ac motoren

OPERATING AND MAINTENANCE INSTRUCTIONS

Low-voltage motors

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Translation Notice:

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1. safety regulations and instructions

These operating instructions contain information on handling the motor types listed in *the chapter1.1* . The steps described in this document are numbered in the order in which they must be followed. Compliance with these instructions must always be ensured by the person responsible for the system when working on or with motors. AC - Motoren makes these instructions available on its website in accordance with the Machinery Directive. Read these operating instructions carefully and completely before starting work. Observe the following warnings to avoid personal injury or malfunctions. AC-Motoren GmbH accepts no liability or warranty for damage or consequential damage caused by failure to observe the operating instructions.

1.1 Validity

These operating instructions are valid for the following low-voltage three-phase AC motors and low-voltage AC motors as defined by the Low Voltage Directive 2014/35/EU:

- ACA series (FCA / ARA / ALA / FRPA / FLPA / FCPA)
- ACM series (FCM / ACR / ACL / FCPR / FCPL / FCMP)
- AWM series (FWM / AWR / AWL / FWMR / FWML / FWMP)
- ACY series (FCY / AYR / AYL / FYPR / FYPL / FCPY)
- AMY series (FMY / AYR / AYL / FYMR / FYML / FYMP)
- AOA series (FOA / AOR / AOL / FOPR / FOPL / FOPA)
- AOM series (FOM / FOPR / FOPL / FOPM)
- AFS series (FFS / FFSP)
- ABS series (FBS / FBSP)

These operating instructions are valid for the following explosion-protected low-voltage three-phase AC motors with type of protection "ec" and "tc" (referred to as Ex motors in these instructions) in accordance with ATEX Directive 2014/34/EU:

- Series / Series ACA (FCA / ARA / ALA / FRPA / FLPA / FCPA)
- Series / ACM series (FCM / ACR / ACL / FCPR / FCPL / FCMP)
- AWM series (FWM / AWR / AWL / FWMR / FWML / FWMP)

For brake motors, motors with mounted frequency inverters, explosion-proof low-voltage three-phase motors with ignition protection type "db / db eb" and "tb" as well as medium-voltage three-phase motors, please use the separate operating and maintenance instructions from AC Motoren GmbH.

1.2 Qualification of staff

Planning and project work on the complete drive, as well as all work involving transport, connection for commissioning and regular maintenance of all motors must be carried out by suitable, qualified, trained and authorized specialist personnel (observe VDE 0105; IEC 364). Specialist personnel within the meaning of this document are persons who, due to their training and experience, are qualified to recognize possible risks and avoid potential hazards in their respective area of responsibility.

1.3 Basic safety rules

Safety risks posed by the motor must be reassessed after installation in the application. To avoid damage to property or personal injury, the following safety rules in accordance with EN 50110-1 must be observed and strictly adhered to:

(1) Disconnection incl. auxiliary circuits
(2) Secure against restarting
(3) Ensure freedom from voltage
(4) Earthing and short-circuiting
(5) Cover or cordon off neighboring live parts

The customary local health and safety regulations, specific regulations and agreements of the operator and the area of use as well as safety symbols and instructions on the motor, packaging and documentation supplied must always be observed when working on the motor.

1.4 Electrical voltage

Check the motor's electrical equipment regularly. Replace loose connections and defective cables immediately. Never remove motor covers until the motor is de-energized and secured. Observe the basic safety rules from *chapter .1.3*

Stand on a rubber mat while working on the electrically charged motor to avoid electric shock.

DANGER - Electrical charge on the motor
Do not open the terminal box until five minutes after switching off the power.

DANGER - Voltage at terminals even when motor is switched off
Do not stay in the danger zone of the motor. When working on the motor, switch off the mains voltage and secure it against being switched on again.

DANGER - Switching on again
If the control voltage is applied or the speed setpoint is saved, the motor restarts automatically after a power failure**.**

1.5 Mechanical movement

Body parts that come into contact with rotating parts can be injured. Items of clothing, jewelry and similar objects can become entangled and be pulled into the motor. Secure the motor against contact. Do not wear loose items of clothing when working on the motor. Never carry out a test run with a feather key (risk of skidding). Never remove motor covers until the motor is de-energized. Observe the basic safety rules from *chapter .1.3*

DANGER - Rotating rotor

1.6 Increased surface temperatures

Individual motor parts can become hot during operation. Do not touch any motor parts during operation. Ensure adequate contact protection to prevent the risk of burns.

DANGER - Surface temperatures

1.7 Noise emission

During operation, the motor generates noise emissions that may be unacceptable for continuous work in the immediate vicinity. Take technical protective measures and protect the operating personnel with appropriate equipment, such as hearing protection.

DANGER - Sound pressure level

1.8 Electromagnetic fields

The entire system generates electromagnetic fields during operation. These can cause faults and malfunctions in medical implants, e.g. pacemakers. Take suitable measures to protect personnel.

DANGER - Electromagnetic fields

1.9 Transportation safety

Tipping or falling motors pose a danger to persons and objects. Only use suitable and tested equipment and carry out the work carefully and prudently.

DANGER - Improper slinging, transporting and lifting

2. Intended use

The motors listed in *chapter1.1* comply with the harmonized standards of the EN / IEC 60034 series (VDE 0530) and are approved as industrial drives only for the intended use specified by AC Motoren GmbH in the catalog and in the associated technical documentation. Any other or additional use is considered improper use. This also includes compliance with all associated product regulations.

Modifications or conversions to the motor are not permitted. Third-party products and components that are used together with the engine, as well as their installation, must be recommended, tested and approved by AC Motoren GmbH. Unauthorized modifications and conversions to the engine will result in the immediate loss of the corresponding warranty and operating license.

NOTE

Modifications and conversions to engines must be approved by AC Motoren GmbH.

When using motors in the standard version, observe the ambient conditions. The motors in the standard version are not suitable for operation in salty or aggressive atmospheres or for outdoor installation. Please state the ambient conditions explicitly when enquiring and ordering. Use in EX areas is prohibited unless expressly intended for this purpose (observe accompanying documentation).

2.1 Improper use

In particular, the following uses of the motor are prohibited and can lead to hazards and loss of warranty:

- Operation of the motor with imbalance, e.g. caused by dirt deposits or icing.
- Resonance operation, operation with vibrations or oscillations that are transmitted from the overall system to the motor and exceed the maximum permissible values specified in ISO 10816-3. Periodically occurring shock loads up to 1G only are permissible. For higher shock loads, please contact AC Motoren GmbH.
- Painting the engine (unless explicitly approved by AC Motoren GmbH).
- Loosening of connections (e.g. screws) during operation.
- Opening the terminal box during operation.
- Operating the motor in the vicinity of flammable substances or components.
- Operating the motor in an explosive atmosphere (unless explicitly approved by AC Motoren GmbH).
- Operation with completely or partially dismantled or manipulated protective devices.
- Cleaning of motors with high pressure and blasting of sealing surfaces.

2.2 Note on subsequently claimed defects

The conformity of the scope of delivery with the accompanying documents must be checked immediately upon receipt of the delivery. AC Motoren GmbH does not accept any warranty for defects claimed subsequently. Make a complaint:

- Visible transport damage on delivery
- Recognizable defects and / or incompleteness

3. Transportation and storage

3.1 Notes on transportation

Lifting eyes or eyebolts for the motors must be used for transportation using suitable lifting gear. The lifting eyes or eyebolts are only intended for lifting the motors without additional attachments such as base plates, gearboxes, etc. Before transportation, make sure that the lifting eyes and eyebolts are screwed in as far as they will go and that the lifting gear is properly fastened and free of damage. If the eyebolts are removed after installation, the threaded holes must be permanently sealed in accordance with the degree of protection.

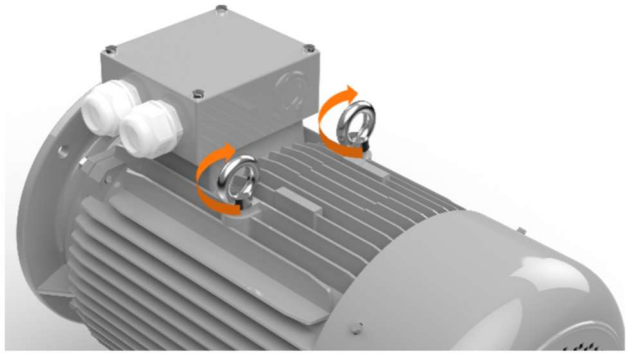

Figure1 : Screw in eyebolts as far as they will go before transportation

For motors with a higher degree of protection (IP65, IP56, IP66) and for Ex motors, the eyebolts (DIN580) must be removed after installation (these are present on cast iron motors from size 100 of the ACM and AWM series). The open threaded holes must be tightened using the supplied hexagon head screws (ISO4017) and washers (DIN125) with a tightening torque in accordance with*Table15* : Tightening torques for screw plugs
 to seal the threaded holes. Use the Loctite surface sealant to permanently seal the threaded holes in accordance with the degree of protection.

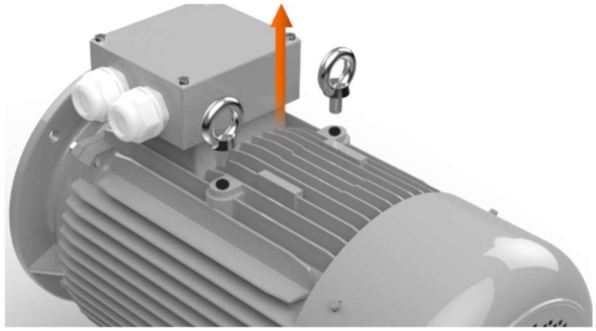

Figure2 : Removing the eyebolts

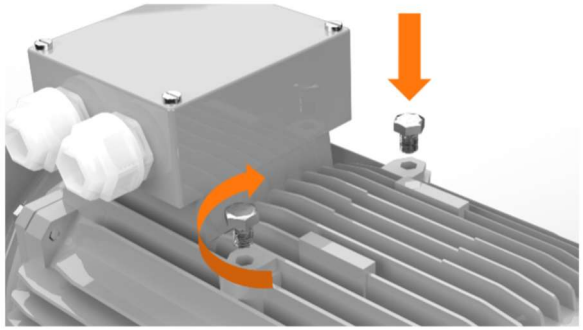

Figure3 : Replacing eyebolts with hexagon head screws for motors with increased IP and Ex motors

NOTE

After installation, eyebolts must be sealed with Loctite and screwed into the threaded hole as far as they will go. Threaded holes must be permanently sealed in accordance with the IP protection class. For motors with a higher IP protection class and Ex motors, use the hexagon head screws supplied

Only remove any transport locks before commissioning and keep the transport lock in a safe place until you need to transport the appliance again.

3.2 Notes on storage

Only store the motors in closed, dry rooms and protect them from mechanical damage. The storage and transport rooms should meet the following environmental conditions:

- Temperature range -20°C to +50°C
- Maximum humidity 60%

Protect against harmful environmental influences during short-term outdoor storage. Motors must not be transported or stored on the fan cowl.
Rotate the motor shaft at least once a year and ensure a low-vibration environment to prevent bearing damage. For longer storage periods, observe the additional measures from *chapter3.2.1* . After a storage period or downtime of more than 12 months, the grease condition of all lubricating parts, such as roller bearings and shaft seals, must be checked before commissioning, if necessary, by means of vibration measurement. If oil removal or contamination can be detected in motors with open roller bearings, the grease should be replaced. Motors with closed roller bearings (type .ZZ. / .RS. / .RZ) should be re-stored after 48 months of standstill.

NOTE

After a long period of storage or downtime, the roller bearings and the insulation resistance must be checked before commissioning.

3.2.1 Additional measures for storage over 12 months

- Check the insulation resistance of all windings
- Check the terminal box for the presence of foreign particles
- Check the cable connections and tightening torques on the terminal board
- Check the terminal box seal for damage
- Drain the condensate from motors with condensation holes

4. Installation and assembly

4.1 General

Observe the following instructions during installation and assembly:

- These operating instructions are available to the staff.
- Use only the thread sizes specified in the EN 50347 standard for base and flange fastening and the required strength class of the screw connections.
- When installing motors with feet and direct coupling, ensure even support, precise alignment and the alignment tolerance specified in *chapter* . 4.2
- When installing motors with a flange, the correct fit of the mating flange and the centering ring was selected by the person responsible for the system

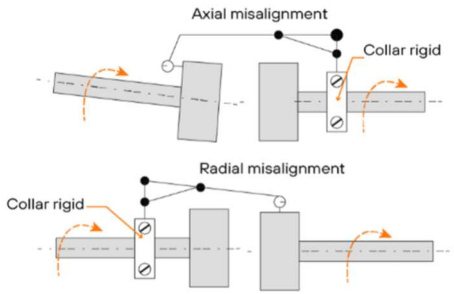

Figure4 : axial and radial shaft misalignment

- Ensure a vibration-free environment. Avoid resonances with the rotational frequency and twice the mains frequency caused by the installation.
- Turn the rotor by hand, listen for unusual grinding noises. Check the direction of rotation when coupled.
- Only mount or remove drive elements (pulley, clutch, etc.) using suitable devices and cover them with a contact guard. The part to be mounted must be heated. Transmission elements must not be knocked onto the shaft. Avoid excessive belt tension.
- Ventilation must not be prevented. It must be ensured that the heated cooling medium that is blown out is not sucked in again. Observe the minimum distances from the fan to the wall specified in *chapter*4.3 .
- All parts attached to the shaft end must be carefully dynamically balanced. The sliders in the standard version are balanced at the factory with a half key (observe accompanying documentation).
- By using cylindrical roller bearings ("reinforced NU bearings"), large radial forces or masses can be absorbed at the motor shaft end. The minimum radial force at the shaft end must be a quarter of the permissible radial force. The permissible radial and axial shaft load must always be considered for all bearing types.
- The user must ensure that the condensation drainage hole (see*Figure5*) on the motors with increased IP protection class (IPX6/IP6X) is sealed watertight and dustproof after draining and during transportation and storage and sealed with Loctite surface sealant.

Figure5 : Seal and close condensation hole after draining with Loctite

- For the IM B14 and IM B34 (flange type according to EN 50347), the maximum screw-in depths specified in*Table1* must be observed. If an IM B14 and IM B34 motor is used without flange attachments, the user must take the appropriate protective measures against the ingress of foreign particles and liquids at the through bores. This also applies to the storage of motors.

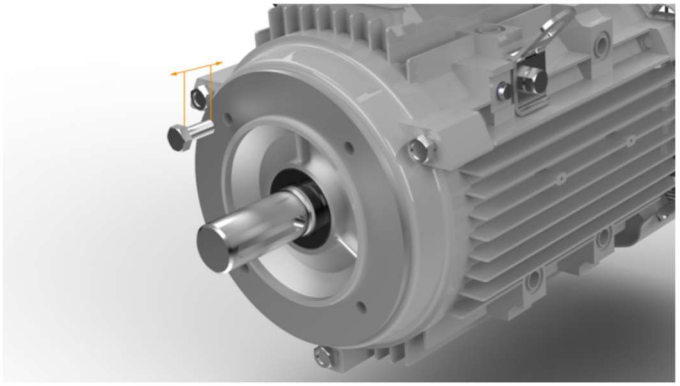

Figure6 : Screw-in depth

Size	Flange type according to EN50347	Screw-in depth
56-63	FT65-FT75	8 mm
71	FT85	10 mm
80	FT100	11 mm
90	FT115	14 mm

Size	Flange type according to EN50347	Screw-in depth
100-112	FT130	15 mm
132	FT165	17 mm
160	FT215	24 mm

Table1 : Screw-in depth for IM B14 and IM B34 designs

4.2 Alignment tolerances

Correct and careful alignment of the motor prevents increased tension in the mounting parts. Observe the generally applicable tolerances for correct shaft alignment specified in *Table2* .

Speed (rpm)	Axial/radial offset	Angular error, mm/100
0-1000	0.07 mm	0,06
1000-2000	0.05 mm	0,05
2000-3000	0.03 mm	0,04
3000-4000	0.02 mm	0,03
4000-5000	0.01 mm	0,02
5000-6000	<0.01 mm	0,01

Table2 : Generally applicable tolerances for shaft alignment

4.3 Minimum distances to the wall

Correct positioning of the motor prevents increased motor heating due to insufficient cooling air flow. Observe the minimum distances between the motor fan and the wall specified in *Table3* .

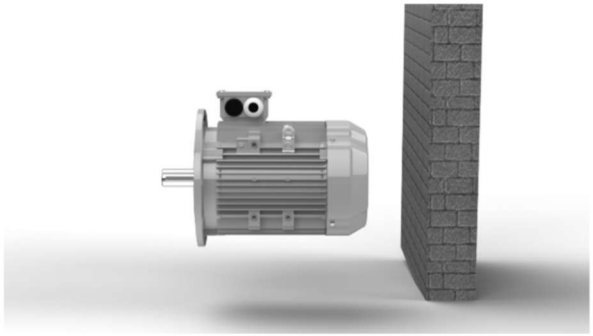

Figure7 : Distance to the wall

Size	Distance to the wall
56	22 mm - all series
63	25 mm - all series
71	28 mm - all series
80	32 mm - all series
90	34 mm - all series
100	36 mm - all series
112	42 mm - all series
132	45 mm - all series
160-180	60 mm - all series
200-225	65 mm - all series
250-280	70 mm - ACM ACY AWM series 90 mm - AOA AOM series
315-355	75 mm - ACM ACY AWM series 110 mm - AOA AOM series

Table3 : Minimum distances to the wall

5. Electrical connection

5.1 General

Work on motors may only be carried out by qualified specialist personnel on a stationary motor that is disconnected and secured against being switched on again, taking into account the safety rules from *the chapter1.3* . This also applies to auxiliary circuits (standstill heating). The rating plate information and the connection diagram in the terminal box must be observed.

NOTE

Observe the specifications on the motor rating plate!

The information in IEC / EN 60034-1 (VDE 0530-1) on operation at the limits of ranges A (±5% voltage or ±2% frequency deviation) and B and the associated heating and deviation of the operating data from the rated data must be observed. Connection cables should be designed in accordance with the system-dependent conditions specified in DIN VDE 0100 (current, ambient temperature, type of installation, etc.). The connection must be made in such a way that a permanently safe electrical connection is maintained (no protruding wire ends). Suitable ring cable lugs must be used for the connections of all main cables to ensure a secure protective conductor connection. The tightening torques can be found in the*Table4* .

NOTE

Use suitable connection cables!

5.1.1 Connection of protective conductor and motor protection device

The thread dimensions for the main cable connection and protective conductor can be found in the*Table4* .

Series Size Thread	Thread main cable connection	Tightening torque main cable connection (Nm) Min. - Max.	Thread Protective conductor connection
ACA BG56	M4	1,9 - 2,2	M4
ACA BG63-132	M5	3,9 - 4,5	M5
ACM BG160-180	M6	6,6 - 7,5	M6
ACM BG200-225	M8	16,0 - 18,4	M8
ACM BG250-280	M10	32,0 - 36,0	M10
ACM BG315	M16	139,0 - 159,0	M10
ACM BG355	M20	273,0 - 312,0	M10
ACY BG56	M4	1,9 - 2,2	M4
ACY BG63-132	M5	3,9 - 4,5	M5
AFS 80-112	M4	0,8 - 1,4	M4
AFS BG132	M5	1,5 - 3,5	M5
AMY BG160-180	M6	6,6 - 7,5	M6
AMY BG200-225	M8	16,0 - 18,4	M8
AMY BG250-280	M10	32,0 - 36,0	M10
AOA BG132	M5	1,5 - 3,5	M5
AOA BG160-180	M6	3,0 - 6,0	M6
AOA BG200-225	M8	5,8 - 8,5	M8
AOA BG80-112	M4	0,8 - 1,4	M4
AOM BG200-225	M8	5,8 - 8,5	M8
AOM BG250-280	M10	10,0 - 16,0	M10
AOM BG315-355	M12	16,0 - 25,0	M12
AWM BG160-180	M6	6,6 - 7,5	M6
AWM BG200-225	M8	16,0 - 18,4	M8
AWM BG250-280	M10	32,0 - 36,0	M10
AWM BG315	M12	68,0 - 74,0	M8
AWM BG355-400	M16	139,0 - 159,0	M8

Table4 : Tightening torques and thread size for main cable and protective conductor connection

Ex motors are equipped as standard with a thermistor (PTC thermistor) as a motor protection device. For all low-voltage three-phase AC motors and low-voltage AC motors, the following temperature sensors are optionally installed in the winding heads of the stator winding or in the roller bearings for temperature monitoring or motor component protection:

- Resistance thermometer (Pt100 / Pt1000)
- Bimetal switch (PTO)
- Thermistor (PTC thermistor)

The standstill heating is optionally installed in the winding heads of the stator winding to prevent condensation and the associated frost damage when the motor is at a standstill in a cold environment. The connections for the temperature sensor and parking heater are located in the terminal box of the motor or in the separate auxiliary terminal box. Observe the information from the motor data sheets and associated documentation, nameplate information and the following instructions when connecting the temperature sensor and parking heater:

- Comply with the requirements of IEC 60664-1 or IEC 61800-5-1 and the safety rules from *chapter1.3* .
- Observe the connection diagrams from *Chapter 5.1.2-5.1.8.* and*Figure39 toFigure45*
- Use an interlock circuit to ensure that the parking heater is not switched on when the engine is running.
- If the cold resistance (at approx. 20°C) of the sensor circuit needs to be measured before the motor is switched on for the first time, the measuring voltage must not exceed 2.5 V DC.

5.1.2 Terminal box ACA, ACM 56 - 132; AFS 80 - 160 three-phase motors

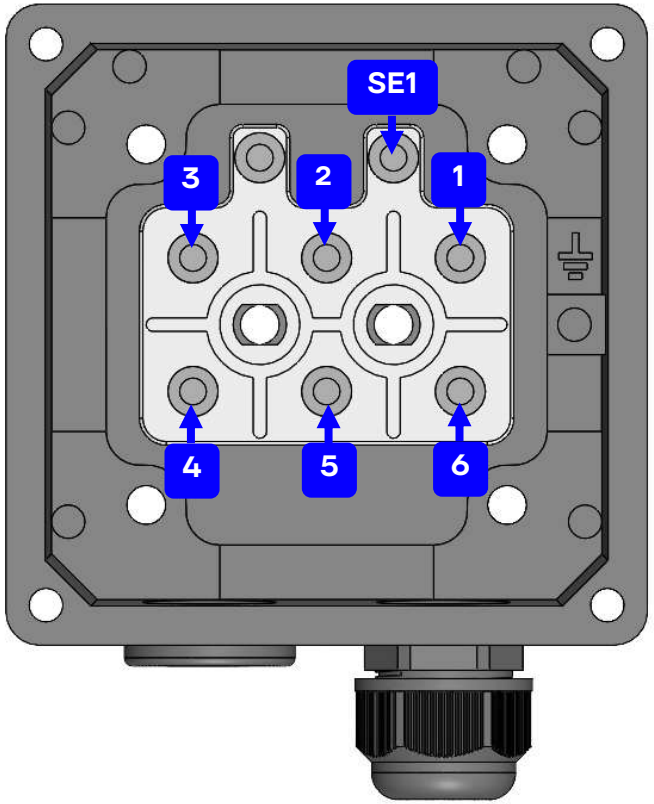

Figure8 : Terminal box for ACA, ACM 56 - 132; AFS 80 - 160 three-phase motors

Wiring diagram AP1	Possible motor protection devices
Terminal 1 = V2 Terminal 2 = U2 Terminal 3 = W2 Terminal 4 = U1 Terminal 5 = V1 Terminal 6 = W1	Terminals SE1: PTC / PTO

Table5 : Wiring diagram for ACA, ACM 56 - 132; AFS 80 - 160 three-phase motors

5.1.3 Terminal box ACA, ACM, AMY 160 - 280 three-phase motors

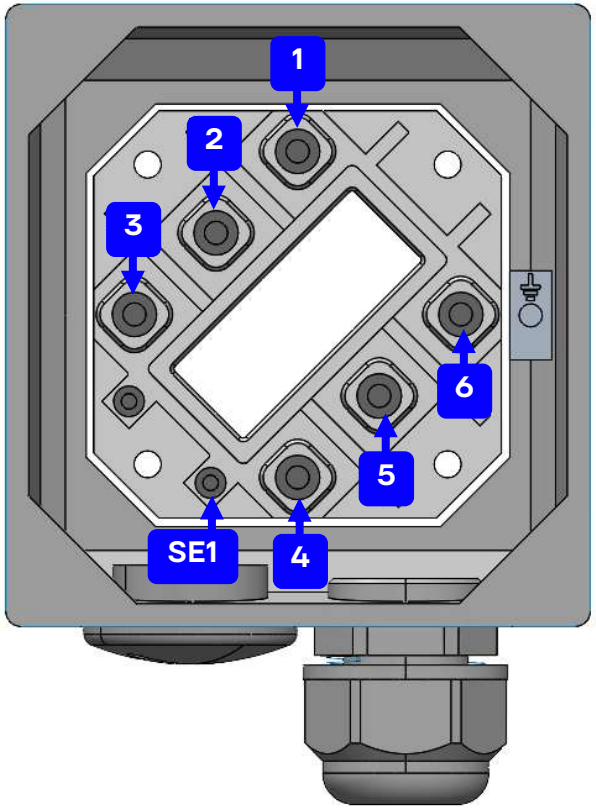

Figure9 : Terminal box for ACA, ACM, AMY 160 - 280 three-phase motors

Wiring diagram AP2	Possible motor protection devices
Terminal 1 = V2 Terminal 2 = U2 Terminal 3 = W2 Terminal 4 = U1 Terminal 5 = V1 Terminal 6 = W1	Terminals SE1: PTC / PTO

Table6 : Wiring diagram for ACA, ACM, AMY 160 - 280 three-phase motors

5.1.4 Terminal box ACA, ACM 56 - 132 three-phase motors; AFS 80-160

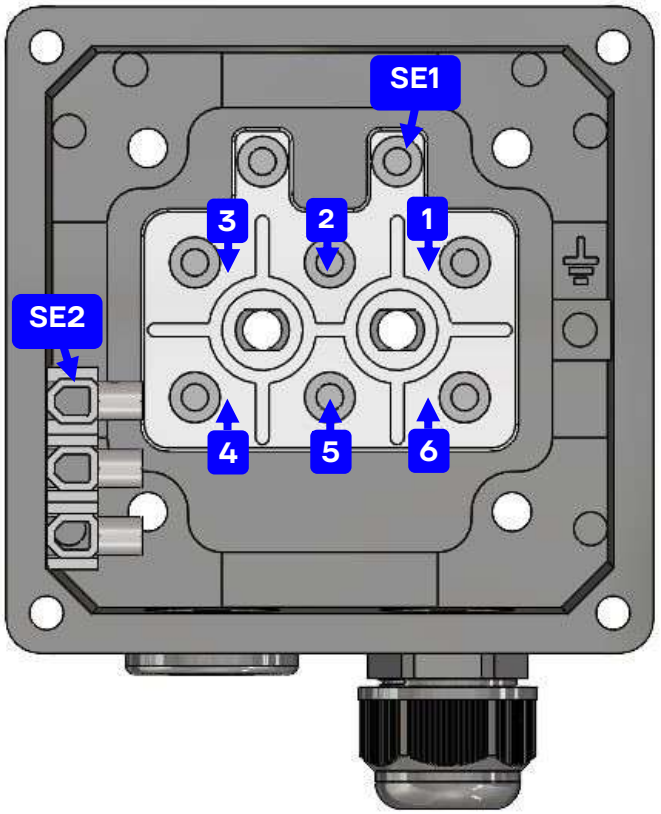

Figure10 : Terminal box for ACA, ACM 56 - 132; AFS 80 - 160 three-phase motors

Wiring diagram AP3	Possible motor protection devices
Terminal 1 = V2 Terminal 2 = U2 Terminal 3 = W2 Terminal 4 = U1 Terminal 5 = V1 Terminal 6 = W1	Terminals SE1: PTC / PTO Terminals SE2: PT100 / PT1000 / heating

Table7 : Wiring diagram for ACA, ACM 56 - 132; AFS 80 - 160 three-phase motors

5.1.5 Terminal box ACA, ACM, AWM, AMY 160 - 280 three-phase motors

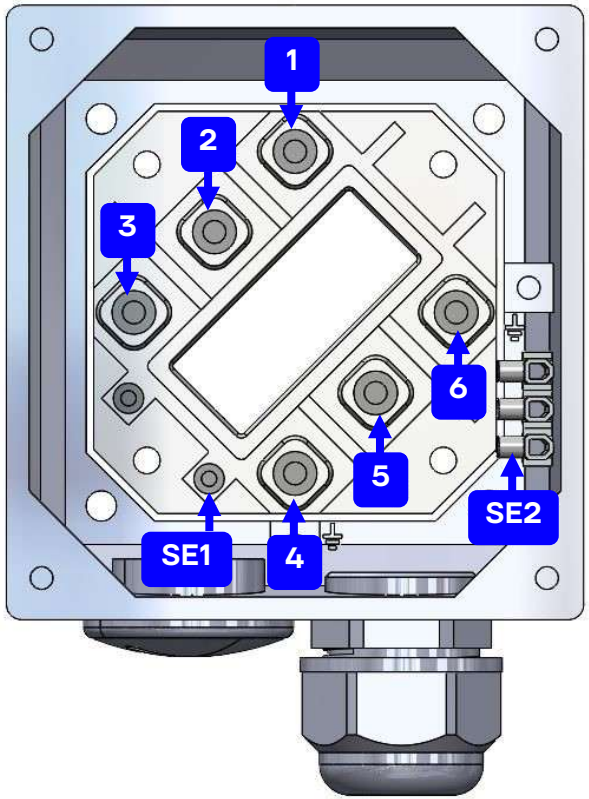

Figure11 : Terminal box for AC motors ACA, ACM, AWM, AMY 160 - 280

Wiring diagram AP4	Possible motor protection devices
Terminal 1 = V2 Terminal 2 = U2 Terminal 3 = W2 Terminal 4 = U1 Terminal 5 = V1 Terminal 6 = W1	Terminals SE1: PTC / PTO Terminals SE2: PTC / PTO / PT100 / PT1000 / heating

Table8 : Wiring diagram for ACA, ACM, AWM, AMY 160 - 280 three-phase motors

5.1.6 Junction box for three-phase motors AWM 315 -

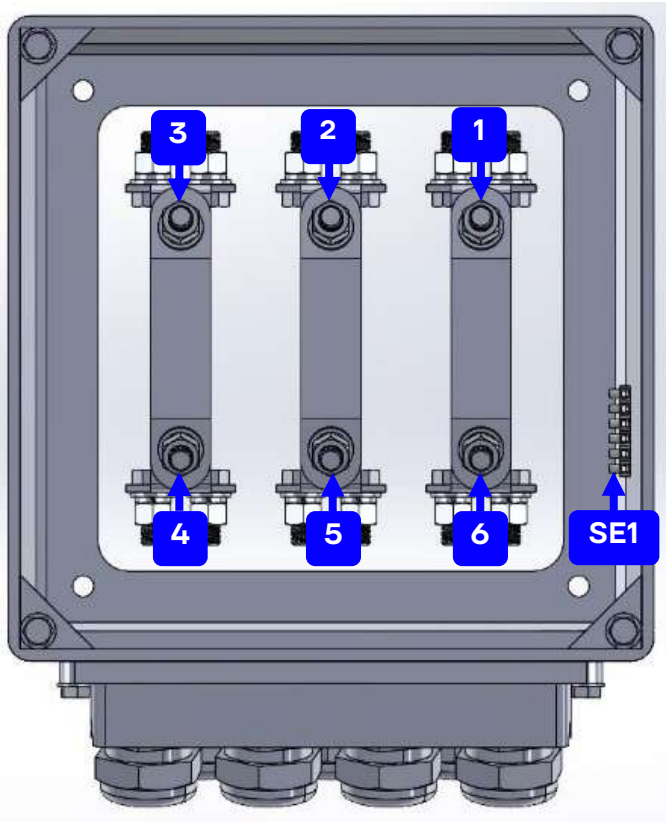

Figure12 : Connection box for three-phase motors AWM 315 - 450

Wiring diagram AP5	Possible motor protection devices
Terminal 1 = V2 Terminal 2 = U2 Terminal 3 = W2 Terminal 4 = U1 Terminal 5 = V1 Terminal 6 = W1	Terminals SE1: PTC / PTO / PT100 / PT1000 / heating

Table9 : Wiring diagram for three-phase motors AWM 315 - 450

5.1.7 Terminal box for AC motors ACM 315 - 355

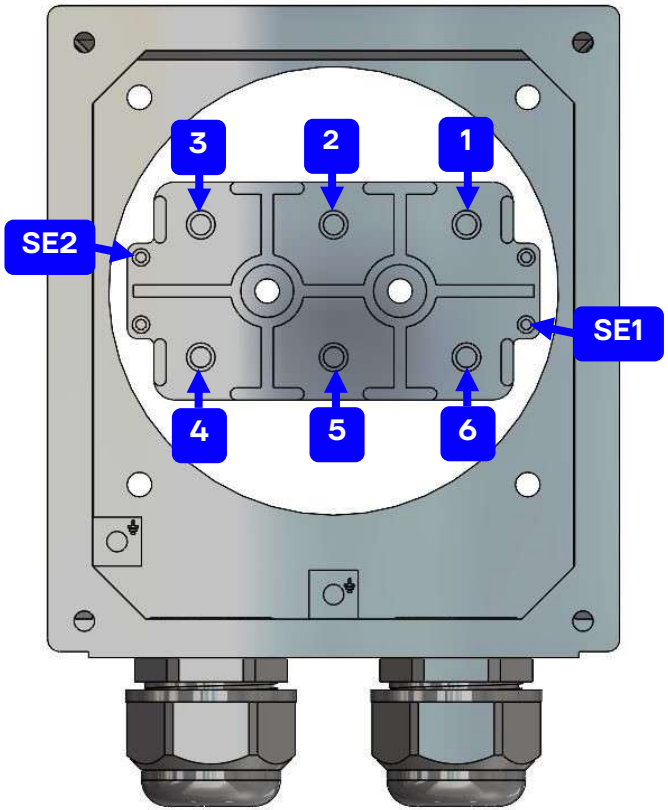

Figure13 : Connection box for AC motors ACM 315 - 355

Wiring diagram AP6	Possible motor protection devices
Terminal 1 = V2 Terminal 2 = U2 Terminal 3 = W2 Terminal 4 = U1 Terminal 5 = V1 Terminal 6 = W1	Terminals SE1: PTC / PTO Terminals SE2: PT100 / PT1000 / heating

Table10 : Wiring diagram for AC motors ACM 315 - 355

5.1.8 Terminal box ACM 315 - 355 three-phase motors

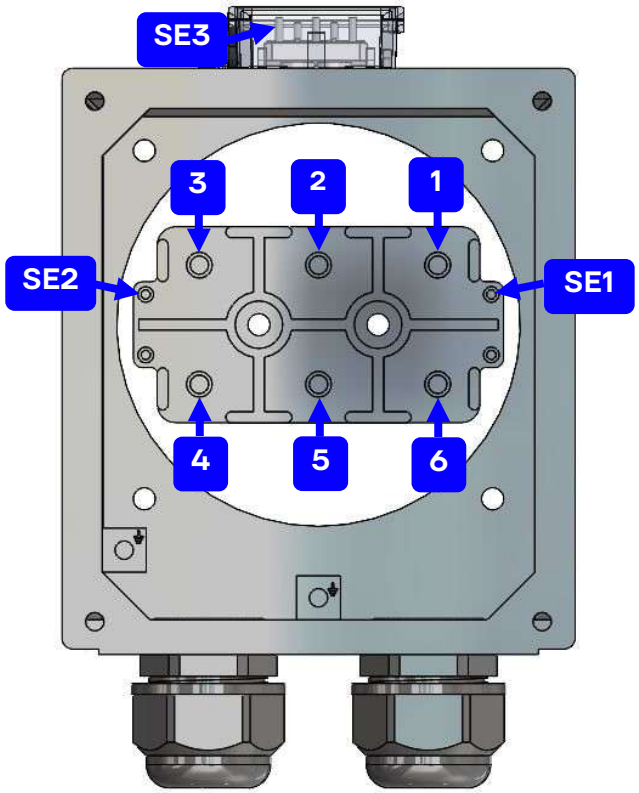

Figure14 : Terminal box for AC motors ACM 315 - 355

Wiring diagram AP7	Possible motor protection devices
Terminal 1 = V2 Terminal 2 = U2 Terminal 3 = W2 Terminal 4 = U1 Terminal 5 = V1 Terminal 6 = W1	Terminals SE1: PTC / PTO Terminals SE2: PT100 / PT1000 / heating Terminals SE3: PT100 / PT1000 / heating

Table SEQ Tabelle * ARABIC 11 : Wiring diagram for AC motors ACM 315 - 355

There must be no foreign bodies, dirt or moisture in the terminal box. Standard motors are only supplied with blanking plugs in the cable entry openings that are suitable for transportation and storage in the rooms and ambient conditions in accordance with *chapter 3.2.* The dummy plugs as well as the remaining unused cable entry openings and the terminal box must be sealed dust- and watertight by the person responsible for the system before commissioning. Check the condition of all seals for damage and remove the feather key before the test run.

5.2 Electromagnetic compatibility

The conformity of the motors as an independent unit with the EMC standards has been tested. The user is responsible for taking suitable measures to ensure that devices and systems as a whole comply with the relevant EMC standards. Each motor is supplied with the binding circuit diagram according to which the connection must be made (*Figure39 toFigure45*

5.3 Connection of outgoing cables

The terminal board is removed at the factory for motors with cables routed out and the connecting cables are connected to the stator winding connections. The connecting cables are color-coded; the color assignment is affixed to the cover plate. In the version with terminal box, the individual wires are labeled. The person responsible for the system connects the individual cables directly in the control cabinet of his system according to this assignment.

5.4 Clamping range of the cable gland

Observe the clamping ranges of the respective cable gland specified in *Table1 :* Clamping ranges of the cable glands

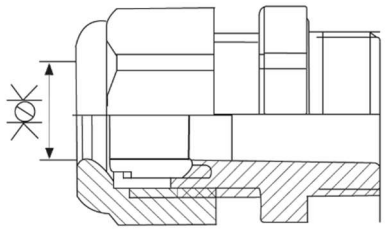

Figure15 : Clamping area

Cable gland	Series	Clamping range, mm
M16 x 1.5	All	3,5 - 8
M20 x 1.5	All	5 - 11
M25 x 1.5	ACA	9 - 16
	AOA	10 - 18
M32 x 1.5	ACA ACY	11 - 20
	AOA	12 - 25
M40 x 1.5	ACM AMY	19 - 29
	AOA AOM	18 - 32
M50 x 1.5	ACM AMY	30 - 35
	AOA AOM	27 - 39
M63 x 1.5	ACM AWM	29 - 40
	AOM	33 - 46
M72 x 2.0	AWM	44 - 52

Table1 : Clamping ranges of the cable glands

5.4.1 Minimum air clearances

Observe the Table2 : Minimum air *clearances*

The minimum air clearances between non-insulated parts are specified in the table below. These values apply for use up to 1000m above sea level (place of use).

Effective value of the voltage, V	Minimum air gap, mm
≤500V	3
≤630V	5,5
≤1000	8,0

Table2 : Minimum air clearances

5.4.2 External fan connection

Motors in the ACA, ACM and AWM series can be optionally configured with forced ventilation (cooling type IC416 in accordance with IEC 60034-6). Observe the information from the motor data sheets and associated documentation, nameplate information and the following instructions when connecting the forced cooling fan:

- Comply with the requirements of IEC 60664-1 or IEC 61800-5-1 and the safety rules from *chapter1.3* .
- Observe the connection diagrams in *chapter 11***.**
- Do not operate the motor without a forced cooling fan.

5.4.3 Frequency inverter connection

When operating standard motors, observe the maximum permissible voltage peaks in accordance with IEC 60034 - 18 - 41. Follow the EMC instructions of the inverter manufacturer and ensure EMC-compliant design Operation

5.5 Commissioning

The installation must be carried out in accordance with the applicable regulations by appropriately trained personnel with the motor de-energized and in compliance with the safety rules and instructions in *chapter0 -6* . Motor rating plate data must be compared with the mains conditions. The dimensions of the connection cables must be adapted to the rated currents of the motor. The motors must be commissioned with overcurrent protection that is set according to the rated data (1.1 times the rated current) of the motor. Otherwise, there is no guarantee or warranty claim in the event of winding damage.

NOTE

Check the insulation resistance before commissioning!

Before switching on the motor for the first time, we recommend testing the insulation resistance of the winding (only permitted outside the Ex area for Ex motors). This should be measured at 25°C ambient temperature and with 500V (motor windings up to 400V) / 1000V (motor windings up to 800V) DC voltage and be greater than 5MΩ. After prolonged storage (12 months or more), an insulation test and vibration measurement should be carried out.
The following measures are recommended for the normal commissioning of motors:

1. Check that the connection has been made in accordance with the wiring diagram
2. Check that all minimum clearances between bare, live parts and to earth are maintained
3. Check that all terminal box connections, mounting parts and earthing connections are firmly tightened
4. Check that auxiliary and additional equipment is in working order
5. Check that unused cable entry openings and the condensation drain hole (if present) are sealed dust and watertight
6. Check that the motor is properly mounted and aligned
7. Check that the operating conditions match the data provided in the motor documentation
8. Check that the cooling air supply is guaranteed, if present, carry out a test run on the forced cooling fan
9. Check that the motor does not make any loud noises or vibrate during a test run without load
10. Check that the no-load current consumption is less than the current value on the motor rating plate
11. Check that the direction of rotation is correct
12. Only switch on the load during a perfect test run
13. Fill out a commissioning log

During commissioning, we recommend monitoring the current consumption under load in order to immediately detect possible overloads and asymmetries on the mains side.

5.5.1 Tightening torques

Tightening torques for screws on the end shield, bearing cover and terminal box for motors of all series can be found in the*Table14* .

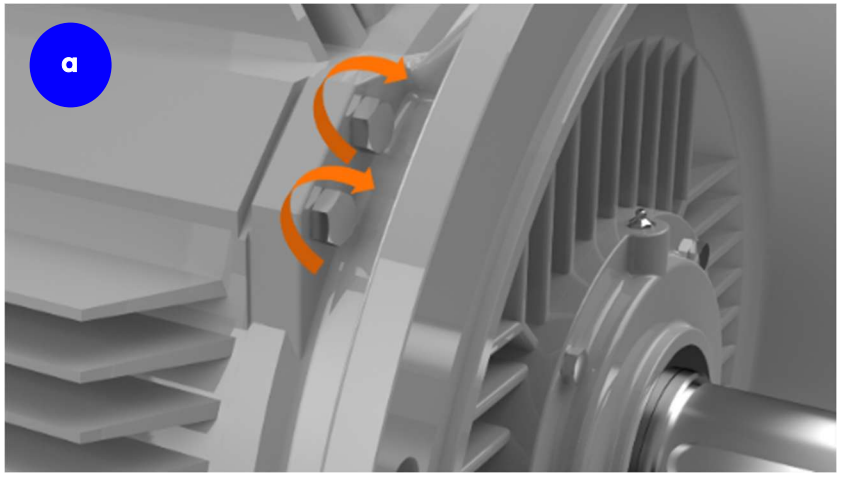

Figure16 : Screws end shield

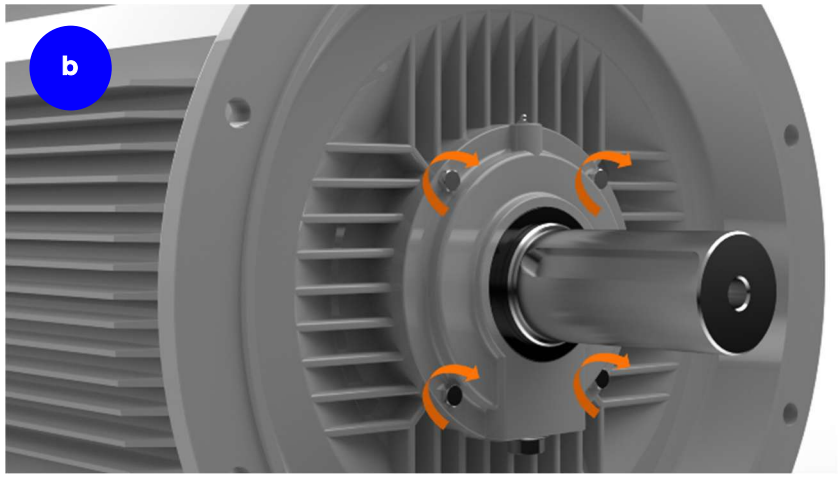

Figure17 : Bearing cover screws

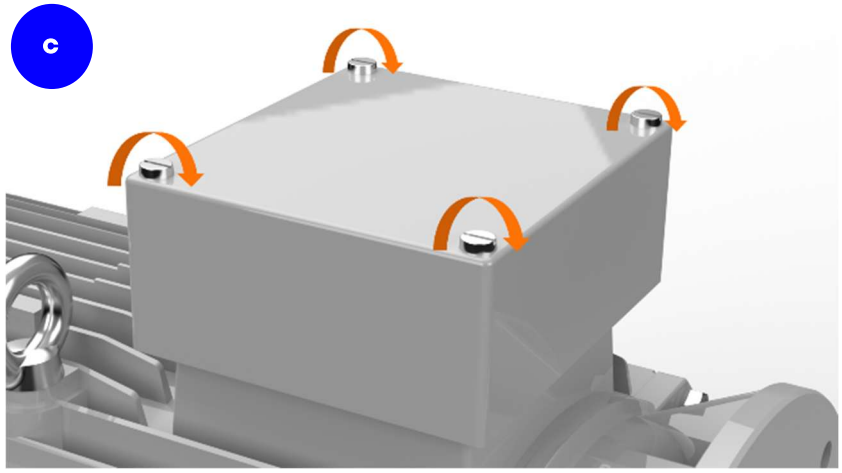

Figure18 : Terminal box screws

Size	Building form	End shield (image a)	Bearing cover (image b)	Terminal box cover (image c)	Terminal box
Thread / tightening torque (Nm)					
BG56	B3/B5/ B14	M4 / 2.0 Nm	-	M4 / 1.0 Nm	M4 / 2.0 Nm
BG63			-	M5 / 1.5 Nm	M5 / 3.0 Nm
BG71			-		
BG80		M6 / 7.0 Nm	-		
BG90			-	M5 / 2.5 Nm	M5 / 4.0 Nm
BG100		M8 / 17 Nm	-		
BG112			-		
BG132			-		
BG160			M6 / 7 Nm	M6 / 3.0 Nm	M6 / 4.5 Nm
BG180		M10 / 34 Nm	M8 / 17 Nm		
BG200		M12 / 60 Nm		M8 / 4.0 Nm	M8 / 7.0 Nm
BG225			M10 / 34 Nm		
BG250				M8 / 4.5 Nm	M10 / 11.5 Nm
BG280					
BG315		M16 / 149 Nm		M10 / 5.5 Nm	M10 / 12.5 Nm
BG355		M20 / 290 Nm		M12 / 7.0 Nm	M12 / 16.0 Nm
BG400					

Table14 : Tightening torques for terminal box, end shield and bearing cover

If a motor is mounted on feet (design B3, B34, B35), the following tightening torques for the screws must be observed (*Table15*

Thread	Tightening torque (Nm) Min.	Tightening torque (Nm) Max.
M4	2,0	3,0
M5	3,5	5,0
M6	6,0	9,0
M8	16,0	24,0
M10	30,0	44,0
M12	46,0	70,0
M16	110,0	165,0
M20	225,0	340,0

Table15 : Tightening torques for screws on the motor feet

Tightening torques for metal and plastic cable glands for direct mounting on the machine and other glands (e.g. reducers) must be applied in accordance with the*Table16* .

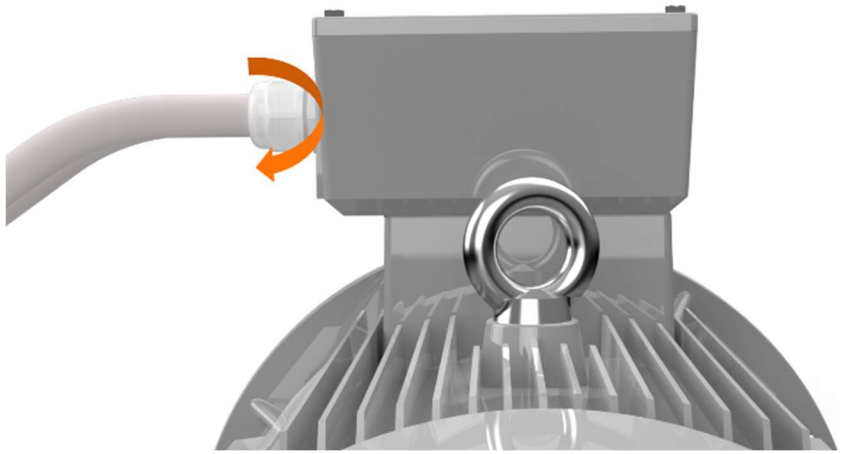

Figure19 : Tightening cable gland

Cable gland	Metal ±10% Nm	Plastic ±10% Nm
M16 x 1.5	10	2
M20 x 1.5	12	4
M25 x 1.5		
M32 x 1.5	18	6
M40 x 1.5		11
M50 x 1.5	20	12
M63 x 1.5		13

Table16 : Tightening torques for cable glands

5.5.2 Setting values for winding and monitoring sensors

If the motor is equipped with temperature sensors for winding and bearing temperature monitoring, set the temperature values for pre-warning and shutdown on the tripping device in accordance with the*Table* **SEQ Tabelle * ARABIC 17** before the first test run.

Sensor position	ATEX marking	Forewarning	Shutdown
Winding (insulation class F)	-	130°C	150°C
	II 3G Ex ec IIC T3 Gc II 3D Ex tc IIIB T200°C Dc II 3D Ex tc IIIC T200°C Dc		
	II 3G Ex ec IIC T4 Gc	110°C	130°C
	II 3D Ex tc IIIB T125°C Dc II 3D Ex tc IIIC T125°C Dc	100°C	120°C
Rolling bearings (in standard design according to 7.3)	-	100°C	110°C

Table SEQ Tabelle * ARABIC 17 : Setting values for temperature sensor

5.6 Motor selection and operation on the frequency inverter

Frequency inverters have expanded the range of applications for three-phase motors. A frequency inverter is used to vary the speed of three-phase AC motors and implement various control and regulation algorithms depending on the topology of the drive system and accuracy requirements. The AC motors listed here are suitable for operation with standard frequency inverters with pulse width modulation (PWM). Observe additional information from *chapter 5.6.2* . regarding maximum winding stress and EMC protective measures. It is recommended to provide each speed-controlled motor with temperature sensors so that they are monitored by the frequency inverter and protect the motor from overheating. with regard to maximum winding stress and EMC protective measures. It is recommended that each speed-controlled motor is fitted with temperature sensors so that they can be monitored by the frequency inverter and protect the motor from overheating.

5.6.1 Power and torque with V/f control. 50Hz and 87Hz characteristic curves

The V/f control is the simplest way to operate asynchronous motors with a variable speed. If the frequency and voltage amplitude of an asynchronous motor are changed in the same ratio, the natural motor characteristic curve (speed - torque characteristic curve) shifts along the speed axis. When the maximum voltage is reached, only the frequency is increased further, the natural motor characteristic curve is shifted further, but flattens out significantly.

Figure20 shows the shift in the motor characteristic curve at different supply frequencies - f1, f2 < f3, f4, f5, f6 > f3. Mn1, Mn2, Mn3, Mn4, Mn5, Mn6 are the rated motor torques at the corresponding supply frequency. Mk1, Mk2, Mk3, Mk4, Mk5, Mk6 are the motor stall torques at the corresponding supply frequency.

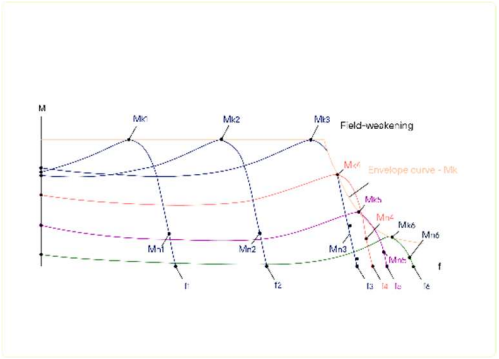

Figure20 : Shift of the motor characteristic curve with V/f control.

f3 is a cut-off frequency. The range at supply frequencies below f3 is called the constant flux range, the range above f3 is called the field weakening range, which is characterized by decreasing torsional and stall torques of the motor.

Example A: An asynchronous motor 1.5kW 4P 230/400V 50Hz is to be operated with speed-adjustable V/f control using a frequency inverter with an input voltage of 400V. The motor has a rated torque of approx. 10Nm, approx. 1450 revolutions per minute and is connected to the frequency inverter in a star connection. In this case, it is possible to retrieve the nominal torque from the motor between 5 and 50Hz (constant flux range). The maximum mechanical shaft power called up is calculated as follows:

$$P,W = \frac{M,Nm \times Drehzahl,upm}{9550} \qquad (1.1)$$

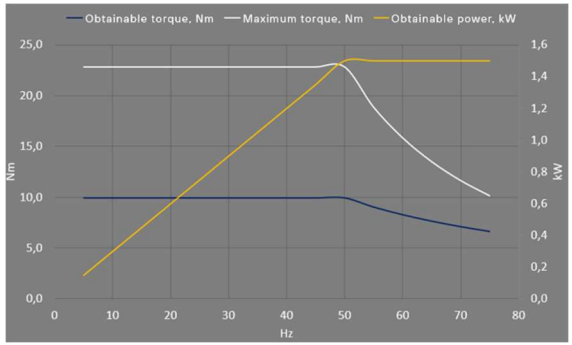

Figure21 : 50Hz - f3 cut-off frequency

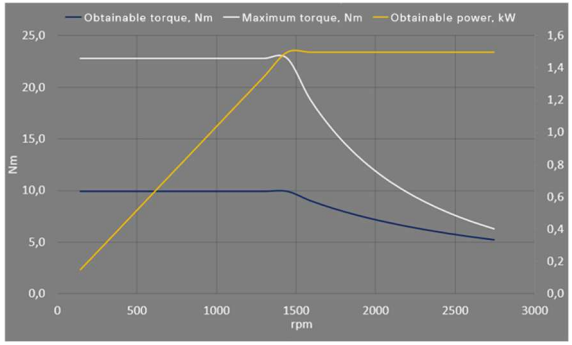

Figure22 : 50Hz characteristic curve of a 1.5kW 4P asynchronous motor

50Hz is the f3 cut-off frequency in*Figure21* above which the motor is in the field weakening range. In the field weakening range, the motor is operated with constant power (1.5 kW). *Figure22* shows the 50Hz characteristic curve with a speed setting range of 1:10 for the motor from **example A** (for IC411, note the reduction factor in continuous operation).

Example B: An asynchronous motor 1.5kW 4P 230/400V is to be operated at variable speed with V/f control using a frequency inverter with an input voltage of 400V. The motor has a rated torque of approx. 10Nm, approx. 1450 revolutions per minute and is connected to the frequency inverter in a delta circuit. In this case, it is possible to call up the nominal torque of the motor between 5 and 87Hz (constant flux range). The maximum mechanical shaft power called up is calculated as follows:

$$P,W = \frac{M,Nm \times Drehzahl,upm}{9550} \quad (1.2)$$

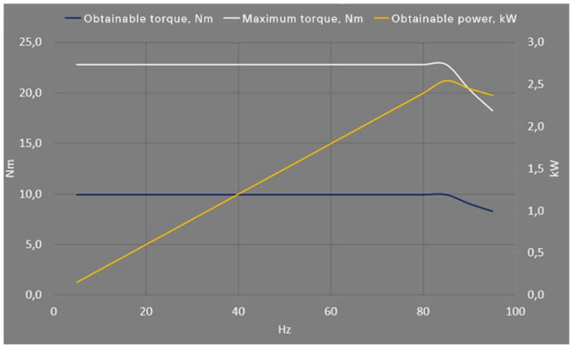

Figure23 : 87Hz - f3 cut-off frequency

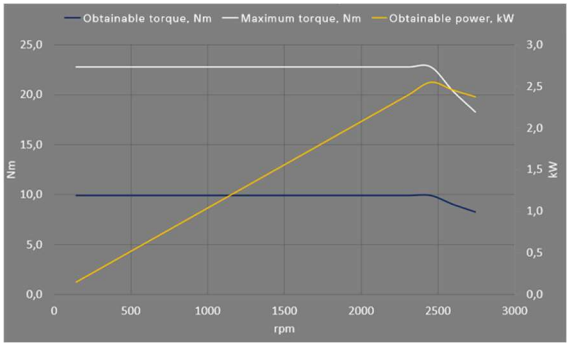

Figure24 : 87 Hz characteristic curve of a 1.5 kW 4P asynchronous motor

87Hz is the f3 cut-off frequency in the sense of the*Figure23* , above which the motor is in the field weakening range. In the field weakening range, the motor is operated with constant power (1.5 kW). *Figure24* shows the 87Hz characteristic curve with speed setting range 1:17 for the motor from **Example A**. (note the reduction factor in continuous operation for IC411). If self-ventilated motors (cooling type IC411) are to be operated continuously in the 5 - 50Hz speed-controlled range, a reduction factor for the torque must be taken into account in **Formula 1.1** and **1.2** in accordance with*Figure25*

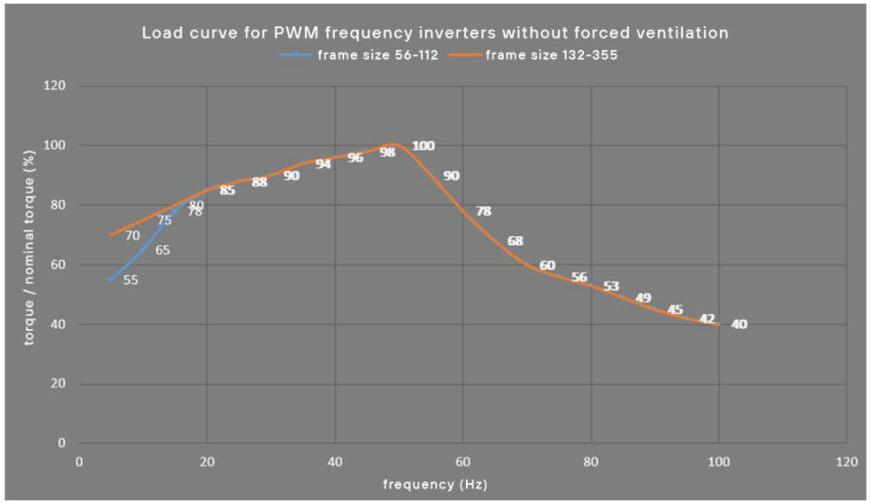

Figure25 : Reduction factor for the torque during operation on the frequency inverter

DANGER - Explosion

The reduction factor for the motor torque in accordance with*Figure25* must be taken into account for Ex motors in continuous operation in the 5 - 50 Hz range. Non-observance can lead to impermissible motor heating and ignition of the explosive atmosphere.

NOTE

Always observe the reduction factor for torque when operating on the frequency inverter!

In applications with constant torque over the entire adjustment range, the motor's own cooling is not sufficient. For such applications, externally ventilated motors with cooling type IC416 should be used.

DANGER - Explosion

In the 5 - 50Hz range of speed-controlled Ex motors in applications with constant torque, the motors must be equipped with a suitable Ex forced cooling fan. Non-observance can lead to impermissible motor heating and ignition of the explosive atmosphere.

5.6.2 Winding insulation, bearing currents and maximum speeds

Standard motors in all series are designed to be operated on a frequency inverter with a maximum input voltage of 480V. For higher input voltages, special motors with VFD windings should be used. The maximum permissible phase-to-earth voltage for a specific voltage rise time can be found at*Figure26* . If the permissible voltage according to the*Figure26* is exceeded, attenuating components such as special motor cables, filters or chokes must be installed. The manufacturers of the frequency inverters will be happy to provide you with further information.

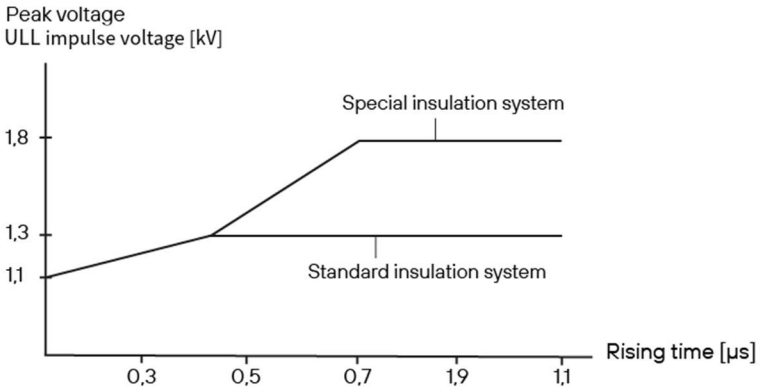

Figure26 : Maximum permissible U_{LL} in connection with voltage rise time

Ensure that the inverter is parameterized correctly and refer to the nameplate and the associated motor documentation for the relevant information. Observe the inverter manufacturer's operating instructions and notes on EMC. Do not exceed the maximum speeds specified in **Table** 3: Maximum permissible speeds during operation on the frequency inverter

Size	Number of poles	Series	Max. Speed, rpm
56-160	2	ACA ACM ACY	6000
		AOA	4500
180-355	2	ACM AMY AWM	4500
		AOM	3600
56-280	4	All	3000
315-355	4	All	2250
56-280	6	All	2000
315-355	6	All	1500
56-280	8	All	1500
315-355	8	All	1125

Table 3: Maximum permissible speeds during operation on the frequency inverter

Take the measures to reduce the bearing currents in accordance with DIN VDE 0530-25 Application guide for rotating electrical machines for use in drive systems. Observe the overall system consisting of inverter, motor and machine. The following steps are suitable for this:

- Project planning of the earthing system with low impedance
- Use of common mode filters at the inverter output
- Limiting the rate of voltage rise by means of an output filter
- Large-scale design of the contacting
- Use of equipotential bonding cables between motor and machine, between motor and inverter
- Use of symmetrically constructed and shielded power cable
- Shield connection on both sides of the motor and inverter
- Use of EMC cable glands
- Use of the current-insulated roller bearing on the non-drive end

6. Maintenance

6.1 General

Work on the motor may only be carried out in accordance with the safety rules and instructions mentioned in *chapters 1 - 6.* Careful and regular maintenance, inspections and revisions are required in order to detect and rectify any faults in good time before any consequential damage can occur. General intervals can be found in the**Table** 4 (intervals should be adapted to the local conditions, such as soiling, load, etc.). All deviations and abnormalities detected during the inspections must be rectified immediately.

Task	Time interval	Deadlines
Initial inspection	After approx. 500 h	After ½ year at the latest
Checking the airways and surface of the motor	Depending on the local degree of soiling	
Regreasing	According to**Table8Table9** or type plate	
Main inspection	Once a year	10.000 h

Table 4 : Reportable maintenance and inspections

6.2 Initial inspection

If present, dispose of the condensation water through drain holes and carry out the following checks when the engine is at a standstill:

- Testing the foundation.
- The following tests are carried out with the engine running:
- Testing the electrical parameters.
- Check the storage temperatures.
- Testing the running noise.

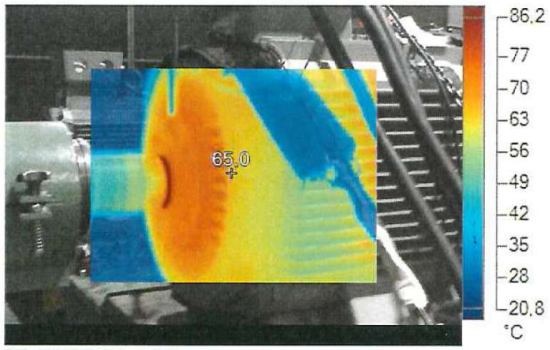

Figure 27: Measurement

6.3 Main inspection

The following tests are carried out when the machine is at a standstill:

- Testing the foundation.
- Check the alignment of the motor.
- Check the fastening screws and tightening torques (see *section 5.5.1*).
- Testing the cables and the insulation material. The test determines whether the cables and the insulation materials used are in proper condition. They must not show any signs of discoloration or even burn marks and must not be broken, torn or defective in any other way.
- Testing the winding insulation resistance (only permissible outside the Ex area for Ex motors).
- Depending on the lubrication quality, local ambient conditions and operating mode, it may also be necessary to change the grease in the regreasable ("open") roller bearings or replace the shaft seals after 10,000 operating hours (but at the latest after expiry of the agreed warranty period).

Figure 28**:** Main inspection

The following tests are carried out with the engine running:

- Testing the electrical parameters
- Checking the storage temperatures
- Testing the running noise
- Performance of bearing vibration analysis

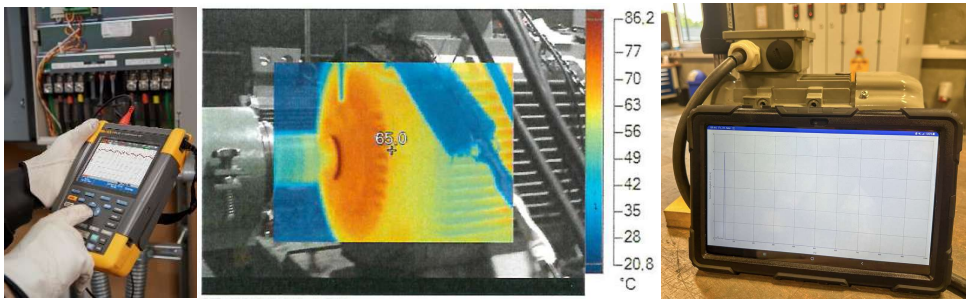

Figure 29**:** Main inspection

6.4 Lubrication of rolling bearings. Grease and lubrication intervals

The lubricating grease quality permits operation of the motors with non-relubricatable rolling bearing types (ZZ, 2RS etc.) for 20,000 hours without renewal of the rolling bearing grease under a motor load (radial and axial load, normal duty cycle) and under the environmental conditions specified in the respective motor documentation. The condition of the lubrication and the entire bearing should be checked before this period, if necessary by means of a bearing vibration analysis. The specified number of running hours and relubrication intervals for open rolling bearing types only apply to operation at nominal speed and a bearing operating temperature of 80°C (ambient temperature 40°C).

When operating on the frequency inverter and at higher ambient temperatures, the specified lubrication intervals must be reduced in accordance with *table 20* due to the associated higher heating of the motor. If the rated speed is exceeded when operating the motor on the frequency inverter, the relubrication interval is reduced in inverse proportion to the increase in speed according to *Table 21*. Multiply the factors from *Tables 20* and *21* by the corresponding lubrication interval from *Table 22* to calculate the adjusted lubrication interval. The bearings are regreased after they have been thoroughly cleaned with suitable solvents.

A calculation example for an ACM 180 - 4P with deep groove ball bearing 6311.C3, the motor is operated at 70Hz and an ambient temperature of 50°C:

$$Schmierfrist = 5400\ BS\ \times 0{,}70\ \times 0{,}75 = 2835\ BS$$

NOTE

For operation at increased speed or ambient temperature, the specified lubrication intervals must be reduced in accordance with *Tables 20* and *21*.

Ambient temperature	41 - 45 °C	46 - 50°C	51 - 55°C	56 - 60°C
Reduction factor for lubrication period	0,90	0,70	0,55	0,30

Table5 : Lubrication interval reduction at increased ambient temperatures

Ratio operating frequency / 50Hz	1,0-1,2	1,21-1,3	1,31-1,4	1,41-1,5	Over 1.5
Reduction factor for lubrication period	0,95	0,85	0,75	0,55	0,35

Table6 : Lubrication interval reduction at increased speeds

The following factors and special operating conditions have an additional influence on bearing change and lubrication intervals:

- Vertical motor installation
- Large vibration or impact load
- Switching frequency and reversing operation
- Increased temperature, dirt and moisture in the environment

Lubricating greases with an identical oil base and thickener must be used. The grease quantity specified on the rating plate must be observed. Approximately

double the quantity should be used for the first relubrication, as the grease lubrication tubes are still empty. The used grease must be disposed of after 3 relubrication processes.

In the standard version, motors of the ACM, AWM and AMY series up to and including frame size 280M and the AOM series up to and including frame size 225 are equipped with permanently lubricated bearings (type .ZZ. or type .RS. or .RZ). If the motors are equipped with open roller bearings, but also with current-insulated or cylindrical roller bearings (NU bearings) in accordance with the motor documentation, the relubrication intervals can be found on the motor rating plate or in *Table 22.*

Size	Number of poles	Bearing type DE	Bearing type NDE	Relubrication intervals, h	Regreasing grease quantity, g
ACM and AMY series. Motors with efficiency classes IE2 and IE3 are marked with *, motors with efficiency classes IE4 and IE5 are marked with **					
160	2	6309.C3* / NU309 6209.C3** / NU309	6309.C3* 6209.C3**	2000	20
	4	6309.C3 / NU309		5400	
	6,8			6900	
180	2	6311.C3* / NU311 6211.C3** / NU311	6311.C3* 6211.C3**	2000	25
	4	6311.C3 / NU311		5400	
	6,8			6900	
200	2	6312.C3* / NU312 6212.C3** / NU312	6312.C3* 6212.C3**	1500	30
	4	6311.C3 / NU311		5000	
	6,8			6500	
225	2	6313.C3* / NU313 6213.C3** / NU313	6313.C3* 6312.C3**	1500	35
	4	6313.C3 / NU313		5000	
	6,8			6500	
250	2	6314.C3* / NU314 6213.C3** / NU313	6314.C3* 6313.C3**	1000	45
	4	6314.C3 / NU314		4500	
	6,8			6300	
280	2	6314.C3 / NU314	6314.C3	1000	45
	4	6317.C3 / NU317	6317.C3* 6314.C3**	4000	70
	6,8			6000	70
315	2	6317.C3 / NU317	6317.C3	1000	
	4	6319.C3 / NU319	6319.C3	3500	90
	6,8			5800	
355	2	6319.C3 / NU319	6319.C3	1000	90
	4	6322.C3 / NU322	6322.C3	2800	120
	6,8			4800	
400	2	6320.C3 / NU320	6320.C3	1000	100
	4	6324.C3 / NU324	6324.C3	2300	145
	6,8			4200	

Table7 : Relubrication intervals ACM & AMY series

Size	Number of poles	Bearing type DE	Bearing type NDE	Relubrication intervals, h	Regreasing grease quantity, g
AOM series					
160	2	6309.C3	6209.C3	8500	12
	4			16000	
	6,8			20000	
	2	NU309	6309.C3	3000	
	4			8000	
	6,8			11000	
180	2	6310.C3	6210.C3	7500	15
	4			15000	
	6,8			19000	
	2	NU310	6310.C3	2500	

	4			7500	
	6,8			10000	
200	2	6312.	6212.C3	6000	20
	4			13000	
	6,8			17000	
	2	NU312	6312.C3	1900	
	4			6000	
	6,8			9000	
225	2	6313.C3	6213.C3	5000	23
	4			12000	
	6,8			16500	
	2	NU313	6313.C3	1600	
	4			5500	
	6,8			9000	
250	2	6315.C3	6315.C3	4000	30
	4			11000	
	6,8			15000	
	2	NU315		1100	
	4			4500	
	6,8			7500	
280	2	6316.C3	6316.C3	3500	33
	4			10000	
	6,8			14500	
	2	NU316		900	
	4			4000	
	6,8			7000	
315	2	6316.C3	6316.C3	2500	33
	4	6319.C3	6319.C3	8500	45
	6,8			13000	
	2	NU316	6316.C3	500	33
	4	NU319	6319.C3	3300	45
	6,8			6000	
355	2	6319.C3	6319.C3	2000	45
	4	6322.C3	6322.C3	6500	60
	6,8			11000	
	2	NU319	6319.C3	300	45
	4	NU322	6322.C3	2300	60
	6,8			4500	

Table8 : Relubrication intervals AOM series

Size	Number of poles	Bearing type DE	Bearing type NDE	Relubrication intervals, h	Regreasing grease quantity, g
AWM series					
160	2	6309.C3 / NU309	6309.C3	2000	15
	4,6,8	6309.C3 / NU309	6309.C3	4000	15
180	2	6311.C3 / NU311	6311.C3	2000	20
	4,6,8	6311.C3 / NU311	6311.C3	4000	20
200	2	6312.C3 / NU312	6312.C3	2000	22
	4,6,8	6312.C3 / NU312	6312.C3	4000	22
225	2	6313.C3 / NU313	6313.C3	2000	24
	4,6,8	6313.C3 / NU313	6313.C3	4000	24
250	2	6314.C3 / NU314	6314.C3	2000	26
	4,6,8	6314.C3 / NU314	6314.C3	4000	26
280	2	6314.C3 / NU314	6314.C3	2000	26
	4,6,8	6317.C3 / NU317	6317.C3	4000	38
315 315X	2	6317.C3 / NU317	6317.C3	2000	38
	4,6,8	6319.C3 / NU319	6319.C3	4000	45
355	2	6317.C3 / NU317	6317.C3	2000	38
	4,6,8	6322.C3 / NU322	6320.C3	4000	60
355X	2	6220.C3 / NU220	6220.C3	2000	40
	4,6,8	6322.C3 / NU322	6322.C3	4000	60

400 400X	2	6220.C3 / NU220	6220.C3	2000	40
	4,6,8	6326.C3 / NU326	6326.C3	4000	85
450X	2	6221.C3 / NU221	6221.C3	2000	45
	4,6,8	6328.C3 / NU328	6328.C3	4000	95

Table9 : Regreasing intervals for open deep groove ball bearings and cylindrical roller bearings

Relubrication is permitted on both running and stationary engines, provided the following points are observed:

- When the motor is running, it must be ensured that the grease outlet opening and the lubrication channel are open. The intended
- Inject a small amount of grease into the bearing and run the engine for 1 - 2 hours. Close the plug of the grease outlet opening. A temporary rise in temperature may occur at the bearing for approx. 10 hours.
- If the engine is not running, use only half the amount of relubricating grease. Then leave the engine running for one hour. After the engine has stopped, inject the remaining amount of relubricating grease into the bearing. After two hours of running, close the grease outlet opening.

For the relubrication of motors, only a grease suitable for the lubrication of ball bearings or roller bearings with the following properties may be used:

Properties of the lubricating grease	2-pole	4-pole	6-pole	8-pole
AWM series				
Base oil	Mineral oil			
Thickener	Polyurea			
Viscosity 40°C	110			
Consistency	2			
Continuous operating temperature, min.	-30 + 180°C			
ACM, AMY, AOM series				
Base oil	Mineral oil			
Thickener	Lithium			
Viscosity 40°C	100			
Consistency	3			
Continuous operating temperature, min.	-25 + 130°C			

Table10 : Selection of grease for relubrication

NOTE

Use suitable grease for relubrication.

Table 23 is a grease specification and only applies to ambient temperatures from -30°C to +60°C, bearing temperatures up to 120°C and operation at the rated speed. Special high-speed greases may be used for operation above the rated speed.

6.5 Service forced cooling fan

Check the condition of the forced cooling fan during each inspection, observing the safety rules and instructions in *chapter 1* -6 . Check the electrical connection and the air ducts. Check for dirt and dust deposits and remove any irregular deposits immediately, as these can lead to imbalances. Replace the permanently lubricated roller bearings of the forced cooling fan motor after 20,000 operating hours.

7. Ex motors with type of protection "ec" and "tc"

7.1 Safety instructions

For the Ex motors with type of protection "ec" and "tc", the special information from the *chapter8* Safety rules, notes on intended and improper use, notes on transportation and storage, notes on installation and assembly, notes on operation and maintenance from *the chapter0 -4 and6 -7* also apply to the Ex motors with type of protection "ec" and "tc". The increased danger posed by explosive atmospheres requires careful observance of this information. Failure to do so may result in the ignition of an explosive atmosphere.

It is necessary that all specialists responsible for project planning, transportation, installation, commissioning and maintenance of Ex motors are qualified in accordance with Directive 99/92/EC, EN 60079-14, EN 60079-17 and national and local regulations.

Within Germany, the technical regulations for operational safety (TRBS), the Hazardous Substances Ordinance (GefStoffV) and the explosion protection regulations (Ex-RL) must also be observed by the operator.

According to the German Ordinance on Industrial Safety and Health (BetrSichV), the operator must assess the hazards that arise before using electrical equipment (risk assessment) and derive suitable protective measures. The presence of a CE and ATEX marking does not release the operator from the obligation to carry out a risk assessment.

DANGER - Explosion

Operation in an explosive atmosphere of an electric motor that is not approved for use in an explosive atmosphere is strictly prohibited.

DANGER - Explosion

Opening the electric motor in an explosive atmosphere is strictly prohibited. Inside the electric motor, individual components may have higher temperatures than the maximum permissible surface temperature of the housing during normal operation.

DANGER - Explosion

Testing the winding insulation in an explosive atmosphere is strictly prohibited. Insulation measurements can cause sparking. After the measurement, the terminal studs should be discharged by short-circuiting.

DANGER - Explosion

Use of the Ex motor in a hybrid explosive atmosphere (mixture of explosive gas and combustible dust) is strictly prohibited.

DANGER - Explosion

Dust deposits with a layer thickness of more than 3 mm. Obstruction of the cooling air flow and heat input from external heat sources can affect the internal cooling and the surface temperature of the Ex motor and must be avoided.

7.2 Meaning Type of protection "e" and "t" and appliance protection level EPL Gc and Dc.

If the formation of an explosive atmosphere cannot be avoided, the zone division determines the degree of danger posed by an explosion. Potentially explosive atmospheres are divided into zones according to the frequency and duration of the occurrence of hazardous explosive atmospheres. Zoning carried out carefully and professionally by the operator of the electrical installation presupposes the explosion protection measures and thus the requirements for the type of protection of the electrical equipment used.

The types of protection are defined in the IEC 60079 series of standards and describe a basic principle by which the potential ignition source is protected against becoming effective. According to IEC 60079, some types of protection are available in different EPL equipment protection levels, which correspond to the specific equipment categories according to the ATEX directive.

The Ex motors with type of protection "e" and equipment protection level EPL Gc and the Ex motors with type of protection "t" and equipment protection level EPL Dc are the subject of these instructions. These Ex motors are electrical devices with an "extended" level of protection in terms of explosion protection and are intended for use in systems in areas where an explosive atmosphere does not occur during normal operation and, if it does, can occur rarely and for short periods.

Table11 shows an assignment between type of protection, device category, application in zone and temperature class.

Type of protection	Representation	Basic principle
Increased safety "e"		Type of protection used for electrical devices in which additional measures are taken to prevent the possibility of impermissibly high temperatures and the occurrence of sparks or arcs during intended operation with an increased degree of safety
Protection by housing "t"		Type of protection against explosive dust atmospheres in which the electrical device has an enclosure with protection against dust ingress and a measure to limit the surface temperature

Table11 : Types of protection for electrical equipment

Type of protection	Device category	Application in zone	Device protection level EPL	Temperature class	Sufficient security
Increased safety "e"	3G	2	Gc	T3 or T4	Trouble-free operation (normal operation)
Protection by housing "t"	3D	22	Dc	125°C	

Table12 : Type of protection, appliance category, application in zone and temperature class

Nameplate data for Ex motors

*Figure30***Figure1Figure30** : Type plate Ex motor shows a sample rating plate from an Ex motor.

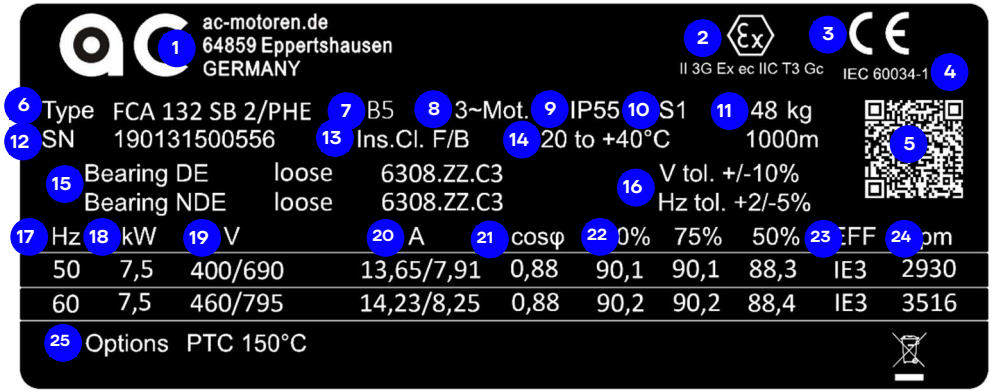

Figure30 : Type plate Ex motor

ID	Nameplate information	ID	Nameplate information	ID	Nameplate information
1	Company logo and address	10	Operating mode	19	Nominal voltage
2	Explosion protection labeling	11	Weight	20	Rated current
3	CE marking	12	Serial number	21	Power factor
4	Standard specification	13	Insulation class	22	Efficiency
5	Data Matrix - Code	14	Ambient conditions (temperature and installation height)	23	Efficiency class
6	Type designation	15	Bearing type	24	Rated speed
7	Design	16	Voltage and frequency tolerance	25	Accessories
8	Motor type	17	Nominal frequency		
9	IP - Protection class	18	Rated power		

Table13 : Nameplate data for Ex motors

7.3 Standards applied

Ex motors from AC - Motoren GmbH have been developed, manufactured and tested in accordance with the state of the art and ISO 9001:2015 and meet the requirements of the following standards:

EN standard	Issue
EN 60034 - 7	2022 + AC: 2023 - 10
EN 60034 - 6	1993 - 11
EN 60079 - 0	2018 - 07
EN 60079 - 7	2015 / A1: 2018 - 01
EN 60529	1991 / A2: 2013 - 10

Table14 : Applied standards statuses

7.4 Additional information on transportation, installation and assembly of Ex motors

This section describes the special features of transporting, installing and mounting Ex motors. The information in *chapter4* must also be observed.

The lifting eyes or eyebolts of the Ex motors must be used for transportation using suitable lifting gear. The lifting eyes and eyebolts are only intended for lifting the Ex motors without additional attachments such as base plates, gearboxes, etc. Before use, make sure that the lifting gear is properly attached and free of damage.

For motors with a higher IP protection class (IP65, IP56, IP66) and for Ex motors, the eyebolts (DIN580) must be removed after installation (these are present on cast iron motors from size 100 in the ACM and AWM series). The threaded holes that are now open must be sealed with the hexagon head screws (ISO4017) and washers (DIN125) supplied. Use the Loctite surface sealant to permanently seal the threaded holes in accordance with the protection class. The hexagon head screws supplied must be tightened to the torques specified in the *Table15 : Tightening* torques for screw plugs to attract.

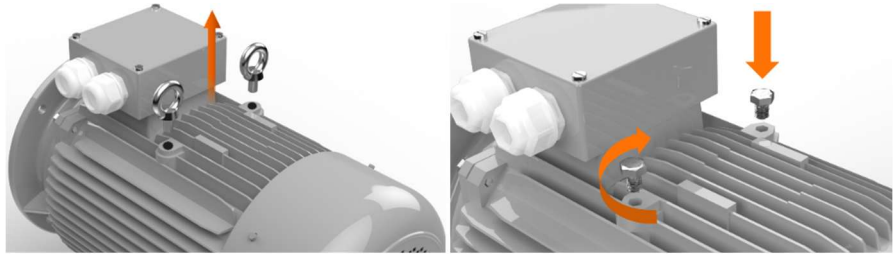

Figure 31**:** Replacing eyebolts with hexagon head screws for motors with increased IP protection class and Ex motors

Motor size	Screw size	Tightening torque, Nm
160 - 180	ISO4017 M12 x 15	43
200 - 225	ISO4017 M16 x 15	106
250	ISO4017 M20 x 20	215
280	ISO4017 M24 x 20	370
315	ISO4017 M30 x 25	410
355	ISO4017 M36 x 25	540

Table15 : Tightening torques for screw plugs

Only remove the existing transport locks before commissioning and keep the transport lock and eyebolts until you need to transport the appliance again.

Only use suitable and ATEX-marked transmission elements such as belts, pulleys and couplings.

Special care must be taken when installing an Ex motor vertically: When installing with the shaft end pointing upwards, the operator / installer of the system must ensure that no foreign objects fall into the motor fan cover and prevent the flow of cooling air. The collection of condensation water in flange basins, e.g. with IEC types V3 / B36, must be avoided by regular drainage, e.g. by means of a condensation drain hole. When installed with the shaft end pointing downwards, Ex motors must be fitted with a protective cover on the motor fan cover as standard. This protective cover must not be damaged and thus prevent the flow of cooling air. It is essential to specify the design when ordering an Ex motor.

NOTE
Eyebolts must be removed. Seal the open threaded hole with Loctite and close it with the hexagon head screw supplied!

7.5 Electrical connection of the Ex motors

All work may only be carried out by qualified specialist personnel on the stationary motor when it is disconnected and secured against being switched on again, taking into account the safety rules in *chapter 1.3.* This also applies to auxiliary circuits (standstill heating). The rating plate information and the connection diagram in the terminal box must be observed.

NOTE
The information on the motor rating plate and connection diagram must be observed.

The cable entries, cable glands, extensions and reducers, blanking plugs must be approved for the Ex area. Connection cables should be designed for the system-dependent conditions specified in DIN VDE 0100 (current, ambient temperature, type of installation, etc.). The connection must be made in such a way that a permanently safe electrical connection is maintained (no protruding wire ends). Cables with a circular cross-section and suitable ring cable lugs must be used for the connections of all main cables. A secure protective conductor connection must be established. Tightening torques can be found in the **table 4.**

NOTE
Use suitable connection cables and cable glands approved for hazardous areas

There must be no foreign bodies, dirt or moisture in the terminal box. Ex motors are only supplied with blanking plugs in the cable entry openings that are suitable for transportation and storage in the rooms and ambient conditions specified in *chapter 3.2.*

The dummy plugs as well as the remaining unused cable entry openings and the terminal box should be sealed dustproof and watertight by the person responsible for the system before commissioning.

7.6 Operation on the frequency inverter

Ex motors with ignition protection type "ec" and "tc" in the standard version include an insulation system that is suitable for operation on frequency inverters with AC input voltage up to 400V. If the frequency inverter used is not approved for operation in the corresponding ATEX zone, the frequency inverter must be installed outside the ATEX zone. The maximum permissible U_{LL} for a specific voltage rise time can be found at **Figure 26** in *chapter 5.6.*2

When operating standard motors, observe the maximum permissible voltage peaks in accordance with IEC 60034 - 18 - 41. If the expected winding stress is to be outside the permissible range, du/dt or sine filters may be used. Observe the permissible voltage drop in the drive train. Follow the EMC instructions of the inverter manufacturer and ensure EMC-compliant design. The maximum permissible speeds according to the **table 18** must be observed. Design your speed-controlled drive so that the Ex motor is not thermally overloaded. Observe the design instructions in *chapter 6.2*. We recommend connecting and evaluating the protective device provided for the motor winding (PTC thermistor) to the frequency inverter to provide additional protection for the Ex motor against overheating.

7.6.1 Properties of a frequency inverter

- Only use frequency inverters that perform load-dependent terminal voltage adjustment in the low speed range (5 - 10 Hz)
- The output and input voltages of the frequency inverter must be matched to the rated motor voltage and mains voltage
- Ex motors must be operated with frequency inverters equipped with the i2t monitoring function
- Note the pulse frequency of the inverter: optimum setting is 4 kHz - 6 kHz

7.6.2 ATEX connection - forced cooling fan

The Ex motors can optionally be configured with forced ventilation (cooling type IC416 in accordance with IEC 60034-6). Observe the information from the motor data sheets and associated documentation, nameplate information and the following instructions when connecting the ATEX forced cooling fan:

- Comply with the requirements of IEC 60664-1 or IEC 61800-5-1 and the safety rules from *chapter 1.3*.
- Observe the connection diagrams in *chapter 13*. The cables to be connected must be fitted with insulated ring cable lugs or eyelets.
- Use suitable ATEX cable glands with at least IP66, as the ATEX forced cooling fans are supplied with transport blanking plugs.
- Never operate the motor without a forced cooling fan. Carry out a test run, make sure that the air flow is drawn in through the fan grille and blown over the motor (see the direction of rotation arrow).
- Pay attention to the passage of the fan wheel: the blades must not be deformed or bent. If the motor is installed vertically, use a protective roof to protect the forced cooling fan from foreign objects falling in.
- The Ex markings between the Ex forced fan and the Ex motor may differ, whereby the lowest explosion protection applies to the entire assembly.

7.7 Further operating conditions of Ex motors

The Ex motors are designed for S1 continuous operation and normal, non-recurring start-ups. Two consecutive starts from a cold state and one start from a warm state are permissible under loads in accordance with EN 60034 - 12. The maximum permissible starting time of the Ex motor with direct connection to the mains is 5 seconds and must not be exceeded. For other starting conditions, please contact AC Motoren GmbH.

Exceeding the tolerances according to IEC / EN 60034-1 (VDE 0530-1) ±5% voltage and ±2% frequency deviation (range A) can lead to impairment of the permissible surface temperature of an Ex motor. For this reason, compliance with the tolerances must be ensured.

As standard, the Ex motors with ignition protection type "ec" and "tc" are suitable for operation at rated speed and rated power in the ambient temperature range from -20°C to +40°C and installation altitude up to 1000m above sea level. If the ambient temperature is between +40°C and +60°C or the installation altitude is above 1000m, the mechanical shaft power taken must be reduced in accordance with the**Table16**

.

Installation height	Ambient temperature						
	≤30°C	35°C	40°C	45°C	50°C	55°C	60°C
1000			100%	96%	92%	87%	82%
1500		100%	97%	93%	89%	84%	79%
2000	100%	97%	94%	90%	86%	82%	77%
2500	96%	93%	90%	86%	83%	78%	74%
3000	92%	89%	86%	82%	79%	75%	70%
3500	88%	85%	82%	79%	75%	71%	67%
4000	82%	79%	77%	74%	71%	67%	63%

Table16 : Power reduction at increased ambient temperature and installation altitude

When using motors with gearboxes, observe the ATEX marking on the gearbox. If an Ex motor is flange-mounted to a gearbox, the temperature of the gearbox oil must be taken into account. If the gearbox oil temperature permanently exceeds 80°C during operation, the A-side standard roller bearing and the A-side standard shaft seal must be replaced with the corresponding high-quality, temperature-resistant components.

7.8 Maintenance and repair

During maintenance and repair, special requirements must be observed and followed for products in the Ex area.

7.8.1 Non-function-critical repair/maintenance on site

Repairs/repairs on site may only be carried out by qualified specialist personnel. The specialist personnel used must be instructed by the end user of the products in accordance with the safety regulations in the Ex area.

A repair plate must be attached after the repair/replacement (see *chapter 7.9.4*).

Repairs must only be carried out using suitable tools for the Ex area (see *chapter 7.9.3*).

7.8.2 Function-critical repair/overhaul

A function-critical repair/overhaul may only be carried out by qualified workshops with certification for the Ex area or by the manufacturer itself. If the product is repaired/repaired by a repair workshop, a repair plate must be attached (see *chapter7.8.4*). Repairs must only be carried out using suitable tools for hazardous areas (*see chapter7.8.3*).

*under the term function-critical

7.8.3 Suitable tools for the Ex area

Tools that are used in hazardous areas are called "low-spark tools" and must be selected and used in accordance with the hazardous area. Low-spark tools are characterized by the fact that they are made of non-ferrous metals, which significantly reduces the generation of sparks.

7.8.4 Repair plate

The repair plate (**Figure32**) must contain the following information:

(1) Repair symbol
(2) Number of the standard "IEC 60079-19" or equivalent
(3) Name of the repairer or registered trademark and repair shop certification
(4) Reference number of the repairer for the repair and date of the process

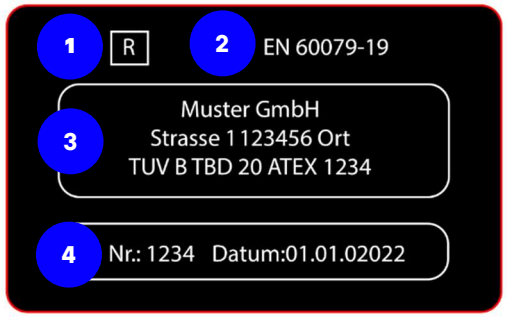

Figure32 : Repair label

7.8.5 Spare parts for repairs

Only original spare parts from the engine manufacturer may be used for repairs/repairs. Spare parts that do not correspond 1-to-1 to the original must be checked and individually approved by the manufacturer.
If a deviating spare part is used without inspection and approval by the manufacturer, the product conformity for the Ex area is void.

NOTE

The term "non-function-critical" covers repairs that have no direct effect on the proper rotation of the shaft or the winding. Example: If only one component is replaced without having to readjust the shaft, this is referred to as "non-function-critical"

NOTE

The term "function-critical" covers repairs where the functionality of the shaft rotation or the winding must be restored. For example: if a component is replaced and the shaft has to be readjusted, this is referred to as "function-critical".

8. Troubleshooting

Table17 : TroubleshootingTable17 describes the causes of any faults that may occur and the corresponding measures to be taken. The work may only be carried out by qualified personnel using suitable tools and aids. For further information, please contact AC Motoren GmbH.

Error	Cause	Measures
Engine does not start	Motor overloaded	Reduce load
	Stator winding wired	Check the winding circuit
	Faulty power supply	Check whether the power supply corresponds to the specifications on the rating plate
	Interruption of a phase	Check cables, check switches
	Mechanical fault	Check that the motor and drive rotate freely. Check bearings and lubrication
	Defective rotor	Check for broken rods or end rings
	Blown fuses	Use a suitable fuse
Motor runs slowly / does not start up at all	Starting load too high	Check starting load
	Undervoltage at motor terminals due to mains voltage drop	Use a higher voltage or higher transformer stage or reduce the load. Use an appropriate cable cross-section.
	Defective rotor / broken rotor bars	Check for broken rods or end rings
	Winding / phase closure	Have it repaired in the workshop
Motor overheats during operation with load	Overload	Reduce load
	Coolant supply prevented by dirt deposits	Ensure proper cooling and cleanliness
	Failure of a phase	Check that the cables are connected correctly
	Earth fault	Have it repaired in the workshop
	Asymmetry of the clamping voltage	Check connecting cables and transformer for faults
Motor vibrations	Incorrect alignment	Align motor
	Substructure is unstable	Reinforce substructure
	Unbalance in clutch / gearbox	Clutch / gearbox balancing
	Imbalance in driven machine	Rebalance the system
	Bearing defect	Replace bearing
	Multiphase motor runs single-phase	Check for open circuit
Noises	Grinding rotating parts	Correct mounting
	Winding / phase closure	Have it repaired in the workshop
	Interruption of a phase	Check cables, check switches
Storage temperature too high	Shaft bent or damaged	Straighten or replace shaft
	Belt drive incorrect	Reduce belt tension, arrange pulley closer to bearing
	Poor alignment	Align motor
	Insufficient / excess grease	Observe lubrication quantity

Table17 : Troubleshooting

9. Waste disposal

The motors are made from components and materials that can be recycled. Observe the respective country-specific legal regulations and provisions for disposal. The motors should be dismantled in accordance with the safety rules and instructions in chapters 1 - 6. Separate the components according to the following groups:

- Steel and iron
- Aluminum
- Non-ferrous metal
- Insulating materials
- Cables and wires
- Electronic waste
- Chemicals such as oil, grease and paint residues
- Packaging

Only dispose of the separated components at a specialist disposal company.

Structure of the motors

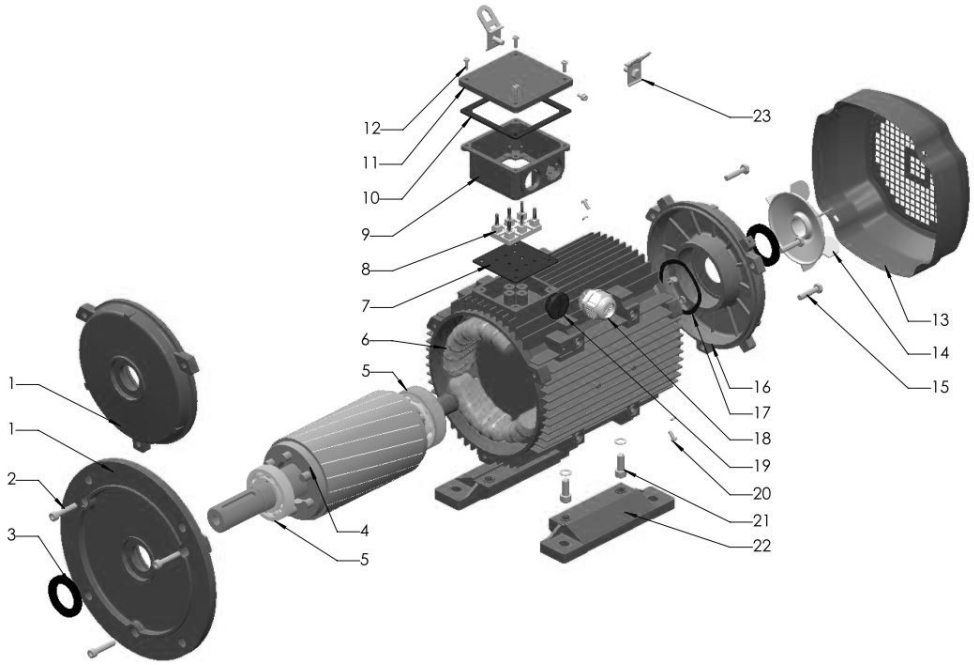

Figure33 : Structure of motors in the ACA - ACY - AFS series

ID	Designation	ID	Designation
1	Flange / end shield A-side	13	Fan cover
2	Flange / end shield screw A-side	14	Fan blade
3	Shaft seal	15	Flange / end shield screw B-side
4	Runner	16	End shield B-side
5	Rolling bearing A-side, B-side	17	Shim
6	Motor housing with stand	18	Cable gland
7	Gasket for lower part of terminal box	19	Blanking plug
8	Clipboard	20	Fastening material for fan cowl
9	Terminal box	21	Fixing material feet
10	Terminal box cover seal	22	Motor feet
11	Terminal box cover	23	Lifting eyes with fastening material
12	Cover screw		

Table18 : Structure of ACA-ACY series motors

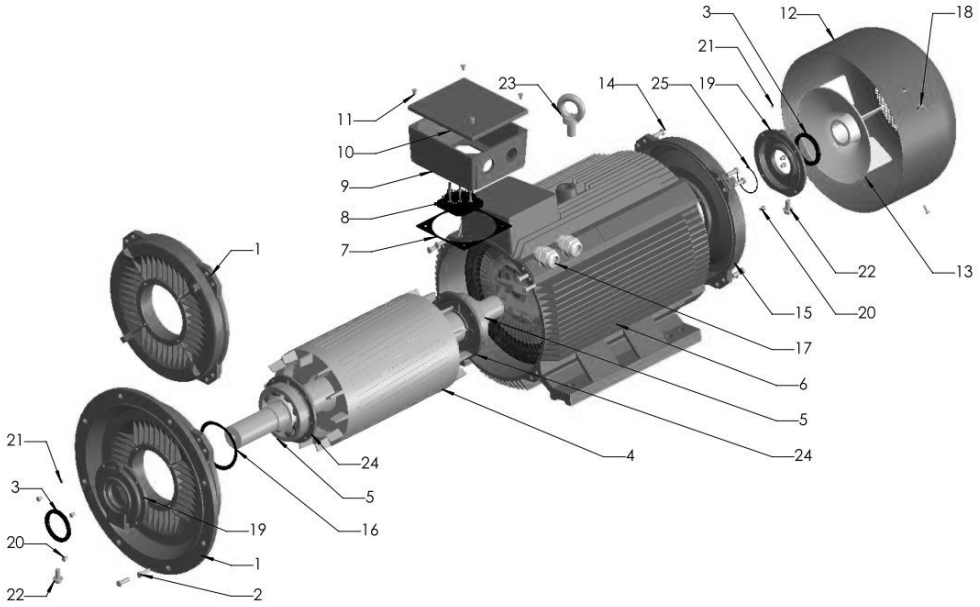

Figure34 : Design of motors from the ACM - AWM - AMY series

ID	Designation	ID	Designation
1	Flange / end shield A-side	14	Flange / end shield screw B-side
2	Flange / end shield screw A-side	15	End shield B-side
3	Shaft seal	16	Shim
4	Runner	17	Cable gland
5	Rolling bearing A-side, B-side	18	Fastening material for fan cowl
6	Motor housing with stand	19	Bearing cover outside A-side, B-side
7	Gasket for lower part of terminal box	20	Bearing cover screw
8	Clipboard	21	Grease nipple
9	Terminal box	22	Screw plug for grease outlet
10	Terminal box cover	23	Ring - screw DIN580
11	Cover screw	24	Bearing cover inside A-side, B-side
12	Fan cover	25	Circlip
13	Fan blade		

Table19 : Structure of motors in the ACM - AMY - AWM series

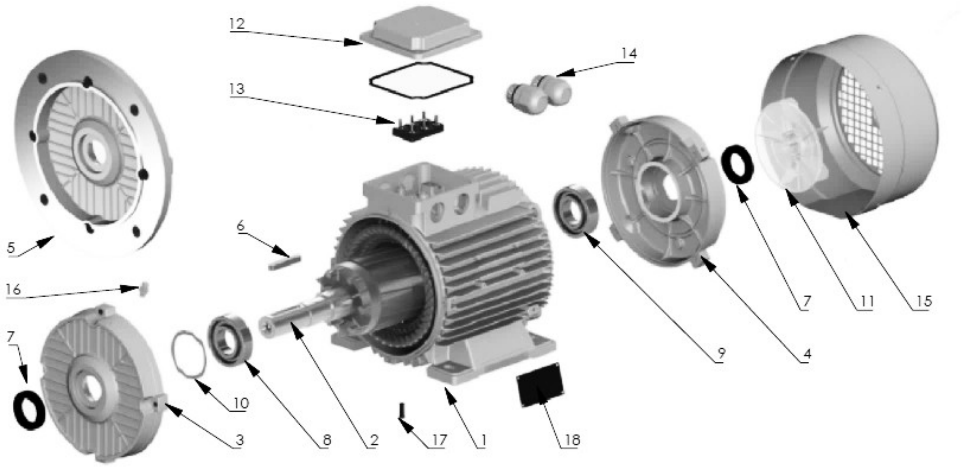

Figure35 : Design of motors in the AOA series sizes 80 - 112

ID	Designation	ID	Designation
1	Stator	10	Shim
2	Runner	11	Fan blade
3	End shield A-side	12	Terminal box cover with seal
4	End shield B-side	13	Clipboard
5	Flange A-side	14	Cable gland
6	Feather key	15	Fan cover
7	Shaft seal	16	Transducer for vibration measurement
8	Bearing A-side	17	Screw plug for condensation hole
9	Bearing B-side	18	Type plate

Table20 : Structure of motors in the AOA series sizes 80 - 112

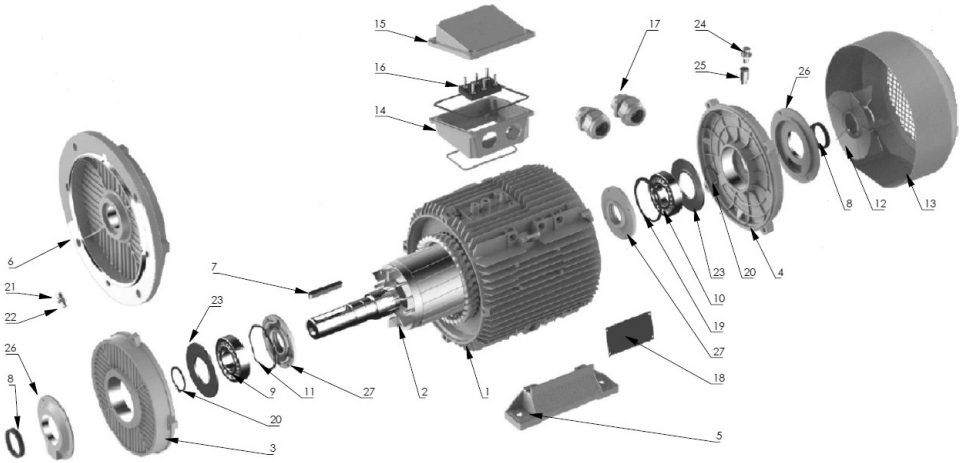

Figure36 : Structure of motors in the AOA series sizes 132 - 225

ID	Designation	ID	Designation
1	Stator	15	Terminal box cover with seal
2	Runner	16	Clipboard
3	End shield A-side	17	Cable glands
4	End shield B-side	18	Type plate
5	Motor feet	19	Circlip inside
6	Flange A-side	20	Circlip outside
7	Feather key	21	Transducer for vibration measurement
8	Shaft seal	22	Screw plug for condensation hole
9	Bearing A-side	23	Grease holder
10	Bearing B-side	24	Grease nipple
11	Shim	25	Extension for grease nipple
12	Fan blade	26	Bearing cover outside
13	Fan cover	27	Bearing cover inside
14	Terminal box		

Table21 : Structure of motors in the AOA series Sizes 132 - 225

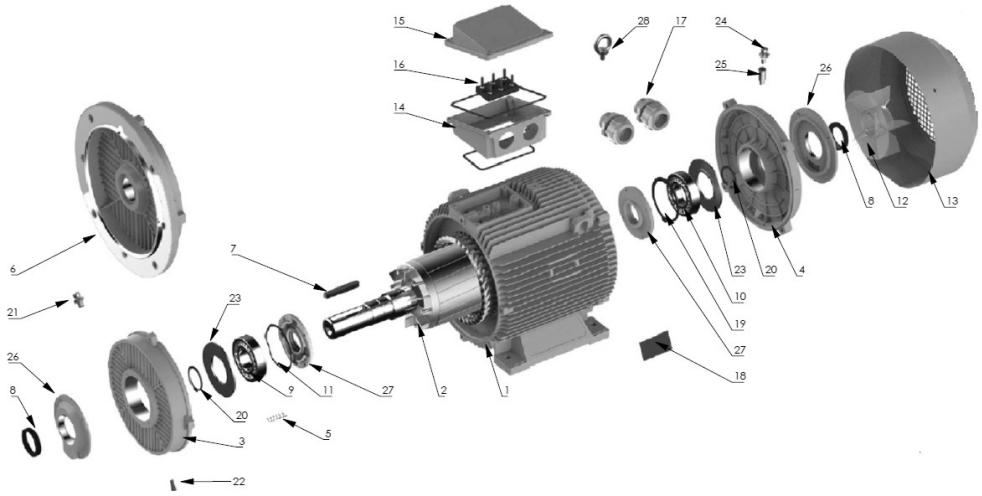

Figure37 : Structure of motors in the AOM series sizes 250 - 355

ID	Designation	ID	Designation
1	Stator	15	Terminal box cover with seal
2	Runner	16	Clipboard
3	End shield A-side	17	Cable glands
4	End shield B-side	18	Type plate
5	Coil spring	19	Circlip inside
6	Flange A-side	20	Circlip outside
7	Feather key	21	Transducer for vibration measurement
8	Shaft seal	22	Screw plug for condensation hole
9	Bearing A-side	23	Grease holder
10	Bearing B-side	24	Grease nipple
11	Shim	25	Extension for grease nipple
12	Fan blade	26	Bearing cover outside
13	Fan cover	27	Bearing cover inside
14	Terminal box		

Table22 : Design of motors in the AOM series sizes 250 - 355

10. Declaration of conformity

Declaration of Conformity ac motoren

Manufacturer: AC-Motoren GmbH
Address: Einsteinstr. 17, D-64859 Eppertshausen
Homepage: www.ac-motoren.de

AC-Motoren GmbH in the sole responsibility confirm herewith, that the below listed three-phase and single-phase asynchronous motors

Types: ACA, FCA, FCPA, ACM, FCM, FCMP, ACR, ACL, FCPR, FCPL, ACY, FCY, FCPY, AMY, FMY, FYMP, AYR, AYL, FYMR, FYML, AGS, FGS, FGSP, AWM, FWM, FWMP, AWL, AWR, FWMR, FWML, AD, FD, FDP, AF, FF, FFP, AY, FY, FYP, ABA, FBA, FBPA, ABS, FBS, FBSP, AH, FH, FHP, AHR, AHL, FHPR, FHPL, AOA, FOA, AOR, AOL, FOPR, FOPL, FOPA, AOM, FOM, FOPM

regarded as a component in accordance with the following standards and rules:

- Council directive 2014/35/EU
- Council directive EMC 2014/30/EU
- Council directive 2024/1781

The accordance with the directives of this directive is verified through the compliance of the following standards:

European Standards, German Version:

- EN IEC 55014-1:2021
- EN IEC 55014-2:2021
- EN 60034-1: 2010+AC:2010
- EN 60034-2-1:2014
- EN IEC 60034-5:2020
- EN 60034-6:1993
- EN IEC 60034-7:2022 + AC:2023
- EN 60034-9:2005+A1: 2007
- EN 60034-30-1:2014
- EN IEC 60034-14:2018
- EN 60038:2011
- EN 60204-1:2018
- EN IEC 61000-3-2:2019+A1:2021
- EN 61000-3-3:2013+A1:2019+A2:2021+A2:2021/AC:2022
- EN IEC 61000-6-1:2019
- EN IEC 61000-6-2:2019
- EN IEC 61000-6-3:2021
- EN IEC 61000-6-4:2019
- EN IEC 61800-3:2023

The commissioning is forbidden as long as the conformity of the final product according to the rule 2006/42/EC is established.
This declaration is no assurance of characteristics in terms of product liability.
The security advices product documentation has to be considered.

Eppertshausen, 10.10.2024

Timo A. Klussmann
-General Manager-

Figure 38: Declaration of conformity

11. Illustrations

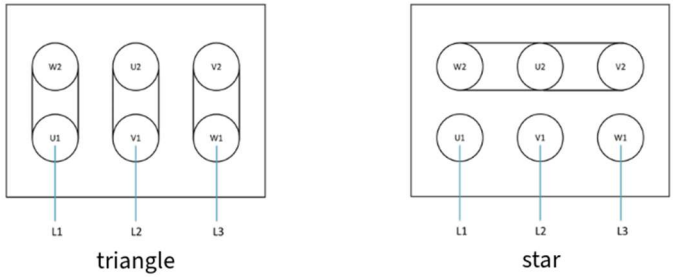

Figure39 : Circuit diagram for single-speed motors

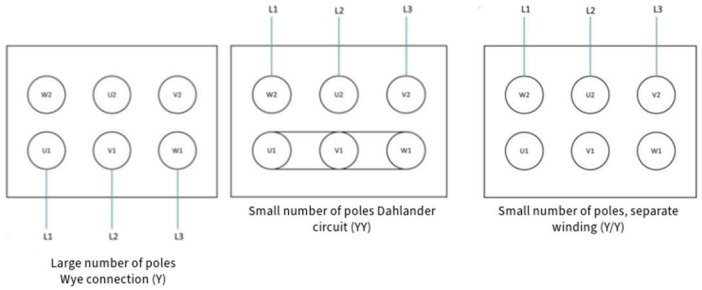

Figure40 : Circuit diagram for pole-changing motors

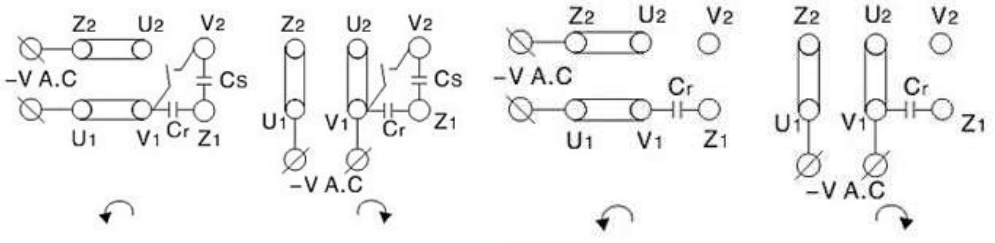

Figure41 : Circuit diagram of AC motors

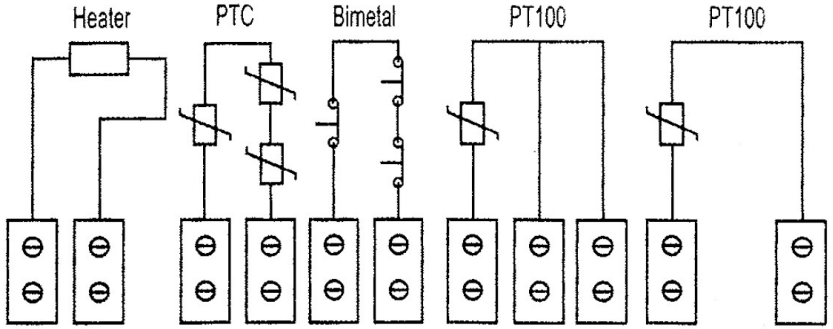

Figure42 : Circuit diagrams for standstill heating, temperature sensor PTC - bimetal (PTO) - PT100 (PT1000) 3-wire or 2-wire

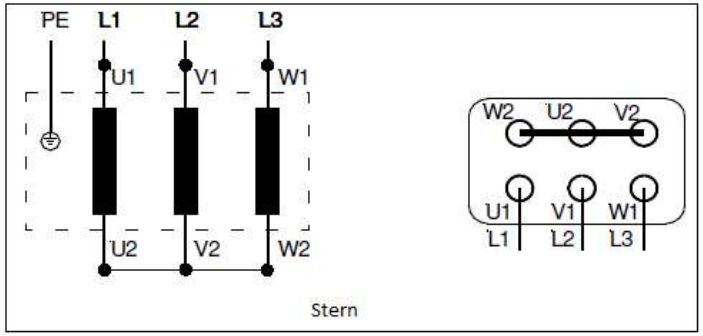

Figure43 : Circuit diagram for forced cooling fan - star

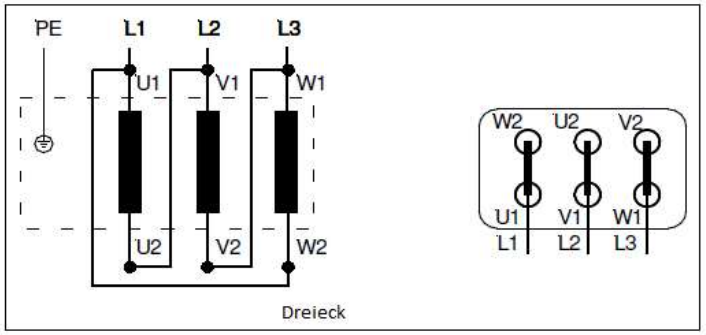

Figure44 : Circuit diagram for forced cooling fan - delta

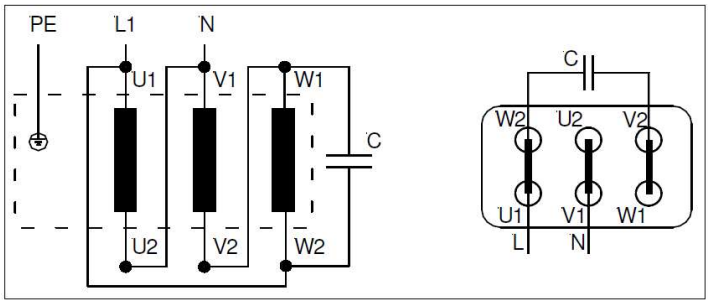

Figure45 : Circuit diagram forced cooling fan - 1~

12. Version list

Version, date	Processor	Remark
2024-3.0	OS	Elaboration Version 3.0