

In-line Pump

Etaline L

60 Hz

Installation/Operating Manual



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Installation/Operating Manual Etaline L

Original operating manual

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Glossary

Back pull-out unit

Pump without pump casing; partly completed machinery

Certificate of decontamination

If a product is to be returned to the manufacturer, the customer declares in a certificate of decontamination that the product has been properly drained to eliminate any environmental and health hazards arising from components in contact with the fluid handled.

Close-coupled design

Motor directly fitted to the pump via a flange or a drive lantern

Discharge line

The pipeline which is connected to the discharge nozzle

Hydraulic system

The part of the pump in which the kinetic energy is converted into pressure energy

IE3

Efficiency class to IEC 60034-30:
3 = Premium Efficiency (IE = International Efficiency)

In-line design

A pump whose suction and discharge nozzle are arranged opposite each other and have the same nominal diameter.

Noise characteristics

Noise emission to be expected, indicated as sound pressure level LPA in dB(A)

Pump

Machine without drive, additional components or accessories

Pump set

Complete pump set consisting of pump, drive, additional components and accessories

Suction lift line/suction head line

The pipeline which is connected to the suction nozzle

1 General

1.1 Principles

This manual is supplied as an integral part of the type series indicated on the front cover. The manual describes the proper and safe use of this equipment in all phases of operation.

The name plate indicates the type series, the main operating data and the material number/series code. The material number/series code uniquely describes the product and is used as identification in all further business processes.

In the event of damage, contact your nearest KSB service center immediately to maintain the right to claim warranty.

Noise characteristics see (⇒ Section 4.7, Page 17)

1.2 Installation of partly completed machinery

To install partly completed machinery supplied by KSB refer to the sub-sections under Servicing/Maintenance.

1.3 Target group

This operating manual is aimed at the target group of trained and qualified specialist technical personnel. (⇒ Section 2.4, Page 9)

1.4 Other applicable documents

Table 1: Overview of other applicable documents

Document	Contents
Data sheet	Description of the technical data of the pump (set)
General arrangement drawing/ outline drawing	Description of mating dimensions and installation dimensions for the pump (set), weights
Drawing of auxiliary connections	Description of auxiliary connections
Hydraulic characteristic curve	Characteristic curves showing head, NPSH req, efficiency and power input
General assembly drawing ¹⁾	Sectional drawing of the pump (set)
Sub-supplier product literature ¹⁾	Operating manuals and other product literature describing accessories and integrated machinery components
Spare parts lists ¹⁾	Description of spare parts
Piping layout ¹⁾	Description of auxiliary piping
List of components ¹⁾	Description of all pump components
Assembly drawing ¹⁾	Sectional drawing of the shaft seal

For accessories and/or integrated machinery components observe the product literature of the corresponding manufacturer.

1.5 Symbols

Table 2: Symbols used in this manual

Symbol	Description
✓	Conditions which need to be fulfilled before proceeding with the step-by-step instructions
▷	Safety instructions
⇔	Result of an action
⇔	Cross-references

1) If agreed to be included in the scope of supply

Symbol	Description
1. 2.	Step-by-step instructions
	Note Recommendations and important information on how to handle the product



2 Safety

All the information contained in this section refers to hazardous situations.

2.1 Key to safety symbols/markings

Table 3: Definition of safety symbols/markings

Symbol	Description
 DANGER	DANGER This signal word indicates a high-risk hazard which, if not avoided, will result in death or serious injury.
 WARNING	WARNING This signal word indicates a medium-risk hazard which, if not avoided, could result in death or serious injury.
CAUTION	CAUTION This signal word indicates a hazard which, if not avoided, could result in damage to the machine and its functions.
	General hazard In conjunction with one of the signal words this symbol indicates a hazard which will or could result in death or serious injury.
	Electrical hazard In conjunction with one of the signal words this symbol indicates a hazard involving electrical voltage and identifies information about protection against electrical voltage.
	Machine damage In conjunction with the signal word CAUTION this symbol indicates a hazard for the machine and its functions.

2.2 General

This operating manual contains general installation, operating and maintenance instructions that must be observed to ensure safe operation of the system and prevent personal injury and damage to property.

The safety information in all sections of this manual must be complied with.

The operating manual must be read and understood by the responsible specialist personnel/operators prior to installation and commissioning.

The contents of this operating manual must be available to the specialist personnel at the site at all times.

Information attached directly to the product must always be complied with and kept in a perfectly legible condition at all times. This applies to, for example:

- Arrow indicating the direction of rotation
- Markings for connections
- Name plate

The operator is responsible for ensuring compliance with all local regulations which are not taken into account.

The electric drive has been designed and constructed in accordance with the requirements of Directive 2014/35/EU ("Low-voltage Directive").

2.3 Intended use

- The product must not be used in potentially explosive atmospheres.
- The pump (set) must only be operated within the operating limits which are described in the other applicable documents.
- Only operate pumps/pump sets which are in perfect technical condition.
- Only use the pump to handle the fluids described in the data sheet or product literature of the pump model or variant.
- Never operate the pump without the fluid to be handled.
- Observe the minimum flow rates indicated in the data sheet or product literature (to prevent overheating, bearing damage, etc).
- Observe the maximum flow rates indicated in the data sheet or product literature (to prevent overheating, mechanical seal damage, cavitation damage, bearing damage, etc).
- Do not throttle the flow rate on the suction side of the pump (to prevent cavitation damage).
- Consult the manufacturer about any use or mode of operation not described in the data sheet or product literature.

Prevention of foreseeable misuse

- Never open the discharge-side shut-off elements further than permitted.
 - The maximum flow rates specified in the product literature or data sheet would be exceeded.
 - Risk of cavitation damage
- Never exceed the permissible operating limits specified in the data sheet or product literature regarding pressure, temperature, mains voltage, mains frequency, ambient temperature, motor rating, speed, etc.
- Observe all safety information and instructions in this manual.

2.4 Personnel qualification and personnel training

All personnel involved must be fully qualified to transport, install, operate, maintain and inspect the machinery this manual refers to.

The responsibilities, competence and supervision of all personnel involved in transport, installation, operation, maintenance and inspection must be clearly defined by the operator.

Deficits in knowledge must be rectified by sufficiently trained specialist personnel training and instructing the personnel who will carry out the respective tasks. If required, the operator can commission the manufacturer/supplier to train the personnel.

Training on the pump (set) must always be supervised by technical specialist personnel.

2.5 Consequences and risks caused by non-compliance with these operating instructions

- Non-compliance with these operating instructions will lead to forfeiture of warranty cover and of any and all rights to claims for damages.
- Non-compliance can, for example, have the following consequences:
 - Hazards to persons due to electrical, thermal, mechanical and chemical effects and explosions
 - Failure of important product functions
 - Failure of prescribed maintenance and servicing practices
 - Hazard to the environment due to leakage of hazardous substances

2.6 Safety awareness

In addition to the safety information contained in this manual and the intended use, the following safety regulations shall be complied with:

- Accident prevention, health and safety regulations
- Explosion protection regulations
- Safety regulations for handling hazardous substances
- Applicable standards, directives and laws

2.7 Safety information for the operator/user

- The operator shall fit contact guards for hot, cold and moving parts and check that the guards function properly.
- Do not remove any contact guards during operation.
- Provide the personnel with protective equipment and make sure it is used.
- Contain leakages (e.g. at the shaft seal) of hazardous fluids handled (e.g. explosive, toxic, hot) so as to avoid any danger to persons and the environment. Adhere to all relevant laws.
- Eliminate all electrical hazards. (In this respect refer to the applicable national safety regulations and/or regulations issued by the local energy supply companies.)
- If shutting down the pump does not increase potential risk, fit an emergency stop control device in the immediate vicinity of the pump (set) during pump set installation.

2.8 Safety information for maintenance, inspection and installation

- Modifications or alterations of the pump are only permitted with the manufacturer's prior consent.
- Use only original spare parts or parts authorized by the manufacturer. The use of other parts can invalidate any liability of the manufacturer for resulting damage.
- The operator ensures that maintenance, inspection and installation is performed by authorized, qualified specialist personnel who are thoroughly familiar with the manual.
- Only carry out work on the pump (set) during standstill of the pump.
- Any work on the pump set shall only be performed when it has been disconnected from the power supply (de-energized).
- The pump casing must have cooled down to ambient temperature.
- Pump pressure must have been released and the pump must have been drained.
- When taking the pump set out of service always adhere to the procedure described in the manual. (⇒ Section 6.1.9, Page 28) (⇒ Section 6.3, Page 31)
- Decontaminate pumps which handle fluids posing a health hazard. (⇒ Section 7.3, Page 37)
- As soon as the work has been completed, re-install and/or re-activate any safety-relevant and protective devices. Before returning the product to service, observe all instructions on commissioning.

2.9 Unauthorized modes of operation

Never operate the pump (set) outside the limits stated in the data sheet and in this manual.

The warranty relating to the operating reliability and safety of the pump (set) supplied is only valid if the equipment is used in accordance with its intended use.

2.10 Electromagnetic compatibility

When operating the motor on a frequency inverter always observe the frequency inverter manufacturer's information on compliance with the Electromagnetic Compatibility Directive. Take additional measures to ensure compliance with the Directive and obtain a connection approval from the local energy supply company if necessary.

3 Transport/Temporary Storage/Disposal

3.1 Checking the condition upon delivery

1. On transfer of goods, check each packaging unit for damage.
2. In the event of in-transit damage, assess the exact damage, document it and notify KSB or the distributor and the insurance company about the damage in writing immediately.

3.2 Transport

	⚠ DANGER
	<p>The pump (set) could slip out of the suspension arrangement Danger to life from falling parts!</p> <ul style="list-style-type: none"> ▷ Only transport the pump (set) in the position indicated. ▷ Never attach the suspension arrangement to the free shaft end or the motor eyebolt. ▷ Pay attention to the weight data and the center of gravity. ▷ Comply with the applicable accident prevention regulations. ▷ Use suitable, permitted lifting accessories, e.g. self-tightening lifting tongs.

To transport the Pump/pump set suspend it as illustrated.

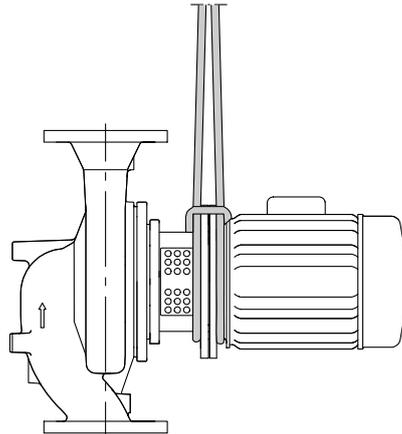


Fig. 1: Transporting the pump set

3.3 Storage/preservation

	CAUTION
	<p>Damage during storage by humidity, dirt or vermin Corrosion/contamination of the pump (set)!</p> <ul style="list-style-type: none"> ▷ For short-term outdoor storage cover the pump (set) or the packaged pump (set) and accessories with waterproof material.
	CAUTION
	<p>Wet, contaminated or damaged openings and connections Leakage or damage to the pump!</p> <ul style="list-style-type: none"> ▷ Clean and cover pump openings and connections as required prior to putting the pump into storage.

If commissioning is to take place some time after delivery, we recommend that the following measures be taken for pump (set) storage:

- Store the pump (set) in a dry, protected room where the atmospheric humidity is as constant as possible.
- Rotate the shaft by hand once a month, e.g. via the motor fan.
- Exposed locating surfaces (shaft ends, flange faces, centering spigots, connector contacts) are treated with a layer of temporary corrosion protection (< 6 months) for transport. Take suitable corrosion protection measures for extended storage periods.
- Replace closed rolling element bearings after 48 months of storage.

If properly stored indoors, the equipment is protected for a maximum of 12 months. New pumps/pump sets are supplied by our factory duly prepared for storage.

For storing a pump (set) which has already been operated, observe the measures to be taken for shutdown. (⇒ Section 6.3.1, Page 31)

3.4 Return to supplier

1. Drain the pump as per operating instructions. (⇒ Section 7.3, Page 37)
2. Always flush and clean the pump, particularly if it has been used for handling noxious, explosive, hot or other hazardous fluids.
3. If the pump set has handled fluids whose residues could lead to corrosion damage in the presence of atmospheric humidity or could ignite upon contact with oxygen, the pump set must also be neutralized, and anhydrous inert gas must be blown through the pump to ensure drying.
4. Always complete and enclose a certificate of decontamination when returning the pump (set).
Always indicate any safety and decontamination measures taken.
(⇒ Section 10, Page 49)

	NOTE
	<p>If required, a blank certificate of decontamination can be downloaded from the KSB web site at: www.ksb.com/certificate_of_decontamination</p>

3.5 Disposal

	! WARNING
	<p>Fluids handled, consumables and operating supplies which are hot or pose a health hazard</p> <p>Hazard to persons and the environment!</p> <ul style="list-style-type: none"> ▷ Collect and properly dispose of the flushing medium and of any residues of the fluid handled. ▷ Wear safety clothing and a protective mask, if required. ▷ Observe all legal regulations on the disposal of fluids posing a health hazard.

1. Dismantle the pump (set).
Collect greases and other lubricants during dismantling.
2. Separate and sort the pump materials, e.g. by:
 - Metals
 - Plastics
 - Electronic waste
 - Greases and other lubricants
3. Dispose of materials in accordance with local regulations or in another controlled manner.

4 Description of the Pump (Set)

4.1 General description

- Non-self-priming in-line pump with low-voltage asynchronous motor to IEC 60034

Pump for handling clean or aggressive fluids which are neither chemically nor mechanically aggressive to the pump materials.

4.2 Product information as per Regulation No. 547/2012 (for water pumps with a maximum shaft power of 150 kW) implementing "Ecodesign" Directive 2009/125/EC

- Minimum efficiency index: see name plate, key to name plate
- The benchmark for the most efficient water pumps is $MEI \geq 0.70$.
- Year of construction: see name plate, key to name plate
- Manufacturer's name or trade mark, commercial registration number and place of manufacture: see data sheet or order documentation
- Product's type and size identifier: see name plate, key to name plate
- Hydraulic pump efficiency (%) with trimmed impeller: see data sheet
- Pump performance curves, including efficiency characteristics: see documented characteristic curve
- The efficiency of a pump with a trimmed impeller is usually lower than that of a pump with the full impeller diameter. Trimming of the impeller will adapt the pump to a fixed duty point, leading to reduced energy consumption. The minimum efficiency index (MEI) is based on the full impeller diameter.
- The operation of this water pump with variable duty points may be more efficient and economic when controlled, for example, by the use of a variable speed drive that matches the pump duty to the system.
- Information relevant for disassembly, recycling or disposal at end of life (⇒ Section 3.5, Page 13)
- Information on benchmark efficiency or benchmark efficiency graph for $MEI = 0.70$ (0.40) for the pump based on the model shown in the Figure are available at: <http://www.europump.org/efficiencycharts>

4.3 Designation

Example: ETL032-032-100 GGWAV11D2

Table 4: Designation key

Code	Description	
ETLL	Type series	
	ETLL	Etaline L
032	Nominal suction nozzle diameter [mm]	
032	Nominal discharge nozzle diameter [mm]	
100	Nominal impeller diameter [mm]	
G	Casing material	
	G	Gray cast iron
	B	Bronze
G	Impeller material if different from casing material	
	G	Gray cast iron
	B	Bronze
	P	Polysulphone
W	Additional code	
	P	Model with casing cover made of polysulphone
	W	WRAS-approved for drinking water

Code	Description	
W	X	Special design
A	Casing cover	
	A	Conical seal chamber
V	Sealing system	
	V	Conical seal chamber with vent
11	Seal code	
	11	Mechanical seal material BQ1EGG
D	Scope of supply	
	D	Pump with motor
2	Shaft unit	
	2	WE 12
	4	WE 14
	6	WE 16

4.4 Name plate

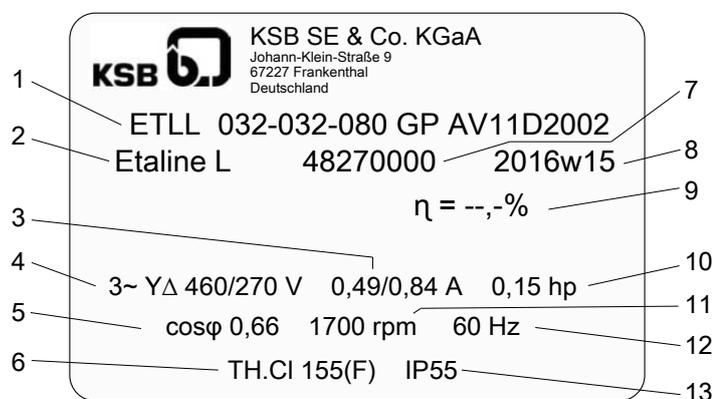


Fig. 2: Name plate (example)

1	Type series code, size and version	2	Type series
3	Phase current	4	Voltage range
5	Power factor	6	Thermal class
7	Material number	8	Series code
9	Efficiency	10	Nominal power
11	Speed	12	Frequency
13	Enclosure		

4.5 Design details

Design

- Close-coupled design / in-line design
- Single-stage
- Horizontal/vertical installation
- Rigid connection between pump and motor

Pump casing

- Radially split volute casing
- In-line design

Impeller type

- Closed radial impeller

Shaft seal

- KSB mechanical seal

Bearings

- Radial ball bearings in motor housing
- Grease lubrication

Drive

- Surface-cooled squirrel-cage motor to KSB standard
- Efficiency class IE3 to IEC 60034-30 (≥ 0.75 kW)
- Winding 60 Hz, 1~ 230 V / 3~ 440-480 V ≤ 1.48 hp (1.10 kW)
- Winding 60 Hz, 3~ 440-480 V ≥ 2.41 hp (1.80 kW)
- Type of construction IM V1
- Enclosure IP55
- Duty cycle continuous duty S1
- Thermal class F

Automation

Automation options:

- PumpDrive

4.6 Configuration and function

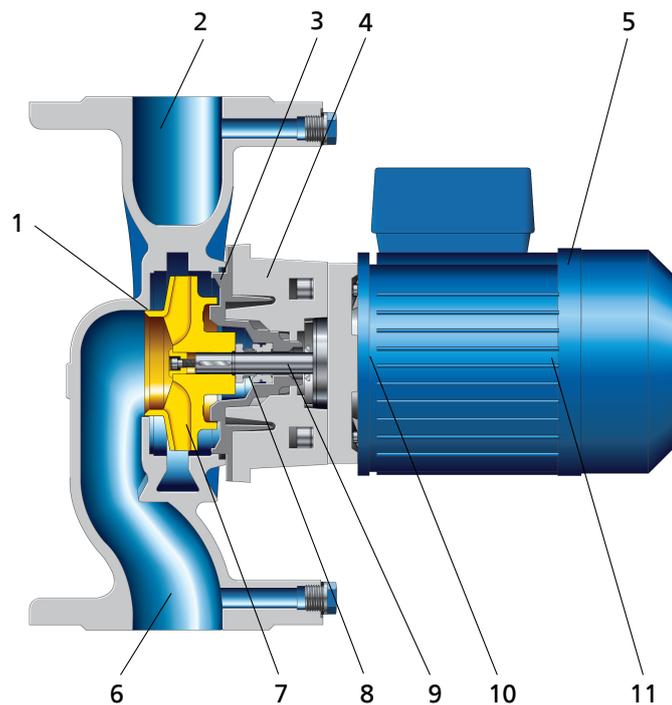


Fig. 3: Sectional drawing

1	Clearance gap	2	Discharge nozzle
3	Cap	4	Drive lantern
5	Motor housing	6	Suction nozzle
7	Impeller	8	Shaft seal
9	Shaft	10	Rolling element bearing
11	Rolling element bearing		

Design The pump is designed with a radial fluid inlet (suction nozzle) and a radial outlet (discharge nozzle) arranged on the same axis. The hydraulic system is rigidly connected to the motor via a shaft. The motor shaft is dynamically balanced.

- Function** The fluid enters the pump via the suction nozzle (6) and is accelerated outward by the rotating impeller (7). In the flow passage of the pump casing the kinetic energy of the fluid is converted into pressure energy. The fluid is pumped to the discharge nozzle (2), where it leaves the pump. The clearance gap (1) prevents any fluid from flowing back from the casing into the suction nozzle. At the rear side of the impeller, the shaft (9) enters the hydraulic system via a cap (3). The shaft passage through the cap is sealed to atmosphere with a shaft seal (8). The shaft runs in rolling element bearings (10 and 11), which are supported by a motor housing (5) linked with the pump casing and/or casing cover via the drive lantern (4).
- Sealing** The pump is sealed by a standardized mechanical seal.

4.7 Noise characteristics

Table 5: Surface sound pressure level L_{pA} ²⁾³⁾

Rated power input P_N		Pump set	
[hp]	[kW]	1450 rpm	2900 rpm
0,16	0,12	36	40
0,24	0,18	36	40
0,3	0,25	-	46
0,5	0,37	36	46
0,7	0,55	-	46
1,0	0,75	37	52
1,5	1,1	-	52
2,4	1,8	-	53
4,0	3	-	53

4.8 Scope of supply

Depending on the model, the following items are included in the scope of supply:

- Pump set

or

- Motor including casing cover

Accessories

- Pump foot for vertical installation of the drive

4.9 Dimensions and weights

For dimensions and weights please refer to the pump's type series booklet.

2) Spatial average; as per ISO 3744 and EN 12639; valid for pump operation in the $Q/Q_{opt} = 0.8 - 1.1$ range and for non-cavitating operation. If noise levels are to be guaranteed: add +3 dB for measuring and constructional tolerance.
 3) Increase for 60 Hz operation: 3500 rpm +3 dB; 1750 rpm +1 dB

5 Installation at Site

5.1 Safety regulations

	⚠ DANGER
	<p>Improper installation in potentially explosive atmospheres Damage to the pump set!</p> <ul style="list-style-type: none"> ▸ Comply with the applicable local explosion protection regulations. ▸ Observe the information given in the data sheet and on the pump/motor name plates.

5.2 Checks to be carried out prior to installation

Foundation Check the structural requirements.
 All structural work required must have been prepared in accordance with the dimensions stated in the outline drawing/general arrangement drawing.

	CAUTION
	<p>Ingress of leakage into the motor Damage to the pump!</p> <ul style="list-style-type: none"> ▸ Never arrange the pump set with the "motor below".

Protective roof **Protective roof/additional roofing**
 For vertical installation with the motor on top, fit a protective roof or additional roofing to prevent foreign objects from falling into the fan hood.

Ventilation **Ventilation**

	⚠ WARNING
	<p>Improper installation Drive overheating!</p> <ul style="list-style-type: none"> ▸ Maintain the specified minimum distances to neighboring assemblies. ▸ Never restrict the ventilation of the drive. ▸ Prevent exhaust air from neighboring assemblies from being drawn in directly.

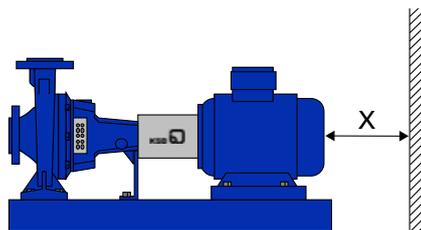


Fig. 4: Minimum distance X

Table 6: Minimum distance X to neighboring assemblies

Shaft centerline height to IEC motor sizes	Minimum distance X
71 - 100	1.18 inch (30 mm)

5.3 Installing the pump set

	CAUTION
	<p>Ingress of leakage into the motor Damage to the pump!</p> <ul style="list-style-type: none"> ▷ Never arrange the pump set with the "motor below".

The pump set may be flanged directly into the piping.

1. Position the pump set on the foundation or in the piping and fasten it.
2. Place a spirit level on the discharge nozzle to align the pump set.

5.4 Piping

5.4.1 Connecting the piping

	⚠ DANGER
	<p>Impermissible loads acting on the pump nozzles Danger to life from leakage of hot, toxic, corrosive or flammable fluids!</p> <ul style="list-style-type: none"> ▷ Do not use the pump as an anchorage point for the piping. ▷ Anchor the pipelines in close proximity to the pump and connect them properly without transmitting any stresses or strains. ▷ Observe the permissible forces and moments at the pump nozzles. (⇒ Section 5.4.2, Page 20) ▷ Take appropriate measures to compensate thermal expansion of the piping.

	CAUTION
	<p>Incorrect grounding during welding work on the piping Destruction of rolling element bearings (pitting effect)!</p> <ul style="list-style-type: none"> ▷ Never ground the electric welding equipment on the pump or baseplate. ▷ Prevent current flowing through the rolling element bearings.

	NOTE
	<p>Installing check and shut-off elements in the system is recommended, depending on the type of plant and pump. However, such elements must not obstruct proper drainage or hinder disassembly of the pump.</p>

- ✓ Suction lift lines have been laid with a rising slope, suction head lines with a downward slope towards the pump.
- ✓ A flow stabilization section having a length equivalent to at least twice the diameter of the suction flange has been provided upstream of the suction flange.
- ✓ The nominal diameters of the pipelines are at least equal to the nominal diameters of the pump nozzles.
- ✓ Adapters to larger nominal diameters are designed with a diffuser angle of approx. 8° to avoid excessive pressure losses.
- ✓ The pipelines have been anchored in close proximity to the pump and connected without transmitting any stresses or strains.

	CAUTION
	<p>Welding beads, scale and other impurities in the piping Damage to the pump!</p> <ul style="list-style-type: none"> ▷ Remove any impurities from the piping. ▷ If necessary, install a filter. ▷ Observe the information given in (⇒ Section 7.2.2.1, Page 36) .

1. Thoroughly clean, flush and blow through all vessels, pipelines and connections (especially of new installations).
2. Before installing the pump in the piping, remove the flange covers on the suction and discharge nozzles of the pump.
3. Check that the inside of the pump is free from any foreign objects. Remove any foreign objects.
4. If required, install a filter in the piping (see drawing: Filter in the piping).

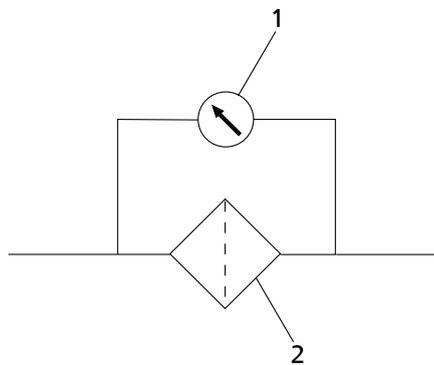


Fig. 5: Filter in the piping

1	Differential pressure gage	2	Filter
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	NOTE
	<p>Use a filter with laid-in wire mesh (mesh width 0.5 mm, wire diameter 0.25 mm) of corrosion-resistant material. Use a filter with a filter area three times the cross-section of the piping. Conical filters have proved suitable.</p>

5. Connect the pump nozzles to the piping.

	CAUTION
	<p>Aggressive flushing and pickling agents Damage to the pump!</p> <ul style="list-style-type: none"> ▷ Match the cleaning operation mode and duration for flusing and pickling service to the casing and seal materials used.

5.4.2 Permissible forces and moments at the pump nozzles

No piping-induced forces and moments (from warped pipelines or thermal expansion, for example) must act on the pump.

5.4.3 Vacuum balance line

	NOTE
	<p>Where fluid has to be pumped out of a vessel under vacuum, installing a vacuum balance line is recommended.</p>

The following rules apply to vacuum balance lines:

- Minimum nominal line diameter: 25 mm.
- The line extends above the highest permissible fluid level in the tank.

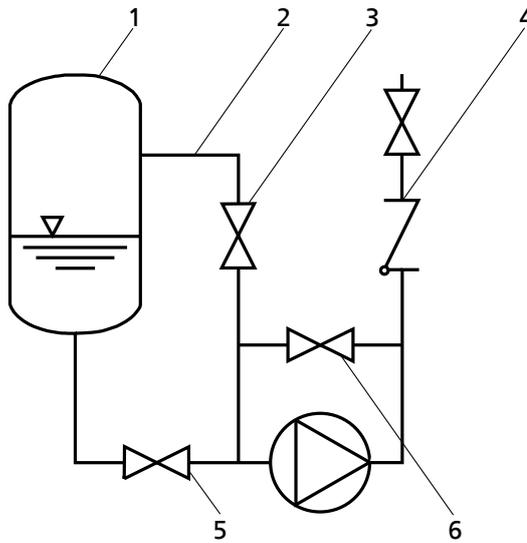


Fig. 6: Vacuum balance line

1	Vessel under vacuum	2	Vacuum balance line
3	Shut-off element	4	Swing check valve
5	Main shut-off element	6	Vacuum-tight shut-off element

	NOTE
	An additional line fitted with a shut-off valve (from the pump discharge nozzle to the balance line) facilitates venting of the pump before start-up.

5.4.4 Auxiliary connections

	! WARNING
	<p>Failure to use or incorrect use of auxiliary connections (e. g. barrier fluid, flushing liquid etc.)</p> <p>Risk of injury from escaping fluid!</p> <p>Risk of burns!</p> <p>Malfunction of the pump!</p> <ul style="list-style-type: none"> ▸ Refer to the general arrangement drawing, the piping layout and pump markings (if any) for the number, dimensions and locations of auxiliary connections. ▸ Use the auxiliary connections provided.

5.5 Enclosure/insulation

	! WARNING
	<p>Volute casing and casing cover / discharge cover take on the same temperature as the fluid handled.</p> <p>Risk of burns!</p> <ul style="list-style-type: none"> ▸ Insulate the volute casing. ▸ Fit protective equipment.

	CAUTION
	<p>Risk of potentially explosive atmosphere due to insufficient ventilation Explosion hazard!</p> <ul style="list-style-type: none"> ▷ Ensure ventilation of the space between the casing cover/discharge cover and the bearing cover.
	CAUTION
	<p>Heat build-up in the bearing bracket Damage to the bearings!</p> <ul style="list-style-type: none"> ▷ Never insulate the bearing bracket / bearing bracket lantern and casing cover.

5.6 Electrical connection

	⚠ DANGER
	<p>Hazardous voltage Danger of death from electric shock!</p> <ul style="list-style-type: none"> ▷ Have all work performed only by qualified specialist personnel and only when the drive is at a standstill and secured against unintentional start-up. This also applies to auxiliary circuits (e.g. standstill heater). ▷ The drive must not be electrically connected at any point in time when work is performed on the open terminal box.
	⚠ WARNING
	<p>Incorrect connection to the mains Damage to the mains network, short circuit!</p> <ul style="list-style-type: none"> ▷ Observe the technical specifications of the local energy supply companies.
	NOTE
	<p>Always protect three-phase motors with a current-dependent overload protection device with additional phase failure protection.</p>

Select the motor power cables in accordance with IEC 60364, taking into account the current load of the cable at the given ambient temperature and the requisite heat dissipation to IEC / EN 60204-1 as a result of cable routing.

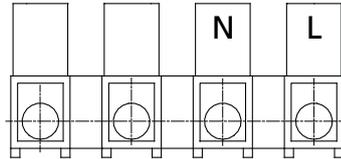
5.6.1 Motor connection inside the terminal box

Observe the following when performing any work on the terminal box:

- Always use the original sealing element to close the terminal box so that it is dust- and watertight.
- Do not damage components on the inside of the terminal box (e.g. terminal board and cable connections).
- Ensure that no foreign bodies, contamination or moisture are present in the terminal box. Terminal box cable entries to DIN 42925
- Close additional open cable entries using O-rings or suitable gaskets.
- Observe prescribed tightening torques for cable glands and other screws/bolts.
- When retrofitting cable glands to safeguard the required level of enclosure protection, ensure that the gasket is seated properly on the outside of the terminal box.

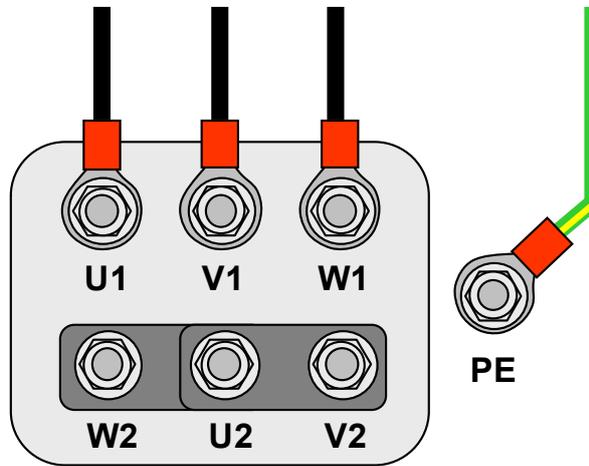
Connecting the motor

1. Check the voltage of the available power supply network against the data on the motor name plate.
2. Knock out any knock-out openings in the terminal box. While doing this, avoid causing damage to the terminal board, cable connections, etc. inside the terminal box.
3. Connect the motor in star or delta configuration in accordance with the rated voltage (see name plate) and the available power supply network.

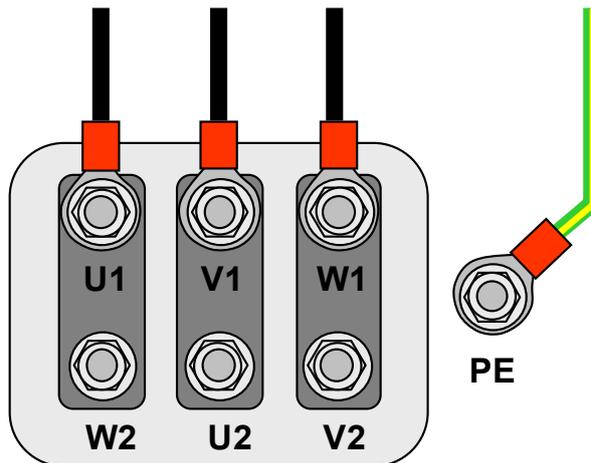


1~, configuration

To connect a single-phase motor to the AC power grid, connect the phase conductor to terminal "L" and neutral to terminal "N".



3~, star configuration



3~, delta configuration

4. Connect the ground conductor (PE).

5.6.1.1 Tightening torques

Unless other tightening torques are indicated on the motor, use the following values:

Table 7: Tightening torques

Thread	Tightening torque	
	[lbf in]	[Nm]
M4	10	1,2
M5	17	2,0
M6	26	3,0
M8	53	6,0
M10	88	10,0

6 Commissioning/Start-up/Shutdown

6.1 Commissioning/Start-up/Shutdown

	 DANGER
	<p>Hazardous voltage Danger of death from electric shock!</p> <ul style="list-style-type: none"> ▸ Have all work performed only by qualified specialist personnel and only when the drive is at a standstill and secured against unintentional start-up. This also applies to auxiliary circuits (e.g. standstill heater). ▸ The drive must not be electrically connected at any point in time when work is performed on the open terminal box.

Before commissioning and whenever returning the product to service, perform the electrical safety checks stipulated by EN 60204-1.

6.1.1 Prerequisites for commissioning/start-up

Before commissioning/starting up the pump set, make sure that the following conditions are met:

- The drive has been mounted and aligned correctly.
- The operating conditions have been verified against the name plate data.
- The ground connection and potential equalization connection have been implemented correctly.
- All fastening bolts/screws, connecting elements and electrical connections have been tightened to the specified tightening torques.
- Measures have been taken to prevent accidental contact with moving and live parts.
- Components (cables, etc.) that are sensitive to temperature do not come into contact with the motor housing.
- The pump set has been properly connected to the electric power supply and is equipped with all protection devices.
- The pump has been primed with the fluid to be handled. The pump has been vented.
- The direction of rotation has been checked.
- All auxiliary connections required are connected and operational.
- After prolonged shutdown of the pump (set), the activities required for returning the pump (set) to service have been carried out. (⇒ Section 6.4, Page 32)

6.1.2 Checking the ground conductor connection

Check that the ground conductor has been correctly connected in accordance with EN 60204.

6.1.3 Checking the insulation resistance

Prior to commissioning and following prolonged storage or standstill periods, the insulation resistance will need to be checked and verified.

	NOTE
	<p>If windings have been dried after having been repaired or cleaned, bear in mind that the insulation resistance of warm windings is lower. The insulation resistance can only be correctly evaluated after converting to the reference temperature of 25 °C.</p>

The insulation resistance of the stator winding must equal at least 1.5 megohms in motors for 220 -1000 V.

6.1.4 Filling in the lubricant

Grease-lubricated bearings have been packed with grease.

6.1.5 Priming and venting the pump

	 DANGER
	<p>Formation of a potentially explosive atmosphere inside the pump Explosion hazard!</p> <ul style="list-style-type: none"> ▷ Before starting up the pump set, vent the pump and suction line and prime both with the fluid to be handled.

	CAUTION
	<p>Increased wear due to dry running Damage to the pump set!</p> <ul style="list-style-type: none"> ▷ Never operate the pump set without liquid fill. ▷ Never close the shut-off element in the suction line and/or supply line during pump operation.

1. Vent the pump and suction line and prime both with the fluid to be handled. Connection 6D can be used for venting (see drawing of auxiliary connections). For vertical installation with the motor on top, use connection 5B (if provided) for venting (see drawing of auxiliary connections).
2. Fully open the shut-off element in the suction line.
3. Fully open all auxiliary feed lines (barrier fluid, flushing liquid, etc.) if any.
4. Open the shut-off element (if any) in the vacuum balance line and close the vacuum-tight shut-off element if any.

	 WARNING
	<p>Hot fluid handled spurting out when vent plug is opened Risk of electric shock! Risk of scalding!</p> <ul style="list-style-type: none"> ▷ Protect electrical components from fluid handled spurting out. ▷ Wear protective clothing (e.g. gloves).

	NOTE
	<p>For design-inherent reasons, the existence of some volume not filled with fluid handled after the pump has been primed prior to commissioning cannot be excluded. Once the motor is started up the pumping effect will immediately fill this volume with the fluid handled.</p>

6.1.6 Checking the direction of rotation

	 DANGER
	<p>Temperature increase resulting from contact between rotating and stationary components Damage to the pump set!</p> <ul style="list-style-type: none"> ▷ Never check the direction of rotation by starting up the unfilled pump set.

	<p>! WARNING</p> <p>Hands inside the pump casing Risk of injuries, damage to the pump!</p> <ul style="list-style-type: none"> ▷ Never insert your hands or any other objects into the pump if the pump has not been de-energized and secured against unintentional start-up.
	<p>! WARNING</p> <p>Parts flying off Personal injury and damage to property!</p> <ul style="list-style-type: none"> ▷ When checking the direction of rotation with the coupling removed, secure the respective keys to protect them from being thrown off.
	<p>CAUTION</p> <p>Drive and pump running in the wrong direction of rotation Damage to the pump!</p> <ul style="list-style-type: none"> ▷ Refer to the arrow indicating the direction of rotation on the pump. ▷ Check the direction of rotation. If required, check the electrical connection and correct the direction of rotation.

The correct direction or rotation of the motor and pump is clockwise (seen from the motor end).

1. Start the motor and stop it again immediately to determine the motor's direction of rotation.
2. Check the direction of rotation.
The motor's direction of rotation must match the arrow indicating the direction of rotation on the pump.
3. If the impeller rotates in the wrong direction of rotation, check and correct the electrical connection of the motor and the control system if applicable.

6.1.7 Commissioning/start-up

	<p>! DANGER</p> <p>Non-compliance with the permissible pressure and temperature limits if the pump is operated with the suction and discharge lines closed. Leakage of hot or toxic fluids!</p> <ul style="list-style-type: none"> ▷ Never operate the pump with the shut-off elements in the suction line and/or discharge line closed. ▷ Only start up the pump set with the discharge side gate valve slightly or fully open.
	<p>! DANGER</p> <p>Excessive temperatures due to dry running or excessive gas content in the fluid handled Damage to the pump set!</p> <ul style="list-style-type: none"> ▷ Never operate the pump set without liquid fill. ▷ Prime the pump as per operating instructions. ▷ Always operate the pump within the permissible operating range.

	CAUTION
	<p>Abnormal noises, vibrations, temperatures or leakage Damage to the pump!</p> <ul style="list-style-type: none"> ▷ Switch off the pump (set) immediately. ▷ Eliminate the causes before returning the pump set to service.

- ✓ The system piping has been cleaned.
- ✓ The pump, suction line and inlet tank (if any) have been vented and primed with the fluid to be handled.
- ✓ The priming and venting lines have been closed.

	CAUTION
	<p>Start-up against open discharge line Motor overload!</p> <ul style="list-style-type: none"> ▷ Make sure the motor has sufficient power reserves. ▷ Use a soft starter. ▷ Use speed control.

1. Fully open the shut-off element in the suction head line / suction lift line.
2. Close or slightly open the shut-off element in the discharge line.
3. Start up the motor.
4. Immediately after the pump has reached full rotational speed, slowly open the shut-off element in the discharge line and adjust it to comply with the duty point.

	⚠ DANGER
	<p>Seal leakages at operating temperature Hot or toxic fluid could escape!</p> <ul style="list-style-type: none"> ▷ Once the operating temperature has been reached, re-tighten the hexagon socket head cap screws between casing and casing cover.

6.1.8 Checking the shaft seal

Mechanical seal The mechanical seal only leaks slightly or invisibly (as vapor) during operation. Mechanical seals are maintenance-free.

6.1.9 Shutdown

	CAUTION
	<p>Heat build-up in the pump Damage to the shaft seal!</p> <ul style="list-style-type: none"> ▷ Depending on the system, the pump set requires sufficient after-run time for the fluid temperature to drop after the heat source has been switched off.

- ✓ The shut-off element in the suction line is and remains open.
1. Close the shut-off element in the discharge line.
 2. Switch off the motor and make sure the pump set runs down smoothly to a standstill.

	NOTE
	<p>If the discharge line is equipped with a non-return or check valve, the shut-off element may remain open as long as the system conditions and regulations are being met.</p>

For prolonged shutdown periods:

1. Close the shut-off element in the suction line.
2. Close any auxiliary lines.
If the fluid to be handled is fed in under vacuum, also supply the shaft seal with barrier fluid during standstill.

	CAUTION
	<p>Risk of freezing during prolonged pump shutdown periods Damage to the pump!</p> <ul style="list-style-type: none"> ▷ Drain the pump and cooling/heating chambers (if any) or protect them against freezing.

6.2 Operating limits

	⚠ DANGER
	<p>Non-compliance with operating limits for pressure, temperature and speed Explosion hazard! Hot or toxic fluid could escape!</p> <ul style="list-style-type: none"> ▷ Comply with the operating data indicated in the data sheet. ▷ Never handle fluids for which the pump has not been designed. ▷ Avoid prolonged operation against a closed shut-off element. ▷ Never operate the pump at temperatures exceeding those specified in the data sheet or on the name plate unless the written consent of the manufacturer has been obtained.

6.2.1 Ambient temperature

	CAUTION
	<p>Operation outside the permissible ambient temperature Damage to the pump (set)!</p> <ul style="list-style-type: none"> ▷ Observe the specified limits for permissible ambient temperatures.

Observe the following parameters and values during operation:

Table 8: Permissible ambient temperatures

Permissible ambient temperature	Value
Maximum	104 °F (40 °C)
Minimum	See data sheet

6.2.2 Frequency of starts

	⚠ DANGER
	<p>Excessive surface temperatures of the motor Explosion hazard!</p> <ul style="list-style-type: none"> ▷ The limit value for stopping the pump must never exceed the specified surface temperature of the respective temperature class. ▷ If the specified surface temperature of the respective temperature class is exceeded, immediately switch off the pump set and determine the cause.

The frequency of starts is usually determined by the maximum temperature increase of the motor. This largely depends on the power reserves of the motor in steady-state operation and on the starting conditions (DOL, star-delta, moments of inertia, etc). If the starts are evenly spaced over the period indicated, the following limits can be used for orientation for start-up with the discharge-side gate valve slightly open:

Table 9: Frequency of starts

Material	Maximum frequency of starts
	[Starts/hour]
G (EN-GJL-150)	15
B (G-CuSn10Zn)	6
P (PSu-GF30)	6

	CAUTION
	<p>Re-starting while motor is still running down Damage to the pump (set)!</p> <ul style="list-style-type: none"> ▷ Do not re-start the pump set before the pump rotor has come to a standstill.

6.2.3 Fluid handled

6.2.3.1 Flow rate

Table 10: Flow rate

Temperature range (t)	Minimum flow rate	Maximum flow rate
-22 °F to +158 °F (-30 °C to +70 °C)	≈ 15 % of $Q_{opt}^{4)}$	See hydraulic characteristic curves
> 158 °F to +284 °F (> 70 °C to +140 °C)	≈ 25 % of $Q_{opt}^{4)}$	

The following calculation formula can be used to check whether an additional heat build-up may lead to a dangerous temperature increase at the pump surface.

$$T_o = T_f + \Delta \vartheta$$

$$\Delta \vartheta = \frac{g \times H}{c \times \eta} \times (1 - \eta)$$

Table 11: Key

Symbol	Description	Unit
c	Specific heat capacity	J/kg K
g	Gravitational constant	m/s ²
H	Pump discharge head	m
T _f	Fluid temperature	°C
T _o	Temperature at the casing surface	°C

4) Best efficiency point

Symbol	Description	Unit
η	Pump efficiency at duty point	-
$\Delta\vartheta$	Temperature difference	K

6.2.3.2 Density of the fluid handled

The power input of the pump changes in proportion to the density of the fluid handled.

	CAUTION
	<p>Impermissibly high density of fluid handled.</p> <p>Motor overload!</p> <ul style="list-style-type: none"> ▷ Observe the information on fluid density in the data sheet. ▷ Make sure the motor has sufficient power reserves.

6.2.3.3 Abrasive fluids

Do not exceed the maximum permissible solids content specified in the data sheet. When the pump handles fluids containing abrasive substances, increased wear of the hydraulic system and shaft seal is to be expected. In this case, reduce the commonly recommended inspection intervals.

6.2.4 Voltages and frequencies

Motor operation off the rated point will cause a rise in motor temperature. A voltage tolerance of $\pm 5\%$ and a frequency tolerance of $\pm 2\%$ are permissible.

Any situation where both the voltage and the frequency tolerance apply simultaneously shall be governed by the provisions of range A as described in EN 60034-1. The motors can be operated continuously in range A. In accordance with EN 60034-1, prolonged operation in range B is not recommended.

6.2.5 Maximum permissible speed

Comply with the maximum speed indicated on the name plate.

6.2.6 Altitude

- ≤ 3280 ft (1000 m) above MSL: without power derating
- > 3280 ft (1000 m) above MSL: installation at altitudes of up to 13123 ft (4000 m) above MSL is possible with power derated by 3.8 % per 1640 ft (500 m).

6.3 Shutdown/storage/preservation

6.3.1 Measures to be taken for shutdown

The pump (set) remains installed

- ✓ Sufficient fluid is supplied for the operation check run of the pump.
 1. For prolonged shutdown periods, start up the pump (set) regularly between once a month and once every three months for approximately five minutes. This will prevent the formation of deposits within the pump and the pump intake area.

The pump (set) is removed from the pipe and stored

- ✓ The pump has been properly drained (⇒ Section 7.3, Page 37) and the safety instructions for dismantling the pump have been observed.
- 1. Spray-coat the inside wall of the pump casing, and in particular the impeller clearance areas, with a preservative.
- 2. Spray the preservative through the suction and discharge nozzles. It is advisable to then close the nozzles (e.g. with plastic caps or similar).
- 3. Oil or grease all exposed machined parts and surfaces of the pump (with silicone-free oil and grease, food-approved, if required) to protect them against corrosion. Observe the additional instructions.

When the pump set is temporarily put into storage, only the wetted low alloy components must be preserved. Commercially available preservatives can be used for this purpose. Observe the manufacturer's instructions for application/removal.

Observe the additional instructions and information provided. (⇒ Section 3, Page 12)

6.4 Returning to service after storage

For returning the equipment to service observe the sections on commissioning/start-up and the operating limits.

In addition, carry out all servicing/maintenance operations before returning the pump (set) to service. (⇒ Section 7, Page 33)

	<p style="background-color: #f4a460; padding: 2px;">! WARNING</p> <p>Failure to re-install or re-activate protective devices Risk of personal injury from moving parts or escaping fluid!</p> <ul style="list-style-type: none"> ▷ As soon as the work has been completed, re-install and re-activate any safety-relevant devices and protective devices.
	<p style="background-color: #0070c0; color: white; padding: 2px;">NOTE</p> <p>If the pump has been out of service for more than one year, replace all elastomer seals.</p>

7 Servicing/Maintenance

7.1 Safety regulations

	 DANGER
	<p>Sparks produced during maintenance work Explosion hazard!</p> <ul style="list-style-type: none"> ▷ Observe the safety regulations in force at the place of installation. ▷ Never open a pump set that is connected to the power supply. ▷ Always perform maintenance work on pump sets outside potentially explosive atmospheres.

	 DANGER
	<p>Improperly serviced pump set Explosion hazard! Damage to the pump set!</p> <ul style="list-style-type: none"> ▷ Service the pump set regularly. ▷ Prepare a maintenance schedule with special emphasis on lubricants, shaft seal and coupling.

The operator ensures that all maintenance, all inspections and all installation work is performed by authorized, qualified specialist personnel who are thoroughly familiar with the manual.

	 WARNING
	<p>Unintentional starting of pump set Risk of injury by moving components and shock currents!</p> <ul style="list-style-type: none"> ▷ Make sure that the pump set cannot be started up unintentionally. ▷ Always make sure the electrical connections are disconnected before carrying out work on the pump set.

	 WARNING
	<p>Fluids handled, consumables and operating supplies which are hot or pose a health hazard Risk of personal injury!</p> <ul style="list-style-type: none"> ▷ Observe all relevant laws. ▷ When draining the fluid take appropriate measures to protect persons and the environment. ▷ Decontaminate pumps which handle fluids posing a health hazard.

	 WARNING
	<p>Insufficient stability Risk of crushing hands and feet!</p> <ul style="list-style-type: none"> ▷ During assembly/dismantling, secure the pump (set)/pump parts against tilting or tipping over.

A regular maintenance schedule will help avoid expensive repairs and contribute to trouble-free, reliable operation of the pump (set) with a minimum of maintenance expenditure and work.

	NOTE
	<p>All maintenance, service and installation work can be carried out by KSB Service or an authorized workshop. Find your contact in the attached "Addresses" booklet or on the Internet under "www.ksb.com/contact".</p>

Never use force when dismantling and reassembling the pump set.

7.2 Maintenance/inspection

7.2.1 Supervision of operation

	⚠ DANGER
	<p>Rotating or live parts Death, serious injury or damage to property!</p> <ul style="list-style-type: none"> ▸ If covers have to be removed, de-energize the motor beforehand. ▸ Avoid touching live or rotating parts.
	⚠ DANGER
	<p>Incorrectly serviced shaft seal Fire hazard! Hot fluids escaping! Damage to the pump set!</p> <ul style="list-style-type: none"> ▸ Service the shaft set regularly.
	⚠ DANGER
	<p>Excessive temperatures as a result of bearings running hot or defective bearing seals Fire hazard! Damage to the pump set!</p> <ul style="list-style-type: none"> ▸ Regularly check the rolling element bearings for running noises.
	⚠ DANGER
	<p>Hot surface Risk of burns!</p> <ul style="list-style-type: none"> ▸ Never touch a motor when it is in operation. ▸ Let the motor cool down. ▸ Only remove covers if indicated.
	⚠ WARNING
	<p>Condensing air humidity inside the motor if the motor and/or ambient temperatures frequently change Risk of corrosion by condensation!</p> <ul style="list-style-type: none"> ▸ Always observe the information provided on ambient conditions.

	<p>CAUTION</p>
	<p>Impermissibly high temperature of fluid handled Damage to the pump!</p> <ul style="list-style-type: none"> ▷ Prolonged operation against a closed shut-off element is not permitted (heating up of the fluid). ▷ Observe the temperature limits in the data sheet and in the section on operating limits.
	<p>CAUTION</p>
	<p>Increased wear due to dry running Damage to the pump set!</p> <ul style="list-style-type: none"> ▷ Never operate the pump set without liquid fill. ▷ Never close the shut-off element in the suction line and/or supply line during pump operation.

While the system is in operation, observe and check the following:

- The pump must run quietly and free from vibrations at all times.
- Check the shaft seal. (⇒ Section 6.1.8, Page 28)
- Check the static sealing elements for leakage.
- Check the rolling element bearings for running noises.
 Vibrations, noise and an increase in current input occurring during unchanged operating conditions indicate wear.
- Monitor the correct functioning of any auxiliary connections.
- Monitor the stand-by pump.
 To make sure that stand-by pumps are ready for operation, start them up once a week.
- Monitor the bearing temperature.
 The bearing temperature must not exceed 194 °F (90 °C) (measured on the motor housing).
- Deviations from normal operation such as increased power consumption, temperatures or vibrations, unusual noises or odors, tripping of monitoring devices, etc.

	<p>CAUTION</p>
	<p>Operation outside the permissible bearing temperature Damage to the pump!</p> <ul style="list-style-type: none"> ▷ The bearing temperature of the pump (set) must never exceed 194 °F (90 °C) (measured on the outside of the motor housing).
	<p>NOTE</p>
	<p>After commissioning, increased temperatures may occur at grease-packed rolling element bearings due to the running-in process. The final bearing temperature is only reached after a certain period of operation (up to 48 hours depending on the conditions).</p>

7.2.2 Inspection work

	 DANGER
	<p>Excessive temperatures caused by friction, impact or frictional sparks Fire hazard! Damage to the pump set!</p> <ul style="list-style-type: none"> ▷ Regularly check the cover plates, plastic components and other guards of rotating parts for deformation and sufficient distance from rotating parts.

7.2.2.1 Cleaning filters

	CAUTION
	<p>Insufficient inlet pressure due to clogged filter in the suction line Damage to the pump!</p> <ul style="list-style-type: none"> ▷ Monitor contamination of filter with suitable means (e.g. differential pressure gage). ▷ Clean filters in appropriate intervals.

7.2.2.2 Checking the motor

Carry out the following measures:

- Check that the electrical connections are firmly seated.
- Verify that ventilation paths are unobstructed and clean.
- Check that the terminal box is closed safely.

7.2.3 Lubrication and lubricant change

7.2.3.1 Maintenance of rolling element bearings

Maintenance for long-term storage

Extended storage periods decrease the service life of the lubricating grease. This in turn reduces the service life of the bearings.

- The rolling element bearings should be completely replaced after a storage period of more than 4 years.

Maintenance for normal operating conditions

Recommended bearing replacement interval under normal operating conditions:

Table 12: Bearing replacement

Ambient temperature	Bearing replacement interval
104 °F (40 °C)	20,000 h

	NOTE
	<p>The service life of the bearings is reduced by vertical installation, high vibration loads, shock loads, frequent reversing duty, higher ambient temperature, and higher rotating speeds, for example.</p>

7.2.3.1.1 Grease lubrication

The bearings are supplied packed with high-quality lithium-soap grease.

7.2.3.1.2 Intervals

The rolling element bearings of the motor are grease-packed and maintenance-free.

7.3 Drainage/cleaning

	 WARNING
	<p>Fluids handled, consumables and operating supplies which are hot or pose a health hazard</p> <p>Hazard to persons and the environment!</p> <ul style="list-style-type: none"> ▷ Collect and properly dispose of the flushing medium and of any residues of the fluid handled. ▷ Wear safety clothing and a protective mask, if required. ▷ Observe all legal regulations on the disposal of fluids posing a health hazard.

1. Use connection 6B to drain the fluid handled (see auxiliary connections).
2. Always flush the system if it has been used for handling noxious, explosive, hot or other hazardous fluids.
Always flush and clean the pump before transporting it to the workshop.
Provide a certificate of decontamination for the pump.

7.4 Dismantling the pump set

7.4.1 General information/Safety regulations

	 DANGER
	<p>Insufficient preparation of work on the pump (set)</p> <p>Risk of personal injury!</p> <ul style="list-style-type: none"> ▷ Properly shut down the pump set. (⇒ Section 6.1.9, Page 28) ▷ Close the shut-off elements in the suction and discharge line. ▷ Drain the pump and release the pump pressure. (⇒ Section 7.3, Page 37) ▷ Close any auxiliary connections. ▷ Allow the pump set to cool down to ambient temperature.
	 WARNING
	<p>Unqualified personnel performing work on the pump (set)</p> <p>Risk of personal injury!</p> <ul style="list-style-type: none"> ▷ Always have repair and servicing work performed by specially trained, qualified personnel.
	 DANGER
	<p>Hot surface</p> <p>Risk of burns!</p> <ul style="list-style-type: none"> ▷ Never touch a motor when it is in operation. ▷ Let the motor cool down. ▷ Only remove covers if indicated.
	 WARNING
	<p>Improper lifting/moving of heavy assemblies or components</p> <p>Personal injury and damage to property!</p> <ul style="list-style-type: none"> ▷ Use suitable transport devices, lifting equipment and lifting tackle to move heavy assemblies or components.

Always observe the safety instructions and information.

For dismantling and reassembly observe the general assembly drawing.

In the event of damage, you can always contact our service staff.

Prior to dismantling, label the respective assignment of fastening elements as well as the arrangement of internal connections for future reassembly.

- Drive**
- Replace any corroded bolts/screws.
 - Never damage the insulation of live parts.
 - Document the position of any rating plates and additional plates or labels to be removed.
 - Avoid damaging the centering spigots.

Protect rolling element bearings against the ingress of contamination and moisture.

	NOTE
	All maintenance, service and installation work can be carried out by KSB Service or an authorized workshop.

	NOTE
	After a prolonged period of operation the individual components may be hard to pull off the shaft. If this is the case, use a brand name rust penetrating agent and/or - if possible - an appropriate puller.

7.4.2 Preparing the pump set

1. De-energize the pump set and secure it against unintentional start-up.
2. Reduce pressure in the piping by opening a consumer installation.
3. Disconnect and remove all auxiliary pipework.

7.4.3 Removing the complete pump set from the piping

	NOTE
	For further dismantling the pump casing may remain installed in the piping.

- ✓ The notes and steps stated in (⇒ Section 7.4.1, Page 37) to (⇒ Section 7.4.2, Page 38) have been observed/carried out.
1. Disconnect the discharge and suction nozzles from the piping.
 2. Depending on the pump/motor size, remove the supports from the pump set.
 3. Remove the complete pump set from the piping.

7.4.4 Removing the back pull-out unit

	 WARNING
	<p>Back pull-out unit tilting Risk of crushing hands and feet!</p> <ul style="list-style-type: none"> ▸ Suspend or support the back pull-out unit at the pump end.

- ✓ The notes and steps stated in (⇒ Section 7.4.1, Page 37) to (⇒ Section 7.4.3, Page 38) have been observed/carried out.
1. If required, suspend or support the back pull-out unit to prevent it from tilting.
 2. Undo hexagon socket head cap screws 914.42 at the casing cover.
 3. Pull the back pull-out unit out of the volute casing.
 4. Remove and dispose of O-ring 412.50.
 5. Place the back pull-out unit on a clean and level surface.

7.4.5 Removing the impeller

- ✓ The notes and steps stated in (⇒ Section 7.4.1, Page 37) to (⇒ Section 7.4.4, Page 38) have been observed/carried out.
- ✓ The back pull-out unit has been placed in a clean and level assembly area.
 1. Undo hexagon socket head cap screw 914.21 (right-hand thread!). Take safety device 930 and washer 554.03 off the impeller hub.
 2. Remove impeller 230 with an impeller removal tool.
 3. Place impeller 230 on a clean and level surface.
 4. Take key 940.01 out of the shaft of motor 800.

7.4.6 Removing the mechanical seal

- ✓ The notes and steps stated in (⇒ Section 7.4.1, Page 37) to (⇒ Section 7.4.5, Page 39) have been observed/carried out.
- ✓ The back pull-out unit has been placed in a clean and level assembly area.
 1. Prise circlip 932 out of the groove with a screwdriver and pull it off the shaft of motor 800.
 2. Remove the rotating assembly of mechanical seal 433 (primary ring) from the shaft of motor 800.
 3. Prise the stationary assembly of mechanical seal 433 (mating ring) out of cap 580 with a screwdriver, taking care not to damage the mating ring!

7.5 Reassembling the pump set

7.5.1 General information/Safety regulations

	<p>⚠ WARNING</p>
	<p>Improper lifting/moving of heavy assemblies or components Personal injury and damage to property!</p> <ul style="list-style-type: none"> ▷ Use suitable transport devices, lifting equipment and lifting tackle to move heavy assemblies or components.
	<p>CAUTION</p>
	<p>Improper reassembly Damage to the pump!</p> <ul style="list-style-type: none"> ▷ Reassemble the pump (set) in accordance with the general rules of sound engineering practice. ▷ Use original spare parts only.

Sequence Always reassemble the pump in accordance with the corresponding general assembly drawing.

Sealing elements Check O-rings for any damage and replace by new O-rings if required.
Always use new gaskets. Make sure that new gaskets have the same thickness as the old ones.
Always fit gaskets of asbestos-free materials or graphite without using lubricants (e.g. copper grease, graphite paste).

Assembly adhesives Avoid the use of assembly adhesives if possible.
Should an assembly adhesive be required after all, use a commercially available contact adhesive (e.g. Pattex) or sealant (e.g. HYLOMAR or Eppe 33).
Only apply adhesive at selected points and in thin layers.
Never use quick-setting adhesives (cyanoacrylate adhesives).

Coat the locating surfaces of the individual components with graphite or similar before reassembly.

Tightening torques When reassembling the pump set, tighten all screws/bolts as indicated.

7.5.2 Installing the mechanical seal

Installing the mechanical seal

The following rules must be observed when installing the mechanical seal:

- Work cleanly and accurately.
 - Only remove the protective wrapping of the contact faces immediately before installation takes place.
 - Prevent any damage to the sealing surfaces or O-rings.
 - ✓ The notes and steps stated in (⇒ Section 7.5.1, Page 39) have been observed/carried out.
 - ✓ The bearing assembly as well as the individual parts have been placed in a clean and level assembly area.
 - ✓ All disassembled parts have been cleaned and checked for wear.
 - ✓ Any damaged or worn parts have been replaced by original spare parts.
 - ✓ The sealing surfaces have been cleaned.
1. Clean the mating ring location in cap 580.

	CAUTION
	<p>Elastomers in contact with oil/grease Shaft seal failure!</p> <ul style="list-style-type: none"> ▷ Use water as an assembly lubricant. ▷ Never use oil or grease as assembly lubricant.

2. Carefully insert the mating ring. Make sure to apply pressure evenly.
3. Fit the rotating assembly of mechanical seal 433 (primary ring) on the shaft of motor 800.

7.5.3 Fitting the impeller

- ✓ The notes and steps stated in (⇒ Section 7.5.1, Page 39) to (⇒ Section 7.5.2, Page 40) have been observed/carried out.
 - ✓ The pre-assembled unit (motor, cap, drive lantern, casing cover) as well as the individual parts have been placed in a clean and level assembly area.
 - ✓ All disassembled parts have been cleaned and checked for wear.
 - ✓ Any damaged or worn parts have been replaced by original spare parts.
 - ✓ The sealing surfaces have been cleaned.
1. Slide circlip 932 onto the shaft of motor 800 until it snaps into the groove.
 2. Insert key 940.01 and slide impeller 230 onto the shaft of motor 800.
 3. Fasten hexagon socket head cap screw 914.21 with safety device 930 and washer 554.03.

7.5.4 Installing the back pull-out unit

	WARNING
	<p>Back pull-out unit tilting Risk of crushing hands and feet!</p> <p>▸ Suspend or support the back pull-out unit at the pump end.</p>

- ✓ The notes and steps stated in (⇒ Section 7.5.1, Page 39) to (⇒ Section 7.5.3, Page 40) have been observed/carried out.
- ✓ Any damaged or worn parts have been replaced by original spare parts.
- ✓ The sealing surfaces have been cleaned.
 1. Suspend or support the back pull-out unit to prevent it from tilting.
 2. Fit a new O-ring 412.50 on cap 580.
 3. Insert the back pull-out unit into volute casing 102.
 4. Tighten hexagon socket head cap screws 914.12 on casing cover 161.

7.6 Tightening torques

Table 13: Tightening torques for bolted/screwed connections at the pump

Part No. ⁵⁾	Thread	Tightening torque	
		[lbf in]	[Nm]
903.02	1/4	486	55
903.39	1/4	486	55
914.21	M4	22	2,5
	M5	35	4
	M6	62	7
914.42	M6	89	10
	M8	221	25

7.7 Spare parts stock

7.7.1 Ordering spare parts

Always quote the following data when ordering replacement or spare parts:

- Type series
- Size
- Material variant
- Seal code
- Material number
- Series code

Refer to the name plate for all data.

Also supply the following data:

- Part No. and description
- Quantity of spare parts
- Shipping address
- Mode of dispatch (freight, mail, express freight, air freight)

5) See general assembly drawing.

7.7.2 Recommended spare parts stock for 2 years' operation to DIN 24296
Table 14: Quantity of spare parts for recommended spare parts stock

Part No.	Description	Number of pumps (including stand-by pumps)						
		2	3	4	5	6 and 7	8 and 9	10 and more
230	Impeller	1	1	1	2	2	2	20 %
412.50	O-ring	4	6	8	8	9	10	100 %
433	Mechanical seal	1	1	2	2	2	3	25 %
914.21	Hexagon socket head cap screw	1	1	1	2	2	2	20 %
930	Safety device	1	1	1	2	2	2	20 %

8 Trouble-shooting

	 WARNING
	<p>Improper remedial work Risk of personal injury!</p> <p>▷ For any work performed in order to remedy faults observe the relevant information given in this operating manual and/or the product literature provided by the accessories manufacturers.</p>

If problems occur that are not described in the following table, consultation with KSB's customer service is required.

- A** Pump delivers insufficient flow rate
- B** Motor overload
- C** Motor protection switch / thermistor tripping unit trips the pump set
- D** Increase in bearing temperature
- E** Leakage at the pump
- F** Excessive leakage at the shaft seal
- G** Vibration during pump operation
- H** Impermissible temperature increase in the pump
- I** Drive does not start

Table 15: Trouble-shooting

A	B	C	D	E	F	G	H	I	Possible cause	Remedy ⁶⁾
X	-	-	-	-	-	-	-	-	Pump delivers against an excessively high pressure.	Re-adjust to duty point. Check system for impurities. Fit a larger impeller. ⁶⁾ Increase the speed (frequency inverter).
X	-	-	-	-	-	X	X	-	Pump and/or piping are not completely vented or primed.	Vent or prime.
X	-	-	-	-	-	-	-	-	Supply line or impeller clogged.	Remove deposits in the pump and/or piping.
X	-	-	-	-	-	-	-	-	Formation of air pockets in the piping	Alter piping layout. Fit a vent valve.
X	-	-	-	-	-	X	X	-	Suction lift is too high, $NPSH_{available}$ (positive suction head) is too low.	Check/alter liquid level (open system). Increase system pressure (closed system). Install pump at a lower level. Fully open the shut-off element in the suction line. Change suction line, if the friction losses in the suction line are too high. Check any strainers installed/suction opening. Observe permissible speed of pressure fall.
X	-	-	-	-	-	-	-	-	Wrong direction of rotation	Check the electrical connection of the motor and the control system if any.
X	-	-	-	-	-	-	-	-	Speed is too low. - Operation with frequency inverter - Operation without frequency inverter	- Increase voltage/frequency at the frequency inverter in the permissible range. - Check voltage.
X	-	-	-	-	-	X	-	-	Wear of internal parts	Replace worn parts by new ones.

6) Pump pressure must be released before attempting to remedy faults on parts which are subjected to pressure.

A	B	C	D	E	F	G	H	I	Possible cause	Remedy ⁶⁾
-	X	-	-	-	-	X	-	-	Pump back pressure is lower than specified in the purchase order.	Re-adjust to duty point. In the case of persistent overloading, turn down impeller. ⁶⁾
-	X	-	-	-	-	-	-	-	Density and viscosity of the fluid handled is higher than stated in the purchase order.	Contact KSB.
-	-	-	-	-	X	-	-	-	Use of unsuitable shaft seal materials	Change the material combination. ⁶⁾
-	X	X	-	-	-	-	-	-	Speed is too high.	Reduce the speed. ⁶⁾
-	-	-	-	X	-	-	-	-	Tie bolts/sealing element defective	Fit new sealing element between volute casing and casing cover. Re-tighten the bolts.
-	-	-	-	-	X	-	-	-	Worn shaft seal	Fit new shaft seal.
-	-	-	-	-	X	-	-	-	Dismantle to find out.	Correct. Fit new shaft seal if required.
-	-	-	-	-	X	-	-	-	Vibrations during pump operation	Correct the suction conditions. Re-balance the impeller. Increase pressure at the pump suction nozzle.
-	-	-	X	-	X	X	-	-	Pump is warped or sympathetic vibrations in the piping.	Check the piping connections and secure fixing of pump; if required, reduce distances between the pipe clamps. Fix the pipelines using anti-vibration material.
-	-	-	X	-	-	-	-	-	Increased axial thrust	Clean balancing holes in the impeller.
X	X	-	-	-	-	-	-	-	Motor running on two phases only	Replace the defective fuse. Check the electric cable connections. Check the motor winding.
-	-	-	-	-	-	X	-	-	Rotor out of balance	Clean the impeller. Re-balance the impeller.
-	-	-	X	-	-	X	X	-	Flow rate is too low.	Increase the minimum flow rate.
-	-	X	-	-	-	-	-	-	Incorrect setting of motor protection switch	Check setting. Fit new motor protection switch.
-	-	-	-	-	-	-	-	X	No voltage	Check mains fuses, mains voltage and operating status of the frequency inverter.
-	-	-	-	-	-	-	-	X	Mains cables connected incorrectly/ Fault in supply line	Check wiring

9 Related Documents

9.1 Installation examples

Table 16: Horizontal installation

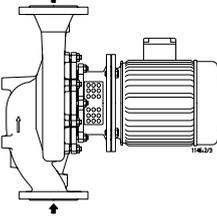
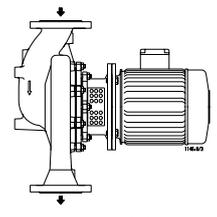
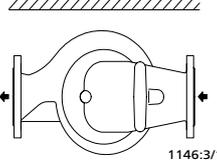
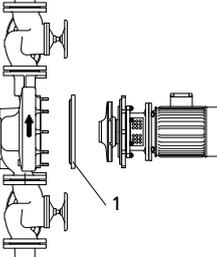
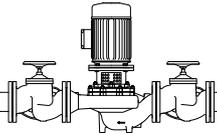
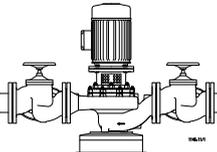
Example drawing	Special features
 <p data-bbox="491 622 708 678">Direction of flow from bottom to top</p>	<p data-bbox="719 389 1442 423">Direction of flow from bottom to top</p>
 <p data-bbox="491 918 708 974">Direction of flow from top to bottom</p>	<p data-bbox="719 685 1442 719">Direction of flow from top to bottom</p> <p data-bbox="719 725 1442 813">The volute casing and/or back pull-out unit must be turned by 180° so that the terminal box remains in its current position on top.</p>
 <p data-bbox="491 1160 708 1216">Horizontal installation</p>	<p data-bbox="719 981 1442 1014">Horizontal installation (for example under the ceiling)</p> <p data-bbox="719 1021 1442 1108">The volute casing and/or back pull-out unit must be turned by 90° so that the terminal box remains in its current position on top.</p>
 <p data-bbox="491 1496 708 1547">Installation with blind flange</p>	<p data-bbox="719 1223 1442 1256">1 = blind flange (accessories)</p> <p data-bbox="719 1263 1442 1350">If one of the pumps needs to be serviced, the pump chamber can be shut off by a blind flange so that the system remains operational.</p>

Table 17: Vertical installation

Example drawing	Special features
 <p data-bbox="485 396 715 454">Vertical installation without feet</p>	<p data-bbox="719 255 979 284">Mounted without feet</p> <p data-bbox="719 293 1445 353">Installed directly in the piping. Always anchor the pipes in close proximity to the pump in this case.</p>
 <p data-bbox="485 620 715 676">Vertical installation with pump foot</p>	<p data-bbox="719 461 1118 490">Mounted on pump foot (accessory)</p> <p data-bbox="719 499 991 528">Available upon request.</p>

Spare parts kits	Part No.	Description
Motor	554	Washer
	914	Hexagon socket head cap screw
	930	Safety device

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