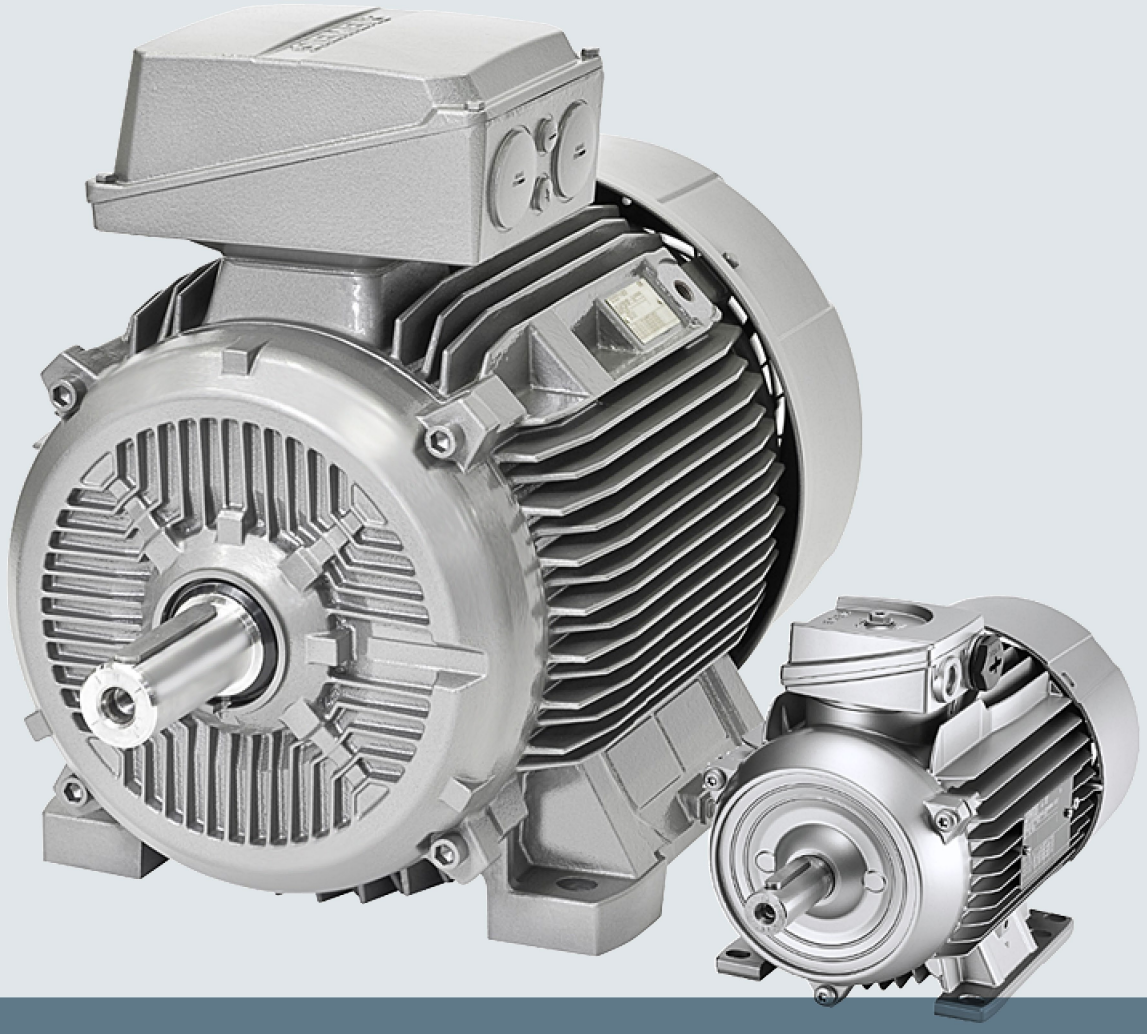
SIEMENS



SIMOTICS GP, SD, XP, DP

Low-voltage motors

1LA5/6/7/9, 1LE1, 1LG4/6, 1LP7/9, 1FP1, 1MA6/7, 1MB1, 1MF6/7, 1PC1/3, 1PP6/7/9

Operating instructions

Edition 01/2016

siemens.com

SIEMENS

SIMOTICS GP, SD, DP, XP

Low-Voltage Motors
Low-voltage motors

Operating Instructions

01/2016

5 610 00000 02 000

Legal information

Warning notice system

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

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

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

⚠CAUTION
indicates that minor personal injury can result if proper precautions are not taken.

NOTICE
indicates that property damage can result if proper precautions are not taken.

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

Qualified Personnel

The product/system described in this documentation may be operated only by **personnel qualified** for the specific task in accordance with the relevant documentation, in particular its warning notices and safety instructions. Qualified personnel are those who, based on their training and experience, are capable of identifying risks and avoiding potential hazards when working with these products/systems.

Proper use of Siemens products

Note the following:

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

Trademarks

Disclaimer of Liability

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

Siemens AG
Division Process Industries and Drives
Postfach 48 48
90026 NÜRNBERG
GERMANY

Order number: 5 610 00000 02 000
℗ 12/2015 Subject to change

Table of contents

Introduction 1

1.1 About these instructions

These instructions describe the machine and explain how to handle it, from initial delivery to final disposal of the equipment. Keep these instructions for later use.
Read these operating instructions before you handle the machine and follow the instructions to become familiar with its design and operating principles and thus ensure safe, problem-free machine operation and long service life.
Please contact the Service Center (Page 145) if you have any suggestions on how to improve this document.

Text format features

The warning notice system is explained on the rear of the inside front. Always follow the safety instructions and notices in these instructions.
In addition to the safety-related warning notices which you must read, you will find the text in these instructions is formatted in the following way:

1. Handling instructions are always formatted as a numbered list. Always perform the steps in the order given.

- Lists are formatted as bulleted lists.
  - Lists on the second level are hyphenated.

Note

A Note is an important item of information about the product, handling of the product or the relevant section of the document. Notes provide you with help or further suggestions/ideas.

1.2 Information for the reader

Note for 1LE1, 1FP1, 1MB1, 1PC1, 1PC3 machines

Note for 1LE1, 1PC1 and 1PC3 machines, frame sizes 80 and 90 with central terminal box locking

Information about explosion-protected machines

Safety information 2

2.1 Information for those responsible for the plant or system

This electric machine has been designed and built in accordance with the specifications contained in Directive 2006/95/EC up to April 19, 2016 - and from April 20, 2016 according to Directive 2014/35/EU ("Low-Voltage Directive") and is intended for use in industrial plants. Please observe the country-specific regulations when using the electric machine outside the European Community. Follow the local and industry-specific safety and setup regulations. The persons responsible for the plant must ensure the following:

- Planning and configuration work and all work carried out on and with the machine is only to be done by qualified personnel.
- The operating instructions must always be available for all work.
- The technical data as well as the specifications relating to the permissible installation, connection, ambient and operating conditions are taken into account at all times.
- The specific setup and safety regulations as well as regulations on the use of personal protective equipment are observed.

Note

Use the services and support provided by the appropriate Service Center (Page 145) for planning, installation, commissioning, and servicing work.

You will find safety instructions in the individual sections of this document. Follow the safety instructions for your own safety, to protect other people and to avoid damage to property. Observe the following safety instructions for all activities on and with the machine.

2.2 Additional information: Information for plant managers (ATEX)

This machine has been designed and built in accordance with Directive 94/9/EC until April 19, 2016 and from April 20, 2016 in accordance with Directive 2014/34/EU ("Explosion Protection Directive"), and it is intended for use in industrial plants with a potentially explosive atmosphere.
Commissioning in the European Community in accordance with Directive 2006/42/EU ("Machinery Directive") is forbidden until the plant into which the machine will be installed has been shown to conform with this directive. Please observe the country-specific regulations when using the machine outside the European Community.

⚠ WARNING

Commissioning prior to establishing conformance

If the machine is commissioned prior to determining the plant conformance, the explosion protection of the plant is not ensured. An explosion can occur. This can result in death, serious injury or material damage.

Do not commission the machine until it has been confirmed that the plant conforms with the explosion protection directive.

2.3 The five safety rules

For your own personal safety and to prevent material damage when carrying out any work, always observe the safety-relevant instructions and the following five safety rules according to EN 50110-1 "Working in a voltage-free state". Apply the five safety rules in the sequence stated before starting work.

Five safety rules

1. Disconnect the system.

   Also disconnect the auxiliary circuits, for example, anti-condensation heating.
2. Secure against reconnection.
3. Verify absence of operating voltage.
4. Ground and short-circuit.
5. Provide protection against adjacent live parts.

To energize the system, apply the measures in reverse order.

2.4 Qualified personnel

All work at the machine must be carried out by qualified personnel only. For the purpose of this documentation, qualified personnel is taken to mean people who fulfill the following requirements:

- Through appropriate training and experience, they are able to recognize and avoid risks and potential dangers in their particular field of activity.
- They have been instructed to carry out work on the machine by the appropriate person responsible.

2.5 Safe handling

Workplace safety depends on the attentiveness, care, and common sense of the personnel who install, operate, and maintain the machine. In addition to the safety measures cited, as a matter of principle, the use of caution is necessary when you are near the machine. Always pay attention to your safety.
Also observe the following to prevent accidents:

- General safety regulations applicable in the country where the machine is deployed.
- Manufacturer-specific and application-specific regulations
- Special agreements made with the operator
- Separate safety instructions supplied with the machine
- Safety symbols and instructions on the machine and its packaging

⚠WARNING

Live parts

Electric machines contain live parts.

Fatal or severe injuries and substantial material damage can occur if the covers are removed or if the machine is not handled, operated, or maintained properly.

- Always observe the “five safety rules" (Page 14) when carrying out any work on the machine.
- Only remove the covers using the methods described by these operating instructions.
- Operate the machine properly.
- Regularly and correctly maintain the machine.

⚠WARNING

Rotating parts

Electric machines contain dangerous rotating parts.

Fatal or severe injuries and substantial material damage can occur if the covers are removed or if the machine is not handled, operated, or maintained properly.

- Only remove the covers using the methods described by these operating instructions.
- Operate the machine properly.
- Perform regular maintenance on the machine.
- Secure free-standing shaft ends.

⚠ WARNING

Hot surfaces

Electric machines have hot surfaces. Do not touch these surfaces. They could cause burns.

- Allow the machine to cool before starting work on the machine.
- Only remove the covers using the methods described by these operating instructions.
- Operate the machine properly.

⚠ CAUTION

Hazardous substances

Chemical substances required for the setup, operation and maintenance of machines can present a health risk.

Poisoning, skin damage, cauterization of the respiratory tract, and other health damage may result.

- Read the information in these operating instructions and the product information supplied by the manufacturer.
- Observe the relevant safety regulations and wear the personal protective equipment specified.

⚠ CAUTION

Flammable substances

Chemical substances required for the setup, operation and maintenance of machines may be flammable.

Burns and other damage to health and material may result.

- Read the information in these operating instructions and the product information supplied by the manufacturer.
- Observe the relevant safety regulations and wear the personal protective equipment specified.

⚠ WARNING

Interference to electronic devices caused by electrical power equipment

Electrical power equipment generate electric fields during operation. Potentially lethal malfunctions can occur in medical implants, e.g. pacemakers, in the vicinity of electrical power equipment. Data may be lost on magnetic or electronic data carriers.

- It is forbidden for people with pacemakers to enter the vicinity of the machine.
- Protect the personnel working in the plant by taking appropriate measures, such as erecting identifying markings, safety barriers and warning signs and giving safety talks.
- Observe the nationally applicable health and safety regulations.
- Do not carry any magnetic or electronic data media.

2.6 Interference voltages when operating the converter

⚠ WARNING

Interference voltages when operating the converter

When a converter is in operation, the emitted interference varies in strength depending on the converter (manufacturer, type, interference suppression measures undertaken). On machines with integrated sensors (e.g. PTC thermistors), interference voltages caused by the converter may occur on the sensor lead. This can cause faults which can result in eventual or immediate death, serious injury or material damage.

Observe the EMC instructions of the converter manufacturer in order to avoid exceeding the limit values according to IEC/EN 61000-6-3 for drive systems comprising machine and converter. You must put appropriate EMC measures in place.

2.7 Safety instructions: Explosion-proof machines

Note

The increased level of danger in hazardous areas demands that you pay particular attention to the notes marked with ⟨Ex⟩.

2.8 Special designs and construction versions

Note

Before carry out any work on the machine, determine the machine version.

If there are any deviations or uncertainty, contact the manufacturer, specifying the type designation and serial number (see the rating plate), or contact the Siemens Service Center (Page 145).

2.9 Special conditions for explosion-proof machines

Special conditions for the safe use of explosion-protected machines with **X** marking (excerpt from EC or EU prototype test certificate, Point 17).

Zone 21

- Do not operate the motors with excessively thick deposits of dust.
- When the motors are mounted with the free shaft end pointing upwards, prevent foreign bodies from dropping into the ventilation openings using an appropriate mechanical design.
- For motors with a fixed connecting cable: The free end of the cable must be connected according to valid regulations for electrical installations.

Description 3

3.1 Area of application

The three-phase machines of this series are used as industrial drives. They are designed for a wide range of drive applications both for line operation as well as in conjunction with frequency converters.
They are characterized by their high power density, extreme robustness, long service life and outstanding reliability.

Intended use of the machines

These machines are intended for industrial installations. They comply with the harmonized standards of the series EN / IEC 60034 (VDE 0530). It is prohibited that these motors are used in hazardous zones if the marking on the rating plate does not explicitly permit line or converter operation. If other/more wide-ranging demands (e.g. protection so that they cannot be touched by children) are made in special cases – i.e. use in non-industrial installations – these conditions must have been complied with in the plant or system itself when the motors are installed.

Note

Machine directive

Low-voltage motors are components designed for installation in machines in accordance with the current Machinery Directive. Commissioning is prohibited until it has been absolutely identified that the end product is in conformance with this Directive. Observe machinery directive EN 60204-1!

3.1.1 Operating UL-certified machines with a converter

Note

Operating a machine with a converter

Implement all machines of the overall machine-converter system according to UL-File E227215 assuming that the machines are only to be operated with a converter and are supplied with UL certificate.
The company operating the equipment is responsible for implementing this in the actual application.

3.1.2 CE marking

Note

Use of machines without CE identification

Machines without CE marking are intended for operation outside the European Economic Area (EEA). Do not use any machines without CE mark within of the EEA!

3.1.3 IE2 marking

Note

IE2 marking

Since January 1, 2015, according to REGULATION (EC) No. 640/2009, low-voltage motors with power ratings above 7.5 kW up to 375 kW – and with efficiency IE2 – have this label. This is mandatory within the European Economic Area (EEA). Customers are solely responsible in ensuring the correct use.
When connecting the machine to a converter, carefully observe the rules and notes in Chapter "Connecting a converter."

3.2 Rating plates

Rating plate

The rating plate shows the identification data and the most important technical data. The data on the rating plate and the contractual agreements define the limits of proper usage.

Data on the rating plate

Item	Description	Item	Description
General data		**Electrical data**	
1	Type of machine	31	Electrical data
2	Machine type	32	-
3	Serial number (incl. date of manufacture YY.MM)	33	Rated voltage [V]
4	Standards	34	Winding connections
5	Additional details (optional)	35	Frequency [Hz]
6	Customer data (optional)	36	Rated power [kW]
7	Country of origin	37	Rated current [A]
8	Production location	38	Power factor [cosφ]

Item	Description	Item	Description
9	Identification number of testing agency (optional)	39	Rated speed [rpm]
10	Regulations (optional)	40	Efficiency class
Mechanical data		41	Efficiency
11	Frame size	42	Torque [Nm] (optional)
12	Type of construction	43	Rated power [hp] (optional)
13	Degree of protection	44	Service factor (optional)
14	Machine weight [kg]	45	Starting current ratio (optional)
15	Temperature class	46	Operating mode (optional)
16	Ambient temperature range (optional)	47	NEMA data (optional)
17	Installation altitude (only if higher than 1000 m)	48	Anti-condensation heating (optional)
18	Vibration severity grade	49	Company logo
19	Bearing sizes	50	CODE: Motor code number for converter parameterization (optional)
20	Relubrication data/specifications (optional)	51	Converter data
21	Brake data (optional)	52	Marine regulation
22	Mechanical speed limit		

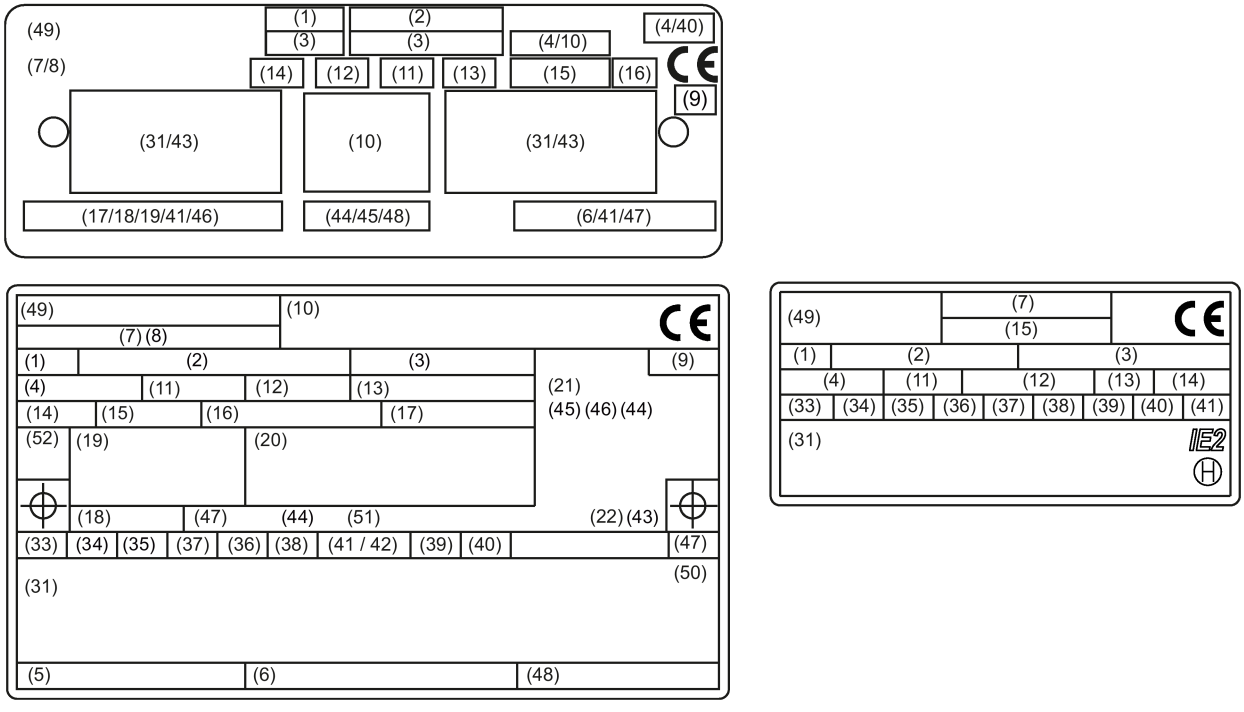


Figure 3-1 Examples of rating plates

3.3 Installation

3.3.1 Machine design

Machines of this series are low-voltage three-phase induction or reluctance-synchronous machines with a cylindrical shaft end and keyway. They can be supplied as single-speed machines with different efficiency classes or as pole changing machines for several speeds. In the case of machines with feet (IM B3 type of construction), the feet are cast or bolted on. It is possible to change over the bolted on mounting feet on the machine enclosure, for example to change the terminal box position; only authorized retrofit partners may carry out this work.
Measures for alignment and mounting (Page 59)

3.3.2 Regulations

The regulations and standards used as basis to design and test this machine are stamped on the rating plate. The machine design basically complies with the following standards:

Table 3- 1 Applicable general regulations

Feature	Standard
Dimensioning and operating behavior	EN / IEC 60034-1
Procedure for determining the losses and the efficiency of rotating electrical machines and inspections	EN / IEC 60034-2-1 EN / IEC 60034-2-2 EN / IEC 60034-2-3
Degree of protection	EN / IEC 60034-5
Cooling	EN / IEC 60034-6
Type of construction	EN / IEC 60034-7
Terminal designations and direction of rotation	EN / IEC 60034-8
Noise emission	EN / IEC 60034-9
Starting characteristics of rotating electrical machines	EN / IEC 60034-12
Vibration severity grades	EN / IEC 60034-14
Efficiency classification of three-phase squirrel-cage induction motors	EN / IEC 60034-30
IEC standard voltages	IEC 60038

Supplementary regulations for explosion-proof machines

Table 3- 2 Regulations applied for explosion-protected machines

Feature	Standard
Electrical equipment for hazardous gas atmospheres, Part 0: General requirements	EN / IEC 60079-0
Electrical equipment for hazardous gas atmospheres, Part 7: Increased safety "e"	EN / IEC 60079-7
Electrical equipment for hazardous gas atmospheres, Part 14: Electric installations for endangered atmospheres (except underground excavation)	EN / IEC 60079-14
Electrical equipment for hazardous gas atmospheres, Part 15: Type of protection "n"	EN / IEC 60079-15
Electrical equipment for hazardous gas atmospheres, Part 19: Repairs and overhauls	EN / IEC 60079-19
Potentially explosive atmosphere - Part 31: Device dust explosion protection by enclosure "t"	EN / IEC 60079-31
Electrical equipment for use in the presence of combustible dust - Part 17: Inspection and maintenance of electrical systems in hazardous areas (except underground excavation)	EN / IEC 60079-17
Directive on the approximation of the laws of the Member States concerning equipment and protective systems intended for use in hazardous areas.	Directive 94/9/EC (up to April 19, 2016) Directive 2014/34/EU (from April 20, 2016)

3.3.2.1 Regulations of the customs union Eurasia

Table 3- 3 Applicable general regulations

Feature	Standard	EAC
Dimensioning and operating behavior	EN / IEC 60034-1	GOST R IEC 60034-1
Procedure for determining the losses and the efficiency of rotating electrical machines and inspections	EN / IEC 60034-2-1 EN / IEC 60034-2-2 EN / IEC 60034-2-3	GOST R IEC 60034-2-1 GOST R IEC 60034-2-2 GOST RIEC 60034-2-3
Degree of protection	EN / IEC 60034-5	GOST R IEC 60034-5
Cooling	EN / IEC 60034-6	GOST R IEC 60034-6
Type of construction	EN / IEC 60034-7	GOST R IEC 60034-7
Terminal designations and direction of rotation	EN / IEC 60034-8	GOST R IEC 60034-8
Noise emission	EN / IEC 60034-9	GOST R IEC 60034-9
Starting characteristics of rotating electrical machines	EN / IEC 60034-12	GOST R IEC 60034-12
Vibration severity grades	EN / IEC 60034-14	GOST R IEC 60034-14
Efficiency classification of three-phase squirrel-cage induction motors	EN / IEC 60034-30	GOST R IEC 60034-30
IEC standard voltages	IEC 60038	GOST R IEC 60038

Table 3- 4 Regulations applied for explosion-protected machines

Feature	Standard	EAC
Electrical equipment for hazardous gas atmospheres, Part 0: General requirements	EN / IEC 60079-0	GOST 30852 0 - 2002
Electrical equipment for hazardous gas atmospheres, Part 7: Increased safety "e"	EN / IEC 60079-7	GOST 30852 8 - 2002
Electrical equipment for hazardous gas atmospheres, Part 14: Electric installations for endangered atmospheres (except underground excavation)	EN / IEC 60079-14	GOST 30852 13 - 2002
Electrical equipment for hazardous gas atmospheres, Part 15: Type of protection "n"	EN / IEC 60079-15	GOST 30852 14 - 2002
Electrical equipment for hazardous gas atmospheres, Part 19: Repairs and overhauls	EN / IEC 60079-19	GOST 30852 18 - 2002
Potentially explosive atmosphere - Part 31: Device dust explosion protection by enclosure "t"	EN / IEC 60079-31	GOST R IEC 60079-31
Electrical equipment for use in the presence of combustible dust - Part 17: Inspection and maintenance of electrical systems in hazardous areas (except underground excavation)	EN / IEC 60079-17	GOST 30852 16 - 2002
Directive on the approximation of the laws of the Member States concerning equipment and protective systems intended for use in hazardous areas.	Directive 94/9/EC (up to April 19, 2016) Directive 2014/34/EU (from April 20, 2016)	TR CU

3.3.3 Cooling and ventilation

3.3.3.1 General

This series of machines includes induction three-phase machines or reluctance-synchronous drives with a closed primary (inner) cooling circuit and an open, secondary cooling air circuit (surface cooling). The surface cooling varies depending on the version.

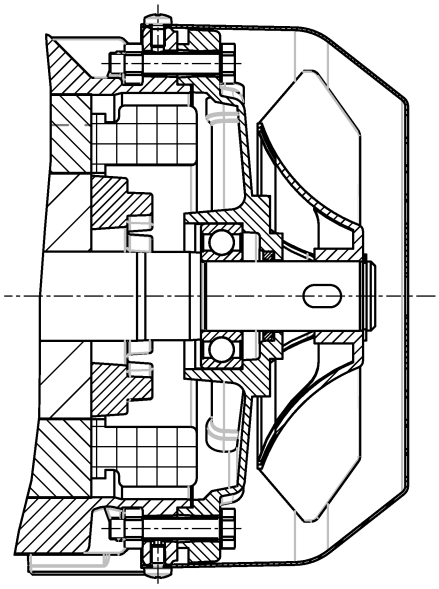
3.3.3.2 Machines with a fan

Self-ventilation (standard): Cooling IC 411 in accordance with EN / IEC 60034-6

Located at the ND end of the stator housing is an air intake cowl that guides the external air on its way to the motor. The external air is drawn in through openings in the air intake cowl and flows axially across the outer cooling ribs of the motor frame. The fan wheel for the external flow of cooling air is attached to the machine shaft.
The fan wheels are bidirectional.
Check the cooling effect below rated speed in the case of frequent switching or braking – or if the speed is controlled continually below the rated speed.

Note explosion-protected machines

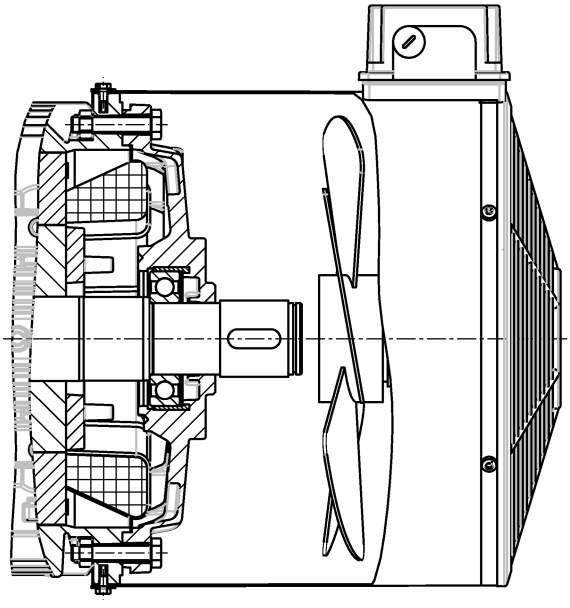
Machines for use in Zone 21 and Zone 22 have a metal fan.



Forced ventilation (optional): Type of cooling IC 416 in accordance with EN / IEC 60034-6

Cooling that does not depend on the speed is achieved by means of a separately driven fan wheel (forced ventilation). Forced ventilation does not depend on the operating state of the machine.

The fan wheel for the external flow of cooling air is powered by an independent module and is enclosed by the fan cover.



3.3.3.3 Machines without a fan (optional)

Surface cooling by free convection: Cooling IC 410 in accordance with EN / IEC 60034-6

IC410 IC4A1A0

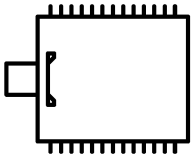


Figure 3-2 IC410

Surface cooling by relative movement of cooling air: Type of cooling IC 418 in accordance with EN / IEC 60034-6

IC418 IC4A1A8

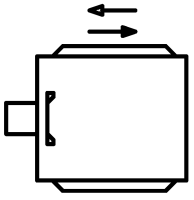


Figure 3-3 IC418

3.3.4 Bearings

In order to support the machine shaft and maintain its position in the non-moving part of the machine, only 2 rolling-contact bearings are used. One roller bearing performs the function of a location bearing that transfers axial and radial forces from the rotating machine shaft to the non-moving part of the machine. The second roller bearing is implemented as floating and support bearing in order to allow thermal expansion inside the machine and transfer radial forces.
The nominal (calculated) useful life of the bearings according to ISO 281 is at least 20,000 hours with utilization of the permissible radial/axial forces. However, the achievable useful life of the bearings can be significantly longer in the case of lower forces (e.g. operation with self-aligning couplings).
Roller bearings with permanent lubrication are maintenance-free.

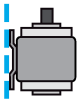
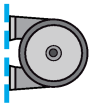
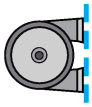
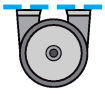
3.3.5 Balancing

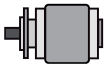
As standard, the motor is balanced dynamically with a half featherkey (code "H") in accordance with ISO 8821.
The balance quality corresponds to vibration level "A". Vibration level "B" is optional or possible on request.

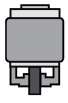
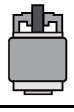
3.3.6 Types of construction/method of installation

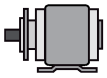
The type of construction of the machine is stated on the rating plate.

Table 3- 5 Type of construction

Basic type of construction code	Diagram	Other methods of installation	Diagram
IM B3 (IM 1001)		IM V5 (IM 1011)	
		IM V6 (IM 1031)	
		IM B6 (IM 1051)	
		IM B7 (IM 1061)	
		IM B8 (IM 1071)	

Basic type of construction code	Diagram	Other methods of installation	Diagram
IM B5 (IM 3001)		IM V1 (IM 1011)	
		IM V3 (IM 3031)	

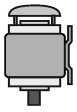
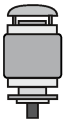
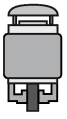
Basic type of construction code	Diagram	Other methods of installation	Diagram
IM B14 (IM 3601)		IM V18 (IM 3611)	
		IM V19 (IM 3631)	

Basic type of construction code	Diagram
IM B35 (IM 2001)	
IM B34 (IM 2101)	

Types of construction/Installation conditions for explosion-proof machines

The type of construction of the machine is stated on the rating plate.
In the case of explosion-proof machines where the shaft extensions point downwards (types of construction IM V5, IM V1 or IM V18) a protective top cover is mandatory. Explosion-proof machines with IM V5, IM V1 and IM V18 types of construction are fitted with a canopy at the factory.

Table 3- 6 Construction type with protective top cover

Conditions of installation	Graphics-Based Representation
IM V5 (IM 1011)	
IM V1 (IM 3011)	
IM V18 (IM 3611)	

3.3.7 Degree of protection

The machine has a type of protection as stamped on the rating plate, and can be installed in dusty or humid environments.
Machines intended for use in Zone 1 (type of protection Flameproof Enclosure "d" or Increased Safety "e") or in Zone 2 (type of protection "n") are designed with IP 55 degree of protection.
Machines intended for use in Zone 21 have IP 65 degree of protection. Machines intended for use in Zone 22 have IP 55 degree of protection and can be used in dusty environments such as grinders, silos, animal feed plants, and malthouses, as well as in certain areas of the chemical industry.

3.3.8 Environmental conditions

Limit values for the standard version

Relative humidity for ambient temperature T_{amb} 40 °C	Max. 55 %
Ambient temperature	-20 °C to +40 °C
Installation altitude	≤ 1000 m
Air with normal oxygen content, usually	21 % (V/V)

If the environmental conditions are different from the details listed here, then the values on the rating plate will apply.
The machine is suitable for tropical climates.

3.3.9 Optional built-on and built-in accessories

Machines can be equipped with the following integrated components/devices:

- Temperature sensors integrated in the stator winding in order to monitor the temperature and protect the stator winding from overheating.
- Anti-condensation heating for machines whose windings are subject to a risk of condensation due to the climatic conditions.

Machines can be equipped with the following mounted components/devices:

- Brake
- Rotary pulse encoder
- External fan (forced ventilation)
- Shock pulse measurement

3.3.10 Class

3.3.10.1 Zone 1 with Ex e IIC Gb type of protection (increased safety "e")

CE	0158		II	2	G	Ex	e	IIC	T3	Gb
①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩	⑪

EAC	ГБ 05		1	Ex	e	IIC	T3	Gb	X
①	②	③	⑫	⑦	⑧	⑨	⑩	⑪	⑬

① CE - or EAC marking
② Identification number or name of nominated testing agency
③ Code for prevention of explosions
④ Equipment group: II not for mining, but other hazardous zones
⑤ Device category: 2 for occasional danger
⑥ Atmosphere: G for gas
⑦ Explosion protection: International
⑧ Type of protection: "e" Increased Safety
⑨ Explosion group: IIC for acetylene
⑩ Temperature class: T3 for maximum surface temperature of 200° C
⑪ Device protection level: Gb for a high level of protection in hazardous zones with explosive gas mixtures
⑫ Zone 1
⑬ "X" special conditions

3.3.10.2 Zone 1 with Ex e IIB Gb type of protection (increased safety "e")

CE	0158		II	2	G	Ex	e	IIB	T3	Gb
①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩	⑪

EAC	ГБ 05		1	Ex	e	IIB	T3	Gb	X
①	②	③	⑫	⑦	⑧	⑨	⑩	⑪	⑬

① CE - or EAC marking
② Identification number or name of nominated testing agency
③ Code for prevention of explosions
④ Equipment group: II not for mining, but other hazardous zones
⑤ Device category: 2 for occasional danger
⑥ Atmosphere: G for gas
⑦ Explosion protection: International
⑧ Type of protection: "e" Increased Safety
⑨ Explosion group: IIB for ethylene
⑩ Temperature class: T3 for maximum surface temperature of 200° C
⑪ Device protection level: Gb for a high level of protection in hazardous zones with explosive gas mixtures
⑫ Zone 1
⑬ "X" special conditions

3.3.10.3 Zone 2 with type of protection Ex nA IIC Gc, non sparking

CE		II	3	G	Ex	nA	IIC	T3	Gc
①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩

EAC	ГБ 05		2	Ex	nA	IIC	T3	Gc	X
①	⑪	②	⑫	⑥	⑦	⑧	⑨	⑩	⑬

① CE - or EAC marking
② Code for prevention of explosions
③ Device group: II not for mining, but other hazardous zones
④ Device category: 3 for infrequent, short-term danger
⑤ Atmosphere: G for gas
⑥ Explosion protection: International
⑦ Type of protection: "nA" for non-sparking
⑧ Explosion group: IIC for acetylene
⑨ Temperature Class: T3 for maximum surface temperature of 200° C
⑩ Device protection level: Gc for an extended level of protection in hazardous zones with explosive gas mixtures
⑪ Identification number or name of nominated testing agency
⑫ Zone 2
⑬ "X" special conditions

3.3.10.4 Zone 2 with type of protection Ex nA IIB Gc, non sparking

CE		II	3	G	Ex	nA	IIB	T3	Gc
①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩

EAC	ГБ 05		2	Ex	nA	IIB	T3	Gc	X
①	⑪	②	⑫	⑥	⑦	⑧	⑨	⑩	⑬

① CE - or EAC marking
② Code for prevention of explosions
③ Device group: II not for mining, but other hazardous zones
④ Device category: 3 for infrequent, short-term danger
⑤ Atmosphere: G for gas
⑥ Explosion protection: International
⑦ Type of protection: "nA" for non-sparking
⑧ Explosion group: IIB for ethylene
⑨ Temperature Class: T3 for maximum surface temperature of 200° C
⑩ Device protection level: Gc for an extended level of protection in hazardous zones with explosive gas mixtures
⑪ Identification number or name of nominated testing agency
⑫ Zone 2
⑬ "X" special conditions

3.3.10.5 Zone 21 with type of protection Ex tb IIIC Db (equipment dust explosion protection provided by the enclosure "t")

CE	0158		II	2	D	Ex	tb	IIIC	T125°C	Db
①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩	⑪

EAC	ГБ 05		Ex	tb	IIIC	T125°C	Db	X
①	②	③	⑦	⑧	⑨	⑩	⑪	⑫

① CE - or EAC marking
② Identification number or name of nominated testing agency
③ Code for prevention of explosions
④ Equipment group: II not for mining, but other hazardous zones
⑤ Equipment category: 2 for occasional danger
⑥ Atmosphere: D for dust
⑦ Explosion protection: International
⑧ Protection type: "tb" for protection by enclosure
⑨ Explosion group: IIIC for conductive dust
⑩ Maximum surface temperature: T 125° C
⑪ Equipment protection level: Db for a high level of protection level in flammable dusty atmospheres
⑫ "X" special conditions

3.3.10.6 Zone 22 with type of protection Ex tc IIIB Dc (equipment dust explosion protection provided by the enclosure "t")

CE		II	3	D	Ex	tc	IIIB	T125°C	Dc
①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩

EAC	ГБ 05		Ex	tc	IIIB	T125°C	Dc	X
①	⑪	②	⑥	⑦	⑧	⑨	⑩	⑫

① CE - or EAC marking
② Code for prevention of explosions
③ Device group: II not for mining, but other hazardous zones
④ Device category: 3 for infrequent, short-term danger
⑤ Atmosphere: D for dust
⑥ Explosion protection: International
⑦ Type of protection: "tc" for protection by enclosure
⑧ Explosion group: IIIB for non-conductive dust
⑨ Maximum surface temperature: T 125° C
⑩ Device protection level: Dc for an extended protection level in flammable dust atmospheres
⑪ Identification number or name of nominated testing agency
⑫ "X" special conditions

Preparing for use

4

Good planning and preparation of machine applications are essential in terms of keeping installation simple and avoiding errors, ensuring safe operation, and allowing access to the machine for servicing and corrective maintenance.
This chapter outlines what you need to consider when configuring your plant in relation to this machine and the preparations you need to make before the machine is delivered.

4.1 Safety-related aspects to consider when configuring the plant

A number of residual risks are associated with the machine. These are described in the chapter titled "Safety information" (Page 13) and in related sections.
Take appropriate safety precautions (covers, barriers, markings, etc.) to ensure the machine is operated safely within your plant.

4.2 Observing the operating mode

Observe the machine's operating mode. Use a suitable control system to prevent overspeeds, thus protecting the machine from damage.

4.3 Delivery

Checking the delivery for completeness

The drive systems are put together on an individual basis. When you take receipt of the delivery, please check immediately whether the items delivered are in accordance with the accompanying documents. Siemens will not accept any claims relating to items missing from the delivery and which are submitted at a later date.

- Report any apparent transport damage to the delivery agent immediately.
- Report any apparent defects/missing components to the appropriate SIEMENS office immediately.

Archive the safety and commissioning notes provided in the scope of delivery as well as the optionally available operating instructions so that these documents are always easily accessible.
The rating plate optionally enclosed as a loose item with the delivery is provided to enable the motor data to be attached on or near the machine or installation.

4.4 Transport and storage

When carrying out any work on the machine, observe the general safety instructions (Page 13) and the specifications contained in EN 50110-1 regarding safe operation of electrical equipment.

⚠ WARNING

Risk of dropping and swinging when transported suspended

If you transport the motor suspended from cables or ropes, the cables or ropes can break, e.g. as a result of damage. Further, if not adequately attached, the motor can swing. This can result in death, serious injury, or material damage.

- Use additional, suitable lifting equipment for transport and during installation.
- Two cables alone must be able to carry the complete load.
- Prevent the lifting equipment from sliding by appropriately securing it.

⚠ WARNING

Toppling over or slipping of the motor

The motor can slide or topple over if it is not correctly lifted or transported. This can result in death, serious injury, or material damage.

- Use all the lifting eyes on the machine.
- When using the lifting eyes on the machine, do not attach any additional loads or weight. The lifting eyes are only designed for the weight of the machine itself.
- Any eyes that are screwed in must be tightly fastened.
- Eyebolts must be screwed in right up to their supporting surface.
- Comply with the permissible eyebolt loads.
- When necessary, use suitably dimensioned transport equipment, for example hoisting straps (EN1492-1) and load restraints (EN12195-2).

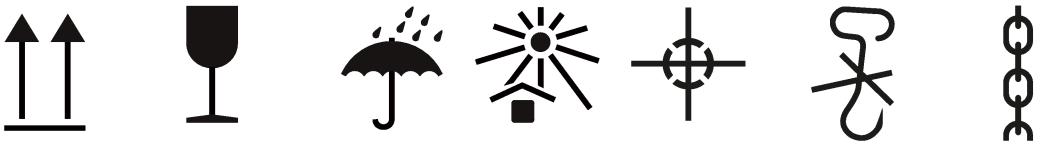
Note

When lifting the machines for transport, only lift them in a position that corresponds to their basic construction type.

4.4.1 Types of construction on the rating plate

The type of construction of the machine is stated on the rating plate.
If any transport locks are in place, remove them before commissioning. Store the transport locks or disable them. Use the transport locks when transporting the motors again or reactivate the transport locks.
The machines are packed in different ways depending on how they are transported and their size. If not otherwise contractually agreed, the packaging corresponds to the packing guidelines according to ISPM (International Standards for Phytosanitary Measures).

Comply with the images shown on the packaging. Their meaning is as follows:



Up | Fragile goods | Protect against moisture | Protect against heat | Center of gravity | Hand hooks forbidden | Attach here

4.4.2 Storage

Storing outdoors

NOTICE
Damage to the motor
Damage can occur if incorrectly stored.
Take all precautions to protect the motor under extreme climatic conditions, e.g. salt-laden and/or dusty, moist/humid atmospheres.

Choose a dry storage location which is safe from flooding and free from vibration. Repair any damage to the packaging before putting the equipment into storage if this is necessary to ensure proper storage conditions. In order to ensure protection against ground moisture, locate machines, equipment and crates on pallets, wooden beams or foundations. Prevent equipment from sinking into the ground. Do not impede air circulation under the stored items. Covers or tarpaulins used to protect the equipment against the weather must not come into contact with the surfaces of the equipment. Use wooden spacer elements to ensure that air can circulate freely around the equipment.

Storing indoors

The storage rooms must provide protection against extreme weather conditions. They must be dry, free from dust, frost and vibration and well ventilated.

Bare metal surfaces

For transport, the bare surfaces (shaft ends, flange surfaces, centering edges) should be coated with an anti-corrosion agent which will last for a limited amount of time (<6 months). Apply suitable anti-corrosion measures for longer storage times.

Condensation drain hole

Open any condensation drain holes to drain the condensation depending on the environmental conditions, every six months at the latest.

4.4.3 Explosion hazard during commissioning, if stored incorrectly

⚠WARNING

Risk of explosion due to damaged sealing materials

Storing the machine at temperatures that do not fall within the specified limits can damage the material of the seals and cause them to fail. As a result, a potentially explosive gaseous atmosphere can enter the machine and be ignited during commissioning. Explosions can occur. This can result in death, serious injury or material damage.

The materials used are specially designed for the temperature range required by the customer. Do not store the motor in conditions that lie outside the specified temperature limits. The relevant temperature limits are specified on the rating plate.

Storage temperature

Permissible temperature range: -20 °C to +50 °C
The relative humidity of the air should be less than 60 %.
For machines that have a special design regarding the coolant temperature in the operating state or the installation altitude, other conditions could apply regarding the storage temperature. In this case, refer to the machine rating plate for data on the coolant temperature and installation altitude.

Storage time

Turn the shafts 1x every year to avoid bearing brinelling. Prolonged storage periods reduce the useful life of the bearing grease (aging).

Open bearings

- For open bearings, e.g. 1Z, check the status of the grease when stored for longer than 12 months.
- Replace the grease if it is identified that the grease has lost its lubricating properties or is polluted. The consistency of the grease will change if condensation is allowed to enter.

Closed bearings

- For sealed bearings, replace the DE and NDE bearings after a storage time of 48 months.

NOTICE

Storage

The motor can be damaged if you use it or store it unprotected outdoors.

- Protect the motor against intensive solar radiation, rain, snow, ice and dust. Use a superstructure or additional cover, for example.
- If required, contact the Siemens Service Center, or technically coordinate outdoors use.

4.5 Electromagnetic compatibility

Note

If the torque levels are very unequal (e.g. when a reciprocating compressor is being driven), a non-sinusoidal machine current will be induced whose harmonics can have an impermissible effect on the supply system and cause impermissible interference emissions as a result.

Note

Converter

- If operated with a frequency converter, the emitted interference varies in strength, depending on the design of the converter (type, interference suppression measures, manufacturer).
- Avoid that the specified limit values stipulated for the drive system (consisting of the motor and converter) are exceeded.
- You must observe the EMC information from the manufacturer of the converter.
- The most effective method of shielding is to conductively connect a shielded machine supply cable to the metal terminal box of the machine (with a metal screw connection) over a large surface area.
- On machines with integrated sensors (e.g. PTC thermistors), disturbance voltages caused by the converter may occur on the sensor cable.

When used in accordance with their intended purpose and operated on an electrical supply system with characteristics according to EN 50160, the enclosed machines comply with the requirements of the EC Directive concerning electromagnetic compatibility.

Immunity to interference

The machines in principle fulfill the requirements of interference immunity in conformity with EN / IEC 61000-6-2 . If machines with integrated sensors (e.g. PTC thermistors) are used, the operating company must ensure sufficient interference immunity by selecting a suitable sensor signal lead (possibly with shielding, connected in the same way as the machine feeder cable) and a suitable evaluation unit.
When operating the machines from a converter at speeds higher than the rated speed, then the mechanical speed limits must be carefully observed (safe operating speed EN / IEC 60034-1).

4.6 Converter operation

4.6.1 Parameterizing the converter

- If the design of the motor requires connection to a particular converter type, the rating plate will contain corresponding additional information.
- Correctly parameterize the converter. Parameterizing data can be taken from the machine rating plate (not the supplementary rating plate with the operating data when connected to a converter).
  You can find parameter data here:
  - In the operating instructions for the converter.
  - In the SIZER engineering tool
  - In the SINAMICS Configuration Manuals.
  - For explosion-protected machines, also in the declaration of compliance with the order 2.1.
- Do not exceed the specified maximum speed limit n_{max}. You can either find this on the rating plate n_{max}, under the supplementary plate for converter operation as the highest speed, or in Catalog D81.1.
- Check that it is guaranteed that the machine is cooled for commissioning.

4.6.2 Reducing bearing currents during operation with converter (low voltage)

Taking the following actions will reduce the bearing currents:

- Ensure that the contacts are established over a large area. Solid copper cables are not suitable for high frequency grounding because of the skin effect.

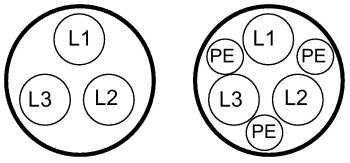
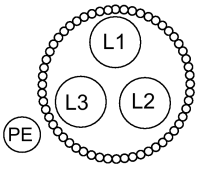
Equipotential bonding conductors:
Use equipotential bonding conductors:

- Between motor and driven machine
- Between motor and converter
- Between the terminal box and the RF grounding point at the motor enclosure.

Selecting and connecting the cable:
As far as possible, use symmetrically arranged, shielded connection cables. The cable shielding, made up of as many strands as possible, must have good electrical conductivity. Braided shields made of copper or aluminum are very suitable.

- The shield is connected at both ends, at the motor and converter.
- To ensure good discharging of high-frequency currents, provide contacting over a large surface area:
  - as contact established through 360° at the converter
  - at the motor, for instance with EMC glands at the cable entries

- If the cable shield is connected as described, then it ensures the specified equipotential bonding between the motor enclosure and converter. A separate RF equipotential bonding conductor is then not necessary.

	
Concentric copper or aluminum shield	Steel armor

- If the cable shield is not connected due to special secondary conditions, or not adequately connected, then the specified equipotential bonding is not provided. In this particular case, use a separate RF equipotential bonding conductor:
  - Between the motor enclosure and protective ground rail of the converter.
  - Between motor enclosure and driven machine
  - Use braided flat copper straps or high-frequency cables with finely-stranded conductors for the separate RF equipotential bonding cable. Solid copper cables are not suitable for high frequency grounding because of the skin effect.
  - Ensure that the contacts are established over a large area.

Overall system design

To specifically reduce and prevent damage caused by bearing currents, you must consider the system as a whole, which comprises the motor, converter, and driven machine. The following precautions help to reduce bearing currents:

- In the overall system, set up a properly meshed grounding system with low impedance.
- Use the common-mode filter (damping cores) at the converter output. The Siemens sales representative is responsible for selection and dimensioning.
- Limit the rise in voltage by using output filters. This dampens the harmonic content in the output voltage.

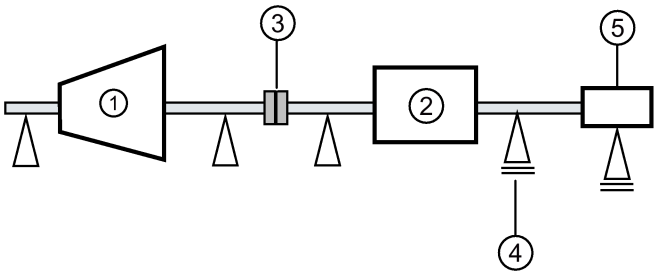
Note

Converter documentation

The operating instructions for the converter are not part of this documentation. Refer also to the configuration information for the converter.

4.6.3 Insulated bearings when operated with a converter

If the machine is operated from a low-voltage converter, insulated bearings are fitted at the NDE and an insulated encoder with insulated bearings (option).
Comply with the plates on the machine relating to bearing insulation and possible bridges.



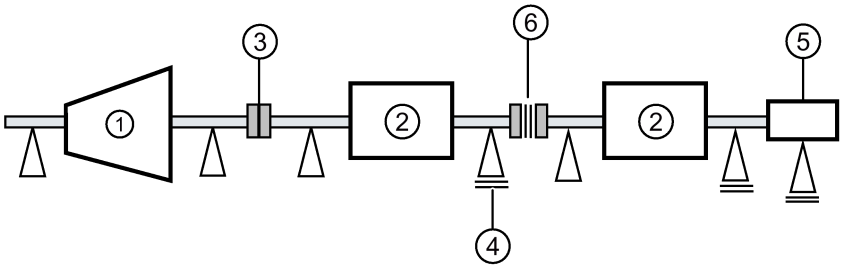
① Driving machine
② Motor
③ Coupling
④ Insulated bearings
⑤ Insulated tachometer fitting

Figure 4-1 Schematic representation of a single drive

NOTICE
Bearing damage
The bearing insulation must not be bridged. Damage may be caused to the bearings if there is a flow of current. • Also for subsequent installation work, such as the installation of an automatic lubrication system or a non-insulated vibration sensor, make sure that the bearing insulation cannot be bridged. • Contact the Service Center, if necessary.

Tandem operation

If you connect two motors in series in "tandem operation", install an insulated coupling between the motors.



① Driving machine
② Motor
③ Coupling
④ Insulated bearings
⑤ Insulated tachometer fitting
⑥ Insulated coupling

Figure 4-2 Schematic representation of a tandem drive

NOTICE
Bearing damage If the coupling between the motors of the tandem drive is not insulated, bearing currents can cause damage to the drive-end bearings of both motors. Use an insulated coupling to link the motors.

4.6.4 Operation with insulated coupling (EX)

If you connect two motors in series in "tandem operation", fit a coupling between the motors; this coupling should satisfy the ATEX Directive or the regulations that apply in the country where the equipment is installed.

Mechanical limit speeds for converter operation

Table 4- 1 Explosion-protected motors in Zones 2, 21 and 22 with type of protection "n" or protection against dust explosion (motor series 1LA, 1LG)

Motor frame size	Motor type		2-pole [1]		4-pole		6-pole		8-pole	
			n_{max}	f_{max}	n_{max}	f_{max}	n_{max}	f_{max}	n_{max}	f_{max}
			rpm	Hz	rpm	Hz	rpm	Hz	rpm	Hz
1LA5, 1LA6, 1LA7, 1LA9										
56 M	**1LA7/1LA9**	05.	6000	100	3000	100	2000	100	1500	100
63 M	**1LA7/1LA9**	06.	6000	100	3000	100	2000	100	1500	100
71 M	**1LA7/1LA9**	07.	6000	100	3000	100	2000	100	1500	100
80 M	**1LA7/1LA9**	08.	6000	100	3000	100	2000	100	1500	100
90 L	**1LA7/1LA9**	09.	6000	100	3000	100	2000	100	1500	100
100 L	**1LA6/1LA7/1LA9**	10.	5400	90	3000	100	2000	100	1500	100
112 M	**1LA6/1LA7/1LA9**	11.	5400	90	3000	100	2000	100	1500	100
132 S/M	**1LA6/1LA7/1LA9**	13.	4800	80	3000	100	2000	100	1500	100
160 M/L	**1LA6/1LA7/1LA9**	16.	4500	75	3000	100	2000	100	1500	100
180 M/L	**1LA5/1LA9**	18.	5100 [2) 3)]	85 [2) 3)]	3000	100	2000	100	1500	100
200 L	**1LA5/1LA9**	20.	5100 [2) 3)]	85 [2) 3)]	3000	100	2000	100	1500	100
225 S/M	**1LA5**	22.	5100 [3)]	85 [3)]	3000	100	2000	100	1500	100
1LG4, 1LG6										
180 M/L	**1LG4/1LG6**	18.	4500	75	3000	100	2000	100	1500	100
200 L	**1LG4/1LG6**	20.	4500	75	3000	100	2000	100	1500	100
225 S/M	**1LG4/1LG6**	22.	4500	75	3000	100	2000	100	1500	100
250 M	**1LG4/1LG6**	25.	3900	65	3000	100	2000	100	1500	100
280 S/M	**1LG4/1LG6**	28.	3600	60	3000	100	2000	100	1500	100
315 S/M/L	**1LG4/1LG6**	31.	3600 [1)]	60 [1)]	2600	87	2000	87	1500	100

[1)] For continuous operation in the range f_{max} (n_{max}), on request.

[2)] For 1LA9 motors, frame sizes 180 M/L and 200 L, n_{max} = 4500 rpm and f_{max} = 75 Hz.

[3)] The values in the following table are used for explosion-protected motors with option D19

Frame size	N_{max}	f_{max}
	rpm	Hz
180 M/L	3300	55
200 L	3100	51
225 S/M	3000	50

Table 4- 2 Explosion-proof motors 1MB1

Motor frame size	2-pole [1]		4-pole		6-pole		8-pole	
	n_{max}	f_{max}	n_{max}	f_{max}	n_{max}	f_{max}	n_{max}	f_{max}
	rpm	Hz	rpm	Hz	rpm	Hz	rpm	Hz
71 M	6000	100	3000	100	2000	100	1500	100
80 M	6000	100	3000	100	2000	100	1500	100
90 S/L	6000	100	3000	100	2000	100	1500	100
100 L	5100	85	3000	100	2000	100	1500	100
112 M	5100	85	3000	100	2000	100	1500	100
132 S/M	3800	63	3000	100	2000	100	1500	100
160 M/L	4500	75	3000	100	2000	100	1500	100
180 M/L	4500	75	3000	100	2000	100	1500	100
200 L	4500	75	3000	100	2000	100	1500	100
225 S/M	3600	60	3000	100	2000	100	1500	100
250 M	3600	60	3000	100	2000	100	1500	100
280 S/M	3600	60	3000	100	2000	100	1500	100
315 S/M/L	3600	60	2600	87	2000	100	1500	100

[1] For continuous operation in the range f_{max} (n_{max}), on request.

Assembly

5

When carrying out any work on the machine, observe the general safety instructions (Page 13) and the specifications contained in EN 50110-1 regarding safe operation of electrical equipment.

Note

Loss of conformity with European directives

In the delivery state, the machine corresponds to the requirements of the European directives. Unauthorized changes or modifications to the machine lead to the loss of conformity with European directives and the loss of warranty.

⚠ WARNING

Explosion hazard when making modifications to the machine

Substantial modifications to the machine are not permitted – or may only be performed by the manufacturer. Otherwise an explosion can occur in an explosive atmosphere. This can result in death, serious injury or material damage.

Please contact the Service Center, if necessary.

5.1 Preparing for installation

5.1.1 Requirements for installation

The following requirements must be satisfied prior to starting installation work:

- Staff have access to the operating and installation instructions.
- The machine is unpacked and ready for mounting at the installation location.

Note

Measure the insulation resistance of the winding before starting installation work

Wherever possible, measure the insulation resistance of the winding before starting installation work. If the insulation resistance lies below the specified value, take appropriate remedial measures. These remedial measures may necessitate the machine being removed again and transported.

Note

Note also the technical data on the rating plates on the motor enclosure.

NOTICE
Damage to the motor
To avoid material damage, before commissioning, check whether the correct direction of rotation of the machine has been set on the customer side, e.g. by decoupling from the driven load.

Note

The increased level of danger in hazardous areas demands that you pay particular attention to the notes marked with ⟨Ex⟩.

5.1.2 Insulation resistance

5.1.2.1 Insulation resistance and polarization index

Measuring the insulation resistance and polarization index (PI) provides information on the condition of the machine. It is therefore important to check the insulation resistance and the polarization index at the following times:

- Before starting up a machine for the first time
- After an extended period in storage or downtime
- Within the scope of maintenance work

The following information is provided regarding the state of the winding insulation:

- Is the winding head insulation conductively contaminated?
- Has the winding insulation absorbed moisture?

As such, you can determine whether the machine needs commissioning or any necessary measures such as cleaning and/or drying the winding:

- Can the machine be put into operation?
- Must the windings be cleaned or dried?

Detailed information on testing and the limit values can be found here:
"Testing the insulation resistance and polarization index" (Page 49)

5.1.2.2 Testing the insulation resistance and polarization index

⚠WARNING

Hazardous voltage at the terminals

During and immediately after measuring the insulation resistance or the polarization index (PI) of the stator winding, hazardous voltages may be present at some of the terminals. Contact with these can result in death, serious injury or material damage.

- If any power cables are connected, check to make sure line supply voltage cannot be delivered.
- Discharge the winding after measurement until the risk is eliminated, e.g. using the following measures:
  - Connect the terminals with the ground potential until the recharge voltage drops to a non-hazardous level
  - Attach the connection cable.

Measure the insulation resistance

1. Before you begin measuring the insulation resistance, please read the operating manual for the insulation resistance meter you are going to use.
2. Make sure that no power cables are connected.
3. Measure the winding temperature and the insulation resistance of the winding in relation to the machine enclosure. The winding temperature should not exceed 40° C during the measurement. Convert the measured insulation resistances in accordance with the formula to the reference temperature of 40° C. This thereby ensures that the minimum values specified can be compared.
4. Read out the insulation resistance one minute after applying the measuring voltage.

Limit values for the stator winding insulation resistance

The following table specifies the measuring voltage and limit values for the insulation resistance. These values correspond to IEEE 43-2000 recommendations.

Table 5- 1 Stator winding insulation resistance at 40° C

V_N [V]	V_{Meas} [V]	R_C [MΩ]
U ≤ 1000	500	≥ 5
1000 ≤ U ≤ 2500	500 (max. 1000)	100
2500 < U ≤ 5000	1000 (max. 2500)	
5000 < U ≤ 12000	2500 (max. 5000)	
U > 12000	5000 (max. 10000)	

U_{rated} = rated voltage, see the rating plate

U_{meas} = DC measuring voltage

R_C = minimum insulation resistance at reference temperature of 40° C

Conversion to the reference temperature

When measuring with winding temperatures other than 40° C, convert the measuring value to the reference temperature of 40° C according to the following equations from IEEE 43-2000.

(1) $R_C = K_T \cdot R_T$	R_C	Insulation resistance converted to 40° C reference temperature
	k_T	Temperature coefficient according to equation (2)
	R_T	Measured insulation resistance for measuring/winding temperature T in °C
(2) $K_T = (0.5)^{(40-T)/10}$	40	Reference temperature in °C
	10	Halving/doubling of the insulation resistance with 10 K
	T	Measuring/winding temperature in °C

In this case, doubling or halving the insulation resistance at a temperature change of 10 K is used as the basis.

- The insulation resistance halves every time the temperature rises by 10 K.
- The resistance doubles every time the temperature falls by 10 K.

For a winding temperature of approx. 25° C, the minimum insulation resistances are 20 MΩ (U ≤ 1000 V) or 300 MΩ (U > 1000 V). The values apply for the complete winding to ground. Twice the minimum values apply to the measurement of individual assemblies.

- Dry, new windings have an insulation resistance of between 100 and 2000 MΩ, or possibly even higher values. An insulation resistance value close to the minimum value could be due to moisture and/or dirt accumulation. The size of the winding, the rated voltage and other characteristics affect the insulation resistance and may need to be taken into account when determining measures.
- Over its operating lifetime, the motor winding insulation resistance can drop due to ambient and operational influences. Calculate the critical insulation resistance value depending on the rated voltage by multiplying the rated voltage (kV) by the specific critical resistance value. Convert the value for the current winding temperature at the time of measurement, see above table.

Measuring the polarization index

1. To determine the polarization index, measure the insulation resistances after one minute and ten minutes.
2. Express the measured values as a ratio:

   $PI = R_{insul\ 10\ min} / R_{insul\ 1\ min}$

Many measuring devices display these values automatically following the measurement. For insulation resistances > 5000 MΩ, the measurement of the PI is no longer meaningful and consequently not included in the assessment.

$R_{(10\ min)} / R_{(1\ min)}$	Assessment
≥ 2	Insulation in good condition
< 2	Dependent on the complete diagnosis of the insulation

NOTICE
Damage to insulation If the critical insulation resistance is reached or undershot, this can damage the insulation and cause voltage flashovers. • Contact the Service Center (Page 145). • If the measured value is close to the critical value, you must subsequently check the insulation resistance at shorter intervals.

Limit values of the anti-condensation heating insulation resistance

The insulation resistance of the anti-condensation heating with respect to the machine housing should not be lower than 1 MΩ when measured at 500 V DC.

5.2 Installation

5.2.1 Machine installation

Note

In order to prevent the eyebolts loosening, after mounting, tighten these or remove them.

NOTICE
Damage to mounted components Material damage can occur if you use the mounted components to help lift the motor. Do not use the mounted components to help lift the motor.

- For vertical installation, use all of the eyebolts provided and when necessary, hoisting straps (DIN EN 1492-1) and/or lashing straps (DIN EN 12195-2) to stabilize the position of the motor.
- Prevent foreign bodies from falling into the fan cover. For vertical machine installation with the shaft end facing downwards, attach a protective canopy.
- If the shaft extension is facing upwards, the user must prevent liquid from moving along the shaft and entering the motor.
- Clean bare metal surfaces with anti-corrosion agent using white spirit to ensure proper installation and / or machine mounting.
- Do not obstruct the ventilation! Do not draw in the discharged air directly – also from adjacent equipment.

- Avoid exposing them to direct, intense solar radiation, rain, snow, ice, or also dust for extended periods. Attach a covering structure or an additional cover when using or storing outdoors.
- Do not exceed the permissible axial and radial forces.
- Only use explosion-protected machines in appropriate areas in accordance with directive 1999/92/EG .
  If the certification is supplemented by an X, please note the special conditions in the EC type test certificate.Special conditions for explosion-proof machines (Page 17)
- When installing electrical systems in hazardous zones, observe EN / IEC 60079-14 and the corresponding country regulations.
- The machine temperature class specified on the rating plate must be equal to or greater than the temperature class of any combustible gases that may develop.
- At the completely installed drive system, investigate the influence of heat and cold sources on mounted components according to EN 60079-14.
  Recommended maximum interface temperatures for flange-mounted motors:

Type of protection	**Ex e, Ex nA**	
Supply voltage	Line supply	
Control range	-	
Cooling method	Self-cooled	
Frame size	63 ... 200	
Mechanical design	EN 50347	
Ambient temperature	-20 °C ... +40 °C	
Temperature class	T3	
No. of poles	2	4
Max. shaft temperature	60 °C	75 °C
Max. flange temperature	60 °C	75 °C

- Select mounted equipment such as brakes, external fans or incremental encoders according to the requirements of Directive 94/9/EC up to April 19, 2016 – or from April 20, 2016, Directive 2014/34/EU.

5.2.2 Cooling

⚠WARNING

Overheating and failure of the motor

Death, severe injury or material damage can occur if you do not carefully observe the following points.

- Do not obstruct ventilation.
- Prevent the air expelled by neighboring equipment from being immediately sucked in again.
- For machines with a vertical type construction with air entry from above, prevent the ingress of foreign bodies and water in the air entry openings (standard IEC / EN 60079-0).
- If the shaft extension is facing upwards, liquid must be prevented from entering by moving along the shaft.

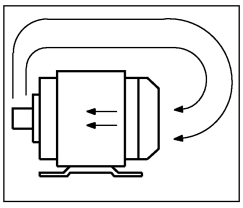
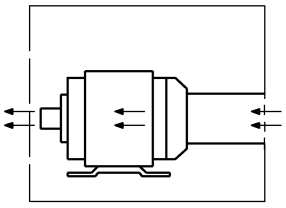
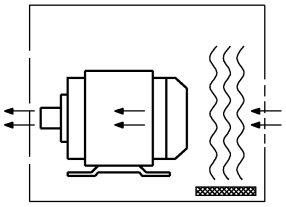
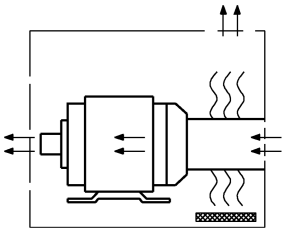
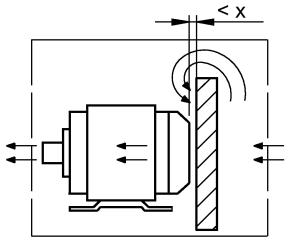
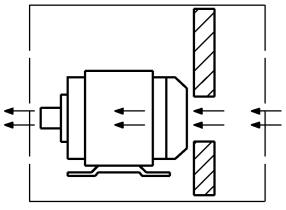
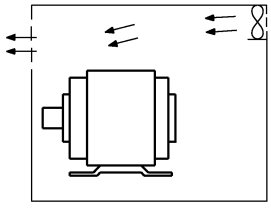
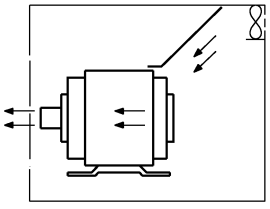
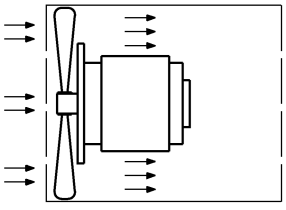
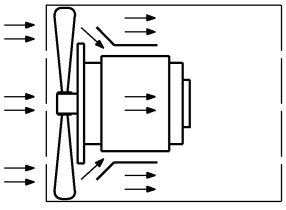
⚠WARNING

Damage caused by small parts falling in

Material damage and injury can occur if the fan is destroyed and therefore the motor overheats.

- For types of construction with the shaft extension facing downwards, prevent small parts from falling into the fan cover by providing suitable covers (standard IEC / EN 60079-0).
- Prevent the cooling airflow from being reduced as a result of covers that might be in place.

Table 5- 2 Air guidance

Incorrect	Correct
	
	
	
	
	

Minimum dimension "x" for the distance between neighboring modules and the air intake of the machine

Table 5- 3 Minimum dimension "X" for the distance between neighboring modules and the air intake of the machine

Frame size	X [mm]
63 ... 71	15
80 ... 100	20
112	25
132	30
160	40
180 ... 200	90
225 ... 250	100
280 ... 315	110

5.2.3 Machines with type of construction IM B15, IM B9, IM V8 and IM V9

Types of construction without bearings on the drive side

These machines do not have their own bearing system for the machine shaft at the drive end (DE). The machine shaft is accepted by the (hollow) shaft or coupling of the system or driven machine.

- Using the centering edge, the machine is aligned with respect to enclosures, flanges or driven machines.
- Note that the temperature of the motor and motor shaft increases during operation. The thermal expansion of the machine shaft must be compensated by the customer by applying suitable measures.
  Use the spring washers provided to locate the NDE bearing without any play.

NOTICE

Damage to the motor

Material damage can occur if the following notes are not carefully observed:

- The IM B3 bearing shield with built-in distance ring mounted at the DE is only used as transport lock. A warning label is attached to this bearing shield.
- The spacer ring is not a roller bearing.
- Remove the bearing shield and the spacer ring.
- Remove the transport lock before commissioning.

5.2.4 Foot mounting

Note

Only authorized retrofit partners must be employed to relocate the bolted on mounting feet at the machine enclosure.

After attaching the mounting feet, you must note the following in order to avoid stressing and deforming the machine.

- Ensure that the foot mounting surfaces are aligned in one plane and are parallel to the machine shaft.
- Post-machine the foot mounting surfaces or use thin shims, for example.
- Professionally touch up damaged painted surfaces.
- Observe the information provided in Chapter Aligning and mounting (Page 58)

5.2.5 Balancing

The rotor is dynamically balanced. The balancing quality corresponds to vibration severity grade "A" for the complete machine as standard. The optional vibration severity grade "B" is indicated on the rating plate.
The declaration regarding the type of featherkey for balancing is generally marked on the rating plate and optionally on the face of the shaft end.

Designation:

- As a standard measure, balancing is carried out dynamically with a half featherkey (code "H") in accordance with ISO 8821.
- "F" means balancing with a whole featherkey (optional version).
- "N" means balancing without a featherkey (optional version).

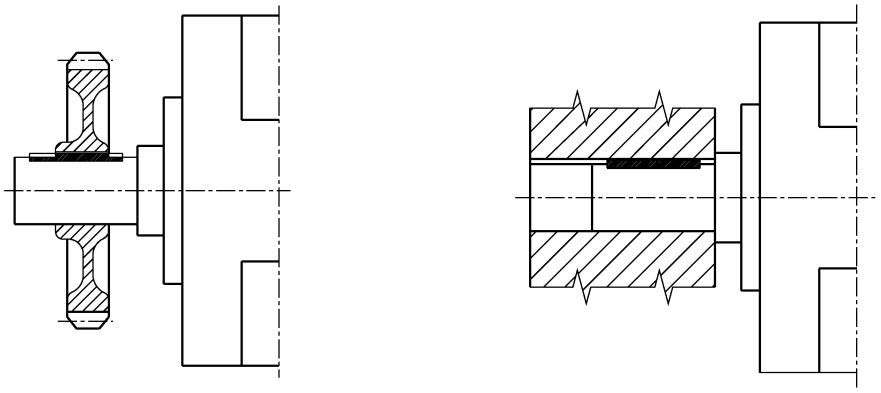
⚠ CAUTION

Incorrect installation or removal

To avoid injury and material damage, carefully observe general touch protection measures for output transmission elements:

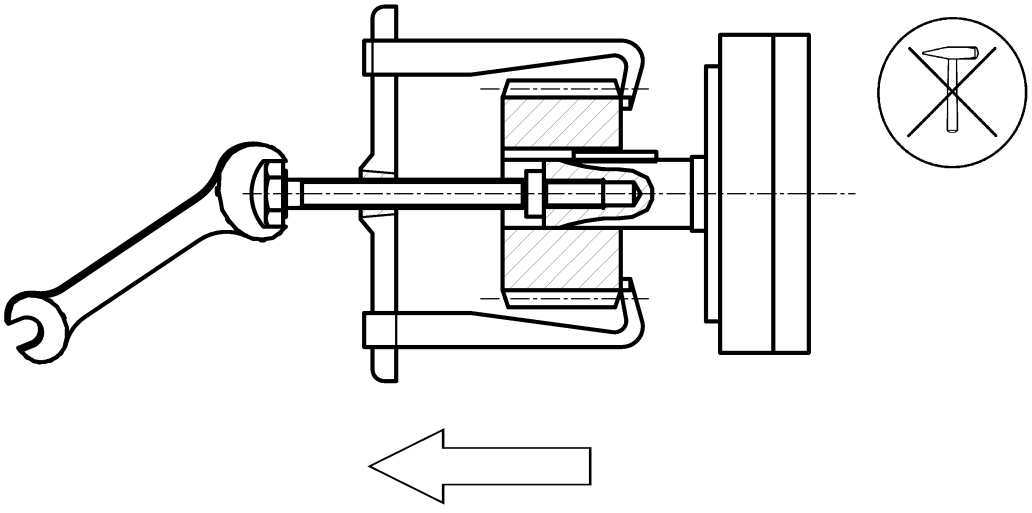
- The general touch protection measures for drive output elements must be observed.
- Drive output elements may only be pushed on or pulled off with the correct equipment.
- The feather keys are only locked against falling out during shipping. If you commission a machine without a drive output element, the feather keys must be secured to prevent them from being thrown out.

The featherkey data on the shaft and transmission element must indicate the correct type of balancing in each case and must be correctly mounted.
The balancing quality corresponds to vibration severity grade "A" for the complete machine; vibration severity grade "B" is possible as an option, i.e. in order to ensure the desired balancing quality, it must be ensured that the featherkey data on the hub and machine shaft complement each other in the case of a shorter or longer output transmission element.

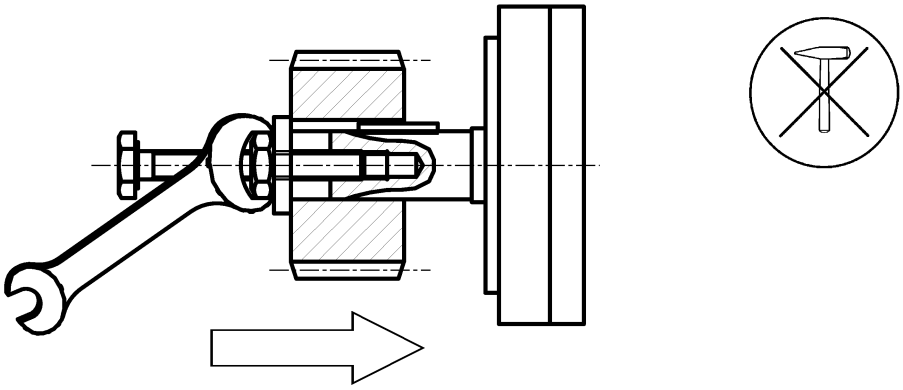


Align the offset at the coupling between electrical machines and the driven machines so that the maximum permissible vibration values according to ISO 10816 are not exceeded.

5.2.5.1 Mounting and withdrawing output transmission elements



Withdrawing output transmission elements



Mounting output transmission elements

- When mounting output transmission elements (coupling, gear wheel, belt pulley etc.) use the thread at the shaft end.
  If possible, heat up the output transmission elements as required.
- Use a suitable device when withdrawing output elements.
- When mounting or withdrawing, do not apply any blows, for example with a hammer or similar tool, to the parts to be mounted or withdrawn.
- Only transfer radial or axial forces specified in the catalog to the motor bearings via the shaft extension.

5.2.6 Noise emission

⚠ CAUTION
Hearing damage when operating three-phase motors
If the permissible sound pressure level is exceeded, hearing damage can occur when operating three-phase motors at their rated power.
Observe the maximum permissible sound pressure level according to the ISO 1680 standard. The maximum permissible sound pressure level is 70 dB (A).

5.3 Alignment and fastening

Observe the following when aligning and mounting:

- Ensure a flat and uniform contact surface for foot and flange mounting.
- Precisely align the machine when couplings are used.
- Ensure that the mounting surfaces are clean and free of any dirt.
- Remove any anti-corrosion protection using white spirit.

- Avoid installation-related resonances with the rotating frequency and twice the line frequency.
- Note any unusual noise when the rotor is manually turned.
- Check the direction of rotation with the motor uncoupled.
- Avoid rigid couplings.
- Repair any damage to the paint, this must be done immediately and correctly.

5.3.1 Note for repainting/touching up the paint finish of explosion-protected machines

Note

Repainting/touching up the paint finish of explosion-protected machines

For explosion-protected machines, observe the information in Chapter Repainting/touching up (Page 105).

5.3.2 Measures for alignment and mounting

The following measures are required in order to compensate any radial offset at the coupling and to horizontally adjust the electrical machine with respect to the driven load:

- **Vertical positioning**
  For vertical mounting positions, avoid deforming the machines by placing shims under the mounting feet. Keep the number of shims low; only use a few stacked shims.
- **Horizontal positioning**
  To position the machine horizontally, shift it sideways on the foundation and ensure that the axial position is maintained (angularity error).
- When positioning the motor, ensure that a uniform axial gap is maintained around the coupling.

- **Smooth running**

  Preconditions for smooth, vibration-free operation according to DIN 4024 include:

  – Stable foundation design free of any shock or vibration.

  – A precisely aligned coupling.

  – A well-balanced drive output element (coupling, belt pulleys, fans, ...)

  Maintain the maximum permissible vibration in operation according to ISO 10816.
  Avoid inadmissible vibration caused by imbalance, for example (drive output element), external vibration or any resonance over the complete speed range.
  It may be necessary to completely balance the machine with the drive output element or the system resonance frequency must be shifted.

- **Foot mounting/flange mounting**

  – Use the specified thread sizes laid down in EN 50347 when flanging the machine to a foundation or a machine flange.

  – Mount the machine at four foot or flanged holes that are at right angles to one another. The customer is responsible for selecting the strength (property class) of the mounting elements.
  For mounting elements up to and including frame size 160, property class 5.6 or higher is recommended, from frame size 180, property class 8.8 or higher.

  – Select the correct screw length for IM B14 flanges.

5.3.3 Flatness of the supporting surfaces for conventional motors

Frame size	Flatness [mm]
≤ 132	0.10
160	0.15
≥ 180	0.20

5.3.4 Machine frame mounting feet (special design)

Note

For terminal boxes mounted at the NDE (option H08), dimension C can deviate from EN 50347.
For motors with double or triple holes at the NDE, maintain the foot mounting dimensions as specified in standard EN 50347 .

Electrical connection

6

When carrying out any work on the machine, observe the general safety instructions (Page 13) and the specifications contained in EN 50110-1 regarding safe operation of electrical equipment.

6.1 Connecting the machine

⚠DANGER

Hazardous voltages

Death, injury or material damage can occur. Note the following safety information before connecting-up the machine:

- Only qualified and trained personnel should carry out work on the machine while it is stationary.
- Disconnect the machine from the power supply and take measures to prevent it being reconnected. This also applies to auxiliary circuits.
- Check that the machine really is in a no-voltage condition.
- Establish a safe protective conductor connection before starting any work.
- If the incoming power supply system displays any deviations from the rated values in terms of voltage, frequency, curve form or symmetry, such deviations will increase the temperature and influence electromagnetic compatibility.
- Operating the machine on a line supply system with a non-grounded neutral point is only permitted over short time intervals that occur rarely, e.g. the time leading to a fault being eliminated (ground fault of a cable, EN 60034-1).

Observe the information in EN / IEC 60034-1 (VDE 0530-1) regarding operation at the limits of the A zones (±5 % voltage difference and ±2 % frequency difference) and the B zones, especially in respect of temperature increase and deviation of the operating data from the rated data on the rating plate. Never exceed the specified limits!
Connect up so that a permanently safe electrical connection is guaranteed (no protruding wire ends); use the assigned cable-end fittings (e.g. cable lugs, end sleeves).
Connect up the line supply voltage and arranged the disconnecting link in accordance with the circuit diagram provided in the terminal box.
Select connecting cables according to DIN VDE 0100 taking into account the rated current and the system-dependent conditions (e.g. ambient temperature, routing type etc. according to DIN VDE 0298 or EN / IEC 60204-1).
The technical specifications stipulate the following that have to be taken into account with respect to the motor connection:

- Direction of rotation.
- The number and arrangement of the terminal boxes.
- The circuit and connection of the machine winding.

All cable glands and blanking plugs must be implemented according to Directive 94/9/EC up to April 19, 2016 - or from April 20, 2016, Directive 2014/34/EU. They must also be certified for use in hazardous zones.

- Any openings that are not being used must be sealed using the appropriate certified blanking plugs.
- Please observe the manufacturer's specifications when fitting cable glands.

The following features make this type of electrical connection different from that for standard machines:

- For machines marked with Zone A, maintain area A in EN / IEC 60034-1 (VDE 0530-1) (±5 % voltage or ±2 % frequency deviation, waveform, line supply symmetry) so that the temperature rise remains within the permissible limits.
- Larger deviations from the rated data may result in electrical machines heating up to impermissible levels. This information must be specified on the rating plate. Under no circumstances exceed the limits!
- Protect every machine with type of protection increased safety "e" or protection afforded by the enclosure "t" in accordance with EN / IEC 60079-14 against an inadmissible temperature rise using a current-dependent, delayed circuit breaker with phase failure protection and asymmetry detection corresponding to EN / IEC 60947 or using an equivalent device in all phases.
- For machines with type of protection increased safety "e", select the overcurrent device with current-dependent delayed trip so that the tripping time, which should be taken from the characteristic of the switch for the ratio I_A / I_N of the machine to be protected, is no longer than the safe-locked rotor time t_E. Take the ratio I_A / I_N as well as the safe-locked rotor time t_E from the rating plate. Set the protective device to the rated current. Up to April 19, 2016, use a tripping unit certified to Directive 94/9/EC - and from April 20, 2016, Directive 2014/34/EU.
- For machines with increased safety "e" type of protection, in the event of a locked rotor the protective device must disconnect within the t_E time specified for the relevant temperature class. Protect electric machines used for heavy duty starting (acceleration time > 1.7 x t_E time - locked rotor time) by monitoring the starting process using suitable equipment corresponding to the data provided in the EC or EU type examination certificate.
  Direct monitoring of the winding temperature is permissible as a means of thermal machine protection, provided that this is certified and specified on the rating plate.
- With pole-changing machines, separate, interlocked protective devices are required for each speed step. Equipment with EC or EU type examination certificate are recommended.

6.1.1 Terminal designations

With the terminal designations according to DIN VDE 0530 Part 8 or EN / IEC 60034-8 for three-phase machines, the following principle definitions apply:

Table 6- 1 Terminal designations (with the 1U1-1 as an example)

1	U	1	-	1	Designation
x					Index showing the pole assignment for pole-changing machines (where applicable, a lower number indicates a lower speed) or, in special cases, for a subdivided winding.
	x				Phase designation (U, V, W)
		x			Index showing the start (1) / end (2) or tapping point of the winding (if there is more than one connection per winding)
				x	Additional index for cases in which it is obligatory to connect parallel power feed cables to several terminals with otherwise identical designations

6.1.2 Direction of rotation

The standard motors are suitable for clockwise and counter-clockwise rotation.
For defined directions of rotation (direction of rotation arrow), appropriately connect the line power cables.

- If you connect the line cables with phase sequence L1, L2, L3 at U, V, W or according to NEMA at T_1 T_2 T_3 , then the machine rotates in the clockwise direction.
- If you interchange two connections, e.g. L1, L2, L3 at V, U, W or according to NEMA at T_2 T_1 T_3 , then the machine rotates counter-clockwise.

	According to IEC	According to NEMA
Clockwise rotation	U V W	T_1 T_2 T_3
Counter-clockwise rotation	V U W	T_2 T_1 T_3

Direction of rotation of the motor when looking at DE

6.1.3 Connection with/without cable lugs

In the case of terminals with terminal clamps, distribute the conductors in such a way that the clamping heights on both sides of the fillet are about the same. This method of connection requires that you must bend a single conductor in a U shape or use a cable lug. The same applies to the inner and outer terminals of the ground conductor.

When connecting up using cable lugs, select their size corresponding to the required cable cross-section and the stud size. An inclined arrangement is only permitted provided the required air clearances and creepage distances are carefully maintained.
Remove insulation from the ends of the conductors so that the remaining insulation almost reaches the cable lug.

Note

The direct contact between the cable lug surfaces and the contact nuts or contact screws ensure that the connection can conduct current.

6.1.4 Connection with cable lug for explosion-protected machines

⚠ WARNING

Short-circuit hazard

Live conductors released from the terminal board can cause short circuits. Death or serious injury can result.

- You must bend single-core line conductors into a U shape in order to prevent the contact force being transferred at just one side.
- In order to prevent the cable lug from rotating, for a line connection using a cable lug, angle single- or multi-core cables downwards through an angle of approx. 40°.

See also

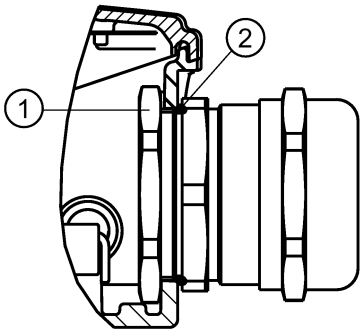
Type of conductor connection (Page 81)

6.1.5 Connecting protruding cables

In the case of connection cables brought out of the machine, no terminal board is installed on the terminal base of the machine housing. The connection cables are directly connected to stator winding terminals at the factory.
The connection cables are color-coded or labeled. The customer directly connects individual cables in the control cabinet for their system in accordance with the labeling.

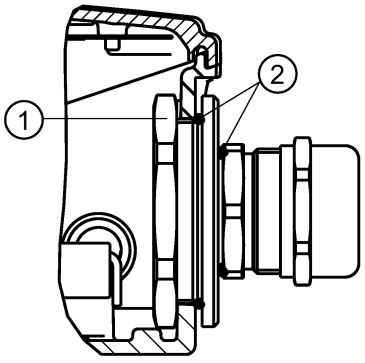
6.1.6 Cable glands

Cable glands with (sheet metal) nuts (EN 50262)



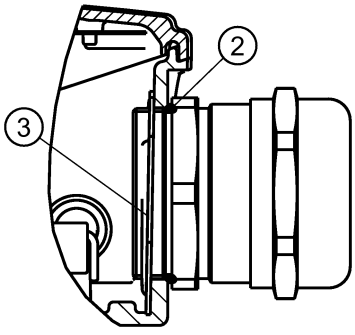
① Nut
② O ring

Cable glands with reductions and (sheet metal) nuts (EN 50262)



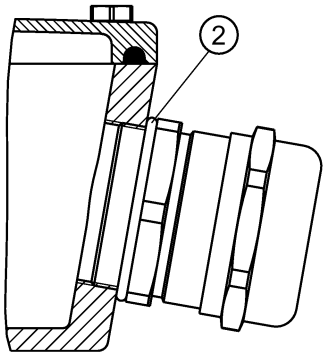
① Nut
② O ring

6.1.6.1 Mounting position of sheet metal nuts in screw-type connections



② O ring
③ Mounting position of metal-sheet nuts

Cable glands with connecting thread in the terminal box (EN 50262)



② O ring

6.1.7 Terminal box

⚠DANGER

Hazardous voltage

Electric motors have high voltages. When incorrectly handled, this can result in death or severe injury.

Switch off the machine so that it is in a no-voltage condition before you open the terminal box.

NOTICE

Damage to the terminal box

If you incorrectly carry out work on or in the terminal box, this can result in material damage. You must observe the following to avoid damaging the terminal box:

- Ensure that the components inside the terminal box are not damaged.
- It must be ensured that there are no foreign bodies, dirt or moisture in the terminal box.
- Close the terminal box using the original seal so that it is dust tight and water tight.
- Use O-rings or suitable flat gaskets to seal entries in the terminal box (DIN 42925) and other open entries.
- Please observe the tightening torques for cable glands and other screws.
- When performing a test run, secure the feather keys without output elements.

6.1.7.1 Terminal boxes - terminal board versions 1LE10 80...90 (aluminum motors)

Machines, frame sizes 80 … 90, are supplied with different terminal boards depending on the winding as well as the type and number of installed parts.

⚠WARNING

Hazardous voltage

Loosening the safety torx screw can result in death, serious injury or material damage.

Do not loosen the safety torx screw with respect to the center terminal, as this ensures a conductive connection between the grounding conductor and frame!

NOTICE

Serious damage to the machine

Failure to observe these measures will destroy the motor.

- Only rotate the terminal box if the connection cables have still not been laid.
- If you release the safety torx screw at both sides of the outer connecting terminals, this can destroy the machine.
- Remove the three large snap hooks on the terminal board before rotating the the terminal box. Keep the snap hooks pressed while rotating the terminal box and use a screwdriver to re-engage when finished.

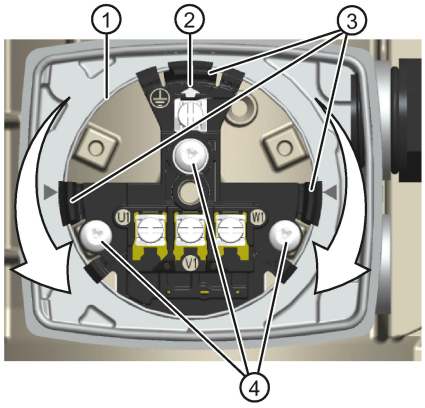
6.1.7.2 Versions

Standard design

It is possible to turn the top side of a machine terminal box 4 x 90 degrees (if screwed on). The terminal box can be turned 4x90 degrees on the terminal base of the machine's housing in the case of a terminal board with 6 terminal studs (standard design).
For machines with frame sizes 80 ... 90, with central terminal box locking (basic or optional terminal board), the terminal box can be rotated continuously through 360 degrees.

Installation instructions

1. Press the three large snap hooks ③ over the flange ① of the terminal box towards the inside.
2. Hold the snap hooks ③ pressed inwards, detach the terminal box, raise it slightly and rotate it to the required POSITION. Observe the arrow for the position of the terminal box ②.
3. Press the terminal box lightly towards the machine housing. Use a screwdriver to allow the large snap hooks ③ to engage over the flange ① of the terminal box.



① Flange
② Terminal box positioner
③ Snap hooks
④ Safety Torx screws

Optional terminal board (star or delta circuit)

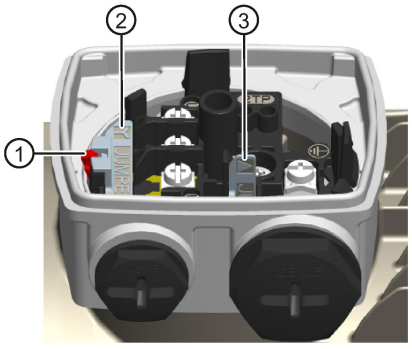
NOTICE
Arcing at the optional terminal board can destroy the machine
In order to avoid destroying the machine: • To change the operating mode, always press the jumper fully into the base of the slot and use the red locking lever to ensure that it is engaged.

Connection system for the optional terminal board

For machines with optional terminal board (star or delta connection), set the operating mode using jumpers.

Installation instructions

1. Open the red locking lever ① and remove the jumper ② from the slot.
2. Release the snap hook on the compartment and remove the jumper ③.
3. Press the jumper ③ fully into the base of the slot and engage the locking lever at its end position.
4. Press the jumper ② into the compartment and allow the snap hooks to re-engage at the compartment.



Explosion-protected machines (with the exception of machines for Zone 22) are equipped with terminal boxes with type of protection increased safety "e".
Please note in this regard design, connection options and spare parts.
Note the explosion protection information designated with Ex in the operating instructions!
Have authorized Siemens workshops perform any repairs.

6.1.7.3 Protruding connection cables

⚠ WARNING

Risk of short-circuit and voltage hazard

A short circuit can occur if connecting cables are clamped and crushed between parts of the enclosure and the cover plate.
This can result in death, severe injury and material damage.

- During disassembly and particularly when installing the cover plate, make sure that the connecting cables are not clamped between enclosure parts and the cover plate.

⚠CAUTION

Damage to connecting cables that are freely led out

You must observe the following note to avoid damaging connecting cables that are freely led out:

- It must be ensured that there are no foreign bodies, dirt, or moisture in the terminal base of the machine enclosure.
- Use O-rings or suitable flat gaskets to seal entries in cover plates (DIN 42925) and other open entries.
- Seal the terminal base of the machine enclosure using the original seal of the cover plate to prevent dust and water from entering.
- Please observe the tightening torques for cable glands and other screws.

6.1.7.4 Connecting the temperature sensor/anti-condensation heater

Connecting optional integrated devices and equipment

In addition to the current-dependent overload protective device located in the connecting cables, use the optionally available integrated devices and equipment, for example, temperature sensor, anti-condensation heating.
Auxiliary circuits are connected in the terminal box.

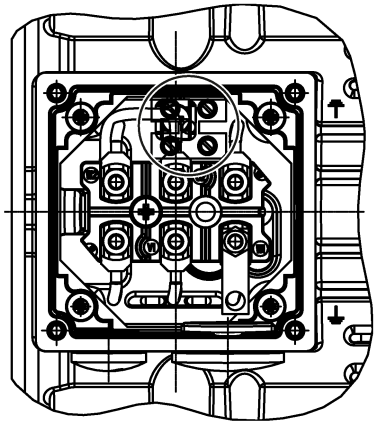


Figure 6-1 Connection to terminal strip

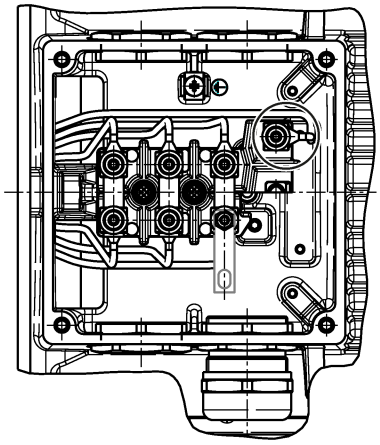
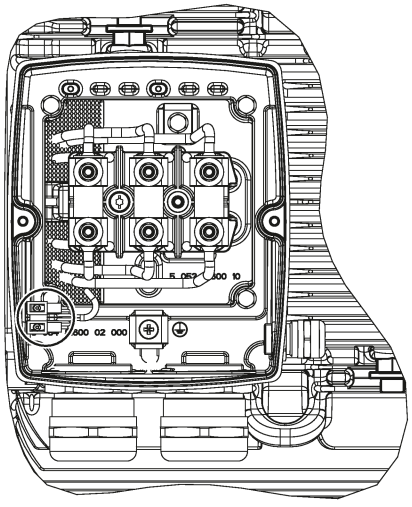
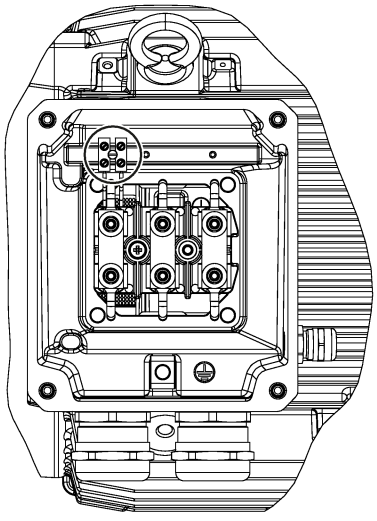


Figure 6-2 Connection to terminal board

The temperature sensor / anti-condensation heater is connected in the terminal box.

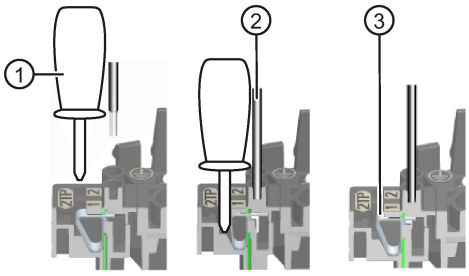


Aluminum



Cast iron

Connection at the temperature sensor using a spring-loaded connection system

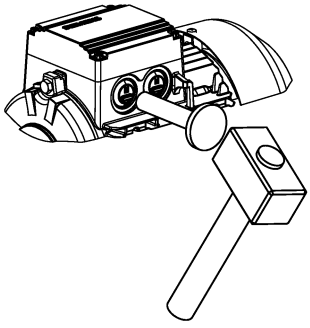


① Flat-head screwdriver
② Sensor cable
③ Tension spring

6.1.7.5 Cable entry

Knockout openings

NOTICE
Damage to the terminal box
To avoid damaging the terminal box: • Knockout openings in the terminal box must be knocked out using appropriate methods. • Do not damage the terminal box, the terminal board, the cable connections etc. inside the terminal box.



Assembly and laying of cables

Screw the screw-type connection into the housing or fasten with a nut.

Note

The screw-type connections must have been matched to the connecting cables used (armoring, braid, shield).

NOTICE

Damage to terminal board

The terminal board can be damaged for incorrect installation and routing. You must apply the following measures to avoid damaging the terminal board:

- Remove the screw-type connections (EN 50262) only when the terminal box is closed.
- Tighten the screw-type connections to rated torque value only when the terminal box is closed.
- Tighten the screw-type connections only finger tight when the terminal box is open.
- Make sure that the three large snap hooks are engaged when tightening the screw connections.

Cable entries for explosion-proof machines

The cable entries (cable glands) must have an EC or EU type examination certificate, and be certified for the particular hazardous zone.

- Any openings that are not being used must be sealed using the corresponding certified plugs.
- Please observe the manufacturer's specifications when fitting cable entries.
- Before installing the cable, remove the dust protection element or plug from the cable gland.

6.1.7.6 Thread sizes in terminal box

Table 6- 2 Thread sizes in the cast iron terminal box

Frame size	Type	Type of protection / Zone	Standard thread		Additional thread with mounting parts	
			Size	Number	Size	Number
71 ... 90	1MB1	Non sparking "n"	M 25x1.5	1	-	-
		Zone 21	M 16x1.5	1		
		Zone 22				
100 ... 132	1LA6	Non-sparking "n"	M 32x1.5	2	M 16x1.5	1
		Zone 22				
	1MA6	Increased safety "e"				
	1MB1	Non-sparking "n"				
		Zone 21				
		Zone 22				

Frame size	Type	Type of protection / Zone	Standard thread		Additional thread with mounting parts	
160	1LA6	Non-sparking "n"	M 40x1.5	2	M 16x1.5	1
		Zone 22				
	1MA6	Increased safety "e"				
	1MB1	Non-sparking "n"				
		Zone 21				
		Zone 22				
180	1MA6	Increased safety "e"	M 40x1.5	2	M 16x1.5	2
	1LG4 1LG6 1MB1	Non-sparking "n"				
		Zone 21				
		Zone 22				
200	1MA6	Increased safety "e"	M 50x1.5	2	M 16x1.5	2
	1LG4 1LG6 1MB1	Non-sparking "n"				
		Zone 21				
		Zone 22				
225	1MA6	Increased safety "e"	M 50x1.5	2	M 20x1.5	2
	1LG4 1LG6 1MB1	Non-sparking "n"				
		Zone 21				
		Zone 22				
250 ... 315	1MA6	Increased safety "e"	M63 x 1.5	2	M 20x1.5	2
	1LG4 1LG6 1MB1	Non-sparking "n"				
		Zone 21				
		Zone 22				

Table 6- 3 Thread sizes in the aluminum terminal box

Frame size	Type	Type of protection / Zone	Standard thread		Additional thread with mounting parts	
			Size	Number	Size	Number
63 ... 90	1LA7 1LA9 1MA7	Increased safety "e"	M 16 x 1.5 M 25 x 1.5	1 1	-	-
		Non sparking "n"				
		Zone 21				
		Zone 21				
80 ... 90	1MB1	Non-sparking "n"	M 16 x 1.5 M 25 x 1.5	1 1	-	-
		Zone 21				
		Zone 21				
100 ... 132	1LA7 1LA9 1MA7	Increased safety "e"	M 32x1.5	4	-	-
		Non sparking "n"				
		Zone 21				
		Zone 22				
100 ... 132	1MB1	Non sparking "n"	M 32x1.5	2	M 16x1.5	1
		Zone 21				
		Zone 22				
160	1LA7 1LA9 1MA7	Increased safety "e"	M 40x1.5	4	-	-
		Non sparking "n"				
		Zone 21				
		Zone 22				
160	1MB1	Non sparking "n"	M 40x1.5	2	M 16x1.5	1
		Zone 21				
		Zone 22				
180	1LA5	Zone 21	M 40x1.5	2	M 16x1.5	1
		Zone 22				
180	1LG4 1LG6	Non sparking "n"	M 40x1.5	2	M 20x1.5	2
		Zone 21				
		Zone 22				
180	1MA6	Increased safety "e"	M 40x1.5	2	M 16x1.5	2
200 ... 225	1LA5	Zone 21	M 50x1.5	2	M 16x1.5	1
		Zone 22				
200	1MA6	Increased safety "e"	M 50x1.5	2	M 16x1.5	2
200	1LG4 1LG6	Non sparking "n"	M 50x1.5	2	M 20x1.5	2
		Zone 21				
		Zone 22				
225	1LG4 1LG6 1MA6	Increased safety "e"	M 50x1.5	2	M 20x1.5	2
		Non sparking "n"				
		Zone 21				
		Zone 22				

6.2 Tightening torques

6.2.1 Electrical connections - Termincal board connections

Table 6- 4 Tightening torques for electrical connections on the terminal board

	Thread ⌀		M 3,5	M 4	M 5	M 6	M 8	M 10	M 12	M 16
	Nm	min	0,8	0,8	1,8	2,7	5,5	9	14	27
		Max.	1,2	1,2	2,5	4	8	13	20	40

6.2.2 Cable glands

Note

Avoid damaging the cable jacket.

Adapt the tightening torques to the cable jacket materials.

You should refer to the table in order to find the correct tightening torque for any metal and plastic cable glands that are to be mounted directly on the machine, as well as for any other screw-type connections (such as adapters).

Table 6- 5 Tightening torques for cable glands

	Metal ± 10% [Nm]	Plastic ± 10% [Nm]	Clamping range [mm]		O ring Cord dia. [mm]
			Standard -30 °C ... 100 °C Ex -30 °C ... 90 °C	Ex -60 °C ... 90 °C	
M 12 x 1.5	8	1.5	3.0 ... 7.0	-	2
M 16 x 1.5	10	2	4.5 ... 10.0	6.0 ... 10.0	
M 20 x 1.5	12	4	7.0 ... 13.0	6.0 ... 12.0	
M 25 x 1.5			9.0 ... 17.0	10.0 ... 16.0	
M 32 x 1.5	18	6	11.0 ... 21.0	13.0 ... 20.0	
M 40 x 1.5			19.0 ... 28.0	20.0 ... 26.0	
M 50 x 1.5	20		26.0 ... 35.0	25.0 ... 31.0	
M 63 x 1.5			34.0 ... 45.0	-	

6.2.3 Terminal boxes, end shields, grounding conductors, sheet metal fan covers

If no other tightening torques are specified, then the values in the following table apply.

Table 6- 6 Tightening torques for screws on the terminal box, end shields, screw-type grounding conductor connections

Thread ∅		M 3.5	M 4	M 5	M 6	M 8	M 10	M 12	M 16	M20
Nm	min	0.8	2	3.5	6	16	28	46	110	225
	max	1.2	3	5	9	24	42	70	165	340

Note

Tightening torque for the condensation drain plug

Tighten the condensation drain plug M6x0.75 with a torque between 1.5 and 2.0 Nm!

Table 6- 7 Tightening torques for self-tapping screws on the terminal box, end shields, screw-type grounding conductor connections, sheet metal fan covers

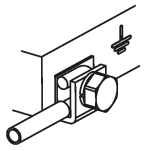
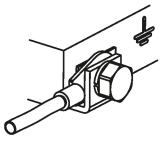
Thread ∅		M 4	M 5	M 6
Nm	min	4	7,5	12,5
	max	5	9,5	15,5

6.3 Connecting the grounding conductor

The machine's grounding conductor cross-section must comply with EN / IEC 60034-1. Please also observe installation regulations such as those specified in EN / IEC 60204-1. Basically, there are two ways of connecting a grounding conductor to the machine.

- Internal grounding with a connection in terminal box at the location intended for this purpose and marked accordingly.
- External grounding with connection at the stator housing at the locations intended for this purpose and marked accordingly.

6.3.1 Grounding connection type

Enclosure grounding method		Cable cross-section [mm²]
Connection of an individual conductor under the external grounding bracket.		… 10
Connection is made using a DIN cable lug under the external grounding bracket. DIN 46 234		… 25

6.3.2 Minimum surface area of grounding conductor

Table 6- 8 Minimum cross-sectional area of grounding conductor

Minimum cross-sectional area of phase conductor for installation S [mm²]	Minimum surface area of associated grounding connection [mm²]
S ≤ 16	S
16 < S ≤ 35	16
S > 35	0.5 S

Internal ground terminal

When making connections, ensure the following:

- Ensure that the connecting surface is bare and is protected against corrosion using a suitable substance, e.g. acid-free Vaseline.
- Arrange the flat washer and spring washer under the bolt head.
- Locate the cable lug under the clamping bracket.
- Use the terminals designated for the grounding conductor in the terminal box.
- Comply with the tightening torque (Page 77) for the terminal screw.

For machines, frame sizes 80 ... 90 with central terminal box locking, a cable lug, size M4 according to DIN 46237 can be used to connect the inner grounding.

External ground terminal

When making connections, ensure the following:

- Ensure that the connecting surface is bare and is protected against corrosion using a suitable substance, e.g. acid-free Vaseline.
- Position the cable lug between the contact bracket and the grounding bracket; do not remove the contact bracket pressed into the enclosure!
- Arrange the flat washer and spring washer under the bolt head.
- Use the terminals designated for the grounding conductor in the terminal box.
- Comply with the tightening torque (Page 77) for the terminal screw.

Table 6- 9 Screw size of the grounding cable, external grounding

Frame size	Thread size for the grounding conductor
63 ... 90	M4/ M5
100 ... 112	M5
132 ... 180	M6
200 ... 225	M8
200 1LG, 1LE15/6, 1FP1, 1MB15/6	2x M6
225 ... 315 1LG, 1LE15/6, 1MA, 1MB15/6	2x M8

6.4 Conductor connection

Cross-sections that can be connected depending on the size of the terminal (possibly reduced due to size of cable entries)

⚠WARNING

Short-circuit hazard

Connection and installation errors at connecting cables and cover washers can result in a short-circuit. Death or serious physical injury can result.

Note the following precautionary measures:

- Do not lay connection cables over the central dome of the terminal board.
- Observe the opening direction and the mounting position of the cover washers on the terminal board.

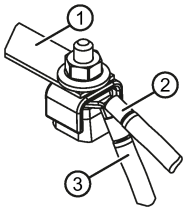
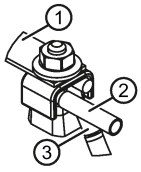
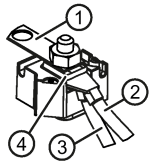
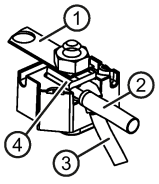
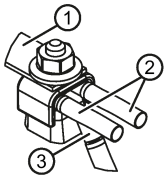
Table 6- 10 Max. conductor connection for standard machines and Zone 22

Frame size	Max. connectable conductor cross-section [mm²]
63 ... 90	1,5 2.5 with cable lug
100 ... 112	4,0
132	6,0
160 ... 180	16,0
200	25,0
225	35.0 with cable lug
250 ... 280	120,0
315	240,0

Table 6- 11 Max. conductor connection for explosion-proof machines (with the exception of Zone 22) and VIK standard version

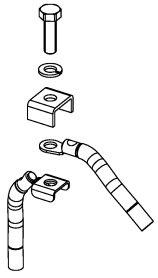
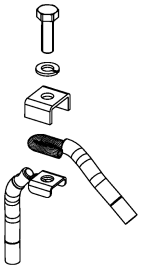
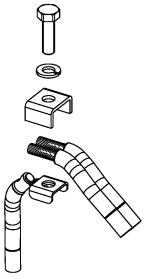
Frame size	Max. connectable conductor cross-section [mm²]
63 ... 112	4,0
132	6,0
160	16,0
180	10,0
180 (1LG4, 1LG6)	16,0
200 ... 225	50,0
250 ... 280	120,0
315	240,0

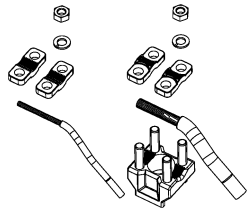
6.4.1 Type of conductor connection

Terminal board				**Conductor cross-section [mm²]**
Connection with cable lug DIN 46 234 Bend down the cable lug for the connection.				... 25
Connection of an individual conductor with terminal clamp				... 10
Connection of two conductors of approximately the same thickness with terminal clamp				... 25

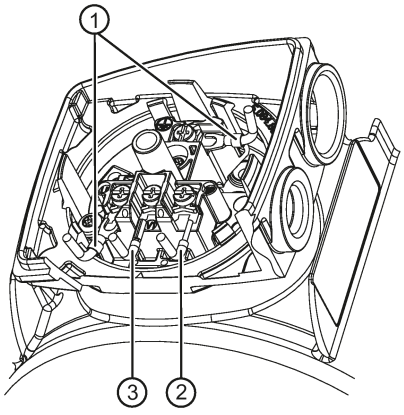
① Link rail
② Power supply cable
③ Motor connecting cable
④ Cover washer

6.4.2 Conductor connection types for explosion-protected machines

Terminal board			**Conductor cross-section [mm²]**
Bend down the cable lug for the connection!	1MA618.		… 10
	1MA620.		… 35
Connection of an individual conductor with terminal clamp	1MA618. ... 20.		… 25
Connection of two conductors of the same thickness with terminal clamp	1MA618. ... 20.		… 25

Connection terminal 1MA6, 1MB153., 1MB163. and 1LG4/6 in type of protection Ex nA.			Conductor cross-section [mm²]
	Frame size/option		
	18. ... 22.		2,5 … 25
	25. ... 28.		10 … 95
	31.		25 … 135
	31. + L00 / R50		50 … 300
	18. ... 22.	 	… 16
	25. ... 28.		… 35
	31.		… 70
	31. + L00 / R50		… 120
	18. ... 22.		16 … 50
	25. ... 28.		50 … 120
	31.		95 … 240
	31. + L00 / R50		120 … 400

Recommended connection variants



① Cable lugs DIN 46237 with insulating sleeve (round and open)

② Rigid cable (insulation removed at ends ≤ 8 mm)

③ End sleeves DIN 46228 ≤ 8 mm

If air gaps ≥ 5.5 mm (up to 690 V) are observed between non-insulated components, you can also use alternative connection elements without insulating sleeve, for example cable lugs acc. to DIN 46234 .

6.5 Connecting optional mounted components

See the list of additional operating instructions: Further documents (Page 145)

6.6 Connecting converters

NOTICE

Excessively high supply voltage

Material damage can occur if the supply voltage is too high for the insulation system.

The machines can be operated with line voltages ≤ 500 V with SINAMICS G converters and SINAMICS S converters (uncontrolled and controlled infeed) when maintaining the permissible peak voltages.

The maximum permissible voltage rate of rise (gradient) is 9 kV/µs.

$\hat{U}_{conductor\text{-}conductor}$ ≤ 1500 V; $\hat{U}_{conductor\text{-}ground}$≤ 1100 V

For VSD machines, the following data apply:
$\hat{U}_{conductor\text{-}conductor}$ ≤ 1600 V, $\hat{U}_{conductor\text{-}ground}$ ≤ 1400 V, voltage rise times of ts > 0.1 µs.

See the list of additional operating instructions:Further documents (Page 145)

⚠WARNING

Machine overheating

Operating explosion-protected machines at the converter without using the appropriate protective equipment can result in death or severe injury.

Always use PTC thermistor monitoring when operating explosion-protected machines at the converter. Tripping units according to directive 94/9/EC are always necessary when using PTC thermistor monitoring.

Machines with non-sparking "nA" type of protection
The operation of the explosion-proof machines on the converters is permitted, when the specifications for the speed control range and torque characteristic are observed, and if winding temperature monitoring is ensured via the integrated temperature sensors in conjunction with a certified tripping unit.

Machines with increased safety "e" type of protection
Converter operation for these machines must be expressly certified. It is essential that you observe the separate manufacturer's information and instructions. Converter and protective devices must be marked as belonging together and the permitted operating data must be defined in the common EC-type examination certificate.

Machines connected to converters for Zone 21 and Zone 22
These machines are generally equipped with three PTC thermistors in accordance with DIN 44082 with a rated response temperature that depends on the maximum possible surface temperature. Select the PTC thermistors in accordance with this standard. The maximum temperature at the cable entries is 120 °C. Use suitable cables for this temperature. Do not

exceed the maximum frequency dependent on the number of poles, which is stamped on the rating plate.

System, converter - cable - electrical machine

Please observe the information in accordance with EN / IEC 60034-17 and EN / IEC 60034-25 regarding winding stress. For line supplies with operating voltages up to 690 V, the maximum value of the voltage peaks at the end of the cable must not exceed twice the value of the converter's DC-link voltage.

6.7 Final measures

Before closing the terminal box/terminal base of the machine enclosure, check the following:

- Establish the electrical connections in the terminal box in accordance with the details in the sections above and tighten with the correct torque.
- Maintain air clearances between non-insulated parts:
  ≥ 5.5 mm up to 690 V, ≥ 8 mm up to 1000 V.
- Avoid protruding wire ends!
- In order not to damage the cable insulation, freely arrange the connecting cables.
- Connect the machine corresponding to the specified direction of rotation.
- Keep the inside of the terminal box clean and free from trimmed-off ends of wire.
- Ensure that all seals and sealing surfaces are undamaged and clean.
- Correctly and professionally close unused openings in the terminal boxes.

Before closing the terminal box, check that

- the air clearances for explosion-protected machines (with the exception of machines for Zone 22) between non-insulated parts are maintained: ≥ 10 mm to 690 V.
- the minimum creepage distance for explosion-protected machines (with the exception of machines for Zone 22) between non-insulated parts is maintained: ≥ 12 mm to 690 V.

Commissioning

7

When carrying out any work on the machine, observe the general safety instructions (Page 13) and the specifications contained in EN 50110-1 regarding safe operation of electrical equipment.

7.1 Setpoint values for monitoring the bearing temperature

Prior to commissioning

If the machine is equipped with bearing thermometers, set the temperature value for disconnection on the monitoring equipment before the first machine run.

Table 7- 1 Set values for monitoring the bearing temperatures before commissioning

Set value	Temperature
Alarm	115 °C
Shutting down	120 °C

Normal operation

Measure the normal operating temperature of the bearings T_{op} at the installation location in °C. Set the values for shutdown and warning corresponding to the operating temperature T_{op}.

Table 7- 2 Set values for monitoring the bearing temperatures

Set value	Temperature
Alarm	$T_{operation}$ + 5 K ≤ 115 °C
Shutting down	$T_{operation}$ + 10 K ≤ 120 °C

7.2 Measures before commissioning

NOTICE
Damage to the machine In order to avoid material damage, check the following points before commissioning the motor: • Using appropriate measures, check whether the correct direction of rotation of the motor has been set by the customer, e.g. by decoupling from the driven load. • Ensure that temperature-sensitive parts (cables, etc.) are not in contact with the machine enclosure. • Ensure that the condensation drain holes are always located at the lowest part of the motor.

NOTICE
Damage caused by insufficient cooling Effective cooling is no longer possible if air guidance of the machine is not provided as intended. This can damage the machine. • Before commissioning, attach the covers to guarantee the intended air guidance.

Measures
Once the system has been correctly installed, you should check the following prior to commissioning:

- Ensure that the machine has been correctly installed and aligned.
- Connect the machine corresponding to the specified direction of rotation.
- Ensure that the operating conditions match the data specified on the rating plate.
- Lubricate the bearings, depending on the version. Ensure that machines with roller bearings, which have been stored for longer than 24 months, are relubricated. Also observe the notes in Chapter Preparation for use.
- Ensure that any optional supplementary machine monitoring equipment has been connected correctly and is functioning as it should.
- For versions with bearing thermometers, check the bearing temperatures when the machine starts to run for the first time. Set the values for alarm and shutdown at the monitoring device. Also observe the notes in Chapter Setting values for monitoring the bearing temperature.
- Corresponding to the control and speed monitoring functions implemented, ensure that the machine cannot exceed the permissible speeds specified on the rating plate.
- Ensure the correct setting conditions of the drive output elements depending on the type (e.g. alignment and balancing of couplings, belt forces in the case of a belt drive, tooth forces and tooth flank backlash/play in the case of gear wheel output, radial and axial clearance in the case of coupled shafts).
- Comply with the minimum insulation resistances and minimum air clearances.

- Ensure correct grounding and potential bonding connection of the protective conductor.
- Tighten all mounting bolts, connection elements and electrical connections to the specified torques.
- Remove any lifting eyes that were screwed after installation – or secure them to prevent them becoming loose.
- Rotate the rotor to ensure that it does not touch the stator.
- Implement all touch protection measures for both moving and live parts.
- Ensure that free shaft extensions cannot be touched, e.g. by attaching covers.
- Secure any featherkeys so that they cannot be flung out.
- Ensure that the optional external fan is ready for operation and connected so that it rotates in the specified direction.
- Ensure that the cooling airflow is not obstructed or diminished in any way.
- If an optional brake is being used, ensure that it is functioning perfectly.
- Comply with the specified mechanical limit speed n_{max}, and ensure that it is not exceeded.

If the design of the machine requires the converter to be assigned in a particular way, the relevant information will be provided on the rating plate or an additional label.

Note

It may be necessary to perform additional checks and tests in accordance with the specific situation on site.

See also

Observing the operating mode (Page 37)

7.3 Switching on

Measures for start-up

After installation or inspections, the following measures are recommended for normal start-up of the machines:

- Start the machine without a load; to do this, close the motor starter protector and do not switch the machine off prematurely. You should limit how often you switch the machine off while it is starting up and still running at a slow speed, for checking the direction of rotation or the required dimensions, for example. Allow the machine to run to a standstill before switching it back on again.
- Check the mechanical operation for noises or vibrations at the bearings and bearing end shields.
- If the motor does not run smoothly and/or there are any abnormal noises, switch it off and determine the cause as it slows down.
- If mechanical operation improves immediately after the machine is switched off, then the cause is magnetic or electrical. If mechanical operation does not improve immediately after switching the machine off, then the cause is mechanical, such as an imbalance in

the electrical machines or in the driven machine, inadequate alignment of the machine set, operation of the machine with the system resonating (system = machine + base frame + foundation, etc.).

- If there are no problems with the machine's mechanical operation, switch on any cooling devices that are being used and continue to monitor the machine for a while during no-load operation.
- If it runs perfectly, connect a load. Check that it runs smoothly, and read off and document the values for voltage, current and power. As far as possible, read off and document the corresponding values for the driven machine as well.
- Monitor and document the temperatures of the bearings, windings, etc. until the system reaches a steady state, in as much as this is possible with the available measuring instruments.

Measures to take when commissioning explosion-proof machines

After installation or inspections, the following measures are recommended for normal start-up of the machines:

- Start the machine without a load; to do this, close the motor starter protector and do not switch the machine off prematurely.
- You should limit how often you switch the machine off while it is starting up and still running at a slow speed, for checking the direction of rotation or the required dimensions, for example.
- Allow machines to reach a standstill before switching them back on.

Operation

8

When carrying out any work on the machine, observe the general safety instructions (Page 13) and the specifications contained in EN 50110-1 regarding safe operation of electrical equipment.

8.1 Safety instructions

8.1.1 Safe handling

Workplace safety depends on the attentiveness, care, and common sense of the personnel who install, operate, and maintain the machine. In addition to the safety measures cited, as a matter of principle, the use of caution is necessary when you are near the machine. Always pay attention to your safety.
Also observe the following to prevent accidents:

- General safety regulations applicable in the country where the machine is deployed.
- Manufacturer-specific and application-specific regulations
- Special agreements made with the operator
- Separate safety instructions supplied with the machine
- Safety symbols and instructions on the machine and its packaging

⚠WARNING

Live parts

Electric machines contain live parts.

Fatal or severe injuries and substantial material damage can occur if the covers are removed or if the machine is not handled, operated, or maintained properly.

- Always observe the “five safety rules" (Page 14) when carrying out any work on the machine.
- Only remove the covers using the methods described by these operating instructions.
- Operate the machine properly.
- Regularly and correctly maintain the machine.

⚠WARNING

Rotating parts

Electric machines contain dangerous rotating parts.

Fatal or severe injuries and substantial material damage can occur if the covers are removed or if the machine is not handled, operated, or maintained properly.

- Only remove the covers using the methods described by these operating instructions.
- Operate the machine properly.
- Perform regular maintenance on the machine.
- Secure free-standing shaft ends.

⚠WARNING

Hot surfaces

Electric machines have hot surfaces. Do not touch these surfaces. They could cause burns.

- Allow the machine to cool before starting work on the machine.
- Only remove the covers using the methods described by these operating instructions.
- Operate the machine properly.

⚠CAUTION

Hazardous substances

Chemical substances required for the setup, operation and maintenance of machines can present a health risk.

Poisoning, skin damage, cauterization of the respiratory tract, and other health damage may result.

- Read the information in these operating instructions and the product information supplied by the manufacturer.
- Observe the relevant safety regulations and wear the personal protective equipment specified.

⚠ CAUTION

Flammable substances

Chemical substances required for the setup, operation and maintenance of machines may be flammable.

Burns and other damage to health and material may result.

- Read the information in these operating instructions and the product information supplied by the manufacturer.
- Observe the relevant safety regulations and wear the personal protective equipment specified.

8.1.2 Safety instructions during operation

Switching on the machine

⚠ DANGER

Hazardous voltages

Electrical machines are at hazardous voltage levels. Contact with these can result in death, serious injury or material damage.

Operating the machine on a line supply system with a non-grounded neutral point is only permitted for short periods of time that occur rarely, e.g. the time leading to a fault being eliminated. Cable ground fault EN / IEC 60034-1.

NOTICE

Damage to the machine or premature bearing failure

The bearings can be damaged if the following is not observed.

- It is absolutely crucial that you maintain the permissible vibration values to avoid damage to the machine or its destruction.
- In operation, observe the vibration values in accordance with ISO 10816.
- Under all circumstances maintain the minimum radial load of cylindrical roller bearings of 50% corresponding to what is specified in the catalog.
- Take the appropriate measures to reduce bearing currents. Observe the Chapter Converter operation.

⚠WARNING

Faults in operation

Changes with respect to normal operation indicate that there is an impaired function. This can cause faults which can result in eventual or immediate death, severe injury or material damage.

For instance, observe the following signs that could indicate a malfunction:

- Higher power drawn than usual
- Higher temperatures than usual
- Unusual noises
- Unusual smells
- Response of monitoring equipment

Immediately contact the maintenance personnel if you identify any irregularities. If you are in doubt, immediately switch off the machine, being sure to observe the system-specific safety conditions.

NOTICE

Risk of corrosion due to condensation

If the machine and/or ambient temperatures fluctuate, this can result in condensation inside the machine.

- If available, remove the drain plugs or screws to drain the water depending on the ambient and operating conditions.
- If available, re-attach the drain plugs or screws.

If the motor is equipped with drain plugs, then the water can drain away by itself.

Switching on the machine with anti-condensation heating (optional)

⚠CAUTION

Machine overheating

Minor injury or material damage can occur if you do not observe the following:

- If available, switch off the anti-condensation heating each time before switching on.

See also

Converter operation (Page 42)

8.1.3 Safety information for explosion-protected machines in operation

⚠ WARNING

Explosion hazard

⟨Ex⟩ These explosion-protected machines are not suitable for hybrid explosive environments.

This can result in death, serious injury or material damage.

Use in atmospheres where there is a risk of explosion caused by both gas and dust simultaneously is absolutely prohibited.

⟨Ex⟩

Only install machines with type of protection increased safety "e", and machines for Zone 2 in hazardous areas, according to the regulations laid down by the responsible regulatory body. They are responsible for determining the hazard level of each area (division into zones). Layers of dust on machines for Zone 21 and Zone 22 must – under no circumstances – be higher than 5 mm!

- If there are no other specifications in the EC or EU-type examination certificate or on the rating plate regarding operating mode and tolerance, electrical machines are designed for continuous duty and normal starting procedures that are performed infrequently and do not result in excessive temperature rise. Only use these machines for the operating mode specified on the rating plate.
- Measures for maintaining the temperature class:
  For machines equipped with their own fan and S1 line supply operation, a function-tested, current-dependent protective device that monitors all three phase conductors provides sufficient protection for the machine. This protective device is set to the rated current and must switch off machines with 1.2x the rated current within 2 hours or less. Do not switchoff for 1.05-fold or smaller rated current. Pole-changing machines require a separate switch for each pole number; further, temperature monitoring using PTC thermistors is required. If an anti-condensation heating system is available, it may only be switched on when the machines are not in operation.

8.1.4 Safety instructions for cleaning

Cleaning

To ensure problem-free machine cooling, the air ducts (ventilation grilles, channels, cooling fins, tubes) must be free of pollution.

⚠ WARNING

Risk of explosion when cleaning with compressed air

If you clean the machine with compressed air, plastic components may become statically charged and ignite a potentially explosive atmosphere; an explosion can occur. This can result in death, serious injury or material damage.

- Do not use compressed air to clean motors when installed in hazardous zones!

8.1.5 Safety instruction regarding cooling

8.1.5.1 Safety instructions when operating machines with fan

⚠ CAUTION

Risk of injury when touching the fan

There is a risk of injury at machines equipped with a fan cover (e.g. fan cover used in the textile industry), as the fan is not completely touch protected.

- Do not touch the rotating fan.
- Do not put your fingers into the larger air discharge openings.
- Manual intervention must be prevented on the customer's side by using suitable measures, e.g. appropriate housings or a protective grating.

8.1.5.2 Safety instruction regarding forced ventilation/external fan (optional)

Forced ventilation (optional): Type of cooling IC 416 in accordance with EN / IEC 60034-6

⚠ WARNING

Risk of burning

Operating the machine without external fan results in overheating. This may result in death, personal injury and material damage.

- Never commission the machine without an external fan.

8.1.5.3 Machines with textile fan covers

In order to guarantee an essentially unobstructed flow of cooling air containing fluff, remains of materials or similar dirt, machines with a fan cover for textile applications have a larger air discharge cross-section between the edge of the cover and the cooling ribs of the machine frame.
These machines have a warning sticker on the fan cover.

8.1.6 Stoppages

Longer non-operational periods

Note

- For longer non-operational periods (> 1 month), either operate the machine or at least turn the rotor regularly, approximately once per month.
- Please refer to the section "Switching on" before switching on to recommission the motor.
- Remove any machine rotor locking devices before you turn the rotor.

NOTICE

Restricted motor function

If not used for longer periods of time, material damage or complete motor failure can occur.

If the motor is out of service for a period of more than 12 months, then environmental effects can damage the motor.

- Apply suitable corrosion protection, preservation, packing and drying measures.

Switching on the anti-condensation heater

Switch on any anti-condensation heating while the machine is not being operated.

Taking the machine out of service

Details regarding the necessary measures, Chapter Preparing for use (Page 37).

Lubricating before recommissioning

NOTICE

Dry running bearings

Bearings can be damaged if they do not have sufficient grease.

- Re-grease the bearings if they have been out of service for more than one year. The shaft must rotate so that the grease can be distributed in the bearings. Observe the data on the lubricant plate.

Chapter Storage (Page 111).

8.2 Fault tables

Note

Before removing any faults, please read the information in Chapter Safety information (Page 13).

Note

If you operate the motor with a converter, and an electrical fault occurs, then also observe the information in the converter operating instructions.

The tables below list general faults caused by mechanical and electrical influences.

Table 8- 1 Electrical influences

								Electrical fault characteristics	
↓								Machine will not start up	
	↓							Machine starts up reluctantly	
		↓						Rumbling noise during startup	
			↓					Rumbling noise during operation	
					↓			Overheating during no-load operation	
						↓		Overheating when under load	
							↓	Overheating of individual winding sections	
								Possible causes of faults	**Remedial measures**[1)]
X	X		X			X		Overload	Reduce load
X								Interruption of a phase in the supply line	Check switches and supply lines
	X	X	X			X	X	Interruption of a phase in the supply line after switching on	Check switches and supply lines
X	X							Supply voltage too low, frequency too high	Check power supply conditions
					X			Supply voltage too high, frequency too low	Check power supply conditions
X	X	X	X				X	Stator winding incorrectly connected	Check winding connections
	X	X	X				X	Winding short circuit or phase short circuit in stator winding	Measure the winding resistances and insulation resistances, repair after consultation with manufacturer
						X		Incorrect direction of rotation of axial fan	Check connections

(1) As well as eliminating the cause of the fault (as described under "Remedial measures"), you must also rectify any damage the machine may have suffered.

Table 8- 2 Mechanical effects

				Mechanical fault characteristics	
↓				Grinding noise	
	↓			Overheating	
		↓		Radial vibrations	
			↓	Axial vibrations	
				Possible causes of faults	**Remedial measures**[1)]
X				Rotating parts are grinding	Determine cause and adjust parts concerned
	X			Reduced air supply, fan possibly rotating in the wrong direction	Check airways, clean machine
		X		Rotor not balanced.	Check feather key declaration (H, F, N)
		X		Rotor out of true, shaft bent	Please consult the manufacturer.
		X	X	Poor alignment	Align machine set, check coupling. [2)]
		X		Coupled machine not balanced	Re-balance coupled machine
			X	Surges from coupled machine	Inspect coupled machine
		X	X	Imbalance originating from gearing	Adjust/repair gearing
		X	X	Resonance in the overall system (comprising machine and foundation)	Reinforce foundation following consultation
		X	X	Changes in foundation	Determine cause of changes; eliminate if necessary; realign machine

1) As well as eliminating the cause of the fault (as described under "Remedial measures"), you must also rectify any damage the machine may have suffered.
2) Note any changes that take place while the temperature is rising.

8.3 Deactivating

Commission any devices provided for protection against condensation after switching off the machine.

Maintenance 9

Through careful and regular maintenance, inspections, and overhauls you can detect faults at an early stage and resolve them. This means that you can avoid consequential damage. Operating conditions and characteristics can vary widely. For this reason, only general maintenance intervals can be specified here. Maintenance intervals should therefore be scheduled to suit the local conditions (dirt, starting frequency, load, etc.).
When carrying out any work on the machine, observe the general safety instructions (Page 13) and the specifications contained in EN 50110-1 regarding safe operation of electrical equipment.
Comply with the IEC / EN 60079-17 standard during all service and maintenance work on the machine.

Note

Service Center

Please contact the Service Center (Page 145), if you require support with servicing, maintenance or repair.

9.1 Safety instructions for inspection and maintenance

⚠ WARNING

Rotating and live parts

Electric machines contain live and rotating parts. Fatal or serious injuries and substantial material damage can occur if maintenance work is performed on the machine when it is not stopped or not de-energized.

- Perform maintenance work on the machine only when it is stopped. The only operation permissible while the machine is rotating is regreasing the roller bearings.
- When performing maintenance work, comply with the five safety rules (Page 14).

⚠ WARNING

Machine damage

If the machine is not maintained it can suffer damage. This can cause faults which can result in eventual or immediate death, serious injury or material damage.

Perform regular maintenance on the machine.

⚠ CAUTION

Dust disturbances when working with compressed air

When cleaning with compressed air, dust, metal chips, or cleaning agents can be whirled up. Injuries can result.

When cleaning using compressed air, make sure you use suitable extraction equipment and wear protective equipment (safety goggles, protective suit, etc.).

NOTICE

Damage to insulation

If metal swarf enters the winding head when cleaning with compressed air, this can damage the insulation. Clearance and creepage distances can be undershot. This may cause damage to the machine extending to total failure.

When cleaning with compressed air, ensure there is adequate extraction.

NOTICE

Machine damage caused by foreign bodies

Foreign bodies such as dirt, tools or loose components, such as screws etc., can be left by accident inside the machine after maintenance is performed. These can cause short circuits, reduce the performance of the cooling system or increase noise in operation. They can also damage the machine.

- When carrying out maintenance work, make sure that no foreign bodies are left in or on the machine.
- Securely attach all loose parts again once you have completed the maintenance procedures.
- Carefully remove any dirt.

Note

Operating conditions and characteristics can vary widely. For this reason, only general intervals for inspection and maintenance measures can be specified here.

9.2 Preparation and notes

9.2.1 North American market (optional)

When making changes or repairs, maintain the corresponding design standards! These machines are labeled on the rating plate with the following markings.

Underwriters Laboratories

Canadian Standard Association

Canadian Standard Association Energy Efficiency Verification

9.2.2 Customs union Eurasia (optional)

When making changes or repairs, maintain the corresponding design standards! These machines are labeled on the rating plate with the following markings.

Customs union Eurasia

Eurasian customs union

Explosion-protected

9.2.3 Paint finish resistant to sea air

⚠WARNING

Risk of explosion as a result of processes with high levels of electrostatic charging

Carefully observe the appropriate precautionary measures in order to avoid death or severe injury.

For paint finish "resistant to sea air" (C4 according to EN ISO 12944-2) for motors belonging to explosion group III, processes that generate significant levels of electrostatic discharge are absolutely not permissible. Paint can be electrostatically charged as a result of intensive dust turbulence or processes with high levels of electrostatic charging. Electrostatic discharges can occur. Minimize the risk of electrostatic charging by applying the following effective measures.

- Increase the conductivity of bulk goods and plant/system parts, e.g. by applying an appropriate coating.
- Increase the humidity or ionization.
- Reduce the amount of fine components in bulk goods, e.g. resulting from abrasion
- Restrict the degree of dispersion, e.g. by selecting plug conveying instead of dilute phase conveying.
- Reduce the flow rate, the mass flow rate or the air velocity.
- Avoid large heaps of bulk goods.
- Transport using gravity is the preferred choice rather than pneumatic transport.
- When pneumatically transporting bulk goods, use conductive hoses in order to avoid electrostatic discharge.

Additional measures are listed in IEC 60079-32-1.

9.2.4 Touch up any damaged paintwork

If the paint is damaged, it must be repaired in order to protect the unit against corrosion.

Note

Paint system

Contact the Service Center (Page 145) before you repair any paint damage. They will provide you with more information about the correct paint system and methods of repairing paint damage.

9.2.5 Repainting

⚠ WARNING

Explosion hazard caused by incorrect painting

The paint coat can become electrostatically charged where there is a thick coat. Electrostatic discharges can occur. There is a risk of explosion if potentially explosive mixtures are also present at this moment. This can result in death, serious injury or material damage.

You must comply with one of the following requirements when you repaint painted surfaces:

- Limit the total paint film thickness according to the explosion protection group:
  - IIA, IIB: Total paint coating thickness ≤ 2 mm
  - IIC: Overall coating thickness ≤ 0.2 mm for motors of group II (gas)
- Limit the surface resistance of the paint used:
  - Surface resistance ≤ 1 GΩ for motors of groups II and III (gas and dust)
- Charge transfer limit
  - 60 nC for Group I or Group IIA devices
  - 25 nC for Group IIB devices
  - 10 nC for Group IIC devices
  - 200 nC for Group III devices (values not valid for strongly charge generating processes)
- Breakdown voltage ≤ 4 kV for explosion group III (gas and dust)

9.2.5.1 Warning when repainting

⚠ WARNING

Risk of explosion as a result of processes with high levels of electrostatic charging

For paint finishes in explosion group III, the paint can be electrostatically charged as a result of intensive dust turbulence or processes with high levels of electrostatic charging. Electrostatic discharges can occur. Minimize the risk of electrostatic charging by applying effective measures according to IEC 60079-32-1. This can result in death, serious injury or material damage.

Note

Paint finishes for IIC are optionally available with more than 200 µm coat thickness.
Paint finishes exceeding 200 µm are tested with respect to electrostatic charging.
Motors with a coating thickness exceeding 200 µm may only be painted over if the conditions mentioned above are complied with.

9.3 Inspection

Notes

Note

Pay particular attention to the relubrication intervals for rolling bearings that deviate from the inspection intervals.

Note

When servicing a three-phase machine, it is generally not necessary to dismantle it. The machine only has to be dismantled if the bearings are to be replaced.

9.3.1 Optional built-on accessories

See the list of additional operating instructions: Further documents (Page 145)

9.3.2 First inspection after installation or repair

Perform the following checks after approximately 500 operating hours or at the latest six months after commissioning:

Table 9- 1 Checks after assembly or repair

Check	When the motor is running	At stand-still
The stated electrical characteristics are being observed.	X	
The permissible bearing temperatures are not exceeded (Page 87).	X	
The smooth running characteristics and machine running noise have not deteriorated.	X	
The motor foundation has no cracks and indentations. (*)	X	X

(*) You can perform these checks while the motor is running or at a standstill.
Additional tests may also be required according to the system-specific conditions.

NOTICE
Machine damage When carrying out the inspection, if you detect any impermissible deviations from the normal state, you must rectify them immediately. They may otherwise cause damage to the machine.

9.3.3 Main inspection

Check that the installation conditions are observed. We recommend that the following checks are performed after approx. 16 000 operating hours or at the latest after two years:

Table 9- 2 Checks that have to be performed during the general inspection

Checking	When the motor is running	At stand-still
The electrical parameters are maintained	X	
The permissible bearing temperatures are not exceeded (Page 87)	X	
The smooth running characteristics and machine running noise have not deteriorated	X	
The motor foundation has no cracks and indentations (*)	X	X
The machine is aligned within the permissible tolerance ranges		X
All the fixing bolts/screws for the mechanical and electrical connections have been securely tightened		X
All the potential connections, grounding connections and shield supports are correctly seated and properly bonded		X
The winding insulation resistances are sufficiently high		X
Any bearing insulation is fitted as shown on the plates and labels		X
The CABLES and insulating parts and components are in good condition and there is no evidence of discoloring		X

(*) You can perform these checks while the motor is at standstill or, if required, while running.

NOTICE
Machine damage When carrying out the inspection, if you detect any impermissible deviations from the normal state, you must rectify them immediately. They may otherwise cause damage to the machine.

9.4 Maintenance

9.4.1 Maintenance intervals

⚠ CAUTION
Skin irritations and eye inflammations Many greases can cause skin irritations and eye inflammations. • Follow all safety instructions of the manufacturer.

The machines are equipped with permanently lubricated roller bearings. A regreasing device is optional.
Please note the following in order to identify faults at an early stage, rectify them and avoid follow-on damage:

- Maintain the machine regularly and carefully.
- Inspect the machine.
- Motors must be allocated a revision/inspection number after inspection.

Operating situations and characteristics can vary widely. For this reason, only general maintenance intervals are specified here. Maintenance intervals should therefore be scheduled to suit the local conditions (dirt, starting frequency, load, etc.).

NOTICE
Motor failure Material damage can occur if the machine develops faults or is overloaded. • Immediately inspect the machine if faults occur. • An immediate inspection is especially necessary, if the three-phase motor is excessively stressed, either electrically or mechanically (e.g. overload or short-circuit).

Measures, intervals and deadlines
Measures after operating period intervals or deadlines have elapsed:

Table 9- 3 Operating period intervals

Measures	Operating period intervals	Intervals
Initial inspection	After 500 operating hours	After 1/2 year at the latest
Relubrication (optional)	See the lubricant plate	
Clean	Depending on the degree of pollution	
Main inspection	Approximately every 16000 operating hours	After two years at the latest
Drain condensate	Depending on the climatic conditions	

9.4.2 Re-greasing

For machines with regreasing system, relubrication intervals, grease quantity and grease grade are provided on the lubricant plate. Additional data can be taken from the main machine rating plate.
Grade of grease for standard motors (IP55) UNIREX N3 - ESSO.

Note

It is not permissible to mix different types of grease.

Prolonged storage periods reduce the useful lifetime of the bearing grease. Check the condition of the grease if the equipment has been in storage for more than 12 months. If the grease is found to have lost oil content or to be contaminated, the machine must be immediately relubricated before commissioning. For information on permanently-greased bearings, please refer to the section titled Storage (Page 111).

Procedure

To relubricate the roller bearings, proceed as follows:

1. Clean the grease nipples at the drive end and non-drive end.
2. Press-in the specified grease and amount of grease according to the data stamped on the lubrication plate.
   - Please observe the information on the rating and lubricant plates.
   - Regreasing should be carried out when the motor is running (max. 3600 rpm).

The bearing temperature can rise significantly at first, and then drops to the normal value again when the excess grease is displaced out of the bearing.

9.4.3 Cleaning

Cleaning the grease ducts and spent grease chambers

The spent grease collects outside each bearing in the spent grease chamber of the outer bearing cap. When replacing bearings, remove the spent grease.

Note

Dismantle the bearing cartridges to replace the grease in the lubrication duct.

Cleaning the cooling air ducts

Regularly clean the cooling air ducts through which the ambient air flows.
The frequency of the cleaning intervals depends on the local degree of fouling.

NOTICE

Damage to the machine

Material damage can occur if you direct compressed air in the direction of the shaft outlet or machine openings.

- Avoid pointing compressed air directly onto shaft sealing rings or labyrinth seals of the machine.

Note

Please note the safety instructions for cleaning (Page 95).

9.4.4 Cleaning machines with cover for the textile industry

In the case of machines with fan covers for the textile industry, regularly remove fluff balls, fabric remnants, and similar types of contamination (particularly at the air passage opening between the fan cover and cooling fins of the machine enclosure) to ensure that the cooling air can flow without obstruction.

9.4.5 Drain condensate

If there are condensation drain holes present, open these at regular intervals, depending on climatic conditions.

⚠ WARNING

Hazardous voltage

The winding can be damaged if objects are introduced into the condensation holes (optional). This can lead to death, serious injury or material damage.

Note the following to maintain the degree of protection:

- Switch off the machine so that it is in a no-voltage condition before you open the condensation drain holes.
- Close the condensation drain holes, e.g. using T-plugs, before commissioning the machine.

NOTICE

Reduction of the degree of protection

If condensation drain holes are not closed, then this can result in material damage to the motor.
In order to maintain the degree of protection, after the condensation has been drained, you must close all of the drain holes.

9.5 Corrective maintenance

When carrying out any work on the machine, observe the general safety instructions (Page 13) and the specifications contained in EN 50110-1 regarding safe operation of electrical equipment.

Comply with the IEC / EN 60079-17 standard during all service and maintenance work on the machine.

⚠WARNING

Explosion hazard when carrying out repair work

Repairs are only permissible within the scope of the work described in these operating instructions. Otherwise an explosion can occur in an explosive atmosphere. This can result in death, serious injury or material damage.

For repairs to go beyond this scope, please contact the Service Center.

⚠WARNING

Explosion hazard due to increased surface temperature

Components within the motor may be hotter than the maximum permissible surface temperature for the enclosure. In an explosive atmosphere, dust can ignite and an explosion occur. This can result in death, serious injury or material damage.

- Do not open the motor in an explosive and dusty atmosphere when it is still at normal operating temperature.
- Allow the machine to cool down before opening it.

9.5.1 Storage

Refer to the rating plate or the catalog for the designations of the bearings being used.

Bearing lifetime

Prolonged storage periods reduce the useful lifetime of the bearing grease. For permanently lubricated bearings, this reduces the bearing service life.
We recommend that the bearings or grease are replaced after a storage time of 12 months; if the time exceeds 4 years, replace the bearings or the grease.

Replacing bearings

Recommended interval after which bearings are to be replaced under normal operating conditions:

Table 9- 4 Bearing replacement intervals

Ambient temperature	Principle of operation	Bearing replacement intervals
40 °C	Horizontal coupling operation	40 000 h
40 °C	With axial and radial forces	20 000 h

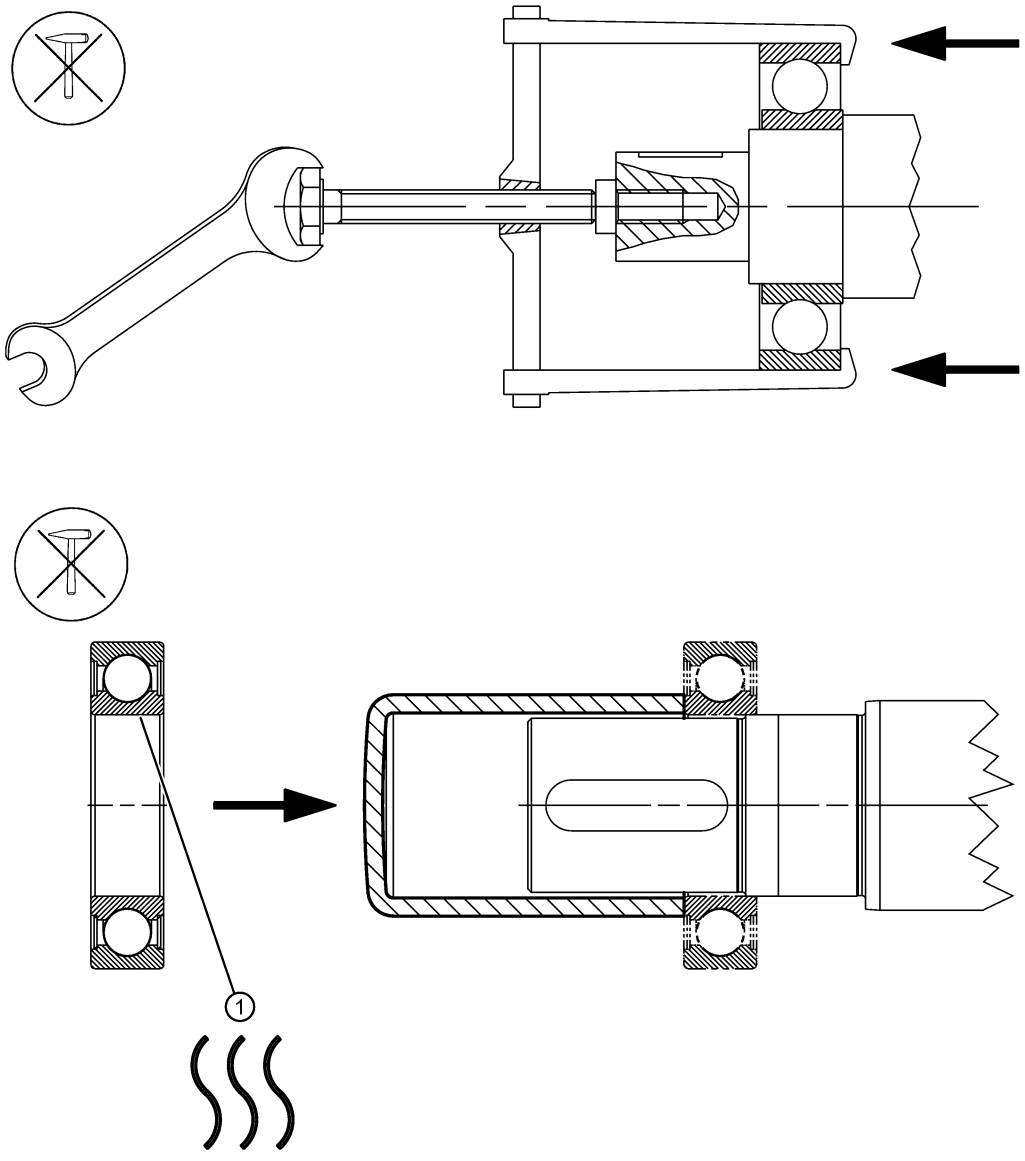
- Do not reuse bearings that have been removed.
- Remove the dirty spent grease from the bearing shield.
- Replace the existing grease with new grease.
- Replace the shaft seals when the bearings are replaced.
- Slightly grease the contact surfaces of the sealing lips.

Note

Special operating conditions

The operating hours are reduced, e.g.

- When machines are vertically mounted.
- High vibration and surge loads
- Frequent reversing operation
- Higher ambient temperatures.
- High speeds etc.



① Heat up 80 ... 100 °C

9.5.1.1 Replacing bearings in explosion-proof machines

- When changing the bearings, renew the sealing rings and only use original Siemens spare parts.
- For radial sealing rings with dust protection lip (DIN 3760-AS), completely fill the spaces (100%) in the sealing ring as well as in the bearing shield hub with a suitable grease.

9.5.2 Dismantling

Note

Before commencing removal, you should mark how each of the fastening elements has been assigned, as well as how internal connections are arranged. This simplifies subsequent reassembly.

Fan

NOTICE
Destruction of the fan
Material damage can occur by forcefully removing the fan from the shaft.
Take care not to damage the snapping mechanisms on fans that are equipped with these.

Plastic fan

- Correctly expose the breakout openings provided in the fan plate
- Heat up the fans to a temperature of approximately 50 °C around the area of the hub.
- Use a suitable tool to pull off the fan (puller).
- Locate the arms of the pulling tool in the the breakout openings and slightly tension the pressure screw of the tool.
- Simultaneously release the two snap-in lugs of the fan from the shaft groove
  Keep the snap-in lugs in this position.
- Uniformly withdraw the fan from the shaft by turning the pressure screw of the pulling tool.
- Do not apply any hammer blows to avoid damaging the rotor shaft, the fan and the bearings.
- Order the appropriate new parts if damaged.

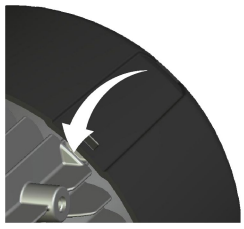
Metal fan

- Remove the locking ring.
- Use a suitable tool to pull off the fan (puller).
- Locate the arms of the pulling tool in the openings in the fan in the vicinity of the hub.
- Alternatively, the pulling tool can be placed at the outer edge of the fan plate.
- Uniformly withdraw the fan from the shaft by turning the pressure screw of the pulling tool.
- Do not apply any hammer blows to avoid damaging the rotor shaft, the fan and the bearings.
- Order the appropriate new parts if damaged.

Plastic fan cover

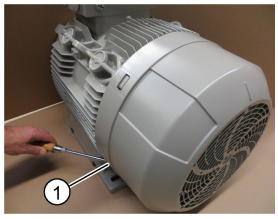
Frame size FS80 ... FS160

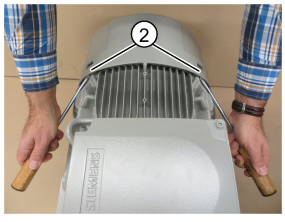
1. Carefully release the snap openings of the cover one after the other from the lugs.
2. Do not insert the lever directly under the lug, as otherwise it could break.
3. Take care to not damage the catch mechanism. Order the appropriate new parts if damaged.



Frame size FS180 ... FS200

1. Carefully release the first snap opening of the cover.
2. For machines with type construction B3, select the snap opening in the area of the machine mounting feet.
3. Insert the lever at the edge of the cover close to the lug.
4. Carefully release two other snap openings together and then withdraw the cover.
5. Take care to not damage the catch mechanism. Order the appropriate new parts if damaged.





Protective cover

Canopies with spacer bolts or with bolted holding brackets

NOTICE
Destruction of the mounting elements Forcibly removing or separating can destroy the distance bolts, the connecting elements of the mounting bracket or the fan cover. 1. Release the fixing screw on the outer surface of the canopy. 2. Under no circumstances remove the spacer bolts or the mounting bracket – or forcibly separate them from one another or the cover.

Canopies with welded support brackets

1. Release the fixing screws at the contact location (canopy foot - riveting nut) at the outer surface of the cover mesh.

9.5.2.1 Bearing bushes

Protect the bearings against the ingress of dirt and moisture.

9.5.2.2 Links

1. Replace any corroded screws.
2. Take care not to damage the insulation of live parts.
3. Document the position of any rating and supplementary plates that have been removed.
4. Avoid damaging the centering edges.

9.5.3 Assembly

If possible, assemble the machine on and alignment plate. This ensures that the mounting feet surfaces are all on the same plane.
Avoid damaging the windings protruding out of the stator enclosure when fitting the end shield.

Sealing measures

1. Apply Fluid-D to the centering edge.
2. Check the terminal box seals, and if required, replace these.
3. Repair any damage to the paint, also to screws/bolts.
4. Take the necessary measures to ensure compliance with the applicable degree of protection.
5. Do not forget the foam rubber cover in the cable entry. Completely seal the holes, and ensure that cables do not come into contact with sharp edges.

See also

Terminal boxes, end shields, grounding conductors, sheet metal fan covers (Page 120)

9.5.3.1 Fitting the bearing cartridges

When fitting the bearing cartridges, observe the specified screw tightening torques (Page 120).

9.5.3.2 Fitting bearings

Sealing the bearings

Note the following details:

- Shaft sealing rings are used to seal machines at the rotor shaft.
  - For V rings, comply with the assembly dimension.
- Use the specified bearings.
- Ensure that the bearing sealing disks are in the correct position.
- Insert the elements for bearing preloading at the correct end.
- Fixed bearings can have a locking ring or bearing cover.
- Seal the bearing cap screws with the appropriate gaskets or with grease.
- Do not interchange the position of the bearing covers (DE and NDE or inner and outer).

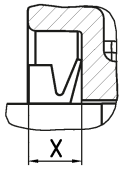
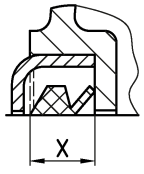
Bearing seals for explosion-protected machines

Note

Bearing seals for explosion-protected machines

For explosion-protected machines, only use the original replacement and repair parts.

Mounting dimension "x" of V rings

Motor types	Frame size	X [mm]	
All	71	4.5 ±0.6	**Standard design**  **Special design** 
	80 ... 112	6 ±0.8	
	132 ... 160	7 ±1	
1LA 1MA6	180 ... 200		
1FP1	180 ... 200	11 ±1	
1LG 1MA622 1LE 1MB1	180 ... 225	11 ±1	
1LG 1MA6 1LE 1MB1	250 ... 315	13.5 ±1.2	

9.5.3.3 Mounting fans

- Take care not to damage the snapping mechanisms on fans that are equipped with these.
- To ensure this, the fans should be heated to a temperature of approximately 50 °C around the area of the hub.
- If any damage is caused, request new parts.

9.5.3.4 Mounting the fan cover

⚠ CAUTION

Incorrectly mounting covers with snap mechanism

Avoid injury caused by touching the rotating fan or material damage caused by partial or complete release of the cover while the machine is operational.

- Carefully ensure that all four snap openings of the cover completely engage in the associated snap-in lugs.

Plastic fan hub FS 80 ... 200

- Align the cover with the line marked on the edge of the cover with the middle enclosure rib as extension to the terminal box base.
- Center the cover by axially moving on the snap-in lugs of the enclosure or the bearing shield cams.
- First engage two snap openings positioned next to one other, then carefully press the cover into position with the two openings situated opposite these using the snap-in lugs, and snap it into place.
- Attach the cover using all four of its snap-in lugs by applying axial pressure to the reinforced edge of the cover in the area of the cover mesh.
- If required, use a rubber hammer and apply it once or several times to the edge of the cover in the axial direction. When doing this, take care not to damage or destroyed the mesh of the cover.
- When fitting the cover, do not overextend it (you could break it).

9.5.3.5 Canopy; mounting a rotary pulse encoder under the canopy

Canopy; incremental encoder under the canopy

Guide the fixing screws through the holes on the external surface of the canopy and tighten to a torque of 3 Nm ±10%.

9.5.3.6 Reassembly: Miscellaneous information

- Position all rating and supplementary plates as in the original state.
- Where relevant, fix electric cables.
- Check the tightening torques of all screws, as well as those of screws that have not been released.

9.5.4 Screw lock washers

Nuts or bolts that are mounted together with locking, resilient and/or force-distributing elements (e.g., safety plates, spring-lock washers, etc.) must be refitted together with identical, fully functional elements.
Locking and sealing elements must always be replaced!

9.5.5 Electrical connections - Termincal board connections

Table 9- 5 Tightening torques for electrical connections on the terminal board

	Thread ∅		M 3,5	M 4	M 5	M 6	M 8	M 10	M 12	M 16
	Nm	min	0,8	0,8	1,8	2,7	5,5	9	14	27
		Max.	1,2	1,2	2,5	4	8	13	20	40

9.5.6 Cable glands

Note

Avoid damaging the cable jacket.

Adapt the tightening torques to the cable jacket materials.

You should refer to the table in order to find the correct tightening torque for any metal and plastic cable glands that are to be mounted directly on the machine, as well as for any other screw-type connections (such as adapters).

Table 9- 6 Tightening torques for cable glands

	Metal ± 10% [Nm]	Plastic ± 10% [Nm]	Clamping range [mm]		O ring Cord dia. [mm]
			Standard -30 °C ... 100 °C Ex -30 °C ... 90 °C	Ex -60 °C ... 90 °C	
M 12 x 1.5	8	1.5	3.0 ... 7.0	-	2
M 16 x 1.5	10	2	4.5 ... 10.0	6.0 ... 10.0	
M 20 x 1.5	12	4	7.0 ... 13.0	6.0 ... 12.0	
M 25 x 1.5			9.0 ... 17.0	10.0 ... 16.0	
M 32 x 1.5	18	6	11.0 ... 21.0	13.0 ... 20.0	
M 40 x 1.5			19.0 ... 28.0	20.0 ... 26.0	
M 50 x 1.5	20		26.0 ... 35.0	25.0 ... 31.0	
M 63 x 1.5			34.0 ... 45.0	-	

All cable glands and blanking plugs must be implemented according to Directive 94/9/EC up to April 19, 2016 - or from April 20, 2016, Directive 2014/34/EU. They must also be certified for use in hazardous zones.

- Any openings that are not being used must be sealed using the appropriate certified blanking plugs.
- Please observe the manufacturer's specifications when fitting cable glands.

9.5.7 Terminal boxes, end shields, grounding conductors, sheet metal fan covers

If no other tightening torques are specified, then the values in the following table apply.

Table 9- 7 Tightening torques for screws on the terminal box, end shields, screw-type grounding conductor connections

	**Thread ∅**		**M 3.5**	**M 4**	**M 5**	**M 6**	**M 8**	**M 10**	**M 12**	**M 16**	**M20**
	Nm	min	0.8	2	3.5	6	16	28	46	110	225
		max	1.2	3	5	9	24	42	70	165	340

Table 9- 8 Tightening torques for self-tapping screws on the terminal box, end shields, screw-type grounding conductor connections, sheet metal fan covers

	**Thread ∅**		**M 4**	**M 5**	**M 6**
	Nm	min	4	7,5	12,5
		max	5	9,5	15,5

9.5.8 Optional add-on units

See the list of additional operating instructions: Service & support (Page 145)

Table 9- 9 Assigning standard brakes for 1LE1 machines

Frame size (BG)	Brake type	Size assignment of the brakes	Tightening torque of manual lifting lever Nm
80	2LM8 010–3NA10 1)	08	2.8
90	2LM8 020–4NA10 1)	10	4.8
100	2LM8 040–5NA10 1)	12	4.8
112	2LM8 060–6NA10 1)	14	12
132	2LM8 100–7NA10 1)	16	12
160	2LM8 260–8NA10 1)	20	23
180	2LM8 315–0NA10 1)	20	23
200	2LM8 400–0NA10 1)	25	40
225	2LM8 400–0NA10 1)	25	40
250	KFB 63 2)	63	40
280	KFB 100 2)	100	40
315	KFB 160 2)	160	40

1) INTORQ Corp.

2) PINTSCH BUBENZER Corp.

Tightening torque applied to the fastening screws used for attaching external fans to the housing, see Terminal boxes, end shields, grounding conductors, sheet metal fan covers (Page 77)

Spare parts 10

10.1 Parts order

In addition to the exact part designation, please specify the machine type and the serial number in all orders for spare parts and repair parts. The part designation must be identical to the designation stated in the list of parts and specified together with the appropriate part number.

When spare and repair parts are ordered, the following details must be provided:

- Designation and part number
- Order number and serial number of the machine

Spare parts information and database
Using the Siemens order number and the associated serial number, you can download spare parts information from a database for almost all current motors → Spares On Web (https://b2b-extern.automation.siemens.com/spares_on_web)

10.2 Parts groups definition

The following parts groups are differentiated:

Spare parts
Spare parts are machine parts that can be ordered during the production time and for a further five years after discontinuation of production. These parts should be replaced only by authorized service or modification partners.

Repair parts
Repair parts are machine parts that can be supplied during the active production of the machine (until the product discontinuation).
Repair parts are parts used for the repair or modification of the current products. These parts should be replaced only by authorized service or modification partners.

Standardized parts
Standardized parts are machine parts obtained from free trade outlets in accordance with their necessary dimensions, materials and surface finish. A detailed list can be found in the "Standardized parts" section.

Other parts
Other parts are small parts required to complete the exploded drawing. They cannot, however, be supplied as individual spare or repair parts. The delivery in assembly units (e.g. complete terminal box) is possible on request.

The following supply commitment apply to replacement machines and spare parts following delivery of the motor:

- For up to five years, in the event of total machine failure, Siemens will supply a comparable machine with regard to the mounting dimensions and functions.
- Spare parts will be available for up to five years.
- After the time period of up to five years, Siemens provides information about spare parts and will supply documents when required.
- Spare machine deliveries after the active production of the machine series are also identified as "Spare motor" on the nameplate. Spare parts are offered only on request for these machines.

10.3 Ordering example

Table 10- 1 Ordering example

End shield, drive end	1.40 End shield
Machine type *	1LA7163-4AA60
Ident: No. *	E0705/1234567 01 001

* corresponding to the rating plate

Table 10- 2 Ordering example

End shield, drive end	1.40 End shield
Machine type *	1LE1002-1DB43-4AA0
Ident: No. *	E0605/0496382 02 001

* corresponding to the rating plate

Take the type and serial number from the rating plate and the machine documentation. When replacing rolling-contact bearings, in addition to the bearing identification code, the replacement code for the bearing version is required. Both of these codes are specified on the rating plate and in the machine documentation. They are also shown on the installed bearings.

The graphical representations in this chapter show schematic diagrams of the basic versions. They are used for spare part definitions. The supplied version may differ in details from these representations.

10.4 Machine parts

Part	Description	Part	Description
1.00	**DE bearings**		**Terminal box, complete**
1.30	Bolt	5.30	Rubber stopper (1MA618.-20.)
1.31	Spring lock washer according to SN 60727	5.31	Terminal clamp (1MA618.-20.)
1.32	Bolt	5.32	Angle (1MA618.-20.)
1.33	Nut	5.33	Washer (1MA618.-20.)
1.40	End shield	5.36	Spring lock washer according to SN 60727
1.43	Shaft sealing ring	5.37	Spring lock washer according to SN 60727
1.44	Bearing cover	5.42	Terminal box housing, including seal
1.45	Bolt	5.43	Entry plate
1.46	Cover ring	5.44	Terminal box top side
1.47	O ring	5.45	Enclosure
1.48	Self-tapping screw	5.46	Bolt
1.49	Bolt	5.47	Bolt
1.50	Flanged nut	5.48	Spring lock washer according to SN 60727
1.56	Spacer washer	5.49	Self-tapping screw
1.58	Spring washer	5.51	Nut
1.60	Roller bearing	5.52	Cable gland
1.61	Spring band for end shield hub	5.53	Sealing plug
1.62	1LG sealing plug	5.54	O ring
1.63	T plugs 1LE + 1FP, cast iron 100..315	5.55	Nut
1.64	DE bearing cover, inner	5.60	Connecting terminal plate screw
1.65	Grease nipple	5.61	Bolt
1.67	Outer bearing cover	5.62	Spring lock washer according to SN 60727
1.68	Grease slinger (optional)	5.63	Mounting rail
1.69	Compression spring	5.64	Spring washer
3.00	**Rotor, complete**	5.65	Bolt
3.02	Locking ring	5.68	O ring
3.38	Featherkey	5.69	Sealing plug
3.88	Featherkey for fan	5.70	Terminal clamp
4.00	**Stator, complete**	5.72	Contact bracket
4.04	Eyebolt	5.76	Terminal plate / contact bracket
4.05	Disk	5.78	Spring lock washer according to SN 60727
4.07	Housing foot	5.79	Bolt
4.08	Housing foot, left	5.80	Self-tapping screw 1LE + 1FP
4.09	Housing foot, right	5.81	Self-tapping screw
4.10	Spring lock washer according to SN 60727	5.82	O ring
4.11	Bolt	5.83	Seal
4.12	Nut	5.84	Terminal box cover
4.14	Nut	5.85	Terminal box cover including seal (optional screw)
4.18	Rating plate	5.86	Protection mark
4.19	Self-tapping screw	5.87	Bolt
4.20	Cover	5.88	Spring lock washer according to SN 60727

Part	Description	Part	Description
4.30	Contact bracket	5.89	Bolt
4.31	Grounding bracket	5.90	The top side of the terminal box can be rotated 4 x 90 degrees, complete (for subsequent mounting)
4.35	Disk	5.91	Bolt
4.37	Terminal board	5.92	Terminal box cover
4.38	Spring lock washer according to SN 60727	5.93	Seal
4.39	Grounding screw (self-tapping screw)	5.94	Bolt
4.40	Disk	5.95	Terminal box top side
4.41	Grounding lug	5.96	Sealing plug
5.00	**Terminal box, complete**	5.97	Nut
5.02	spacer	5.98	Metal-sheet nut
5.03	Seal	5.99	Adapter plate
5.04	Seal	**6.00**	**NDE bearings**
5.06	Mounting rail	6.02	Locking ring
5.08	Spacer sleeve	6.03	Bearing cover NDE, inner
5.09	Bolt	6.10	Roller bearing
5.10	Complete terminal board	6.11	Spring band for end shield hub
5.11	Terminal block	6.20	End shield
5.13	Link rail	6.23	Shaft sealing ring
5.14	Lower section of the terminal box	6.24	Bearing cover NDE, outer
5.15	Plug	6.25	Lubrication sleeve
5.16	Spring lock washer according to SN 60727	6.26	Cover
5.17	Bolt	6.27	Outer bearing cover
5.18	Spring lock washer according to SN 60727	6.28	Bolt
5.19	Self-tapping screw	6.29	Self-tapping screw
5.21	Screw (drilled)	6.30	Bearing cover NDE, inner
5.24	Bolt	6.31	Nut
5.25	Combination screw M3.5	6.45	Bolt
5.26	Set: Jumper plug Y, jumper plug Δ	6.64	Nut
5.27	Clamp	6.65	Grease nipple
5.28	High saddle terminal	6.67	Rubber bush
5.29	Lower saddle terminal	6.72	Grease slinger
		7.00	**Complete ventilation**
		7.04	Fan
		7.12	Locking ring
		7.19	Bolt
		7.40	Fan cover
		7.41	bracket
		7.47	Sleeve
		7.48	Spring lock washer according to SN 60727
		7.49	Bolt

Tools for mounting and withdrawing roller bearings; fans and output transmission elements cannot be supplied.

10.5 Standardized parts

Table 10- 3 Purchase standard parts according to dimensions, material and surface properties through normal commercial channels.

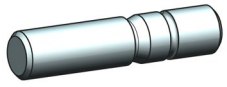
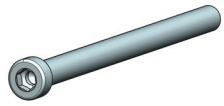
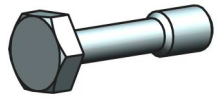
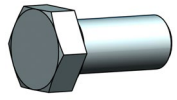
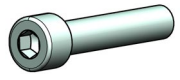
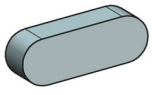
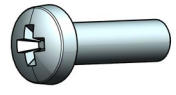
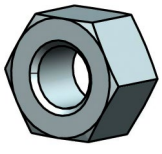
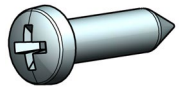
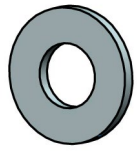
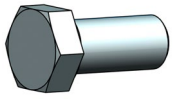
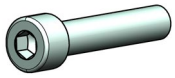
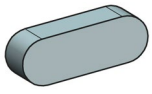
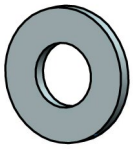
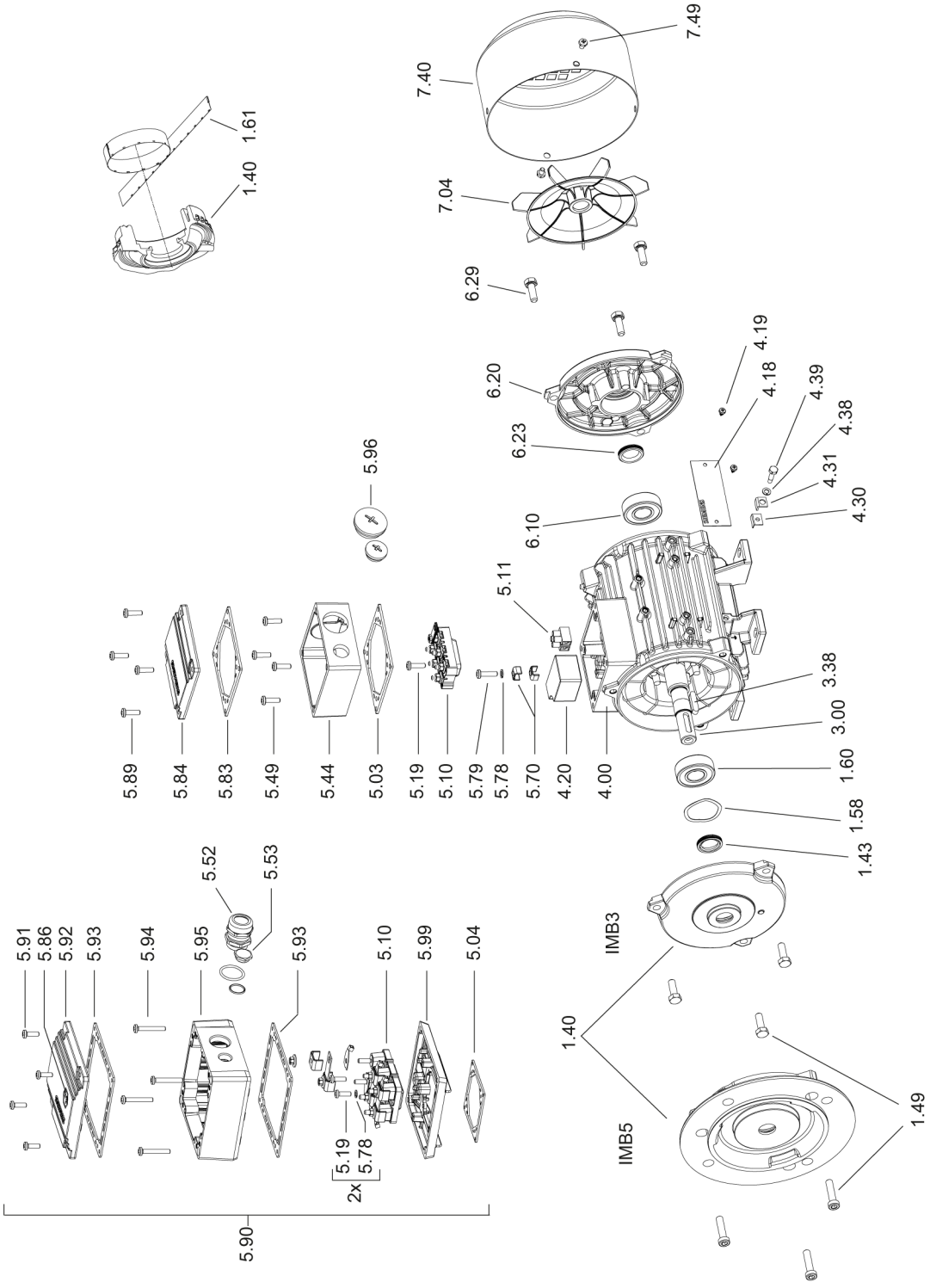
No	Standard	Picture	No	Standard	Picture
3.02 6.02 7.12	DIN 471		1.30 1.31 1.32 1.45 1.49 4.11 4.19 5.09 5.17 5.19 5.24 5.47 5.46 5.49 5.60 5.61 5.65 5.79 5.87 5.89 5.91 5.94 6.29 6.45 7.49	DIN 939	
	DIN 472			DIN 6912	
				DIN 7964	
4.04	DIN 580			EN ISO 4014	
	DIN 582			EN ISO 4017	
1.60 6.10	DIN 625			EN ISO 4762	
3.38	DIN 6885			EN ISO 7045	
1.33 1.50 4.12 4.14 5.55 6.30	EN ISO 4032			EN ISO 7049	
			4.05 7.48	EN ISO 7089 EN ISO 7090	

Table 10- 4 Purchase commercially available standard parts according to the dimensions, materials and surface.

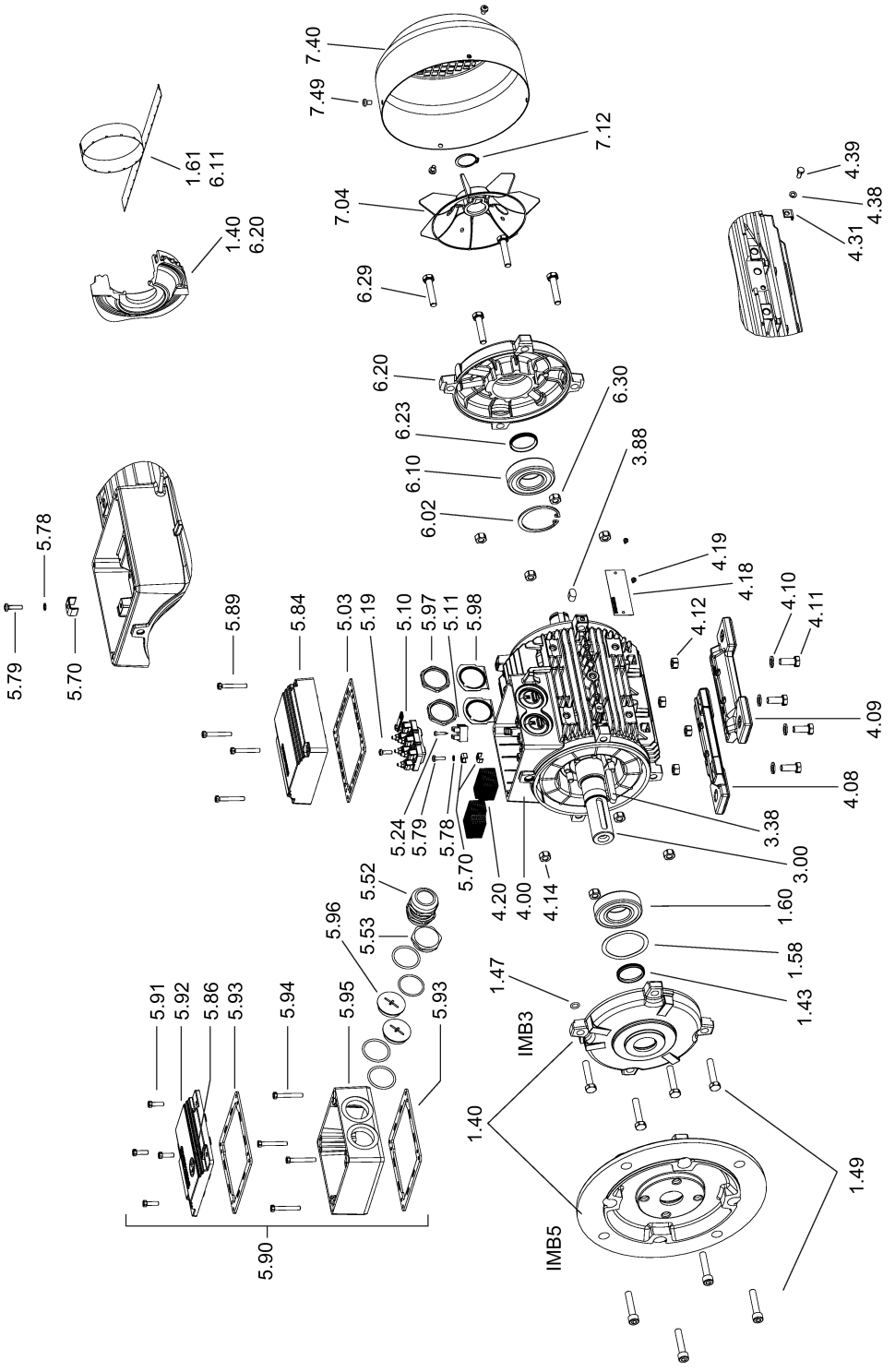
No	Standard	Picture	No	Standard	Picture
6.02	DIN 472 (FS 160)		1.49 (FS 132/160) 4.11 6.29 (FS 132/160)	EN ISO 4014	
				EN ISO 4017	
4.04	DIN 580			EN ISO 4762	
3.38	DIN 6885		4.05	EN ISO 7089 EN ISO 7090	

10.6 Exploded drawings

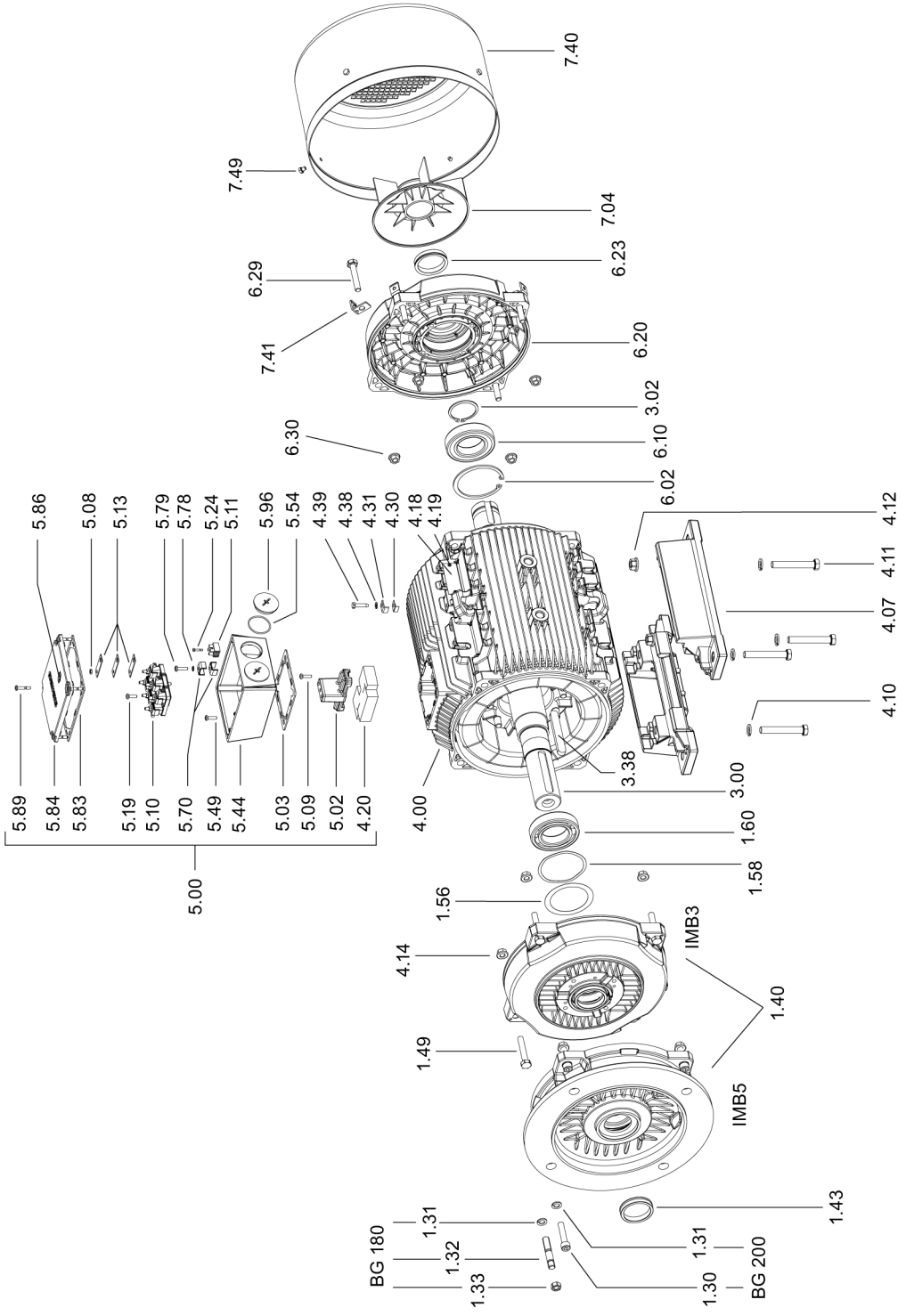
10.6.1 1LA,1LP,1MA,1MF,1PP6/7/9 FS 63 ... 90L



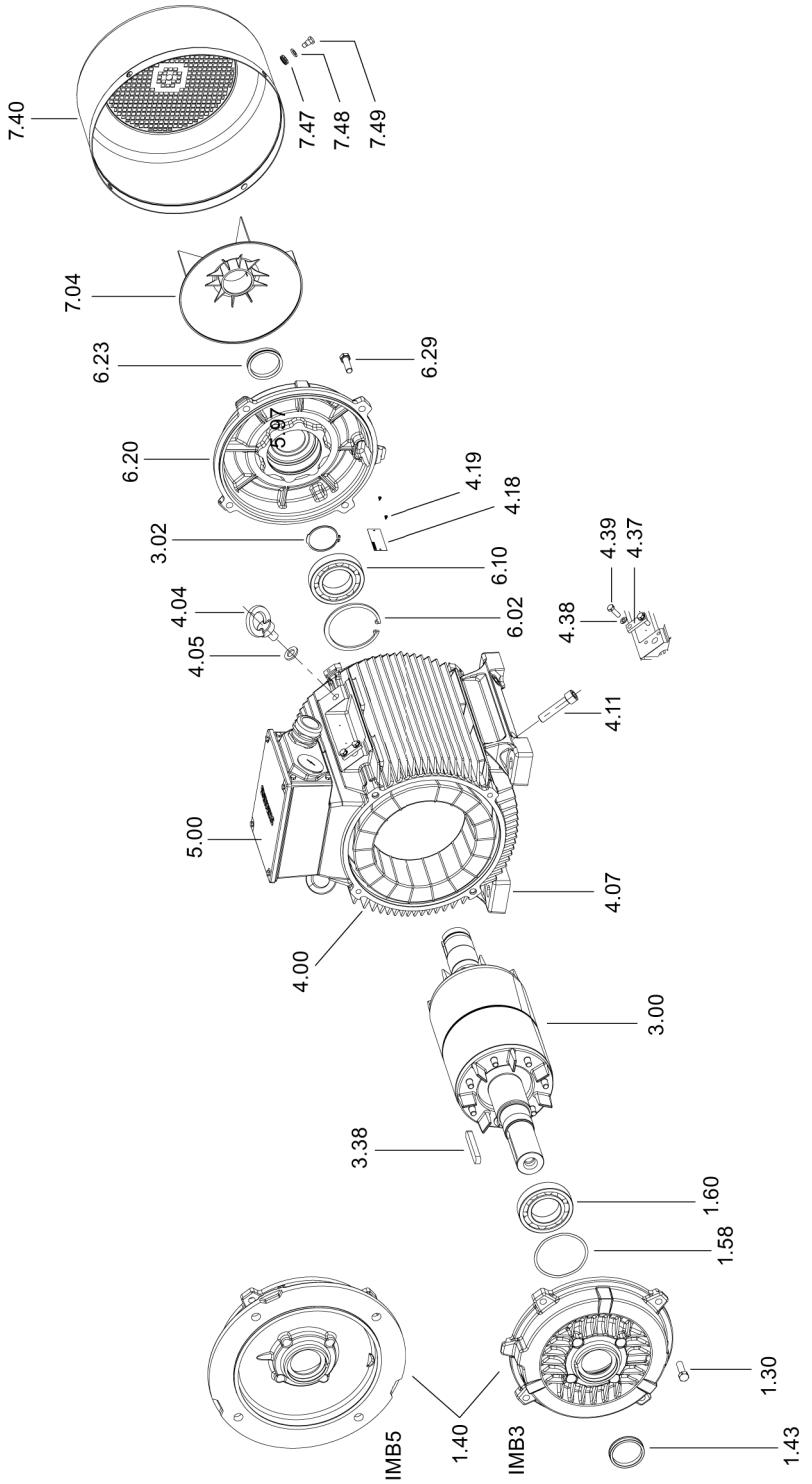
10.6.2 1LA,1LP,1MA,1MF,1PP6/7/9 FS 100 ... 160



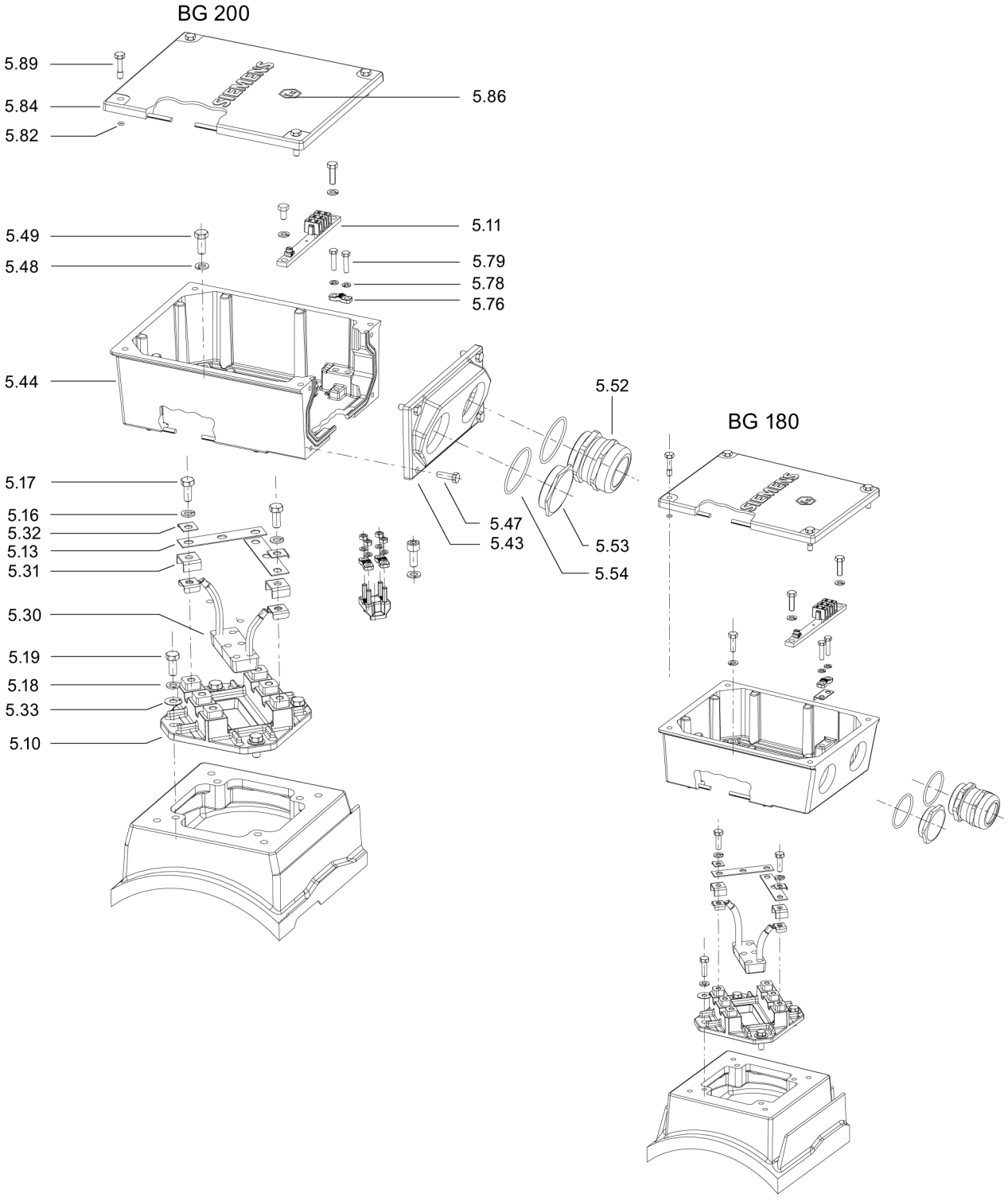
10.6.3 1LA5180 ... 225



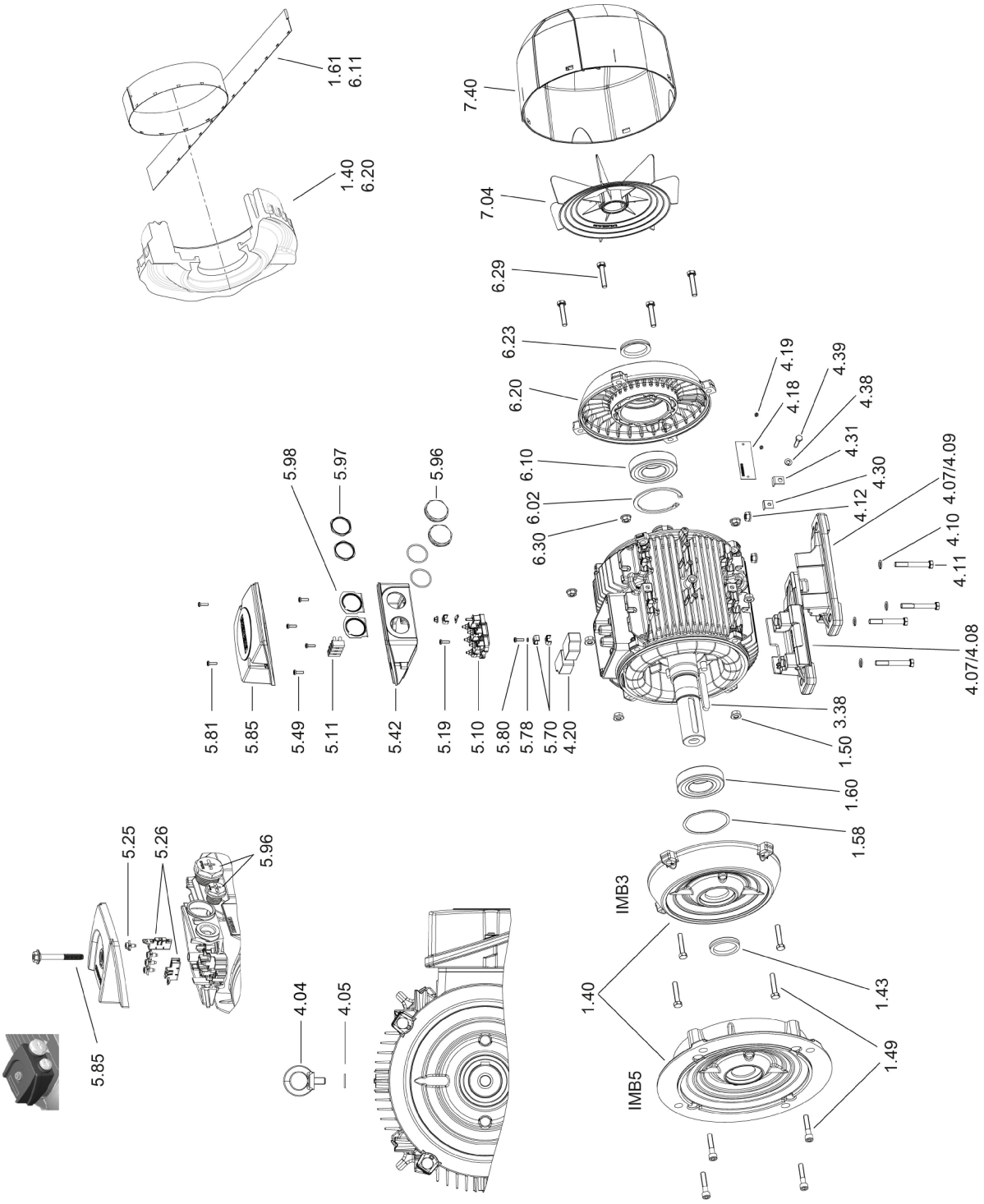
10.6.4 1MA6180 ... 200



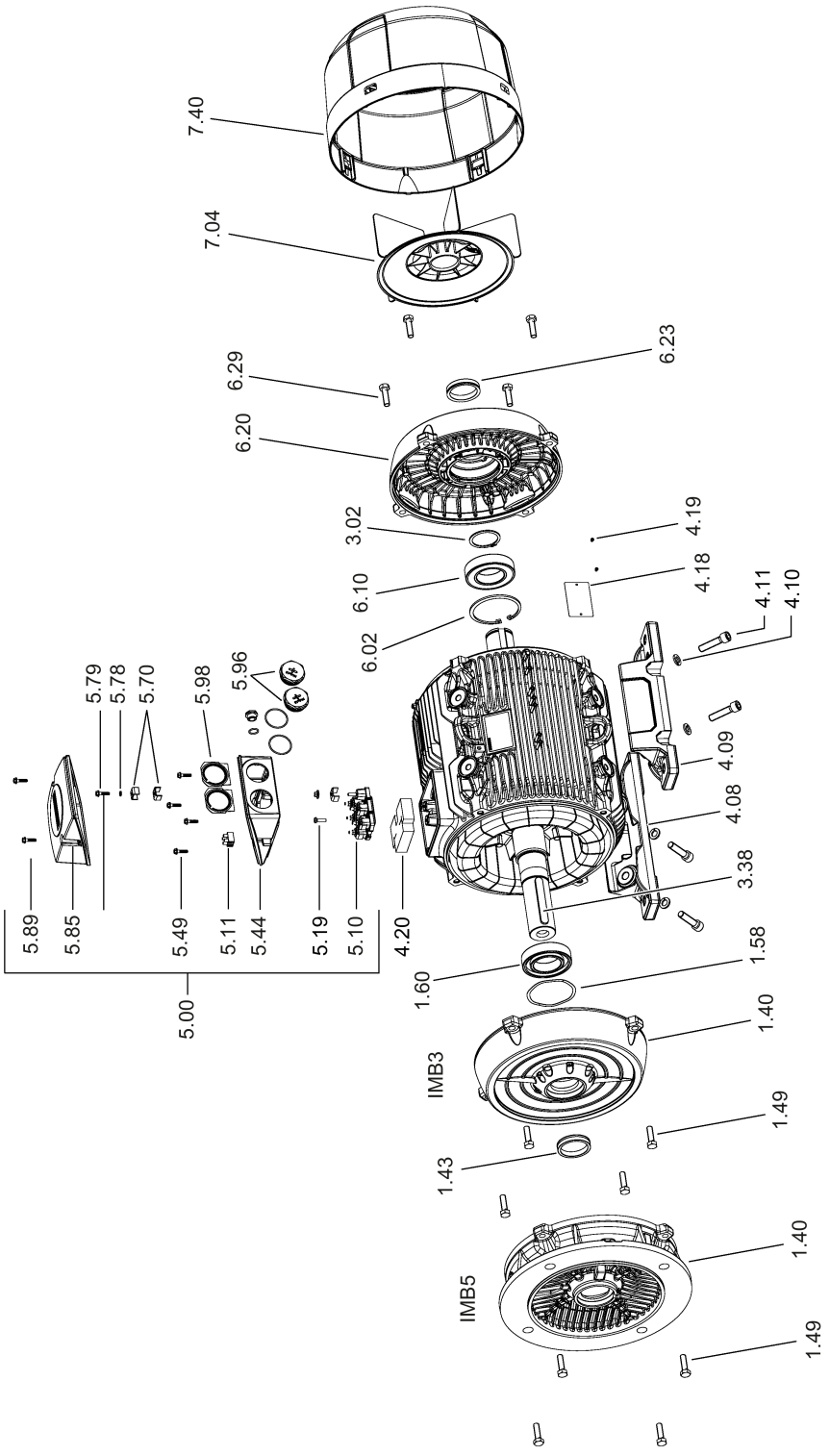
10.6.5 Terminal boxes 1MA6180 ... 200



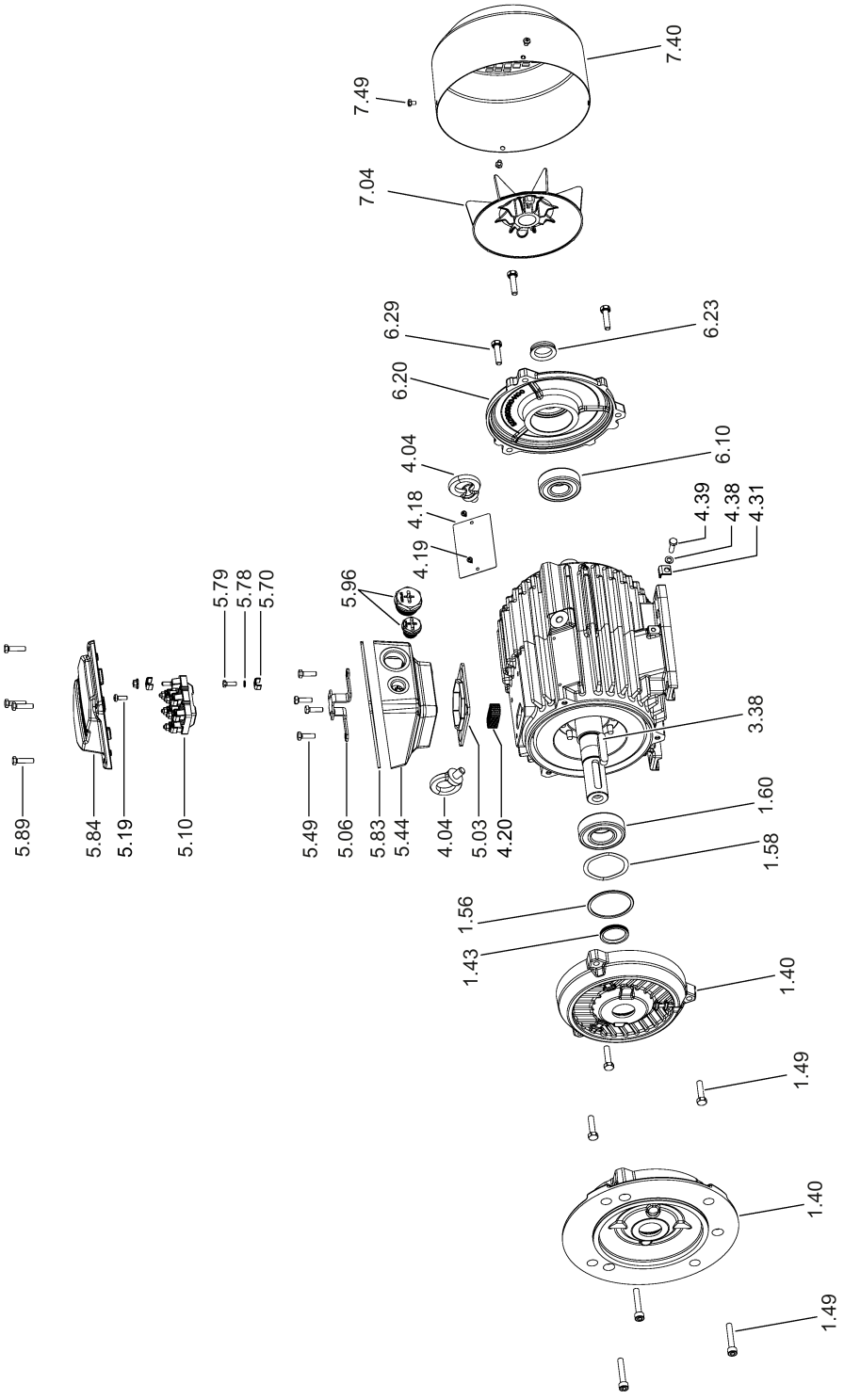
10.6.6 1LE1 / 1FP1 / 1MB1 FS 80 ... 160 aluminum



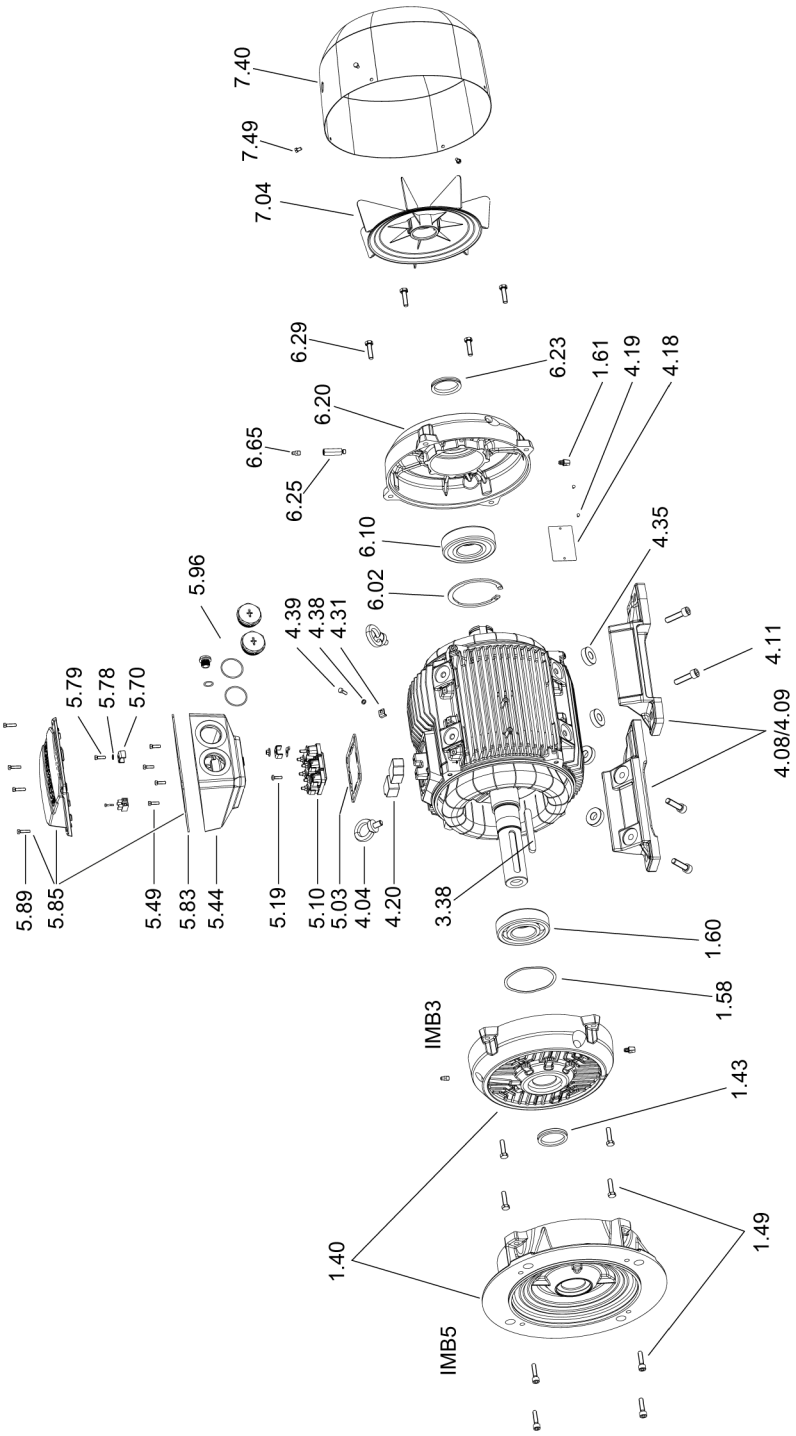
10.6.7 1LE1 FS 180 ... 200 aluminum



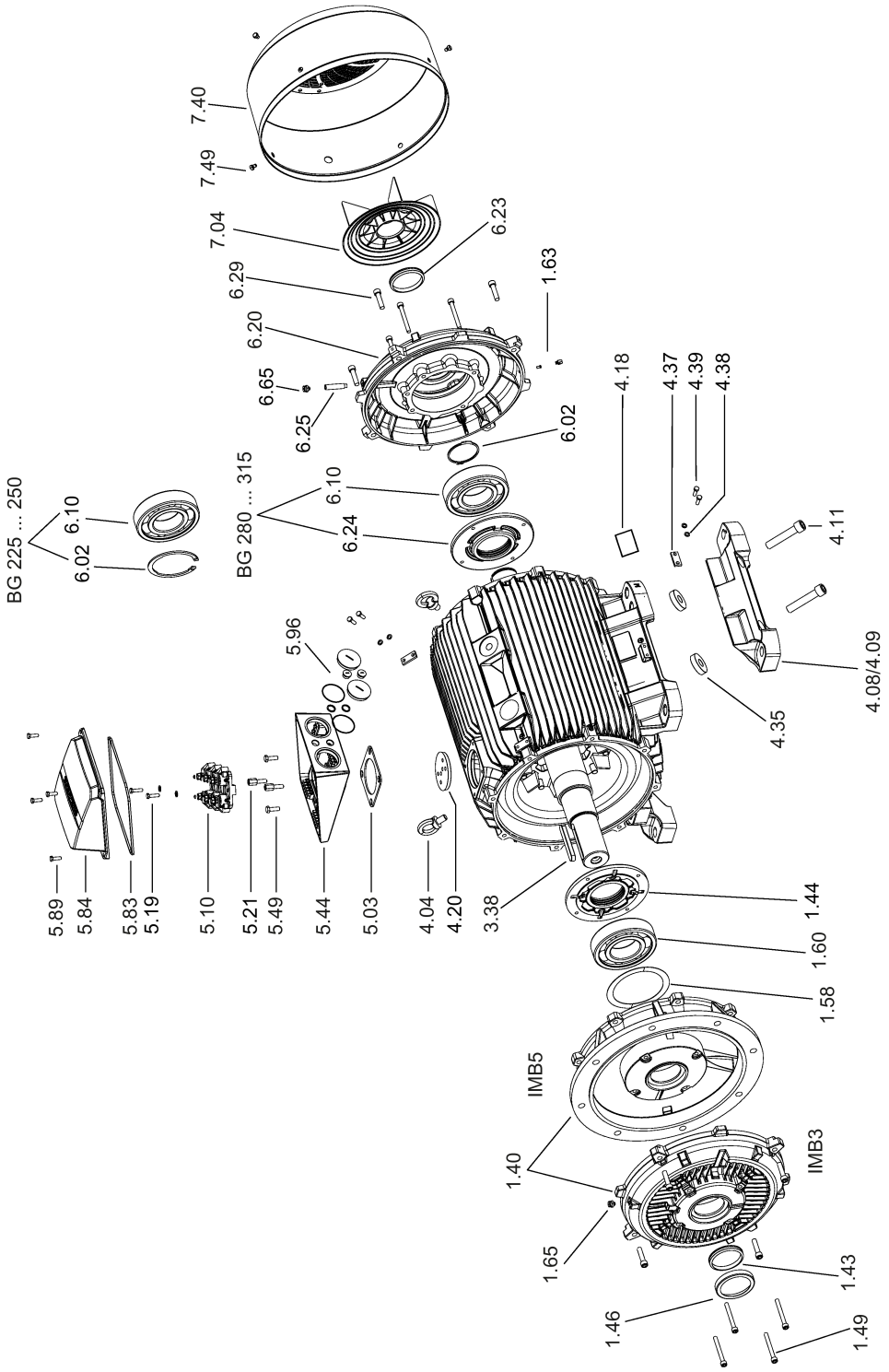
10.6.8 1LE1 / 1MB1 FS 71 ... 90 cast iron



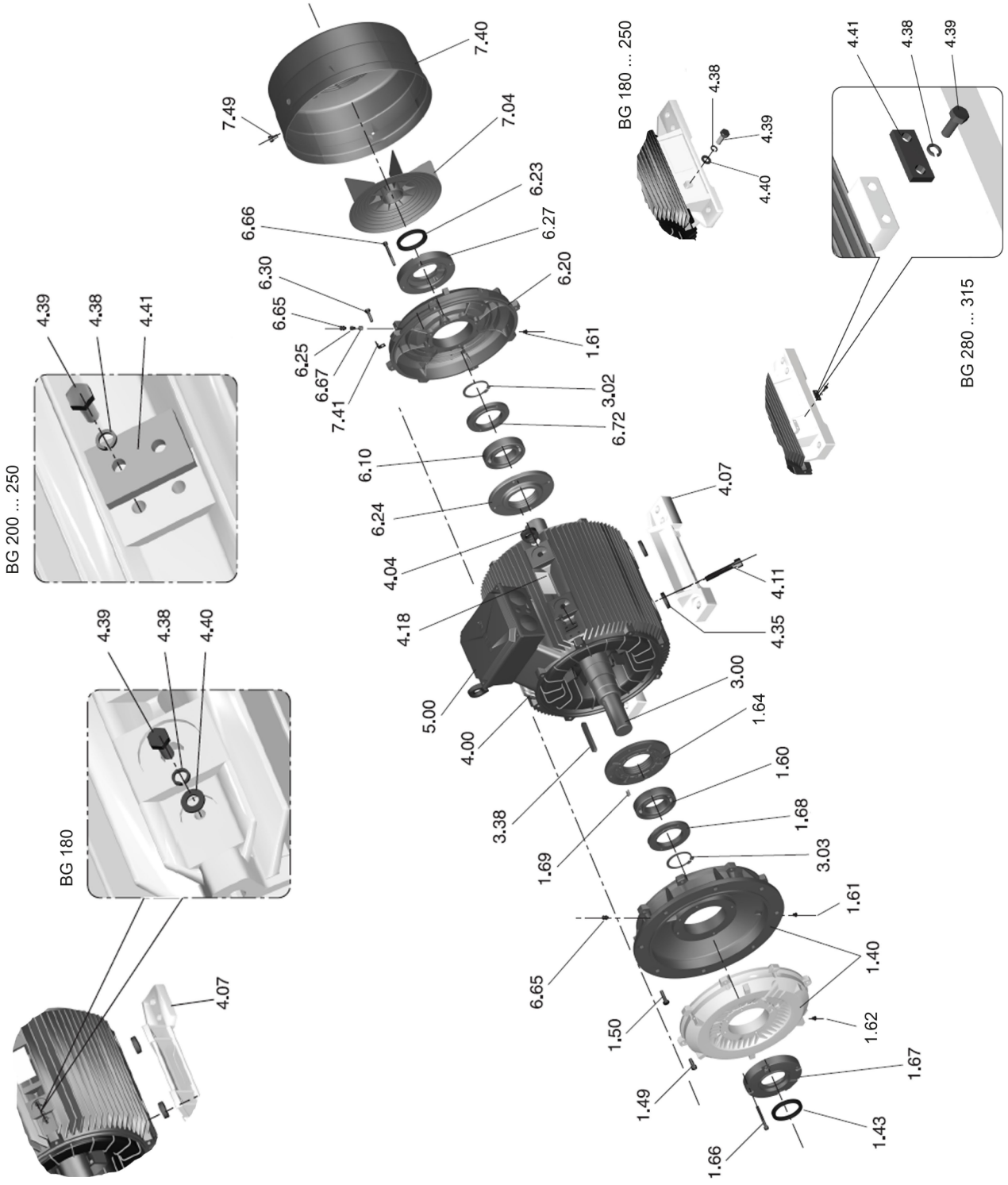
10.6.9 1LE1 / 1FP1 / 1MB1 FS 100 ... 200 cast iron



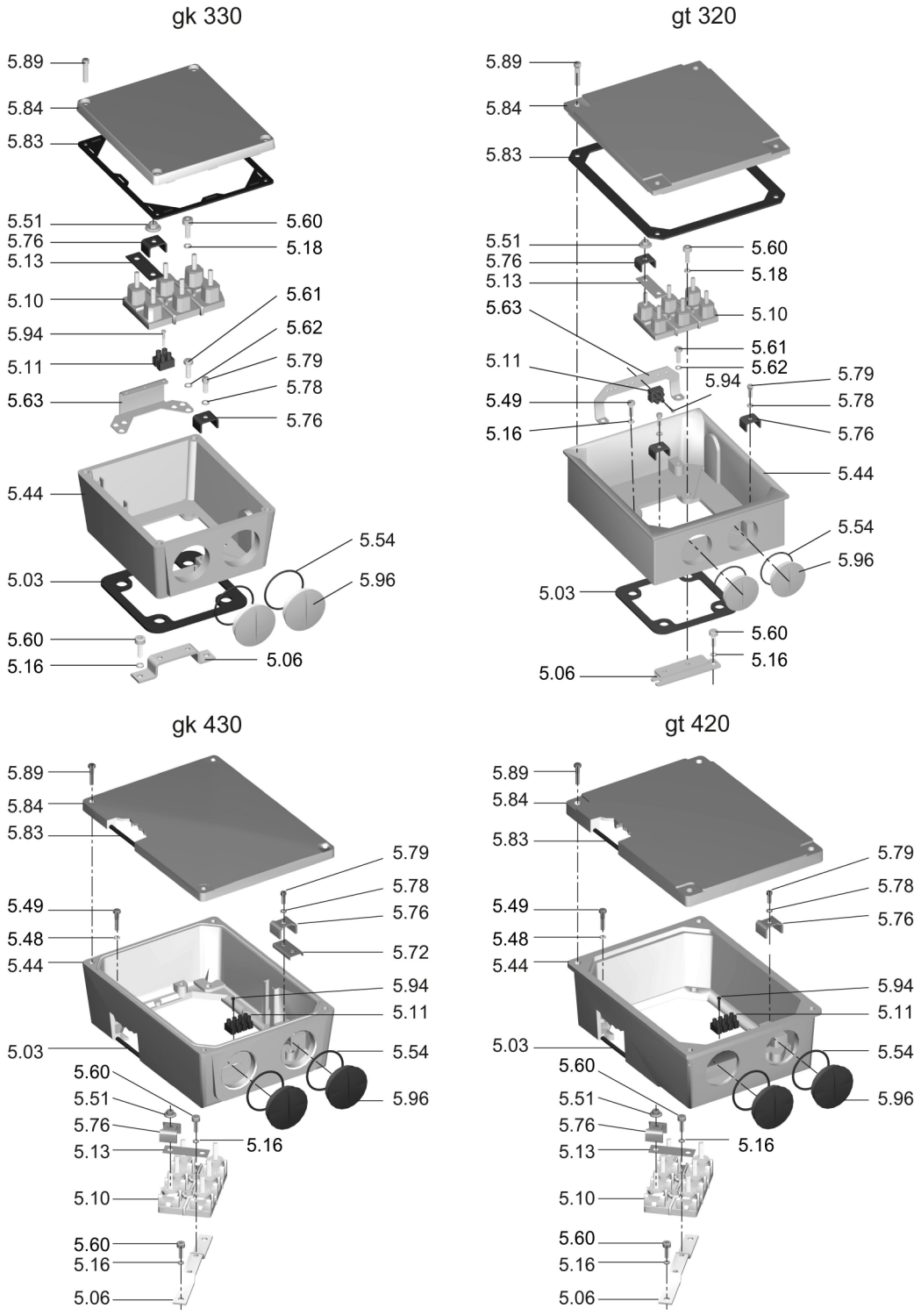
10.6.10 1LE1 / 1MB1 BG 225 ... 315 cast iron



10.6.11 1LG4/6 FS 180 ... 315

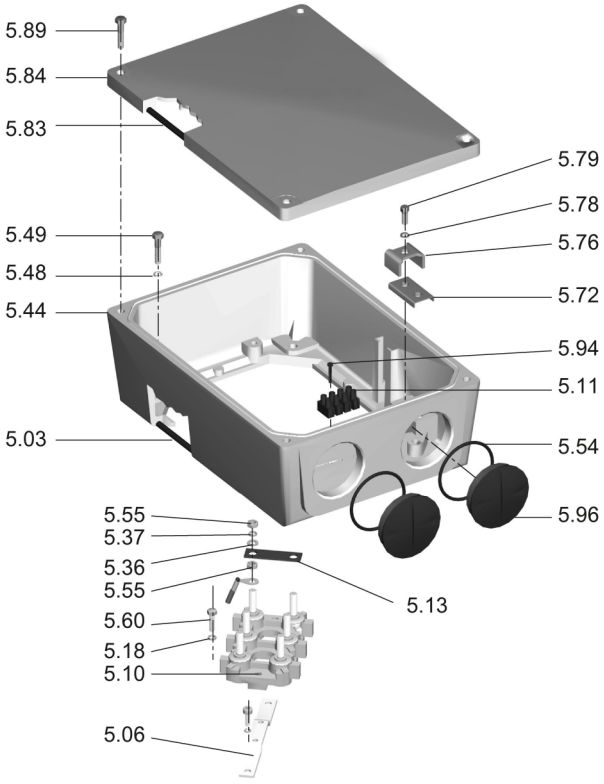


10.6.12 Terminal box gk330, gt320, gk430, gt420

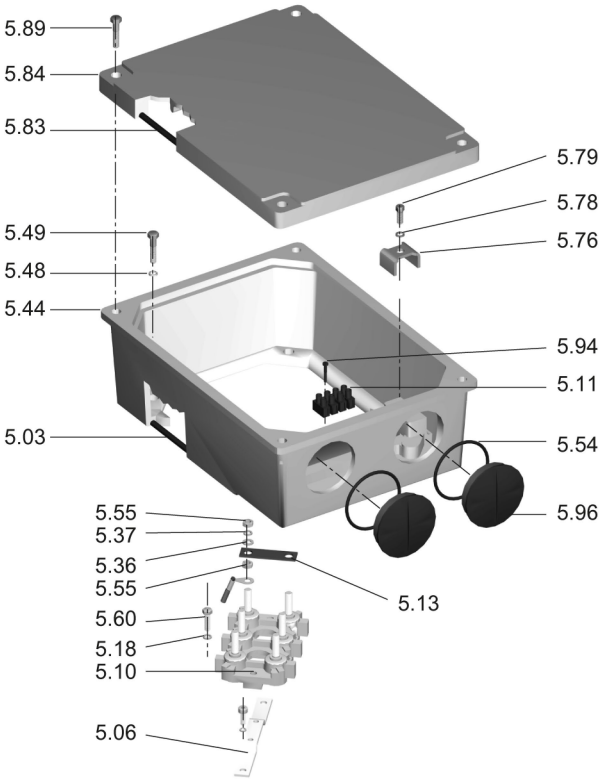


10.6.13 Terminal box gk431, gt421, gt520, gt540

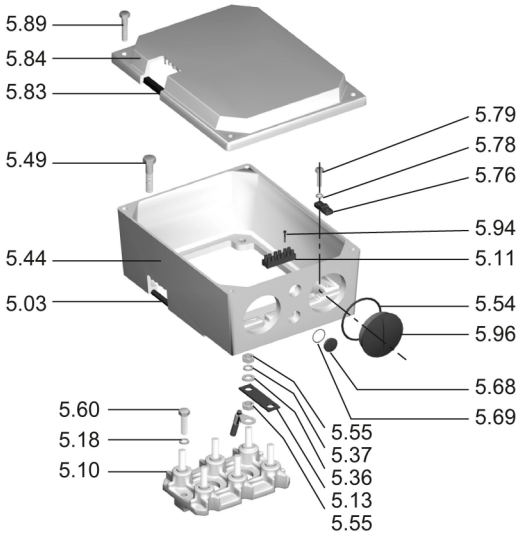
gt 431



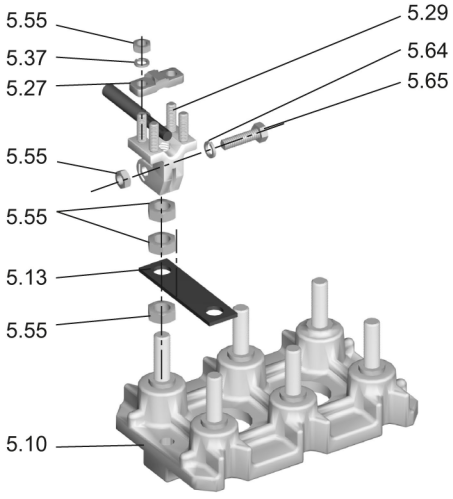
gt 421



gt 520

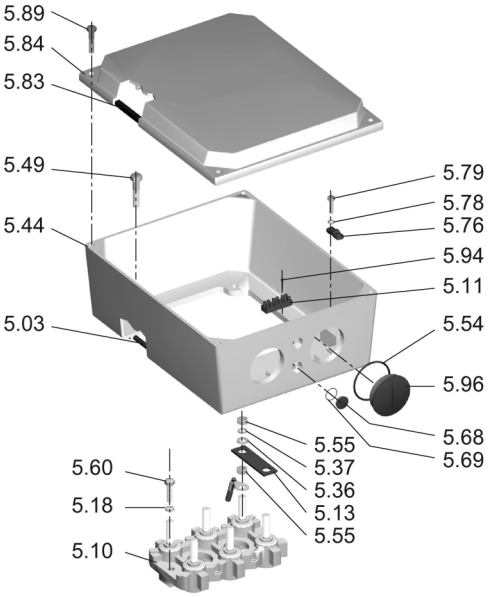


gt 540

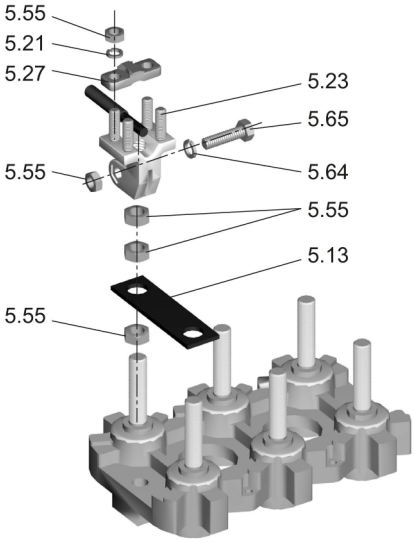


10.6.14 Terminal box 1LG4/6 gt620, gt640, gt791

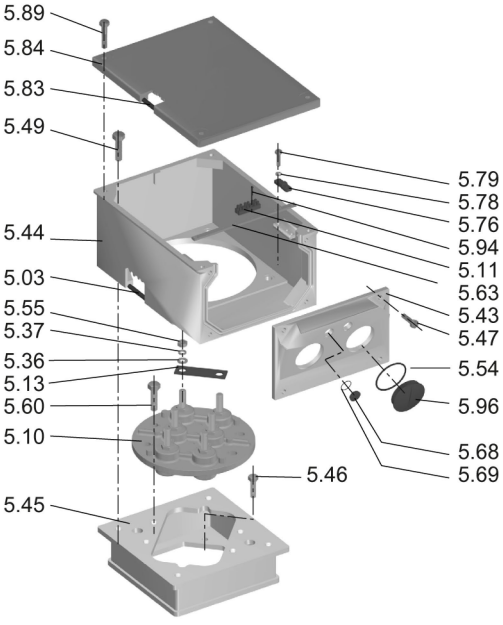
gt 620



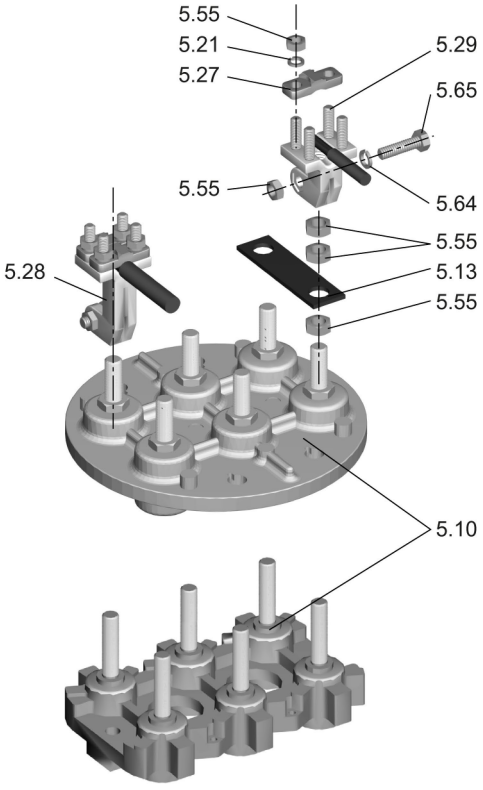
gt 640



gt 791



gt 791



11 Disposal

11.1 Introduction

Protecting the environment and preserving its resources are corporate goals of the highest priority for us. Our worldwide environmental management system to ISO 14001 ensures compliance with legislation and sets high standards in this regard. Environmentally friendly design, technical safety and health protection are always firm goals even at the product development stage.
Recommendations for the environmentally friendly disposal of the machine and its components are given in the following section. Be sure to comply with local disposal regulations.

11.2 Preparing for disassembly

Disassembly of the machine must be carried out and/or supervised by qualified personnel with appropriate expert knowledge.

1. Contact a certified waste disposal organization in your vicinity. Clarify what is expected in terms of the quality of dismantling the machine and provision of the components.
2. Follow the five safety rules (Page 14).
3. Disconnect all electrical connections and remove all cables.
4. Remove all liquids such as oil and cooling liquids. Collect the liquids separately and dispose of them in a professional manner.
5. Detach the machine fixings.
6. Transport the machine to a suitable location for disassembly.

See also

Corrective maintenance (Page 111)

11.3 Dismantling the machine

Dismantle the machine using the general procedures commonly used in mechanical engineering.

⚠ WARNING
Machine parts can fall
The machine is made up of heavy parts. These parts are liable to fall during dismantling. This can result in death, serious injury or material damage.
Before you release any machine parts, secure them so that they cannot fall.

11.4 Disposal of components

Components

The machines consist mainly of steel and various proportions of copper and aluminum. Metals are generally considered to be unlimitedly recyclable.
Sort the components for recycling according to whether they are:

- Iron and steel
- Aluminum
- Non-ferrous metal, e.g. windings

  The winding insulation is incinerated during copper recycling.
- Insulating materials
- Cables and wires
- Electronic waste

Process materials and chemicals

Sort the process materials and chemicals for recycling according to whether they are for example:

- Oil
- Grease
- Cleaning substances and solvents
- Paint residues
- Anti-corrosion agent
- Coolant additives such as inhibitors, antifreeze or biocides

Dispose of the separated components according to local regulations or via a specialist disposal company. The same applies for cloths and cleaning substances which have been used while working on the machine.

Packaging material

- If necessary, contact a suitable specialist disposal company.
- Wooden packaging for sea transport consists of impregnated wood. Observe the local regulations.
- The foil used for water-proof packaging is an aluminum composite foil. It can be recycled thermally. Dirty foil must be disposed of via waste incineration.

Service & support

A

A.1 Siemens Industry Online Support

Technical queries or additional information

If you have any technical queries or you require additional information, please contact Technical Support (https://support.industry.siemens.com/cs/ww/en/sc/2090).
Please have the following data ready:

- Type
- Serial number

You can find this data on the rating plate.

On-site service and spare parts

If you wish to request on-site service or order spare parts, please contact your local Siemens sales office. This office will contact the responsible service center on your behalf.
You can obtain optimum support everywhere using the SIOS App. The SIOS App is available for Apple iOS, Android and Windows phone.

A.2 Further documents

These operating instructions can also be obtained at the following Internet site:
http://support.industry.siemens.com (Page 145)

General Documentation

1.517.30777.30.000	1XP8001 encoder
5 610 00000 02 000	Operating_Instructions_Simotics GP, SD, DP, XP
5 610 00000 02 002	Operating_Instructions_Compact_Simotics XP
5 610 00002 09 000	Incremental encoder 1XP8012-1x
5 610 00002 09 001	Incremental encoder 1XP8012-2x
5 610 70000 02 015	External fan
5 610 70000 10 020	Spring-loaded brake

Observe all of the other documents available for this machine.

Glossary

AS
Drive end (DE)

BA
Operating instructions

CE
CE marking

CSA
Canadian Standard Association

CSA E
Canadian Standard Association Energie Efficiency Verification

CT
Coolant temperature

DE
Drive end (D end of shaft)

DIR
Directive

EAC
Zollunion Eurasien - Eurasian Customs Union

EC type examination certificate
Evidence of a machine certified by an inspection body
Verification of a machine certified by a certified testing body

EMC
Electromagnetic compatibility

EN
European Standard

Ex
Codes for explosion-protected equipment

F marking
Balanced with full featherkey

GOST
Gosudarstwenny Standart

H marking
Balanced with half featherkey

IC
International Cooling (standard)

IEC

International Electrotechnical Commission

IM

International mounting standard design

Internet

www.siemens.com/motors

IP

Degree of protection

ISPM

International Standards for Phytosanitary Measures

N marking

Balanced without featherkey (non)

NDE

Non-drive end

NE/NDE

Non-drive end

SH

Shaft height

TR CU

Technical regulations of customs union

UL

Underwriters Laboratories

VIK

Verband der industriellen Energie- und Kraftwirtschaft (German Association of Industrial Energy Users and Self-Generators)

Zone 1

Atmosphere: Gas; Danger level: Occasional danger; Type of protection: Increased safety "e"

Zone 2

Atmosphere: Gas; Danger level: Infrequent and short-term danger; Type of protection: Non-sparking "n"

Zone 21

Atmosphere: Dust; Danger level: Occasional danger; Type of protection: Protection by enclosure "t"; device protection level "Db"

Zone 22

Atmosphere: Dust; Danger level: Infrequent and short-term danger; Type of protection: Protection by enclosure "t"; device protection level "Dc"

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Q

R

S

T

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