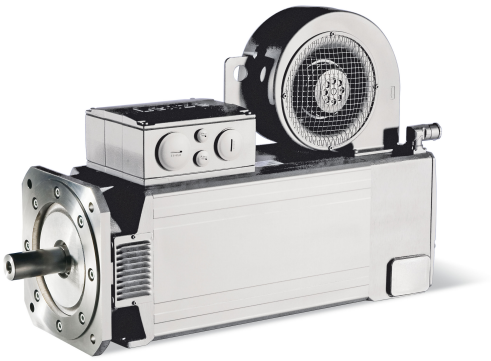
Project planning EN



Servo motors

MQA asynchronous servo motor

Lenze

Contents

Contents

About this document

Document description

This document addresses to all persons who want to carry out any configurations with the products described.

The data and information compiled in this document serve to support you in the dimensioning and selection processes and in carrying out the electrical and mechanical installation. You will receive information regarding product extensions and accessories.

- The document includes safety instructions which must be observed.
- All persons working on and with the drives must have the documentation at hand during work and observe the information and notes relevant for it.
- The documentation must always be complete and in a perfectly readable state.

NOTICE

Please observe the notes in the following chapters!

▸ Safety instructions 📖 10
▸ Information on mechanical installation 📖 21
▸ Information on electrical installation 📖 22

Further documents

Information and tools with regard to the Lenze products can be found on the Internet:
www.Lenze.com → Downloads

Notations and conventions

This document uses the following conventions to distinguish different types of information:

Numbers			
	Decimal separator	Point	In general, the decimal point is used. Example: 1 234.56
Warning			
	UL warning	UL	Are used in English and French.
	UR warning	UR	
Text			
	Programs	» «	Software Example: »Engineer«, »EASY Starter«
Icons			
	Page reference	🕮	Reference to another page with additional information Example: 🕮 16 = see page 16
	Documentation reference	🌍	Reference to another documentation with additional information Example: 🌍 EDKxxx = see documentation EDKxxx

Layout of the safety instructions

⚠DANGER!

Indicates an extremely hazardous situation. Failure to comply with this instruction will result in severe irreparable injury and even death.

⚠WARNING!

Indicates an extremely hazardous situation. Failure to comply with this instruction may result in severe irreparable injury and even death.

⚠CAUTION!

Indicates a hazardous situation. Failure to comply with this instruction may result in slight to medium injury.

NOTICE

Indicates a material hazard. Failure to comply with this instruction may result in material damage.

Product information

Product description

The MQA asynchronous servo motor for precisely controlled motion.
The naturally ventilated MQA asynchronous servo motor is suitable for applications that require a high dynamic performance, high construction-related operational reliability and precisely controlled motion.

In connection with the i700 and i950 servo inverters, Servo Drives 9400, and Inverter Drives 8400 TopLine, high-performance drive solutions in the torque range from 66 to 1100 Nm can be obtained.

Customer benefit

- Optimum controllability and high dynamic performance thanks to low moments of inertia
- Optimal smooth running characteristics for exact work results
- Wide speed setting range
- Field weakening operation usable
- Robust resolvers are included as a standard, and incremental encoders or absolute value encoders ensure a high precision

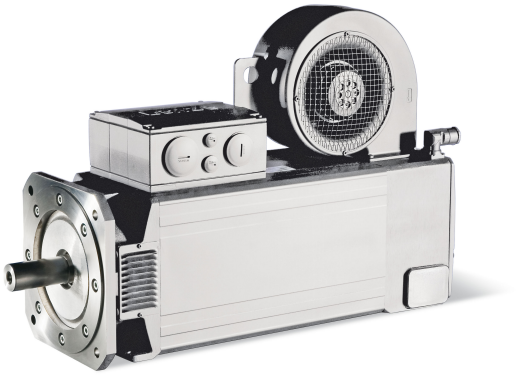


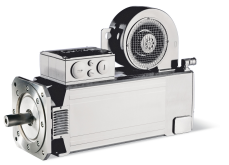
Fig. 1: Asynchronous servo motor MQA22P08-

Identification of the products

Product name: MQA asynchronous servo motor

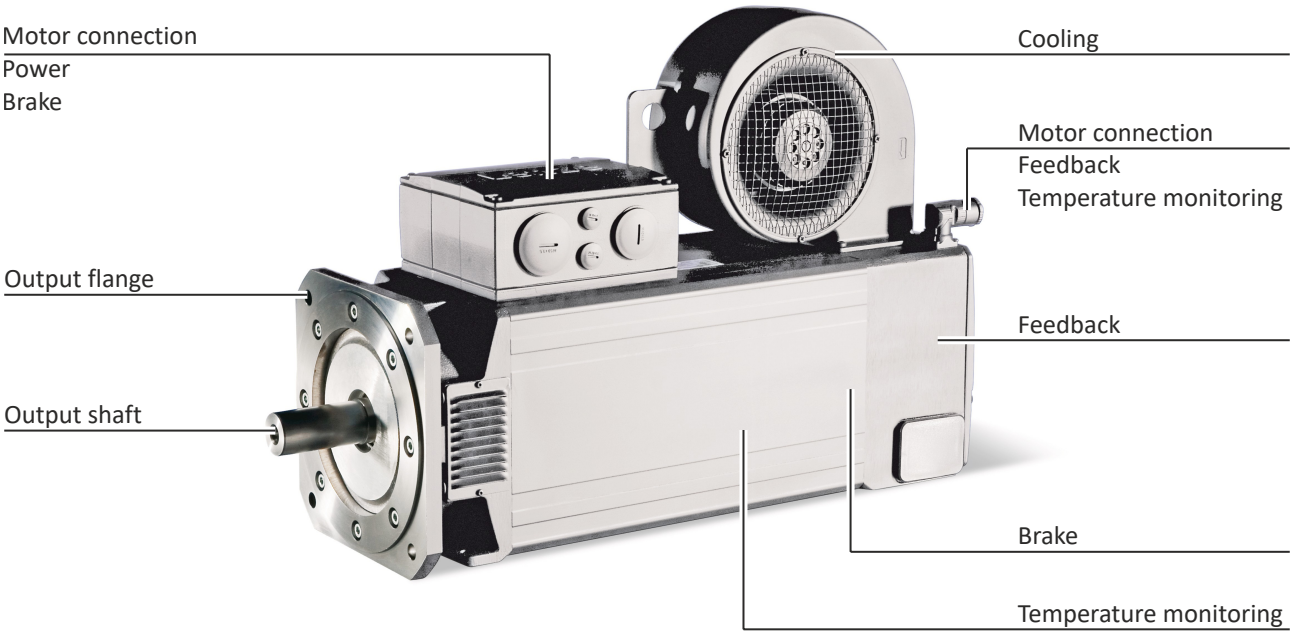
	Motor				
Example	MQA	20	L	14	H

Meaning	Variant					
Product family		MQA				
Size			20 22 26			
Overall length				L ... T		
Rated speed	rpm x 100				05 ... 29	
Inverter mains connection	3 x 400 V					H



Features

The following figure provides an overview of the elements and connections on the product.
Their position, size and appearance may vary.



The modular system

Values printed in bold are standard designs. Values that are not printed in bold are potential extensions, some of them including a surcharge.

Motor		MQA20	MQA22	MQA26
Technical data				
Rated power	kW	10.6 ... 20.3	11.5 ... 38.4	17.0 ... 60.2
Rated torque	Nm	66.2 ... 71.3	125 ... 145	257 ... 296
Max. torque	Nm	250	500	1100
Rated speed	rpm	1420 ... 2930	760 ... 2935	550 ... 2235
Color		**Primed RAL9005 matt jet black** RAL color		
Surface and corrosion protection		**OKS-G** Different types of OKS		
Output shaft				
Solid shaft with featherkey	mm	38 x 80	38 x 80	55 x 110
Solid shaft without keyway	mm	38 x 80	38 x 80	55 x 110
Shaft material		Steel		
Shaft sealing ring material		FKM		
Shaft seal		**Standard** Oil-proof Dust-proof		
A-side end shield		**Not oil-proof** Oil-proof		
Design		With flange (B3/B35)		
Output flange	mm	FF215 FF265	FF265	FF265 FF350
Cooling		Forced ventilated IP23s		
Dust filter		**Without** With		
Motor connection				
Power + brake + blower		**ICN connector** Terminal box	**Terminal box**	
Encoder + temperature monitoring		**ICN connector**		
Spring-applied holding brake		**Without** With		
Standard braking torque	Nm	80.0	130	260
Increased braking torque	Nm	130	260	-
DC brake voltage	V	24		
AC brake voltage	V	230 (not for cURus an ICN connector)		
Feedback				
Without functional safety		**Resolver** Absolute value encoder Incremental encoder		
With functional safety		Resolver Incremental encoder		
Temperature monitoring		**PT1000 temperature sensor** TCO thermal contact (not for ICN connector and spring-applied brake)		

Information on project planning

Safety instructions

Disregarding the following basic safety measures and safety information may lead to severe personal injury and damage to property!

Observe all specifications of the corresponding documentation supplied. This is the precondition for safe and trouble-free operation and for obtaining the product features specified.

Please observe the specific safety information in the other sections!

Basic safety instructions

⚠ DANGER!

Dangerous electrical voltage

Possible consequences: Death or severe injuries from electric shock

- ▸ Any work on the device must only be carried out in a deenergized state.
- ▸ After switching off the mains voltage, observe the signs on the product.

Product

- The product must only be used as directed.
- Never commission the product in the event of visible damage.
- The product must never be technically modified.
- Never commission the product before assembly has been completed.
- The product must never be operated without required covers.
- Connect/disconnect all pluggable terminals only in de-energized condition.
- Only remove the product from the installation in the de-energized state.

Personnel

Only qualified and skilled personnel are allowed to work with the product. IEC 60364 and/or CENELEC HD 384 define the qualifications of these persons as follows:

- They are familiar with the installation, mounting, commissioning, and operation of the product.
- They possess the appropriate qualifications for their tasks.
- They are familiar with all regulations for the prevention of accidents, directives, and laws applicable at the location and are able to apply them.

Electrical connection

When working on energized products, comply with the applicable national accident prevention regulations.

The electrical installation work must be carried out according to the appropriate regulations (e.g. cable cross-sections, fusing, PE conductor connection). Additional information can be obtained from this documentation.

This documentation contains notes about installation according to EMC regulations. Also observe these notes for CE-marked products. The manufacturer of the system or machine is responsible for adherence to the limits required in connection with EMC legislation.

Operation

Where appropriate, you must equip the system with additional monitoring and protective devices. Comply with the safety regulations and other regulations applicable at the place of operation.

After disconnecting the product from the supply voltage, do not touch live device parts and power terminals immediately because capacitors may be charged. Observe the corresponding information labels on the product.

Dirt or dust deposits impede the heat dissipation and cooling. Remove any such deposits where appropriate at regular intervals.

Process engineering

The procedural notes and circuit details described are only proposals. It is up to the user to check whether they can be adapted to the particular applications. Lenze does not take any responsibility for the suitability of the procedures and circuit proposals described.

Disposal

The products and accessories must be properly disposed of in accordance with the applicable regulations. The products contain raw materials that can be recycled such as metals, plastics and electronic components.

Application as directed

NOTICE

Please observe the notes in the following chapters!

▸ Safety instructions 10
▸ Information on mechanical installation 21
▸ Information on electrical installation 22

- The product must only be actuated under the operating conditions and power limits specified in this documentation.
- The product meets the protection requirements of 2014/35/EU: Low-Voltage Directive.
- The product is not classed as a machine under 2006/42/EC: Machinery Directive.
- No machine is to be commissioned or put into operation as intended in conjunction with the product until it has been determined that the machine meets the regulations of EC Directive 2006/42/EC: Machinery Directive; observe EN 60204−1.
- Commissioning or putting into operation as intended is only permitted in compliance with the EMC Directive 2014/30/EU.
- The product is not a household appliance. Instead, it is a component that is intended exclusively for further use in the context of commercial or professional use as defined by EN 61000−3−2.
- The product can be used according to the technical data if the drive systems have to comply with categories in accordance with EN 61800−3.
- Do not use the built-in brakes as fail-safe brakes. Disruptive factors that cannot be influenced may cause the braking torque to be reduced.
- The product is only to be operated together with an inverter.
- The harmonized standards of the series IEC/EN60034 are used.

Foreseeable misuse

- Operate directly on the mains voltage
- Use in potentially explosive atmospheres
- Operate in aggressive environments (acids, gases, vapors, dusts, oils)
- Operate under water
- Operate under radiation
- Operate in generator mode

Residual hazards

Even if notes given are taken into consideration and protective measures are implemented, the occurrence of residual risks cannot be fully prevented.

The user must take the residual hazards mentioned into consideration in the risk assessment for his/her machine/system.

If the above is disregarded, this can lead to severe injuries to persons and damage to property!

Product

Observe the warning labels on the product!

Dangerous electrical voltage:
Before working on the product, make sure there is no voltage applied to the power terminals!
After mains disconnection, the power terminals will still carry the hazardous electrical voltage for the time given next to the symbol!

Electrostatic sensitive devices:
Before working on the product, the staff must ensure to be free of electrostatic charge!

High leakage current:
Carry out fixed installation and PE connection in compliance with:
EN 61800−5−1 / EN 60204−1

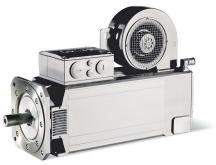
Hot surface:
Use personal protective equipment or wait until the device has cooled down!

Protection of persons

- The product does not provide any safety-related functions.
  - A higher-level safety system must be implemented.
  - Provide additional monitoring and protective equipment complying with the safety regulations applicable in each case.
- The power terminals may carry voltage in the switched-off state or when the motor is stopped.
  - Before working, check whether all power terminals are deenergized.
- Voltages may occur on the drive components (e.g. capacitive, caused by inverter supply).
  - Careful earthing must be carried out at the marked positions of the components.
- There is a risk of burns from hot surfaces!
  - Provide protection against accidental contact.
  - Use personal protective equipment or wait until the device has cooled down!
  - Prevent contact with flammable substances.
- Risk of injury from rotating parts.
  - Before working on the drive system, ensure that the motor is at a standstill.
- There is a danger of unintentional start-up or electric shocks!
- Installed brakes are no fail-safe brakes.
  - torque may be reduced by disruptive factors that cannot be influenced such as ingressing oil.

Motor protection

- Version with plug:
  - Never disconnect the plug when energized. The plug could be destroyed.
  - Switch off the voltage supply or disable the inverter prior to disconnecting the plug.
- Installed thermal detectors are no full protection for the machine.
  - Limit the maximum current if necessary. Parameterize the inverter so that it will be switched off after several seconds of operation with $I > I_{rated}$ especially if there is a danger of blocking.
  - The integrated overload protection does not prevent overloading under all conditions.
- The fuses are no motor protection.
  - Use a current-dependent motor protection switch.
  - Use the built-in thermal detectors.
- Excessively high torques cause a fracture of the motor shaft.
  - Do not exceed the maximum torques according to the technical data on the nameplate.
- Lateral forces on the motor shaft are possible.
  - Align the shafts of motor and driven machine exactly to each other.



Drive dimensioning

In order to carry out an accurate drive dimensioning process, you can use our configuring software, the »Drive Solution Designer«.

With the «Drive Solution Designer«, you can design the drive both quickly and to a high quality. The software contains profound and proven expertise with regard to drive applications and mechatronic drive components.

Please get in touch with your Lenze representative.

The dimensioning is suitable for:

- kinematic profiles
- operating modes S1, S2, S3, S6 📖 71
- simple linear speed profiles, not for S-curves or similar

The following 3 elements are taken into consideration in the dimensioning process:

Drive function

On the basis of the values required for the process that are specified, a drive is selected, for which all operating points are within the speed-torque characteristic curve of the motor.

As a result, a motor with a suitable speed and an inverter with a sufficient maximum current are selected. Further limits (maximum speed, installation height...) are specified in tables.

Mechanical strength

On the basis of the occurring forces and torques, a drive is selected that has a sufficient mechanical strength (endurance strength for the periodically occurring torques and fatigue strength for the sporadically occurring torques).

Thermal dimensioning

For the inverter, the thermal dimensioning process is carried out on the basis of the continuous inverter current or on the basis of the continuous torque from the motor-inverter combination, which can be reached.

The motor is thermally dimensioned on the basis of the mean speed and the effective torque.

The mean speed of the drive should not exceed the values specified.

If dimensioning processes are complex or reach limit loads, please refer to your Lenze representative.

Operation chart

S1 operation	S2,S3 and S6 operation	Speed profiles
↓	↓	↓
Check operating conditions		
↓	↓	↓
Define required input variables		
↓	↓	↓
Determine correction factor		
Operating modes and operating time	Operating modes and operating time	
Ambient temperature and installation height	Ambient temperature and installation height	Ambient temperature and installation height
↓	↓	↓
Determine motor on the basis of the forces acting		
↓	↓	↓
↓	↓	Define load characteristic for the individual time segments
↓	↓	↓
↓	↓	Calculation of the values required for the process
↓	↓	↓
Inspect and select motor		
↓	↓	↓
Final configuration		

Check operating conditions

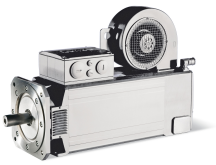
Check
Approvals
Conformities
Supply voltage
Degree of protection
Ambient temperature
Surface protection

▸ Standards and operating conditions 🕮 24

▸ Surface and corrosion protection 🕮 20

Define required input variables

Necessary input variables	Note	Symbol	Unit
Mean speed utilisation	Relating to the load speed n_L		%
Ambient temperature		T_U	°C
Site altitude Amsl		H	m
Radial force		F_{rad}	N
Axial force		F_{ax}	N
Transmission element at the output	Gear wheels, sprockets …		
Effective diameter of the transmission element		d_w	mm
Load torque	Only with S1, S2, S3, and S6 operating modes	M_L	Nm
Load speed	Only with S1, S2, S3, and S6 operating modes	n_L	rpm
Short-time maximum torque	Emergency off, quick stop, occasional high starting duty	$M_{L,max}$	Nm
Runtime with maximum torque		t_L	%



Determine correction factor

Operating modes S1, S2, S3, S6, and operating time							
Operating mode S1		Operating mode S2		Operating mode S3		Operating mode S6	
ED	k_L	ED	k_L	ED	k_L	ED	k_L
%		min		%		%	
100	1.0	10	1.4 - 1.5	15	1.4 - 1.5	15	1.5 - 1.6
		30	1.15 - 1.2	25	1.3 - 1.4	25	1.4 - 1.5
		60	1.07 - 1.1	40	1.15 - 1.2	40	1.3 - 1.4
		90	1.0 - 1.05	60	1.05 - 1.1	60	1.15 - 1.2

▸ Operating modes of the motor 🕮 71

Ambient temperature and installation height				
Ambient temperature	Installation height amsl			
	≤ 1000 m	≤ 2000 m	≤ 3000 m	≤ 4000 m
	Correction factor			
T_U	k_H	k_H	k_H	k_H
≤ 20 °C	1.15	1.06	0.97	0.89
30 °C	1.07	0.99	0.90	0.83
40 °C	1.00	0.92	0.83	0.77
50 °C	0.92	0.85	0.76	0.71
60 °C	0.83	0.77	0.70	0.65

Determine product on the basis of the forces

Transmission element			Gear wheels	Sprockets	Toothed belt pulleys (depending on the preloading)	Narrow V-belt (depending on the preloading)
Additional radial force factor	f_z		≥ 17 teeth = 1.0 < 17 teeth = 1.15	≥ 20 teeth = 1.0 < 20 teeth = 1.25 < 13 teeth = 1.4	With belt tightener= 2.0 - 2.5 Without belt tightener= 2.5 - 3.0	1.5 - 2.0
			Calculation		**Check**	
Radial force	F_{rad}	N	$F_{rad} = 2000 \times \frac{M_{L,max} \times f_z}{dw}$		$F_{rad} \leq F_{rad,max}$	
Axial force	F_{ax}	N			$F_{ax} \leq F_{ax,max}$	

dw Effective diameter of transmission element

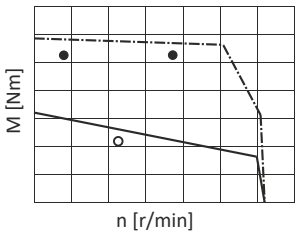
▸ Radial forces and axial forces 🕮 26

Operating mode S1

Check and select servo motor/inverter combination			
	Check	Selection	Unit
Output torque	$M_{rated} \geq M_L / (k_L \times k_H)$	M_{rated}	Nm
Output speed	$n_{rated} \geq n_L$	n_{rated}	rpm

▸ Rated data 🕮 28

Operating modes S2, S3, and S6

Check and select servo motor/inverter combination			
	Check	**Selection**	**Unit**
Output torque	$M_{rated} \geq M_L / (k_L \times k_H)$	M_{rated}	Nm
Output speed (recommendation)	$n_{rated} \geq n_L$	n_{rated}	rpm
Max. output torque.	$M_{max} \geq M_L$	M_{max}	Nm
Max. output speed	$n_{max} \geq n_L$	n_{max}	rpm
All operating points (●)			
below the maximum torque characteristic of the servo motor/ inverter combination here, $M_{L,max}$ must be considered		n_L M_L	
Thermally effective operating point (○)		n_L	
below the S1 torque characteristic of the servo motor		$M_L / (k_L \times k_H)$	

▸ Rated data 📖 28

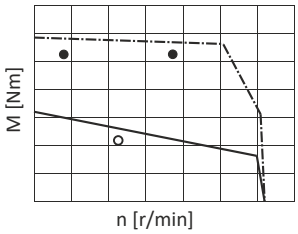
▸ Torque characteristics 📖 35

Speed profiles

Temporal load characteristic for the individual time segments z							
Total time	**Individual time segments**	**Load speed**	**Load speed variation**	**Steady-state load torque**	**Torque**	**Acceleration torque**	**Moment of inertia**
t	**Δt_z**	**$n_{L,z}$**	**$\Delta n_{L,z}$**	**$M_{L,z}$**	**M_z**	**$M_{s,z}$**	**J_L**
s	**s**	**rpm**	**rpm**	**Nm**	**Nm**	**Nm**	**kgcm²**

	Calculation	**Symbol**	**Unit**
Load cycle duration	$T = \sum \Delta t_z$	T	s

Calculation of the values required for the process			
	Calculation	**Symbol**	**Unit**
Torque per time segment	$M_z = M_{L,z} + J_L \frac{2\pi \times \Delta n_{L,z}}{60 \times \Delta t_z}$	M_z	Nm
Maximum torque of the profile	$M_{P,max} = \max (M_z)$	$M_{P,max}$	Nm
Effective torque	$M_{eff} = \sqrt{\frac{1}{T} \sum_z M_z^2 \times \Delta t_z}$, $T \leq 1min$	M_{eff}	Nm
Mean speed	$n_m = \lvert \overline{n_{L,z}} \rvert = \frac{1}{T} \sum_z \lvert n_{L,z} \rvert \times \Delta t_z$	n_m	rpm
Maximum load speed	$n_{L,max} = \max (n_{L,z})$	$n_{L,max}$	rpm

Check and select servo motor/inverter combination			
	Check	**Preselection**	**Unit**
Output torque	$M_{rated} > M_{eff} / k_H$	M_{rated}	Nm
Output speed	$n_{rated} \geq n_m$	n_{rated}	rpm
Load-matching factor			
for an optimum dynamic performance/ control properties	Requirement k_J = 0.5 ... 10 Optimum k_J = 1	$k_J = J_L / (J_M + J_B)$	
Checking the motor torques			
Acceleration torque	$M_{S,z} = M_z + (J_M + J_B) \times \frac{2\pi \times \Delta n_{L,z}}{60 \times \Delta t_z}$	$M_{S,z}$	Nm
Effective torque	$M_{S,eff} = \sqrt{\frac{1}{T}\sum_z M_{S,z}^2 \times \Delta t_z}$	$M_{S,eff}$	
All operating points (●)			
below the maximum torque characteristic of the servo motor/ inverter combination here, $M_{L,max}$ must be considered		$n_{L,z}$ $M_{S,z}$	
Thermally effective operating point (○)		n_m $M_{S,eff} / k_H$	
below the S1 torque characteristic of the servo motor			

▸ Rated data 🕮 28

▸ Torque characteristics 🕮 35

Final configuration

	Check
Connection dimensions	Output shaft Output flange
Product extensions	Motor connection (connector/terminal box) Brake Feedback Blower

More information about the final configuration:

▸ The modular system 📖 9

▸ Product extensions 📖 51

Surface and corrosion protection

Depending on the ambient conditions, the surface and corrosion protection system (called OKS) offers solutions for optimum protection.

Various surface coatings ensure that the motors operate reliably at high air humidity, in outdoor installation or in the presence of atmospheric impurities. Any color from the "RAL Classic" collection can be chosen for the top coat.

Surface and corrosion protection	Applications	Type
OKS-G (primed)	• Dependent on subsequent top coat applied	Standard
OKS-S (small)	• Standard applications • Internal installation in heated buildings • Air humidity up to 90 %	Optional
OKS-M (medium)	• Internal installation in non-heated buildings • Covered, protected external installation • Air humidity up to 95 %	
OKS-L (large)	• External installation • Air humidity above 95 % • Chemical industrial plants • Food industry	

Surface and corrosion protection	Corrosivity category	Surface coating	Colour	Coating thickness
	DIN EN ISO 12944-2	Design		
OKS-G (primed)		• 2K PUR priming coat	• RAL 9005 matt jet black	60 ... 90 µm
OKS-S (small)	Comparable to C1	• 2K-PUR top coat	• According to RAL Classic	80 ... 120 µm
OKS-M (medium)	Comparable to C2	• 2K PUR priming coat • 2K-PUR top coat		110 ... 160 µm
OKS-L (large)	Comparable to C3			140 ... 200 µm

Information on mechanical installation

Important notes

- Install the product according to the information in the chapter "Standards and operating conditions".

  ▸ Standards and operating conditions 📖 24
- The technical data and the data regarding the supply conditions can be found on the nameplate and in this documentation.
- Ambient media − especially chemically aggressive ones − may damage shaft sealing rings, lacquers and plastics.
- Lenze offers special surface and corrosion protection in this case.

NOTICE

Bearing damage caused by unbalance!

Shafts with keyway are balanced with a half featherkey!

▸ Balance transmission elements with a half featherkey!

Transport

- Ensure appropriate handling.
- Make sure that all component parts are securely mounted. Secure or remove loose component parts.
- Only use safely fixed transport aids (e.g., eye bolts or support plates).
- Do not damage any components during transport.
- Avoid electrostatic discharges on electronic components and contacts.
- Avoid impacts.
- Check the carrying capacity of the hoists and load handling devices. The weights can be found in the shipping documents.
- Secure the load against tipping and falling down.
- Standing beneath suspended loads is prohibited.

Installation

- The mounting surfaces must be plane, torsionally rigid and free from vibrations.
- The mounting areas must be suited to absorb the forces and torques generated during operation.
- Ensure an unhindered ventilation.
- For versions with a fan, keep a minimum distance of 10 % from the outside diameter of the fan cover in intake direction.

Information on electrical installation

Important notes

⚠ DANGER!

Risk of injury and risk of burns from dangerous voltage

Power terminals may also carry voltage in the switched-off state or when the motor is stopped and may cause life-threatening cardiac arrhythmia and serious burns.

- ▸ Disconnect the product from the mains.
- ▸ Check that the power terminals are deenergized before starting work.

- When working on energized products, comply with the applicable national accident prevention regulations.
- The electrical installation must be carried out according to the appropriate regulations (e.g. cable cross-sections, fuses, PE connection).
- The manufacturer of the system or machine is responsible for adherence to the limits required in connection with EMC legislation.

Operation on an external inverter

A max. pulse voltage amplitude of U_{pk} = 1560 V at the motor terminals must not be exceeded. Here, the minimum pulse rise time must be t_R = 0.1 µs.

If it cannot be ruled out that the permissible voltage peaks will be exceeded or that the minimum pulse rise time will not be reached, the following measures must be initiated:

- Reduction of the DC-bus voltage (threshold for brake chopper voltage)
- Use of filters, chokes
- Use of special motor cables

Preparation

The notes for the electrical connection can be found in the enclosed mounting instructions.

EMC-compliant wiring

The EMC-compliant wiring is described in detail in the documentation of the Lenze inverters.

Technical data

Notes regarding the given data

The power values, torques and speeds specified in the configuration are rounded values and apply to:

- ambient temperature T_U = 40 °C for motors (in compliance with EN 60034)
- Site altitude ≤ 1000 m above mean sea level

The selection tables specify the inverter/ motor combination with the achievable torques.

The rated data applies to the S1 operating mode S1 (in accordance with EN 60034) and the operation on a servo inverter with a switching frequency of at least 4 kHz.

NOTICE

In case of other operating conditions, the achievable values can differ for those mentioned.

▶ In case of extreme operating conditions, please get in touch with your Lenze representative.

Standards and operating conditions

Conformities and approvals

Conformities			
CE	2011/65/EU	RoHS Directive	
	2014/30/EU	EMC Directive (reference: CE-typical drive system)	
	2014/35/EU	Low-Voltage Directive	
EAC	TP TC 020/2011	Eurasian conformity: Electromagnetic compatibility of technical means	
	TP TR 004/2011	Eurasian conformity: Safety of low voltage equipment	

Approvals			
cURus	-	UL 1004-1	for USA and Canada (requirements of the CSA 22.2 No. 100) servo motor, Lenze File No. E210321
		UL 1004-6	
UkrSepro		for Ukraine	

Protection of persons and device protection

Degree of protection			
EN	EN 60529,EN 60034-5	IP23S	

Temperature class			
Insulation system	EN 60034-1	F (155 °C)	Insulation system

Permissible voltage		
Limit curve A of the pulse voltage	IEC/TS 60034-25:2007	IEC/TS 60034-25:2007
IVIC C	IEC 60034-18-41	at 500 V

EMC data

Noise emission		
Fulfils requirements according to	EN 60034-1	A final overall assessment of the drive system is indispensable

Noise immunity		
Fulfils requirements according to	EN 60034-1	A final overall assessment of the drive system is indispensable

Environmental conditions

Climate			
Storage	EN IEC 60721-3-1:1997	1K3 (-20 ... +40 °C)	>3 months
		1K3 (-20 ... +60 °C)	<3 months
Transport	EN IEC 60721-3-2:1997	2K3 (-20 ... +70 °C)	
Operation	EN IEC 60721-3-3:1995 + A2:1997	3K3 (-10 ... +40 °C)	Operation with brake
		3K3 (-15 ...+40 °C)	Operation, without brake

Site altitude		
0 … 1000 m amsl	-	without current derating
1000 … 4000 m amsl		reduce power by 5 %/1000 m

Air humidity		
Without condensation	-	Average relative humidity 85 %

Vibration resistance		
Operation	EN IEC 60721-3-3:1995 + A2:1997	3M6

Vibration severity			
A	EN 60034-14	-	-

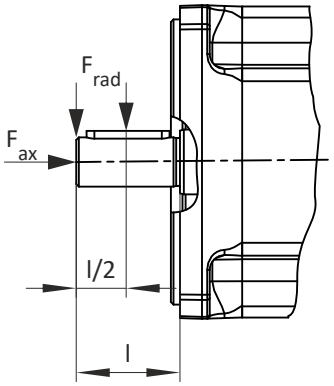
Vibration velocity		
Free suspension	-	1.6 mm/s

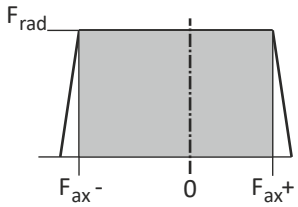
Smooth running, axial runout, concentricity			
Normal class	EN 50347 / IEC 60072-1	-	-

Radial forces and axial forces

The values of the bearing service life L_{10h} refer to an average motor speed of 3000 rpm. Depending on the ambient temperatures, they are also limited by the grease lifetime.

Application of forces





Application of force at l/2

Motor			MQA 20	MQA 22	MQA 26
Bearing service life 5000					
Radial force	F_{rad}	rated	3400	3600	6950
Min. axial force	$F_{ax,-}$	rated	-1330	-2370	-2500
Max. axial force	$F_{Fax,+}$	rated	690	1700	1580
Bearing service life 10000					
Radial force	F_{rad}	rated	2500	2800	5400
Min. axial force	$F_{ax,-}$	rated	-1020	-1740	-1800
Max. axial force	$F_{Fax,+}$	rated	380	1090	880
Bearing service life 20000					
Radial force	F_{rad}	rated	1950	2200	4300
Min. axial force	$F_{ax,-}$	rated	-780	-1280	-1300
Max. axial force	$F_{Fax,+}$	rated	140	640	380
Bearing service life 30000					
Radial force	F_{rad}	rated	1700	1900	3700
Min. axial force	$F_{ax,-}$	rated	-690	-1080	-1090
Max. axial force	$F_{Fax,+}$	rated	40	440	160
Bearing service life 50000					
Radial force	F_{rad}	rated	-	1600	-
Min. axial force	$F_{ax,-}$	rated	-	-880	-
Max. axial force	$F_{Fax,+}$	rated	-	240	-

Application of force at l

Motor			MQA 20	MQA 22	MQA 26
Bearing service life 5000					
Radial force	F_{rad}	rated	3150	3500	6400
Min. axial force	$F_{ax,-}$	rated	-1170	-2240	-2080
Max. axial force	$F_{Fax,+}$	rated	530	1600	1150
Bearing service life 10000					
Radial force	F_{rad}	rated	2300	2600	5000
Min. axial force	$F_{ax,-}$	rated	-920	-1640	-1600
Max. axial force	$F_{Fax,+}$	rated	280	1100	680
Bearing service life 20000					
Radial force	F_{rad}	rated	1800	2050	4000
Min. axial force	$F_{ax,-}$	rated	-710	-1200	-1160
Max. axial force	$F_{Fax,+}$	rated	70	560	230
Bearing service life 30000					
Radial force	F_{rad}	rated	1400	1800	3400
Min. axial force	$F_{ax,-}$	rated	-650	-1020	-1090
Max. axial force	$F_{Fax,+}$	rated	0	380	50
Bearing service life 50000					
Radial force	F_{rad}	rated	-	1450	-
Min. axial force	$F_{ax,-}$	rated	-	-850	-
Max. axial force	$F_{Fax,+}$	rated	-	200	-

Rated data

Inverter mains connection 400 V, Forced ventilated motors

Motor			MQA 20L29H	MQA 20L14H	MQA 22P29H	MQA 22P17H	MQA 22P14H	MQA 22P08H
Degree of protection			IP23	IP23	IP23	IP23	IP23	IP23
Standstill torque	M_0	Nm	76.0	76.0	156	156	156	156
Rated torque	M_{rated}	Nm	66.2	71.3	125	130	135	145
Max. torque	M_{max}	Nm	250	250	500	500	500	500
Rated speed	n_{rated}	rpm	2930	1420	2935	1670	1425	760
Max. speed	n_{max}	rpm	6500	6500	6500	6500	6500	6500
Rated power	P_{rated}	kW	20.3	10.6	38.4	22.7	20.1	11.5
Standstill current	I_0	A	54.0	27.0	102	59.0	51.0	29.5
Rated current	I_{rated}	A	46.9	26.5	86.0	50.3	45.6	27.6
Max. current	I_{max}	A	188	106	344	201	182	110
Rated voltage	V_{rated}	V	360	360	360	360	360	360
Rated frequency	f_{rated}	Hz	100	50	100	58	50	28
Moment of inertia	J	kgcm²	171	171	487	487	487	487
Efficiency	η		0.900	0.800	0.900	0.880	0.860	0.770
Stator terminal resistance	$R_{UV\ 20\ °C}$	Ω	0.183	0.731	0.089	0.268	0.357	1.072
Stator terminal resistance	$R_{UV\ 150\ °C}$	Ω	0.276	1.102	0.134	0.404	0.538	1.616
Mutual inductance	L_H	mH	13.68	57	23.2	23.86	93.3	92.8
Stator leakage inductance	$L_{1\sigma}$	mH	0.493	1.979	0.892	0.895	3.568	3.53
Rotor leakage inductance	$L_{2\sigma}$	mH	0.524	2.103	1.203	1.206	4.813	4.762
Stator resistance	$R_{1,\ 20}$	Ω	0.0915	0.365	0.134	0.134	0.536	0.536
Rotor resistance	$R_{2',\ 20}$	Ω	0.09	0.361	0.12	0.12	0.477	0.477
Weight	m	kg	63.0	63.0	102	102	102	102

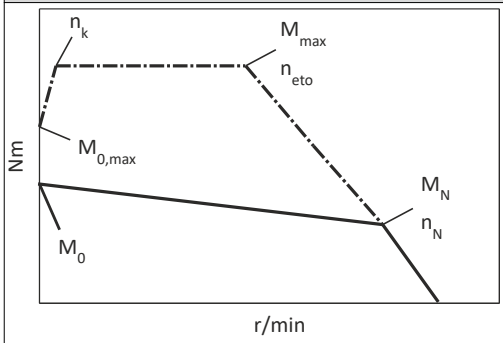
Motor			MQA 26T22H	MQA 26T12H	MQA 26T10H	MQA 26T05H
Degree of protection			IP23	IP23	IP23	IP23
Standstill torque	M_0	Nm	325	325	325	325
Rated torque	M_{rated}	Nm	257	282	288	296
Max. torque	M_{max}	Nm	1100	1100	1100	1100
Rated speed	n_{rated}	rpm	2235	1200	1030	550
Max. speed	n_{max}	rpm	5500	5500	5500	5500
Rated power	P_{rated}	kW	60.2	35.4	31.1	17
Standstill current	I_0	A	171	109	85.5	48.5
Rated current	I_{rated}	A	138	88.8	76.2	44.5
Max. current	I_{max}	A	552	355	305	178
Rated voltage	V_{rated}	V	340	360	360	360
Rated frequency	f_{rated}	Hz	76	42	36	20
Moment of inertia	J	kgcm²	1340	1340	1340	1340
Efficiency	η		0.920	0.820	0.870	0.810
Stator terminal resistance	$R_{UV\ 20\ °C}$	Ω	0.05	0.15	0.196	0.589
Stator terminal resistance	$R_{UV\ 150\ °C}$	Ω	0.075	0.226	0.295	0.888
Mutual inductance	L_H	mH	18.38	16.8	69.23	69.96
Stator leakage inductance	$L_{1\sigma}$	mH	0.78	0.65	2.91	2.873
Rotor leakage inductance	$L_{2\sigma}$	mH	1.3	0.69	5.09	5.049
Stator resistance	$R_{1,\ 20}$	Ω	0.075	0.075	0.294	0.294
Rotor resistance	$R_{2',\ 20}$	Ω	0.0621	0.1	0.25	0.25
Weight	m	kg	193	193	193	193

Selection tables

Notes on the selection tables

The selection tables represent the combinations of servo motors and servo inverters. The serve as a rough overview.

In the case of the servo inverters, the overload capacity depending on the switching frequency in the default setting is taken into consideration. For more information, please refer to the inverter documentation.

Graphical representation of the operating points		Explanation	Notes
	M_0	Standstill torque	
	$M_{0,max}$	Max. standstill torque	With an active load observe (e. g. vertical drive axes, hoists, test benches, unwinders).
	M_{rated}	Rated torque	
	n_{rated}	Rated speed	
	M_{max}	Max. torque	Can usually be used with a passive load (e. g. horizontal drive axes).
	n_{eto}	Transition speed	
	n_k	Derating speed	Due to a derating of the inverter output current to the derating speed, for some inverters the achievable max. standstill torque is smaller than the max. speed when the value of 5 Hz is not reached.

Derating speed

Motor	Derating speed
	n_k
	rpm
MQA20	150
MQA22	
MQA26	

9400 HighLine servo drives

The data apply to a mains voltage of 3x 400 V and a switching frequency of 8 kHz of the inverter.

If the motors are operated at a lower switching frequency, please get in touch with your Lenze representative!

When operating at 4 kHz, the motor generates just 95 % of its rated torque with increased noise emissions.

MQA20 ... 22, forced ventilated

Motor			Inverter								
			E94A□□								
			E0174	E0244	E0324	E0474	E0594	E0864	E1044	E1454	E1724
MQA20L14H											
Standstill torque	M_0	Nm	32.5	66.0							
Rated torque	M_{rated}	Nm	32.5	66.0							
Max. standstill torque	$M_{0,max}$	Nm	154.2	190.0							
Max. torque	M_{max}	Nm	154.2	190.0							
MQA20L29H											
Standstill torque	M_0	Nm			28.0	51.6	51.6				
Rated torque	M_{rated}	Nm			28.0	51.6	51.6				
Max. standstill torque	$M_{0,max}$	Nm			116.0	148.2	192.8				
Max. torque	M_{max}	Nm			116.0	148.2	192.8				
MQA22P08H											
Standstill torque	M_0	Nm		116.0	156.0						
Rated torque	M_{rated}	Nm		116.0	145.0						
Max. standstill torque	$M_{0,max}$	Nm		313.0	402.0						
Max. torque	M_{max}	Nm		313.0	402.0						
MQA22P14H											
Standstill torque	M_0	Nm					118.0				
Rated torque	M_{rated}	Nm					118.0				
Max. standstill torque	$M_{0,max}$	Nm					372.0				
Max. torque	M_{max}	Nm					372.0				
MQA22P17H											
Standstill torque	M_0	Nm					99.0	156.0			
Rated torque	M_{rated}	Nm					99.0	130.0			
Max. standstill torque	$M_{0,max}$	Nm					325.0	463.0			
Max. torque	M_{max}	Nm					325.0	463.0			
MQA22P29H											
Standstill torque	M_0	Nm							109.0	156.0	156.0
Rated torque	M_{rated}	Nm							109.0	125.0	125.0
Max. standstill torque	$M_{0,max}$	Nm							335.0	416.0	486.0
Max. torque	M_{max}	Nm							335.0	416.0	486.0

MQA26, forced ventilated

Motor			Inverter									
			E94A□□									
			E0474	E0594	E0864	E1044	E1454	E1724	E2024	E2454	E2924	E3664
MQA26T05H												
Standstill torque	M_0	Nm	268.0	268.0	325.0							
Rated torque	M_{rated}	Nm	268.0	268.0	296.0							
Max. standstill torque	$M_{0,max}$	Nm	665.0	826.0	1100.0							
Max. torque	M_{max}	Nm	665.0	826.0	1100.0							
MQA26T10H												
Standstill torque	M_0	Nm			270.0	298.0	325.0					
Rated torque	M_{rated}	Nm			270.0	288.0	288.0					
Max. standstill torque	$M_{0,max}$	Nm			713.0	855.0	1044.0					
Max. torque	M_{max}	Nm			713.0	855.0	1044.0					
MQA26T12H												
Standstill torque	M_0	Nm				219.0	291.0	325.0	325.0			
Rated torque	M_{rated}	Nm				219.0	282.0	282.0	282.0			
Max. standstill torque	$M_{0,max}$	Nm				609.0	739.0	840.0	950.0			
Max. torque	M_{max}	Nm				609.0	739.0	840.0	950.0			
MQA26T22H												
Standstill torque	M_0	Nm							242.0	290.0	325.0	325.0
Rated torque	M_{rated}	Nm							242.0	257.0	257.0	257.0
Max. standstill torque	$M_{0,max}$	Nm							711.0	843.0	1001.0	1100.0
Max. torque	M_{max}	Nm							711.0	843.0	1001.0	1100.0

8400 TopLine inverter drives

The data apply to a mains voltage of 3x 400 V and a switching frequency of 8 kHz of the inverter.

If the motors are operated at a lower switching frequency, please get in touch with your Lenze representative!

When operating at 4 kHz, the motor generates just 95 % of its rated torque with increased noise emissions.

MQA20 ... 22, forced ventilated

Motor			Inverter						
			E84AVTC□						
			1134	1534	1834	2234	3034	3734	4534
MQA20L14H									
Standstill torque	M_0	Nm	-	76.0	76.0	76.0	76.0		
Rated torque	M_{rated}	Nm	-	71.3	71.3	71.3	71.3		
Max. standstill torque	$M_{0,max}$	Nm	146.0	202.0	249.2	250.0	250.0		
Max. torque	M_{max}	Nm	146.0	202.2	249.2	250.0	250.0		
MQA20L29H									
Standstill torque	M_0	Nm			-	76.0	76.0	76.0	76.0
Rated torque	M_{rated}	Nm			-	66.2	66.2	66.2	66.2
Max. standstill torque	$M_{0,max}$	Nm			121.8	140.9	183.7	224.5	250.0
Max. torque	M_{max}	Nm			121.8	140.9	183.9	225.5	250.0
MQA22P08H									
Standstill torque	M_0	Nm	-	156.0	156.0	156.0	156.0		
Rated torque	M_{rated}	Nm	-	144.5	144.5	144.5	144.5		
Max. standstill torque	$M_{0,max}$	Nm	222.8	310.5	377.0	372.9	374.6		
Max. torque	M_{max}	Nm	223.0	310.5	377.0	372.9	374.6		
MQA22P14H									
Standstill torque	M_0	Nm		-	-	156.0	156.0	156.0	156.0
Rated torque	M_{rated}	Nm		-	-	134.7	134.7	134.7	134.7
Max. standstill torque	$M_{0,max}$	Nm		185.1	230.6	267.1	343.7	418.3	500.0
Max. torque	M_{max}	Nm		185.1	230.6	267.1	344.4	420.0	500.0
MQA22P17H									
Standstill torque	M_0	Nm			-	-	156.0	156.0	156.0
Rated torque	M_{rated}	Nm			-	-	129.8	129.8	129.8
Max. standstill torque	$M_{0,max}$	Nm			198.6	230.2	300.0	365.3	447.0
Max. torque	M_{max}	Nm			198.6	230.4	300.0	367.5	449.9
MQA22P29H									
Standstill torque	M_0	Nm					-	-	156.0
Rated torque	M_{rated}	Nm					-	-	124.9
Max. standstill torque	$M_{0,max}$	Nm					176.1	218.9	263.2
Max. torque	M_{max}	Nm					176.4	219.6	264.1

MQA26, forced ventilated

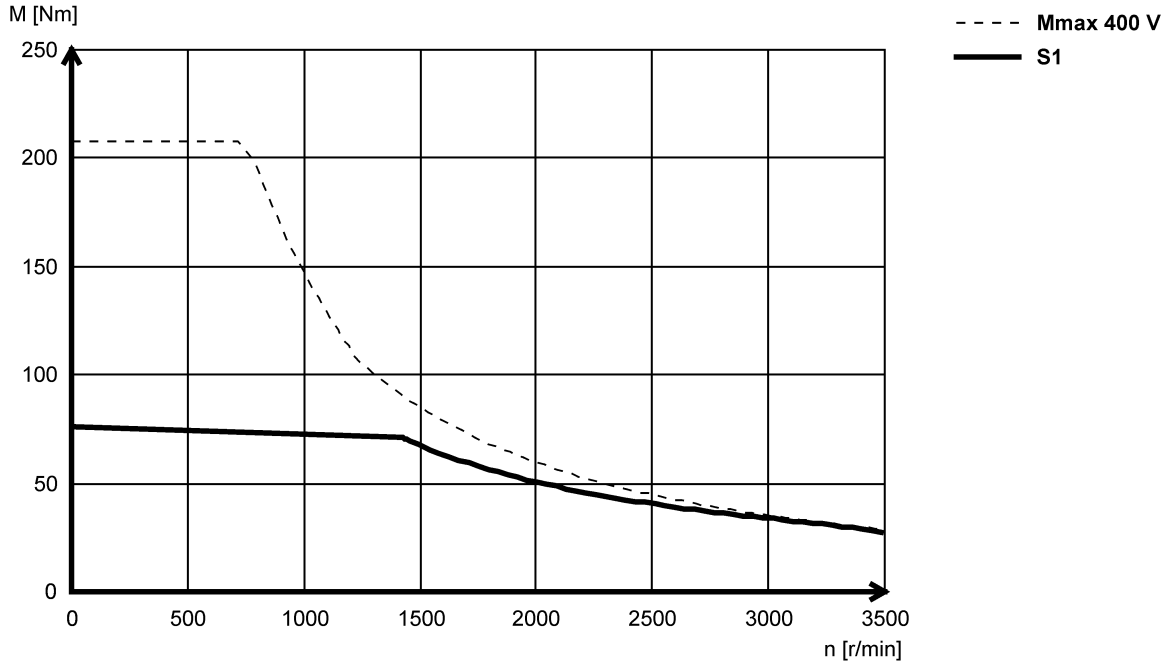
Motor			Inverter					
			E84AVTC□					
			1534	1834	2234	3034	3734	4534
MQA26T05H								
Standstill torque	M_0	Nm	-	-	325.0	325.0	325.0	325.0
Rated torque	M_{rated}	Nm	-	-	295.2	295.2	295.2	295.2
Max. standstill torque	$M_{0,max}$	Nm	390.4	489.6	567.1	744.4	902.3	1080.2
Max. torque	M_{max}	Nm	390.4	490.2	568.0	744.8	904.7	1080.2
MQA26T10H								
Standstill torque	M_0	Nm				-	-	325.0
Rated torque	M_{rated}	Nm				-	-	288.3
Max. standstill torque	$M_{0,max}$	Nm				429.7	532.5	638.2
Max. torque	M_{max}	Nm				431.4	534.1	641.5
MQA26T12H								
Standstill torque	M_0	Nm					-	325.0
Rated torque	M_{rated}	Nm					-	281.7
Max. standstill torque	$M_{0,max}$	Nm					458.2	550.4
Max. torque	M_{max}	Nm					460.6	552.9

Torque characteristics

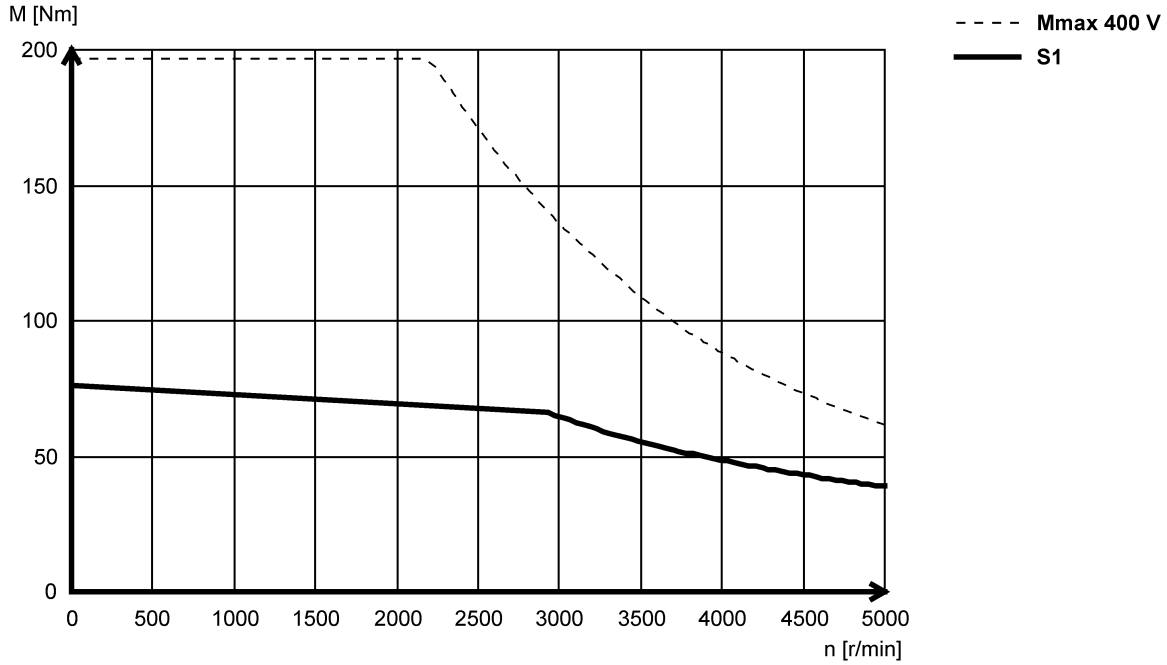
The torque/speed characteristic for your motor/inverter combination can be found on the Internet:
http://www.lenze.com → Product Finder → M-n characteristics

The following data apply to a mains voltage 3 x 400 V of the inverter.

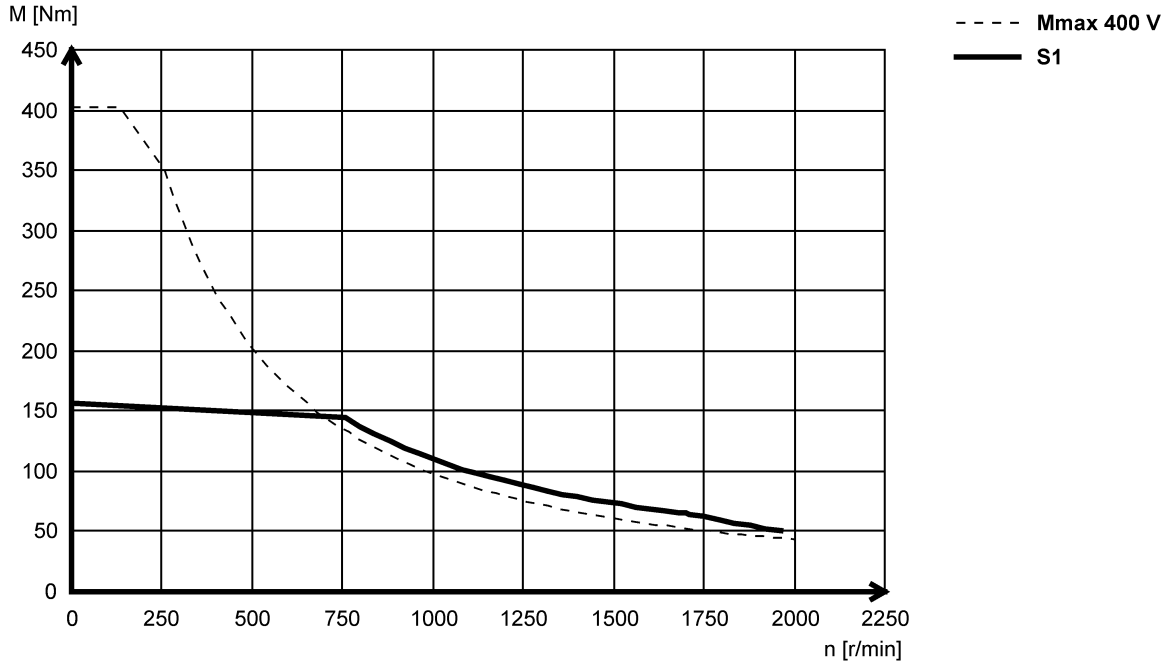
MQA20L14H (forced ventilated)



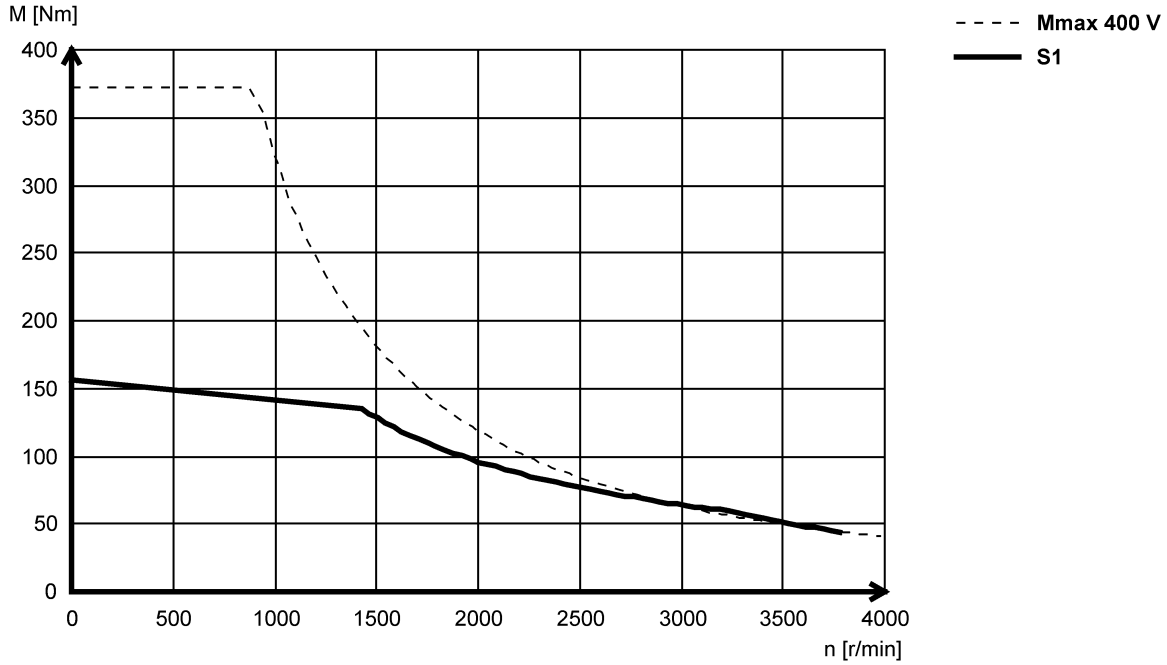
MQA20L29H (forced ventilated)



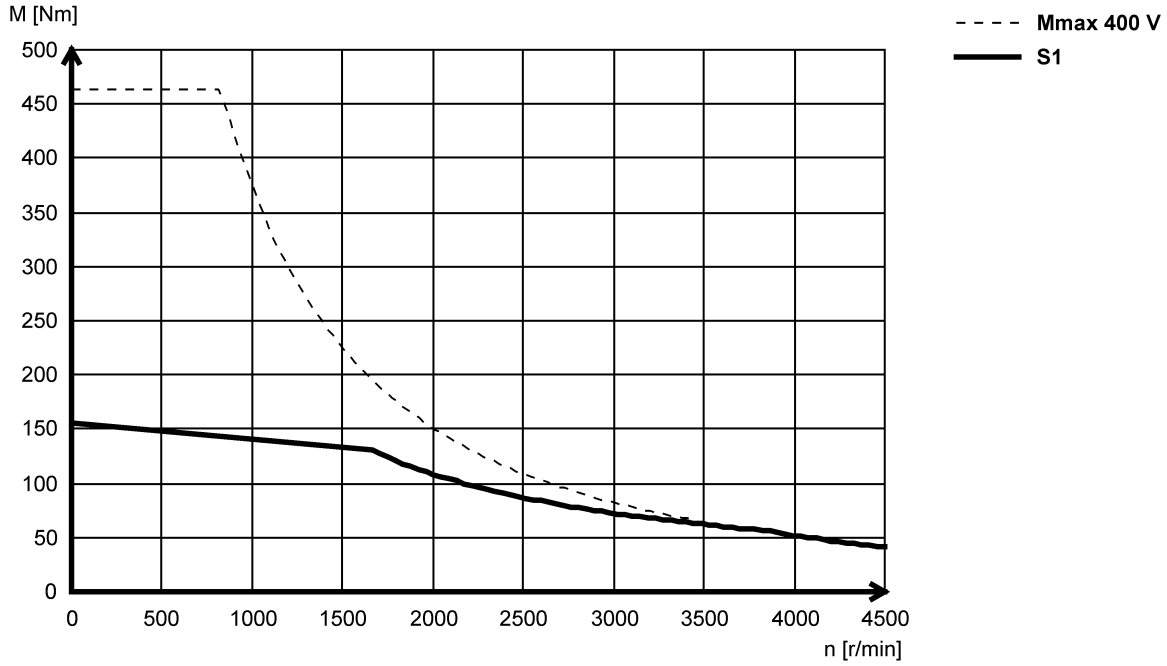
MQA22P08H (forced ventilated)



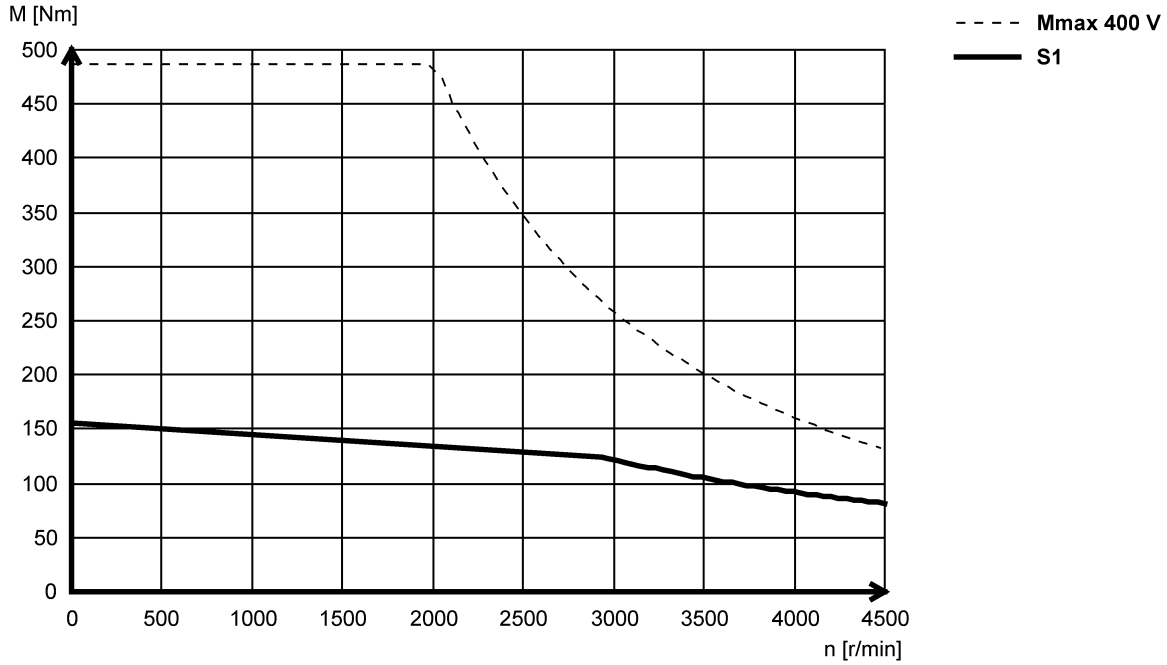
MQA22P14H (forced ventilated)



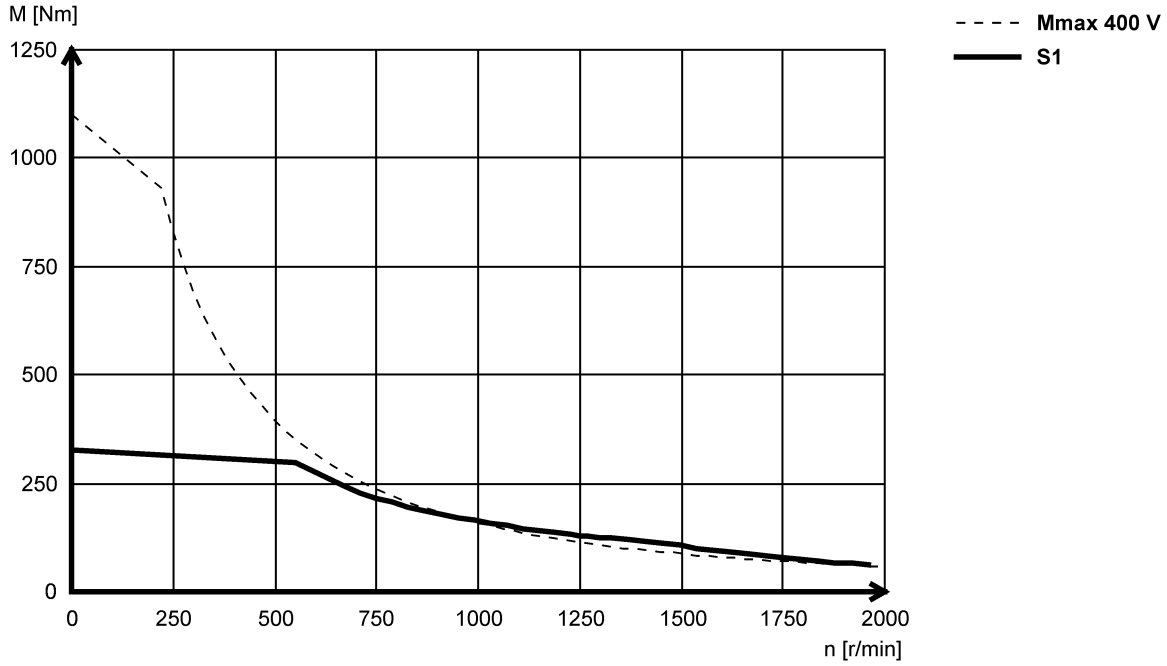
MQA22P17H (forced ventilated)



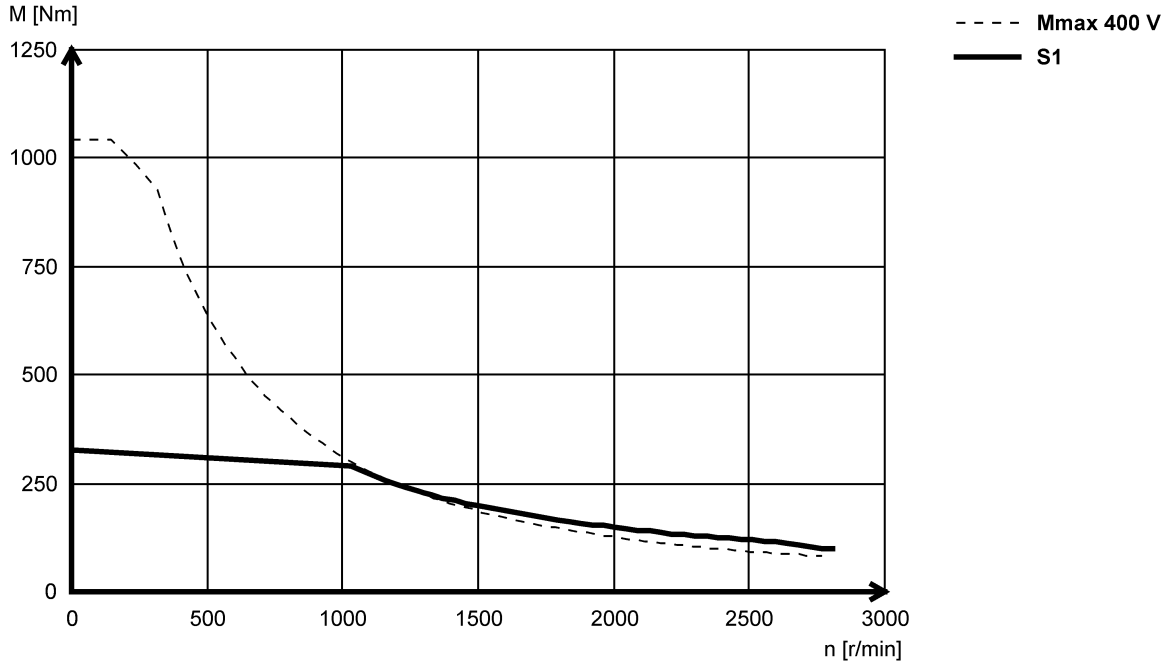
MQA22P29H (forced ventilated)



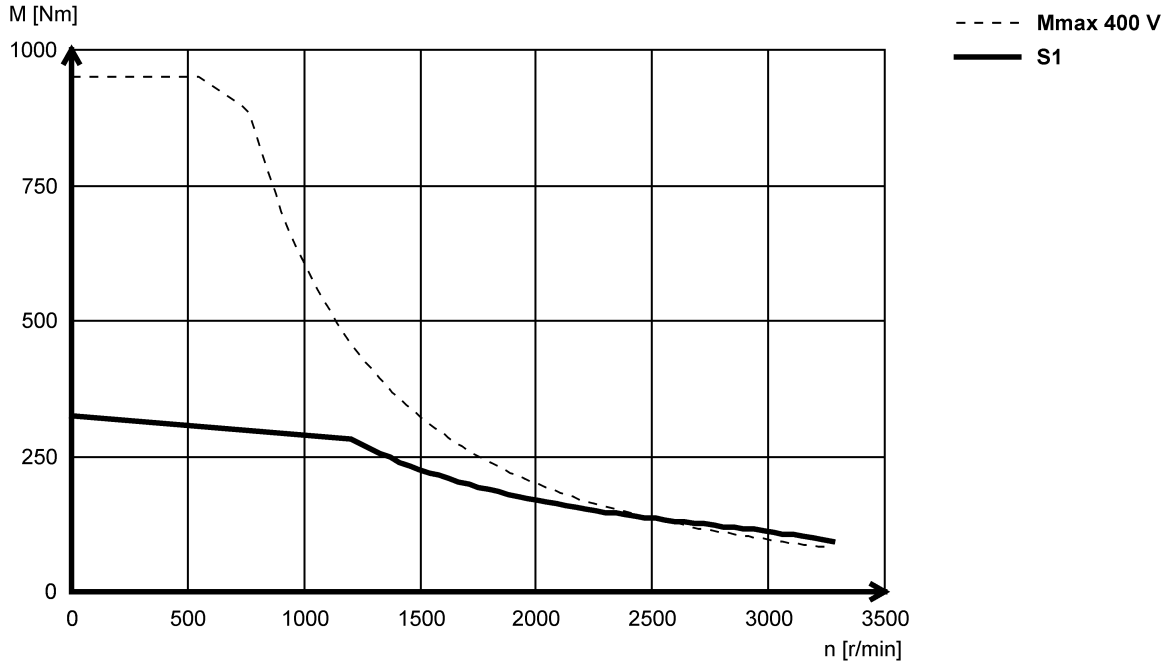
MQA26T05H (forced ventilated)



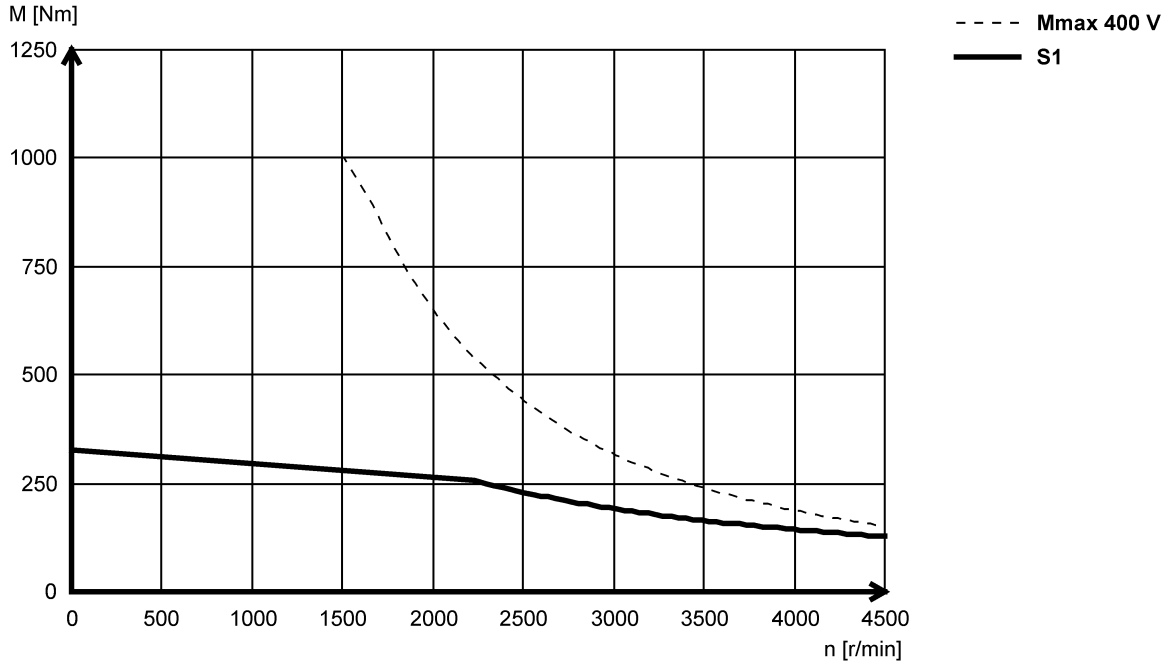
MQA26T10H (forced ventilated)



MQA26T12H (forced ventilated)



MQA26T22H (forced ventilated)



Dimensions

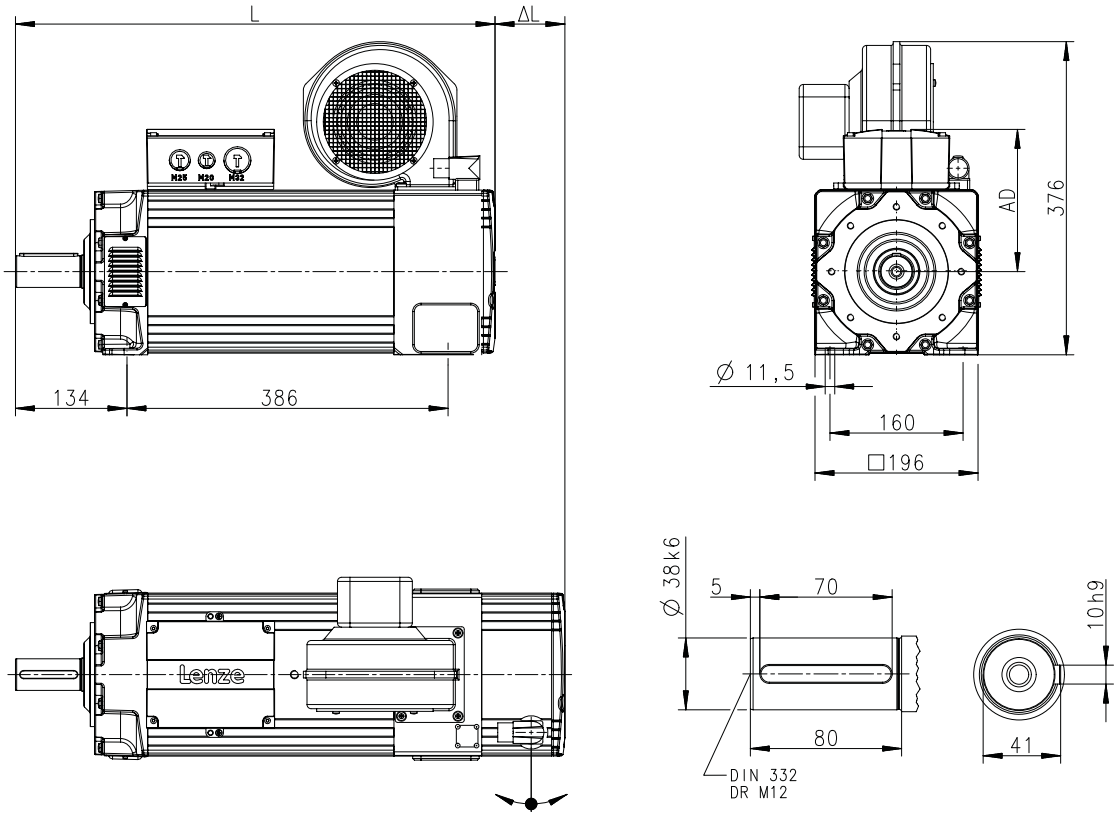
Notes on the basic dimensions

Table content		Explanation
Total length without brake	L	Total length of the drive with resolver
Total length with brake	L	Total length of the drive with resolver
Motor/connection distance	AD	Distance from center of motor to end of connector/terminal box

Basic dimensions

MQA20, forced ventilated

Design B3



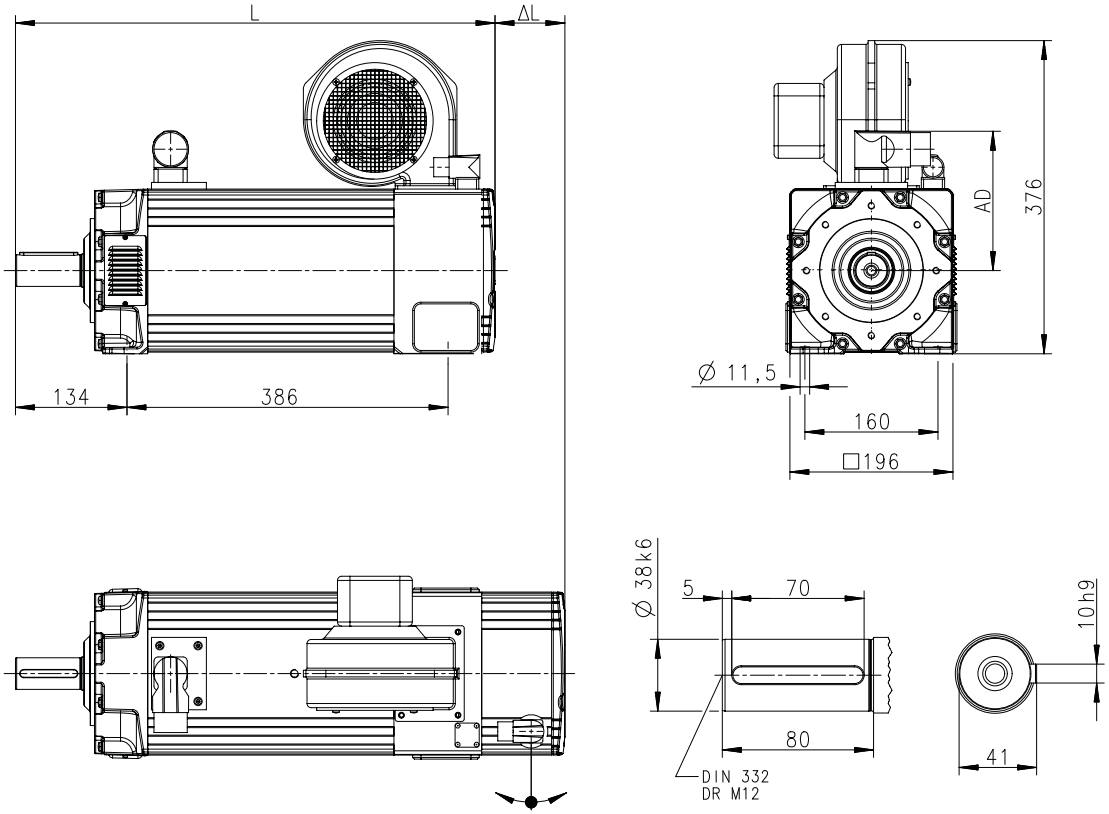
8800714-00

Motor			MQA 20L14H	MQA 20L29H
Total length without brake	L	mm	577	
Motor/connection distance	AD	mm	171	

Δ L ▸ Additional lengths 🕮 49

MQA20, forced ventilated

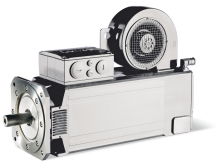
Design B3



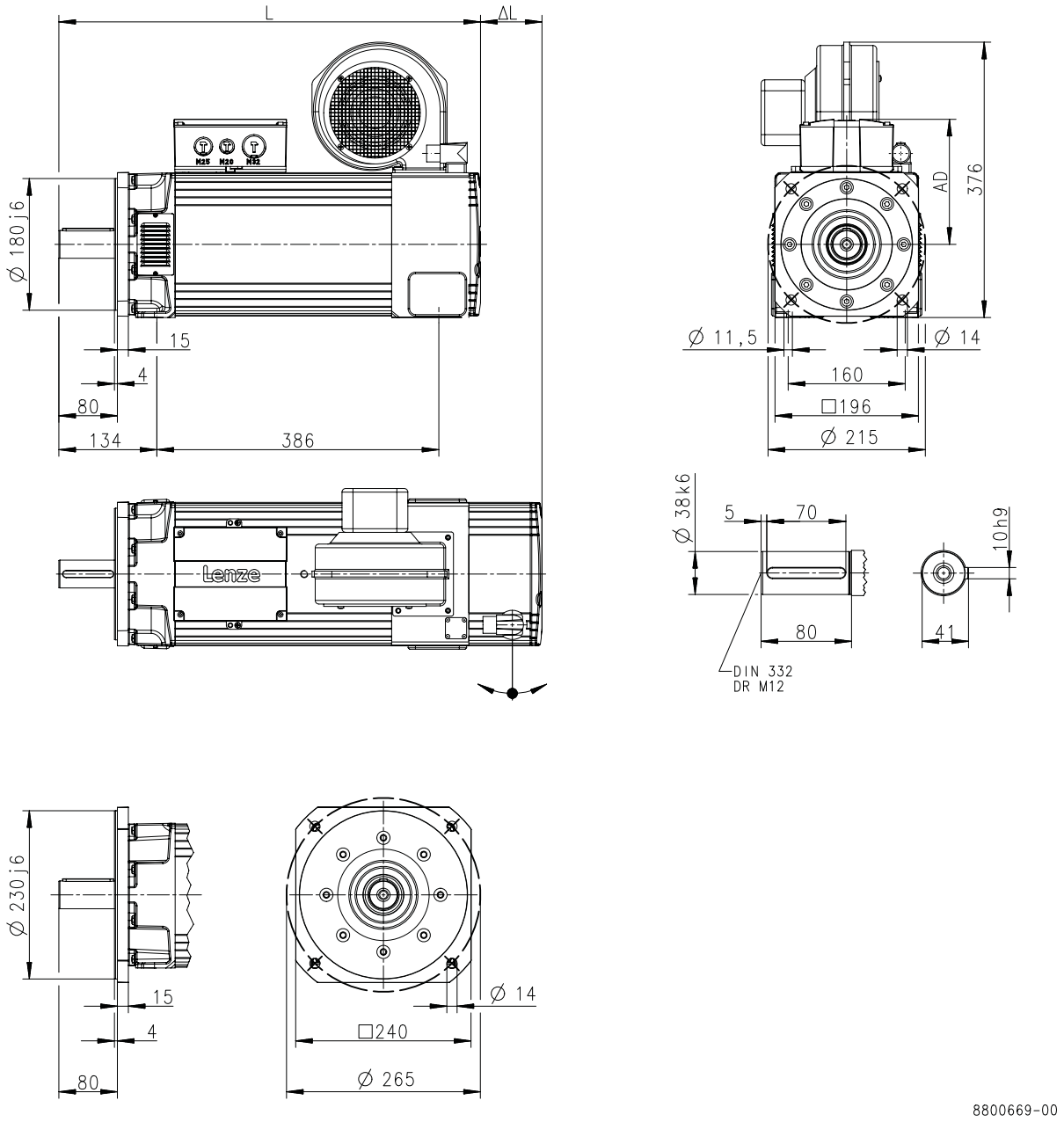
8800712-00

Motor			MQA 20L14H	MQA 20L29H
Total length without brake	L	mm	577	
Motor/connection distance	AD	mm	171	

Δ L ▸ Additional lengths 🕮 49



MQA20, forced ventilated
Design B35-FF215/265



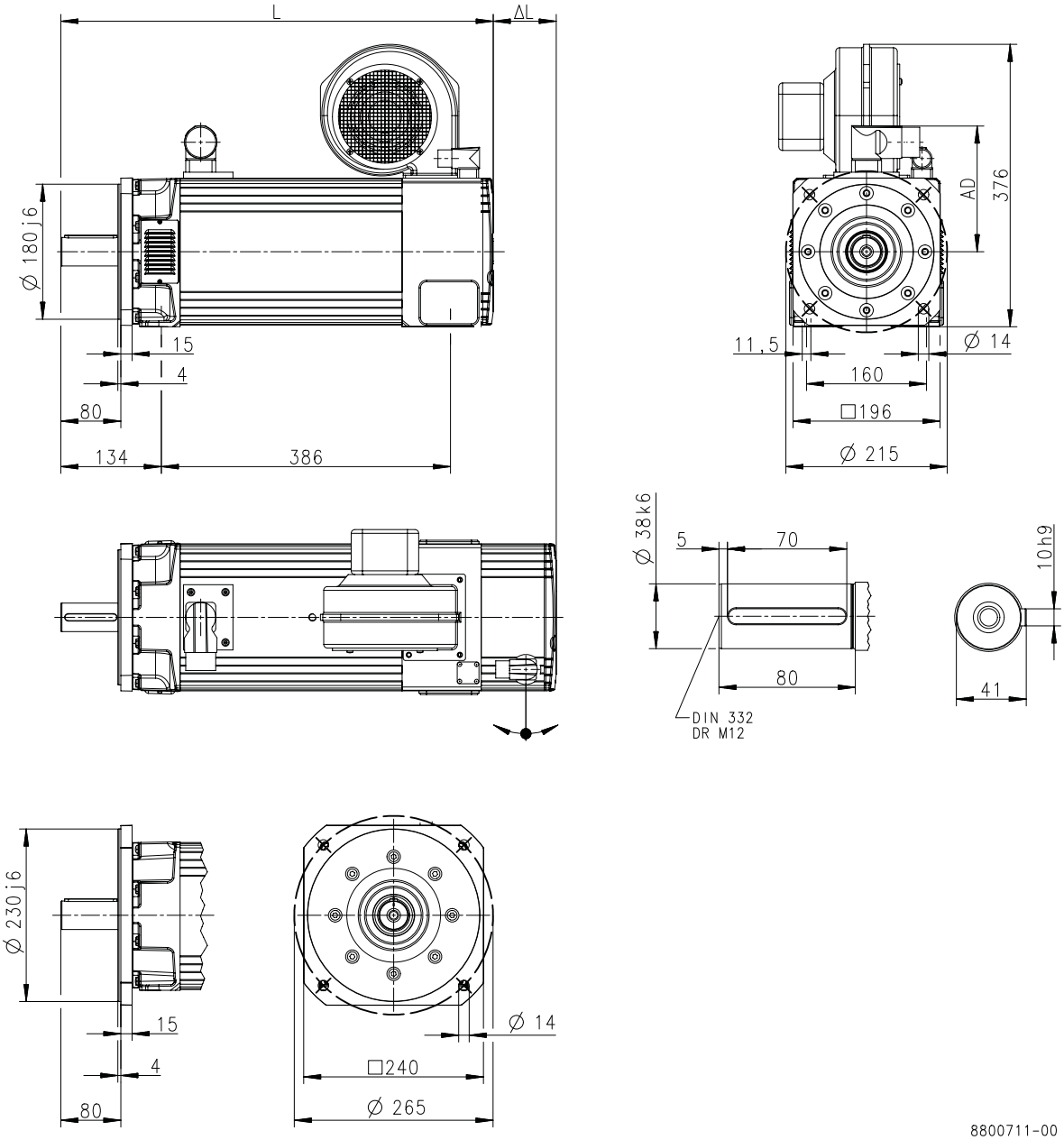
8800669-00

Motor			MQA 20L14H	MQA 20L29H
Total length without brake	L	mm	577	
Motor/connection distance	AD	mm	171	

Δ L ▸ Additional lengths 📖 49

MQA20, forced ventilated

Design B35-FF215/265

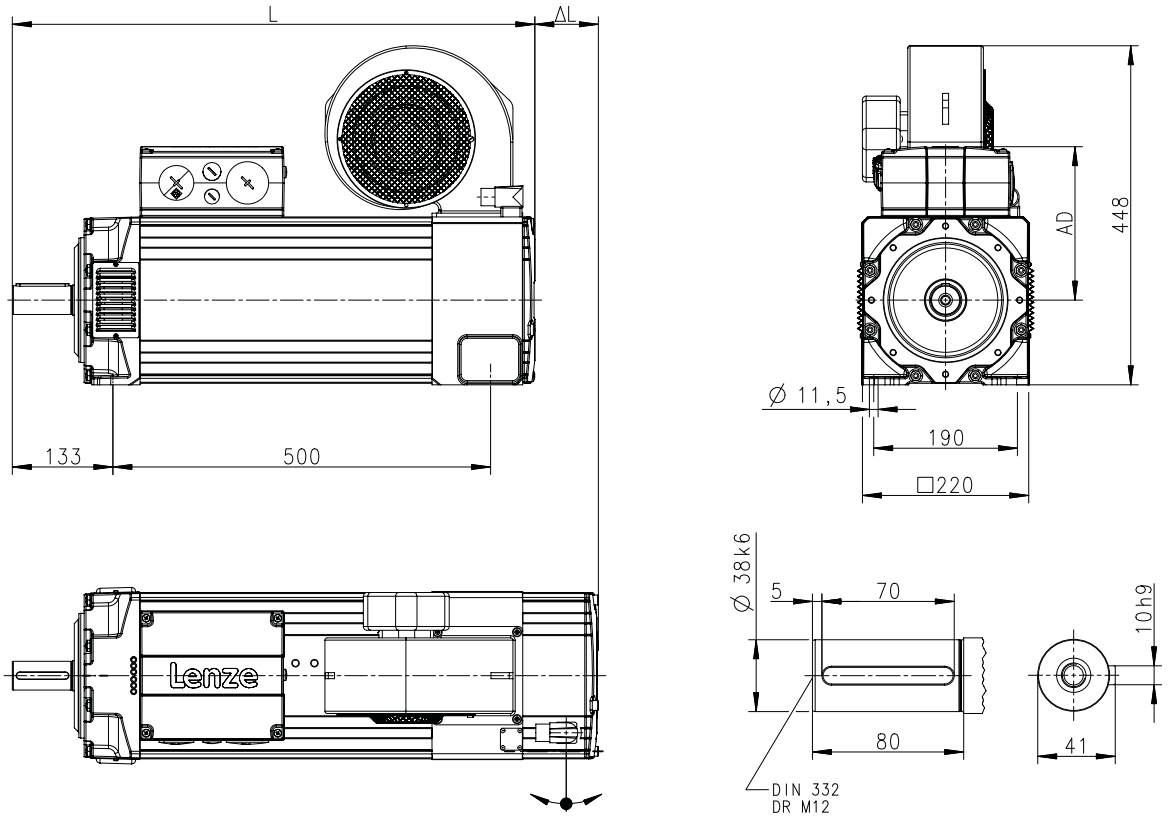


Motor			MQA 20L14H	MQA 20L29H
Total length without brake	L	mm	577	
Motor/connection distance	AD	mm	171	

Δ L ▸ Additional lengths 🕮 49

MQA22, forced ventilated

Design B3



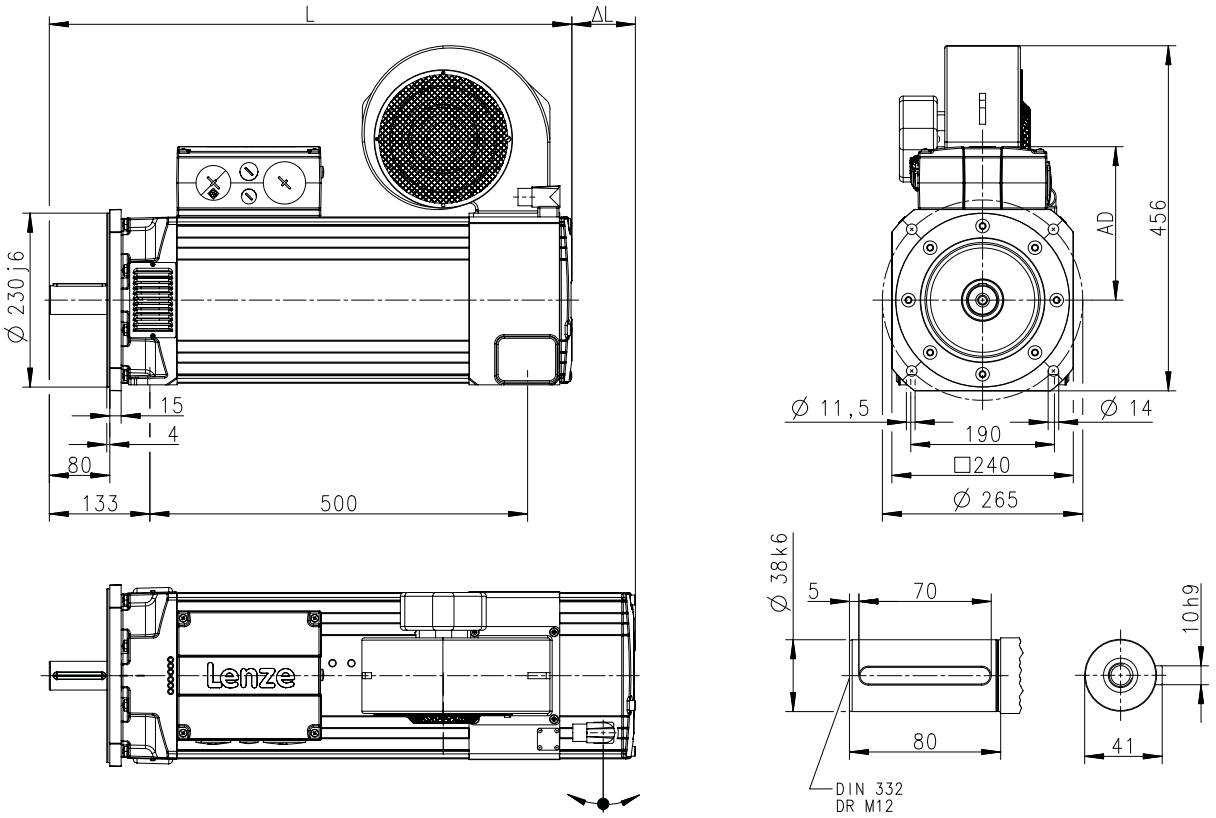
8800716-00

Motor			MQA 22P08H	MQA 22P14H	MQA 22P17H	MQA 22P29H
Total length without brake	L	mm	691			
Motor/connection distance	AD	mm	203			

Δ L ▸ Additional lengths 🕮 49

MQA22, forced ventilated

Design B35-FF265



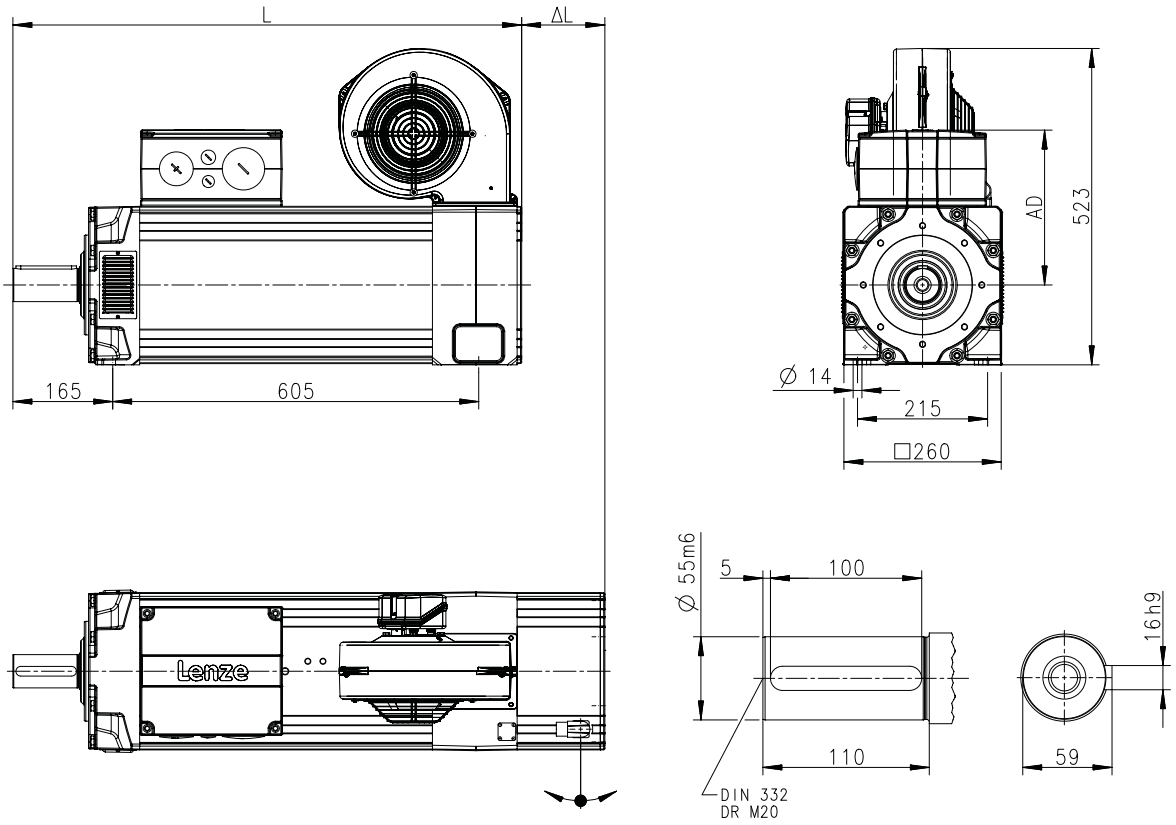
8800715-00

Motor			MQA 22P08H	MQA 22P14H	MQA 22P17H	MQA 22P29H
Total length without brake	L	mm	691			
Motor/connection distance	AD	mm	203			

Δ L ▸ Additional lengths 🕮 49

MQA26, forced ventilated

Design B3



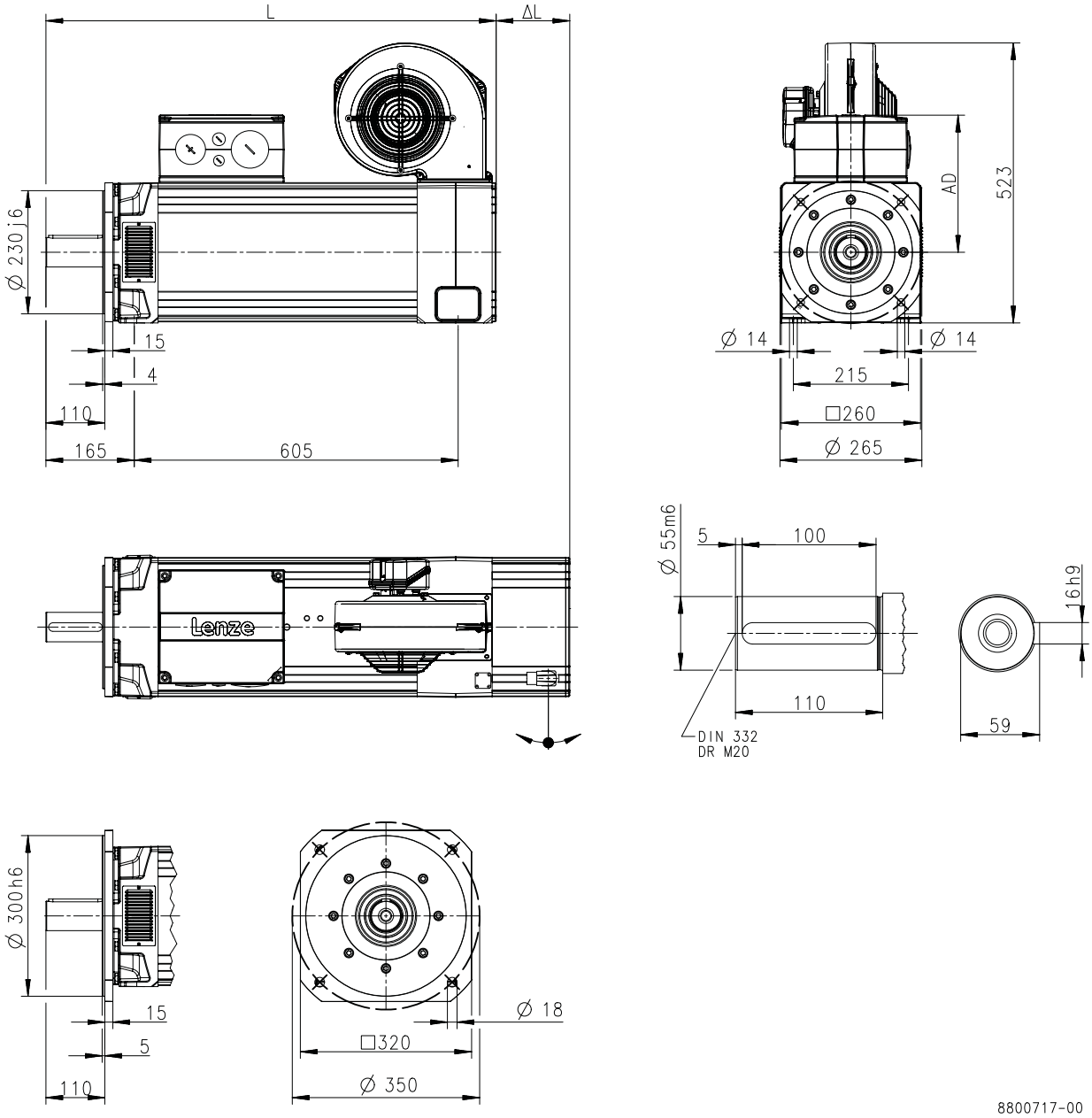
8800718-00

Motor			MQA 26T05H	MQA 26T10H	MQA 26T12H	MQA 26T22H
Total length without brake	L	mm	841			
Motor/connection distance	AD	mm	256			

Δ L ▸ Additional lengths 🕮 49

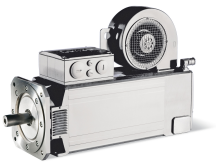
MQA26, forced ventilated

Design B35-FF350



Motor			MQA 26T05H	MQA 26T10H	MQA 26T12H	MQA 26T22H
Total length without brake	L	mm	841			
Motor/connection distance	AD	mm	256			

Δ L ▸ Additional lengths 🕮 49



Additional lengths

The motor code indicates the short designation of the brake and feedback.
Detailed information can be found for

- Product codes 📖 68
- Brakes 📖 57
- Feedback 📖 62

MQA20

Motor			MQA20L14H	MQA20L29H
Cooling type			**Forced**	**Forced**
Feedback (without brake B0)				
R☐0	Δ L	mm	0	
S☐☐ / T☐☐ / E☐☐	Δ L	mm	0	
Brake (F1/FG) and feedback				
R☐0	Δ L	mm	84	
S☐☐ / T☐☐ / E☐☐	Δ L	mm	127	
Brake (F2/FH) and feedback				
R☐0	Δ L	mm	152	
S☐☐ / T☐☐ / E☐☐	Δ L	mm	152	

MQA22

Motor			MQA22P08H	MQA22P14H	MQA22P17H	MQA22P29H
Cooling type			**Forced**	**Forced**	**Forced**	**Forced**
Feedback (without brake B0)						
R☐0	Δ L	mm	0			
S☐☐ / T☐☐ / E☐☐	Δ L	mm	0			
Brake (F1/FG) and feedback						
R☐0	Δ L	mm	82			
S☐☐ / T☐☐ / E☐☐	Δ L	mm	125			
Brake (F2/FH) and feedback						
R☐0	Δ L	mm	157			
S☐☐ / T☐☐ / E☐☐	Δ L	mm	157			

MQA26

Motor			MQA26T05H	MQA26T10H	MQA26T12H	MQA26T22H
Cooling type			**Forced**	**Forced**	**Forced**	**Forced**
Feedback (without brake B0)						
R☐0	Δ L	mm	0			
S☐☐ / T☐☐ / E☐☐	Δ L	mm	0			
Brake (F1/FG) and feedback						
R☐0	Δ L	mm	138			
S☐☐ / T☐☐ / E☐☐	Δ L	mm	176			
Brake (F2/FH) and feedback						
R☐0	Δ L	mm	176			
S☐☐ / T☐☐ / E☐☐	Δ L	mm	176			

Weights

Basic weights

The basic weights are listed in the rated data.

▸ Rated data 📖 28

Observe ▸ Additional weights 📖 50!

Additional weights

Motors

Motor			MQA20	MQA22	MQA26
Spring-applied holding brake					
Standard braking torque	m	kg	13.0	20.5	30.7
Increased braking torque	m	kg	15.4	26	-

Product extensions

Motor connection

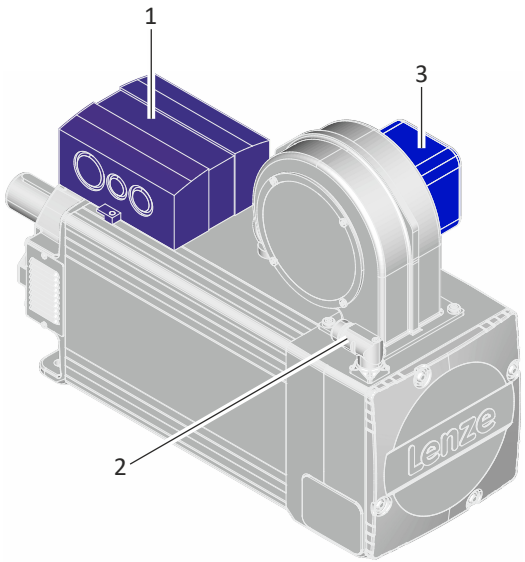
Connection via terminal box

If a motor is to be connected to an existing cable or plug connectors are not to be used for other reasons, the connection can also be made via a terminal box.

The connection for feedback and temperature monitoring is generally via the ICN connector and the electric fan is connected via a terminal box.

The terminals are designed as tension spring terminals to ensure here the long-term vibration resistance of the cable contacts with adequate contact pressure required.

Position of the connections



Position	Meaning
1	Power connection Brake connection PE connection
2	Feedback connection Connection of temperature monitoring
3	Blower connection

Cable glands

The cut-outs for the cable glands are closed with sealing plugs.

The cable glands are arranged on both sides with MQA20.

The cable glands are arranged on one side with MQA22 and MQA26. If required, the terminal box can be rotated by 180 ° after loosening the screws in the terminal box.

Motor		MQA20	MQA22	MQA26
Screwed connections		2x M20 x 1.5 2x M25 x 1.5 2x M32 x 1.5	1x M40 x 1.5 1x M50 x 1.5 1x M20 x 1.5 1x M16 x 1.5	1x M50 x 1.5 1x M63 x 1.5 1x M20 x 1.5 1x M16 x 1.5
Cable cross-section	mm^2	2.5 ... 16	10 ... 35	-
Terminal design		Spring-loaded terminal	Screw terminal	Threaded bolt
Stripping length	mm	18 ... 20	18	-
Threaded bolt		-	-	M12
Tightening torque	Nm	-	3.2	15.5

Terminal box, power		
Contact	**Name**	**Meaning**
U1	L1	Motor winding phase
V1	L2	
W1	L3	
PE	PE	PE conductor

Terminal box, DC brake		
Contact	**Name**	**Meaning**
BD1	+	Brake +
BD2	-	Brake -

Terminal box, AC brake		
Contact	**Name**	**Meaning**
~	L1	Mains
	N	
+	+	Holding brake (factory-wired)
-	-	
Schalter		Switching contact - DC switching

Terminal box, temperature monitoring		
Contact	**Name**	**Meaning**
R1	+	Temperature sensor +
R2	-	Temperature sensor -

Terminal box, 1-phase separate fan		
Contact	**Name**	**Meaning**
PE	PE	PE conductor
U1	L1	Mains
U2	N	

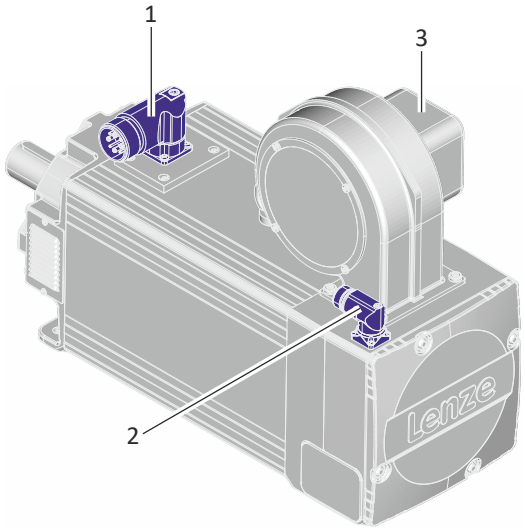
Terminal box, 3-phase separate fan		
Contact	**Name**	**Meaning**
PE	PE	PE conductor
U1	L1	Mains connection
V1	L2	
W1	L3	

Connection via ICN connector

The connectors can be rotated by 270 ° and are provided with a bayonet catch. Since the catch of the connector is also compatible with conventional box nuts, existing mating connectors with a screw plug can continue to be used without any problems.

In order to provide for a quick and error-free connection of Lenze motors to Lenze inverters, we recommend using prefabricated Lenze system cables.

Position of the connections



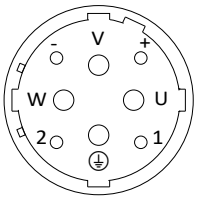
Position	Meaning
1	Power connection Brake connection PE connection
2	Feedback connection Connection of temperature monitoring
3	Blower connection

Power and brake connection

Valid for MQA20

ICN-M40 connector assignment

8-pole

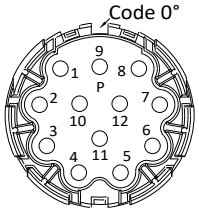


ICN M40 8-pole		
Contact	**Name**	**Meaning**
+	BD1	Holding brake +
-	BD2	Holding brake -
PE	PE	PE conductor
U	U	Power phase U
V	V	Power phase V
W	W	Power phase W
1		Not assigned
2		Not assigned

Feedback and temperature monitoring connection

ICN-M23 connector assignment

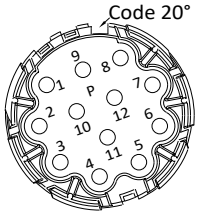
Resolver



ICN M23 for resolvers		
Contact	**Name**	**Meaning**
1	+Ref	Transformer windings
2	-Ref	Transformer windings
3	+VCC ETS	Supply: Electronic nameplate (Only for motors and inverters that support this function)
4	+COS	Stator windings cosine
5	-COS	Stator windings cosine
6	+SIN	Stator windings sine
7	-SIN	Stator windings sine
8		Not assigned
9		Not assigned
10	Schirm	Encoder housing shield
11	+	Temperature monitoring: PT1000
12	-	Temperature monitoring: PT1000

ICN-M23 connector assignment

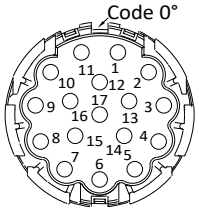
Incremental and SinCos absolute value encoder Hiperface©



ICN M23 for incremental and SinCos absolute value encoder Hiperface		
Contact	**Name**	**Meaning**
1	B	Track B / + SIN
2	A^-	Track A inverse /-COS
3	A	Track A / + COS
4	+UB	Supply +
5	GND	Mass
6	Z^-	Zero track inverse /-RS485
7	Z	Zero track / + RS485
8		Not assigned
9	B^-	Track B inverse/-SIN
10	Schirm	Encoder housing shield
11	+	Temperature monitoring: PT1000
12	-	Temperature monitoring: PT1000

ICN-M23 connector assignment

SinCos absolute value encoder with EnDat interface



ICN M23 SinCos absolute value encoder with EnDat		
Contact	**Name**	**Meaning**
1	UP Sensor	Up Sensor
2		Not assigned
3		Not assigned
4	0 V Sensor	0 V sensor
5	+	PT1000/KTY temperature sensor
6	-	PT1000/KTY temperature sensor
7	+UB	Supply +
8	Takt	EnDat interface cycle
9	Takt-	Inverse EnDat interface cycle
10	GND	Mass
11	Schirm	Encoder housing shield
12	B	Track B
13	B-	Track B inverse/-SIN
14	Daten	EnDat interface data
15	A	Track A
16	A-	Track A inverse /-COS
17	Daten-	Data inverse EnDat interface

Brakes

⚠CAUTION!

They may not be used as safety elements (particularly with hoist axes) without additional measures being implemented.

The brakes used are not fail-safe brakes in the sense that prospective disruptive factors, e.g. oil ingress, can lead to a reduction in torque!

- The brakes must only be used as holding brakes for holding the axes at a standstill or in the deenergised state.
- The brake must not be used as a service brake.

⚠CAUTION!

If no suitable voltage (incorrect value, incorrect polarity) is applied to the brake, the brake will be applied and can be overheated and destroyed by the motor continuing to rotate.

Motor supply cables

If long motor supply cables are used, pay attention to the ohmic voltage drop along the cable and compensate for it with a higher voltage at the input end of the cable.

The following applies to Lenze system cables:

$$U[V] = U_B[V] + 0.08\frac{[V]}{[A]\times[m]} \times l_{Lg}[m] \times I_B[A]$$

U	V	Resulting supply voltage
U_B	V	Rated voltage of the brake
l_{Lg}	m	Cable length
I_B	A	Rated current of the brake

NOTICE

- The brakes become active when the supply voltage has been switched off (closed-circuit principle).
- When using the brakes purely as holding brakes, virtually no wear occurs on the friction surfaces.
- The friction surfaces must always be free from oil and grease because even small amounts of grease or oil will considerably reduce the braking torque.

NOTICE

In case of travel axes, the compliance of the permissible ratio of mass inertia load/brake motor (J_L/J_{MB}) ensures that the permissible maximum switching energy of the brake will not be exceeded and at least the values given for the emergency stop functions from the given speed (see rated data) are applied.

For hoist axes, the load torque resulting from the weight acts additionally. In this case, the specifications for (J_L/J_{MB}) do not apply.

To simplify matters, the friction energy per switching cycle can be calculated using the formula below and must not exceed the limit value for emergency stops, which depends on the switching rate:

$$Q = \frac{1}{2} \times J_{ges} \times \left(2\pi \times \frac{\Delta n}{60} \right)^2 \times \frac{M_N}{M_N - M_L}$$

Q	J	Friction energy
J_{total}	kgm^2	Total mass inertia (motor + load)
Δn	rpm	Differential speed
M_N	Nm	Rated torque of the brake
M_L	nM	Load torque

The shortest operating times of the brakes are achieved by DC switching of the voltage and an external suppressor circuit (varistor or spark suppressor).

Without suppressor circuit, the operating times may increase. A varistor/ spark suppressor limits the breaking voltage peaks. It must be ensured that the power limit of the suppressor circuit is not exceeded. This limit depends on the brake current, brake voltage, disengagement time and the switching operations per time unit.

Furthermore the suppressor circuit is necessary for interference suppression and for increasing the service life of the relay contacts (external, is not integrated into the motor).

It is not possible to readjust the brake.

Spring-applied brakes

Rated data

Engagement and disengagement times apply to rated voltage (± 0 %) and suppressor circuit of the brakes with a varistor with DC switching. Without a suppressor circuit, the times may be longer.

The currents are the maximum values when the brake is cold (value used for dimensioning the current supply). The values for a motor at operating temperature are considerably lower.

With 24 V DC brake: smoothed DC voltage, ripple ≤ 1 %.

With 230 V AC brake: connection to an integrated rectifier (no cURus possible).

Maximum switching energy for each emergency stop with n= 3000 rpm for at least 300 , and a maximum of 4 emergency stops per hour.

Standard braking torque

Supply voltage DC 24 V

Motor			MQA20L	MQA22P	MQA26T
Supply voltage range	V_{in}	V	21.6 ... 26.4		
Supply voltage	V_{rated}	V	24		
Bemessungsdrehmoment					
At 20 °C	M_{rated}	Nm	90	150	300
At 120 °C	M_{rated}	Nm	80	130	260
Rated current	I_{rated}	A	3.13	3.75	
Engagement time t1	t_1	ms	70	50	175
Disengagement time t2	t_2	ms	220	260	320
Friction energy	Q_E	kJ	18	23	51
Weight	m	kg	13	20.5	30.7
Massenträgheitsmoment					
Brake	J	kgcm²	6.88	18.1	70.4
Brake motor	J_{MB}	kgcm²	177	505	1405
Load/brake motor ratio	J_L/J_{MB}		19.6	8.2	12.7

Motor code			F1

Standard braking torque

Supply voltage AC 230 V

Motor			MQA20L	MQA22P	MQA26T
Supply voltage range	V_{in}	V	207 ... 253		
Supply voltage	V_{rated}	V	230		
Bemessungsdrehmoment					
At 20 °C	M_{rated}	Nm	90	150	300
At 120 °C	M_{rated}	Nm	80	130	260
Rated current	I_{rated}	A	0.37	0.44	0.37
Engagement time t1	t_1	ms	70	130	175
Disengagement time t2	t_2	ms	220	260	360
Friction energy	Q_E	kJ	18	23	51
Weight	m	kg	13	20.5	30.7
Massenträgheitsmoment					
Brake	J	kgcm²	6.88	18.1	70.4
Brake motor	J_{MB}	kgcm²	177	505	1405
Load/brake motor ratio	J_L/J_{MB}		19.6	8.2	12.7

Motor code			FG

Increased braking torque

Supply voltage DC 24 V

Motor			MQA20L	MQA22P
Supply voltage range	V_{in}	V	21.6 ... 26.4	
Supply voltage	V_{rated}	V	24	
Bemessungsdrehmoment				
At 20 °C	M_{rated}	Nm	150	300
At 120 °C	M_{rated}	Nm	130	260
Rated current	I_{rated}	A	2.58	3.75
Engagement time t1	t_1	ms	70	175
Disengagement time t2	t_2	ms	240	320
Friction energy	Q_E	kJ	31	39
Weight	m	kg	15.4	26
Massenträgheitsmoment				
Brake	J	kgcm²	14.1	36.3
Brake motor	J_{MB}	kgcm²	185	523
Load/brake motor ratio	J_L/J_{MB}		33	14.1

Motor code			F2

Increased braking torque

Supply voltage AC 230 V

Motor			MQA20L	MQA22P
Supply voltage range	V_{in}	V	207 ... 253	
Supply voltage	V_{rated}	V	230	
Bemessungsdrehmoment				
At 20 °C	M_{rated}	Nm	150	300
At 120 °C	M_{rated}	Nm	130	260
Rated current	I_{rated}	A	0.3	0.44
Engagement time t1	t_1	ms	70	130
Disengagement time t2	t_2	ms	240	310
Friction energy	Q_E	kJ	31	39
Weight	m	kg	15.4	26
Massenträgheitsmoment				
Brake	J	kgcm²	14.1	36.3
Brake motor	J_{MB}	kgcm²	185	523
Load/brake motor ratio	J_L/J_{MB}		33	14.1

Motor code			FH

Feedback

For speed control with a servo inverter, the servo motor can be equipped with the following feedback systems:

Inverter	Feedback without functional safety		
	Resolver	Absolute value encoder	Incremental encoder
i950 servo inverter	RS0	AM1024-8V-H AS1024-8V-H	-
i700 servo inverter	RS0	AM1024-8V-H AS1024-8V-H	-
8400 TopLine inverter drives	RS0	AM1024-8V-H AS1024-8V-H	IG2048-5V-S IG2048-5V-T IG4096-5V-T
9400 HighLine servo drives	RS0	AM32-5V-E AM1024-8V-H AM2048-5V-E AS1024-8V-H AS2048-5V-E	IG2048-5V-S IG2048-5V-T IG4096-5V-T

Inverter	Feedback with functional safety		
	Resolver	Absolute value encoder	Incremental encoder
i950 servo inverter	RV03	-	-
9400 HighLine servo drives	RV03	-	IG1024-5V-V3

Feedbacks in the environment of functional safety

Motors can perform speed-dependent safety functions for safe speed and/or safe relative position monitoring in a drive system by Lenze inverters or Controllers. In case of inverters, these functions are implemented by integrable safety modules and in case of Controllers by the additionally required Safety Controller.

When planning systems/installations of this kind, always observe the following:

- When using just one single feedback system in the environment of these safety applications, the applicable safety engineering standard IEC 61800-5-2 (adjustable speed electrical power drive systems - Part: 5-2: Safety requirements - Functional) stipulates special requirements for the connection between feedback system and motor shaft.
- This is due to the fact that two-channel safety systems at this point in the mechanical system are actually designed as single-channel systems. If this mechanical connection is designed with considerable overdimensioning, the standard permits exclusion of the fault "encoder-shaft breakage" or "encoder-shaft slip". As such, the permissible angular acceleration limit values must not be exceeded for the individual drive solutions.

You can find the limit values in the corresponding feedback data of the individual motor ranges.

Speed-dependent safety functions

Examples of speed-dependent safety functions:

- Safe stop 1 (SS1)
- Safe operational stop (SOS)
- Safely limited speed (SLS)
- Safe maximum speed (SMS)
- Safe direction (SDI)
- Operation mode selector (OMS) with confirmation (ES)
- Safe speed monitor (SSM)
- Safely limited increment (SLI)

Resolver

The stator-supplied, 2-pole resolver with two stator windings shifted by 90 degrees and a rotor winding with a transformer winding can record both the speed and the rotor position, just like a single-turn absolute value encoder. The rotor position can be determined within one mechanical motor revolution after a voltage failure.

Feedback type			**Resolver**	
Feedback			**RS0**	**RV03**
Speed-dependent safety functions			No	Yes
Design			Mounting	
Resolution - angle		'	0.8	0.8
Min. accuracy		'	-10	-10
Max. accuracy		'	10	10
Absolute positioning			1 revolution	1 revolution
Max. speed	n_{max}	rpm	8000	8000
Max. DC input voltage	$V_{in,max}$	V	10	10
Max. input frequency	$f_{in,max}$	kHz	4	4
Ratio stator/rotor			0.3	0.3
Min ratio tolerance		%	-5	-5
Max ratio tolerance		%	5	5
Rotor impedance	Z_{ro}	Ω	51+j90	51+j90
Stator impedance	Z_{so}	Ω	102+j150	102+j150
Impedance	Z_{rs}	Ω	44+j76	44+j76
Min. insulation resistance at DC 500 V	R_{min}	MΩ	10	10
Number of pole pairs			1	1
Max. angle error Min		'	-10	-10
Max. angle error Max		'	10	10

Speed-dependent safety functions

Feedback			**RV03**
Motor code			**RV03**
Max. permissible angular acceleration	α	rad/s^2	22000
Functional safety			
IEC 61508			SIL3
EN 13849-1			Up to Performance Level e

Incremental encoder

Incremental encoders can be used for speed measurement. Homing is required in order to enable positioning later.

Feedback type			**SinCos-Inkremental**		**TTL-Inkremental**	
Feedback			**IG1024-5V-V3**	**IG2048-5V-S**	**IG2048-5V-T**	**IG4096-5V-T**
Speed-dependent safety functions			Yes	No	No	No
Design			Mounting			
Pulses			1024	2048	2048	4096
Output signals			SinCos 1 Vss	SinCos 1 Vss	TTL	TTL
Interfaces			SinCos		A, B; N; Ai, Bi; Ni	
Absolute revolution			0	0	0	0
Min. accuracy		'	-0.8	-0.8	-2	-2
Max. accuracy		'	0.8	0.8	2	2
Min. DC input voltage	$V_{in,min}$	V	4.75	4.5	4.75	4.75
Max. DC input voltage	$V_{in,max}$	V	5.25	5.5	5.25	5.25
Max. current consumption	I_{max}	A	0.07	0.1	0.15	0.15
Limit frequency	f_{max}	kHz	200	180	300	300

Speed-dependent safety functions

Feedback type			**SinCos incremental**
Feedback			**IG1024-5V-V3**
Motor code			**S1S**
Max. permissible angular acceleration	α	rad/s^2	73000
Functional safety			
IEC 61508			SIL3
EN 13849-1			Up to Performance Level e

Absolute value encoder

Absolute value encoders can detect the speed, the rotor position, and the machine position with a very high resolution. They are used for the positioning of dynamic applications and do not require homing.

Feedback type			**SinCos absolute value encoder**			
Feedback			**AM1024-8V-H**	**AM2048-5V-E**	**AS1024-8V-H**	**AS2048-5V-E**
Speed-dependent safety functions			No	No	No	No
Design			Mounting	Mounting	Mounting	Mounting
Encoder type			Multi-turn	Multi-turn	Single-turn	Single-turn
Resolution		bit	-	-	-	-
Pulses			1024	2048	1024	2048
Output signals			SinCos 1 Vss	SinCos 1 Vss	SinCos 1 Vss	SinCos 1 Vss
Interfaces			Hiperface	EnDat	Hiperface	EnDat
Absolute revolution			4096	4096	1	1
Resolution - angle			0.4	0.4	0.4	0.4
Min. accuracy		'	-0.8	-0.6	-0.8	-0.6
Max. accuracy		'	0.8	0.6	0.8	0.6
Fehlergrenze Positionswert						
System accuracy			-	-	-	-
Integral nonlinearity			-	-	-	-
Min. DC input voltage	$V_{in,min}$	V	7	4.75	7	4.75
Max. DC input voltage	$V_{in,max}$	V	12	5.25	12	5.25
Max. current consumption	I_{max}	A	0.08	0.25	0.08	0.15
Limit frequency	f_{max}	kHz	200	200	200	200

Blower

The motors are cooled as a standard by means of a separate radial fan.

The separate fans are optionally available with a dust filter.

Rated data 50 Hz

Motor series			**MQA**	
Size			**20**	**22**
Degree of protection			IP23	
Number of phases			1	1
Rated voltage	V_{rated}	V	230	230
Rated power	P_{rated}	kW	0.09	0.26
Rated current	I_{rated}	A	0.39	1.1

Motor series			**MQA**		
Size			**20**	**22**	**26**
Degree of protection			IP23		
Number of phases			3	3	3
Rated voltage	V_{rated}	V	400	400	400
Rated power	P_{rated}	kW	0.067	0.23	0.43
Rated current	I_{rated}	A	0.13	0.37	0.68

Rated data 60 Hz

Motor series			**MQA**	
Size			**20**	**22**
Degree of protection			IP23	
Number of phases			1	1
Rated voltage	V_{rated}	V	230	230
Rated power	P_{rated}	kW	0.12	0.3
Rated current	I_{rated}	A	0.49	1.28

Motor series			**MQA**		
Size			**20**	**22**	**26**
Degree of protection			IP23		
Number of phases			3	3	3
Rated voltage	V_{rated}	V	400	400	400
Rated power	P_{rated}	kW	0.1	0.37	0.6
Rated current	I_{rated}	A	0.16	0.48	0.79

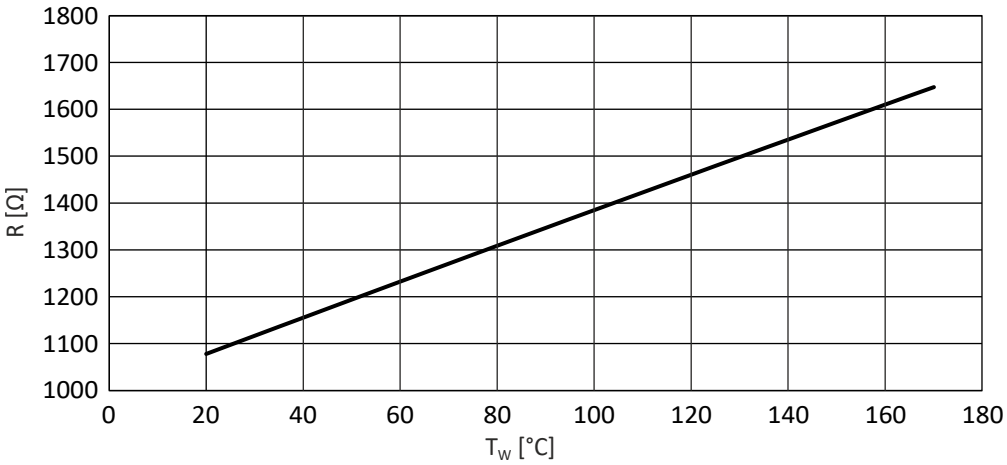
Temperature monitoring

Thermal detectors PT1000

The thermal detector used continuously monitors the motor temperature. The temperature information is transferred to the inverter using the system cable of the feedback system. **This is not a full motor protection!**

This makes it possible to determine the motor temperature in the permissible operating range with great accuracy.

When supplying the thermal sensors with a measurement current of 1 mA, the connection between the temperature and the resistance measured applies.



R	Resistance
T_W	Winding temperature

Product codes

Product code of MQA asynchronous servo motor

Example	M	Q	A	20	L	14	-	RS0	B0

Meaning	Variant	Product code
Product family	Motor	M
Type	Compact servo motors	Q
Variant	Asynchronous	A
Motor frame size	Square dimension 200 mm	20
	Square dimension 220 mm	22
	Square dimension 260 mm	26
Overall length		L P T
Rated speed	rpm x 100	05 ... 29
Inverter mains connection	3 x 400 V	H
Feedback	SinCos absolute value encoder, single-turn, EnDat AS2048-5V-E	ECN
	SinCos absolute value encoder, multi-turn, EnDat AM32-5V-E	EQI
	SinCos absolute value encoder, multi-turn, EnDat AM2048-5V-E	EQN
	Resolver	RS0
	Safety resolver RV03	RV0
	SinCos safety incremental encoder, single-turn IG1024-5V-V3	S1S
	SinCos incremental encoder, single-turn IG2048-5V-S	S20
	SinCos absolute value encoder, multi-turn, Hiperface® AM1024-8V-H	SRM
	SinCos absolute value encoder, single-turn, Hiperface® AS1024-8V-H	SRS
	TTL incremental encoder IG2048-5V-T	T20
	TTL incremental encoder IG4096-5V-T	T40
Brake	Without brake	B0
	Spring-applied brake DC 24 V	F1
	Spring-applied brake DC 24 V, reinforced	F2
	Spring-applied brake AC 230 V	FG
	Spring-applied brake AC 230 V, reinforced	FH

Environmental notes and recycling

Lenze has been certified to the worldwide DIN EN ISO 14001 environmental management standard for many years. As part of our environmental policy and the associated climate responsibility, please note the following information on hazardous ingredients and the recycling of Lenze products and their packaging:

CE Lenze products are partly subject to the EU Directive 2011/65/EU on the restriction of certain hazardous substances in electrical and electronic equipment (RoHS). This is documented accordingly in the EU declaration of conformity and with the CE mark.

Lenze products are not subject to EU Directive 2012/19/EU on waste electrical and electronic equipment (WEEE), but some contain batteries/rechargeable batteries in accordance with EU Directive 2006/66/EC (Battery Directive). The disposal route, which is separate from household waste, is indicated by corresponding labels with the "crossed-out trash can".
Any batteries/rechargeable batteries included are designed to last the life of the product and do not need to be replaced or otherwise removed by the end user.

21 PAP Lenze products are usually sold with cardboard or plastic packaging. This packaging complies with EU Directive 94/62/EC on packaging and packaging waste (Packaging Directive). The required disposal route is indicated by material-specific labels with the "recycling triangle".
Example: "21 - other cardboard"

REACH Lenze products are subject to the European Regulation EC No. 1907/2006 (REACH Chemicals Regulation). When used as intended, exposure of substances to humans, animals and the environment is excluded.

Lenze products are industrial electrical and electronic products and are disposed of professionally. Both the mechanical and electrical components such as electric motors, gearboxes or inverters contain valuable raw materials that can be recycled and reused. Proper recycling and thus maintaining the highest possible level of recyclability is therefore important and sensible from an economic and ecological point of view.

- Coordinate professional disposal with your waste disposal company.
- Separate mechanical and electrical components, packaging, hazardous waste (e.g. gear oils) and batteries/rechargeable batteries wherever possible.
- Dispose of the separated waste in an environmentally sound and proper manner (no household waste or municipal bulky waste).

What?	Material	Disposal instructions
Pallets	Wood	Return to manufacturers, freight forwarders or reusable materials collection system
Packaging material	Paper, cardboard, pasteboard, plastics	Collect and dispose of separately
Products		
Electronic devices	Metal, plastics, circuit boards, heatsinks	As electronic waste give to professional disposer for recycling
Gearbox	Oil	Drain oil and dispose of separately
	Casting, steel, aluminium	Dispose as metal scrap
Motors	Casting, copper, rotors, magnets, potting compound	As engine scrap give to professional disposer for recycling
Dry-cell batteries/rechargeable batteries		As used batteries give to professional disposer for recycling

Further information on Lenze's environmental and climate responsibility and on the topic of energy efficiency can be found on the Internet:

www.Lenze.com → search word: "Sustainability"

Appendix

Good to know

Approvals and directives

CCC	China Compulsory Certification documents the compliance with the legal product safety requirements of the PR of China - in accordance with Guobiao standards.
$_{C}^{CSA}{}_{US}$	CSA certificate, tested according to US and Canada standards
UE	Union Européenne documents the declaration of the manufacturer that EU Directives are complied with.
CEL	China Energy Label documents the compliance with the legal energy efficiency requirements for motors, tested according to the PR of China and Guobiao standards
CSA	CSA Group (Canadian Standards Association) CSA certificate, tested according to Canada standards
$UL^{Energy}{}_{US\ CA}$	Energy Verified Certificate Determining the energy efficiency according to CSA C390 for products within the scope of energy efficiency requirements in the USA and Canada
$_{C}UL_{US}$	UL certificate for products, tested according to US and Canada standards
$_{C}UR_{US}$	UL certificate for components, tested according to US and Canada standards
EAC	Customs union Russia / Belarus / Kazakhstan certificate documents the declaration of the manufacturer that the specifications for the Eurasian conformity (EAC) required for placing electronic and electromechanical products on the market of the entire territory of the Customs Union (Russia, Belarus, Kazakhstan, Armenia and Kyrgyzstan) are complied with.
UL	Underwriters Laboratory Listed Product
UL_{LISTED}	UL Listing approval mark as proof that the product has been tested and the applicable safety requirements have been confirmed by UL (Underwriters Laboratory).
UR	UL Recognized Component approval mark as proof that the UL approved component can be used in a product or system bearing the UL Listing approval mark.

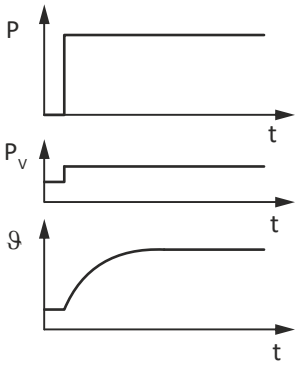
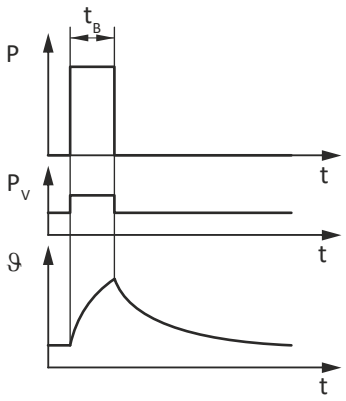
Operating modes of the motor

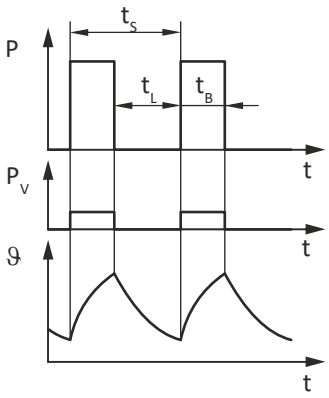
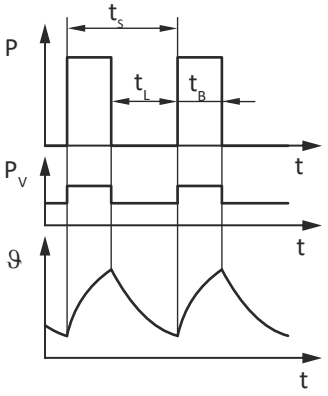
Operating modes S1 ... S10 as specified by EN 60034-1 describe the basic stress of an electrical machine.

In continuous operation a motor reaches its permissible temperature limit if it outputs the rated power dimensioned for continuous operation. However, if the motor is only subjected to load for a short time, the power output by the motor may be greater without the motor reaching its permissible temperature limit. This behaviour is referred to as overload capacity.

Depending on the duration of the load and the resulting temperature rise, the required motor can be selected reduced by the overload capacity.

The most important operating modes

Continuous operation S1	Short-time operation S2
	
Operation with a constant load until the motor reaches the thermal steady state. The motor may be actuated continuously with its rated power.	Operation with constant load; however, the motor does not reach the thermal steady state. During the following standstill, the motor winding cools down to the ambient temperature again. The increase in power depends on the load duration.

Intermittent operation S3	Non-intermittent periodic operation S6
	
Sequence of identical duty cycles comprising operation with a constant load and subsequent standstill. Start-up and braking processes do not have an impact on the winding temperature. The steady-state is not reached. The guide values apply to a cycle duration of 10 minutes. The power increase depends on the cycle duration and on the load period/ downtime ratio.	Sequence of identical duty cycles comprising operation with a constant load and subsequent no-load operation. The motor cools down during the no-load phase. Start-up and braking processes do not have an impact on the winding temperature. The steady-state is not reached. The guide values apply to a cycle duration of 10 minutes. The power increase depends on the cycle duration and on the load period/idle time ratio.

P	Power	P_V	Power loss
t	Time	t_B	Load period
t_L	Idle time	t_S	Cycle duration
ϑ	Temperature		

Enclosures

The degree of protection indicates the suitability of a motor for specific ambient conditions with regard to humidity as well as the protection against contact and the ingress of foreign particles. The degrees of protection are classified by EN 60529.

The first code number after the code letters IP indicates the protection against the ingress of foreign particles and dust. The second code number refers to the protection against the ingress of humidity.

Code number 1	Degree of protection	Code number 2	Degree of protection
0	No protection	0	No protection
1	Protection against the ingress of foreign particles d > 50 mm. No protection in case of deliberate access.	1	Protection against vertically dripping water (dripping water).
2	Protection against medium-sized foreign particles, d > 12 mm, keeping away fingers or the like.	2	Protection against diagonally falling water (dripping water), 15 ° compared to normal service position.
3	Protection against small foreign particles d > 2.5 mm. Keeping away tools, wires or the like.	3	Protection against spraying water, up to 60 ° from vertical.
4	Protection against granular foreign particles, d > 1 mm, keeping away tools, wire or the like.	4	Protection against spraying water from all directions.
5	Protection against dust deposits (dust-protected), complete protection against contact.	5	Protection against water jets from all directions.
6	Protection against the ingress of dust (dust-proof), complete protection against contact.	6	Protection against choppy seas or heavy water jets (flood protection).