

Explosion Proof Marine Motors

Motor Manual

HMCX-80-355

Code: SH123018-01

HOYER
MOTORS

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1 Notice

This manual must be followed to ensure proper and safe installation, operation and maintenance of the motor. Products must be handled by qualified personnel, and health and safety requirements and national legislation must be observed. Ignoring these instructions will invalidate all applicable warranties of Hoyer Motors.

1.1 General information

HMCX series explosion-proof three phase induction motors (hereinafter referred to as “motors”) can be used safely in locations where Zone 1/2 explosive gas or Zone 21 / Zone 22 dust atmospheres are present.

The explosion-proof performance of the HMCX series of explosion proof three-phase induction motors conforms to the following Chinese and international standards:

GB 3836.1-2010, GB 3836.2-2010, GB 3836.3-2010, GB 12476.1-2013, GB 12476.5-2013;

IEC 60079-0:2017, IEC 60079-1:2014, IEC 60079-7:2017/A1:2018, IEC 60079-31:2013,

EN IEC 60079-0:2018, EN 60079-1:2014, EN 60079-7:2015/A1:2016, EN 60079-31:2014.

1.2 Certification designations

 0722  II 2 G Ex db eb IIB/IIC T4 Gb, CNEX 19ATEX 0028X

 0722  II 2 G Ex db IIB/IIC T4 Gb, CNEX 19ATEX 0028X

 0722  II 2 D Ex tb IIIC T130°C Db, CNEX 19ATEX 0028X

IECEX CNEX 19.0019X Ex db eb IIB/IIC T4/T5 Gb
 IECEX CNEX 19.0019X Ex db IIB/IIC T4/T5 Gb
 IECEX CNEX 19.0019X Ex tb IIIC T130°C Db
 IECEX CNEX 19.0019X Ex tc IIIB/IIIC T130°C Dc

1.3 Explosion protection types

The motors have an embossed “Ex” mark clearly and permanently affixed at the upper right corner of the nameplate and enclosure. The explosion-proof enclosure type, including the Ex mark, temperature group, electrical classification and equipment protection group, is shown on the nameplate.

Type 1:

	Ex	db eb	IIB/IIC	T4/T5	Gb
Mark, Explosion-proof					
Type of protection: db for flameproof enclosure main body, eb for increased safety junction box					
Equipment Grouping					
Temperature Class					
Equipment Protection Level					

Type 2:

	Ex	db	IIB/IIC	T4/T5	Gb
Mark, Explosion-proof					
Type of protection: Flameproof enclosure “db”					
Equipment Grouping					
Temperature Class					
Equipment Protection Level					

Type 3:

	Ex	tc	IIIB	T130°C	Dc
Mark, Explosion-proof					
Type of protection: Dust explosion-proof type					
Equipment Grouping: Group IIIB Non conductive dust, IP5X					
Temperature Class					
Equipment Protection Level					

Type 4:

	Ex	tb	IIIC	T130°C	Db
Mark, Explosion-proof					
Type of protection: Dust explosion-proof type					
Equipment Grouping: Group IIIC conductive dust, IP6X					
Temperature Class					
Equipment Protection Level					

1.4 Explosion protection

Markings such as Ex db IIB/IIC T4/T5 Gb or Ex db eb IIB/IIC T4/T5 Gb indicate where the motor is permitted to be used and that it has been designed, built and approved according to the relevant IEC and European standards required for operation in potentially explosive areas.

ATTENTION!

The motor must not be altered in any way, and the operating instructions specified in this document must always be complied with.

Any alteration or repair of the motor must be performed by the manufacturer or by a repair workshop having the necessary explosion protection expertise. Before running the motor after modification or repair, compliance with the requirements of EC Directives 2014/34 EU and 99/92/EC at the site concerned must be ascertained and confirmed by means of an appropriate marking on the motor or by issuing a test report.

If these requirements are not met, the motor is no longer classified as explosion-proof and the marking mentioned above must be removed.

1.5 Additional dust protection requirements

Intended use:

The marking x II 2D Ex tb/tc IIIC T... °C Db must be shown on the motor nameplate.

1.6 Installation and operation

Wire and cable entries must be separately approved entries conforming to category 2G with protection rating at minimum IP 65 or category 2D. Any unused openings must be closed with suitably approved plugs.

1.6.1 Operation and repair

The motors must be operated in accordance with the requirements of EN/IEC 60079-31. Operation with excessive dust deposits is not permitted, due to the risk of exceeding of the permissible surface temperature. Regular cleaning must be performed.

The radial shaft seals are included in the approval. Only original gaskets are to be used.

In motors with provision for regreasing of rolling bearings, it must be ensured that the grease channels are filled with grease, as otherwise explosion protection will not be effective.

1.7 Safety instructions

Warning!

Hazardous voltage. Ensure protection against explosion.

Before installing:

- Switch off the power to the equipment.
- Make sure that the equipment cannot accidentally be switched on again.
- Make sure that the equipment is de-energized.
- Earth and short out the equipment.
- Cover any adjacent electrically live parts, or block them with a screen or barrier.
- Carefully follow the assembly instructions provided for the equipment. Work on the equipment or system must only be performed by suitable qualified personnel in accordance with EN 50110-1/-2 (VDE 0105, Part 100) and IEC 60079-14-17-19.
- Electrical connections must be made in accordance with the relevant specifications (e.g. cross-section of supply wiring and protective earth connection).
- Opening the motor – with the exception of the terminal box – during the warranty period without the manufacturer's permission will render the warranty null and void.
- Original spare parts must be used for all repairs.
- Live and rotating parts of electrical motors can cause serious or fatal injuries.
- All transport, installation, start-up and maintenance work must be carried out by qualified experts. Pay attention to the applicable explosion protection standards and national accident prevention regulations.
- With regard to any equipment subject to these guidelines, it is important to take suitable safety precautions to protect personnel against the risk of injury.
- Personnel must be duly instructed to act with caution and according to regulations while transporting, hoisting, positioning and/or repairing the motor.
- Do not use the motor lifting eyebolts to lift the motor together with attached drive equipment.

- Do not use the supplied lifting eyebolts at ambient temperatures below -20°C, in accordance with DIN 580. The eyebolts may break at low temperatures.
- In accordance with DIN 580, do not apply loads to the eyebolts at an angle greater than 45° to the centre line of the threaded shank. The use of a spreader beam is recommended. See the operating instructions for the layout dimensions of the lifting eyebolts and the minimum dimensions of spreader beams and chain lengths.
- In the case of a motor with a built-in brake, suitable safety measures must be taken to protect against potential failure of the brake, especially in applications involving pulling or lifting of loads.
- Operation of the motor with the supplied shaft protection cover alone is not permitted.
- If a high-voltage test is necessary, the procedures and precautions specified in accident prevention regulations must be followed.

1.8 Motor type designation

This manual applies to HMCX-315 motors with the following type designation:

- 1 HMCX-315ab-c
- 2 HM : Hoyer Motor
- 3 C : Cast iron
- 4 X : Explosion proof
- 5 315 : Shaft height (80, 90, 110, 112, 132, 160, 180, 200, 225, 250, 280, 315, 355)
- 6 a : Frame length: M = medium frame, L = long frame, S = short frame
- 7 b : Core length: 1 = short core, 2 = long core
- 8 c - Number of poles: 2, 4, 6, 8, 10, 12, 14, 16

	HM	C	X	355	M	1	-	4
Hoyer Motor	■							
Cast Iron	■	■						
Explosion proof	■	■	■					
Frame size	■	■	■	■				
Length of frame	■	■	■	■	■			
Length of iron core	■	■	■	■	■	■		
Pole number	■	■	■	■	■	■	■	■

1.9 Service conditions

The motors are designed and manufactured with different protection ratings to suit wet and dirty outdoor locations. At the installation location of the motors, the ambient temperature must be between -20° and +45°C and the elevation must not exceed 1000 metres. Any other permissible ambient temperature range (Tamb) and elevation (NN) must be indicated on the motor nameplate. If the ambient temperature exceeds 30°C, the motor must not be exposed to direct sunlight.

1.9.1 Elevation

The maximum elevation is 1000 metres. Higher elevation is available upon request.

- Maximum relative humidity 95% (at +25°C air temperature).
- The motors are suitable for locations where combustible gases or an explosive air and vapour mixture in ignition group T1 to T4/T5 is present.
- The motors are suitable for locations where combustible dust with ignition group T130°C is present.

1.9.2 Electrical conditions

Rated frequency: 50 Hz/60 Hz

Rated voltage:

- 200 V, 220 V, 230 V, 240 V, 290 V, 380 V, 400 V, 415 V, 440 V, 460 V, 480 V, 500 V, 525 V, 550 V, 575 V, 660 V, 690 V, 720 V, 1000 V, 1140 V, 380/660 V, 400/690 V, 415/720 V, 550/950 V, 660/1140 V

Duty: S1 (continuous operation) or S2-S10

The stator windings are designed with Class F or Class H insulation.

1.10 Special conditions for use

The ambient temperature range for DOL operation is limited to -40 °C ... +60 °C.

The ambient temperature range for VFD operations is limited to -40 °C ... +50 °C (for frame sizes 80-315) and to -40 °C ... +45 °C (for frame size 355).

The ambient temperature range for special size HMCX-280M-2 105kW 440V 60Hz is limited to: -40 °C ... +50 °C.

The ambient temperature range -40 °C ... +45 °C with temperature class T5 is applicable (for DOL operations only) for sizes HMCX-90S, HMCX-90L, HMCX-100L1, HMCX-112M and HMCX-160M.

For repair of the flameproof joints due regard must be given to the structural specifications provided by the manufacturer. Repair in compliance with the values in Tables 1 and 2 of EN 60079-1 is not allowed.

All electrical connections shall be tightened with the tightening torques specified in the manufacturer's instructions according to table 2 and table 5.

For VFD operation and for duty types other than S1, the motor temperature shall be monitored by PTC-thermistors in the stator windings. These devices have to be connected to suitable tripping units that have been functionally tested for this purpose.

For VFD operation, the manufacturer's instructions for machine fed from converters have to be respected. The following VFD operation parameters must be complied with:

- switching frequency: ≥ 2000 Hz
- inverter output du/dt : ≤ 1500 V/ μ s

Use fasteners with a minimum yield stress of 640 N/mm².

Note: If the ambient and electrical conditions are different from the those stated in sections 1.9.1 and 1.9.2, see the motor's main and auxiliary nameplates for the specific design.

2 Receipt, Transport and Storage

Upon receipt and for transport:

- Use transport locks for all transport operations.
- Avoid moisture and shocks during transport.
- Check the motor for external damage.
- If damage is found, inform the sales representative of Hoyer Motors.
- Check all nameplate data and compare it with the requirements for the motor.
- Remove transport locks if present.
- Turn the shaft by hand to check for free rotation.

2.1 Storage

Ensure the use of correct lifting lugs. Lifting lugs are dimensioned for the weight of the motor.

- Do not apply extra weight.
- If necessary, use suitable special equipment such as lifting gear and ropes.
- Store in a dry, dust-free and vibration-free location.
- Carefully consider long-term storage procedures.

Short-term storage (less than 2 months)

The motor should be stored in a place with a controllable environment. A good warehouse or storage location has:

- A stable temperature, preferably in the range from 10°C (50°F) to 50°C (120°F). If the anti-condensation heaters are energised and the surrounding air is above 50°C (120°F), ensure that the motor is not overheated.

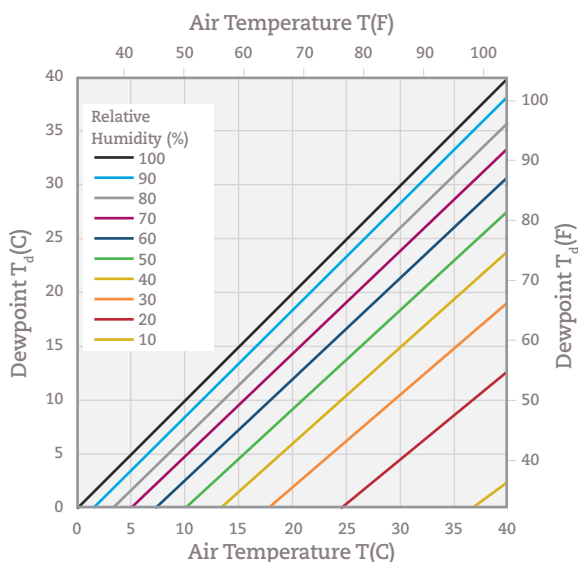


Figure 1

- Low air humidity, preferably below 90%. The motor temperature must be kept above the dew point shown in the figure to prevent water vapour from condensing inside the motor. If the motor is equipped with anti-condensation heaters, they should be energised. Proper operation of the anti-condensation heaters must be checked periodically. If the motor is not equipped with anti-condensation heaters, other methods of heating the motor must be used to prevent water vapour from condensing in the motor.
- A stable support free from excessive vibration and shocks. If vibration levels are expected to be too large, the motor should be isolated by placing suitable rubber blocks under the motor feet.
- Air that is ventilated, clean and free from dust and corrosive gases.
- Protection against harmful insects, vermin and chemicals.

Long-term storage (more than 2 months)

In addition to the measures described for short-term storage, the following actions are necessary:

- Measure the insulation resistance and temperature of the windings to check whether the motor has been stored improperly, even for a short time.
- Check the condition of the paintwork every three months. If corrosion is seen, remove it and apply a new coat of paint.
- Check the condition of the anti-corrosion coating on bare metal surfaces every three months. If corrosion is seen, remove it gently with emery cloth and apply an anti-corrosion coating.
- Provide small ventilation openings if the motor is stored in a wooden crate. Prevent water, dust and insects from entering the crate.

Outdoor storage

If the motor must be stored outdoors, do not leave the motor in the standard transport packaging.

Instead the motor must be:

- Taken out of its plastic wrap
- Covered to completely prevent rain from entering the motor; The cover should allow ventilation of the motor
- Placed on at least 100 mm (4") high rigid supports, to ensure that no moisture can enter the motor from below

- Protected against harmful insects and vermin
- Packed in special outdoor packaging

2.2 Transport

Do not use the motor lifting eyebolts to suspend the motor together with attached equipment, such as a pump, transmission mechanism, etc.

Do not use the eyebolts when the ambient temperature is below -20°C . At this temperature the eyebolts may break, causing personal injury and/or damage to equipment. The direction of the load applied to the eyebolts must not exceed 45° from the centre line of the threaded shank. Spreader beams are recommended for lifting. See Table 8 for installation dimensions of eyebolts and minimum dimensions of spreader beams and chain lengths.

Do not remove the transport safety device on the shaft until after the motor has been placed on the specified base. To protect the bearings in case of further transport, the transport safety device must be fitted again.

ATTENTION!

When tilting the motor from a horizontal position to a vertical position, ensure that the shaft does not touch the ground, as otherwise the bearings will be damaged. Ensure that the eyebolts are in the correct positions.

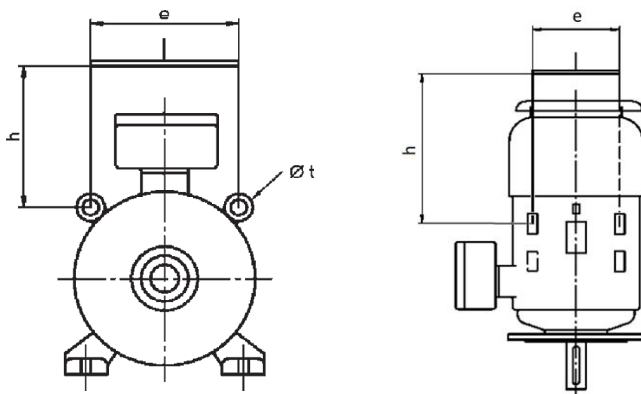


Figure 2

Table 1: Minimum dimensions of eyebolts and spreader beams

Frame size	Diameter t	Horizontal		Vertical	
		e	h	e	h
80	19	188	130	220	187
90	19	207	150	220	187
100	19	205	170	242	201
112	19	222	190	262	236
132	23	232	200	307	247
160	27	336	230	314	293
180	27	346	260	402	372
200	33	352	280	451	399
225	33	430	290	510	490
250	39	447	330	546	548
280	39	600	350	600	574
315	55	655	370	700	595
355	65	707	450	816	893

Mechanical inspection: After removing the transport safety device, rotate the motor shaft by hand to check for free movement. In the case of a motor equipped with a brake, release the brake by applying power and then manually rotate the shaft (10 minutes at most).

3 Installation and Commissioning

ATTENTION!

The electrical control system must ensure that the motor voltage and the heater voltage cannot be applied at the same time.

3.1 Preparation

- Before opening the packaging, check the motor packaging for any damage.
- After opening the packaging, remove any dust on the motor and carefully remove the corrosion protection coating on the shaft extension and flange spigot.
- To ensure correct connection and protection of the motor, check the nameplate data before installation and placing in service.
- Before working on the motor, disconnect and lock out the power supply.
- Before using the motor the first time, remove the transport bracket and clean the shaft, feet and flange to remove the protective coating.

Check the following for any non-conformity before installing the motor. If any non-conformity is found, do not place the motor in service.

- Check that all information on the motor nameplate corresponds to the order document and the conditions of use.
- Check that the explosion-proof enclosure type and designation are correct. Also check that the explosion-proof enclosure type stated on the motor nameplate is suitable for the potentially explosive atmosphere where the motor is intended to be used.
- Check that all bolts are properly tightened and spring washers are present. Also check that the joints between all parts of the flameproof enclosure are tight.
- Check all flameproof parts for cracks or defects. (Not necessary with a brand-new motor)
- If the motor has a nipple for regreasing, check that the nipple is filled with grease.
- For motors with bearing temperature sensors, check that all sensors are connected properly. Ensure that the leads of bearing thermal protection devices do not interfere with the fan.
-

3.2 Insulation resistance measurement

Before placing the motor in service, check the data sheet and measure the insulation resistance without any supply wires connected, as the wires can distort the measurement. If the measured insulation resistance is less than 10 M Ω at 25°C, the winding must be oven dried. The nominal value is typically 100 M Ω . The insulation resistance is not acceptable if the measured value is less than 5 M Ω . When oven drying the windings, set the oven temperature to approximately 85°C for 10 to 18 hours, followed by 100°C for 7 to 9 hours. The nominal insulation resistance drops by 50% for every 20°C rise in motor temperature. Measuring equipment must always be calibrated at least every year.

During installation, the motor must be aligned with the driven equipment. Otherwise the bearings may be damaged and the shaft may be broken. Check the tightness of bolts and pins of couplings or gears, check for free and smooth rotation, and check for any shaft misalignment or abnormal sounds.

- Check that the motor mounting bolts are firmly secured, the bearings are properly lubricated and the enclosure is securely earthed.
- Check that the protective devices comply with the requirements and are fitted securely.
- Check that the connection is correct and that the starting device is in good condition with good contacts and securely earthed.
- Check that voltage of the three-phase power supply is within the specified range, with no imbalance between the three phases.
- Check the bearings and the lubrication system. Add grease properly if necessary, or clean up and replace the grease.

3.3 Support and alignment

The end-user is fully responsible for construction of the support. The contact surface for the motor feet or flange must be free of paint, dirt and other objects. Otherwise the motor height may be incorrect or the motor may be misaligned.

Mount the motor on a sturdy, clean and flat support. It must be sufficiently rigid to withstand short-circuit forces. It is important to ensure that the mounting conditions do not cause resonance at the rotational frequency or twice the supply frequency.

Always use suitable tools to mount or remove drive components. Do not hit the drive components with a hammer, as this can damage the bearings or degrade the balancing. The rotors are balanced with a half key for G2.5 according to ISO 21940-11. Make sure that the drive components are the same. Correct alignment is essential to avoid bearing failure, shaft failure and vibration failure. Use only suitable alignment methods. Re-check the alignment after final tightening of the bolts or studs.

Check the following dimensions before adjusting the alignment - not all variants are covered:

- Vertical positioning: To avoid motor tipping and bending, use shims to stabilise the motor.
- Horizontal positioning: Fix the motor axial position and make sure the axial gap is uniform.
- Stable support: Vibration free, accurate machine alignment and balanced drive.
- Foot/Foot-flange mounting: Mount the motor with the correct bolts and tightening torques. Make sure the motor feet and/or flange bolts are in full contact with the mounting surface.

3.4 Removing the terminal box cover

ATTENTION!

Follow the instructions carefully to remove the terminal box cover. Motors frame size 180 and below have a special threaded terminal box cover design.

3.4.1 Removing the terminal box cover, frame size 180 and below

1. Unscrew the locking bolt on the terminal box cover.
2. Fit a bar between the two elevated handles in the terminal box cover to turn the cover anti-clockwise as it is threaded. DO NOT use a crowbar or similar tool between the terminal box and cover as it can cause damage on the thread and motor protection.
3. After turning the terminal box cover, gently lift off the terminal box cover.

3.4.2 Removing the terminal box cover, frame size 200 and above

1. Unscrew the bolts, note that two of them are smaller
2. In two positions where the two smaller bolts are located, use one of the longer bolts in each side

Place the longer bolts and screw them in, in order to release/lift the terminal box cover.

1. The lifting of the terminal box cover must be performed equally in order not to damage the flame proof joint

3.5 Points to observe during motor start-up

If the motor does not run after it is energised, switch off power immediately to avoid damage to the motor. Do not start the motor again until the cause of the fault has been eliminated.

If more than one motor is powered by a variable speed drive, do not start all of these motors at the same time. Start them one by one in the sequence from large to small.

If a motor is started at reduced voltage, it must be operating with no load or a low load. The maximum permissible number of successive starts per hour is 2 with the motor cold or 1 with the motor warm.

4 Electrical Connection and Wiring

4.1 General information

The motors are designed to operate with supply variations conforming to IEC 60034-1, Zone A: $\pm 5\%$ voltage and $\pm 2\%$ frequency. The motors will operate with greater variations according to Zone B of IEC 60034-1 section 7.3, but with larger variation in performance.

Three-phase motors manufactured by Hoyer Motors are designed according to IEC 60034-1 and can operate with the rated power and torque load within the mains voltage and frequency variations of zone A and, for a short time, of zone B.

Earthing must be carried out according to local regulations before the motor is connected to the supply voltage.

The power connection of the explosion-proof motor must comply with the provisions of EN/IEC 60079-14 in addition to the usual installation provisions. Overload protection by means of a motor protection switch or equivalent protection device is also required. A PTC thermistor with a trigger mechanism is also suitable as an overload protection device.

Attention!

- Connect the motor, control system, overload protection device and earthing according to local installation regulations.
- Automatic resetting of a triggered monitoring device is not allowed.
- The electrical control system must ensure that the motor voltage and the heater voltage cannot be applied at the same time.
- Do not modify the motor in any way. The provisions of this operating instructions manual must be observed at all times.

If the motor has a direct cable entry fitting, the free end of the cable leading to the motor must be secured by an entry fitting dimensioned for a suitable range of cable diameters. If the cable entry fitting on the motor has a strain relief, the cable can be routed freely; otherwise the cable must be secured near the motor to provide strain relief. The maximum

operating temperature of the cable must not be exceeded. The terminal box is located at the top of the motor. The cable entry (a bell-shaped hole for rubber-insulated cable, or a threaded hole for conduit cable entry or armoured cable entry) is connected to the bottom part of the terminal box facing to the right and aligned horizontally. The terminal box can be rotated by 180 degrees to allow cable entry from the opposite direction.

4.2 Tightening torques

The bolts must be fastened with anaerobic sealant. This can be achieved by loosening the head of the fixing screw to turn the terminal box to the desired position. Then retighten the fasteners to the torque specified for the thread size.

Table 2: Tightening torques - Terminal box

Thread size	Tightening torque
M5	6 Nm
M6	10 Nm
M8	25 Nm
M10	49 Nm
M12	85 Nm
M16	210 Nm
M20	425 Nm

4.3 Power cable and connection diagrams

For the power connection, select a suitable multi-core cable and terminals according to the rated current and relevant standards. Use appropriate cable glands and seals in the cable entries according to the type and diameter of the cable.

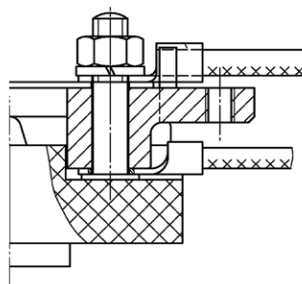


Figure 3: Connection with cable lug

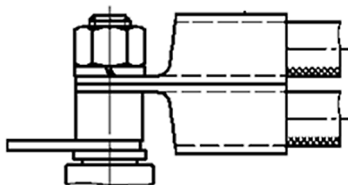


Figure 4: Cable connection with two cable lugs

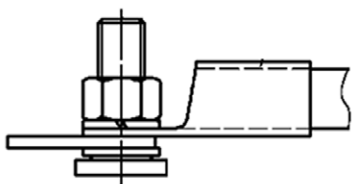


Figure 5: Cable connection with one cable lug

The main wires must be connected to the respective terminals and must be secured with compression nuts, metal washers, etc. Unused cable entries must be closed to maintain the IP rating of the terminal box. Check that the gasket is intact before refitting the terminal box and cover. IECEx/ATEX certified cable glands suitable for the environment must be used. The IP rating of the cable gland should be at least same as the motor protection rating.

All electrical connections must be tightened to the tightening torques specified in the manufacturer's instructions. The tightening torque for the terminal studs is shown in table 3. Observe the maximum permissible conductor cross-section for the terminals. If no other data is available on the terminals, refer to the following table:

Table 3

Frame size	Terminal stud thread size	Cable number	Cable cross-section [mm ²]
80-112	M5	1	4
132-160	M8	1	10
180-225	M8	1	70
250-280	M12	1	95-240
315	M12	1	95-240
		2	16-70
	M16	1	120-300
		2	16-120
355	M16	1	120-300
Terminal board			0.08-4

Attention!

Observe the rating data printed on the terminal board.

To comply with EMC requirements and provide proper earthing, cables must be shielded and EMC cable glands are recommended. All incoming parts must have the same potential as the motor.

Cable glands and seals in cable entries must be suitable for the type and diameter of the cable concerned (clamping range). It is recommended that cables are mechanically protected and clamped close to the terminal box to fulfil the requirements of IEC 60079 and local requirements.

4.4 Connection diagrams

As standard all three-phase motors are suitable for 400 V connection, unless otherwise stated.

- Motors with nameplate data D/Y 230/400 V are connected as star (Y).
- Motors with nameplate data D/Y 400/690 V are connected as delta (D).

The connection diagram is labelled inside the terminal box.

Generally, power to motors must be supplied and protected through protective devices such as RCDs, fuses, MCBs, MCCBs, etc. The connection diagram for Y/D is shown in Figure 1.

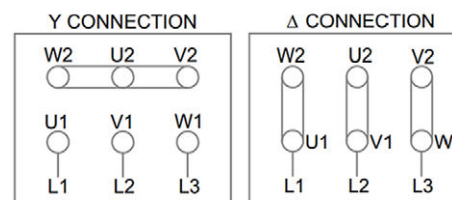



Figure 6: Connection types

4.5 Direction of rotation

Motors are supplied as standard with clockwise rotation as seen from the drive end. The phase sequence is L1, L2, L3 as connected to the terminals shown in Figure 6. To change the direction of rotation, change the phase sequence by (for example) swapping L1 and L2. If the motor is unidirectional,

make sure the shaft rotates in the same direction as the marked arrow.

4.6 Earthing

Earthing of the motor is one of the important safety measures to prevent electrical discharges. The earthing terminal on the enclosure is a galvanised steel or copper bolt, located in a readily visible position on the motor enclosure with the earthing symbol . When making the earth connection, ensure that the terminal contact surface is clean and free of paint, oil and dust. The external earthing terminal must be earthed securely.

4.7 Motor connection check

After completing the motor connection, check it for correctness. If it is correct, energise the motor without a load. The start-up sequence for motors equipped with an auxiliary fan is as follows: Start the auxiliary fan motor first, followed by the main motor.

- The stop sequence for the motors is as follows:
- First stop the main motor.
- Wait 10 minutes, and then stop the auxiliary fan motor.
- Also check the motor for any abnormalities. Do not run the motor under load until proper operation without a load has been confirmed.

The motor must be free of any intermittent or abnormal noises and vibrations at all times when operating with or without a load.

5 Thermal Protection and Heater

Thermal protection is used to prevent motor overheating and for monitoring purposes.

5.1 Thermal protection with thermistors (PTC)

All standard motors have PTC thermistors located in the stator windings.

These PTC thermistors must be connected to the variable speed drive or other protective equipment by appropriate means.

PTC thermistors are used to protect the motor from overheating. PTC thermistors are provided in sets of three, fitted in each phase, unless otherwise stated. The PTC resistance is 60 to 750 Ω at 20°C. The resistance rises in proportion to the temperature. At the peak temperature the resistance approaches infinity. This type of sensor is used in combination with a PLC or a relay for motor protection.

PTC tripping temperature: 145°C for Class F insulation.

5.2 Temperature monitoring with PT100 sensors

PT100 sensors are not standard and can be added upon request. PT100 sensors can be fitted in the motor both in the windings and in the bearings. PT100 sensors can track the temperature rise where they are fitted. This is often used for monitoring of motor temperatures, for example in windings or bearings, and it can indicate overheating. The signals can be processed and used in PLCs.

- PT100 alert temperature: 135°C for Class F insulation.
- PT100 tripping temperature: 145°C for Class F insulation.

5.3 Heat band

A heat band can be fitted in a motor. A heat band allows a minimum temperature to be maintained inside the motor. This prevents moisture condensation during cool-down of the motor. Heat bands are available with two different rated voltages (220–240 V and 110–120 V). The heat band can be energised when the motor is not running.

Upon request of the customer, motors with frame size 80

and above can be fitted with additional stator winding temperature monitoring thermistors (PTC). The PTC or PT100 components are used to monitor the temperature and avoid overheating and burning of the windings. Additional PT100 sensors can be fitted by the user as needed.

The thermal sensors in the stator windings and bearings must be connected to a suitable intrinsically safe system by the end user.

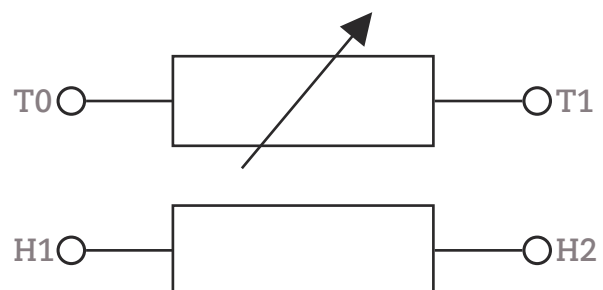
5.4 Winding temperature sensor and heater

The cable lugs should be connected between two spring washers or terminal clamps. The cable lugs of the earthing conductors should be fitted between the spring washers of the earthing stud and earthed reliably to ensure good electrical contact and clearance.

After connecting the cables, check inside the terminal box for correct connection and ensure that the terminal box is free of foreign matter and dust before fitting the lid of the terminal box. Make sure the connection conforms to the wiring diagram, the supply voltage and the data specified on the motor nameplate.

The cable fed into the terminal box must be secured by a strain relief.

Clean the flameproof joint and check for any damage to the flameproof joint. If any damage is found, replace the part with a new part and apply anti-corrosion oil to protect against corrosion.



For motors equipped with winding temperature sensors and heaters, the cables of these components can be fed into the main terminal box or into a separate terminal box. See the wiring diagram in figure 7.

Thermistor connection diagram Heater connection diagram

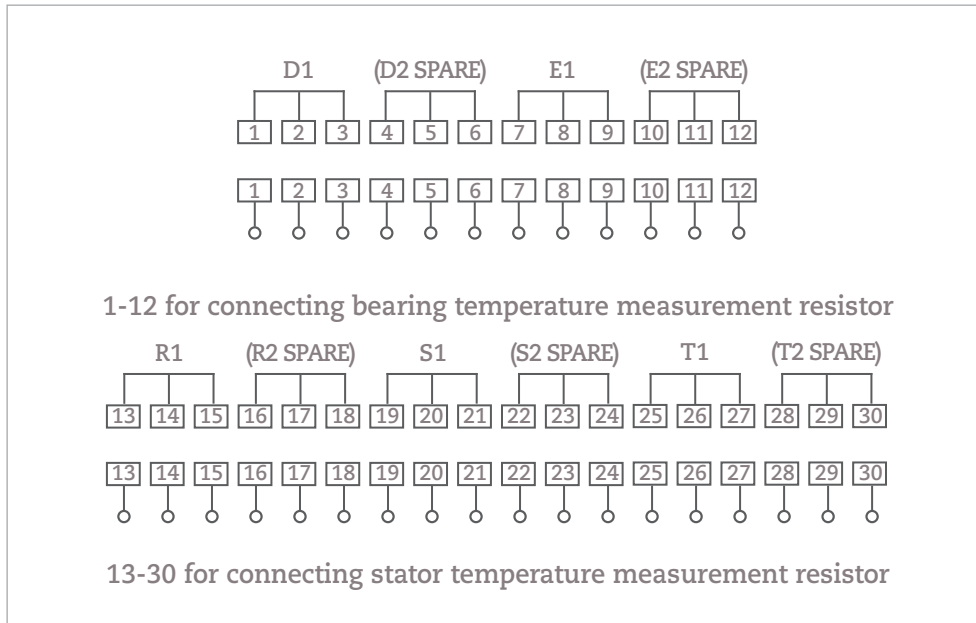


Figure 7: Wiring diagrams for temperature sensors and heater

6 Motor Data and Parts

6.1 General information

The mechanical construction of the motors in this series is designed such that if an explosive mixture at the service site penetrates into the motor and ignites for any reason, the flameproof enclosure will prevent ignition of the explosive mixture surrounding the enclosure.

The motors are designed with a sturdy enclosure, proper air gap or electrical clearance and length of flameproof joint surfaces for all flameproof components of the flameproof enclosure, and maximum permissible enclosure surface temperature to ensure good flameproof capability.

To ensure good flameproof performance of the motor enclosure, all fixing bolts are fitted with lock washers to prevent unintentional loosening of the bolts. The thread allowance between the ends of bolts (or screws) and the bottoms of threaded holes is maintained after the bolts or screws are fitted in blind threaded holes. The thickness of the metal surrounding the threaded holes on the enclosure should

not be less than one-third of the bolt diameter, and at least 3 mm in any case.

The insulating parts of terminal bushings and connecting plates in the terminal box are made of insulating material.

The basic mounting arrangements of the motors are IMB3, IMB35, IMB5 and IMV1. Other special mounting arrangements are also available upon customer request.

The cooling mode of the motors is IC411.

The motors are provided with a cylindrical shaft extension with power transmission by means of a coupling or a spur gear unit. With spur gearing, the gear pitch diameter should not be less than 3 times the shaft extension diameter. Motors with a double shaft extension or a special shaft extension size are also available upon customer request.

6.2 Cross-section view of motor

Motors are available with Ex db protection rating (main enclosure) IP55, IP56, IP65 and IP66. See Figure 8 for the motor layout with an Ex db or Ex eb terminal box.

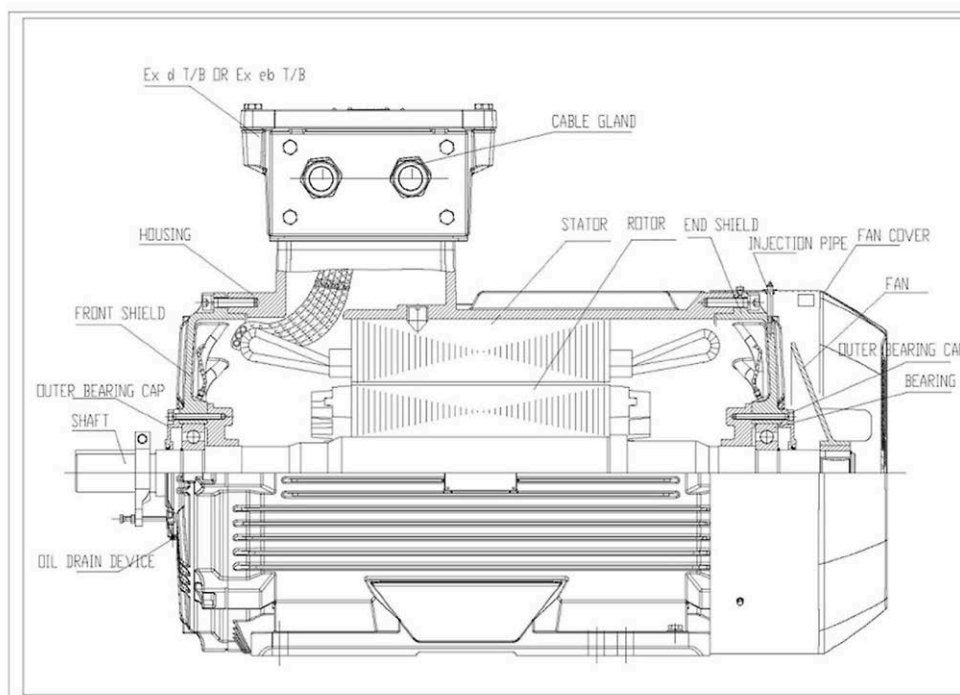


Figure 8

6.3 Terminal boxes

The terminal box of the motor is located on top of the motor frame. The terminal boxes of motors with frame size 80 to 355 are designed with six terminals suitable for the various voltage options defined in the associated certificates. A steel or copper electroplated stud for earthing is present inside the terminal box.

Before working on the motor or attached machinery:

- Ensure that all supply voltages are switched off and locked out.
- Switch off auxiliary power circuits for accessories such as anti-condensation heaters.
- Check the supply voltage and frequency by comparing them with the rated data on the nameplate and the data sheet.
- Ensure that the terminal box is clean and dry.
- Ensure that the flame path of the terminal box is intact and free of any form of damage.
- Close unused Ex-certified cable glands with Ex-certified blind caps.

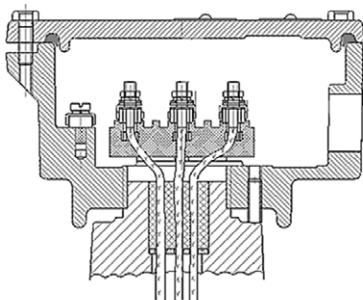
Always use suitable cable lugs for connection of all main supply cables and cables for auxiliary devices, and ensures that cables are connected to the correct terminals according to the supplied connection diagrams.

Motors are only intended for fixed installation unless otherwise stated. Certified Ex cable glands/blind caps for entry points are metric as standard. If cable glands or blind caps are replaced, the replacements must be at least the same Ex classification and IP class as the existing items.

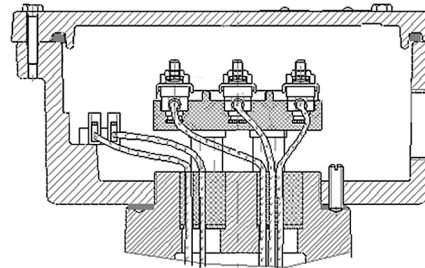
As standard the terminal box rating is IP55. Rating IP56, IP65 or IP66 is available upon request. The terminal box layouts are shown below.

Terminal box for EAR-Ex e

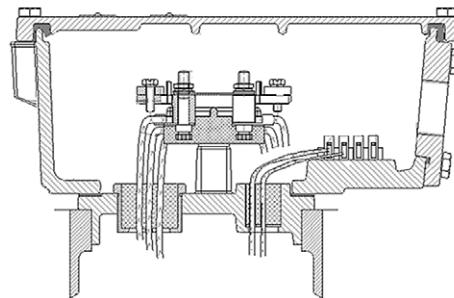
Frame size 80–112:



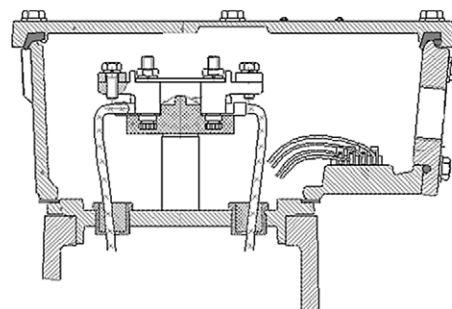
Frame size 132–160:



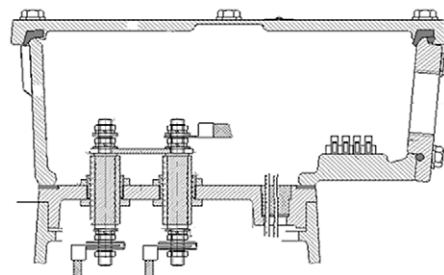
Frame size 180–225:



Frame size 250–280:

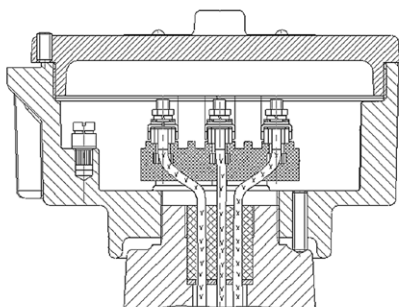


Frame size 315–355:

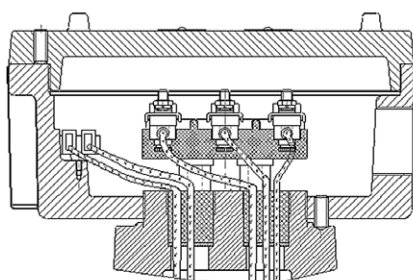


Terminal box for CAR-Ex d

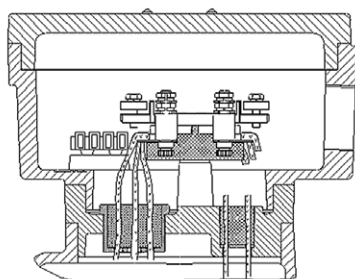
Frame size 80–112:



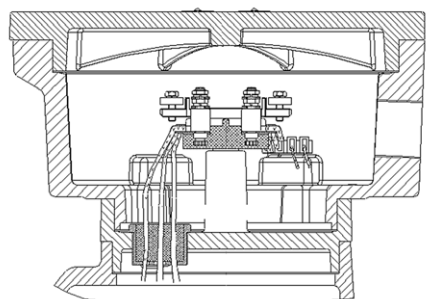
Frame size 132–160:



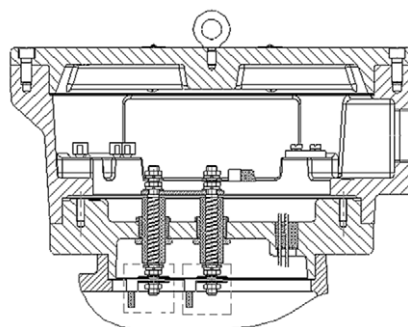
Frame size 180–200:



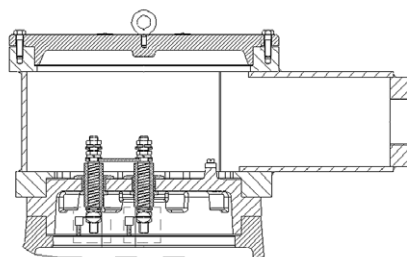
Frame size 225–280:



Frame size 315:



Frame size 355:



For motors with EAR-Ex e or CAR-Ex d terminal boxes, ensure strict compliance with the clearances specified in EN/IEC 60079-7 between all enclosure components, the flameproof joint and bare conductors inside the terminal box, bare conductors and the metal enclosure (see Table 4). Tighten the screws and nuts on live parts to the torques specified below (see Table 5).

Table 4: Clearance and creepage distance

Rated voltage U [V]	Minimum clearance [mm]	Minimum creepage distance [mm]
≤200	4.0	5.0
≤250	5.0	10.3
≤320	10.0	10.0
≤400	10.0	10.0
≤500	10.0	12.5
≤630	10	16
≤800	12	20
≤1000	14	25
≤1250	18	26

Table 5: Tightening torques - terminal board

Thread size	Torque [Nm]
M5	2
M6	3
M8	6
M10	10
M12	15.5
M16	30

6.4 Rotating terminal box Ex db

ATTENTION!

Follow the instructions carefully to rotate the terminal box cover.

Frame size 80–160:

- Remove the terminal box cover. As described in 3.4.1
- Loosen the terminal box and turn it to the required position
- Tighten the screws

Frame size 180–355:

- Remove the terminal box cover. As described in 3.4.2
- Remove the screws connecting the terminal box to the housing
- Turn the box to the required position
- Replace the screws and tighten them

6.5 Cable glands

The cable glands must be IECEx/ATEX certified and must comply with IEC/EN 60079-0 and IEC/EN 60079-11. Pay attention to the protection rating and locking of the cable gland. If the original cable glands or blind plugs need to be replaced, please contact Hoyer.

For the maximum size of the main cable entry for terminal boxes, see the specifications in Table 6. Thread size for auxiliary entries, e.g. for PTC thermistor or heater: M20×1.5.

Table 6: Mains cable entry for Ex e and Ex d terminal boxes

Frame size	Threaded version	Cable external diameter \varnothing [mm]	Terminal thread size
80	1x M25×1.5	8–17.5	M5
90	1x M25×1.5	8–17.5	M5
100	1x M25×1.5	8–17.5	M5
112	1x M25×1.5	8–17.5	M5
132	2x M32×1.5	12–21	M6
160	2x M32×1.5	12–21	M6
180	2x M50×1.5	21–35	M8
200	2x M50×1.5	21–35	M8
225	2x M50×1.5	21–35	M8
250	2x M63×1.5	27–48	M12
280	2x M63×1.5	27–48	M12
315	2x M63×1.5	27–48	M12
355	2x M75×1.5	64–68	M16

The maximum rated operating temperature of cables and cable glands connected to the motor must be greater than the value in table 7 below (reference ambient temperature 40°C):

Table 7

Frame size	80	90	100	112	132	160
Temperature [°C]	68	72	70	56	77	60

Frame size	180	200	225	250	280	315	355
Temperature [°C]	90	90	79	92	99	96	92

If the ambient temperature is above 40°C but does not exceed 60°C, the temperature values in the table above must be increased according to the difference between 40°C and the actual temperature.

Example: With frame size 112 and $T_{amb} = 55^{\circ}\text{C}$, the maximum rated operating temperature of the cable must be $(55 - 40) + 56 = 71^{\circ}\text{C}$

If the motor has direct cable entry (flying leads), the free end of the cable leading to the motor must be connected according to the regulations applicable to the connection range. If the cable entry fitting on the motor has a strain relief, the cable can be routed freely; otherwise the cable must be secured near the motor to provide strain relief. The maximum operating temperature of the cable must not be exceeded.

6.6 Bearings

The motors are designed with ball or rolling bearings. See the nameplate for the specific bearing type.

6.7 Vibration sensors

For motors with frame size 160 and above, M8×0.75 threaded blind holes for vibration sensors can be provided according to the customer's requirements.

7 Variable Frequency Drive Operation

Motors for variable speed drive (VFD) operation are equipped as standard with positive temperature coefficient (PTC) thermistors in the windings for monitoring and protection. The permissible operating characteristics in this mode are stated on the nameplate or an additional label.

An output filter must be installed based upon the length of the cable on the motor side of the VFD. Filter selection and the maximum cable length depend on the instructions and data provided by the VFD manufacturer.

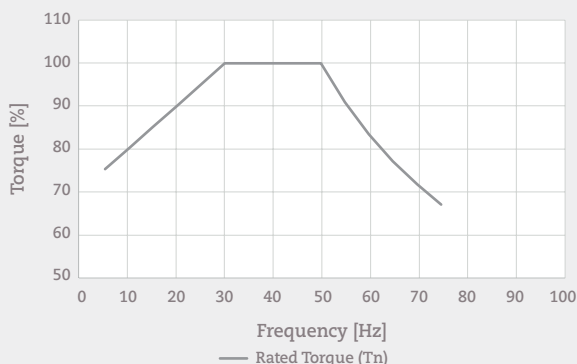
Two methods are used to prevent shaft currents: If the measured shaft stray current is more than 300 mA, the bearing on the non-drive end is replaced by an insulated bearing. Otherwise a shaft earthing ring is fitted to discharge the shaft current.

7.1 VFD operation

50 Hz

- a. 5–50 Hz:
Variable torque (VT 10:1)
- b. 25–50 Hz, 100% TN:
Constant torque (CT 2:1, 100% TN)
- c. 5–50 Hz, 75% TN:
Constant torque (CT 10:1, 75% TN)
- d. 50–75 Hz, 100% P2:
Constant power (CP, 100% P2)

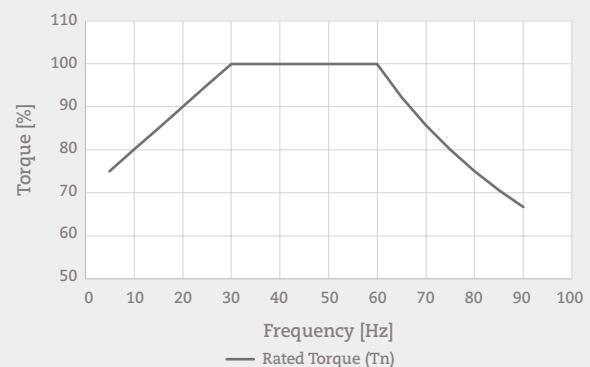
VFD Torque Curve



60 Hz

- a. 6–60 Hz:
Variable torque (VT 10:1)
- b. 30–60 Hz, 100% TN:
Constant torque (CT 2:1, 100% TN)
- c. 6–60 Hz, 75% TN:
Constant torque (CT 10:1, 75% TN)
- d. 60–90 Hz, 100% P2:
Constant power (CP, 100% P2)

VFD Torque Curve



The ambient temperature range for VFD operations is limited to -40 °C ...+50 °C (for frame sizes 80-315) and to -40 °C ...+45 °C (for frame size 355)

The following VFD operation parameters must be complied with:

- Switching frequency: ≥ 2000 Hz
- Inverter output du/dt: ≤ 1500 V/ μ s

8 Operation

8.1 Considerations

Safety equipment must be used during installation and operation at the site. The motor is only intended for fixed installation and use by qualified personnel. Motors must only be used according to the rated nominal values on the motor nameplate.

8.2 Checklist

Check the following before powering on the motor:

- All mechanical and electrical connections are ready for start-up.
- The insulation resistance values correspond to the data in Section 3.2.
- The earthing connection is fitted correctly.
- Couplings and transmissions are sufficiently aligned to allow the machinery to run smoothly.
- The motor is operating within the permissible ambient temperature range.
- The operation data corresponds to the nameplate.
- The monitoring equipment is connected correctly and fully functional.
- Make sure the motor is not running faster than the permissible speed for the application.
- The output power corresponds to the duty type.
- Screws and bolts are fitted and tightened properly.
- The rotor can turn in response to an external force without applied power.
- Protective parts are removed from the motor shaft.
- The external fans rotate in the specified direction.
- All brakes/switches are fully functional.

8.3 Cooling

Check the following with regard to cooling:

- The motor has sufficient airflow.
- No nearby objects radiate additional heat.
- Direct sunlight does not add additional heat.

For flange mounted motors (e.g. B5, B35, V1), make sure that the construction of the machinery allows sufficient air flow along the outer surface of the motor housing. Table 8 shows the minimum distance from the motor fan cover to the wall or other objects (see Figure 9 for reference).

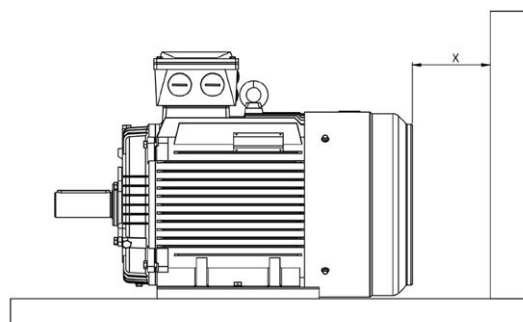


Figure 9: Minimum distance to wall/objects

Table 8: Minimum distance from wall or objects

IEC frame size	Minimum distance from fan cover to wall (X) [mm]
80	40
90	45
100	50
112	55
132	65
160	80
180	90
200	100
225	120
250	125
280	140
315	155
355	175

The air inlet and outlet of the fan housing must be unobstructed to avoid any temperature rise that would shorten the service life of the motor insulation. This must be avoided for motors equipped with noise dampers. In addition, the air vents must be checked and cleaned regularly when the motor is used under severe dust conditions.

This type of motor is designed and manufactured for explosion hazard areas. The following data on the nameplate indicates that the motor is flameproof, along with warnings for use as required:

Explosion-proof type, IP protection rating, maximum surface temperature (temperature class), equipment protection class. The motor type must be suitable for the environmental conditions at the intended use location.

9 Maintenance

Maintenance must be carried out regularly on motors, including monthly maintenance and yearly maintenance (e.g. routine inspection and overhaul).

9.1 Monthly maintenance:

Remove dust and dirt on the enclosure and surfaces and measure the insulation resistance.

- Check the connection terminals of the motor: Check for loose connecting bolts or nuts inside the terminal box. Retighten or replace them where necessary.
- Check all fixing bolts or nuts and the earthing cable: Check the earthing bolts or nuts, fixing bolts on end shields and internal and external bearing covers, connection of the earthing cable and secure fixing.
- Check the bearings and the lubrication system for any grease contamination or insufficiency. Where necessary, regrease or replace the grease properly.
- Check the motor fan and its fixing bolts or nuts for distortion, damage and firm seating. Retighten or replace where necessary.

9.2 Yearly maintenance

Yearly maintenance includes all inspections required in monthly maintenance plus the following:

- Visual inspection: Perform a visual inspection to check for any damage and to ensure that all parts are complete. Remove dust and dirt completely and repair any damaged parts.
- Windings: Measure the insulation resistance of all electrical components with a megohm meter. The insulation resistance should be at least 5 MΩ. See section 3.2.
- The deep-groove ball bearings of motors with frame size up to 250 are sealed on both sides as standard and filled with grease by the bearing manufacturer with grease sufficient for 40,000 operating hours at ambient temperatures up to 45°C for horizontally installed motors with 4 poles or more, or 20,000 operating hours with 2-pole motors.
- The shaft seals must also be exchanged when the bearings are replaced. Refer to the manufacturer's specific repair instructions for disassembly and assembly.
- Motors with frame size 280 or above and motors with

reinforced bearings must be equipped with regreasing devices. The bearings are regreased via the grease nipples located on the bearing plates or the bearing caps, preferably while the motor is running.

- The drip space in the bearing cap for discharge of old grease is large enough to collect the old grease during the nominal bearing service life with state-of-the-art regreasing.
- The specified lubrication intervals and the type and quantity of grease to be used can be found on the motor nameplate.

9.3 Regreasing

Table 9: Regreasing intervals in hours for horizontal installation

Ambient temperature	Speed up to 1800 rpm	Speed up to 3600 rpm
40°C	5000 h	2500 h
50°C	2500 h	1000 h
60°C	2000 h	500 h

ATTENTION!

- For motors with enhanced performance in heavy-duty drive conditions such as belt or gear drive with additional bearing loads and in vertical installation, the values in the table must be reduced by 50%.
- Observe the specified quantity of grease. Overgreasing can lead to a sharp rise in the bearing temperature and hence to failure of the bearing.

ATTENTION!

- Long idle times must be taken into consideration in the use period of the grease. The use period can be reduced considerably, depending on the external load.
- This also applies to bearings with lifetime greasing, for which replacement is recommended after 5 to 6 years. In the event of long idle times, the shaft must be rotated once per month to avoid bearing damage.

When motors are assembled or disassembled, the machined surfaces should be coated with anti-corrosion grease to avoid corrosion and damage.

Be careful to avoid any damage to the stator winding and insulation when removing or fitting the rotor.

When replacing the windings, ensure that the winding characteristics and the insulation structure are not altered. Otherwise the performance of the motor will be changed, and in the worst case the motor will no longer be usable.

If deterioration of the sealing gasket is found, the gasket must be replaced in time.

If deterioration or wear of the V ring or reinforcement of the oil seal is found on the shaft seal, the seal should be replaced promptly.

During reassembly, the surfaces of the flameproof joint must be cleaned completely and must be free of foreign particles. Then type anti-corrosion grease must be applied and a close fit of the flameproof joint with no gap must be ensured.

10 Disposal and Environmental Protection

This information applies to Hoyer low voltage motors with frame sizes 56 to 450.

10.1 Product disposal information

In accordance with Directive 2012/19/EU regarding waste electrical and electronic equipment (WEEE), Hoyer motors are marked with the crossed-out wheeled bin symbol shown in Figure 10.

The symbol can be found on the motor nameplate or on the packaging and relevant documentation.

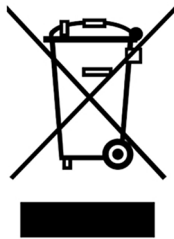


Figure 10 Symbol WEEE marking

The symbol indicates that electrical and electronic equipment must not be disposed of together with ordinary domestic waste and must be treated as WEEE. Electrical and electronic equipment (EEE) contains materials, components and substances that may be hazardous and can present a risk to human health and the environment when waste electrical and electronic equipment (WEEE) is not handled correctly.

More detailed information is available from the relevant local authority.

10.2 RoHS and REACH

All motors from Hoyer Motors comply with the RoHS directive and the REACH regulation. Official documents can be downloaded from the Hoyer Motors website hoyermotors.com.

10.3 Electric motors

Electric motors are manufactured from ferrous metals

(steel, cast iron), non-ferrous metals (copper, aluminium) and plastics. At the end of their service life, motors must be disposed of according to international and local regulations. Waste handling facilities must be licensed and must comply with the environmental requirements of the member states they are located in.

10.4 Packaging material

The packaging of motors from Hoyer Motors consists of cardboard, plastic, steel and wood. These materials are recyclable, and Hoyer recommends recycling them in accordance with the national regulations of each EU member state.

11 Troubleshooting

Refer to the table below for common electrical faults and troubleshooting.

Trouble	Cause	Remedy
1. Motor fails to start	<ol style="list-style-type: none"> 1) Improper power supply 2) Open circuit in winding 3) Windings earthed or interphase short circuit 4) Incorrect winding connections 5) Blown fuses. 6) Incorrect cable connections to the control system 	<ol style="list-style-type: none"> 1) Check the switch, fuses, each set of contacts and cable terminals 2) At the location where the open circuit is found, apply heat to raise the temperature to the level permitted by the insulation class in order to soften the varnish coating, then repair the broken conductor with wire of the same specification. Then re-tape, varnish and dry the repair for good insulation. 3) Follow the procedure described above. In addition, fit insulation on or around the earthed or shorted parts, then varnish and dry them. 4) Check the connection diagram and redo the connections (including binding, insulation and varnishing) 5) Replace fuses with the proper type and rating. 6) Check the connections against the diagrams supplied with control system.
2. Fuses blown after the motor is energized.	<ol style="list-style-type: none"> 1) Single-phase start 2) Motor overloaded or blocked. 3) Fuse rating too low 4) Connecting cable between power supply and motor shorted 	<ol style="list-style-type: none"> 1) Check the power cable, motor cables, fuse and each contact in the switch to locate and correct the problem. 2) Adjust the load to the rated load and correct fault in the driven machinery. 3) Replace fuses with the proper type and rating. Fuse selection is generally based on the following formula: rated current of fuse = starting current/(2-3). 4) Find the short and correct it.
3. After being energised, motor does non run and emits a buzzing sound.	<ol style="list-style-type: none"> 1) Motor overloaded or blocked 2) Power supply not completely switched on 3) Voltage too low 4) Too much hardened grease or too tight assembly with small motors 	<ol style="list-style-type: none"> 1) Reduce the load and locate the blockage. 2) Replace fuses in fuse box, secure loose nuts on terminal studs. use a multimeter to locate the source of the problem and repair it. 3) Check the connection. If motor is designed for Δ connection but is configured with Y connection, change it to Δ connection. Ensure that the supply voltage matches the rated voltage on the nameplate. 4) Replace with proper grease or reassemble.
4. The motor enclosure is electrically live.	<ol style="list-style-type: none"> 1) Incorrect connection of power cable and earth connection 2) Damp windings and severe insulation deterioration 3) Outlet cable and terminal box tied to earth 	<ol style="list-style-type: none"> 1) Find the reason and correct it. 2) Dry the motor and replace the deteriorated insulation. 3) Redo the insulation and repair the terminal box.

Trouble	Cause	Remedy
5. The motor does not accelerate up to nominal speed	<ol style="list-style-type: none"> 1) Supply voltage too low 2) Windings designed for Δ configuration are mis-connected in Y configuration 3) Broken rotor bars or loose rotor 4) Number of winding turns exceeds design value when rewound 	<ol style="list-style-type: none"> 1) Check the supply voltage at the motor input with a voltmeter or multimeter. 2) Change Y connection to Δ connection. 3) Look for cracks near the rings. A new rotor may be required, as repairs are usually temporary. 4) Rewind as necessary.
6 Low insulation resistance	<ol style="list-style-type: none"> 1) Damp windings 2) Ageing winding insulation 	<ol style="list-style-type: none"> 1) Heat or dry the winding. 2) If the insulation can be still be used after checking, then clean, dry and revarnish it. Otherwise replace the insulation.
7. Motor emits abnormal sound during operation	<ol style="list-style-type: none"> 1) Bearings worn out or short of grease 2) Stator or rotor core loose 3) Voltage too high or unbalanced 4) Bearings short of grease 5) Fan colliding with fan cover or air vents blocked 6) Uneven air gaps or contact between stator and rotor 	<ol style="list-style-type: none"> 1) Replace the bearings. 2) Check for the cause of vibration, repress the core. 3) Measure the voltage of the power supply, find the reason and correct it. 4) Clean bearings and regrease. The amount of grease to be added should be one-third to half of the net volume of the bearing housing. 5) Repair the fan and fan cover to achieve correct dimensions and clear the air vents. 6) Adjust the air gap and correct the assembly.
8. Motors overheats while running	<ol style="list-style-type: none"> 1) Supply voltage too high, causing flux density oversaturation in the iron core and overheating of the motor 2) Supply voltage too low, causing the motor to overheat 3) Stator and rotor iron cores rubbing against each other 4) Motor overloaded 5) Frequent motor starts with forward and reverse rotation 6) Fan problem, or the frame or ventilation openings may be blocked by dirt, preventing proper ventilation of the motor 	<ol style="list-style-type: none"> 1) If the supply voltage exceeds the rated voltage too much, contact your power supplier. 2) If the voltage drop in the power cable is too large, replace the cable with a heavier cable. If the supply voltage is too low, contact your power supplier to raise the voltage to the nominal voltage. 3) First determine the cause. If the bearing clearance is larger than the limit value, replace the bearing. If the shaft has bent, straighten it. If the core is loose or deformed, it must be repaired. 4) Reduce the load. 5) Reduce the number of forward and reverse rotations, or replace the motor by a suitable type. 6) Replace the fan if necessary. Open the vent holes and check for a continuous flow of air from the motor.
9. Three-phase current imbalance in no-load operation	<ol style="list-style-type: none"> 1) Supply voltage imbalanced 2) Winding fault such as interturn shorts or a group of turns improperly connected 3) Number of turns not equal after rewinding 	<ol style="list-style-type: none"> 1) Measure the supply voltage. 2) Disassemble the motor to check the windings for polarity and internal faults, then correct the faults. 3) Rewind the windings.

HOYER

EXCEEDING EXPECTATIONS

Hoyer Motors, Motor Manual, October 2022

Head Offices

Denmark
Over Hadstenvej 42 · DK-8370 Hadsten
T +45 86 98 22 55 · F +45 86 98 17 79
hoyermotors@hoyermotors.com

China
Svend Hoyer
Power Transmission Ningbo Co., LTD
No. 1, Building 8, No. 338, Anju Road,
Beilun District, 315821 Ningbo, Zhejiang
T +86 21 8036 4698 · F +86 574 2628 1573
hoyermotors@hoyermotors.cn

Branch Offices

Germany
Landsberger Straße 155 · 80687 München
T +49 89 700 88 235 · F +49 89 543 56 333
germany@hoyermotors.com

Sweden
Liljeholmsstranden 5 · PO box 44017
SE-100 73 Stockholm
T +46 8 446 877 13 · F +46 8 446 877 20
sweden@hoyermotors.com

Benelux
Vasteland 78 · 3011 BN, Rotterdam
T +31 10 420 35 20 · F +31 10 420 44 51
benelux@hoyermotors.com

Norway
Torvet 1 · 3256 Larvik
T +47 33 18 00 11
norway@hoyermotors.com

Poland
Stanisława Konarskiego 11 · 33-100 Tarnów
T +48 668 924 448
poland@hoyermotors.com

Korea
302ho · Code square, 3150-1
Daejeo 2-dong · Gangseo-gu · Busan
T +82 51 944 1268 · F +82 51 996 0252
korea@hoyermotors.com

Japan
Mizunobu Bldg 7F, 1-11-1 · Kitasaiwai
Nishi-ku Yokohama
T +81 35 571 1517
japan@hoyermotors.com

USA
Hoyer Inc · 5826 Cheswood
Houston TX 77087
wind@hoyermotors.com