Submersible Borehole Pump

S 100D; UPA 100C

Installation/Operating Manual

Mat. No.: 01463258

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Installation/Operating Manual S 100D; UPA 100C

Original operating manual

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Contents

Glossary 5

1 General 6

1.1 Principles 6
1.2 Installation of partly completed machinery 6
1.3 Target group 6
1.4 Other applicable documents 6
1.5 Symbols 6

2 Safety 8

2.1 Key to safety symbols/markings 8
2.2 General 8
2.3 Intended use 8
2.4 Personnel qualification and training 9
2.5 Consequences and risks caused by non-compliance with these operating instructions 9
2.6 Safety awareness 9
2.7 Safety information for the operator/user 10
2.8 Safety information for maintenance, inspection and installation work 10
2.9 Unauthorised modes of operation 10

3 Transport/Temporary Storage/Disposal 11

3.1 Checking the condition upon delivery 11
3.2 Transportation 11
3.3 Storage and preservation 11
3.4 Return to supplier 12
3.5 Disposal 12

4 Description of the Pump (Set) 14

4.1 General description 14
4.2 Product Information as per Regulation No. 547/2012 (for 4" and 6" Water Pumps) Implementing "Ecodesign" Directive 2009/125/EC 14
4.3 Designation 14
4.4 Name plate 15
4.5 Design details 15
4.6 Configuration and function 16
4.7 Scope of supply 16
4.8 Dimensions and weights 17

5 Installation at Site 18

5.1 Checks to be carried out prior to installation 18
5.2 Installing the pump set in vertical position 21
5.3 Installing the pump set in horizontal position 23
5.4 Notes on electrical connection 24

5.5 Connection to power supply 26

6 Commissioning/Start-up/Shutdown 28

6.1 Commissioning/start-up 28

6.2 Operating limits 29

6.3 Shutdown 32

7 Servicing/Maintenance 33

7.1 Servicing/inspection 33

8 Trouble-shooting 34

9 Related Documents 35

9.1 S 100D general assembly drawing 35

9.2 UPA 100C general assembly drawing 36

9.3 DN 100 general assembly drawing 37

10 EC Declaration of Conformity 38

11 Certificate of Decontamination 39

Index 40

Glossary

Certificate of decontamination

A certificate of decontamination is enclosed by the customer when returning the product to the manufacturer to certify that the product has been properly drained to eliminate any environmental and health hazards arising from components in contact with the fluid handled.

1 General

1.1 Principles

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

The name plate indicates the type series and size, the main operating data, the order number and the order item number. The order number and order item number uniquely identify the pump (set) and serve as identification for all further business processes.

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

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 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 and installation dimensions for the pump (set), weights
Drawing of auxiliary connections	Description of auxiliary connections
Hydraulic characteristic curve	Characteristic curves showing head, NPSH required, efficiency and power input
General assembly drawing[1)]	Sectional drawing of the pump
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
Drawing for assembly	Sectional drawing for fitting the shaft seal

For accessories and/or integrated machinery components observe the relevant manufacturer's product literature.

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

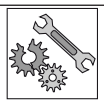
2 Safety

DANGER

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.
	Explosion protection This symbol identifies information about avoiding explosions in potentially explosive atmospheres in accordance with EC Directive 94/9/EC (ATEX).
	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 manual contains general installation, operating and maintenance instructions that must be observed to ensure safe pump operation and prevent personal injury and damage to property.

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

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

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

Information attached directly to the pump must always be complied with and be 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 not taken into account in this manual.

2.3 Intended use

The pump (set) must only be operated within the operating limits described in the other applicable documents.(⇨ Section 1.4 Page 6)

- Only operate pumps/pump sets which are in perfect technical condition.
- Do not operate the pump (set) in partially assembled condition.
- Only use the pump to handle the fluids described in the data sheet or product literature of the pump model.

- Never operate the pump without the fluid 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 discharge-side shut-off elements further than permitted.
  - The maximum flow rate specified in the data sheet or product literature would be exceeded.
  - Risk of cavitation damage
- Never exceed the permissible operating limits specified in the data sheet or product literature regarding pressure, temperature, etc.
- Observe all safety information and instructions in this manual.

2.4 Personnel qualification and 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 means of training and instruction provided by sufficiently trained specialist personnel. 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 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 work

- Modifications or alterations of the pump are only permitted with the manufacturer's prior consent.
- Use only original spare parts or parts authorised by the manufacturer. The use of other parts can invalidate any liability of the manufacturer for resulting damage.
- The operator ensures that all maintenance, inspection and installation work is performed by authorised, qualified specialist personnel who are thoroughly familiar with the manual.
- Only carry out work on the pump (set) during standstill of the pump.
- 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.
- Decontaminate pumps which handle fluids posing a health hazard.
- As soon as the work is completed, re-install and/or re-activate any safety-relevant and protective devices. Before returning the product to service, observe all instructions on commissioning.(⇨ Section 6.1 Page 28)

2.9 Unauthorised 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 supplied pump (set) is only valid if the equipment is used in accordance with its intended use.(⇨ Section 2.3 Page 8)

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 supplying dealer (as applicable) and the insurer about the damage in writing immediately.

NOTE

The pump set is supplied by the manufacturer/supplier in packaging which largely prevents sagging or other damage during transport and/or storage.

3.2 Transportation

CAUTION

Pump set tipping over or slipping out of the suspension arrangement
Personal injury and damage to property!

- ▹ Always make sure pump sets in upright position cannot tip over.

NOTE

Take into account the unequal weight distribution between pump and motor.

Select hoisting tackles suitable for the weight of the pump set.
Take care not to bend or damage the power supply cable during transport.

3.3 Storage and preservation

If commissioning is to take place some time after delivery, we recommend that the following measures be taken:

⚠ WARNING

Pump set tipping over or rolling off
Risk of personal injury!

- ▹ Always secure vertically positioned pump sets against tipping over.
- ▹ Always secure horizontally positioned pump sets against rolling off.

⚠ WARNING

Ambient temperature below the specified minimum
Danger of frost!

- ▹ Never subject the pump set to ambient temperatures which are lower than those permitted for the drinking water/antifreeze mixture provided (see section on drinking water/antifreeze mixture / order documentation).

⚠ WARNING

Laying cables at temperatures below zero degrees
Damage to the cables!

- ▹ Observe the minimum permissible temperature at the cable surface of **-25 °C for moving cables**.
- ▹ Observe the minimum permissible temperature at the cable surface of **-40 °C for stationary cables**.

CAUTION

Improper storage
Damage to the power cables!

- ▷ Support the power cables at the cable entries to prevent permanent deformation. Observe the minimum bending radius[2)] of the cables.
- ▷ Only remove the protective caps from the power cables at the time of installation.

Store the submersible borehole pumps as follows:

1. In their original packaging: **horizontally**
2. Without packaging: **vertically** (with the motor below)
3. In a dry environment
4. Protected against direct sunlight and heat
5. Protected against dirt and dust
6. Protected against freezing
7. Protected against vermin

Further information on storing the pump set after use .

3.4 Return to supplier

1. Drain the pump as per operating instructions.
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 fluids handled by the pump (set) leave residues which might lead to corrosion when coming into contact with atmospheric humidity, or which might ignite when coming into contact with oxygen, the pump set must be neutralised, and anhydrous inert gas must be blown through the pump for drying purposes.
4. Always complete and enclose a certificate of decontamination when returning the pump (set).
   Always indicate any safety and decontamination measures taken.

NOTE

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

3.5 Disposal

⚠ WARNING

Fluids, consumables and supplies which are hot or pose a health hazard
Hazard to persons and the environment!

- ▷ Collect and properly dispose of flushing fluid and 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) See cable manufacturer's documentation or DIN VDE 0298-3.

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

Pump for handling clean or slightly contaminated water.

Verify the fluid composition against the data sheet.

Not approved for handling explosive fluids or for forming part of an explosion-proof system!

4.2 Product Information as per Regulation No. 547/2012 (for 4" and 6" Water Pumps) Implementing "Ecodesign" Directive 2009/125/EC

- Minimum efficiency index: see name plate, key to name plate (⇨ Section 4.4 Page 15)
- The benchmark for most efficient water pumps is MEI ≥ 0.70.
- Year of construction: see name plate, key to name plate (⇨ Section 4.4 Page 15)
- Manufacturer's name or trade mark, commercial registration number and place of manufacture: see data sheet or order documentation
- Product's type and size identificator: see name plate, key to name plate (⇨ Section 4.4 Page 15)
- 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 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.
- 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 on dismantling, recycling and disposal after decommissioning: (⇨ Section 3.5 Page 12)
- Information on benchmark efficiency or benchmark efficiency graph for MEI = 0.7 (0.4) for the pump based on the model shown in the Figure are available at: http://www.europump.org/efficiencycharts

4.3 Designation

Submersible borehole pump
Example: S 100D - 4 / 6

Table 4: Key to the designation

Code	Description
S	Type series
100	Nominal pump size [mm]
D	Design status
4	Flow rate at best efficiency point [m³/h]
6	Number of stages

Submersible borehole pump
Example: UPA 100C 4 - 6

Table 5: Key to the designation

Code	Description
UPA	Type series
100	Nominal pump size [mm]
C	Design status

Code	Description
4	Flow rate at best efficiency point [m³/h]
6	Number of stages

4.4 Name plate

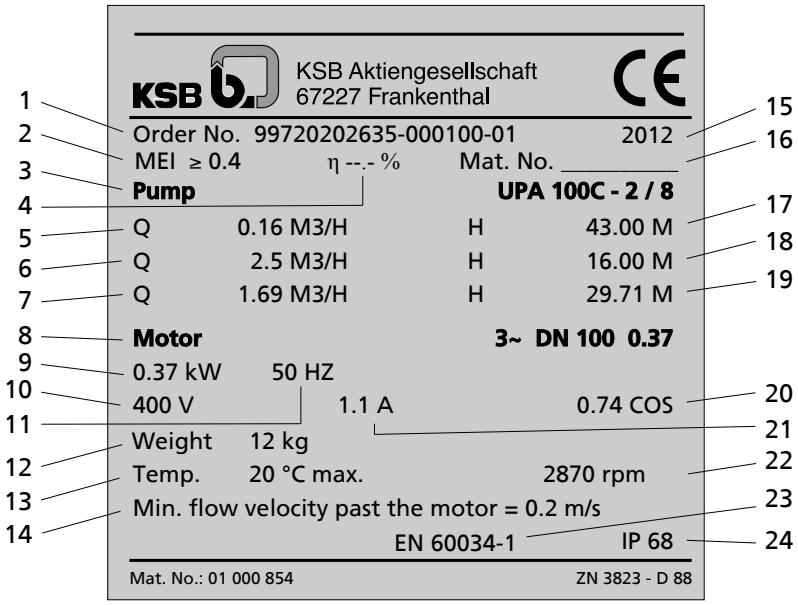


Fig. 1: Name plate

1	Order number	2	Minimum efficiency index
3	Pump designation	4	Efficiency (see data sheet)
5	Minimum flow rate	6	Maximum flow rate
7	Flow rate at duty point	8	Motor designation
9	Rated power	10	Voltage
11	Frequency	12	Weight
13	Maximum fluid temperature	14	Minimum available flow along the motor
15	Year of construction	16	Material number
17	Maximum head	18	Minimum head
19	Head at duty point	20	Power factor
21	Amperage	22	Speed
23	VDE Standard	24	Motor enclosure

4.5 Design details

Design

- Centrifugal pump
- Submersible motor in squirrel-cage design
- Rigid connection between pump and motor
- Shroud design

Impeller type

- Radial or mixed flow versions

Bearing in the motor

- Thrust bearing with tilting pads to absorb the pump's hydraulic thrust

Shaft seal in the motor

- Shaft seal

4.6 Configuration and function

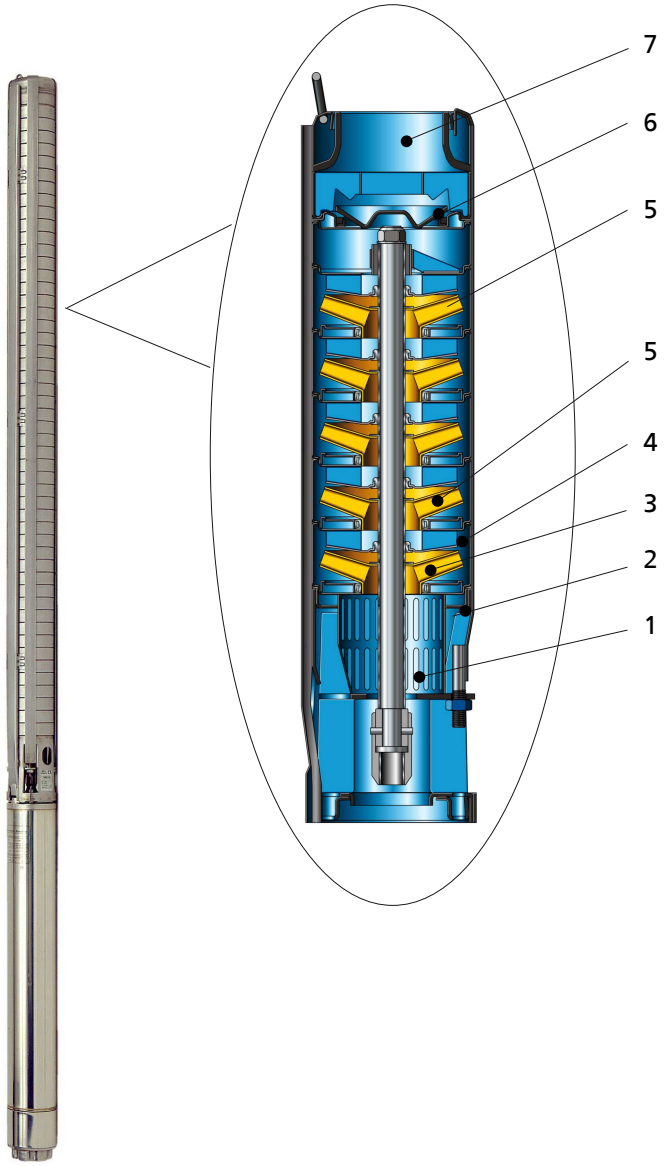


Fig. 2: Sectional drawing of example: UPA 100C

Design Pump and motor are connected by a rigid coupling. The stage casings are supported by a pump shroud, by straps or stud bolts. A suction strainer at the suction casing protects the pump from coarse particles in the fluid. The pipe is connected via a non-return valve or connecting branch, with either internal thread or flanged end.

Function The fluid flows along the motor and enters the suction casing (2) through the suction strainer (1). It is accelerated outward by the suction impeller (3). In the flow passage of the stage casing (4) the kinetic energy of the fluid is converted into pressure energy, and the fluid is routed to the next impeller (5). This process is repeated in all stages until the fluid has passed the last impeller (5). It is then guided through the integrated non-return valve (6) to the connection branch (7), where it leaves the pump. The integrated non-return valve prevents uncontrolled backflow of the fluid.

4.7 Scope of supply

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

- Pump set with motor lead

- Electric extension cable
  optional: connected or supplied loosely
- Back-up name plate
- Accessories, such as:
  - Cable connector
  - Cable ties
  - Cooling shroud
  - Pedestals
  - Electrical protection devices
  - Automatic control units

NOTE

A separate name plate is included in KSB's scope of supply.
This name plate must be attached in a clearly visible position outside the place of installation, e.g. at the control panel, pipeline or mounting bracket.

4.8 Dimensions and weights

For dimensions and weights please refer to the data sheet of the pump (set).

5 Installation at Site

5.1 Checks to be carried out prior to installation

5.1.1 Checking the motor fill

The pump set can be installed directly in vertical or horizontal [3] position without any further preparations. The motors are filled at the factory with water and antifreeze agent. The loss of a few drops of liquid fill will not impair the motor function as the motor will self-prime with clean well water after it has been installed. If larger quantities of leakage are suspected, contact the manufacturer!

5.1.2 Checking the installation position

⚠ WARNING

Impermissible installation position
Damage to the machine! Damage to the bearings!

- ▷ For angled installation, always install the pump set with the discharge side at a rising slope.

The pump set can be installed in vertical or, depending on the number of stages, also in angled or horizontal position.
Never install the pump set with the pump positioned at the lowest point.

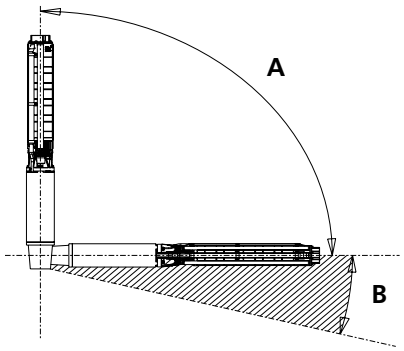


Fig. 3: Installation position

A	Permissible	B	Impermissible

Notes on horizontal installation

Only install the pump set in horizontal position if the following criteria are met:

- Has the pump set been ordered for horizontal installation?
- Has a sufficiently dimensioned cooling shroud been provided?

Horizontal installation of pump sets which were originally designed for vertical installation is impermissible!
Horizontal installation of pump sets without a cooling shroud is impermissible.

Horizontal installation is **impermissible** for pumps with the following number of stages.
See order documentation.

Table 6: Number of stages which are **impermissible** for horizontal installation

S 100D	1 / ..	2 / ..	4 / ..	7 / ..	12 / ..
Number of stages	25	27	24	23	17
	30	30	33	28	21

[3] Only if equipped with a cooling shroud

S 100D	1 / ..	2 / ..	4 / ..	7 / ..	12 / ..
	35	33	40	33	25
	40	38	--	--	--
	50	44	--	--	--
	--	50	--	--	--

5.1.3 Electric wiring

⚠ DANGER

Unqualified personnel connecting extension leads
Installation in a well - electric shock!

- ▷ The extension lead must be connected by a professional electrician only.
- ▷ The cable ends must be dry and clean.

⚠ DANGER

Earth conductor not properly connected
Danger of death from electric shock!

- ▷ Never operate the motor without earth conductor.
- ▷ The earth conductor must be connected by a professional electrician only.

NOTE

The motor lead is selected for submerged operation and must be completely submerged, including the cable connector.
See order documentation for any other use!

Submersible motors are supplied fitted with a motor lead. The motor lead has been extended with a suitably sized extension cable to meet the length required for the specific installation. Unless otherwise indicated, the motor lead is designed for submerged operation only. To meet this condition the cable connector also has to be completely submerged.

Extension cables connected by KSB

If agreed with KSB, the extension cable can be supplied connected to the motor lead with a watertight cable connector.

- Unless otherwise specified in the order documentation, KSB's **extension cables** are designed for:
  - Being laid in free air
  - A voltage drop along the cable of $\Delta U \leqq 3\ \%$

    For any other ways of laying the cable, e.g. in cable ducts, etc. observe the information on the maximum current-carrying capacity as per the applicable directives.

Extension cables connected by the operator

If the supplied extension cable is to be connected at the site, observe the following points:

1. Observe the installation instructions of the cable connector to be used.
2. If the operator is responsible for connecting an extension cable, make sure the extension cable is selected and dimensioned for a maximum voltage drop of ≦3 %. The extension cable has to be approved for the applicable operating conditions.
3. In 4-core cables the earth conductor is part of the power cable and must also be connected in the cable connector when connecting an extension cable.

4. 3-core motor leads do not include an earth conductor. A separate earth conductor is connected on the outside of the motor. The earth conductor has to be extended separately.
   If no earth conductor is provided, the operator shall be responsible for earthing the motor externally. (Core size corresponding to phase conductor, min. 4 mm^2)
5. Connect the shield of shielded extension cables to the earth conductor. 3-core motor leads as described in paragraph 4 must be earthed externally; connect the shield of the extension cable to the earth conductor.
6. Transfer the core identification of the motor lead to the cores of the extension cable. Make sure the colour codes match when connecting the cores.

   The core codes depend on the wiring type of the motor:

Table 7: Core codes

Motors for DOL starting with 1 lead					
U	V	W			
.					
Motors for start/delta starting with 2 leads					
U 1	V 1	W 1	U 2	V 2	W 2
.					
Motors for DOL starting with 2 parallel leads					
U1 - 1	V1 - 1	W1 - 1	U1 - 2	V1 - 2	W1 - 2

5.1.4 Measuring the insulation resistance

⚠ DANGER

Hazardous voltage during and after measurement
Danger of death from electric shock!

- ▹ Do not touch the contact points during and immediately after measurement.
- ▹ Insulation resistance measurement must be effected by a trained electrician only.

Measure the insulation resistance prior to installation and prior to connection to the power supply.

Insulation resistance measurement must be effected by a trained electrician only.

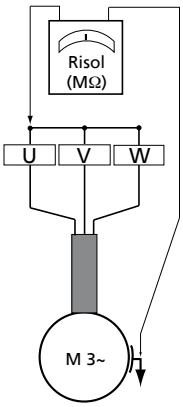
Prior to the measurement, ensure compliance with the operating instructions of the device for measuring the insulation resistance.

✓ An insulation resistance measuring device with a measuring voltage of 1000 V DC is available.

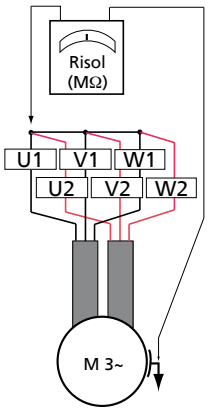
✓ The contact points are clean and dry.

1. Measurement period: 1 minute[4)]
2. Minimum insulation resistance at 20 °C - 30 °C: > 200 MOhm

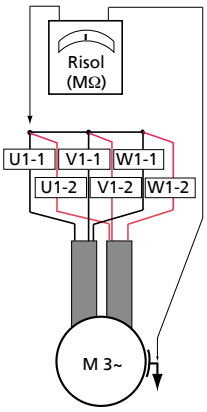
4) The measured value must be steady; a longer measurement period might be needed for larger cable cross-sections.



1 lead



2 leads (for both star and delta operation)



2 leads (parallel)

5.2 Installing the pump set in vertical position

⚠ DANGER

Using damaged cables in a well
Electric shock!

- Do not kink cables (observe the minimum bending radius [5] of the cable) or drag the cables over sharp edges.
- Use cable ties or other suitable fasteners to fasten the power cables as well as any measuring and control cables to the riser or piping **every three meters**.
- Do not use any tools, equipment or accessories with sharp edges (e.g. sharp-edged pipe sockets) during installation.

⚠ WARNING

Persons could fall into unsecured wells/reservoirs/tanks
Risk of personal injury!

- During installation work, take suitable precautions to protect anyone from falling into an open well/reservoir/tank.
- Suitably fence off the work area.

CAUTION

Risk of the pump set falling into the well/reservoir/tank
Damage to the pump set!

- Secure the pump set during the entire installation procedure.
- Dimension any securing devices (supporting clamps, supports, etc.) so that they can carry all weights during the installation.

5) See cable manufacturer's documentation or DIN VDE 0298-3.

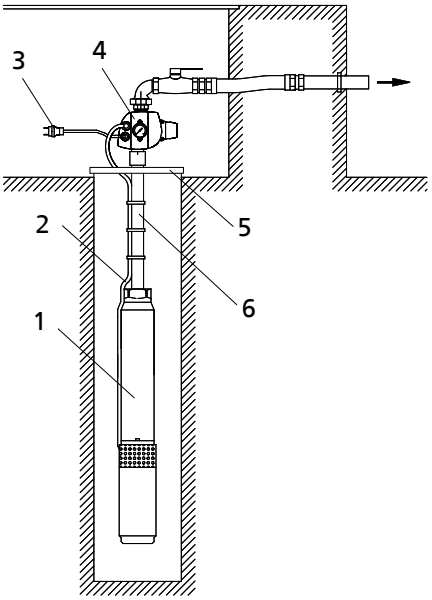


Fig. 4: Example of vertical installation

1	Pump set	2	Power cable
3	Connection to the mains	4	Control unit
5	Well head	6	Riser

Notes on installation

- Install the pump set in such a way that it does not sit on the base of the well.
- Install the pump set in such a way that sand or sludge deposits in the motor area are prevented.
- Install the pump set with the suction strainer above the well screen/filter.
- The use of hemp and hemp paste is recommended for connecting the pump to a threaded pipe connection.
- It is recommended to verify the well dimensions. This can be done, for example, by inserting a pipe of the same outer diameter as the pump set. Remove this pipe before starting with the installation.
- **Always observe the instructions of the pipe supplier!**

  If the pump is to be installed with plastic risers, the pump set can be lowered and held in position with two suitably thick, rust-proof wires attached to the body of the swing check valve.

Lowering the pump set into the well

✓ The extension lead has been connected to the power cable.

✓ Lifting equipment designed for the weight of the pump set is on hand.

1. Observe the installation instructions of the pipe suppliers.
2. Lower the pump set into the well.
3. Every three metres fasten the electric cable as well as any measuring and control cables to the riser with suitable fasteners (e.g. cable clips).

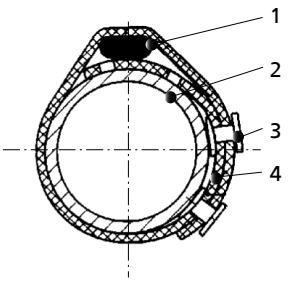


Fig. 5: Cable clip

1	Flat cable	2	Riser
3	Plastic stud	4	Rubber strap

5.3 Installing the pump set in horizontal position

⚠ WARNING

Persons could fall into unsecured wells/reservoirs/tanks
Risk of personal injury!

- ▹ During installation work, take suitable precautions to protect anyone from falling into an open well/reservoir/tank.
- ▹ Suitably fence off the work area.

⚠ WARNING

Installation on mounting surface which is unsecured and cannot support the load
Personal injury and damage to property!

- ▹ Use a concrete of compressive strength class C12/15 which meets the requirements of exposure class XC1 to EN 206-1.
- ▹ The mounting surface must have set and must be completely horizontal and even.
- ▹ Observe the weights indicated.

CAUTION

Temperature and pressure increase of the motor fill
Damage to the motor!

- ▹ Always protect non-flooded pump sets against direct exposure to sun.

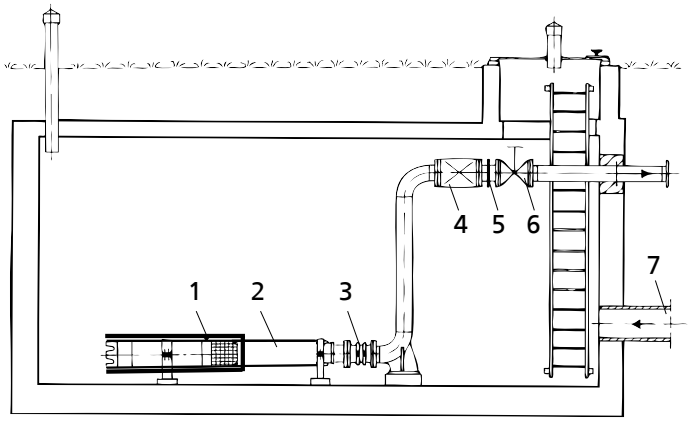


Fig. 6: Example of horizontal installation

1	Cooling jacket	2	Pump set
3	Expansion joint	4	Check valve[6)]

5	Spacer	6	Shut-off valve
7	Inlet nozzle		

Installation instructions

- For horizontal installation, a device guiding the flow along the motor (cooling jacket, shroud, etc.) is required.
- For horizontal installation, install the pump set with the venting pointing upwards at an angle.
- Lay the pipe in such a way that no piping forces (weights, torsional forces, vibrations, etc.) can act on the pump set. To compensate such forces, we recommend fitting a tailored expansion joint between the pump set and the pipe.

Positioning the pump set

✓ The tank or well have been prepared in accordance with the instructions.

✓ The concrete floor is of sufficient strength.

✓ An extension cable of the specified length has been connected to the power cable.

1. Arrange the pedestals in accordance with the general arrangement drawing and fasten them to the foundation with the foundation bolts, anchor bolts, etc. provided by the operator.
2. Position and fasten the pump set (including cooling jacket) on the pedestals.
3. Fit the expansion joint, if any.
4. Install the piping in accordance with the piping layout. **Observe the installation instructions of the pipe supplier.**
5. Fasten the electric cable as well as any measuring and control cables to the pipe with suitable fasteners (e.g. cable clips). Attach them every three metres.

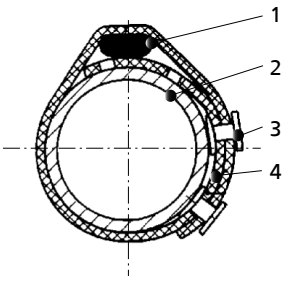


Fig. 7: Cable clip

1	Flat cable	2	Riser
3	Plastic stud	4	Rubber strap

5.4 Notes on electrical connection

KSB's submersible borehole pumps < 1000 V are wired for DOL starting. During start-up and run-up the voltage must not fall below the value specified in the order documentation.

If this starting method is not permitted by the power supply utility, starting devices to reduce starting currents must be provided (e.g. star-delta contactors, autotransformers, starting resistors or soft starters).

6) Only for pump sets without check valve.

General information on the motor

Motor protection
Provide a temperature-compensated overcurrent relay of tripping class 10 or 10 A as motor protection. If an earth leakage relay is used, it must be fitted in the motor power circuit.

Rating
The rating specified on the name plate and in the order confirmation applies to continuous operation S1 to DIN EN 60034-1.

5.4.1 Operation with star-delta contactor, autotransformer and starting resistors

Star-delta contactor

The Y-phase or partial voltage period shall not exceed 4 s. The switchover interval from Y to Δ must not be longer than 60 ms. **Additional delays are not permitted.**

Starting devices

Set up the starting devices for automatic operation, i.e. switchover from partial to full voltage must be automatic.
The partial voltage period shall not exceed 4 s. To operate the pump set with a starting transformer or starting resistor, choose a closed-transition switchover method (Korndorfer connection).

5.4.2 Operation with soft starter

Submersible motors differ from ordinary standardised asynchronous motors in their slim design (low moments of inertia), their output, mechanical seal design and winding type.

The following reference values, based on our experience, ensure safe operation of submersible borehole pumps. The operator is responsible for checking with the manufacturer of the soft starter that the particular features of submersible borehole pumps have been taken into account. Depending on the make the indicated reference values may be exceeded.

Table 8: Reference values for soft starters

Parameter/function	Settings
Minimum starting voltage	40 % of the motor's rated voltage
Ramp time / acceleration (run-up) time	t_H < 4 seconds
Current limitation	I_A / I_N approx. 3.5
Deceleration (run-down) time / stop ramp	t_A < 4 seconds
All special functions, e.g. ▪ Delayed starting ▪ Current control ▪ Speed control ▪ Kick-start / boost function	OFF

1. After run-up, the soft starter must be bypassed by a contactor.
2. Always observe the manufacturer's operating instructions.
3. Soft starters for two-phase connection are only permitted if the starter's control algorithm eliminates the physically caused d.c. components.
4. If the soft starter fulfils motor protection functions, such as an over-current trip (tripping class 10 or 10A), phase failure, etc., these functions must be ensured when the soft starter is bypassed by a contactor.

NOTE

Conspicuous noises or vibrations during run-up and run-down could indicate incorrect parameter settings on the soft starter, such as excessive ramp times, incorrect operating mode (control) or enabled special functions.

5.4.3 Pump operation with frequency inverter

If KSB's submersible borehole pumps are operated with a frequency inverter, the pumps' special design (low moment of inertia, high output, etc.) requires that the following points be observed.

Power reserve
If supplied by KSB for operation with a frequency inverter (see data sheet), the motor comes with a 5 % power reserve. If the submersible borehole pump is retrofitted with a frequency inverter, an electrical loss of 5 % has to be taken into account. To check whether a frequency inverter can be retrofitted, always contact the pump manufacturer.

Maximum permissible run-up and run-down time
The run-up time from standstill to the minimum frequency f_{min} must not exceed 2 seconds. The run-down time must also be limited to a maximum of 2 seconds.

Minimum frequency
The minimum frequency must not be below 30 Hz.

Maximum operating frequency
Do not exceed the maximum operating frequency of 50 Hz/60 Hz respectively.

Maximum permissible rate of voltage rise and voltage peaks
Observe the following limits:

- Maximum rate of voltage rise: du/dt ≤ 500 V/µs
- Maximum peak voltages to earth: J1 insulation ≤ 600 V

NOTE

Compliance with these limits can usually be assured by means of a sine filter or $^{du}/_{dt}$ filter.

Control principle of the frequency inverter
The control principle has to correspond with a linear V/f characteristic. If other control principles are employed, such as field-oriented inverters, inverters with DTC or NOF, the manufacturer of the frequency inverter must ensure that the special features of submersible motors (very small moment of inertia, electrical data) are taken into account.

5.5 Connection to power supply

⚠ DANGER

Work on the pump set by unqualified personnel
Danger of death from electric shock!

- ▷ Always have the electrical connections installed by a trained and qualified electrician.
- ▷ Observe regulations IEC 60364 (DIN VDE 0100).

⚠ WARNING

Incorrect connection to the mains
Damage to the mains network, short circuit!

- ▷ Observe the technical specifications of the local energy supply companies.

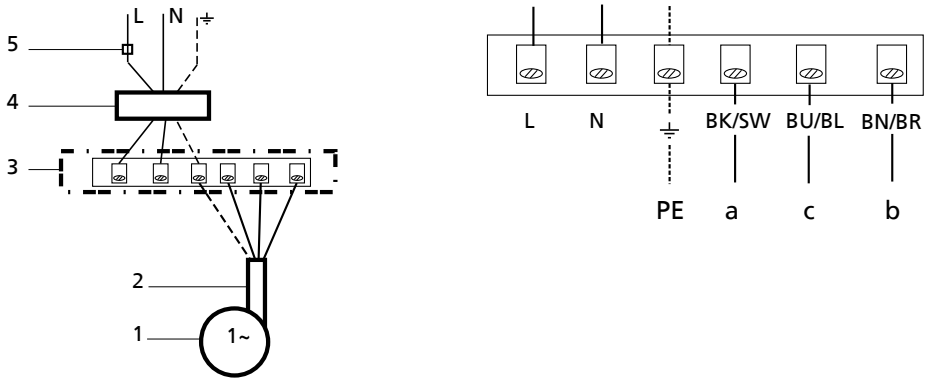
1. Check the available mains voltage against the data on the name plate.
2. Select an appropriate start-up method and observe the respective requirements.

NOTE

Connect shielded motor leads with the exposed shield as short as possible and the shield ends having contact over a large area. Interruptions of the shield must be compliant with EMC[7)]. Observe the EMC instructions of the device manufacturers.

Connecting single-phase (1~) motors

For this motor type a starting device is required. The starting device is not included in the scope of supply.



Circuit diagram: Single-phase (1~) motors with one cable for DOL starting
1 = Motor
2 = Motor lead
3 = Starting device
4 = Control box
5 = Fuse

Codes in the starting device

L = Phase conductor
N = Neutral conductor
PE = Earth conductor; core marking: green/yellow
a = Core marking: black
b = Core marking: brown
c = Core marking: grey (blue)

Connecting three-phase (3~) motors

The 3 current-carrying conductors are designated U, V, W; the earth conductor is designated PE.

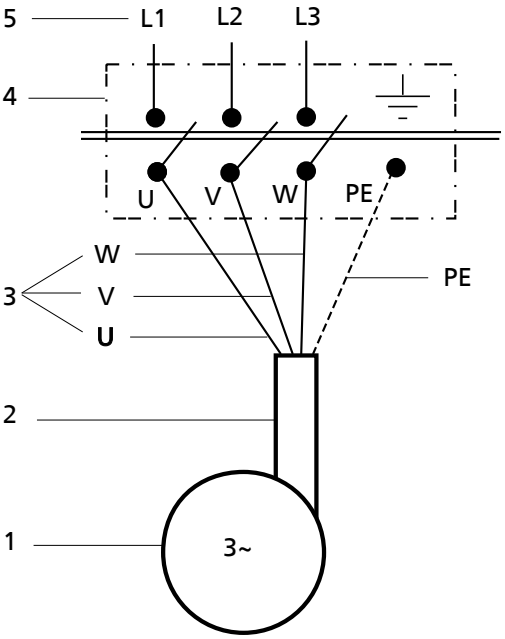


Fig. 8: Circuit diagram: Three-phase (3~) motors with one cable for DOL starting

1	Motor	2	Motor lead
3	Core marking	4	Control box
5	Phase conductor	PE	Earth conductor Core marking: (green/yellow)

7) Electromagnetic compatibility

6 Commissioning/Start-up/Shutdown

6.1 Commissioning/start-up

6.1.1 Start-up

⚠ DANGER

Start-up with defective earth conductor
Personal injury from electric shock!

- ▹ Never switch on a pump set without an earth conductor or with a defective earth conductor.

CAUTION

Starting up the pump set outside the fluid
Damage to the motor!

- ▹ Only start up pump sets when the motor is filled and the unit is fully submerged or flooded!

CAUTION

Operation with closed shut-off valve
Damage to motor and bearings!

- ▹ Never let the pump set run against a closed shut-off valve for more than five minutes.

CAUTION

Continuous operation against a throttled shut-off element
Damage to pump and motor!

- ▹ In continuous operation against a throttled shut-off element, the flow rate must not fall short of Q_{min} (see name plate).

✓ The pump set has been assembled as specified in this manual.
✓ The pump set has been installed as described in this manual.
✓ The power cables, including control and measuring cables, have been fastened and connected in the control box.
✓ The control box and protective equipment have been installed and set properly.
✓ The pump set is completely submerged or flooded.

1. Slightly open the shut-off element on the discharge side.
2. Start up the pump set.
3. Slowly open the shut-off element until the duty point is reached.

NOTE

When starting against an empty pipe, make sure that the air contained in the pipe can escape to the atmosphere.

NOTE

It is not necessary to delay the start-up of a shut-off element with electric actuator, as the running-up time of the pump is shorter than the dead time of the shut-off element.

6.1.2 Checking the direction of rotation

CAUTION

Wrong direction of rotation
Damage to the motor!

- ▹ Do not run the pump set for more than two minutes when checking the direction of rotation.

CAUTION

Uncontrolled backflow of the fluid from the riser
Damage to the pump set!

- ▹ Prevent any **uncontrolled** backflow of the fluid handled with suitable means.
- ▹ **Control** the fluid backflow, e.g. by throttling the gate valve in the discharge line.

For **single-phase a.c. units** the direction of rotation is fixed and cannot be changed.

For **three-phase units**, check the direction of rotation as described below:

✓ The back-up name plate is attached at the place of installation of the submersible borehole pump.

✓ The pump set has been installed completely and is sufficiently covered by the fluid to be handled.(⇨ Section 6.2.6.1 Page 30)

✓ The power supply cable and the measuring and control cables, if any, are connected to the control cabinet.

✓ The shut-off valve in the discharge line has been closed.

1. Switch on the motor at the control cabinet. (⇨ Section 6.1.1 Page 28)
2. Read the pressure on the pressure gauge.
3. Switch off the motor and interchange two phases of the connection cable in the control cabinet.
4. Start up the motor and read the pressure at the pressure gauge.
5. Switch off the motor.
   ⇨ The higher reading at the pressure gauge indicates the correct direction of rotation.
   ⇨ On pumps with free discharge, the correct direction of rotation is indicated by the greater water volume produced, in fountains by the higher jet.
6. Wire the motor for the correct result.

6.2 Operating limits

6.2.1 Switching frequency

To prevent inadmissible heat build-up in the motor, the following max. number of start-ups or minimum standstill periods must be complied with:

- 20 start-ups per hour
- Minimum standstill periods of three minutes

6.2.2 Supply voltage

Observe the permissible voltage and frequency fluctuations to DIN EN 60034-1 section A; U_N ± 5 %, f_N ± 2 %. The limits may differ if specified in the order, see order confirmation.

Star point displacement

Operation with displaced start point must not exceed the value $U_0 > 0.2 \times U_N$ and must be limited to one operating hour.

6.2.3 Voltage limits

Observe the following limits:

- Maximum rate of voltage rise du/dt < 500 V/µs.
- Maximum voltage peaks - J1 insulation < 600 V.

6.2.4 Frequency inverter operation

Do not operate the pump set outside the permissible frequency range of 30 to 50 Hz / 60 Hz.

6.2.5 Star point displacement

The motors are designed for short-time operation with displaced star point (t < 1h). For prolonged operation and $U_0 > 0.2 \times U_N$, consult the manufacturer.

6.2.6 Fluid handled

6.2.6.1 Minimum submergence

Observe the minimum submergence of 0.5 metres.

NOTE

The water level in the well is usually measured with a water level contact meter (well dipper).

Vertical installation

Measurement for vertical installation:
Upper pump edge to lowest (dynamic) water level.
$H_e - H_t \geq 0.5$ metres!

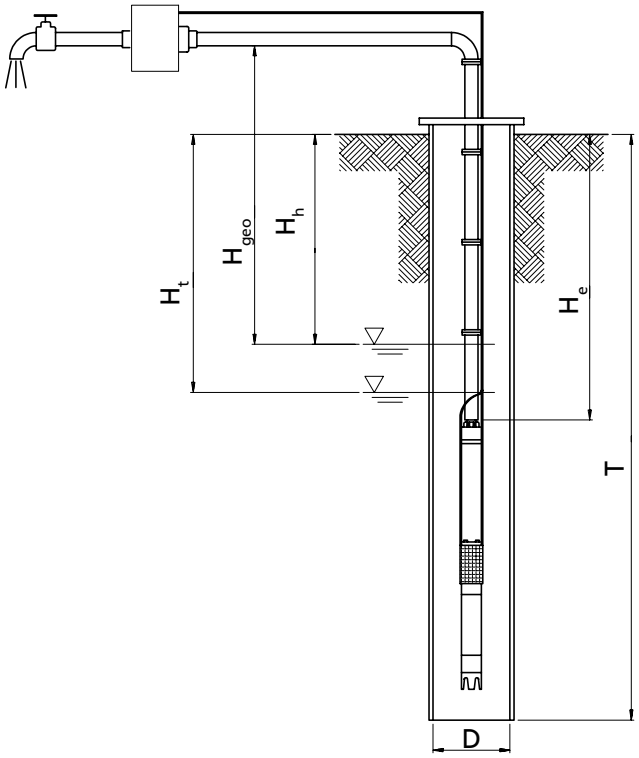


Fig. 9: Minimum submergence for vertical installation

T	Well depth	H_h	Static water level
D	Well diameter	H_t	Dynamic water level
H_e	Installation depth of the pump set	H_{geo}	Height of control box above the static water level in the well

Horizontal installation

Measurement for horizontal installation:
Upper pump edge of suction strainer to lowest (dynamic) water level.

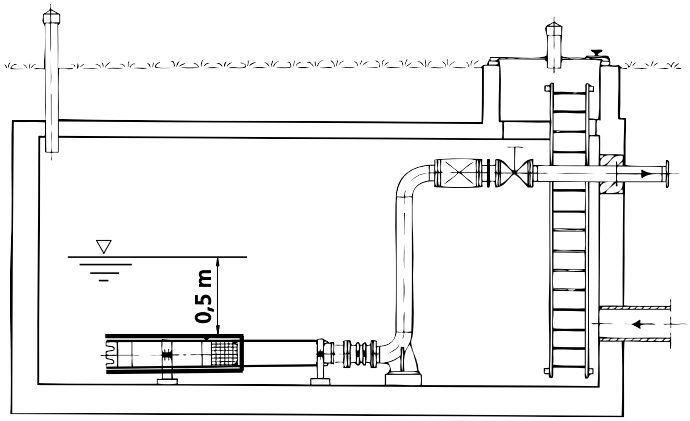


Fig. 10: Minimum submergence for horizontal installation

6.2.6.2 Sand content

Make sure the maximum sand content of 50 g/m³ is not exceeded.

6.2.6.3 Temperature of the fluid handled

Make sure the maximum water temperature T = + 30 °C is not exceeded.

NOTE

The minimum flow velocity in the motor area has to equal 0.08 m/s. For inner well diameters >150 mm always install a cooling jacket.

6.3 Shutdown

CAUTION

Surge pressure caused by sudden shutdown of the pump set
Damage to the machinery right through to the pump set falling down!

- ▷ **Slowly** close the shut-off element on the discharge side.

CAUTION

Uncontrolled backflow of the fluid from the riser
Damage to the pump set!

- ▷ Prevent any **uncontrolled** backflow of the fluid handled with suitable means.
- ▷ **Control** the fluid backflow, e.g. by throttling the gate valve in the discharge line.

1. Slowly close the shut-off element on the discharge side.
2. Switch off the motor immediately after closing the shut-off element.

NOTE

To make sure that the pump set is always ready for instant start-up, start up the pump set approximately every 2 weeks for approximately 5 minutes during prolonged shutdown periods.

7 Servicing/Maintenance

7.1 Servicing/inspection

The submersible borehole pumps are generally maintenance-free. In order to pin-point indications of potential damage at an early stage, regular checks are required. Possible indications of potential damage:

- Temperature rise in the fluid handled
- Increased sand content of the fluid handled
- Change in current consumption
- Change in discharge head / flow rate
- Change in switching frequency
- Increase in noise and vibration levels

The submersible borehole pump need not be removed from the well/tank regularly for inspection.

For any queries and repeat orders, particularly when ordering spare parts, specify the following information (see name plate):

- Pump and/or motor type series and size
- Operating data
- Order number and/or material number

For information concerning repair jobs and spare parts please contact your nearest KSB service centre.

8 Trouble-shooting

A Pump is running but does not deliver
B Pump delivers insufficient flow rate
C Insufficient discharge head
D Vibrations and noise during pump operation
E Unit tripped by overcurrent relay
F Fuses have blown
G Pump set cannot be started up
H Pump set cannot be switched off

Table 9: Trouble-shooting

A	B	C	D	E	F	G	H	Cause	Remedy [8)]
	✗							Pump delivers against an excessively high discharge pressure.	Open the shut-off valve to re-adjust to duty point.
		✗						Pump delivers against an excessively low discharge pressure.	Close the shut-off valve to re-adjust to duty point.
		✗	✗					Deposits in the impellers	Remove deposits. Contact KSB.
	✗	✗						Wrong direction of rotation (in case of 3 ~)	Interchange two of the phases of the power supply cable.
	✗	✗						Wear of internal components	Replace worn parts by new ones. Contact KSB.
	✗			✗				Motor is running on two phases only.	Replace defective fuse. Check cable connections.
✗						✗		No power supply	Check electrical installation, contact electric utility company.
✗				✗				Pump clogged by sand	Clean suction casing, impellers, stage casings and check valve. Contact KSB.
✗				✗	✗	✗		Motor winding or electric cable are defective.	Contact KSB.
✗	✗	✗						Defective or clogged riser (pipe and sealing elements).	Replace affected pipes. Replace sealing elements.
	✗							Water level lowered too much during operation.	Contact KSB.
✗		✗	✗					Impermissible air or gas content in the fluid handled	Contact KSB.
			✗					Mechanical defect on pump or motor	Contact KSB.
			✗					System-induced vibrations	Contact KSB.
	✗		✗					NPSH available (positive suction head) is too low.	Submerge pump deeper.
	✗	✗						Speed is too low.	Check voltage and increase, if necessary. Contact KSB.
					✗			Wrong fuse size	Fit correct fuse size.
				✗		✗	✗	Defective overcurrent relay	Check and replace, if necessary.
				✗				Motor winding not suitable for operating voltage available	Replace the pump set. Contact KSB.

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

9 Related Documents

9.1 S 100D general assembly drawing

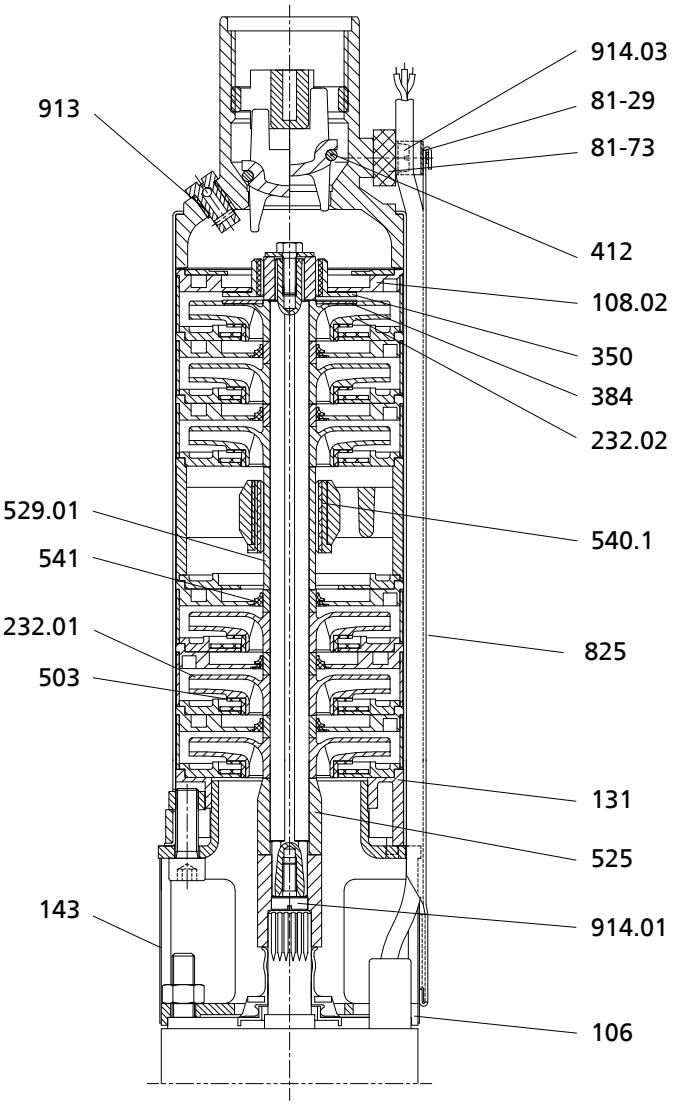


Fig. 11: Sectional drawing of an S 100D pump with radial impellers

Table 10: List of S 100D components

Part No.	Description	Part No.	Description
81-29	Terminal	412	O-ring
81-73	Cable support	503	Impeller wear ring
106	Suction casing	525	Spacer sleeve
108.02	Stage casing	529.01	Bearing sleeve
131	Inlet ring	540.1	Bush
143	Suction strainer	541	Interstage bush
232.01	Impeller	825	Cable guard
232.02	Impeller (last stage)	913	Vent plug
350	Bearing housing	914.01	Hexagon socket head cap screw
384	Thrust collar	914.03	Hexagon socket head cap screw

9.2 UPA 100C general assembly drawing

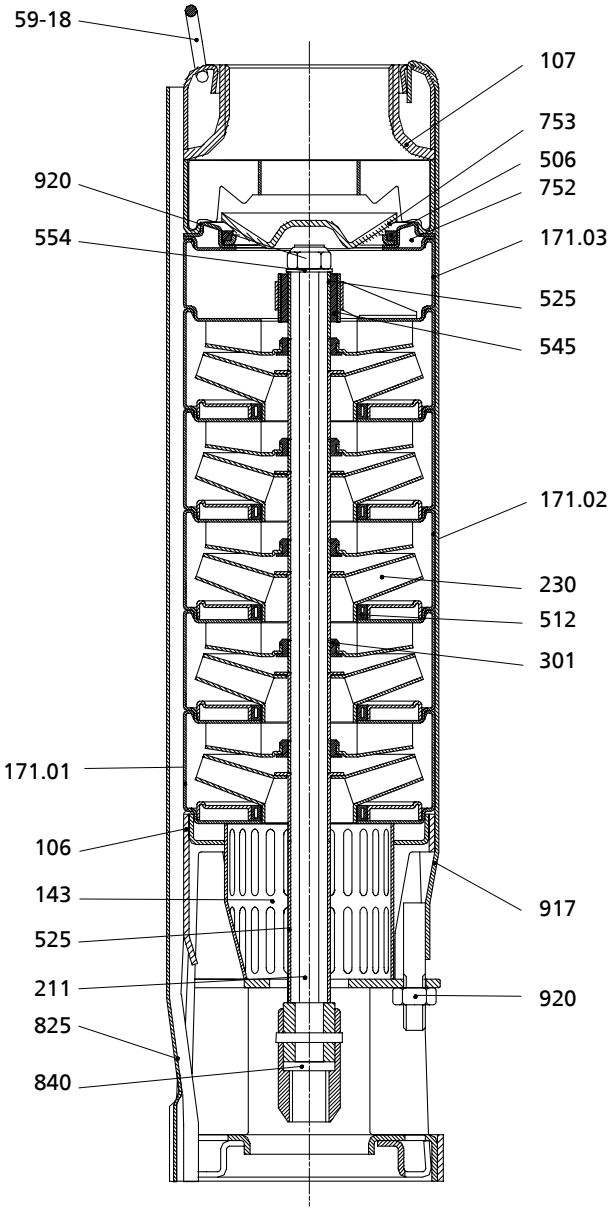


Fig. 12: Sectional drawing of a UPA 100C pump with mixed flow impellers

Table 11: List of UPA 100C components

Part No.	Description	Part No.	Description
59-18	Hook	512	Wear ring
106	Suction casing	525	Spacer sleeve
107	Discharge casing	545	Bearing bush
143	Suction strainer	554	Washer
171.01	Bottom diffuser	752	Valve seat
171.02	Diffuser	753	Valve plug
171.03	Top diffuser	825	Cable guard
211	Pump shaft	840	Coupling
230	Impeller	917	Metal strap
301	Intermediate bearing	920	Nut
506	Retaining ring		

9.3 DN 100 general assembly drawing

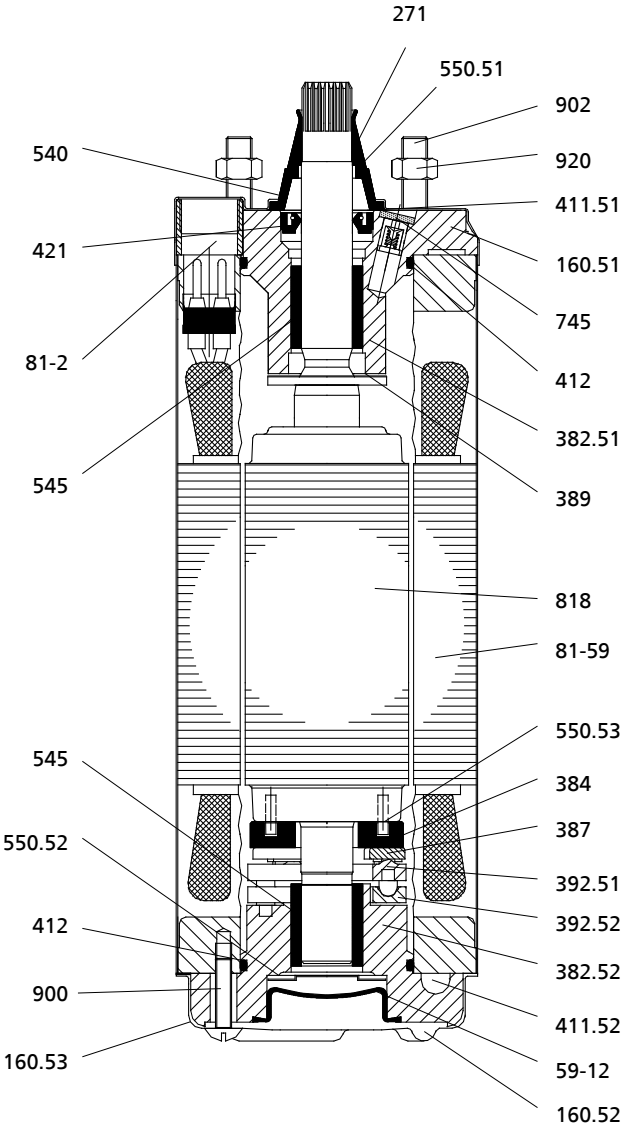


Fig. 13: Example of a DN 100 motor < 3.0 kW

Table 12: List of DN 100 components

Part No.	Description	Part No.	Description
59-12	Diaphragm	412	O-ring
81-2	Plug	421	Lip seal
81-59	Stator	540	Bush
160.51/.52/.53	Cover	545	Bearing bush
271	Sand guard	550.51/.52/.53	Disc
382.51/.52	Bearing carrier	745	Filter
384	Thrust collar	818	Rotor
387	Thrust bearing pad	900	Bolt/Screw
389	Counter thrust bearing ring	902	Stud
392.51/.52	Bearing segment carrier	920	Hexagon nut
411.51/.52	Joint ring		

10 EC Declaration of Conformity

Manufacturer: **KSB Aktiengesellschaft**
Johann-Klein-Straße 9
67227 Frankenthal (Germany)

The manufacturer herewith declares that **the product**:

S 100 D, UPA 100C

- is in conformity with the provisions of the following Directives as amended from time to time:
  - Pump (set): Machinery Directive 2006/42/EC

The manufacturer also declares that

- the following harmonised international standards have been applied:
  - ISO 12100,
  - EN 809/A1,
  - EN 60034-1, EN 60034-5/A1

Person authorised to compile the technical file:
Name
Function
Address (company)
Address (Street, No.)
Address (post or ZIP code, city) (country)

The EC Declaration of Conformity was issued in/on:

Place, date

.....[9)].....

Name

Function
Company
Address

Address

9) A signed, legally binding declaration of conformity is supplied with the product.

11 Certificate of Decontamination

Type .....
Order number/
Order item number[10)] .....

Delivery date .....

Field of application: .....

Fluid pumped[10)]: .....

Please tick where applicable[10)]:

☐ Radioactive

☐ Explosive

☐ Corrosive

☐ Toxic

☐ Harmful

☐ Bio-hazardous

☐ Highly flammable

☐ Safe

Reason for return[10)]: .....

Comments: .....

.....

The product/accessories have been carefully drained, cleaned and decontaminated inside and outside prior to dispatch/ placing at your disposal.

We hereby declare that this product is free from hazardous chemicals, biological or radioactive substances.

On seal-less pumps, the rotor has been removed from the pump for cleaning.

☐ No special safety precautions are required for further handling.
☐ The following safety precautions are required for flushing fluids, fluid residues and disposal:

.....

.....

We confirm that the above data and information are correct and complete and that dispatch is effected in accordance with the relevant legal provisions.

.....	.....	.....
Place, date and signature	Address	Company stamp

10) Required fields

Index

C

Certificate of decontamination 39

D

Description of the fluid handled 14
Disposal 12

F

Frequency inverter operation 30

I

Intended use 8

M

Misuse 9

O

Operating limits 8
Order number 6
Other applicable documents 6

P

Partly completed machinery 6

R

Return to supplier 12

S

Safety 8
Safety awareness 9
Scope of supply 16

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