



Three-phase AC motors

Lenze Smart Motor m300

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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](#)  13
 - ▶ [Information on mechanical installation](#)  19
 - ▶ [Information on electrical installation](#)  20
-

Further documents



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





About this document

Notations and conventions



Notations and conventions

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

Numeric notation			
	Decimal separator	Point	The decimal point is always used. Example: 1 234.56
Warning			
	UL warning	UL	Are used in English and French.
	UR warning	UR	
Text			
	Engineering tools	» «	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

The new freedom in motion for engineers. Lenze Smart Products reduce the number of different drives by up to 70 %. Without contactor and starter, with freely adjustable fixed speeds and many integrated functions for technical material-handling applications. The Lenze Smart motor also fulfils the highest requirements regarding energy efficiency and can be conveniently operated by means of a smart phone.

Reduction in the number of variants made easy

Before now, different output speeds (e. g. for different conveying speeds) were enabled by different gearbox ratios or, in the case of very large differences, by means of the number of pole pairs of the motors. This led to a large number of different drive variants..

Things are different with the Lenze Smart Products: Due to the possibility of freely adjusting the motor speed within a range from 500 – 2600 rpm, very different speeds can be enabled with one single drive variant. The cost and effort involved in design, selection, procurement and storage are thus reduced considerably.

Highlights

- Efficient and usable worldwide
- Usable in all mounting positions, reduces number of variants
- Freely adjustable speed reduces the number of different drives
- Integrated soft start function
- Less wiring thanks to electronic contactor and motor protection function
- Excellent energy efficiency
- Can be operated with an NFC-capable smartphone and Lenze app
- Brake control unit optional for low-wear brake control



Application ranges

- Conveying and travelling drives

Product information

Product description



Product description

Easy adjustment

NFC technology (NFC = Near Field Communication) is used to adapt the Lenze Smart Products to the application as well as for diagnostics). The drive can be adjusted very easily without opening the terminal box, without voltage supply and without time-consuming addressing.

Only an NFC-capable Android smartphone or the Lenze NFC adapter for PCs is needed as a tool. The data can therefore be read and written when the drive is in a de-energised state – via password protection, of course.

Data that can be set

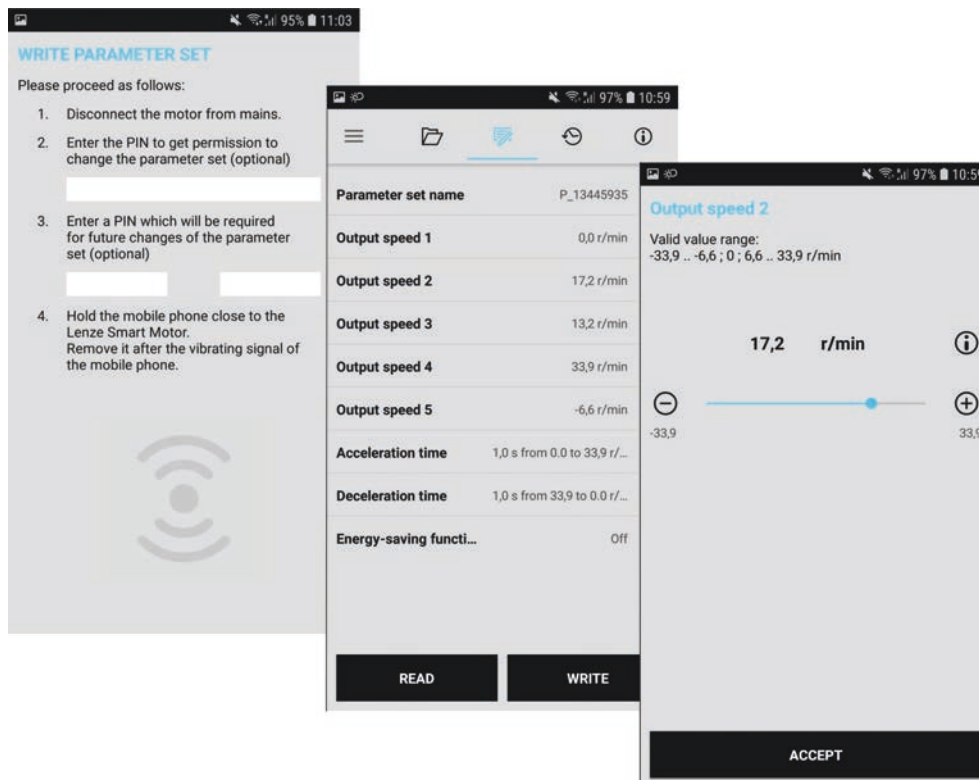
- Name of data record (e. g. the designation of the drive in your documentation)
- Speed and rotating direction 1 (also controllable without digital inputs)
- Speed and rotating direction 2-5 (controllable by means of digital inputs)
- Acceleration time
- Deceleration time
- Energy-saving function

Readable data

- Identification data (Lenze material number and serial number, type designation, software version)
- Error messages
- Operating and power-on hours

Adjustment by means of a smartphone

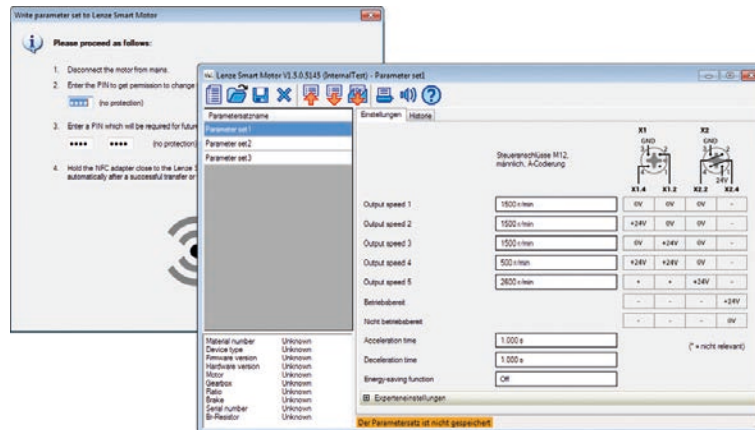
The Lenze Smart Products can be adjusted with an Android smartphone. The corresponding app in German and English can be obtained from www.Lenze.com or the Google Store. For convenience, the data records created can be archived on the smartphone and repeatedly transferred to the Lenze Smart Products for different applications.





Adjusting with a PC

With the »EASY Starter« engineering tool (expanded version, »EASY Advanced« or »Engineer HighLevel« software licence needed) can be used to adjust the Lenze Smart Products. The relevant version can be easily downloaded from <http://www.lenze.com>. As the settings are very simple and clear, there is an easy-to-use dialog box, which can be opened directly via the navigator. The corresponding button is directly accessible in the navigation bar. Analogously to other product settings, the parameter values can be archived.



Starting and stopping smoothly and gently

An acceleration ramp and – in contrast to a conventional starter – a deceleration ramp can be set for Lenze Smart Products. This ensures that the conveyed material is handled in a defined and jerk-free manner..

Contactors and motor protection functions integrated

The Lenze Smart Products can be started and stopped by mean of digital inputs. It is also possible to switch between different speeds and rotating directions. Up to 5 different speed modes (e. g. creep speed and normal speed in both directions as well as stopping) can be used for a motor. Reversing-contactor changes and pole changes are thus a thing of the past.

In addition, motor-protections devices are not needed as monitoring of temperature, short circuits, earth faults and phase failures has already been integrated.

Easy installation

Connection takes place completely from the outside by means of connectors.

The Lenze Smart Products come with an especially clever connecting technology – Phoenix Contact QUICKON. Electrical installation is therefore very easy without special tools and requires less than one minute.

In addition to the QUICKON connector, the M15 connection customary on the market is available.

As a standard feature, the digital inputs and outputs are connected at M12 sockets of the type currently available on the market.

Already existing signal cables can often be reused.

Worldwide and efficient

The drive can be used worldwide:

- In all 3-phase networks with a supply voltage of 400 ... 480 V and a mains frequency of 50 ... 60 Hz
- At ambient temperatures of -30 ... +40 °C
- Is suitable for many approvals

The Lenze Smart Motor fulfils the requirements as described in the highest efficiency requirement for IES2.

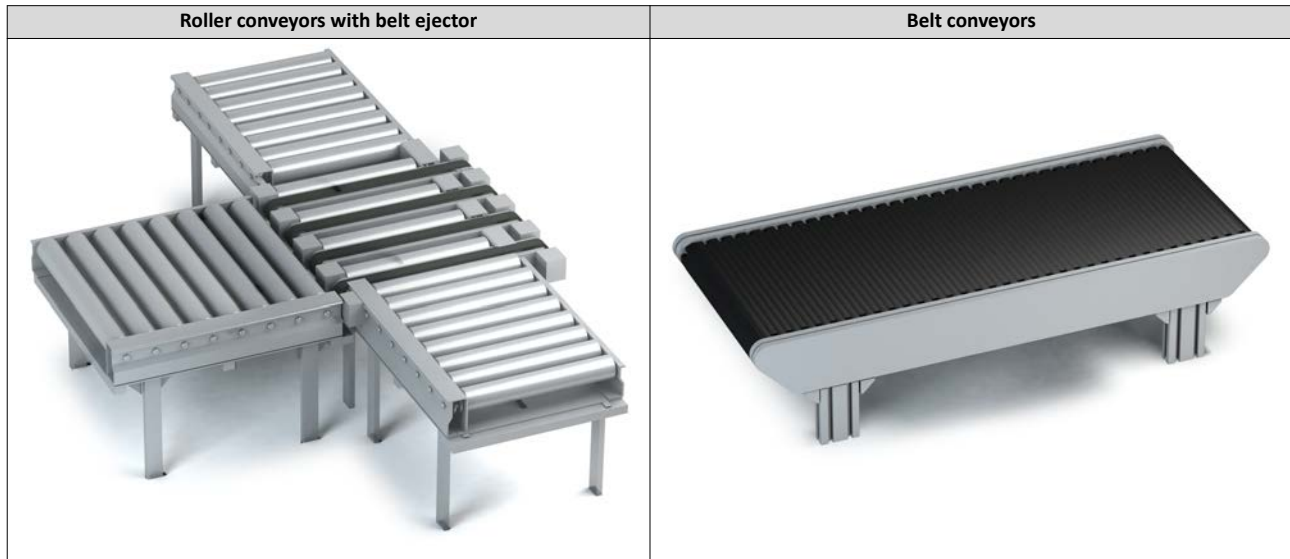
If very little torque is needed in the partial-load operational range, the integrated energy saving function can be used to optimize the energy absorption of the drive.

Product information

Features



Application examples



Identification of the products

Product name of the motor

Product series	Type	Size	Overall length	Number of pole pairs	Motor
MSEMA	XX (without built-on accessories)	063	4	2 (4-pole)	MSEMXX063-42
		080	3		MSEMXX080-32
	BR (with brake)	063	4		MSEMABR063-42
		080	3		MSEMABR080-32

Features

X4 Brake resistor connection

External

Internal brake resistor

X1, X2 Control terminal

M12 connector

X3 Mains connection

In the terminal box
QUICKON connector
M15-connector

PE

X5 Connection of spring-applied brake

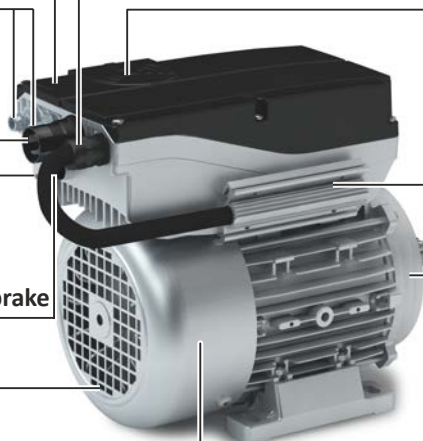
(prewired upon delivery)

Cooling

Integral fan

Spring-applied brake

Standard
LongLife
Manual release lever



Adjustment of speeds

by means of Android smartphone
by means of PC via NFC adapter

External brake resistor

Type

Foot (B3)
Flange (B5) with through holes
Flange (B14) with threaded holes



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		MSEMA□□063-42	MSEMA□□080-32
Technical data			
Max. torque	Nm	7	20
Rated torque	Nm	1.75	5.0
Output speed	rpm	500 ... 2600	
Dimensions			
Design		B3/B14/B5	
Solid shaft with featherkey	mm	11 x 23	19 x 40
Output flange	mm	FT75/FF115	FT130/FF165
Spring-applied brake			
Type		Without Standard LongLife Without/with manual release lever	
brake resistance		Without Integrated External	
Cooling			
		Integral fan	
Monitoring and protective measures		Short circuit (to a limited extent), fault acknowledgement Earth fault (to a limited extent), fault acknowledgement necessary Overvoltage Overcurrent Motor overtemperature Mains phase failure Motor stalling	
Motor connection			
Power connection		Terminal box QUICKON connector M15 connector	
Control terminal		M12 connector	
Surface and corrosion protection		Without Different types of OKS	
Colour		Unpainted Primed/RAL colours	



Information on project planning

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 carry out the drive dimensioning process quickly and with top quality. The software contains profound and proven expertise with regard to drive applications and mechatronic drive components.

Please refer to your competent Lenze sales company.



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

Personnel

The product must only be used by qualified personnel. IEC 60364 or CENELEC HD 384 define the skills of these persons:

- They are familiar with installing, mounting, commissioning, and operating the product.
- They have the corresponding qualifications for their work.
- They know and can apply all regulations for the prevention of accidents, directives, and laws applicable at the place of use.

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.

Application as directed

- 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 a machine in terms of 2006/42/EU: Machinery Directive.
- Commissioning or starting the operation as directed of a machine with the product is not permitted until it has been ensured that the machine meets the regulations of the EC Directive 2006/42/EU: Machinery Directive; observe EN 60204-1.
- Commissioning or starting operation as directed is only permissible if the EMC Directive 2014/30/EU is complied with.
- The product is not a household appliance, but is only designed as a component for commercial or professional use in terms of EN 61000-3-2.
- The product can be used according to the technical data if drive systems have to comply with categories according to EN 61800-3.
- In residential areas, the product may cause EMC interferences. The operator is responsible for taking interference suppression measures.
- 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 a component designed for installation into a machine for horizontal materials handling technology.

Foreseeable misuse

- Connect directly to the inverter
- Use in explosion-protected areas
- Use in aggressive environments
- Operate under water
- Use under radiation
- Operate permanently in generator mode

Information on project planning

Safety instructions
Residual hazards



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!

Protection of persons

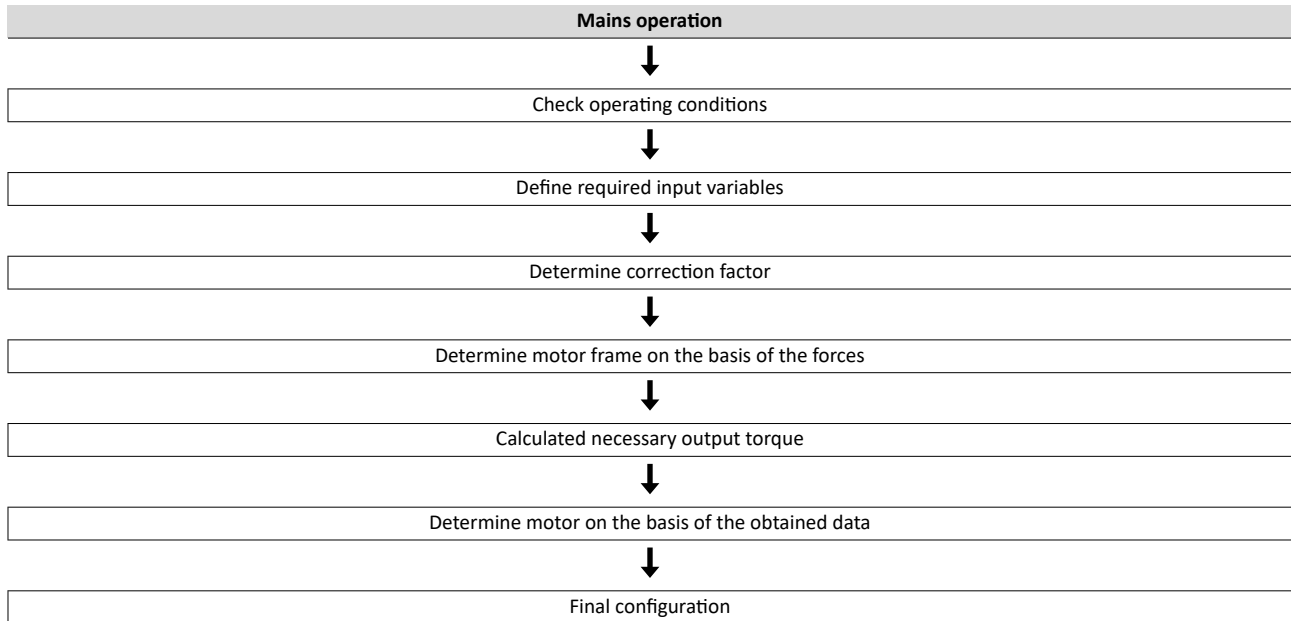
- The product does not provide safety-related functions.
 - A higher-level safety system must be implemented.
 - Additional monitoring and protective equipment complying with the safety regulations applicable in each case must be used.
- The power terminals may carry voltage in the switched-off state or when the motor is stopped.
 - Before working, check whether all power terminals are deenergised.
- Careful earthing in the marked positions of the components must be carried out.
- Risk of burns may be caused by hot surfaces!
 - Provide for a protection against accidental contact.
 - Use the personal protective equipment or wait until the components have cooled down completely!
 - Prevent contact with flammable substances.
- There is a risk of injury due to rotating parts.
 - Before working on the drive system, ensure that the motor is at a standstill.
- There is a danger of unintentional starting or electrical 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

- Design with plug:
 - Never disconnect the plug when energized! Otherwise, the plug can be destroyed.
 - Switch off power supply prior to disconnecting the plug.
- Parameterize the product so that it will be switched off after some seconds of operation with $I > I_N$, especially if there is a danger of blocking.
 - The installed overload protection does not prevent an overload under any conditions.
- The fuses are no motor protection.
- Too high torques cause a fraction of the motor shaft.
 - The maximum torques according to catalog must not be exceeded.
- Align the shafts of motor and driven machine exactly to each other.



Drive dimensioning



Check operating conditions

Check
Approvals Conformity declarations Supply voltage Enclosure Ambient temperature Surface protection

▶ Conformities/approvals [14 29](#)

▶ Environmental conditions [14 18](#)

Necessary input variables

Mains operation			
Max. load torque	$M_{L,max}$	Nm	
Max. load speed	$n_{L,max}$	rpm	
External moments of inertia	J_{ext}	kgcm ²	
Operating time / day	BD	h	
Switching operations per hour	S_h	1/h	

Determine correction factor

Site altitude Amsl	H	m	≤ 1000	≤ 2000	≤ 3000	≤ 4000
Correction factor	k_H		1	0.95	0.9	0.85

Ambient temperature	T_U	°C	≤ 40
Correction factor	k_{TU}		1



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	≥ 20 teeth = 1.0	With belt tightener= 2.0 - 2.5	1.5 - 2.0
			< 17 teeth = 1.15	< 20 teeth = 1.25	Without belt tightener= 2.5 - 3.0	
			Calculation		Check	
Radial force	F_{rad}	N	$F_{rad} = 2000 \times \frac{M_{L,max} \times f_z}{dw}$		$F_{rad} \leq f_w \times F_{rad,max}$	
Axial force	F_{ax}	N			$F_{ax} \leq F_{rad,max} \times 0.5$	

dw Effective diameter of transmission element

► [Radial forces and axial forces](#) 31

Calculate output torque

		Calculation	
Necessary output torque	M_N	N m	$M_N \geq \frac{M_{L,max}}{k_H \times k_{TU}}$

Determine motor on the basis of the data obtained from the rated data

Selection table		Check
Output speed n_N	rpm	$n_{L,max} \approx n_N$
Output torque M_N	Nm	$M_{L,max} \leq M_N$

► [Rated data](#) 32



Final configuration

Check and define connection dimensions	Output shaft Output flange
Select product extensions and accessories	Brake NFC adapter QUICKON connector M15 connector

More information about the final configuration:

- ▶ [The modular system](#) 11
- ▶ [Product extensions](#) 39

Parameters that can be preset by Lenze



The parameters marked with "order-dependent" in the standard setting can be preset order-related by Lenze.

Standard settings

Parameter	Value		Comment
Designation	Delivery	Setting range	
Parameter set name	---	[Text]	File name of the parameter set without file extension *.lsm
Output speed 1	depending on the order	[-2600/i ... -500/i] rpm [0] rpm [500/i ... 2600/i] rpm	CCW rotation: < 0 rpm
Output speed 2			STOP: 0 rpm
Output speed 3			CW rotation: > 0 rpm
Output speed 4			Lenze Smart motor with gearbox: The ratio i is taken into account in the calculation of the output speed.
Output speed 5			
Acceleration time	[0.0 ... 20.0] s		Acceleration time t_1 of the ramp generator from 0 rpm to n_{max} [2600/i] rpm
Deceleration time			Deceleration time t_2 of the ramp generator from n_{max} [2600/i] rpm to 0 rpm
Energy-saving function	[Off]		Optimized for: <ul style="list-style-type: none"> • High dynamic performance • Maximum starting torque and torque • High speed accuracy
	[On]		Reduced energy absorption in partial load operational range. Approx. 50 % of the maximum starting torque are available.

Information on project planning

Final configuration
Environmental conditions



Environmental conditions

Surface and corrosion protection (called OKS)

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

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

For the indoor installation and if no special corrosion protection is required, the products are also available unpainted (without OKS).

Surface and corrosion protection (called OKS)	Applications	Type
without OKS (unpainted)	<ul style="list-style-type: none"> Indoor installation, no special corrosion protection necessary Painting by customer 	Standard
OKS-G (primed)	<ul style="list-style-type: none"> Dependent on subsequent top coat applied 	Optional
OKS-S (small)	<ul style="list-style-type: none"> Standard applications Internal installation in heated buildings Air humidity up to 90% 	
OKS-M (medium)	<ul style="list-style-type: none"> Internal installation in non-heated buildings Covered, protected external installation Air humidity up to 95 % 	

Surface and corrosion protection (called OKS)	Corrosivity category	Surface coating	Colour	Coating thickness
	DIN EN ISO 12944-2	Design		
without OKS (unpainted)				
OKS-G (primed)		<ul style="list-style-type: none"> 2K PUR priming coat 		60 ... 90 µm
OKS-S (small)	Comparable to C1	<ul style="list-style-type: none"> 2K-PUR top coat 	<ul style="list-style-type: none"> Standard: RAL 7012 Optional: RAL Classic 	80 ... 120 µm
OKS-M (medium)	Comparable to C2	<ul style="list-style-type: none"> 2K PUR priming coat 2K-PUR top coat 		110 ... 160 µm



Information on mechanical installation

Important notes

- You must install the product according to specifications in the chapter "standard and operating" conditions.
 - ▶ [Standards and operating conditions](#) 29
- The technical data and the data regarding the supply conditions can be found on the nameplate and in this documentation.
- Observe the information relating to the surface and corrosion protection.
 - ▶ [Environmental conditions](#) 18
- Ambient media – especially chemically aggressive ones – may damage shaft sealing rings, lacquers and plastics. If required, contact your responsible Lenze subsidiary.

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 safely 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 the transport.
- Avoid electrostatic discharge on electronic components and contacts.
- Avoid impacts.
- Check the carrying capacity of the hoists and load handling devices. The weights can be obtained from the shipping documents.
- Secure the load against tipping and falling down.
- Standing under a suspended load is forbidden.

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!

Hazardous voltage!

On the power connections even when disconnected from the mains: residual voltage >60 V!

- ▶ Disconnect the product from the mains and wait until the motor is at a standstill.
- ▶ Make sure that the product is safely isolated from supply!

-
- When working on energised products, comply with the applicable national accident prevention regulations.
 - Carry out the electrical installation in compliance with the relevant 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.

Preparation



The notes for the electrical connection can be found in the enclosed connection diagram of the drive.



Connection according to EN



The following data is valid for a three-phase mains connection with 400 V.

Mains connection with QUICKON connector			
Motor		MSEMA□□063-42	MSEMA□□080-32
Connection		X3	
Laying system		B2	
Connection type		QUICKON connector	
Cable type		Flexible	
Cable cross-section			
Typ.	mm ²	1.5	2.5
Min.	mm ²	1.5	1.5
Max.	mm ²	2.5	2.5

Mains connection M15 connector			
Motor		MSEMA□□063-42	MSEMA□□080-32
Connection		X3	
Laying system		B2	
Connection type		M15 connector	
Cable type		Flexible	
Cable cross-section			
Typ.	mm ²	1.5	2.5
Min.	mm ²	1.5	1.5
Max.	mm ²	2.5	2.5

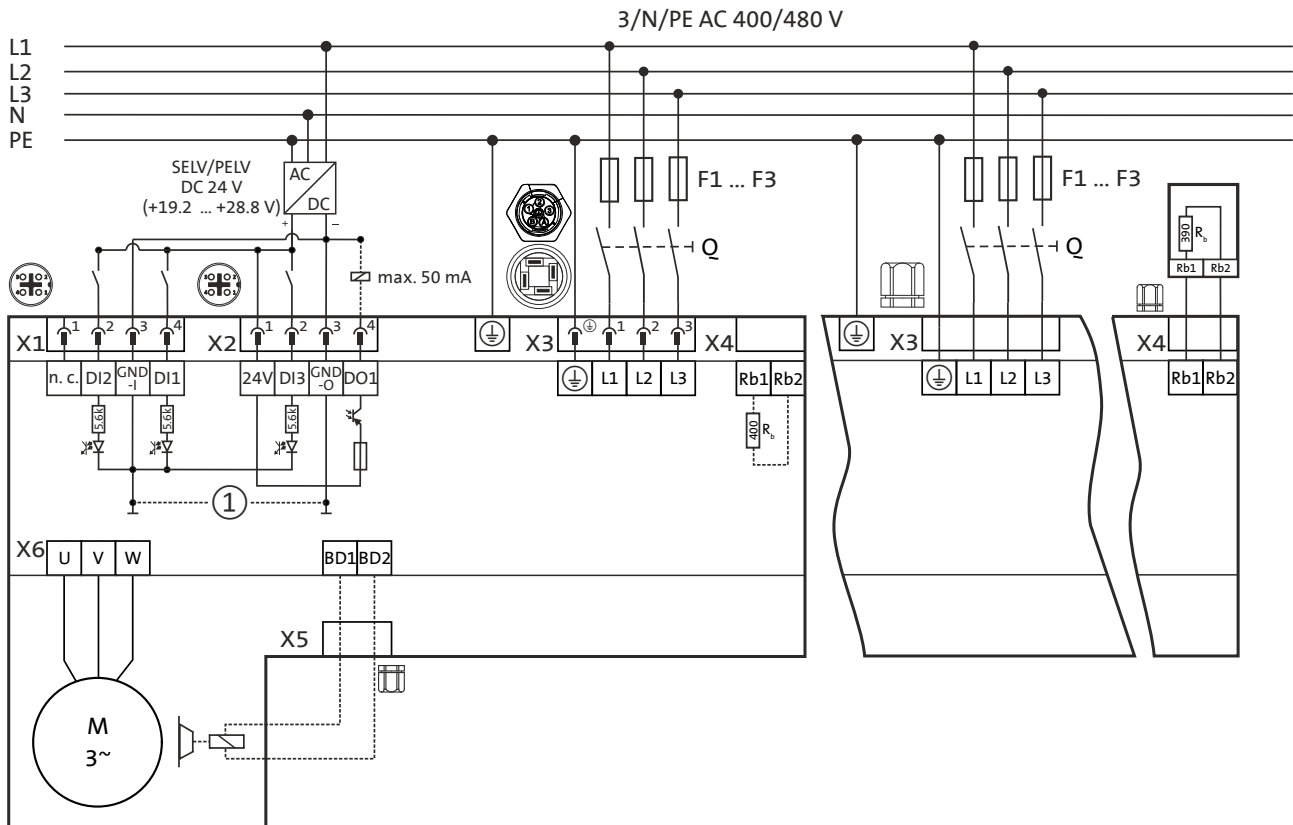
Mains connection cable L1, L2, L3, PE			
Motor		MSEMA□□063-42	MSEMA□□080-32
Connection		X3	
Installation method		B2	
Connection type		Cable	
Cable type		rigid/flexible	
Cable cross-section			
Typ.	mm ²	1.0	1.5
Min.	mm ²	0.75	0.75
Max.	mm ²	1.5	1.5
Stripping length	mm	10	10

Information on electrical installation

Connection according to EN



Single drive connection according to EN 60204-1



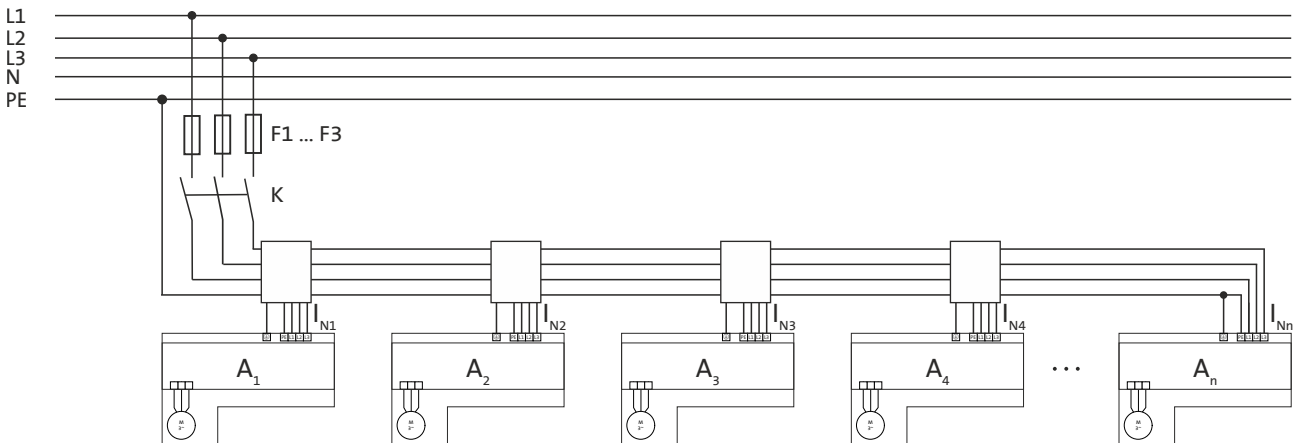
① GND is bridged if the "DI/DO-GND bridged" version is specified on the nameplate.

Fuse data (F1 ... F3)		MSEMA□□063-42	MSEMA□□080-32
Motor			
Cable installation in compliance with		EN 60204-1	
Installation method		B2	
Fuse			
Characteristics		gG/gL	
Typ. rated current	A	6	10
Max. rated current	A	16	16
Semiconductor fuse			
Characteristics		gRL	
Typ. rated current	A	6	10
Max. rated current	A	16	16
Circuit breaker			
Characteristics		C	
Typ. rated current		6	10
Max. rated current	A	16	16

- Use of copper cables insulated with PVC
 - Conductor temperature < 70 °C, ambient temperature < 40 °C
- No bundling of cables or wires, three wires under load



Connection for group drive according to EN 60204-1



Max. total rated mains currents at 40 °C				
Cable installation in accordance with		EN 60204-1		
Main cable				
Laying system		B2		
Cable cross-section	mm ²	1.5	2.5	4.0
Stub				
Laying system		C		
Cable cross-section	mm ²	1.5	2.5	2.5
Max. current load of cable	A	13.1	17.4	21.0
Fuse				
Characteristic		gG/gL		
Typ. rated current	A	-	-	-
Max. rated current	A	10	16	20
Circuit breaker				
Characteristic		gRL		
Typ. rated current	A	-	-	-
Max. rated current	A	10	16	20
$I_{max} \geq I_{N1} + I_{N2} + I_{N3} + I_{N...}$	A	7.6	12.2	17.6

▶ Rated data [32](#)

- Use of copper cables insulated with PVC
 - Conductor temperature $\leq 70\text{ °C}$, ambient temperature $\leq 40\text{ °C}$
- No bundling of cables or wires, three wires under load
- Typical utilisation: 80 % of the respective cable cross-section

Sizing of group drive

Example:

Check of the maximum permissible rated mains current considering the specified data and a simultaneity factor of 100 %.

MSEM063-42	7 drives	12 drives	17 drives
Mains voltage	400 V		
Rated current per motor	1 A		
Max. rated mains current	$I_{N1} + I_{N2} + I_{N3} + I_{N...} \leq I_{max}$		
	$7 \times 1\text{ A} = 7\text{ A} \leq 7.6\text{ A}$	$12 \times 1\text{ A} = 12\text{ A} \leq 12.2\text{ A}$	$17 \times 1\text{ A} = 17\text{ A} \leq 17.6\text{ A}$

Information on electrical installation

Connection according to UL



Connection according to UL



The following data is valid for a three-phase mains connection with 480 V.

Mains connection with QUICKON connector			
Motor		MSEMA□□063-42	MSEMA□□080-32
Connection		X3	
Connection type		QUICKON connector	
Cable cross-section			
Typ.	AWG	16	14
Min.	AWG	16	16
Max.	AWG	14	14

Mains connection M15 connector			
Motor		MSEMA□□063-42	MSEMA□□080-32
Connection		X3	
Connection type		M15 connector	
Cable cross-section			
Typ.	AWG	16	14
Min.	AWG	16	16
Max.	AWG	14	14

Mains connection cable L1, L2, L3, PE			
Motor		MSEMA□□063-42	MSEMA□□080-32
Connection		X3	
Connection type		Cable	
Cable type		rigid/flexible	
Cable cross-section			
Typ.	AWG	18	16
Min.	AWG	18	18
Max.	AWG	16	16
Stripping length	mm	10	10

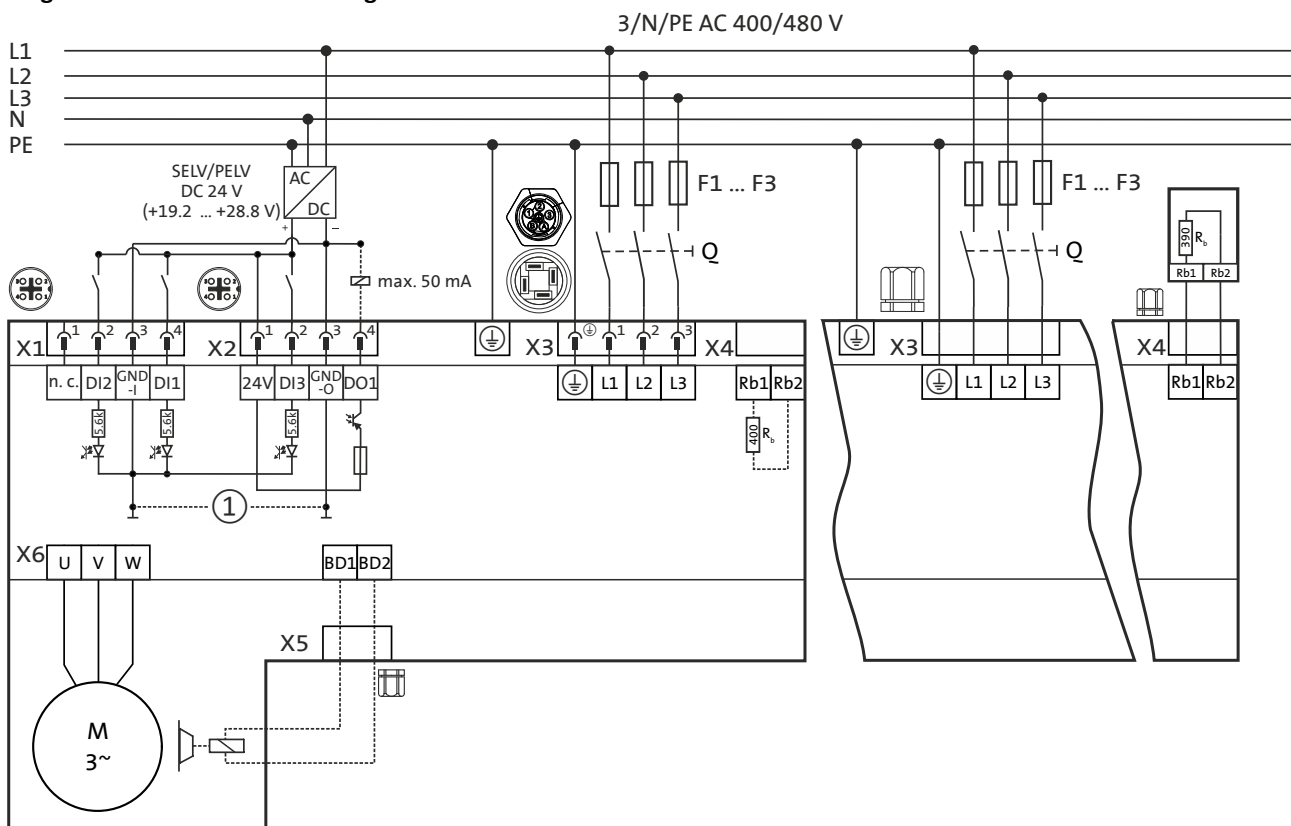


General UL notes

⚠ WARNING!

- ▶ **UL marking**
- ▶ Use 75 °C copper wire only, except for control circuits.
- ▶ Maximum conductor size is AWG14.
- ▶ Cord connected drives are for use only in NFPA 79 applications.
- ▶ Overload protection: 125 % of rated FLA
- ▶ Integral solid state short circuit protection does not provide branch circuit protection. Branch circuit protection must be provided in accordance with the National Electrical Code and any additional local codes.
- ▶ CAUTION - Risk of electric shock. Do not disconnect under load.
- ▶ **Marquage UL**
- ▶ Utiliser exclusivement des conducteurs en cuivre 75 °C, sauf pour la partie commande.
- ▶ Taille de conducteur maximale : AWG14.
- ▶ Les entraînements avec câble d'alimentation sont destinés exclusivement à des applications conformes à la norme NFPA 79.
- ▶ Protection contre les surcharges : homologuée pour 125 % du courant assigné à pleine charge.
- ▶ La protection statique intégrée n'offre pas la même protection qu'un disjoncteur. Une protection par disjoncteur externe doit être fournie, conformément au National Electrical Code et aux réglementations locales applicables.
- ▶ ATTENTION ! Risque de choc électrique. Ne pas débrancher l'équipement sous charge.

Single drive connection according to UL 61800-5-1



① GND is bridged if the "DI/DO-GND bridged" version is specified on the nameplate.

Information on electrical installation

Connection according to UL

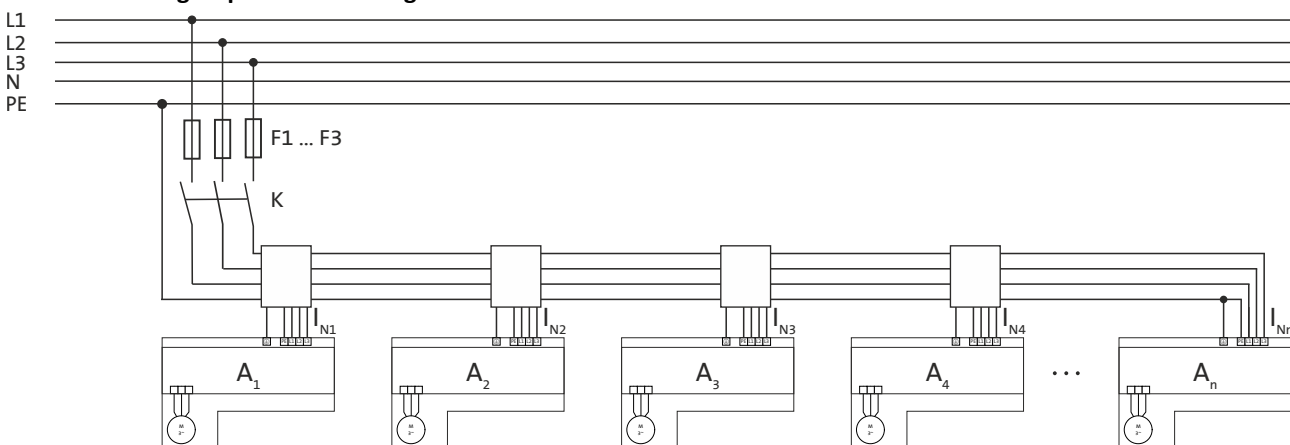


Fuse data (F1 ... F3)			
Motor		MSEMA□□063-42	MSEMA□□080-32
Cable installation in compliance with		UL 61800-5-1	
Fuse		UL 248	
Standard		UL 248	
Typ. rated current	A	3	6
Max. rated current	A	3	10
Semiconductor fuse		UL 248	
Standard		UL 248	
Typ. rated current	A	3	6
Max. rated current	A	3	10
Circuit breaker		UL 489	
Standard		UL 489	
Typ. rated current	A	15	15
Max. rated current	A <td 15	15	

⚠ WARNING!

- ▶ **UL marking**
- ▶ Suitable for use on a circuit capable of delivering not more than 5k rms symmetrical amperes, 480 V maximum.
- ▶ When protected by fuses rated, see table above.
- ▶ When protected by a circuit breaker having an interrupting rating not less than 5k rms symmetrical amperes, 480 Maximum, see table above.
- ▶ **Marquage UL**
- ▶ Convient à une utilisation sur un circuit non susceptible de délivrer plus de 5k ampères symétriques eff, maximum 480 V.
- ▶ Avec une protection par des fusibles du calibre indiqué dans le tableau ci-dessous,
- ▶ Avec une protection par un disjoncteur à courant de coupure assigné d'au moins 5k ampères symétriques eff, maximum 480 V, voir tableau ci-dessous.

Connection for group drive according to UL 61800-5-1





Max. total rated mains currents at 40 °C			
Cable installation in accordance with		UL 61800-5-1	
Main cable			
Cable cross-section	AWG	16	14
Stub			
Cable cross-section	AWG	16	14
Fuse			
Typ. rated current	A	---	---
Max. rated current	A	10	15
Circuit breaker			
Typ. rated current	A	---	---
Max. rated current	A	10	15
$I_{\max} \geq I_{N1} + I_{N2} + I_{N3} + I_{N...}$	A	8.0	12.0

► **Rated data** [32](#)

- Use of copper cables insulated with PVC
 - Conductor temperature ≤ 70 °C, ambient temperature ≤ 40 °C
- No bundling of cables or wires, three wires under load
- Typical utilisation: 80 % of the respective cable cross-section

⚠ WARNING!

► **UL marking**

- Suitable for motor group installation on a circuit capable of delivering not more than 5k rms symmetrical amperes, 480 V maximum.
- When protected by fuses rated, see table above.
- When protected by a circuit breaker having an interrupting rating not less than 5k rms symmetrical amperes, 480/277 V Maximum, see table above.

► **Marquage UL**

- Convient aux circuits de groupes moteur non susceptibles de délivrer plus de 5k ampères symétriques eff, maximum 480 V.
- Avec une protection par des fusibles du calibre indiqué dans le tableau ci-dessous,
- Avec une protection par un disjoncteur à courant de coupure assigné d'au moins 5k ampères symétriques eff, maximum 480/277 V, voir tableau ci-dessous.

Technical data

Notes regarding the given data



Technical data

Notes regarding the given data

The power values, torques and speeds indicated in the catalogue are rounded values and apply to:

- Operating time per day = 8 hrs (100 % ED)
- Duty class up to 10 switching operations per hr
- Ambient temperature $T_U = -30 \dots +40 \text{ }^\circ\text{C}$
- Site altitude $\leq 1000 \text{ m}$ above sea level

The selection tables indicate the mechanically permissible power levels and torques.

The ratings apply to the operating mode S1 (acc. to EN 60034).

NOTICE

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

- ▶ In case of extreme operating conditions, please contact your responsible Lenze sales company.
-



Standards and operating conditions

Conformities/approvals

Conformity		
CE	2014/35/EU	Low-Voltage Directive
	2014/30/EU	EMC Directive (reference: CE-typical drive system)
EAC	TR TC 004/2011	Eurasian conformity: safety of low voltage equipment
	TP TC 020/2011	Eurasian conformity: electromagnetic compatibility of technical means
Approval		
CCC		GB Standard 12350-2009
cULus	UL 61800-5-1	for USA and Canada (requirements of the CSA 22.2 No. 14) Industrial Control Equipment, Lenze File No. E132659

Protection of persons and device protection

Degree of protection		
IP55	EN 60529	
Type 4 indoor only Type 12	NEMA 250	Dependent on the configuration
Insulation resistance		
Overvoltage category III	EN 61800-5-1	Site altitude 0 ... 2000 m above sea level
Overvoltage category II	EN 61800-5-1	Site altitude more than 2000 m above sea level: External measures for compliance with the overvoltage category II are required, e.g. connection of an isolating transformer upstream ,connection of an overvoltage protection system upstream
Protective insulation of control circuits		
Safe mains isolation via double/reinforced insulation for digital inputs and outputs	EN 61800-5-1	Site altitude 0 ... 2000 m above sea level
Upstream connection of overvoltage protection device	EN 61800-5-1	Site altitude more than 2000 m above sea level: Additional external separating measures are necessary for purposes of safe separation.
Protective measures against		
Short circuit	EN 61800-5-1	To a limited extent, fault acknowledgement necessary
Earth fault	EN 61800-5-1	To a limited extent, fault acknowledgement necessary
Overvoltage		Yes
Motor stalling		Yes
Overtemperature of motor		I ² xt-monitoring
Leakage current		
> 3.5 mA AC, > 10 mA DC	EN 61800-5-1	Please observe regulations and safety instructions!
Equipotential bonding		Additional M5 thread with terminal at the terminal box for connecting another PE cable (up to max. 6 mm ²)
Total fault current		
Residual current operated switch 30 mA, Type B		In TN power supply systems
Cyclic mains switching		
3 times a minute, max. 20 times per hour		Mains switching 3 times in one minute must be followed by a pause of 9 minutes.
Starting current		
5.6 A mains power-on current		

Technical data

Standards and operating conditions
Electrical supply conditions



EMC data

Actuation on public supply systems		
Implement measures to limit the radio interference to be expected:		The machine or plant manufacturer is responsible for compliance with the requirements for the machine/plant!
< 1 kW: with mains choke	EN 61000-3-2	
> 1 kW at mains current ≤ 16 A: without additional measures		
Mains current > 16 A: with mains choke or mains filter, with dimensioning for rated power. Rsce ≥ 120 is to be met.	EN 61000-3-12	RSCE: short-circuit power ratio at the connection point of the machine/plant to the public network.
Noise emission		
Category C2	EN 61800-3	
Noise immunity		
Meets requirement in compliance with	EN 61800-3	

Environmental conditions

Climate		
1K3 (-30 °C ... +60 °C)	EN 60721-3-1	Storage, < 3 months
1K3 (-30 °C ... +40 °C)	EN 60721-3-1	Storage, > 3 months
2K3 (-30 °C ... +70 °C)	EN 60721-3-2	Transport
3K3 (-30 °C ... +40 °C) In the case of very low-temperature applications without condensation	EN 60721-3-3	operation
Site altitude		
0 ... 1000 m a.m.s.l.		Without power reduction
1000 ... 4000 m a.m.s.l.		Reduce rated output current by 5%/1000 m
Degree of pollution		
Degree of pollution 2	EN 61800-5-1	
Vibration resistance		
2M2	EN 60721-3-2	Transport
3M4	EN 60721-3-3	operation
Vibration severity		
A	EN 60034-14	

Electrical supply conditions

Possibility of connection to different types of mains power supply enables worldwide use.

The following is supported:

- 3-phase mains connection 400 V
- 3-phase mains connection 480 V

Type of mains power supply		
TT		Mains power supplies with earthed start point Voltage against earth: max. 300 V
TN		



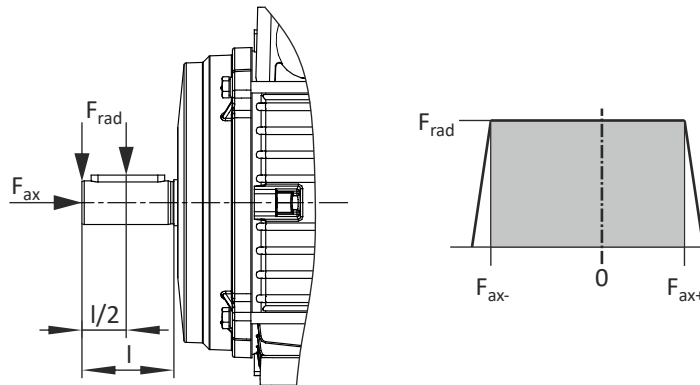
Radial forces and axial forces

Permissible radial and axial forces



The values for the bearing service life L_{10} refer to a medium speed of 2000 rpm. n. Depending on the ambient temperatures, the service life of the bearings is also reduced by the grease lifetime. Data for axial forces relate to the maximum radial force with the corresponding bearing service life.

Application of forces



Application of force at l/2

Bearing service life L_{10}	10000 h			20000 h			30000 h			50000 h		
	F_{rad}	$F_{ax, -}$	$F_{ax, +}$	F_{rad}	$F_{ax, -}$	$F_{ax, +}$	F_{rad}	$F_{ax, -}$	$F_{ax, +}$	F_{rad}	$F_{ax, -}$	$F_{ax, +}$
	N											
Motor												
MSEMA□□063-42	600	-600	300	470	-480	180	410	-430	120	350	-370	70
MSEMA□□080-32	960	-1090	580	770	-860	350	670	-760	250	570	-650	140

Application of force at l

Bearing service life L_{10}	10000 h			20000 h			30000 h			50000 h		
	F_{rad}	$F_{ax, -}$	$F_{ax, +}$	F_{rad}	$F_{ax, -}$	$F_{ax, +}$	F_{rad}	$F_{ax, -}$	$F_{ax, +}$	F_{rad}	$F_{ax, -}$	$F_{ax, +}$
	N											
Motor												
MSEMA□□063-42	400	-600	300	370	-480	180	320	-430	120	300	-370	70
MSEMA□□080-32	880	-1090	580	700	-860	350	610	-760	250	520	-650	140

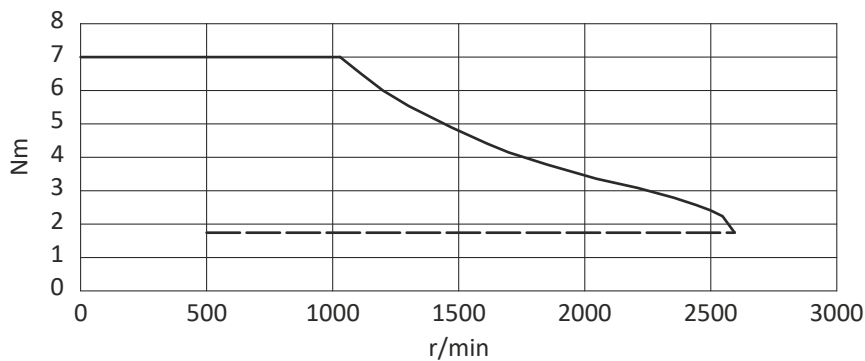


Rated data

Motor			MSEMA□□063-42	MSEMA□□080-32
Mains voltage	U_N	V	3 400 ... 480 AC	3 400 ... 480 AC
Rated torque	M_N	Nm	1.75	5.0
Starting torque	M_a	Nm	7.0	20.0
Adjustment range	n_1	rpm	-2600 ... -500 / 0 / 500 ... 2600	
Rated current				
400 V	I_N	A	1.0	2.8
480 V	I_N	A	0.8	2.3
Rated power	P_N	kW	0.47	1.36
Power factor	$\cos \varphi$		0.99	0.99
Efficiency				
Partial load	$\eta_{75\%}$	%	65.0	73.0
Full load	$\eta_{100\%}$	%	66.0	74.0
Moment of inertia				
Without brake	J	kgcm ²	3.700	28.000
With brake	J_{Br}	kgcm ²	3.715	28.061
Mass				
Without brake	m	kg	5.9	12.5
With brake	m_{Br}	kg	6.8	14.0

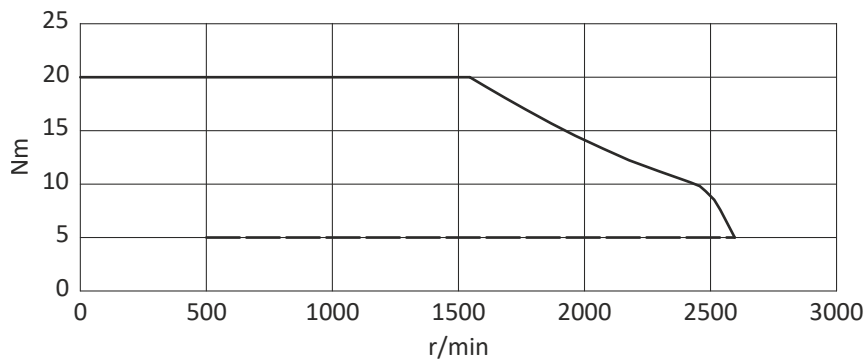
Torque characteristics

MSEMA□□063-42



--- Output torque
 — Starting torque

MSEMA□□080-32



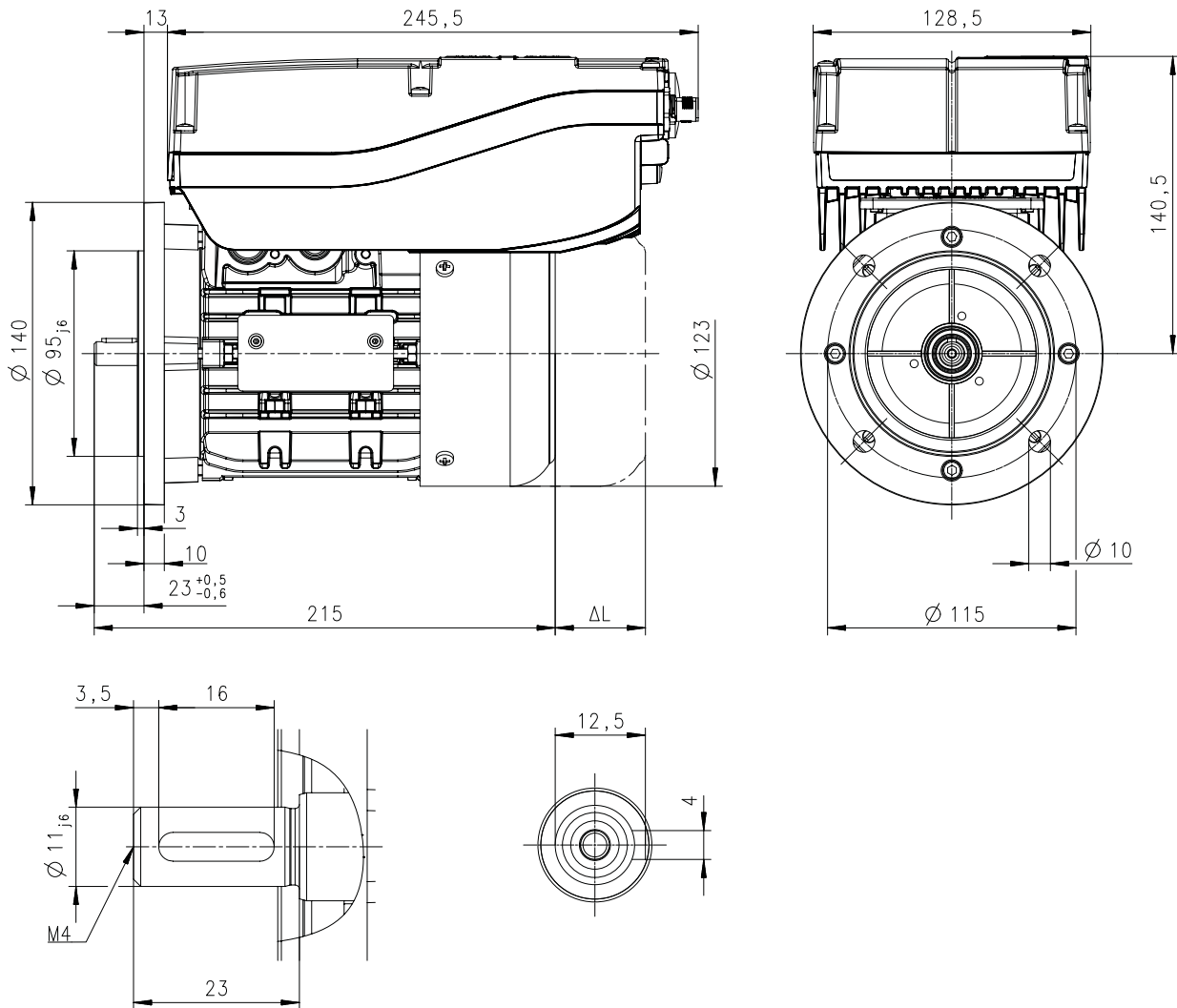
--- Output torque
 — Starting torque

Technical data

Dimensions
Basic dimensions



MSEMA □ □ 063-42
Design B5 (FF115)



8800247-00

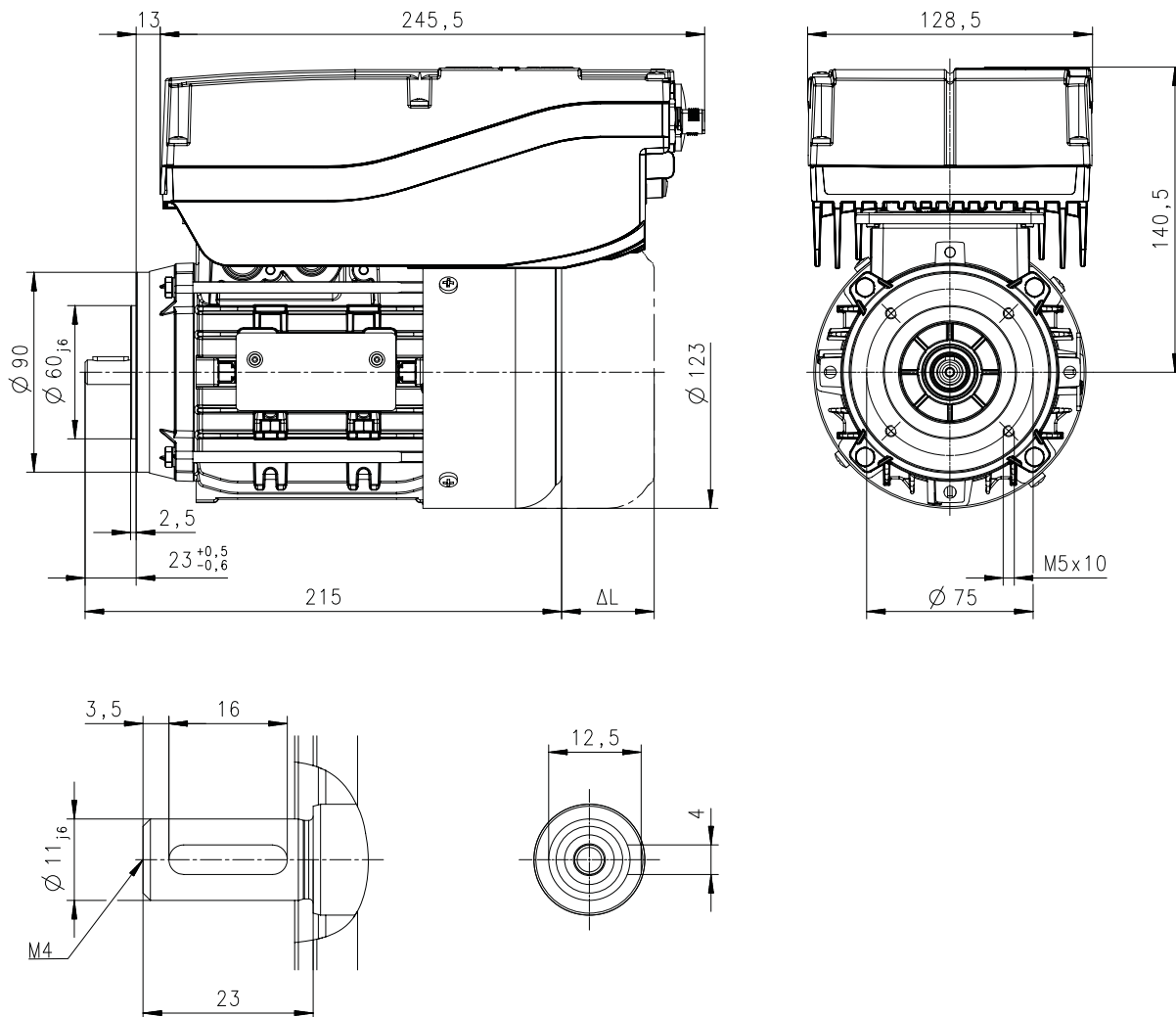
Dimensions			
Length of motor options			
With brake	ΔL	mm	40



Technical data

Dimensions
Basic dimensions

MSEMA □ □ 063-42
Design B14 (FT75)



8800246-00

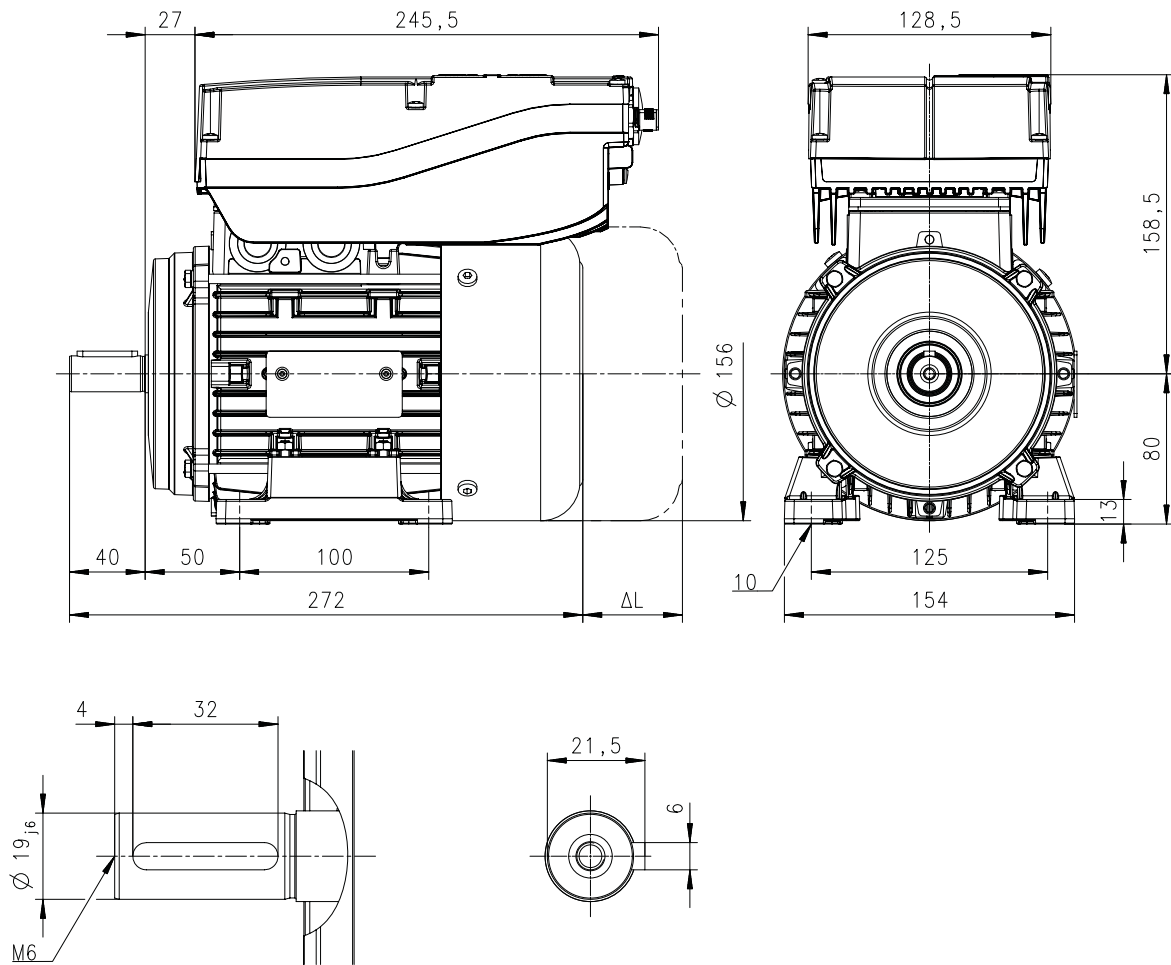
Dimensions			
Length of motor options			
With brake	ΔL	mm	40

Technical data

Dimensions
Basic dimensions



MSEMA □ □ 080-32
Design B3



8800250-00

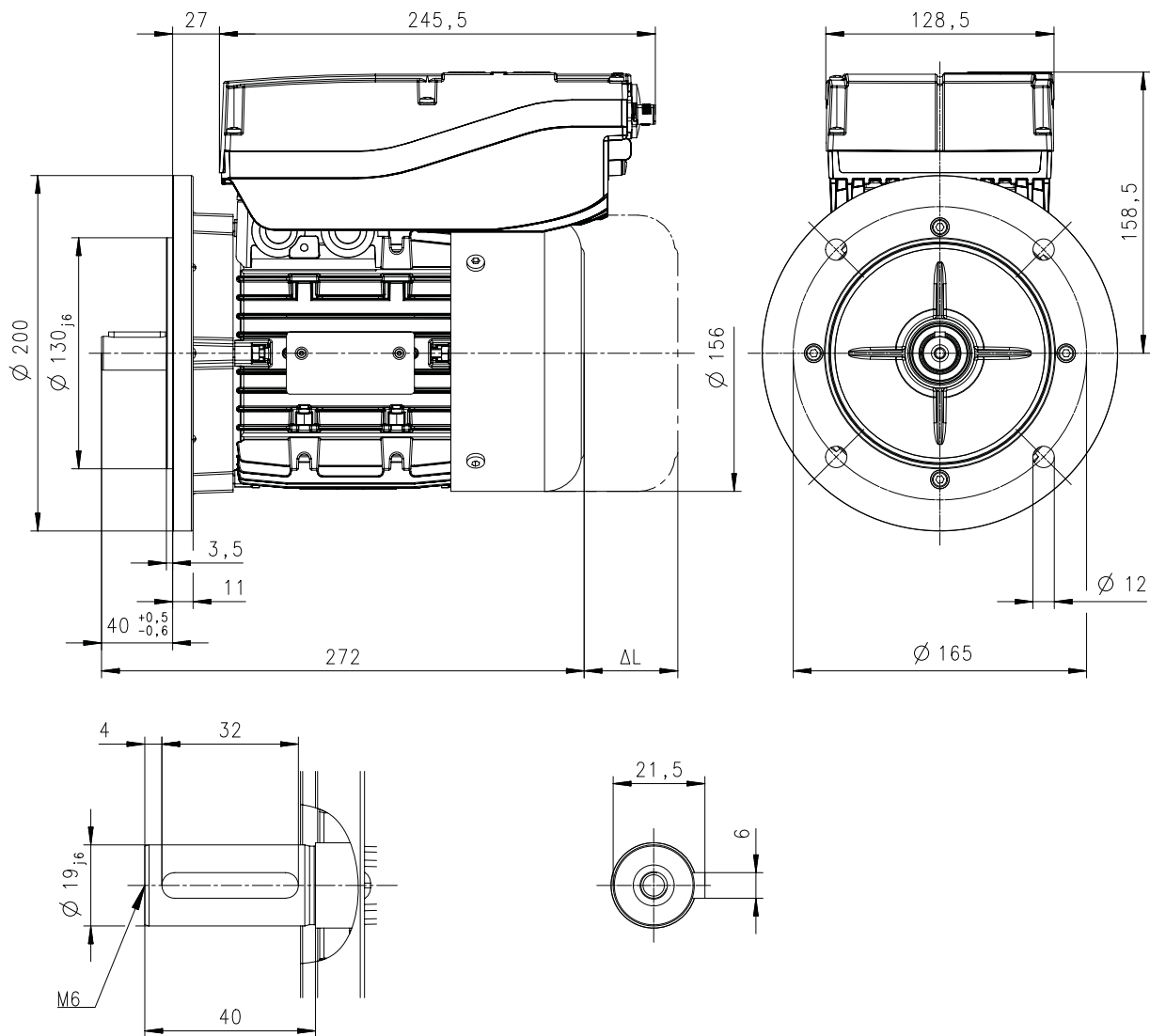
Dimensions			
Length of motor options			
With brake	Δ L	mm	73



Technical data

Dimensions
Basic dimensions

MSEMA □ □ 080-32
Design B5 (FF165)



8800249-00

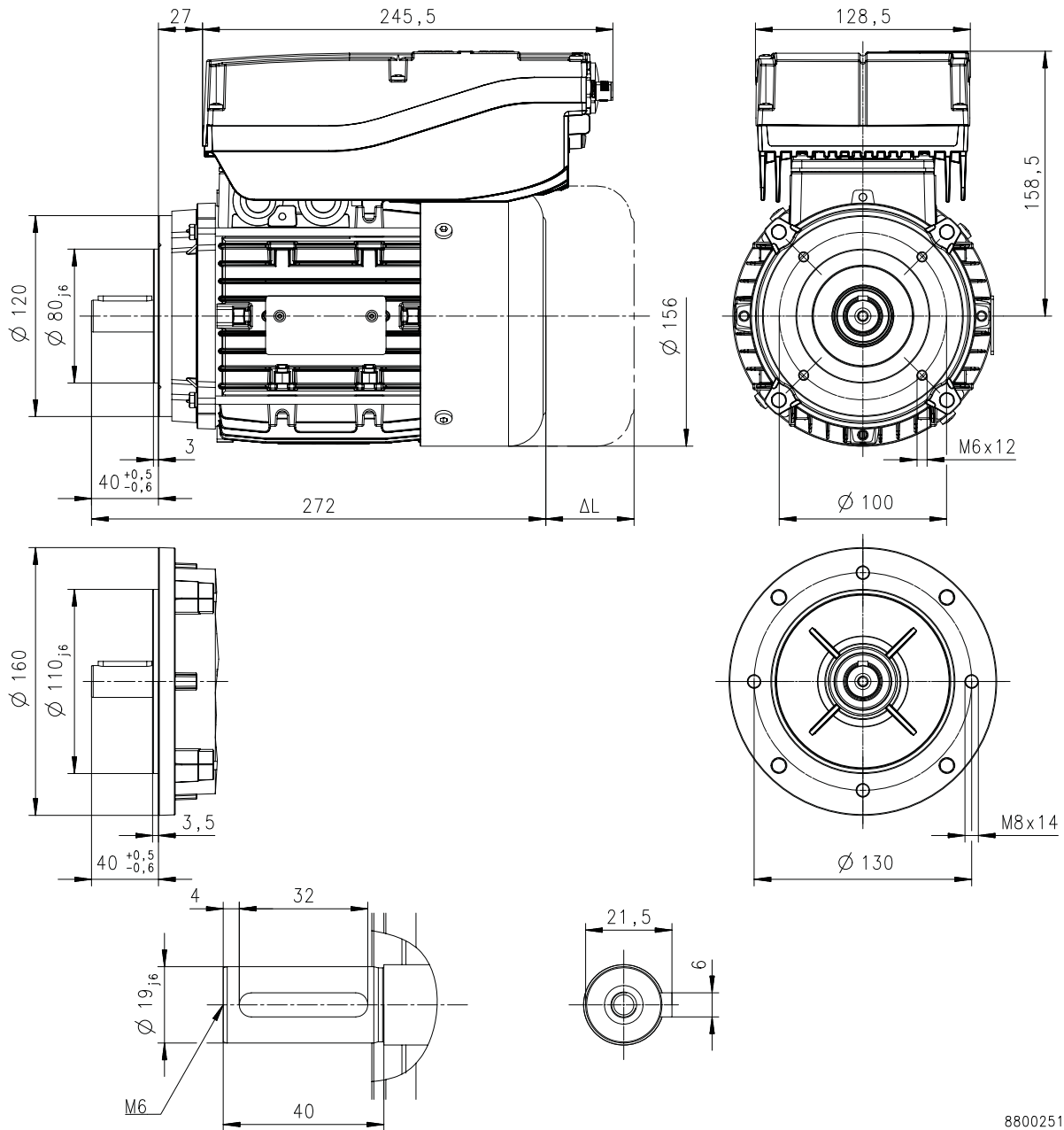
Dimensions			
Length of motor options			
With brake	ΔL	mm	73

Technical data

Dimensions
Basic dimensions



MSEMA □ □ 080-32 Design B14 (FT130)



8800251-00

Dimensions			
Length of motor options			
With brake	ΔL	mm	73



Product extensions

Motor connection

The Lenze Smart Motor can be simply connected via connectors (QUICKON or M15 for power connection, M12 for control terminals).

The power connection can alternatively be established in the terminal box via cable glands using spring terminals.

The connections are kept easily accessible from the fan side.

► [Information on electrical installation](#) 20

The QUICKON connection enables fast and easy connection of motors. The equipment is easy to cable by means of a connecting cable with the QUICKON nut.



QUICKON nuts and QUICKON connectors with QUICKON nuts are available as accessories.

Mains connection X3

Pin assignment for QUICKON connector			
Contact	Name	Meaning	
1	L1	Mains connection Phase L1	
2	L2	Mains connection Phase L2	
3	L3	Mains connection Phase L3	
4	PE	PE conductor	

Pin assignment for M15 connector			
Contact	Name	Meaning	
1	L1	Mains connection Phase L1	
2	L2	Mains connection Phase L2	
3	L3	Mains connection Phase L3	
PE	PE	PE conductor	
A		Not assigned	
B		Not assigned	

Note for the orientation of a right-angle plug:
The position of the contact "2" at the terminal box is in the direction of the terminal box cover.

Terminal assignment in the terminal box			
Contact	Name	Meaning	
1	L1	Mains connection Phase L1	
2	L2	Mains connection Phase L2	
3	L3	Mains connection Phase L3	
PE	PE	PE conductor	

Control connections with M12 connectors

Via the digital inputs of the two M12 control connections, it is possible to switch between different speeds and directions of rotation. Up to 5 different speed settings (e. g. creep speed and normal speed in both directions, as well as stop) can thus be selected. In addition, the operating state is indicated via a digital output.

Product extensions

Motor connection



NOTICE

In the "DI/DO-GND bridged" version, the masses of the control terminal X1 and X2 (GND-I and GND-O) are connected to each other. If only one speed is used, the connection to X2 is sufficient.

Control terminal X1

Pin assignment for M12 connector A coded, pins			
Contact	Name	Meaning	
1	n.c.		
2	DI2	Digital input 2	
3	GND-I	Mass of digital input	
4	DI1	Digital input 1	

Control terminal X2

Pin assignment for M12 connector A coded, pins			
Contact	Name	Meaning	
1	24V	24 V-supply (DO1 supply)	
2	DI3	Digital input 3 (reference X1;3 = GND-I)	
3	GND-O	Mass of digital output	
4	DO1	Digital output 1	



Brakes

Spring-applied brakes

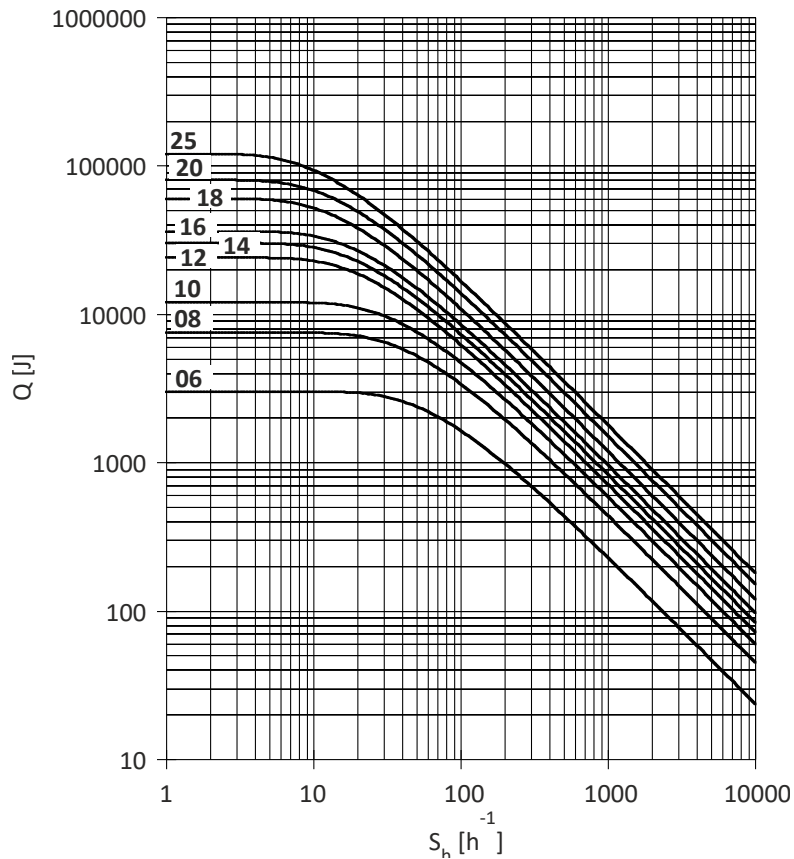
Motors with brake are equipped with a spring-applied brake. It becomes active when the supply voltage is switched off (closed-circuit principle).

For applications with very high switching rates, a LongLife version of the brake with strengthened braking mechanics is available.

Features

Designs	
Standard	1 x 10 ⁶ switching cycles, repeating 1 x 10 ⁶ switching cycles, repeating
LongLife	10 x 10 ⁶ Switching cycles, repeating 15 x 10 ⁶ Switching cycles, repeating
Triggering	Via internal electronics Holding brake, active when equipment deenergised
Enclosure	
Without manual release lever	IP55
With manual release lever	IP54
Friction lining	Asbestos-free, low-wear design

Permissible friction energy



- Q Switching energy per switching cycle
- S_h Switching rate
- 06 ... 25 Brake size

Product extensions

Brakes
Spring-applied brakes



Assignment of the brake

Motor		MSEMABR063-42	MSEMABR080-32
Brake size		06	08
Characteristic torque			
Standard	Nm	4.0	8.0
LongLife	Nm	4.0	8.0

Rated data with standard braking torque

Motor			MSEMABR063-42	MSEMABR080-32
Brake size			06	08
Power input	P_{in}	kW	0.020	0.025
Braking torque at output speed				
100 rpm	M_B	Nm	4.00	8.00
1000 rpm	M_B	Nm	3.70	7.20
1200 rpm	M_B	Nm	3.60	7.00
1500 rpm	M_B	Nm	3.50	6.80
1800 rpm	M_B	Nm	3.40	6.70
2600 rpm	M_B	Nm	3.20	6.30
Maximum switching energy at output speed				
100 rpm	Q_E	KJ	3.00	7.50
1000 rpm	Q_E	KJ	3.00	7.50
1200 rpm	Q_E	KJ	3.00	7.50
1500 rpm	Q_E	KJ	3.00	7.50
1800 rpm	Q_E	KJ	3.00	7.50
2600 rpm	Q_E	KJ	3.00	7.50
Transition operating frequency	$S_{n\dot{u}}$	1/h	79.0	50.0

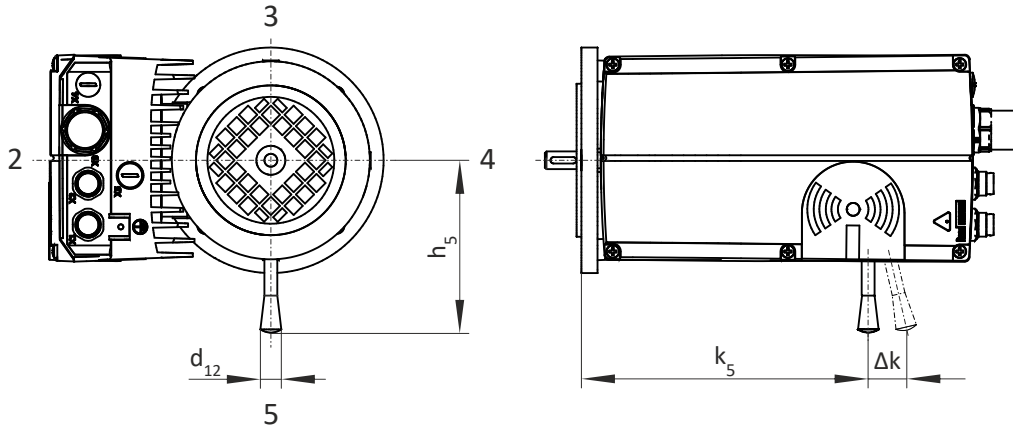


Manual release lever

By using the manual release lever, the brake can be released manually in deenergised operating state. The manual release makes positioning and maintenance work easier.



Please specify the position of the manual release lever (3,4 or 5) when ordering. Manual release lever and terminal box are not possible in the same position (2)!



Motor	Brake size	Dimensions			
		k_5	Δk	h_5	d_{12}
		mm			
MSEMABR063-42	06	178	29	107	13
MSEMABR080-32	08	224	27	116	13

Product extensions

Brake resistors



Brake resistors

The Lenze Smart Motor can be braked in a guided manner along a ramp. If large amounts of regenerative energy are produced during braking, they must be absorbed by a brake resistor.

In addition to a brake resistor (10 W) mounted inside the terminal box, another brake resistor (20 W) can also be connected externally alongside the terminal box via the terminal X4.

These brake resistors are mounted and parameterized at the factory.

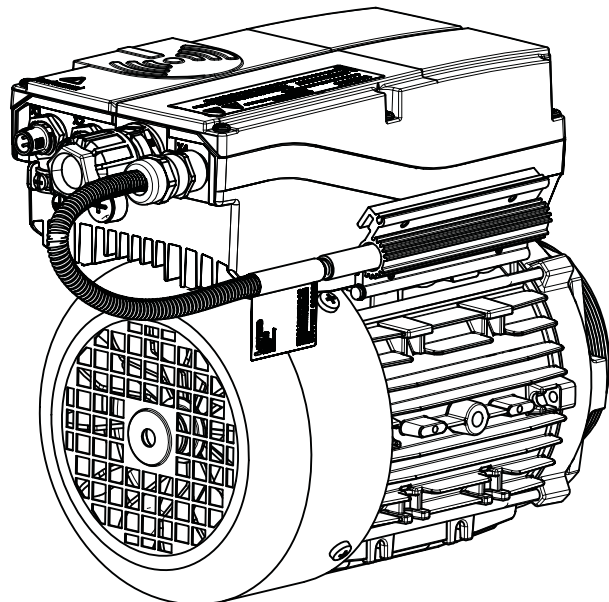
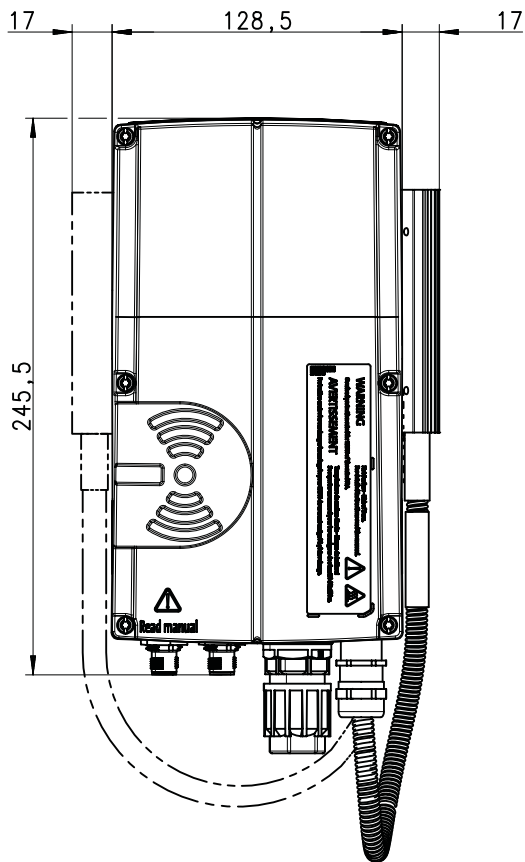
NOTICE

Do not fall below the minimally connectable brake resistance of 180 Ω at the terminal "X4".

If an external brake is used, the power can be increased from 20 W to max. 40 W if the medium speed is > 1000 rpm (arithmetic mean of the process speeds in relation to the motor speed, without standstill).

Motor		MSEMA□□063-42 MSEMA□□080-32	
Brake resistor		Internal	External
Order code			ERBU390R020W
Rated resistance	Ω	400	390
Rated power	W	10	20
Thermal capacity	kWs	0.100	0.250
Mass	kg	0.05	0.17

Terminal box dimensions with external brake resistor





Accessories

Overview

NFC adapter	
	
QUICKON connector	
QUICKON nut	QUICKON connector with nut
	
M15 connector	
M15 connector	
	

NFC adapter

The settings of the Lenze Smart Products can be made with an NFC-capable Android smartphone or a PC. If a PC is used to make the settings, the »EASY Starter« engineering tool must be used to do this (»EASY Advanced« software licence). Communication takes place via the NFC adapter. The adapter is connected to the PC at the USB interface.



NFC adapter		
Version	VPE	Order code
	Piece	
Voltage supply on the input side via USB connection of the PC Diagnostic LEDs hot plug-capable	1	EZAETF001



QUICKON connector

Nuts for QUICKON connection

For fast and easy QUICKON connection, the following nuts (counterparts) can be fitted to the connecting cable. No special tools are needed for installation, only standard tools for stripping the cable.

NOTICE

In the case of the capability for frequent connections (>10 times) a QUICKON connector with nut must be used.



QUICKON nut



QUICKON connector with QUICKON nut

QUICKON connector, 4-pole		
Type	VPE	Order code
	Piece	
QUICKON nut		
Cable diameter: 6 ... 10 mm	1	EWS0088
Cable diameter: 9 ... 14 mm	1	EWS0089
QUICKON connector with QUICKON nut		
Can be plugged in and disconnected safe from touch		
Cable diameter: 6 ... 10 mm	1	EWS0090
Cable diameter: 9 ... 14 mm	1	EWS0091

UMCLN_SGG_100181

The following connector can be mounted to the connecting cable for the M15 connection.



M15 connector		
Type	VPE	Order code
	Piece	
Connection cross-section: 2.5 mm ² Can be assembled in the field Plastics without shielding Crimp sockets included in the scope of supply	5	EWS0109/M



Purchase order



Order accessories separately.

Motor without brake

Motor	Design	Output flange	Product extension	
			Motor connection	brake resistance
MSEMAXX063-42	B3		Terminal box QUICKON connector M15 connector	Without Internal External
	B14	FT75		
	B5	FF115		
MSEMAXX080-32	B3			
	B14	FT130		
	B5	FT165		

Motor with brake

Motor	Design	Output flange	Product extension		
			Motor connection	Brake	brake resistance
MSEMABR063-42	B3		Terminal box QUICKON connector M15 connector	Standard LongLife	Without Internal External
	B14	FT75			
	B5	FF115			
MSEMABR080-32	B3			Without manual release lever With manual release lever	
	B14	FT130			
	B5	FT165			

Product codes



Product codes

Motor product code

Example	M	S	E	MA	XX	063	-	4	2	C1	C
Meaning	Variant	Product code									
Product family	Motor	M									
Product type	Smart Motor		S								
Cooling	Integral fan			E							
Internal key					MA						
Built-on accessories	Without built-on accessories					XX					
	Brake					BR					
Size						063 080					
Overall length							-	3 4			
Number of pole pairs	4-pole motors								2		
Design types	Internal key									C1	
Approval	CE										C
	CE; cULus										L
	CE; CCC										3
	CE; cULus; CCC										5



Appendix

Good to know

Approvals/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.

Appendix

Good to know
Operating modes of the motor



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
<p>Operation with a constant load until the motor reaches the thermal steady state. The motor may be actuated continuously with its rated power.</p>	<p>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.</p>
Intermittent operation S3	Non-intermittent periodic operation S6
<p>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.</p>	<p>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>

P Power
t Time
 t_L Idle time
 ϑ Temperature

P_V Power loss
 t_B Load period
 t_S Cycle duration



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).

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