	28 (37.5)	18.5 (24.8)	32 (42.9)	**1PM4137 - 2L F86 - 17 S1**[3]	**1PM6137 - 2L F87 - 17 7 1**[3]
	1500	4000	10000	10500	22 (29.5)	33 (44.3)	22 (29.5)	39 (52.3)	–	**1PM6138 - 27 F87 - 17 7 1**
	1500	4000	11000	11000	22 (29.5)	33 (44.3)	22 (29.5)	39 (52.3)	–	**1PM6138 - 2L F87 - 17 7 1**[3]
									Water cooling[4]	
100	1500		12000	12000	5 (6.71)	6.5 (8.72)	–	–	**1PM4101 - 27 W26 - 17 S1**	
	1500		18000	18000	5 (6.71)	6.5 (8.72)	–	–	**1PM4101 - 27 W26 - 17 S1**[3]	
	1500		12000	12000	11 (14.8)	14.75 (19.8)	–	–	**1PM4105 - 27 W26 - 17 S1**	
	1500		18000	18000	11 (14.8)	14.75 (19.8)	–	–	**1PM4105 - 27 W26 - 17 S1**[3]	
132	1500		10000	10500	15 (20.1)	21 (28.2)	–	–	**1PM4133 - 27 W26 - 17 S1**	
	1500		15000	15000	15 (20.1)	21 (28.2)	–	–	**1PM4133 - 27 W26 - 17 S1**[3]	
	1500		10000	10500	27 (36.2)	38 (51.0)	–	–	**1PM4137 - 27 W26 - 17 S1**	
	1500		12000	12000	27 (28.2)	38 (51.0)	–	–	**1PM4137 - 27 W26 - 17 S1**[3]	

Option	Description	1PM4	1PM6	1PM6 code
Encoder system for motors without DRIVE-CLiQ interface:	Incremental encoder sin/cos 1 V_{pp}, 256 S/R (Encoder IN256S/R)	**L**		**L**
Encoder system for motors with DRIVE-CLiQ interface:	Incremental encoder 19 bit (Encoder IN19DQ)	**V**		**V**
Type:	IM B35, IM V15, IM V35		IM B5	**1**
			IM V1	**4**
			IM V3	**5**
Fans: Without fan combined with terminal box/metric cable entry	Top/right	**A**		
	Top/DE	**B**		
	Top/NDE	**C**		
	Top/left	**D**		
Axial fan/Blow-out direction below/Direction of air flow DE → NDE combined with terminal box/metric cable entry			Top/right	**A R**
			Top/DE	**B R**
			Top/NDE	**C R**
			Top/left	**D R**
Radial fan/Blow-out direction NDE/Direction of air flow DE → NDE combined with terminal box/metric cable entry			Right side/below	**E D**
			Right side/DE	**F D**
			Right side/NDE[5]	**G D**

1) For continuous duty (with 30% n_{max}, 60% $^2/_3$ n_{max}, 10% standstill) for a duty cycle time of 10 min. For maintenance intervals for motors and components, see 1PM Motors Configuration Manual.
2) Star/delta changeover.
3) With option L37: Version for increased maximum speed.
4) Only star connection possible.
5) For 1PM6101 and 1PM6105 only.
6) Version for increased maximum speeds includes vibration magnitude grade SR. The following options are not possible:
- ZF gearbox mounting prepared
- Shaft seal.

Motor type (continued)	Rated torque for **star**		Rated torque for **delta**		Moment of inertia	Weight, approx.		Rated current for **star**		**SINAMICS S120 Motor Module**	
						1PM4	1PM6			Required rated output current	**Booksize format**
	M_{rated}		M_{rated}		J	m	m	I_{rated}		I_{rated}	Order No.
	S1	S6-40%	S1	S6-40%				S1	S6-40%	S1	
	Nm (lb_f-ft)	Nm (lb_f-ft)	Nm (lb_f-ft)	Nm (lb_f-ft)	kgm^2 (lb_f-in-s^2)	kg (lb)	kg (lb)	A	A	A	
1PM .101- ...	24 (17.7)	33 (24.3)	9 (6.64)	14 (10.3)	0.011 (0.10)	42 (92.6)	45 (99.2)	13	17.5	18	**6SL312☐ -☐TE21-8AA3**
1PM .101-2L...[3]	24 (17.7)	33 (24.3)	9 (6.64)	14 (10.3)	0.011 (0.10)	42 (92.6)	45 (99.2)	13	17.5	18	**6SL312☐ -☐TE21-8AA3**
1PM .105- ...	48 (35.4)	70 (51.6)	18 (13.3)	31 (22.9)	0.024 (0.21)	67 (148)	70 (154)	23	31	30	**6SL312☐ - 1TE23-0AA3**
1PM .105-2L...[3]	48 (35.4)	70 (51.6)	18 (13.3)	31 (22.9)	0.024 (0.21)	67 (148)	70 (154)	23	31	30	**6SL312☐ - 1TE23-0AA3**
1PM .133- ...	70 (51.6)	105 (77.4)	26 (19.2)	47 (34.7)	0.046 (0.41)	90 (198)	94 (207)	41	58	45	**6SL312☐ - 1TE24-5AA3**
1PM .133-2L...[3]	70 (51.6)	105 (77.4)	26 (19.2)	47 (34.7)	0.046 (0.41)	90 (198)	94 (207)	41	58	45	**6SL312☐ - 1TE24-5AA3**
1PM .137- ...	118 (87.0)	178 (131)	44 (32.5)	76 (56.1)	0.085 (0.75)	130 (287)	135 (298)	56	79	60	**6SL312☐ - 1TE26-0AA3**
1PM .137-2L...[3]	118 (87.0)	178 (131)	44 (32.5)	76 (56.1)	0.085 (0.75)	130 (287)	135 (298)	56	79	60	**6SL312☐ - 1TE26-0AA3**
1PM6138- ...	140 (103)	210 (155)	53 (39.1)	93 (68.6)	0.104 (0.92)	–	156 (344)	58	80	60	**6SL312☐ - 1TE26-0AA3**
1PM6138-2L...[3]	140 (103)	210 (155)	53 (39.1)	93 (68.6)	0.104 (0.92)	–	156 (344)	58	80	60	**6SL312☐ - 1TE26-0AA3**
1PM4101- ...	32 (23.6)	41 (30.2)	–	–	0.011 (0.10)	42 (92.6)	–	18	22.5	18	**6SL312☐ -☐TE21-8AA3**
1PM4101- ...[3]	32 (23.6)	41 (30.2)	–	–	0.011 (0.10)	42 (92.6)	–	18	22.5	18	**6SL312☐ -☐TE21-8AA3**
1PM4105- ...	70 (51.6)	94 (69.3)	–	–	0.024 (0.21)	67 (148)	–	38	47	45	**6SL312☐ - 1TE24-5AA3**
1PM4105- ...[3]	70 (51.6)	94 (69.3)	–	–	0.024 (0.21)	67 (148)	–	38	47	45	**6SL312☐ - 1TE24-5AA3**
1PM4133- ...	95 (70.1)	134 (98.8)	–	–	0.046 (0.41)	90 (198)	–	55	74	60	**6SL312☐ - 1TE26-0AA3**
1PM4133- ...[3]	95 (70.1)	134 (98.8)	–	–	0.046 (0.41)	90 (198)	–	55	74	60	**6SL312☐ - 1TE26-0AA3**
1PM4137- ...	172 (127)	242 (178)	–	–	0.085 (0.75)	130 (287)	–	85	114	85	**6SL312☐ - 1TE28-5AA3**
1PM4137- ...[3]	172 (127)	242 (178)	–	–	0.085 (0.75)	130 (287)	–	85	114	85	**6SL312☐ - 1TE28-5AA3**

Cooling: Internal air cooling External air cooling	**0** **1**
Motor Module: Single Motor Module Double Motor Module	**1** **2**

Options

Designation	Order code
Speed[6] • With increased maximum speed	**L37**

When ordering a motor with options, **-Z** should be added to the order number and the order code should also be specified for each additional required version.

Order codes must not be repeated in plain text in the order.

Order No. **1PM4101-2LF86-1AS1-Z**

Order code **L37**

1.6 Rating plate

2 rating plates are supplied with each motor:

- A rating plate is attached to the motor
- A rating plate is provided in the terminal box

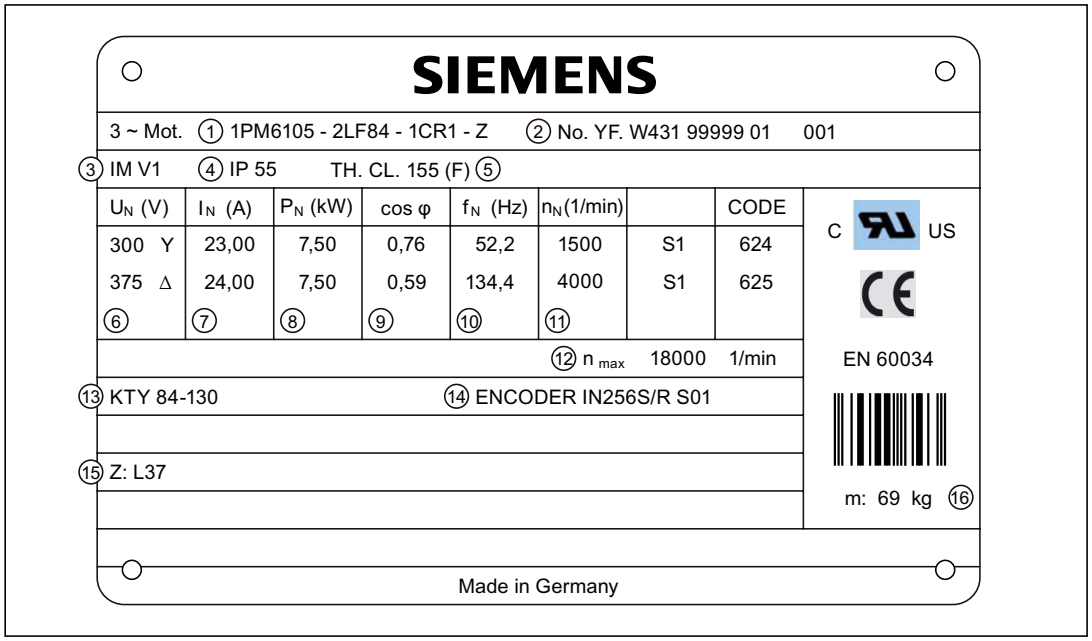


Figure 1-3 Rating plate (example for 1PM6105)

Table 1-2 Description of the rating plate data

Item	Description / Technical data
1	Induction motor MLFB no.
2	Factory serial number
3	Type of construction
4	Degree of protection
5	Temperature class
6	Rated voltage [V]
7	Rated current [A]
8	Rated output [kW]
9	Power factor [cos φ]
10	Rated frequency [Hz]
11	Rated speed [rpm]
12	Maximum speed [rpm]
13	ID, temperature sensor
14	Code, encoder type
15	Additional options
16	Weight [kg]

Configuring

2

2.1 Configuration software

2.1.1 SIZER engineering tool

Overview

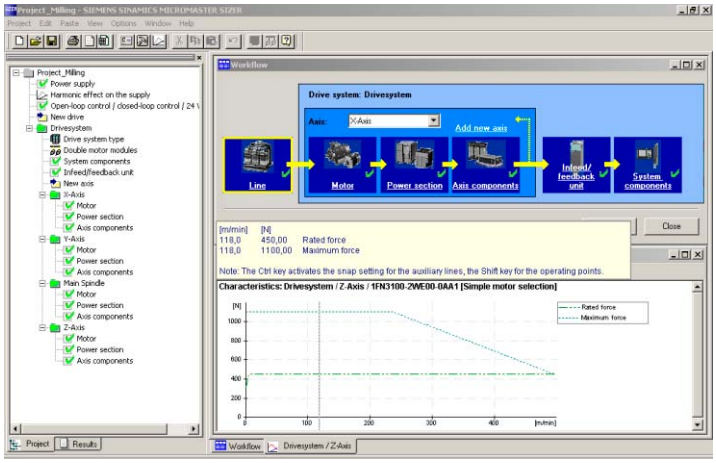


Figure 2-1 SIZER

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

Selection and ordering data

Title	Order No. (MLFB)
Engineering tool 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".

2.1.4 Correct matching of motors and SINAMICS Motor Modules

Situation / load situation	Consequence / result
If the rated current of the SINAMICS Motor Module is higher than the rated current of the motor, the thermal characteristic (S1) of the motor will determine the continuous power of the combination.	The SINAMICS Motor Module will not be fully utilized.
If the rated current of the motor is higher than the rated current of the SINAMICS Motor Module, the rated current of the module will determine the available continuous power.	The thermal capacity of the motor will not be fully utilized.
If the combination is operated in duty cycles, the motor selected must be rated such that the rms current value (I_{rms}) does not exceed the permissible S1 value of the motor. The following generally applies: If you identify a range of 2 limit values or characteristics, the lower limit/characteristic in each case determines the useful range.	

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 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 liquid 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 kgm² (on the motor side)
Δn	Speed variation in rpm
t_B	Acceleration time, in s

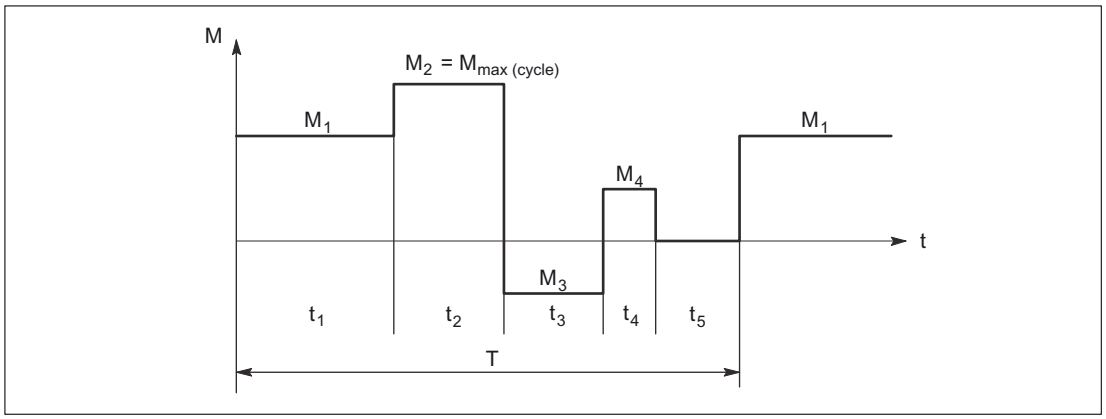


Figure 2-2 Periodic duty cycle (example)

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: $M_N > M_{max\ (cycle)}$.

Selection

- for SINAMICS Motor Module
- for SIMODRIVE power unit
- for SIMOVERT MASTERDRIVES converter/inverter

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).

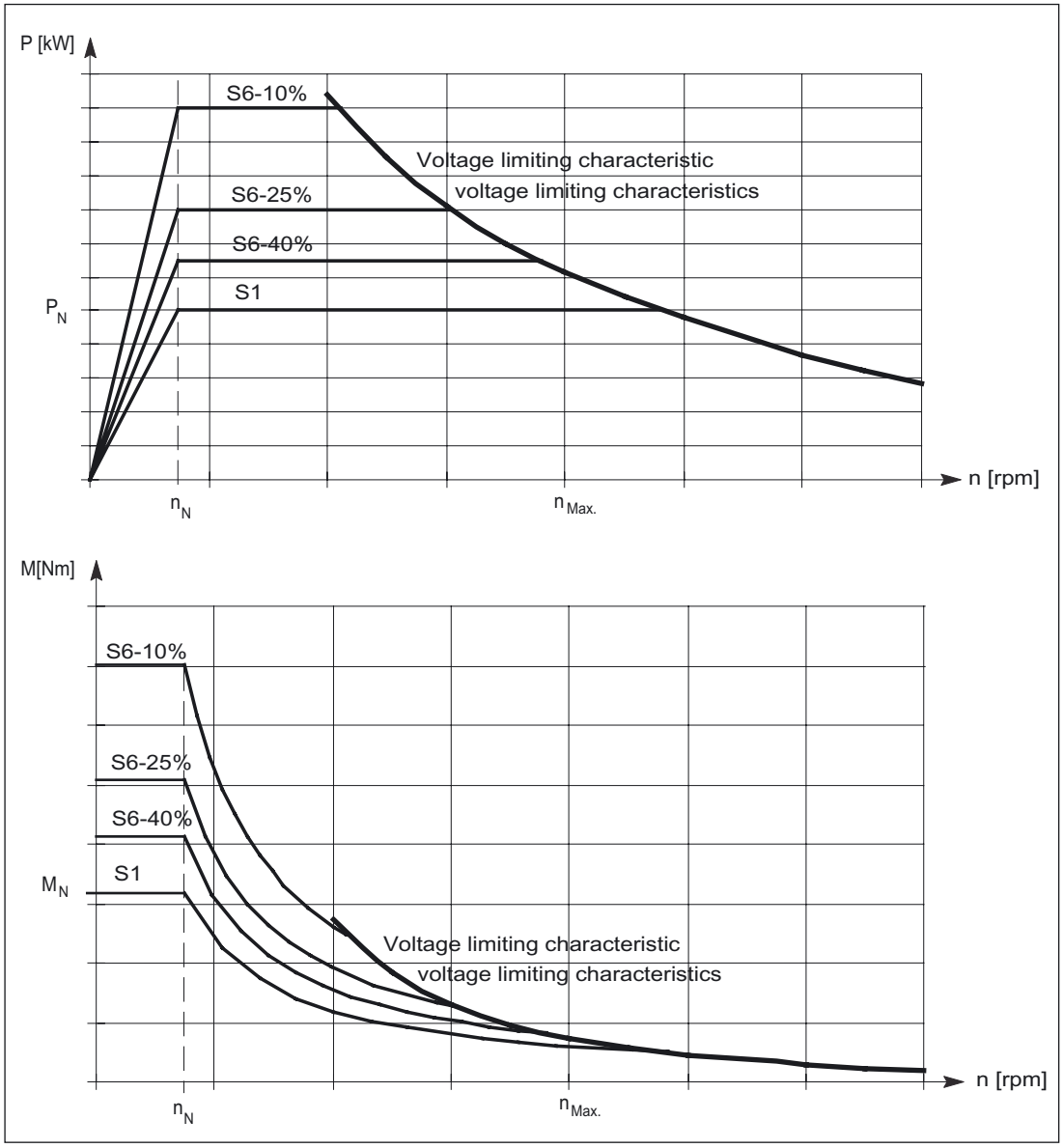


Figure 2-3 Motor selection based on power-speed and torque-speed diagrams

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.

2.3.7 Sample configuration

Moment of inertia J of motor + load = 0.2 kgm², friction is negligible. The application requires the drive to operate continuously in the periodic duty cycle shown in the diagram below.

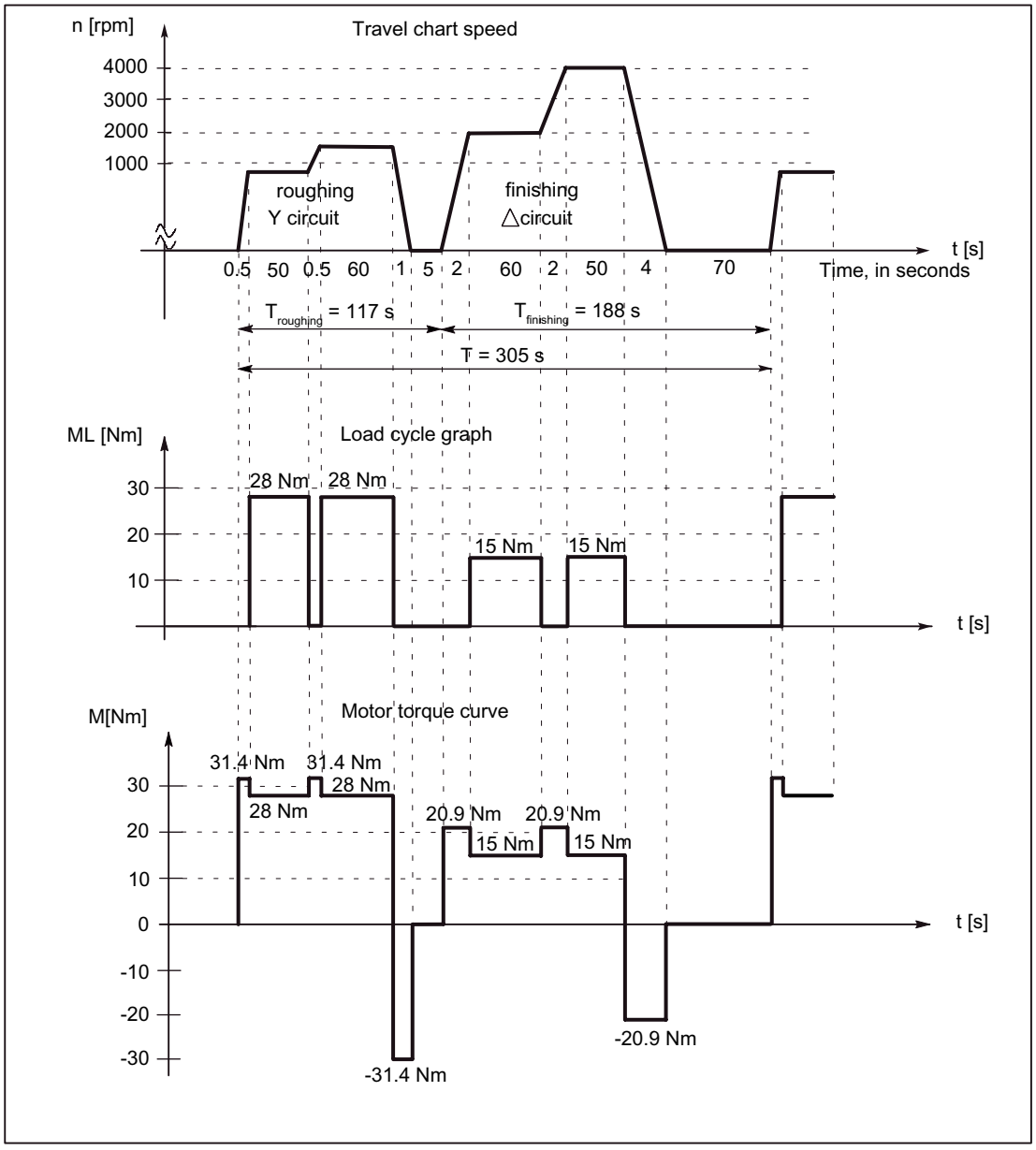


Figure 2-4 Periodic duty cycle

Calculating the accelerating torques

$$M_B = \frac{J \cdot \Delta n}{9.55 \cdot t_a}$$

Table 2-2 Calculating the accelerating torques M_B

Part cycle	J [kgm²]	Δn [rpm]	t_a [s]	Result [Nm]
Acceleration for 0.5 s from 0 to 750 rpm	0,2	750	0,5	31,4
Acceleration for 0.5 s from 750 to 1500 rpm	0,2	750	0,5	31,4
Braking for 1.0 s from 1500 to 0 rpm	0,2	-1500	1,0	-31,4
Acceleration for 2.0 s from 0 to 2000 rpm	0,2	2000	2,0	20,9
Acceleration for 2.0 s from 2000 to 4000 rpm	0,2	2000	2,0	20,9
Braking for 4.0 s from 4000 to 0 rpm	0,2	-4000	4,0	-20,9

Calculating the rms motor torque in the operating cycle

$$M_{eff} = \sqrt{\frac{M_1^2 \cdot t_1 + M_2^2 \cdot t_2 + \ldots + M_n^2 \cdot t_n}{T}}$$

$$M_{eff\ schruppen} = \sqrt{\frac{31{,}4^2 \cdot 0{,}5 + 28^2 \cdot 50 + 31{,}4^2 \cdot 0{,}5 + 28^2 \cdot 60 + (-31{,}4)^2 \cdot 1}{117}} = 27{,}5\ Nm$$

$$M_{eff\ schlichten} = \sqrt{\frac{20{,}9^2 \cdot 2 + 15^2 \cdot 60 + 20{,}9^2 \cdot 2 + 15^2 \cdot 50 + (-20{,}9)^2 \cdot 4}{188}} = 12{,}3\ Nm$$

Selecting the motor and Motor Module or power unit or converter/inverter

Selection	Proceed as follows
Motor	Determined data: n_{max} = 4000 rpm, M_{max} = 31.4 Nm, M_{rms} = 27.5 Nm for roughing M_{rms} = 12.3 Nm for finishing An appropriate motor must be selected from the torque-speed characteristics.
Motor Module, power unit, converter/ inverter	The characteristic of the selected motor includes the rated current. The Motor Module is selected according to the rated current. On the basis of the required peak torque, it must be verified whether a larger Motor Module will be needed in order to meet peak torque requirements.

Mechanical properties of the motors

3

3.1 Cooling

Hollow-shaft motors must be continually cooled independent of the duty type (S1, S6):

- Liquid cooling with water or oil (1PM4)
- Forced ventilation (1PM6)

3.1.1 Liquid cooling

For liquid-cooled motors, the cooling conditions (coolant intake temperature, liquid volume, coolant pressure) must be maintained.

The coolants must be pre-cleaned or filtered in order to prevent the cooling circuit from becoming blocked. After filtering, the max. permissible particle size may be 100 µm.

The checking and change intervals for the coolant should be agreed with the anti-corrosion agent supplier and the cooling system manufacturer.

If the direction of the coolant flow is not specified by arrows, then the intake and outlet openings can be freely selected.

Coolant intake temperature, required cooling power

In order to prevent moisture condensation, the coolant intake temperature must be higher than the ambient temperature. Recommendation: $T_{cool} \geq T_{ambient}$ -2°C

The motors are designed in accordance with EN 60034-1 for operation up to 30 °C coolant temperature, maintaining all of the motor ratings.

If the motors are operated at higher coolant intake temperatures, the derating factors in the following table must be taken into account:

Table 3-1 Derating factor for rated current and rated torque

Coolant intake temperature	≤ 30 °C	≤ 40 °C	≤ 50 °C
Derating factor	1,0	0,9	0,85

Table 3-2 Flow rate, cooling power, connection and coolant pressure

Motor type	Flow rate [l/min]	Cooling power with water [W]	Cooling power with oil [W]	Connection
1PM4101	6	1400	900	G 1/4"
1PM4105	6	2600	1500	G 1/4"
1PM4133	8	2750	1750	G 3/8"
1PM4137	8	3300	2100	G 3/8"
Maximum static coolant pressure: 0.6 MPa (6.0 bar) Pressure drop (this occurs naturally): approx 0.1 MPa (1.0 bar)				

Materials used in the cooling circuit

Bearing shield:	Cast iron
Housing:	Aluminum profile DIN EN 12020
Sealing agent:	Terostat

Heat-exchanger unit

A cooling unit (i.e. heat exchanger) must be used in order to guarantee a coolant intake temperature of 30 °C. More than one motor can be operated on a single heat-exchanger unit. The heat exchangers are not part of the motor scope of supply.

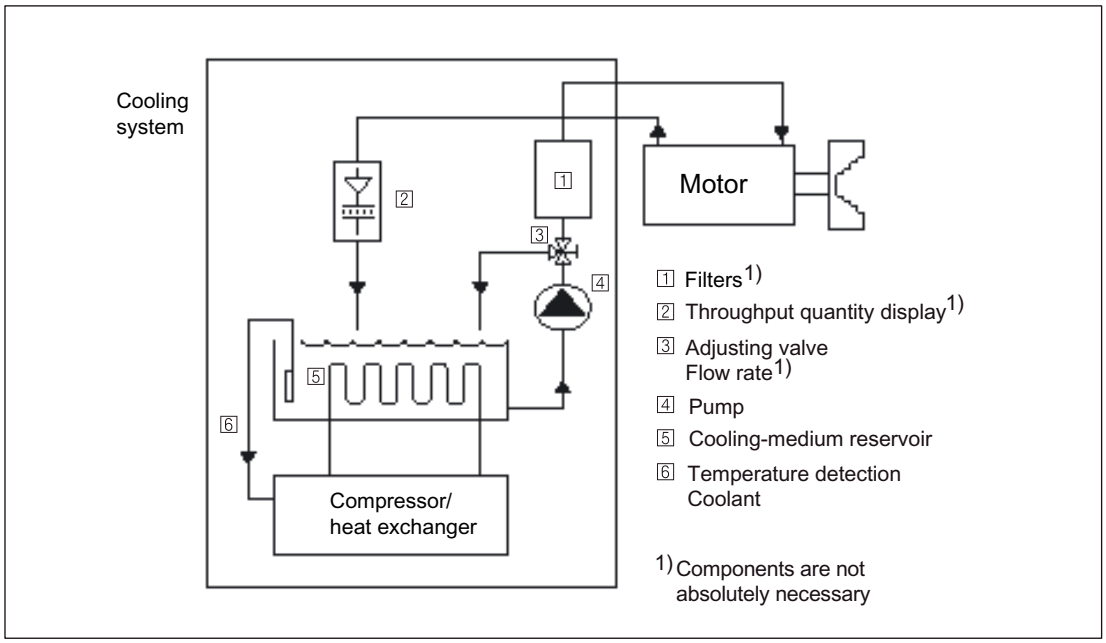


Figure 3-1 Example of a cooling circuit

The following details must be agreed with the heat exchanger manufacturer:

- Materials used in the motor cooling circuit
- Materials of the fittings and coolant hoses
- Anti-corrosion protection additives and chemical additives used

Table 3-3 Addresses of cooling system manufacturers

Company / address	Tel. / Telefax	Internet / E-mail
HYFRA PEDIA Industriekühlanlagen GmbH Industriepark 54, D-56593 Krunkel, Germany	Tel.: +49(0)2687-898-0 Fax: +49(0)2687-898-25	www.hyfra.de infohyfra@hyfra.com
BKW Kälte-Wärme-Versorgungstechnik Benzstrasse 2, D-72649 Wolfschlungen, Germany	Tel.: +49(0)7022-5003-0 Fax: +49(0)7022-5003-30	www.bkw-kuema.de info@bkw-kuema.de
KKT Kraus Industriekühlung GmbH Industriestr. 23 a, D-91207 Lauf a. d. Pegnitz, Germany	Tel.: +49(0)9123-174 01 Fax: +49(0)9123-824-41	www.ktt-kraus.com kkt@kkt-kraus.com
Glen Dimplex Deutschland GmbH Geschäftsbereich RIEDEL Kältetechnik Am Goldenen Feld 18, D-95326 Kulmbach, Germany	Tel.: +49(0)9221-709 555 Fax: +49(0)9221-709-549	www.riedel-cooling.com info@riedel-cooling.com
Schimpke Kühltechnologie Ginsterweg 25-27, D-42781 Haan, Germany	Tel.: +49(0)2129-9438-0 Fax: +49(0)2129-9438-99	www.schimpke.de info@schimpke.de
Pfannenberg GmbH Werner-Witt-Str. 1, D-21035 Hamburg, Germany	Tel.: +49(0)40-73412 127 Fax: +49(0)40-73412 101	www.pfannenberg.com werner.hille@pfannenberg.com

NOTICE

Our recommendations are provided as a guide rather than as a requirement. We cannot accept any liability for the quality and properties/features of third-party products.

3.1.2 Special information about liquid cooling

Notes on water cooling:

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

NOTICE
Non-ferrous metals (e.g. copper, zinc or brass pipes) should not be used in water cooling systems due to the formation of electrolytes. In combination with the motor materials, there is the danger of corrosion.

NOTICE
If frost can be expected while the system is non-operational, is being transported or is in storage, then a commercially available anti-freeze must be added.

Note

As a general rule, an anti-corrosion additive must be added to the cooling water. Different anti-corrosion agents should not be mixed.

The cooling water should fulfill the following prerequisites: Chemically neutral, and free of solids (tap water) For additional requirements, refer to the following table.

Table 3-4 Chemical requirements of 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
Conductivity	< 500 µS/cm
Size of any particles in the coolant	< 0.1 mm

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 are defined by the manufacturer's recommendations for the additives (refer to table) and the prevailing 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.

Manufacturers of chemical additives

Table 3-5 Manufacturers of chemical additives

Company / address	Tel. / Telefax	Internet / E-mail
Tyforop Chemie GmbH Anton-Rée-Weg 7, D-20537 Hamburg, Germany	Tel.: +49 (0)40-209497-0 Fax: +49 (0)40-615299	http:\\www.tyfo.de info@tyfo.de
Clariant Produkte Deutschland GmbH Werk Gendorf, Hr. Dr. Michael Waidelich R&D, Bau 300, 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 0660 Fax: +31 10-460 3240	http:\\www.cimcool.net info.nl@cimcool.net
FUCHS PETROLUB AG Friesenheimer Str. 17, D-68169 Mannheim, Germany	Tel.: +49 (0)621-3802-0 Fax: +49 (0)621-3803-190	http:\\www.fuchs-oil.com contact-de.fpoc@fuchs-oil.de
hebro chemie GmbH Rostocker Str. 40, D-41199 Mönchengladbach, Germany	Tel.: +49 (0)2166-6009-0 Fax: +49 (0)2166-6009-99	http:\\www.hebro-chemie.de info@hebro-chemie.de
HOUGHTON Deutschland GmbH Werkstr. 26, D-52076 Aachen-Oberforstbach, Germany	Tel.: +49 (0)2408-1406-0 Fax: +49 (0)2408-1406-20	http:\\www.houghton.de
Nalco Deutschland GmbH Steinbeisstr. 20-22, D-71691 Freiberg, Germany	Tel.: +49 (0)7141-7030 Fax: +49 (0)7141-178	http:\\www.nalco.com

Note

These recommendations are third-party products which we know to be suitable for the purpose. It goes without saying that equivalent products from other manufacturers may be used. Our recommendations are provided as a guide rather than as a requirement. We cannot accept any liability for the quality and properties/features of third-party products.

NOTICE
The motor power still does not have to be reduced for oil - water mixtures with less than 10 %.

Notes on oil cooling

The following minimum requirements must be met:

Density:	ρ	≥ 780 kg/m^3
Specific thermal capacitance:	c_p	≥ 1870 J/(kgK)
Kinematic viscosity:	v	≤ 10^{-5} m^2/s

NOTICE
If the minimum requirements cannot be met, power derating may be necessary to ensure that the motor is not operated beyond its thermal limit. Please contact the manufacturing plant for further information (see chapter "Preface", Technical Support).

3.1.3 Forced ventilation

The 1PM6 hollow-shaft motors are forced ventilated.

⚠ CAUTION
Temperatures of over 100°C can occur at the surface of the motors.

Note

For air-cooled motors, the cooling ducts, through which the ambient air flows, must be regularly cleaned depending on the degree of pollution at the installation location. These air ducts can be cleaned, e.g. using dry, oil-free compressed air.

For further information about ambient conditions, please refer to chapter "Application of motors".

Technical data for forced ventilation

Table 3-6 Technical data for forced ventilation

	Shaft height 100	Shaft height 132
Fan mounting	Non-drive end (rear of motor)	
Air flow direction	From DE to NDE	
Air discharge	Axial, fan can be rotated through 4x90 degrees	
Air flow [l/s]	40	105

Connection values of separately driven fans

Table 3-7 Supply voltage, rated current and power draw of separately driven fans

Voltage	SH 100		SH 132	
	I_N [A]	I_{max} [A]	I_N [A]	I_{max} [A]
400 V 3 AC, 50 Hz (voltage tolerance ± 10 %)	0,15	0,3	0,25	0,36
400 V 3 AC, 60 Hz (voltage tolerance ± 10 %)	0,15	0,3	0,25	0,36
480 V 3 AC, 60 Hz (voltage tolerance +6% / –10%)	0,15	0,3	0,30	0,36

Recommended connection

The fan is connected via a terminal box. The fan must be operated through motor circuit breakers. The direction of rotation of the fans must be checked.

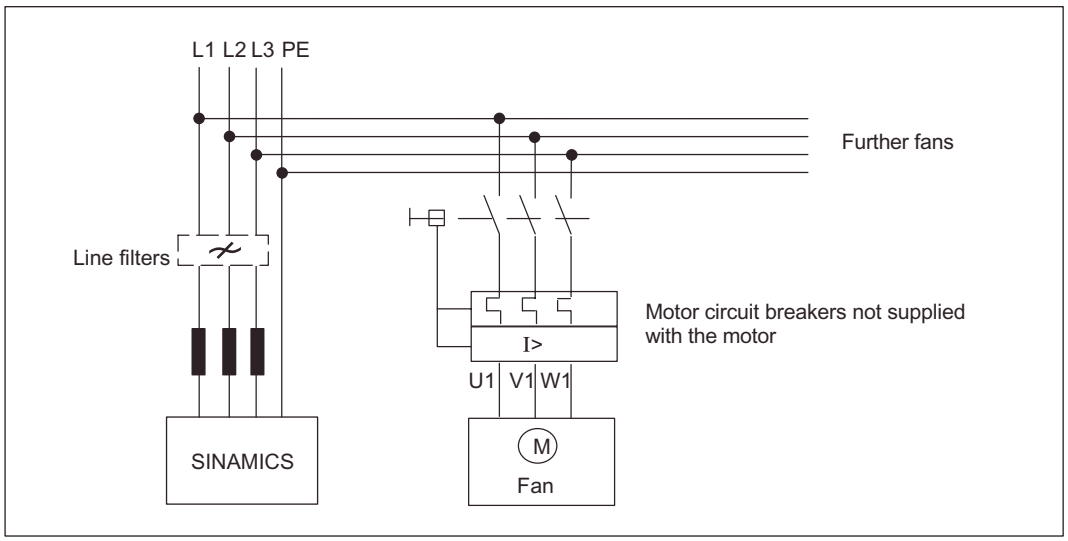


Figure 3-2 Recommended connection

Note

The motor circuit breaker must be set to value I_{max} of the fan.

3.1.4 Coolant gland

The rotary gland for the coolant must be mounted at the non-drive end shaft centering (screwed) - refer to the following diagrams.

The rotary gland is mounted carefully following the manufacturer's specifications.

- GAT (Gesellschaft für Antriebstechnik mbH)
  Schoßbergstr. 19, 65201 Wiesbaden, Germany
  Internet: www.gat-mbh.de
- DEUBLIN GmbH,
  Nassaustrasse 10, 65719 Hofheim, Germany
  Internet: www.deublin.com
- Ott-Jakob Spanntechnik GmbH
  Industriestrasse 3-7, 87663 Lengenwang, Germany
  Internet: www.ott-jakob.de

For the 1PM6 series with mounted axial fan, the fan plus the adapter must be removed to install the rotary gland. A recess/cut-out must be made in the adapter (intermediate housing) to feed in the coolant. This opening must be clean.

NOTICE
When mounting the rotary gland, it must be ensured that the thread is tightly screwed into the non-drive shaft end so that no coolant can leak.

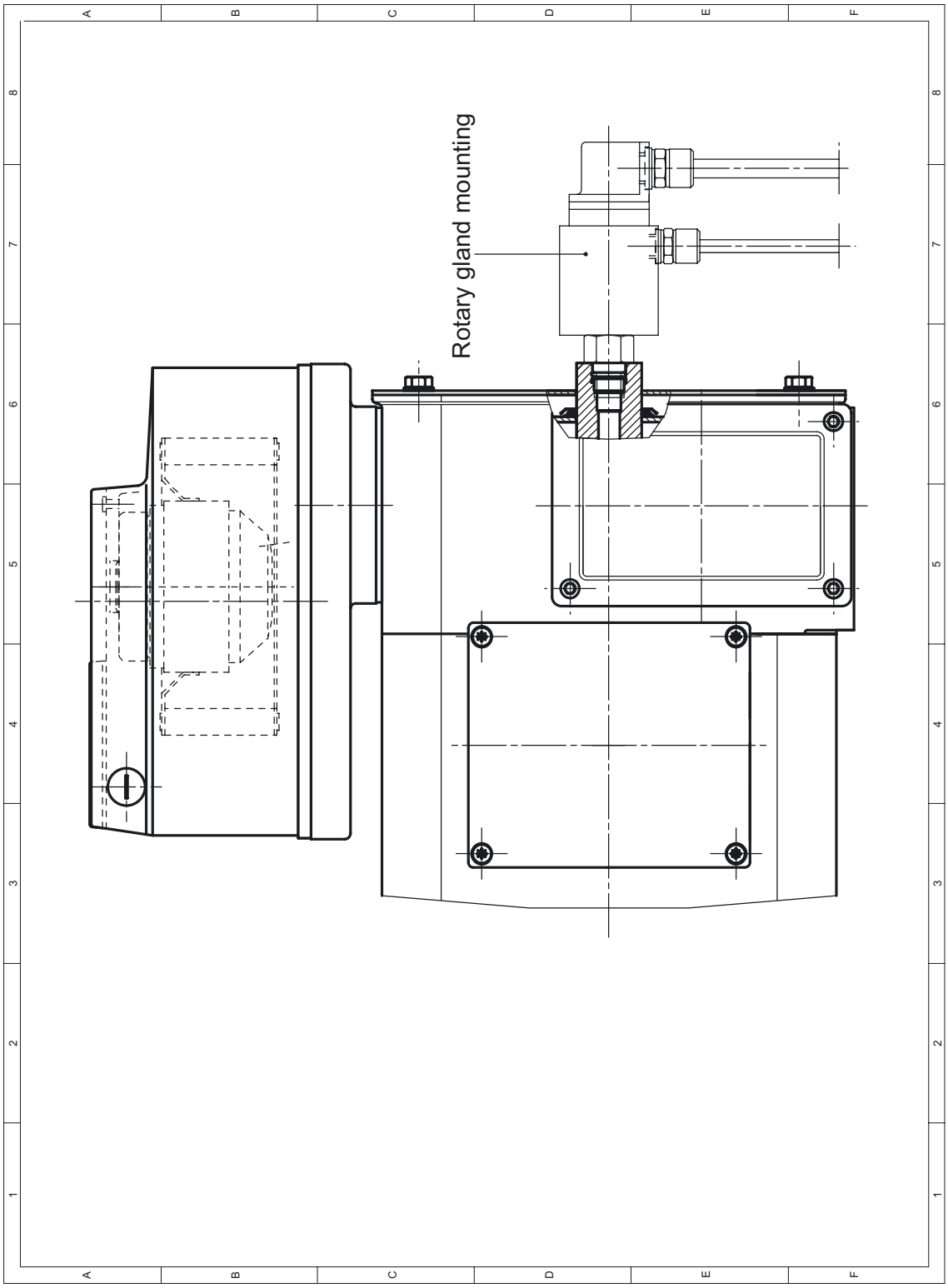


Figure 3-3 Rotary gland for 1PM6, radial fan

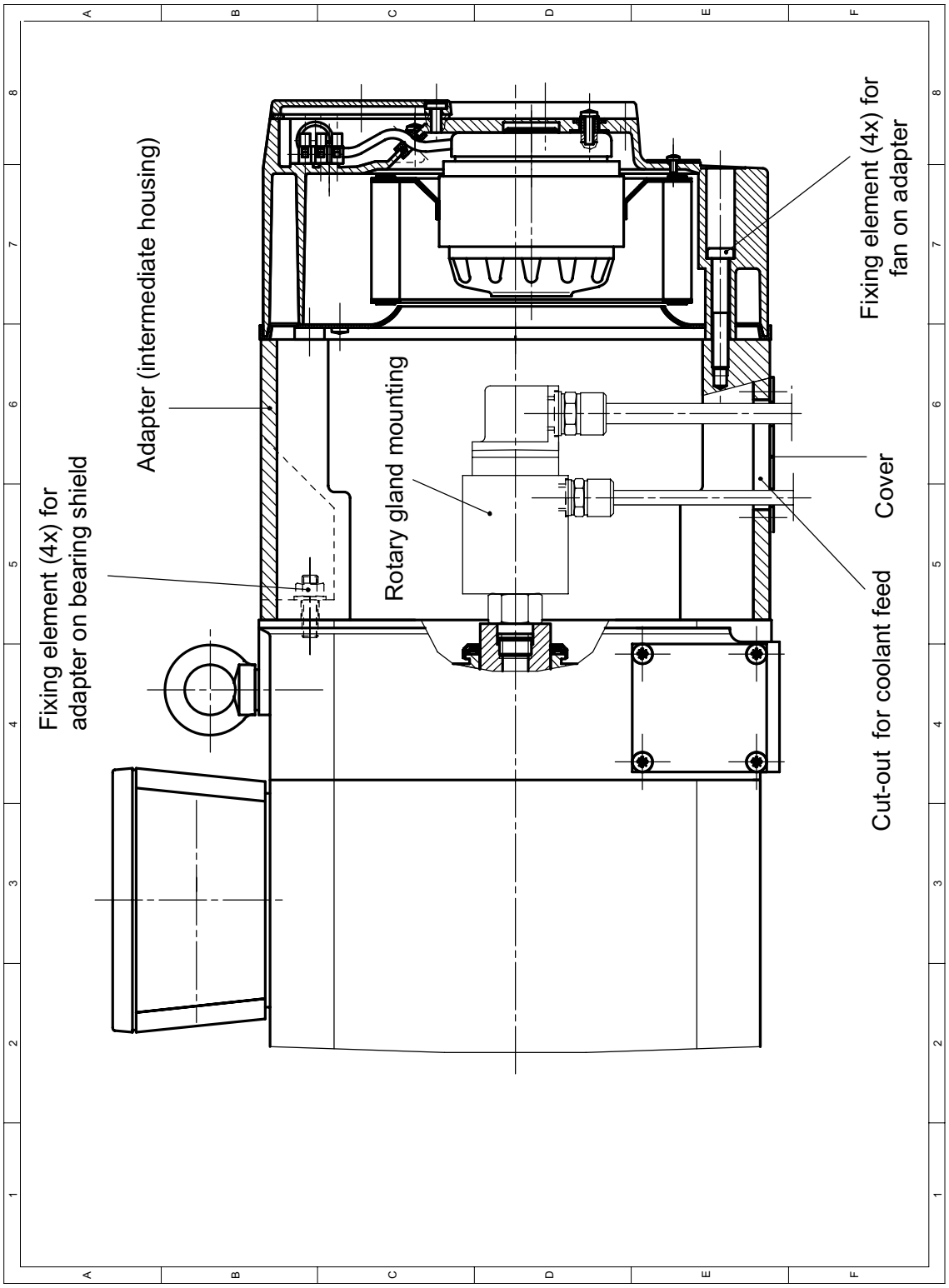


Figure 3-4 Rotary gland for 1PM6, axial fan

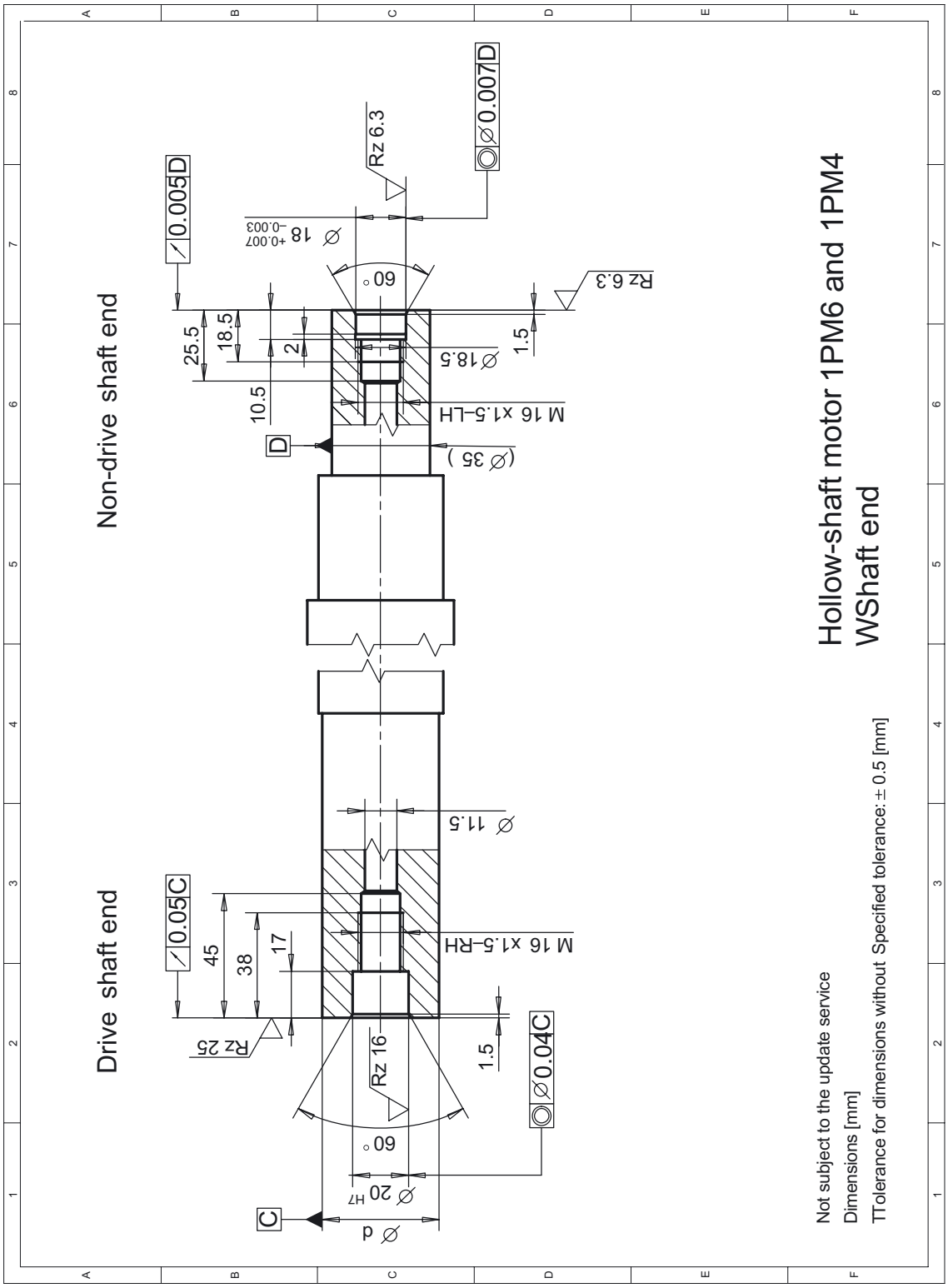


Figure 3-5 1PM6 and 1PM4, shaft end for the radial gland

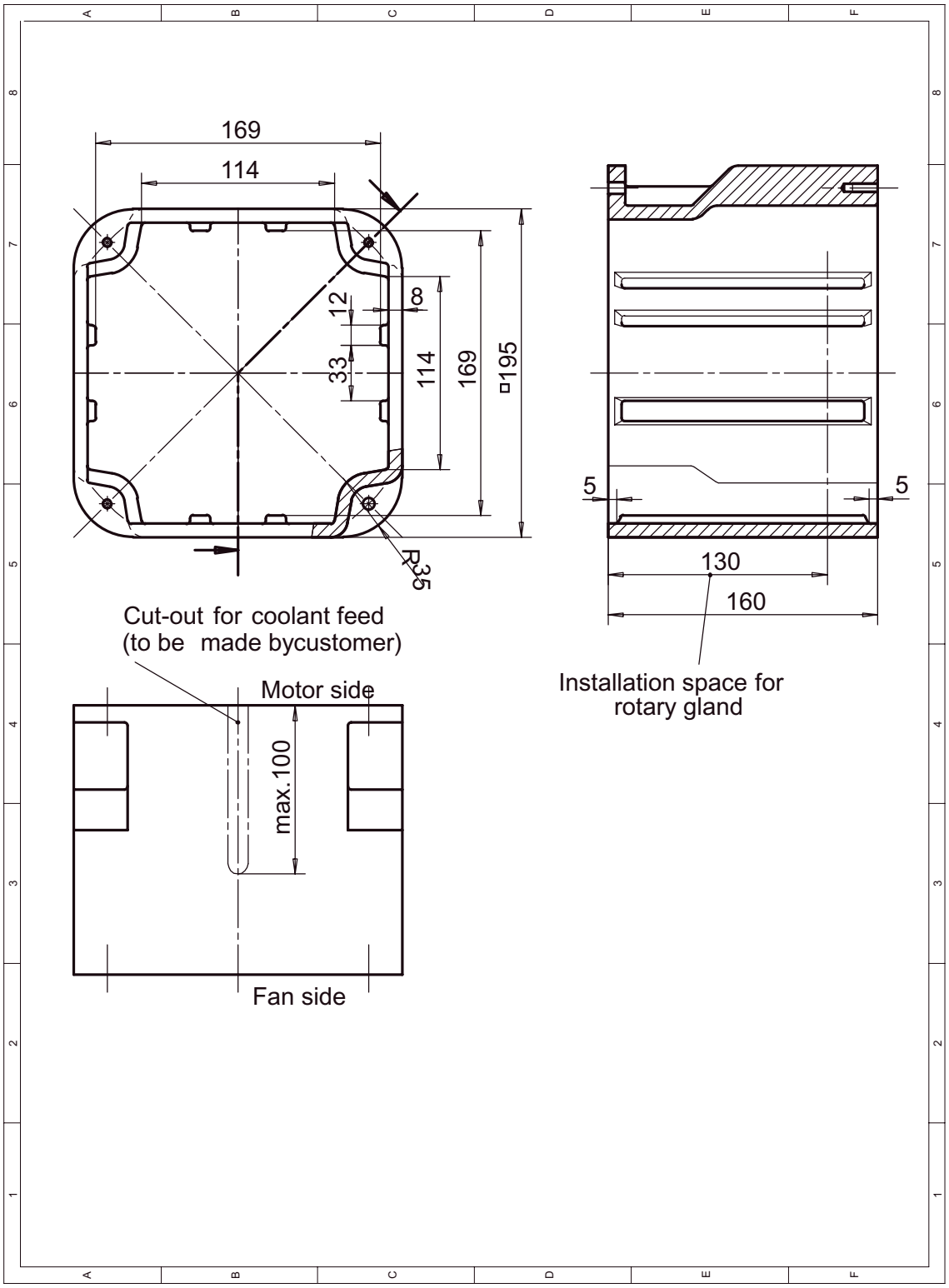


Figure 3-6 Adapter (intermediate housing) for 1PM6 10□

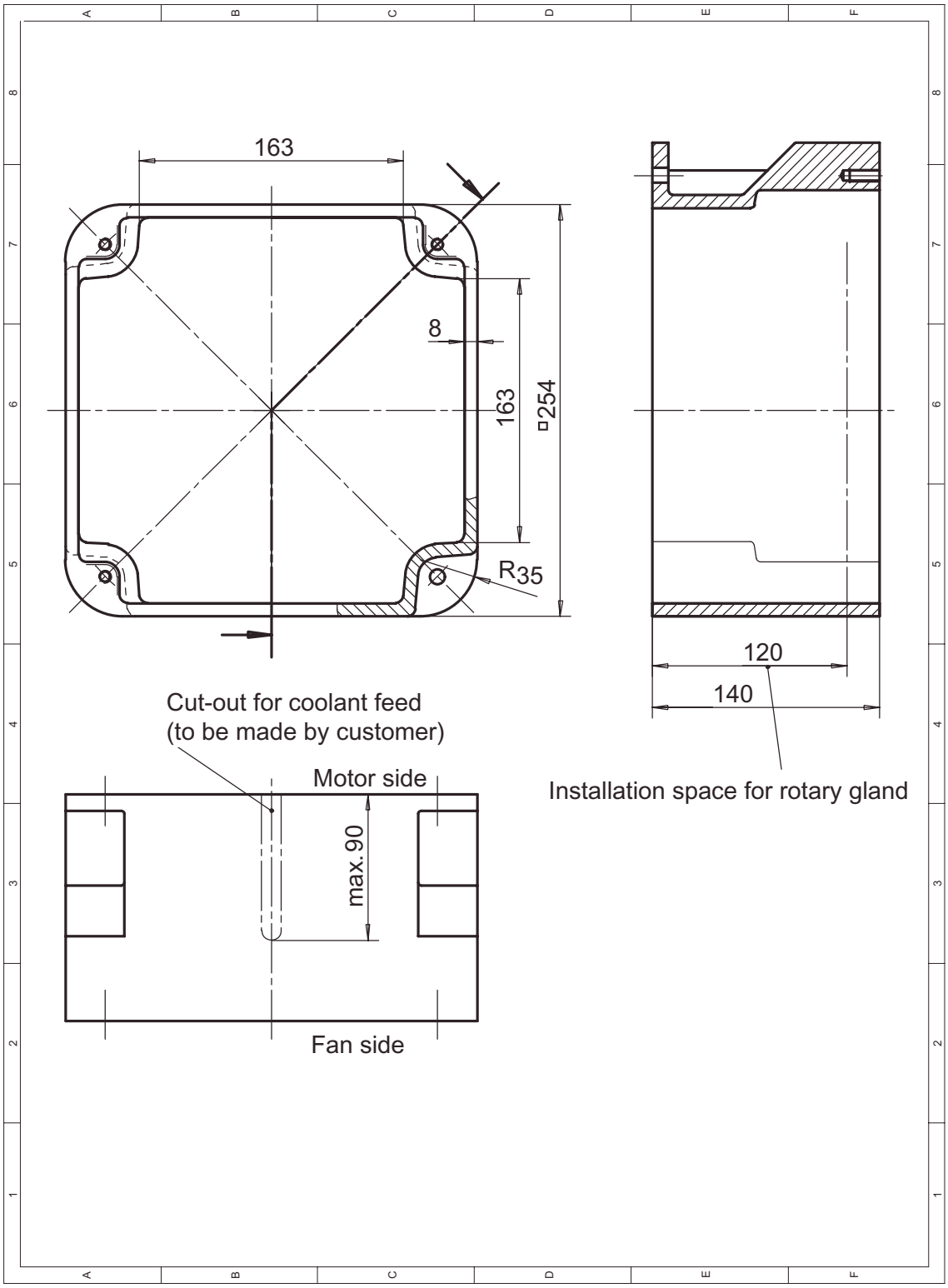


Figure 3-7 Adapter (intermediate housing) for 1PM6 13□

3.2 Degrees of protection of the motor

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
1st digit = protection against ingress of foreign bodies
2nd digit = protection against harmful 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 for the motor.

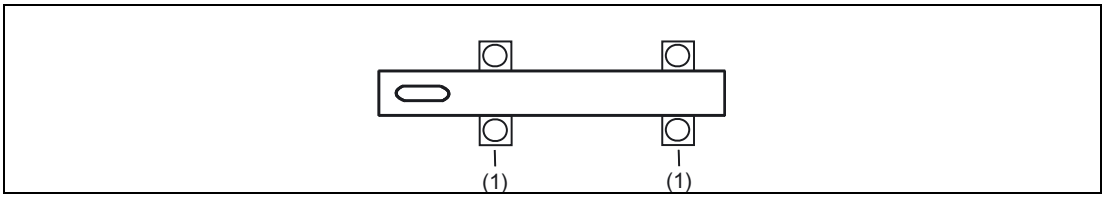
NOTICE
A permanent covering of liquid on the flange is not permitted when the motor is mounted with the shaft end facing upwards (IM V3, IM V36).

3.3 Bearing version

Bearing version for 1PM□ standard: Deep-groove ball bearings with life grease lubrication

Bearing version for 1PM□ with option L37: Spindle bearings

A drive output without any radial force is required, e.g. a coupling drive output.



Single-row (race) bearings with deep-groove ball bearings (1) or spindle bearings with option L37

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

Note

We recommend that the bearings are replaced after approx. 25000 operating hours, however, at the latest after 5 years.

Max. speed and max. continuous speed

Table 3-8 Max. speed and max. continuous speed

Motor type	Without option L37		With option L37	
	Max. speed [rpm]	Max. continuous speed [rpm]	Max. speed [rpm]	Max. continuous speed [rpm]
1PM□101	12000	12000	18000	18000
1PM□105	12000	12000	18000	18000
1PM□133	10500	10000	15000	15000
1PM□137	10500	10000	12000	12000
1PM6138	10500	10000	11000	11000

Bearing change interval t_{LW}

The value for t_{LW} in the following tables refers to the following data:

- Average operating speed n_m
- Coolant temperature of +30 °C for liquid cooling or +40 °C for forced ventilation
- Bearing temperature ≤ 85 °C
- Horizontal mounting position

Table 3-9 Bearing change interval for 1PM□ standard

Shaft height [mm]	Average operating speed n_m [rpm]	Average operating speed n_m [rpm]
100	$n_m \leq 8000$	$8000 < n_m < 12000$
132	$n_m \leq 6000$	$6000 < n_m < 10500$
t_{LW} [h]	**16000**	**8000**

Table 3-10 Bearing change interval for 1PM□ with option L37

Shaft height [mm]	Average operating speed n_m [rpm]	Average operating speed n_m [rpm]
100	$n_m \leq 12000$	$12000 < n_m < 18000$
132	$n_m \leq 10000$	$10000 < n_m < 15000$
t_{LW} [h]	**16000**	**8000**

The permissible speed n_{max} of the appropriate motor must be carefully observed.

Reducing the bearing change intervals

The bearing change intervals t_{LW} must be reduced for:

- Vertical mounting position (reduced by up to 50%)
- Operation predominantly above 75% of the limit speed n_{max}
- High vibration and surge loads
- Frequent reversing operation
- Higher bearing temperatures > +85 °C

3.4 Radial and axial forces

Radial force

In order to guarantee perfect operation, the radial force may not exceed 200 N.

Axial force

The axial force acting on the locating bearings comprises the following components:

- Operational axial force
  - Axial forces acting externally on the motor
  - Axial forces from the coolant pressure of the coolant fed through the rotary gland
- Force due to pre-loaded bearings
- Possible force due to the rotor weight when the motor is vertically mounted

This results in a maximum axial force that is a function of the direction.

⚠ CAUTION
Carefully observe the axial force as a result of the effective hydraulic diameter (surface) of the rotary gland. Force F [N] = A (surface m^2) x p (coolant pressure in N/m^2); 1 bar = 10^5 N/m^2

For axial forces in the direction of the motor, the spring-loading of the bearings can be overcome so that the rotor moves according to the axial bearing play (up to 0.2 mm). The permissible axial force F_{AZ} in operation depends on the motor mounting position.

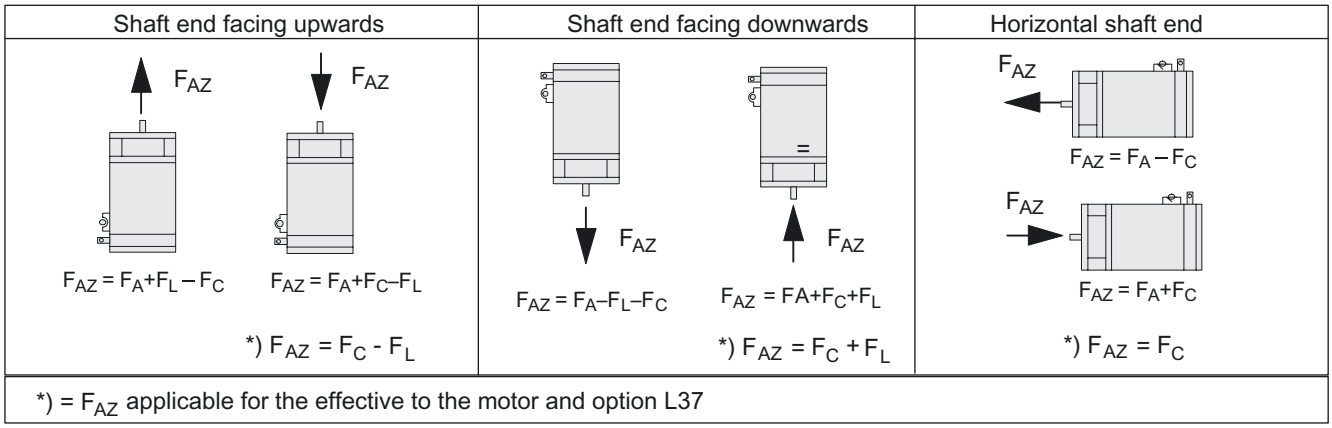


Figure 3-8 Calculating the permissible axial force acc. to the mounting position

Table 3-11 Explanation of abbreviations used:

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

Table 3-12 Max. permissible axial force FA [N] for a max. cantilever force FQ=200 N and a nominal bearing lifetime of 10000 hours

1PM□10□	Speed [rpm]	1500	3000	5000	7000	10000	12000	15000	18000
	Axial force F_A [N]	2120	1750	1510	1340	1180	1090	1020	960
1PM□13□	Speed [rpm]	1500	3000	5000	7000	10500	12000	15000	---
	Axial force F_A [N]	2320	1930	1650	1460	1310	1200	1130	---

For option L37: The perm. speed n_{max} of the appropriate motor must be carefully observed.

Table 3-13 Force due to the rotor weight FL and force due to the spring-loaded bearings FC

Motor type	F_L [N]	F_C [N]
1PM□101	100	550
1PM□105	160	550
1PM□133	235	600
1PM□137	390	600
1PM□138	455	600

3.5 Balancing

In addition to the balance quality of the motor, the vibration quality of motors with mounted couplings is essentially determined by the balance quality of the mounted component.

If the motor and mounted component are separately balanced before they are assembled, then the coupling must be balanced by the same method used to balance the motor.

Table 3-14 Balancing of mounted components

Balancing equipment/process step	Motor with plain shaft end
Auxiliary shaft to balance the mounted component	Auxiliary shaft, without key; use, if necessary, a tapered auxiliary shaft; balancing quality of the auxiliary shaft ≤ 10% of the required balancing quality of the mounted component.
Attaching the mounted component to the auxiliary shaft for balancing	Attach the component with as little play as possible, e.g. using a light press fit on the tapered auxiliary shaft.
Position of the mounted component on the auxiliary shaft for balancing	No special requirements

3.6 Smooth running, concentricity and axial eccentricity

The shaft and flange accuracies are checked according to DIN 42955, IEC 60072-1. Any specifications deviating from these values are stated on the dimension drawings.

Standard: Tolerance N

Option: Tolerance R

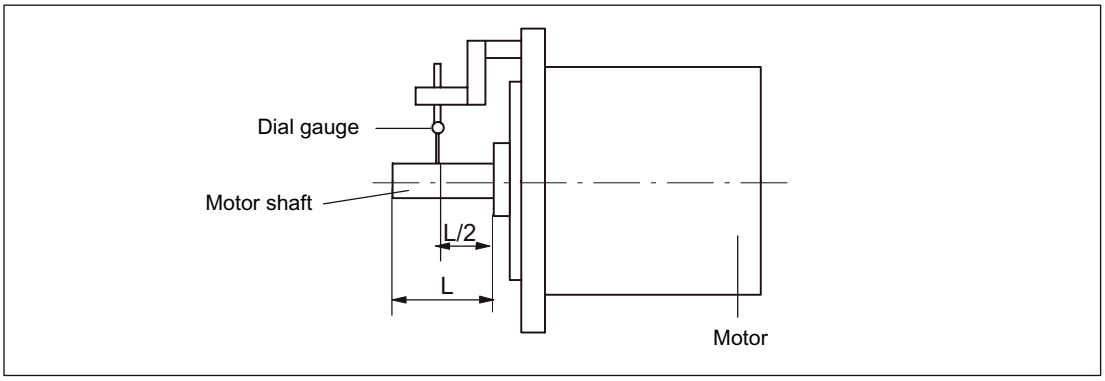


Figure 3-9 Checking the radial eccentricity

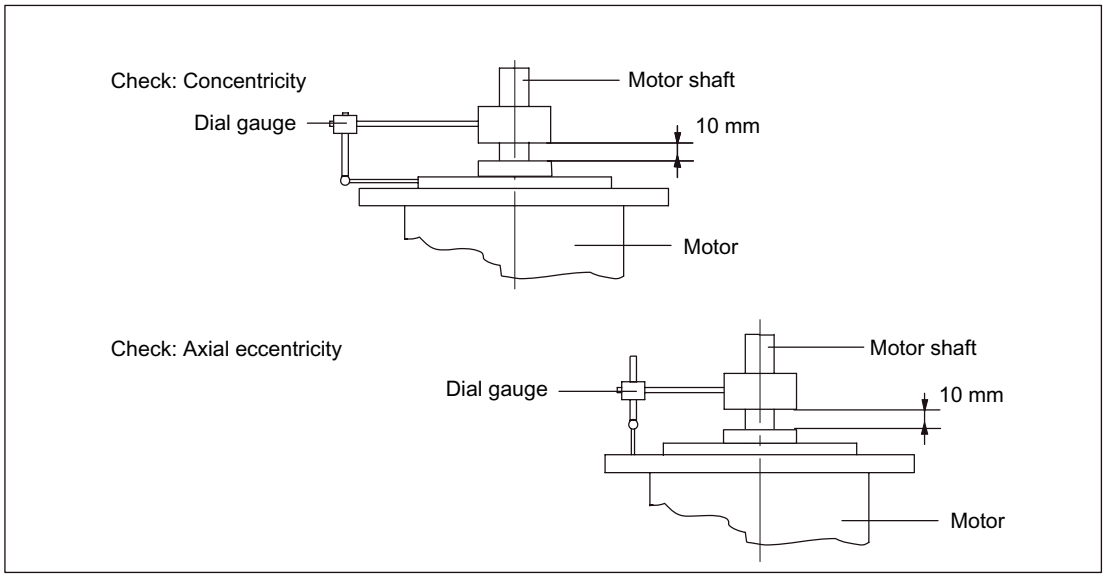


Figure 3-10 Checking the concentricity and axial eccentricity

3.7 Vibration severity grade

Vibration severity grade A (to EN 60034-14, IEC 60034-14)

The values indicated refer only to the motor. These values may increase on the motor due to the overall vibration characteristics of the complete drive installation.

The vibration complies with the severity grade up to rated speed.

The vibration severity limit values are always grade SR for series 1PM6 and 1PM4 motors. As a general rule, it is not possible to achieve a combination of high radial force load capability with high speed and high vibration quality.

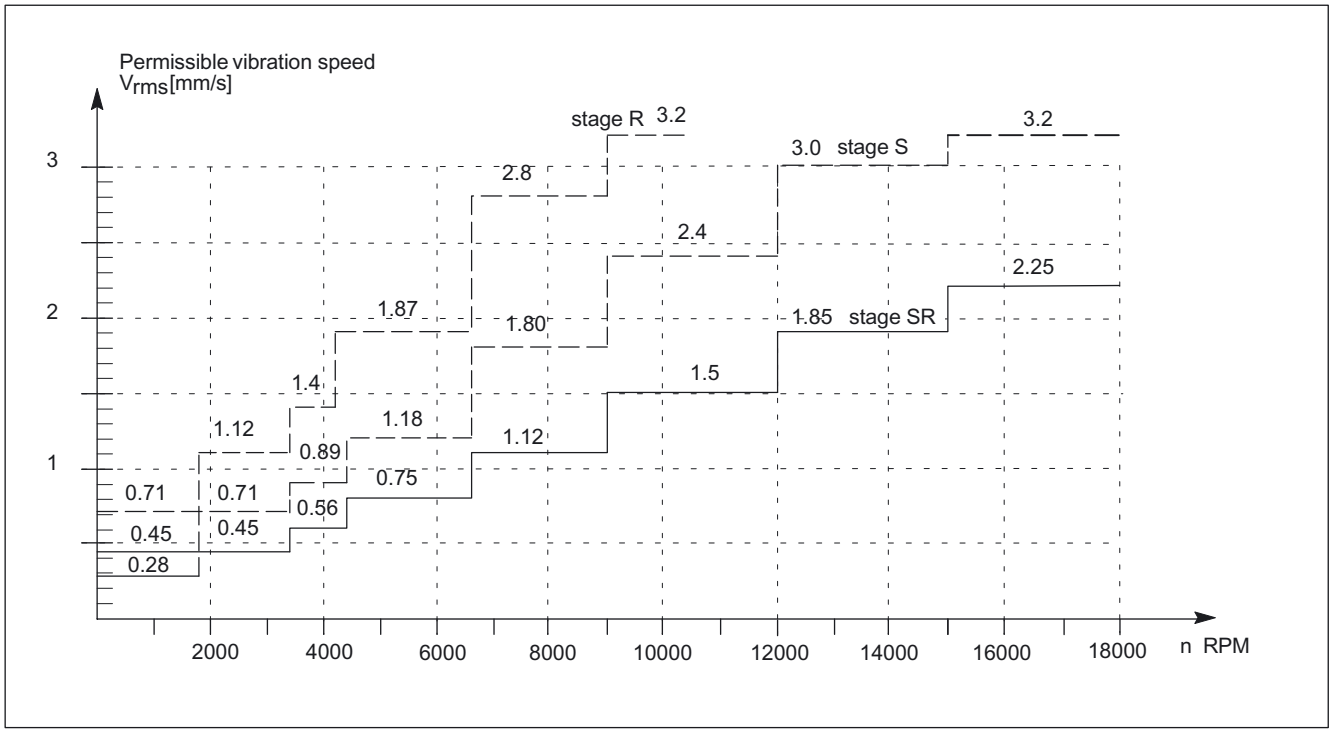


Figure 3-11 Diagram, vibration severity grade limit values, shaft heights 100 to 132

3.8 Paint finish

The motors of the 1PM series are painted as standard. Paint finish: Anthracite (similar to RAL 7016).

Technical data and characteristics

4

Torque and power characteristics

Constant-torque operation is possible from standstill up to the rated operating point. The field and therefore the motor torque remain constant in this base speed range. This is the reason that the power increases linearly with the speed.

The constant-power range, characterized by field weakening, begins from the rated operating point. In the constant power range, the maximum available torque M_{max} at a specific speed n is approximated according to the following formula:

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

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.

The field-weakening range is limited by the voltage limit. In order that safe, reliable operation is guaranteed even when the line supply voltage fluctuates and the motor parameters vary, a safety margin of 30% should always be maintained to the voltage limit at every operating point.

Note

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

P-n graph

The graphs show the typical relationship between motor speed and drive power for 1PM motors for the following duty types according to IEC 60034-1:

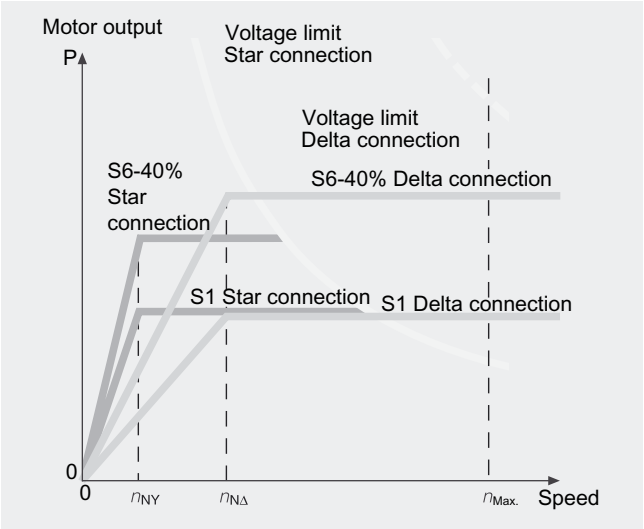


Figure 4-1 Typical P-n graph for 1PM4 oil-cooled motors with selectable star/delta connection and forced-ventilated 1PM6 motors

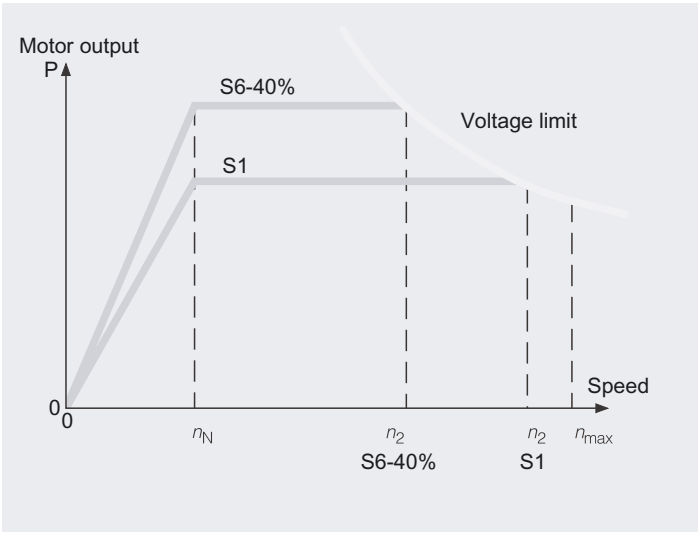


Figure 4-2 Typical P-n graph for 1PM4 water-cooled motors

Motor limits

The speed and power of induction motors are limited for thermal and mechanical [1)] reasons.

1) stress on the shaft end, bearing stress

Limitation	Description
Thermal limiting	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.
Mechanical limiting	The motor must not exceed the mechanical limit speed n_{max}.

4.1 Technical data and characteristics

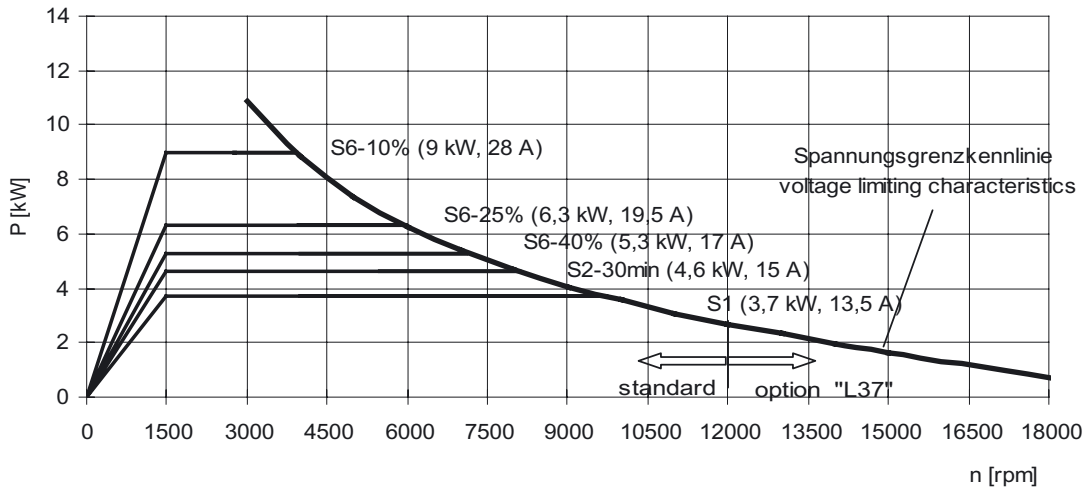
Table 4-1 Explanation of the abbreviations used

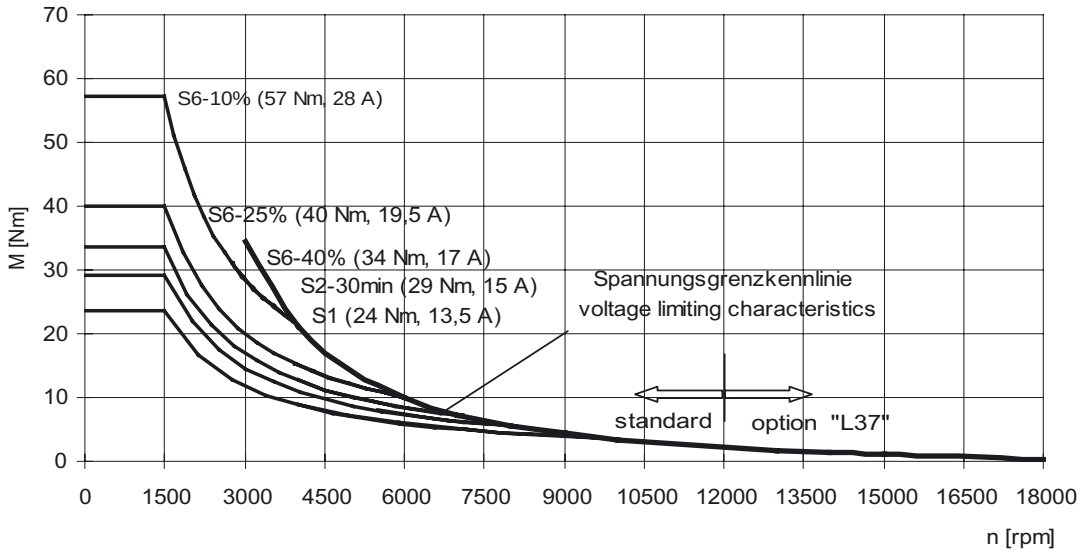
Abbreviation	Units	Description
n_N	1/min (rpm)	Rated speed
P_N	kW	Rated power
M_N	Nm	Rated torque
I_N	A	Rated current
U_N	V	Rated voltage
f_N	Hz	Rated frequency
n_2	1/min (rpm)	Speed for field weakening with constant power
n_{max}	1/min (rpm)	Maximum rotational speed
T_{th}	min	Thermal time constant
I_μ	A	No-load current
I_{max}	A	Maximum current

4.2 1PM6 force-ventilated, 1PM4 oil-cooled

Table 4-2 1PM6101 force-ventilated, 1PM4101 oil-cooled, Y circuit

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	3,7	24	13,5	278	52,7	9711	18000	25	6,8	28



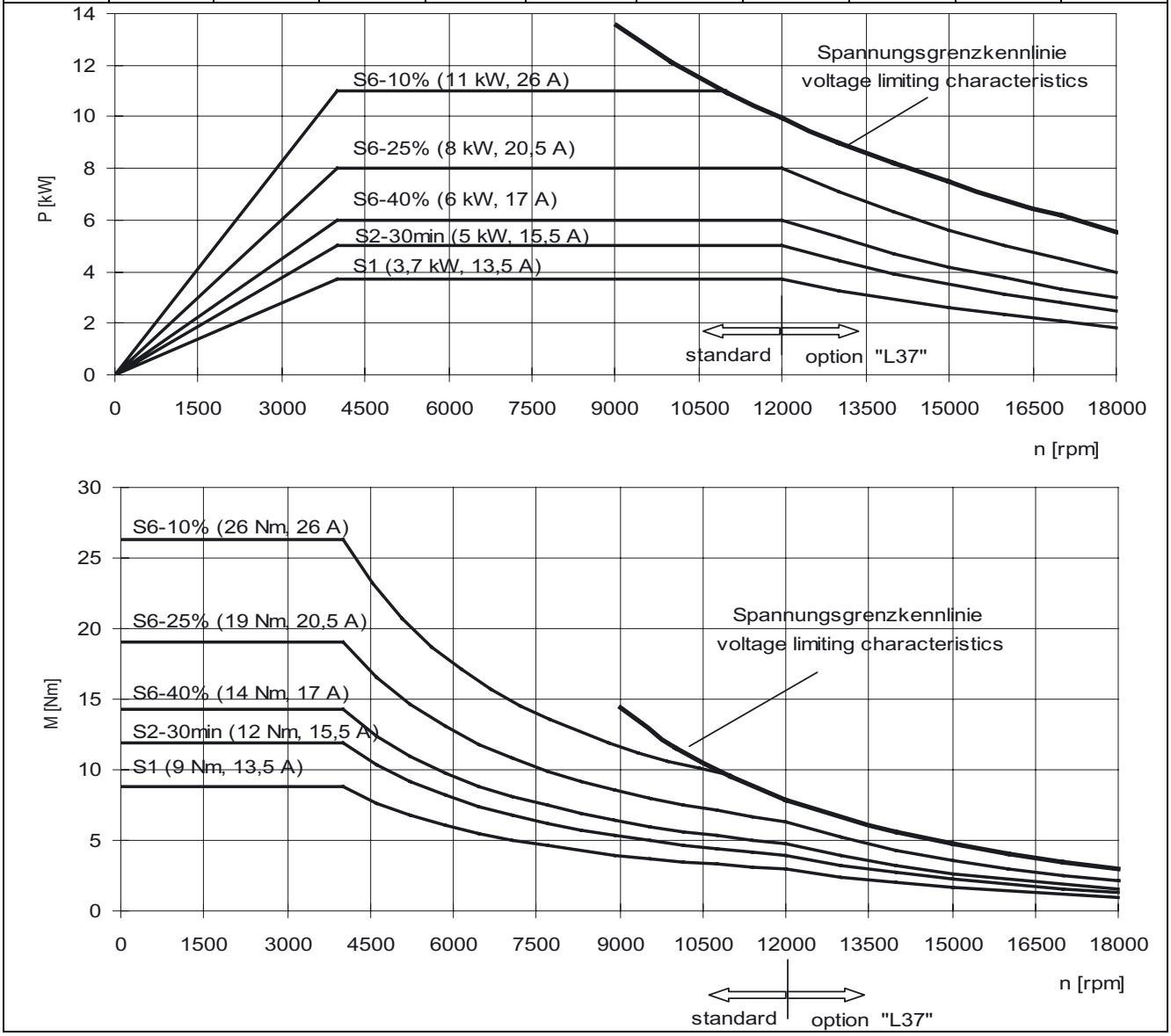


SINAMICS S120 Active Line Module, $U_{line\ rms}$ = 400 V

The characteristic curves are only valid for optimized converter setting data

Table 4-3 1PM6101 force-ventilated, 1PM4101 oil-cooled, Δ circuit

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]
4000	3,7	9	14	336	134,7	12000	18000	25	9,6	26

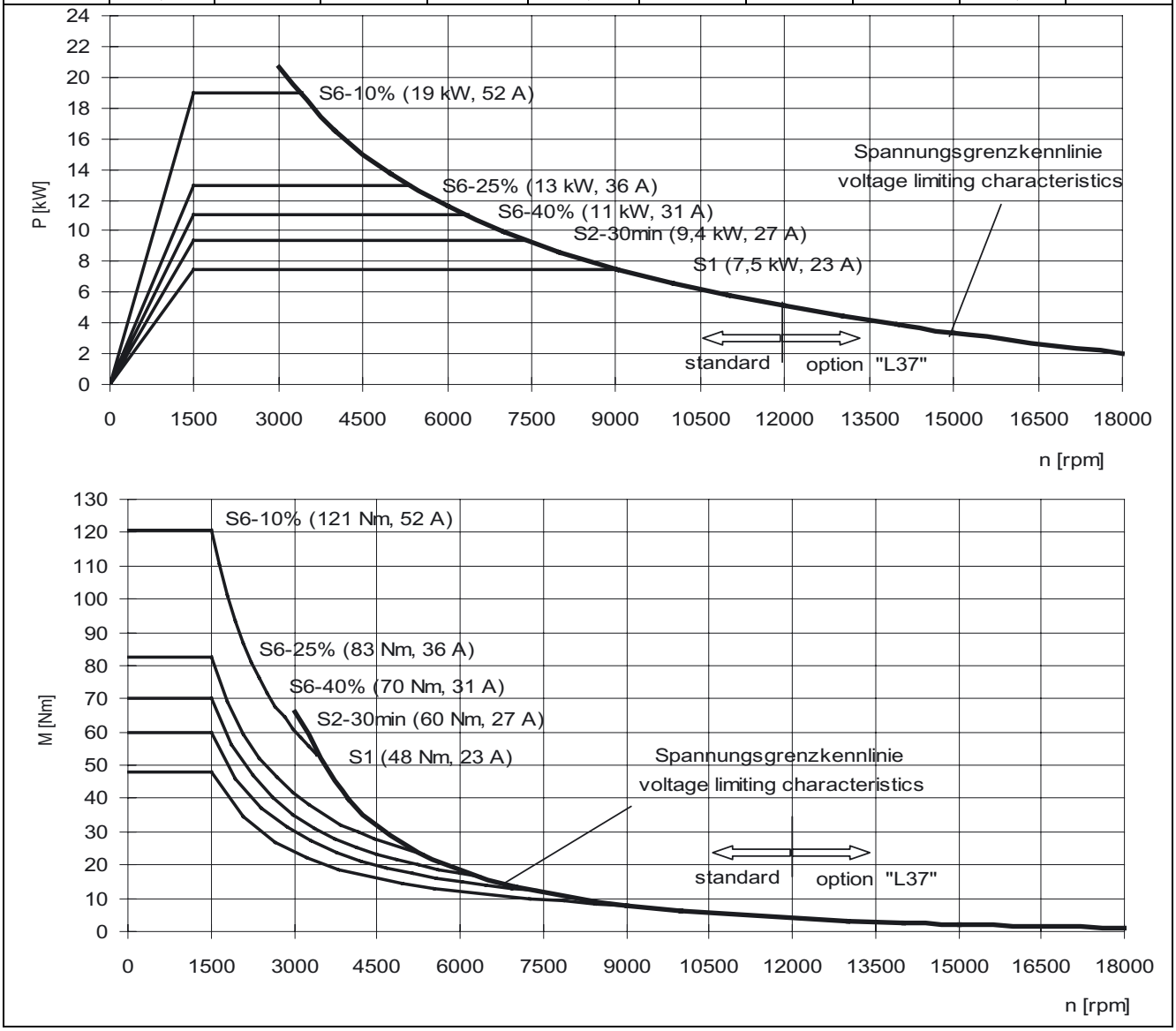


SINAMICS S120 Active Line Module, $U_{line\ rms}$ = 400 V

The characteristic curves are only valid for optimized converter setting data

Table 4-4 1PM6105 force-ventilated, 1PM4105 oil-cooled, Y circuit

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	23	300	52,2	9008	18000	25	12,3	52

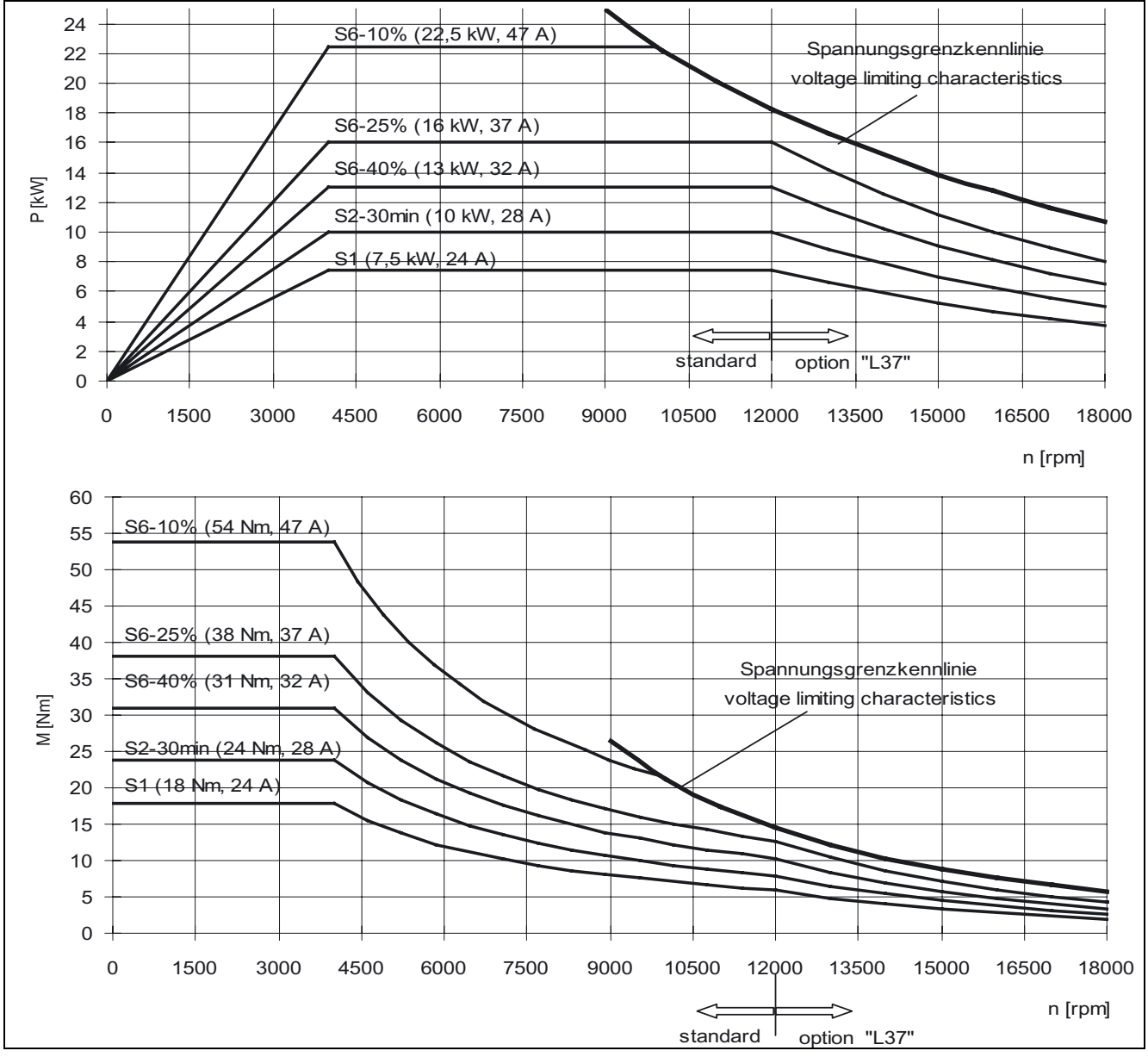


SINAMICS S120 Active Line Module, $U_{line\ rms}$ = 400 V

The characteristic curves are only valid for optimized converter setting data

Table 4-5 1PM6105 force-ventilated, 1PM4105 oil-cooled, Δ circuit

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]
4000	7,5	18	24	375	134,4	12000	18000	25	17,9	47

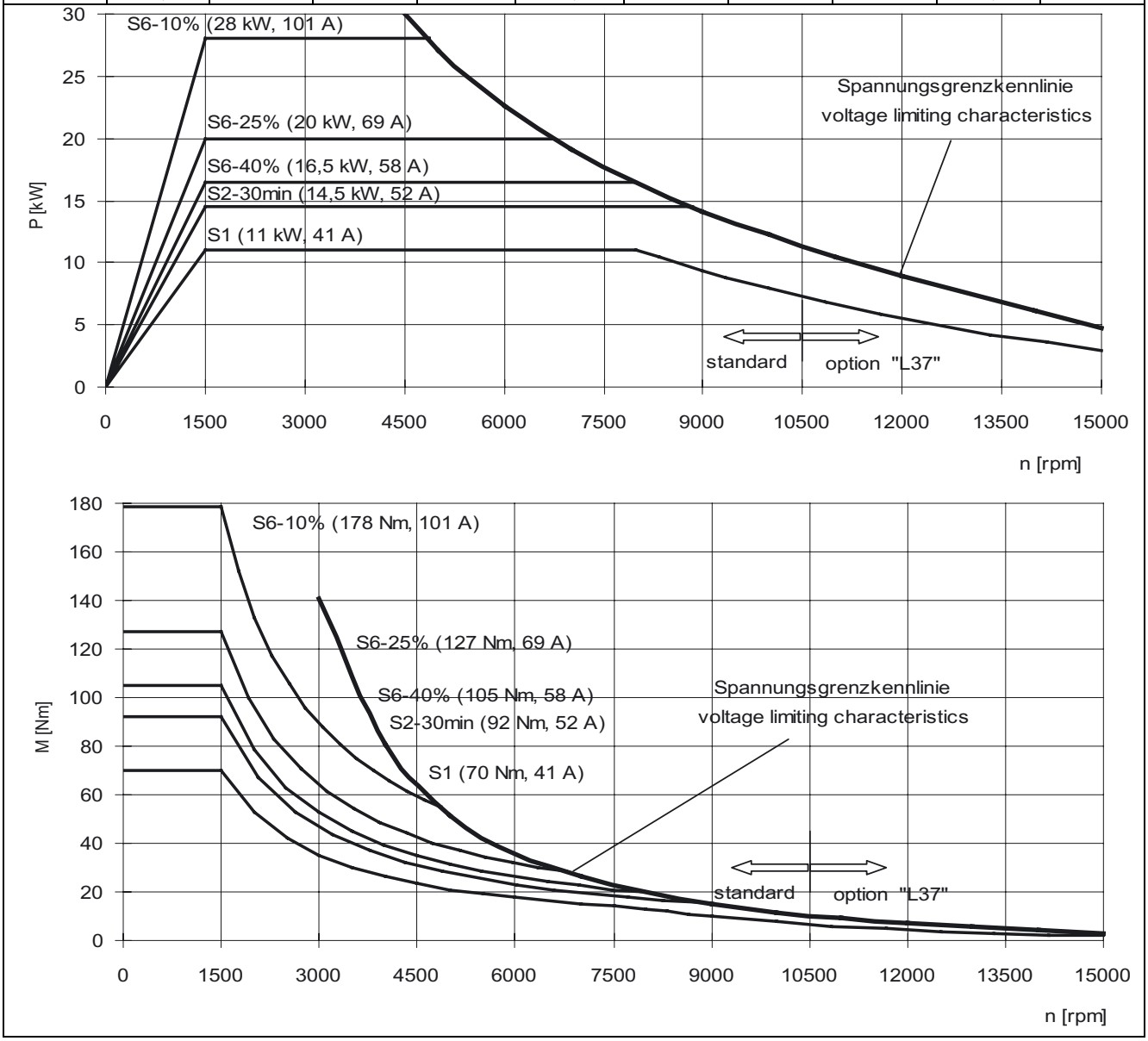


SINAMICS S120 Active Line Module, $U_{line\ rms}$ = 400 V

The characteristic curves are only valid for optimized converter setting data

Table 4-6 1PM6133 force-ventilated, 1PM4133 oil-cooled, Y circuit

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	41	222	51,4	8000	15000	30	17,0	101

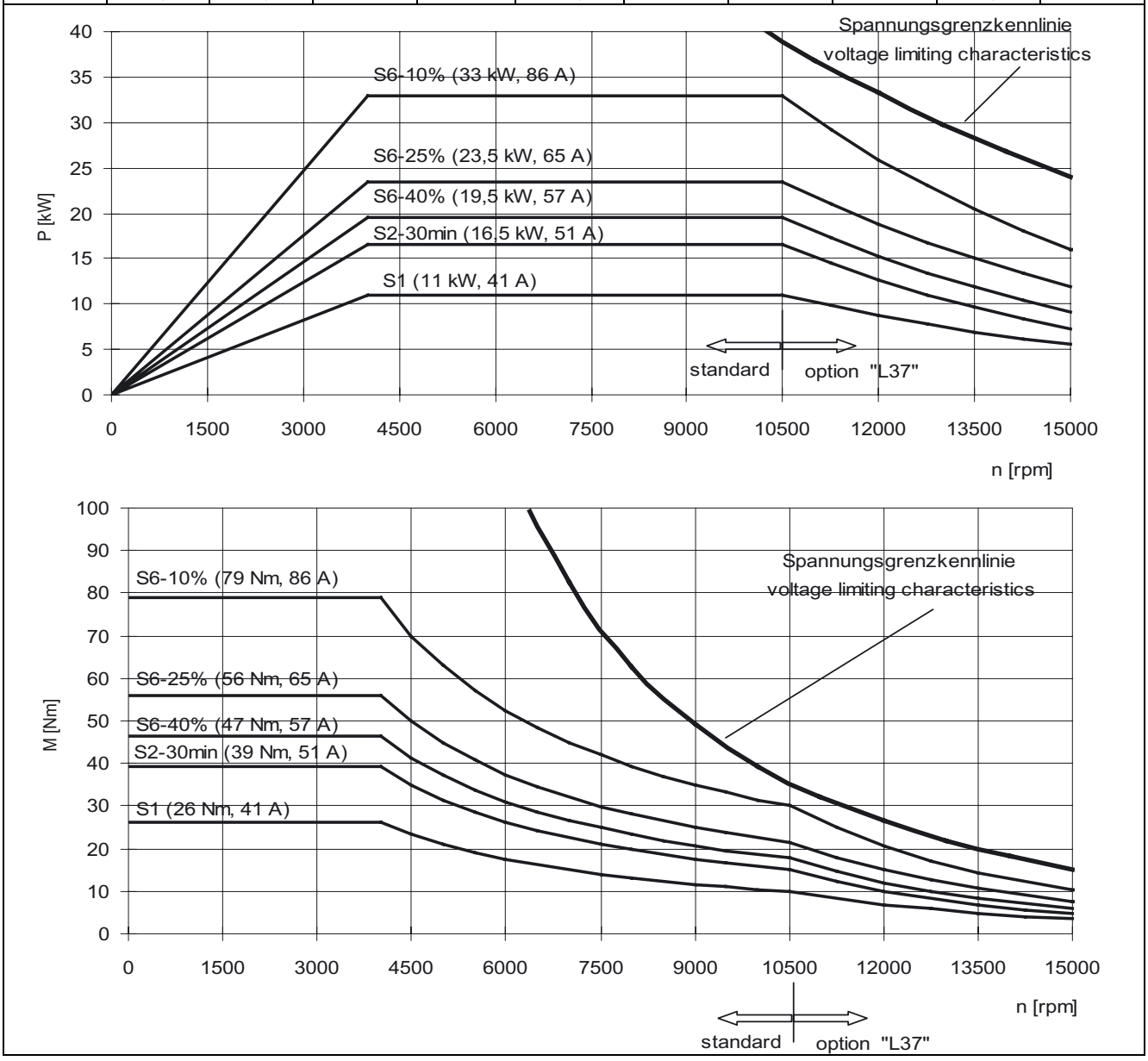


SINAMICS S120 Active Line Module, $U_{line\ rms}$ = 400 V

The characteristic curves are only valid for optimized converter setting data

Table 4-7 1PM6133 force-ventilated, 1PM4133 oil-cooled, Δ circuit

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]
4000	11,0	26,3	41	295	133,9	10500	15000	30	26,5	86

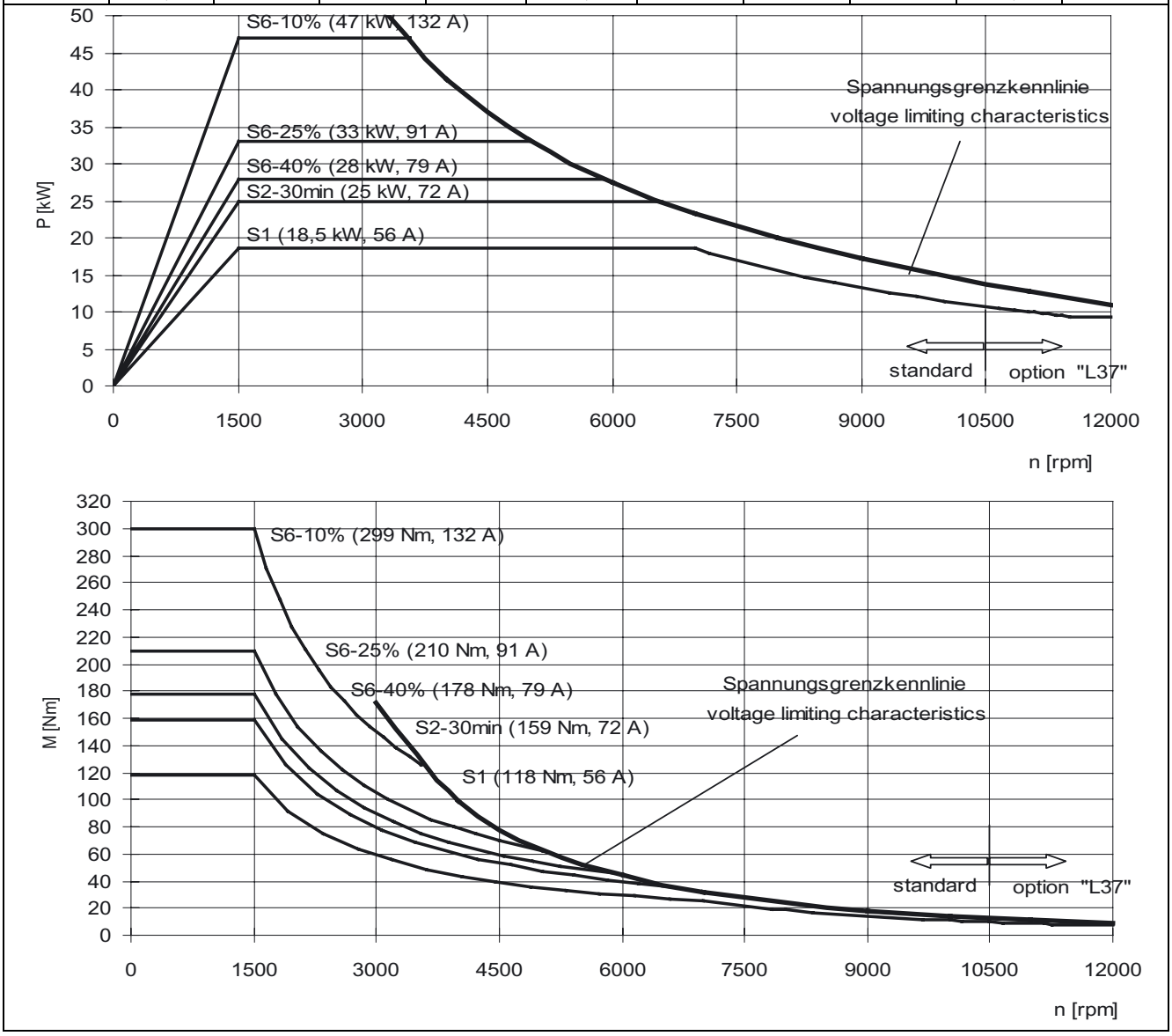


SINAMICS S120 Active Line Module, $U_{line\ rms}$ = 400 V

The characteristic curves are only valid for optimized converter setting data

Table 4-8 1PM6137 force-ventilated, 1PM4137 oil-cooled, Y circuit

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	18,5	118	56	271	51,2	7000	12000	30	24,5	132

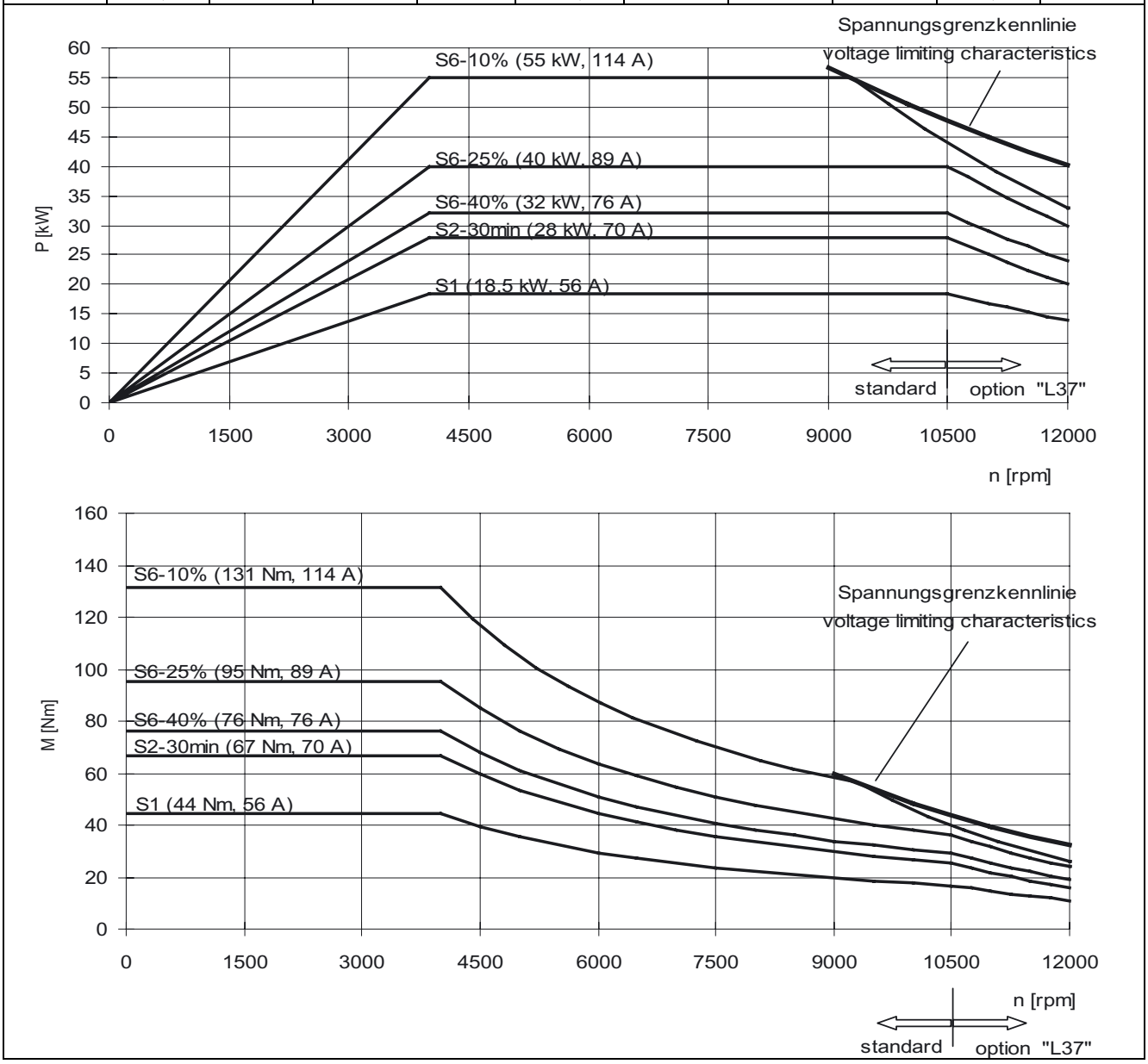


SINAMICS S120 Active Line Module, $U_{line\ rms}$ = 400 V

The characteristic curves are only valid for optimized converter setting data

Table 4-9 1PM6137 force-ventilated, 1PM4137 oil-cooled, Δ circuit

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]
4000	18,5	44	56	366	133,8	10500	12000	30	37,0	114

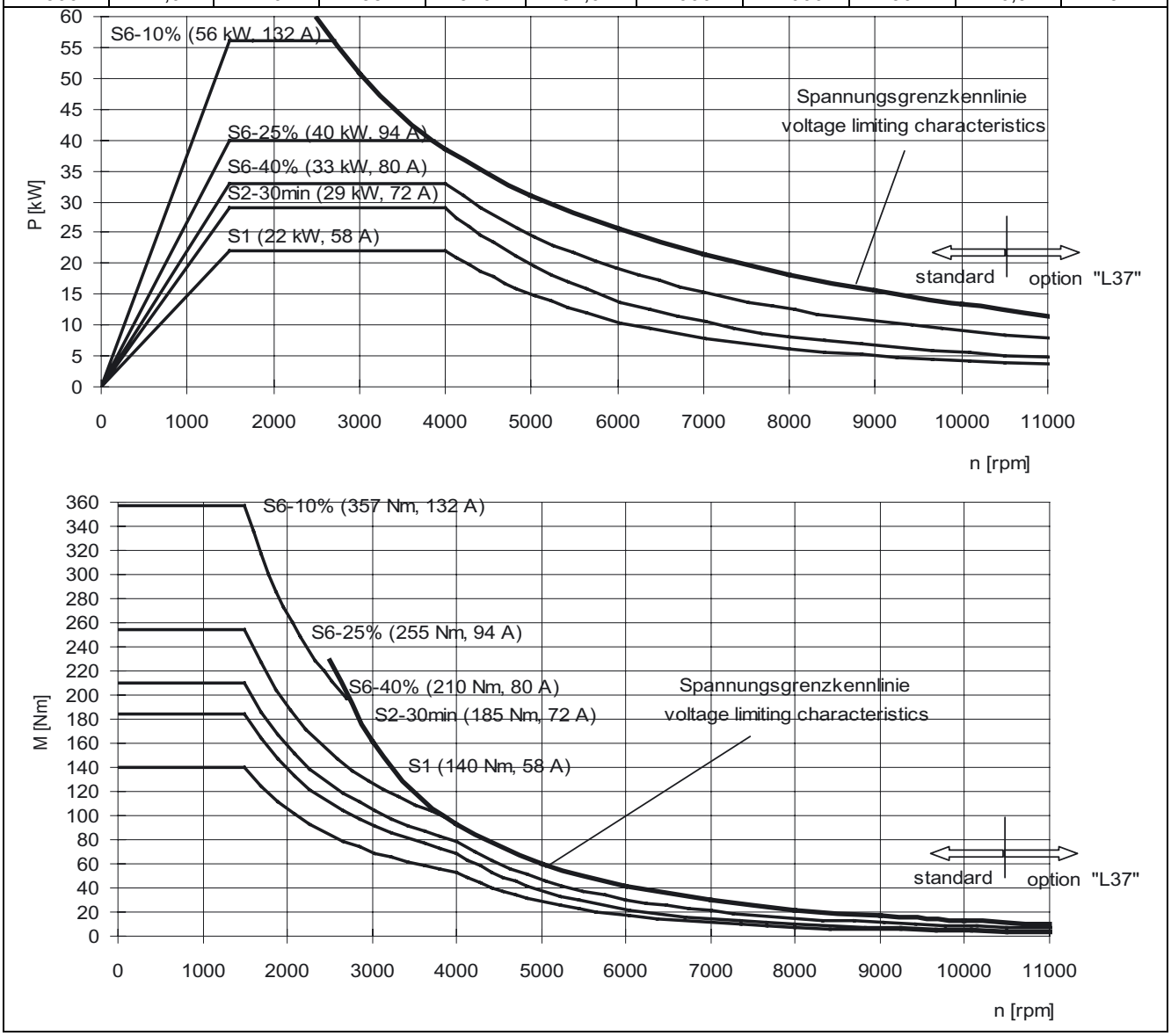


SINAMICS S120 Active Line Module, $U_{line\ rms}$ = 400 V

The characteristic curves are only valid for optimized converter setting data

Table 4-10 1PM6138 force-ventilated, Y circuit

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	58	316	51,0	4000	11000	30	26,9	132

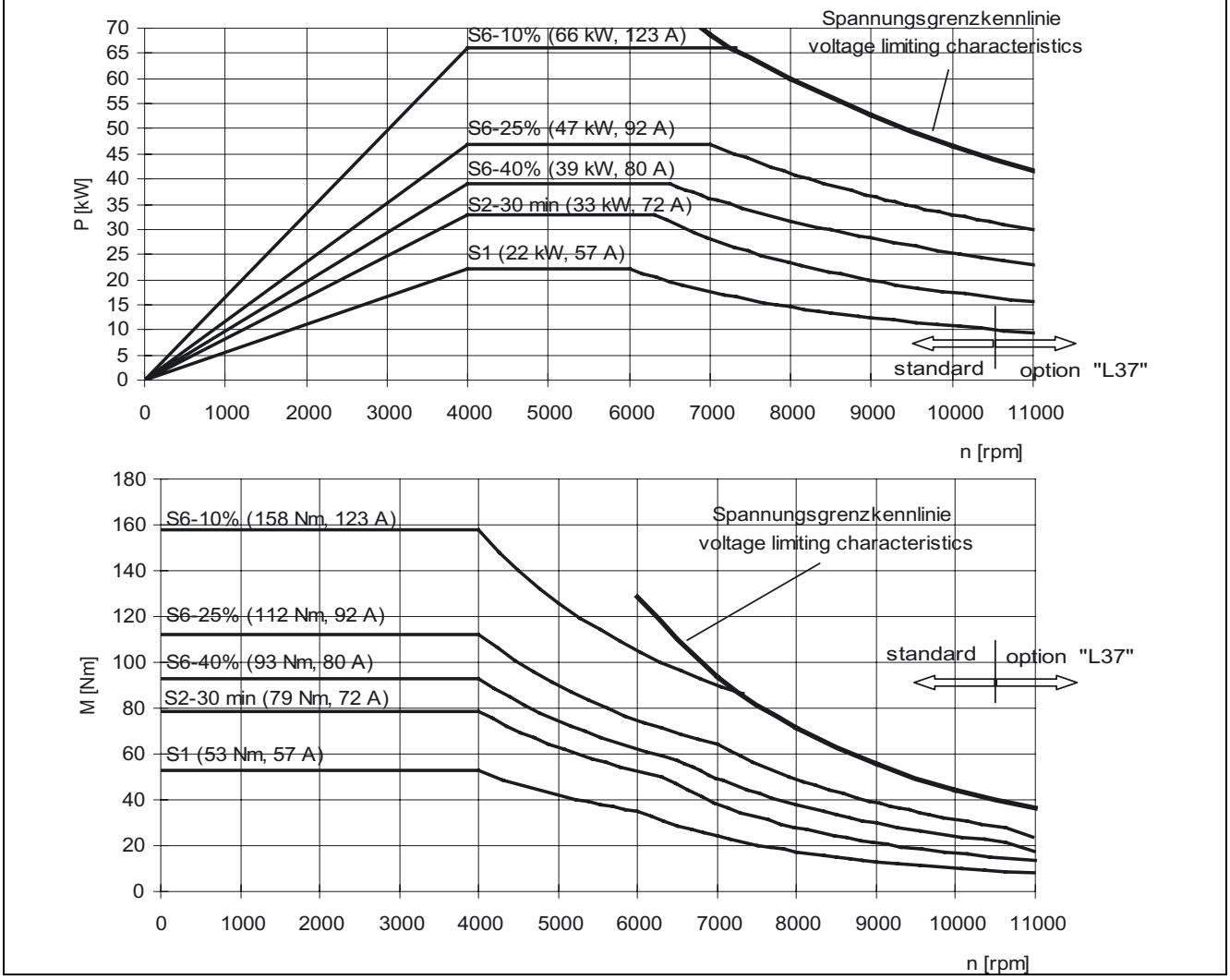


SINAMICS S120 Active Line Module, $U_{line\ rms}$ = 400 V

The characteristic curves are only valid for optimized converter setting data

Table 4-11 1PM6138 force-ventilated, Δ circuit

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]
4000	22,0	53	57	400	133,9	6000	11000	30	36,1	123



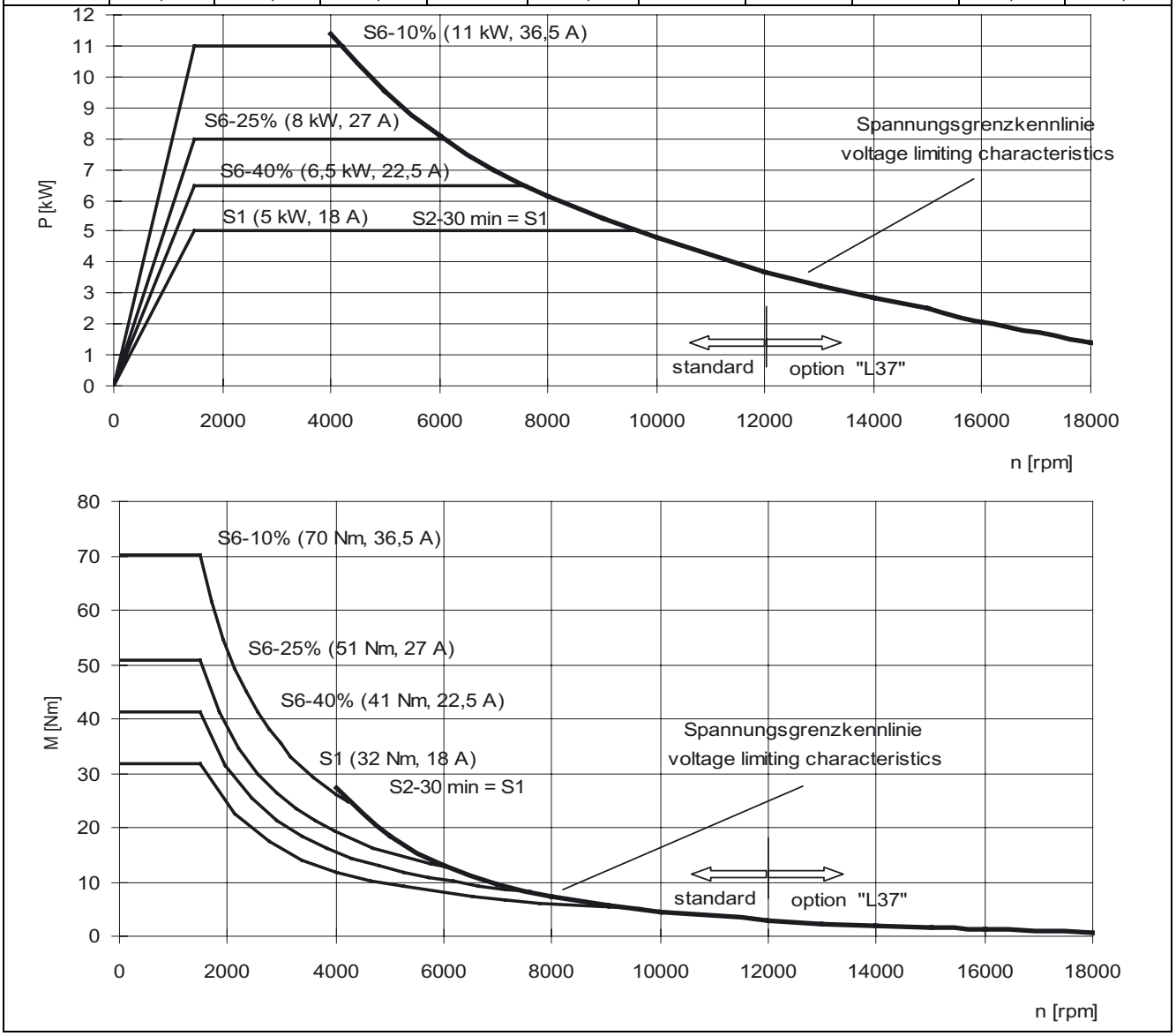
SINAMICS S120 Active Line Module, $U_{line\ rms}$ = 400 V

The characteristic curves are only valid for optimized converter setting data

4.3 1PM4 water-cooled

Table 4-12 1PM4101 water-cooled, Y circuit

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	5,0	32,0	18,0	259	53,6	9665	18000	6	8,1	36,5

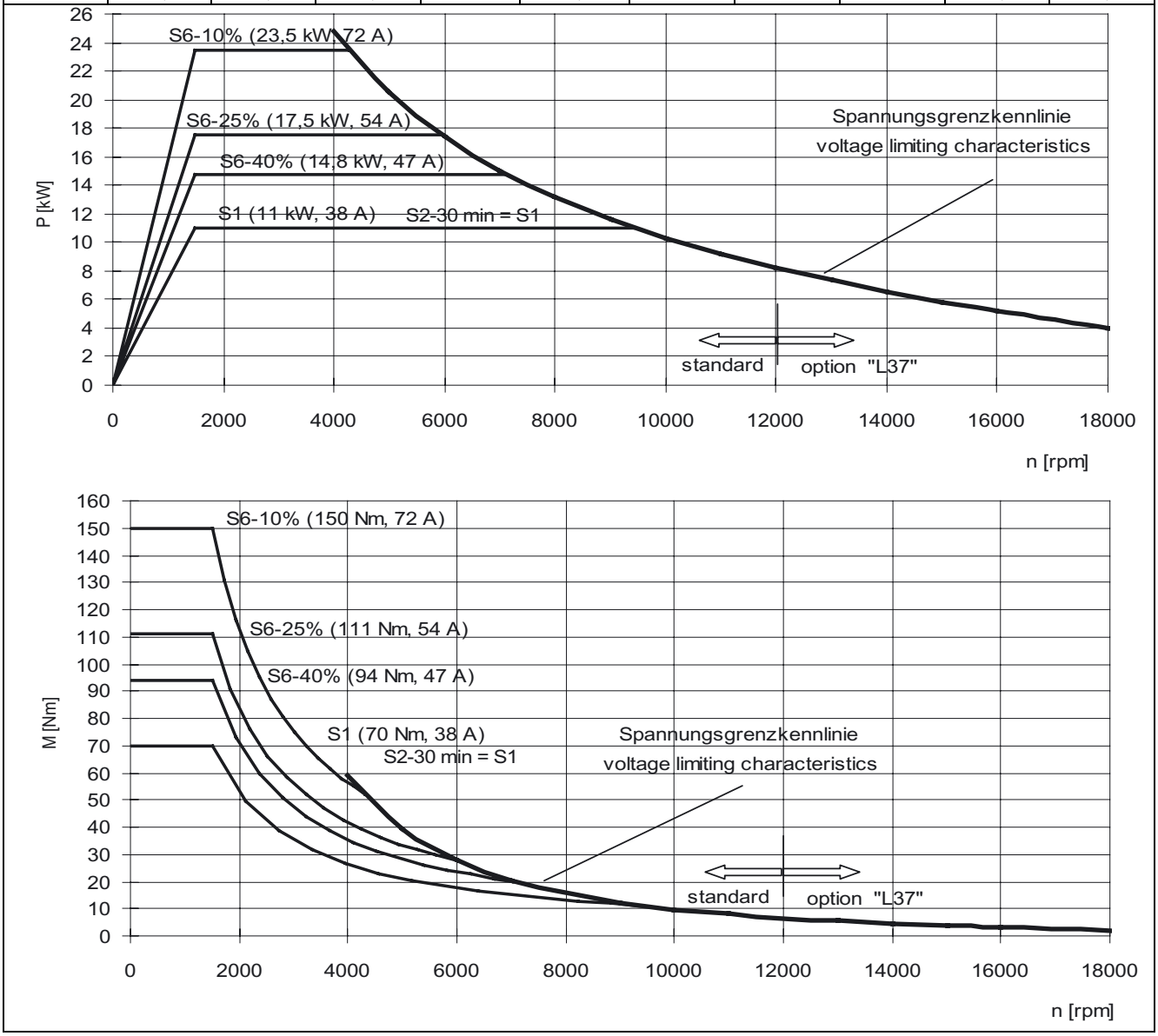


SINAMICS S120 Active Line Module, $U_{line\ rms}$ = 400 V

The characteristic curves are only valid for optimized converter setting data

Table 4-13 1PM4105 water-cooled, Y circuit

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	9460	18000	6	16,4	72,0

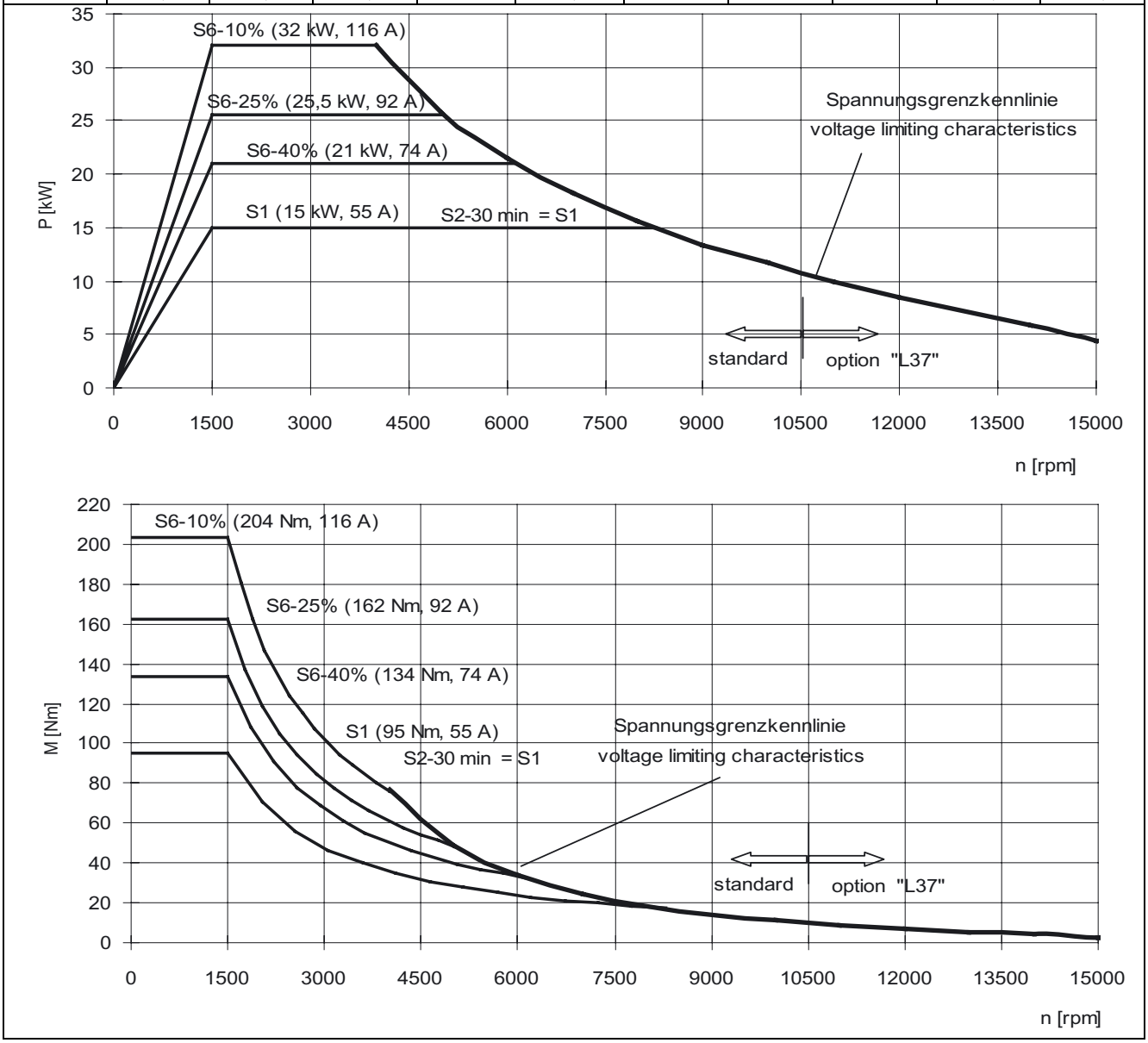


SINAMICS S120 Active Line Module, $U_{line\ rms}$ = 400 V

The characteristic curves are only valid for optimized converter setting data

Table 4-14 1PM4133 water-cooled, Y circuit

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	95,5	55,0	229	51,9	8290	15000	11	17,4	116,0

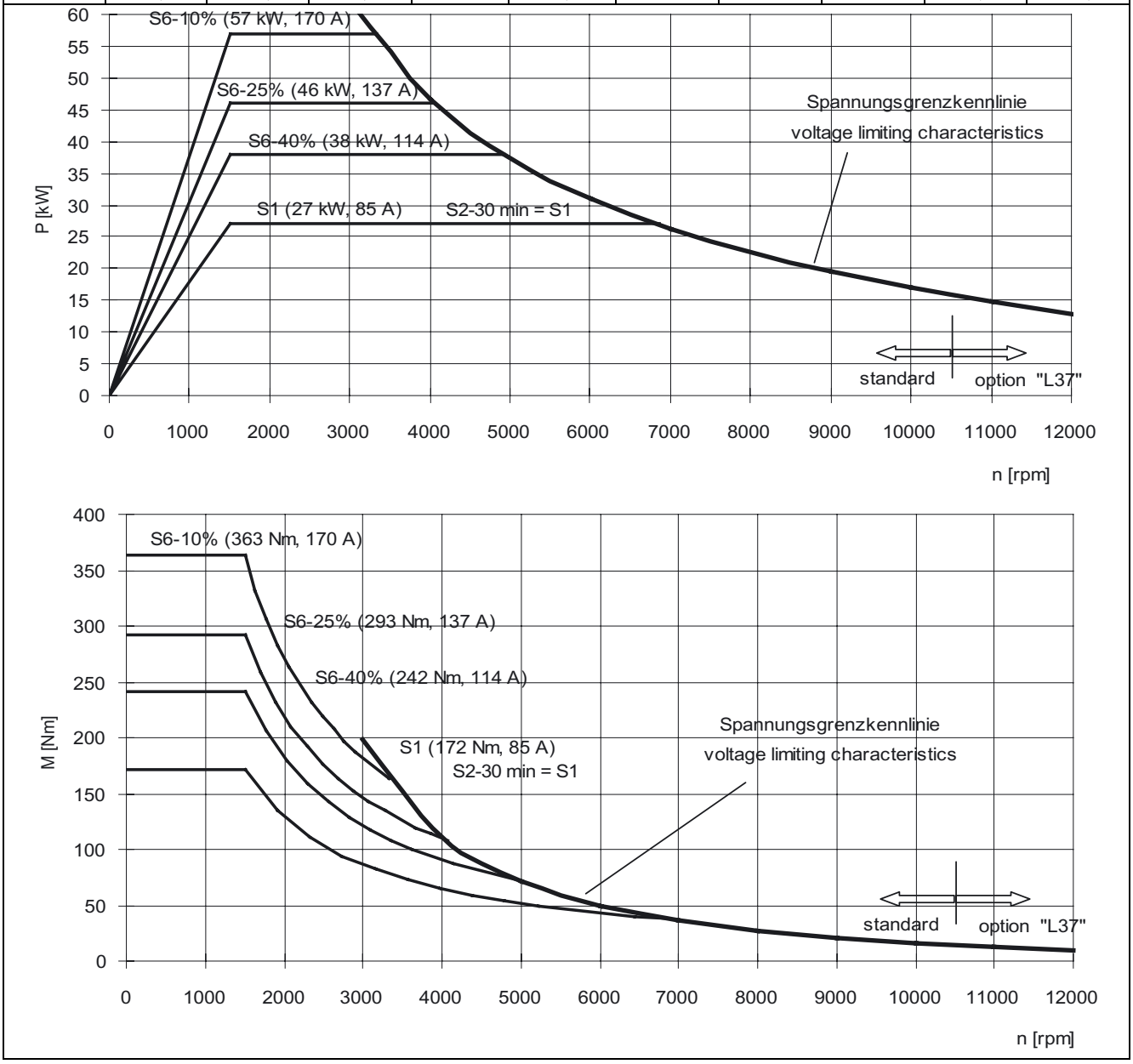


SINAMICS S120 Active Line Module, $U_{line\ rms}$ = 400 V

The characteristic curves are only valid for optimized converter setting data

Table 4-15 1PM4137 water-cooled, Y circuit

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	6863	12000	11	30,3	170,0



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

The characteristic curves are only valid for optimized converter setting data

4.4 Dimension sheets

CAD CREATOR

The CAD CREATOR provides a user-friendly interface which helps you to find product-specific data quickly and supports you in generating plant documentation containing project-specific information.

Benefits

- Multilingual operator interface in English, French, German, Italian and Spanish included
- Dimension sheets with measurements in mm or inches
- Dimension sheets and 2D/3D CAD data for
  - 1FT7 Compact / 1FT6 / 1FK7 synchronous motors
  - 1PH7/1PH4/1PM4/1PM6 asynchronous motors
  - 1FT6/1FK7/1FK7-DYA geared motors
  - 1FW3 torque motors
  - 1FE1 built-in motors

The CAD CREATOR provides you with various options to begin with product configuration:

- Order number
- Order number search
- Geometric data

Once a product is successfully configured, the product-specific information, such as dimension drawing and 2D/3D CAD data are displayed and made available for storing in various formats, e.g.: *.pdf, *.dxf, *.stp oder *.igs.

The CAD CREATOR is available on CD-ROM and as an Internet application.

Additional information is available in the Internet under:

http://www.siemens.com/cad-creator

How up-to-date are the dimension drawings

Note

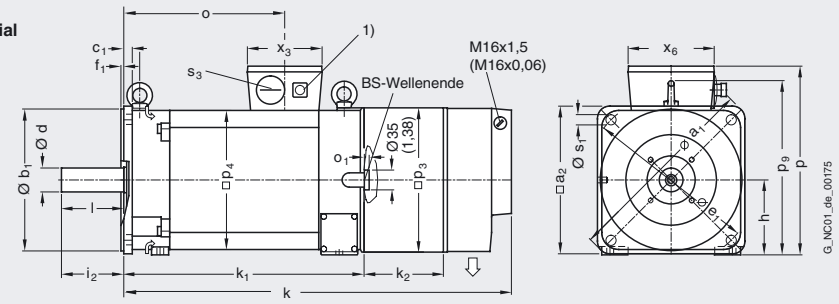
Siemens AG reserves the right to change the dimensions of the motors as part of mechanical design improvements without prior notice. This means that dimensions drawings can go out-of-date. Up-to-date dimension drawings can be requested at no charge from your local SIEMENS representative.

Für Motor		Maße in mm (inches)														AS-Wellenende	
Achshöhe	Typ	**DIN** **IEC**	a_1 P	a_2 –	b_1 N	c_1 LA	e_1 M	f_1 T	h H	i_2 –	p_4 AC	s_1 S	s_3 –	x_3 –	x_6 –	d D	l E
1PM6, Bauform IM B35, Fremdbelüftung																	
100	**1PM6101** **1PM6105**		250 (9,84)	196 (7,72)	180 (7,09)	14 (0,55)	215 (8,46)	4 (0,16)	100 (3,94)	80 (3,15)	190 (7,48)	14 (0,55)	M32x1,5	117 (4,61)	122 (4,80)	38 (1,50)	80 (3,15)
132	**1PM6133** **1PM6137** **1PM6138**		350 (13,78)	260 (10,24)	250 (9,84)	15 (0,59)	300 (11,81)	5 (0,20)	132 (5,20)	110 (4,33)	245 (9,65)	18 (0,71)	M40x1,5	132 (5,20)	152 (5,98)	42 (1,65)	110 (4,33)

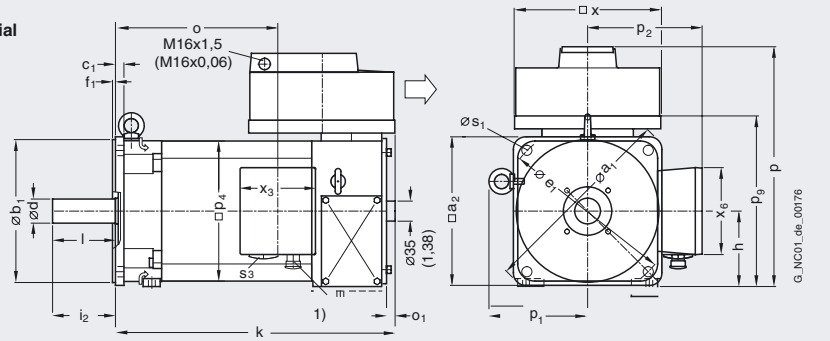
Motor		Maße in mm (inches)								
Achshöhe	Typ	**DIN** **IEC**	k LB	k_1 –	k_2 –	o –	o_1 –	p HD	p_3 –	p_9 –
mit Lüfter axial										
100	**1PM6101**		614 (24,17)	337 (13,27)	160 (6,30)	198 (7,80)	10 (0,39)	259 (10,20)	195 (7,68)	236 (9,29)
	1PM6105		719 (28,31)	442 (17,40)		304 (11,97)				
132	**1PM6133**		684 (26,93)	424 (16,69)	140 (5,51)	284 (11,18)	-2 (-0,08)	333 (13,11)	254 (10,00)	307 (12,09)
	1PM6137		804 (31,65)	544 (21,42)		404 (15,91)				
	1PM6138		874 (34,41)	614 (24,17)		474 (18,66)				

Motor		Maße in mm (inches)								
Achshöhe	Typ	**DIN** **IEC**	k LB	o –	o_1 –	p HD	p_1 –	p_2 –	p_9 –	x –
mit Lüfter radial										
100	**1PM6101**		389 (15,31)	199 (7,83)	20 (0,79)	331 (13,03)	133 (5,24)	159 (6,26)	231 (9,09)	190 (7,48)
	1PM6105		494 (19,45)	304 (11,97)						
132	**1PM6133**		490 (19,29)	285 (11,22)	15 (0,59)	420 (16,54)	172 (6,77)	201 (7,91)	302 (11,89)	256 (10,08)
	1PM6137		610 (24,02)	405 (15,94)						
	1PM6138		680 (26,77)	475 (18,70)						

1PM6
mit Lüfter axial



1PM6
mit Lüfter radial



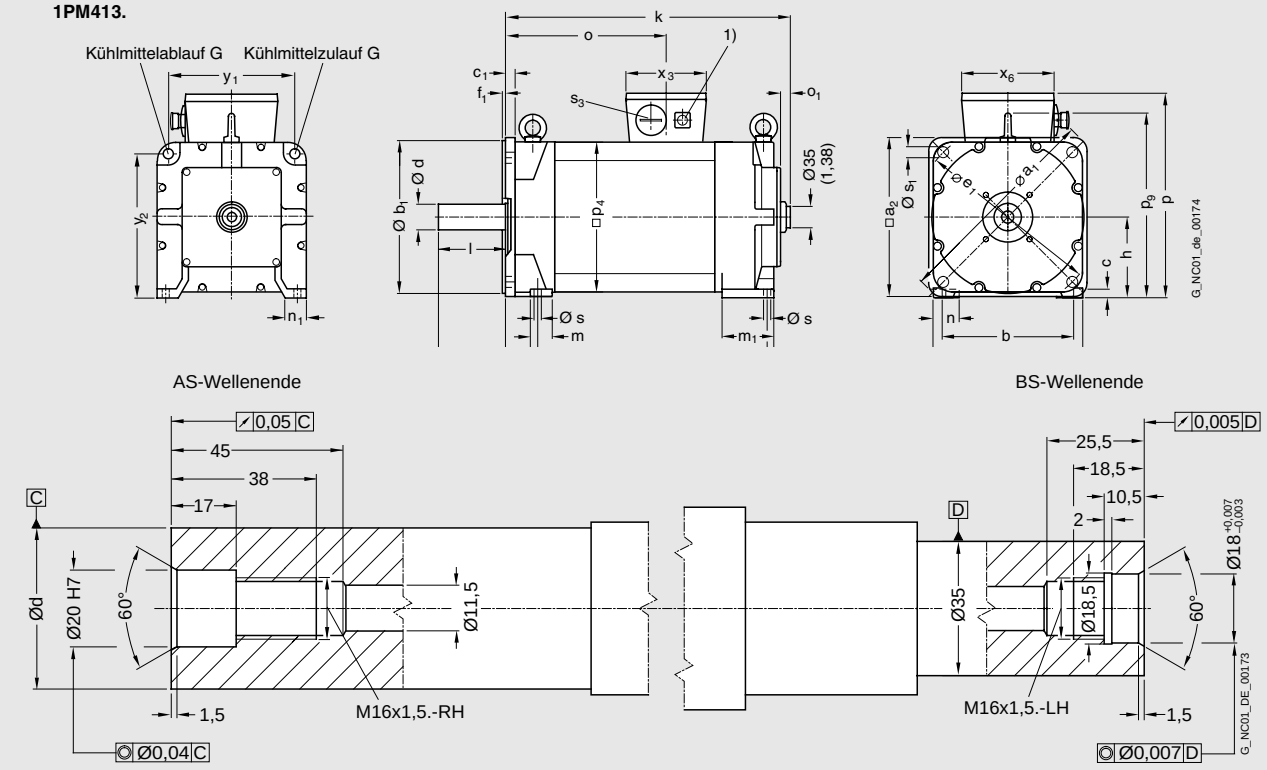
[1] Signalanschluss.

Figure 4-3 1PM6 hollow-shaft motors

Für Motor		Maße in mm (inches)																		
Achshöhe	Typ	**DIN** **IEC**	a B	a_1 P	a_2 –	b A	b_1 N	c HA	c_1 LA	e BB	e_1 M	f AB	f_1 T	G –	h H	i_2 –	k LB	m BA	m_1 –	m_2 –
1PM4, Bauform IM B35, Wasserkühlung																				
100	**1PM4101**		304 (11,97)	250 (9,84)	196 (7,72)	160 (6,30)	180 (7,09)	11 (0,43)	12 (0,47)	326 (12,83)	215 (8,46)	190 (7,48)	4 (0,16)	G1/4	100 (3,94)	80 (3,15)	389 (15,31)	35 (1,38)	60 (2,36)	11 (0,43)
	1PM4105		409 (16,10)							431 (16,97)							494 (19,45)			
132	**1PM4133**		377 (14,84)	350 (13,78)	260 (10,24)	216 (8,50)	250 (9,84)	14 (0,55)	16 (0,63)	400 (15,75)	300 (11,81)	246 (9,59)	5 (0,20)	G3/8	132 (5,20)	110 (4,33)	468 (18,43)	36 (1,42)	85 (3,35)	12 (0,47)
	1PM4137		497 (19,57)							520 (20,47)							588 (23,15)			

Motor		Maße in mm (inches)																AS-Wellenende	
Achshöhe	Typ	**DIN** **IEC**	n AA	n_1 –	o –	o_1 –	p HD	p_4 AC	p_9 –	s K	s_1 S	s_3 –		w_1 C	x_3	x_6	y_1 –	y_2 –	d D	l E
100	**1PM4101**		37 (1,46)	35 (1,38)	199 (7,83)	18 (0,71)	259 (10,20)	190 (7,48)	233 (9,17)	12 (0,47)	14 (0,55)	M32x1,5		44 (1,73)	117 (4,61)	122 (4,80)	154 (6,06)	177 (6,97)	38 (1,50)	80 (3,15)
	1PM4105				304 (11,97)															
132	**1PM4133**		43 (1,69)	35 (1,38)	264 (10,39)	16 (0,63)	335 (13,19)	245 (9,65)	302 (11,89)	12 (0,47)	18 (0,71)	M40x1,5		53 (2,09)	132 (5,20)	152 (5,98)	206 (8,11)	235 (9,25)	42 (1,65)	110 (4,33)
	1PM4137				384 (15,12)															

1PM410.
1PM413.



[1] Signalanschluss.

Figure 4-4 1PM4 hollow-shaft motors

Motor components

5

5.1 Thermal motor protection

A temperature-dependent resistor is integrated as temperature sensor to monitor the motor temperature.

Table 5-1 Features and technical data

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

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

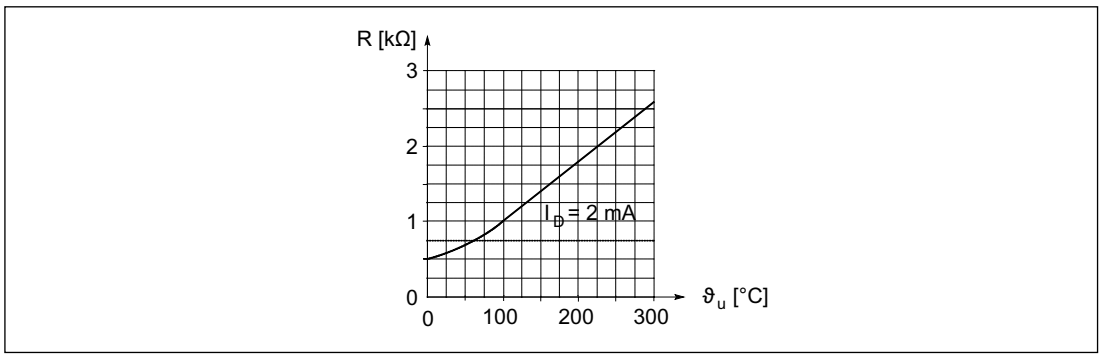


Figure 5-1 Resistance characteristic of the KTY 84 as a function of the temperature

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 at the drive converter. When the motor temperature increases, a message "Alarm motor overtemperature" is output; this must be externally evaluated. If this message is ignored, the drive converter shuts down with the appropriate fault message after a preset time period or when the motor limiting temperature or the shutdown temperature is exceeded.

⚠ 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 a temperature sensor terminal, then it will be destroyed.

5.2 Encoder (option)

The encoder is selected in the motor Order No. (MLFB) using the appropriate letter at the 9th position.

Note

The letter ID at the 9th position of the Order No. (MLFB) differs for motors with and without DRIVE-CLiQ.

Table 5-2 Encoders for motors with and without DRIVE-CLiQ

Encoder type	Order number (MLFB)	
	Without DRIVE-CLiQ	With DRIVE-CLiQ
Incremental encoder sin/cos 1 Vpp 256 pulses/revolution (encoder IN256S/R)	L	-
Incremental encoder 19-bit (encoder IN19DQ)	-	V

5.2.1 Incremental encoders

Function:

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

Table 5-3 Technical data for incremental encoders

Features	Incremental encoder sin/cos 1 Vpp
Mech. limiting speed	18000 rpm
Operating voltage	5 V ± 5%
Current consumption	max. 150 mA
Resolution, incremental (periods per revolution)	256 pulses/revolution
Incremental signals	1 Vpp
Angular error	± 40"
C–D track (rotor position)	1 Vpp

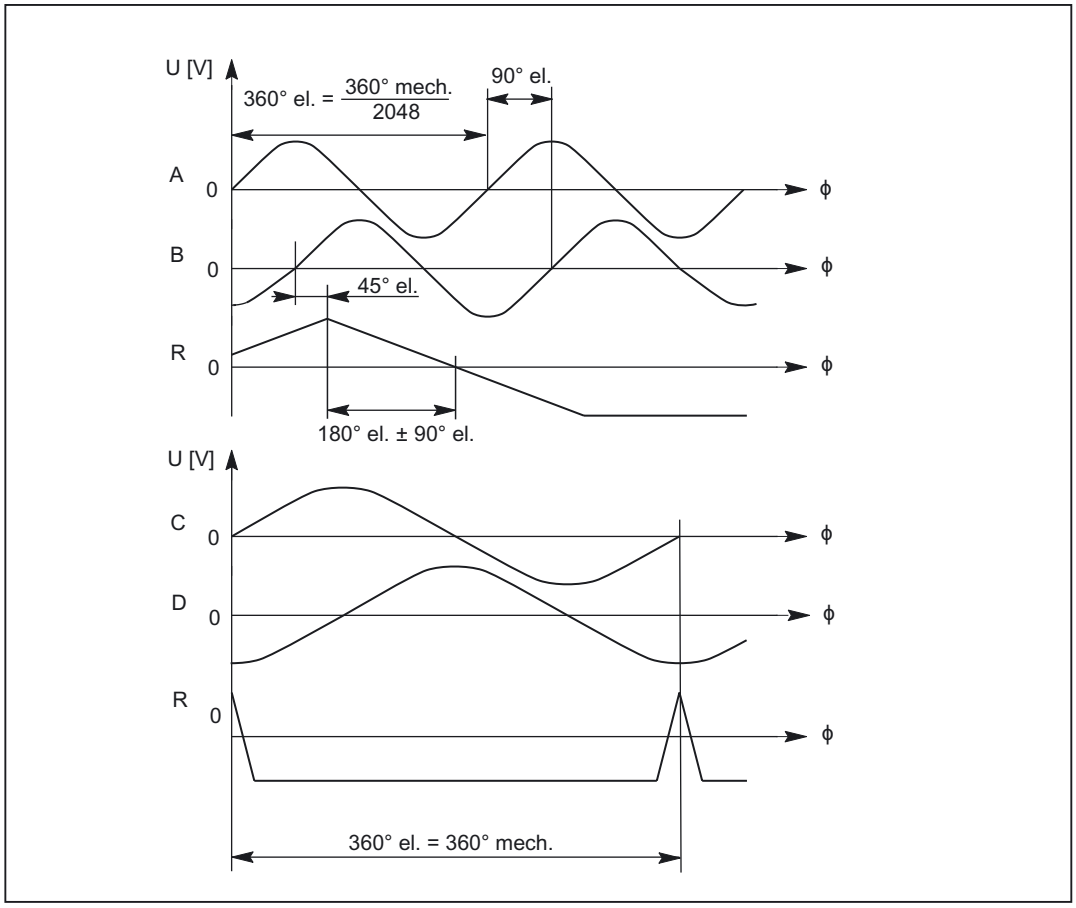


Figure 5-2 Signal sequence and assignment for a positive direction of rotation

Connection methods

6

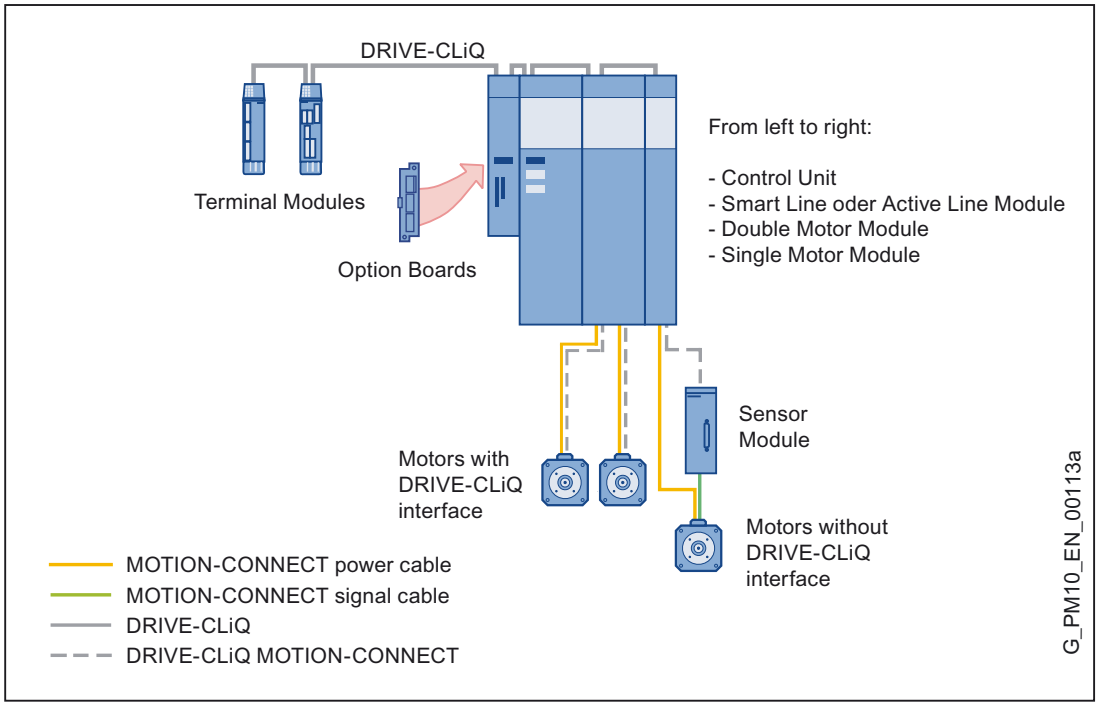


Figure 6-1 SINAMICS S120 system overview

6.1 Motor power connection

Table 6-1 Motor connection

Motor type	Shaft height	Terminal box type	Number of main terminals	Max. connectable cross-section	Terminal strip for temperature sensor	PE connection size/ cable lug width
1PM6 force-ventilated, 1PM4 oil-cooled	100	gk 230	6 x M4	6 mm^2	3 terminals	M4 / 9 mm
	132	gk 330	6 x M5	25 mm^2 with cable lug connection	3 terminals	M5 / 15 mm
1PM4 water-cooled	100	gk 233	3 x M5	16 mm^2	3 terminals	M4 / 9 mm
	132	gk 423	4 x M10	70 mm^2 with cable lug connection	3 terminals	M6 / 15 mm

⚠ CAUTION
Please note the current draw of the motor in your application! Appropriately dimension the connecting cables in accordance with IEC 60204-1.

Star/delta circuit configuration

The star/delta circuit configuration is implemented using an external contactor circuit or as permanent setting by means of jumpers in the terminal box. The jumpers are in the terminal box.

The following motors can be connected in a delta circuit:

- 1PM6 forced ventilation
- 1PM4 oil cooling

Note

Water-cooled 1PM4 motors are only operated in the star circuit configuration. These motors cannot be changed over to a delta circuit configuration.

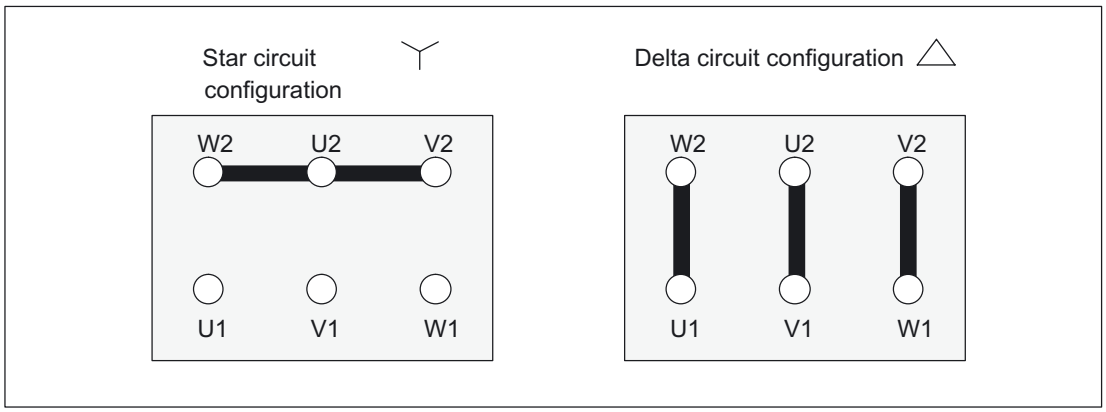


Figure 6-2 Permanent star and delta circuit configurations in the terminal box using jumpers

Connection information

Note

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

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 from the SIEMENS cable accessories kit 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 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 for the 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.
- Make sure that the minimum air clearances specified below are maintained: Supply voltages up to 500 V: Minimum air clearance 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 bolts must be tight (tightening torques, refer to the operating instructions)
  - The minimum air clearances 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

6.2 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.

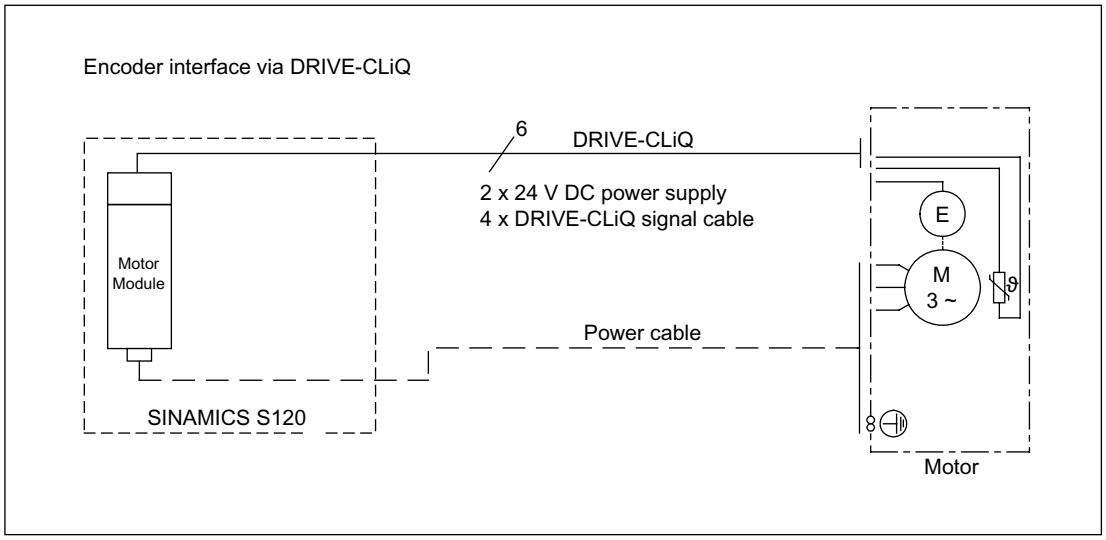


Figure 6-3 Encoder connection on motors with DRIVE-CLiQ

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.

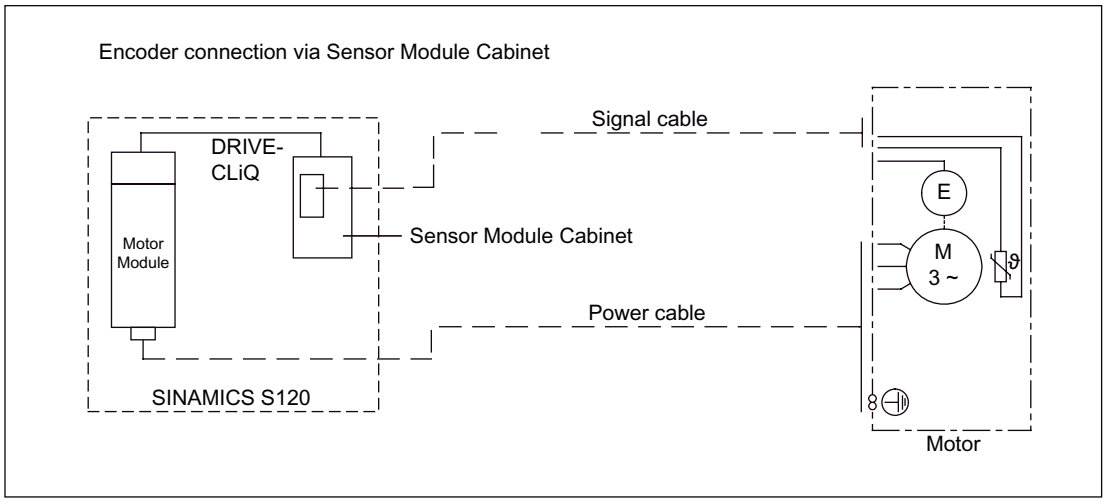


Figure 6-4 Encoder connection on motors without DRIVE-CLiQ

Cables on motors without DRIVE-CLiQ

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

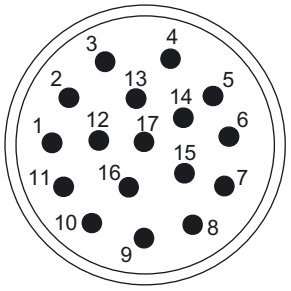
Table 6-5 Pre-assembled cable

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"

Table 6-6 Connection pin assignment for 17-pin flange socket

PIN No.	Incremental encoder sin/cos 1 Vpp	
1	A	
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	M sense	
16	P sense	
17	not connected	



When viewing the plug-in side (pins)

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

Table 7-1 Ambient temperature for operation and storage/transport

Operation	T = –15 °C to +40 °C (without any restrictions)
Storage/transport	T = -20 °C to +70 °C

Derating

If other conditions prevail (ambient temperature > 40° C or installation altitude > 1000 m above sea level), the permissible torque/power must be defined using the factors from the table (torque/power reduction according to EN 60034-6).

For ambient temperatures > 50°C, please contact your local Siemens office.

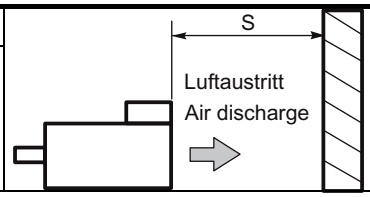
Ambient temperatures and installation altitudes are rounded off to 5° C or 500 m respectively.

Table 7-2 Factors to reduce the torque/power (de-rating)

Installation altitude above sea level	Ambient temperature in °C		
	40	45	50
1000	1.00	0.96	0.92
1500	0.97	0.93	0.89
2000	0.94	0.90	0.86
2500	0.90	0.86	0.83
3000	0.86	0.82	0.79
3500	0.82	0.79	0.75
4000	0.77	0.74	0.71

Minimum distance for a customer-specific environment

The minimum distance S between the intake/exit air openings and other adjacent components must be maintained.

Shaft height	Distance S	
100	30 mm	
132	60 mm	

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.

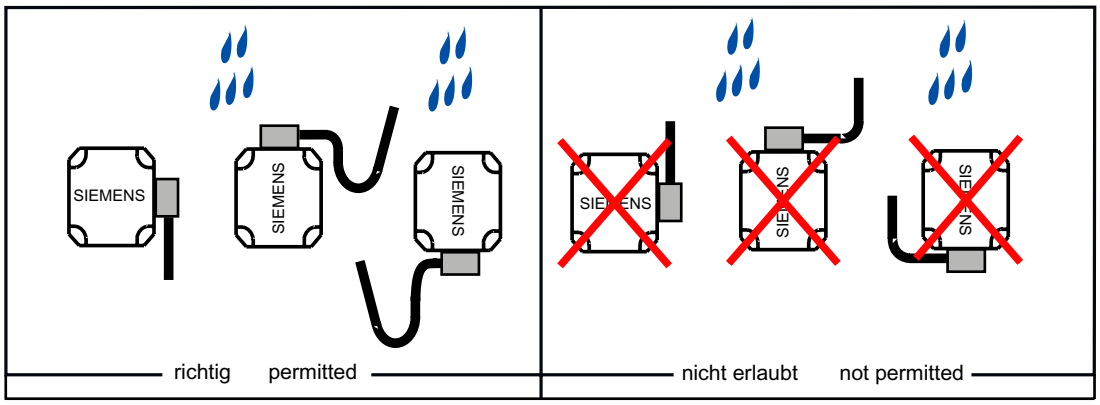


Figure 7-1 Principle of cable routing in a wet/moist environment

7.4 Mounting position

The 1PM6 and 1PM4 motors are available in various types of construction.

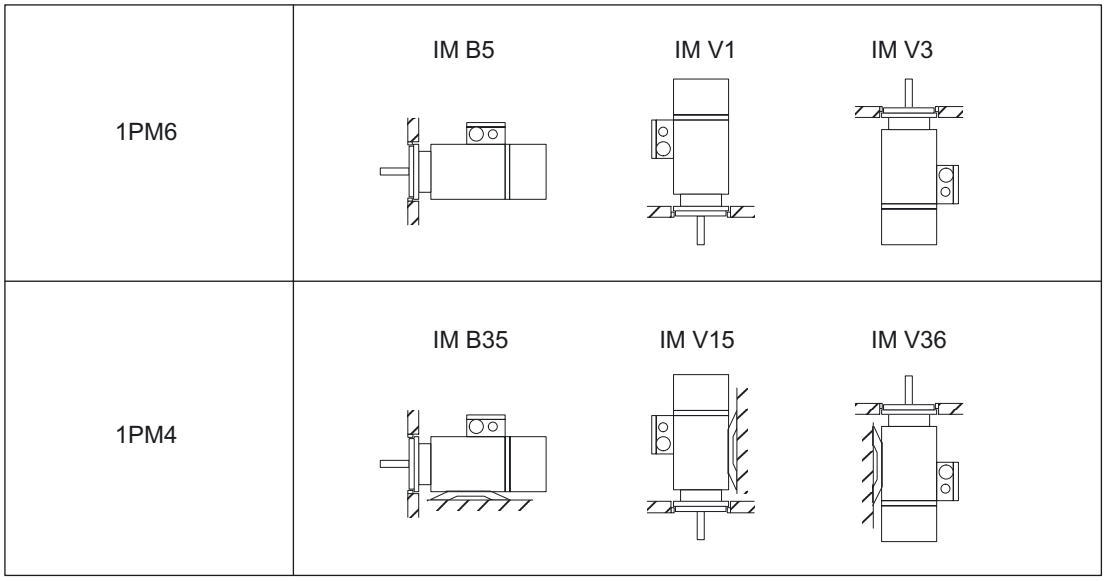


Figure 7-2 Types of construction for 1PM6 and 1PM4

NOTICE
A permanent covering of liquid on the flange is not permitted when the motor is mounted with the shaft end facing upwards (IM V3, IM V36).

Support

For all 1PM6/1PM4 motors, it is possible to provide support at the non-drive end bearing shield.

Note

For 1PM610□ with fan, the motor can only be supported using the threads for the lifting lugs located at the side.

Natural frequency when mounted

When the motor is mounted on the machine/system (flange-mounting is predominantly used) and coupled to the drive train, the resultant vibration characteristics are specific to the system.

The vibration characteristics depend on the stability of the motor support structure and on the balance quality of the drive train when rigidly coupled. These factors can increase the level of motor vibration and, for example, impair the quality of parts machined on machine tools.

Measures to reduce vibration levels

Depending on the actual operating conditions, vibration can be reduced by applying the following measures:

- Reinforcing the motor support structure
- Providing additional support for motors and non-drive end (when flange mounted)
- Vibration decoupling or dampening of the drive train

Appendix

A

A.1 Description of terms

Maximum continuous speed n_{S1}

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

Maximum 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, 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 system.

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.

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.

The motor may not operate continuously at maximum speed n_{max}. Unless a different duty cycle (duty cycle duration 10 minutes) 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

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", "Technische Documentation", "Documentation Overview".

Catalogs

Abbreviations	Catalog
NC 61	SINUMERIK & SINAMICS
NC 60	SINUMERIK & SIMODRIVE
D 21.1	SINAMICS S120
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
DA 48	SIMOSYN Motors

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.

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Suggestions and/or corrections

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V

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