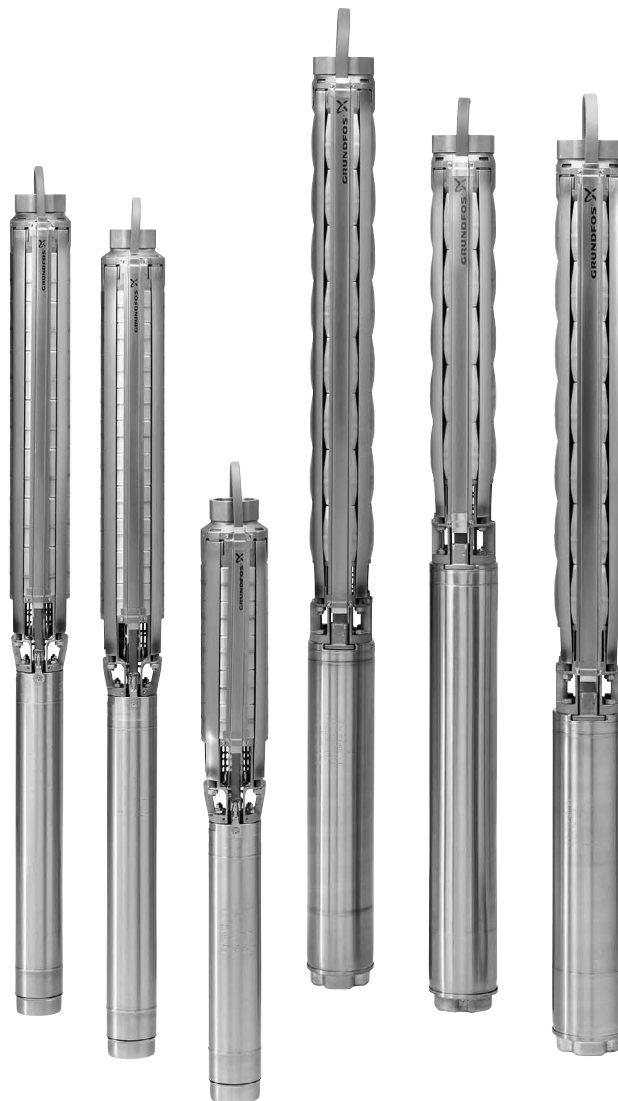


# SP

## Installation and operating instructions



Other languages

<http://net.grundfos.com/qr/i/98074911>

## Original installation and operating instructions.

## CONTENTS

	Page
<b>1. Symbols used in this document</b>	<b>2</b>
<b>2. Introduction</b>	<b>2</b>
<b>3. Delivery and storage</b>	<b>2</b>
3.1 Delivery	2
3.2 Storage	2
<b>4. Applications</b>	<b>3</b>
4.1 Pumped liquids	3
4.2 Sound pressure level	3
<b>5. Preparations before installation</b>	<b>3</b>
5.1 Checking the motor liquid	3
5.2 Positional requirements	5
5.3 Pump/motor diameter	5
5.4 Liquid temperatures/cooling	5
5.5 Pipe connection	6
<b>6. Electrical connection</b>	<b>6</b>
6.1 Frequency converter operation	7
6.2 Motor protection	7
6.3 Lightning protection	8
6.4 Cable sizing	8
6.5 Control of single-phase MS 402 motors	9
6.6 Connection of single-phase motors	9
6.7 Connection of three-phase motors	10
<b>7. Installation</b>	<b>11</b>
7.1 Fitting the motor to the pump	11
7.2 Removing and fitting the cable guard	12
7.3 Connecting the submersible drop cable	12
7.4 Riser pipe	12
7.5 Maximum installation depth below water level [m]	12
7.6 Cable clips	13
7.7 Lowering the pump	13
7.8 Installation depth	13
<b>8. Startup and operation</b>	<b>13</b>
8.1 Startup	13
8.2 Operation	14
<b>9. Maintenance and service</b>	<b>14</b>
<b>10. Fault finding</b>	<b>15</b>
<b>11. Checking motor and cable</b>	<b>16</b>
<b>12. Disposal</b>	<b>16</b>

**Warning**

Prior to installation, read these installation and operating instructions. Installation and operation must comply with local regulations and accepted codes of good practice.

**1. Symbols used in this document****Warning**

If these safety instructions are not observed, it may result in personal injury.

**Warning**

If these instructions are not observed, it may lead to electric shock with consequent risk of serious personal injury or death.

**Caution**

If these safety instructions are not observed, it may result in malfunction or damage to the equipment.

**Note**

Notes or instructions that make the job easier and ensure safe operation.

**2. Introduction**

These instructions apply to Grundfos submersible pumps, type SP, with submersible motors, types Grundfos MS/MMS or Franklin 4"-8".

If the pump is fitted with a motor of another make than Grundfos MS or MMS, note that the motor data may differ from the data stated in these instructions.

**Note**

The USB stick supplied with the product contains installation and operating instructions in various languages.

**3. Delivery and storage****3.1 Delivery****Caution**

The pump should remain in the packing until it is placed in vertical position during installation.

Handle the pump with care.

When the pump part and motor are supplied as separate units (long pumps), fit the motor to the pump as described in section [7.1 Fitting the motor to the pump](#).

**Note**

The extra nameplate supplied with the pump should be fixed at the installation site.

Do not expose the pump to unnecessary impact and shocks.

**3.2 Storage****Storage temperature**

Pump: -20 °C to +60 °C.

Motor: -20 °C to +70 °C.

The motors must be stored in a closed, dry and well ventilated room.

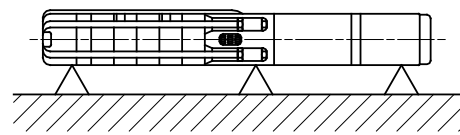
**Caution**

If MMS motors are stored, the shaft must be turned by hand at least once a month. If a motor has been stored for more than one year before installation, the rotating parts of the motor must be dismantled and checked before use.

The pump should not be exposed to direct sunlight.

If the pump has been unpacked, it should be stored horizontally, adequately supported, or vertically to prevent misalignment of the pump. Make sure that the pump cannot roll or fall over.

During storage, the pump can be supported as shown in [fig. 1](#).



**Fig. 1** Pump position during storage

**3.2.1 Frost protection**

If the pump has to be stored after use, it must be stored on a frost-free location, or the motor liquid must be frost-proof.

## 4. Applications

Grundfos SP submersible pumps are designed for a wide range of water supply and liquid transfer applications, such as the supply of fresh water to private homes or waterworks, water supply in horticulture and agriculture, drawdown of groundwater and pressure boosting, and various industrial jobs.

The pump must be installed so that the suction interconnector is completely submerged in the liquid. The pump can be installed horizontally or vertically. See section [5.2 Positional requirements](#).

### 4.1 Pumped liquids

Clean, thin, non-explosive liquids without solid particles or fibres. The maximum sand content of the water must not exceed  $50 \text{ g/m}^3$ . A larger sand content will reduce the life of the pump and increase the risk of blockage.

**Caution** When pumping liquids with a density higher than that of water, motors with correspondingly higher outputs must be used.

If liquids with a viscosity higher than that of water are to be pumped, contact Grundfos.

The pump versions SP A N, SP A R, SP N, SP R and SPE are designed for liquids with higher aggressiveness than drinking water.

The maximum liquid temperature appears from section [5.4 Liquid temperatures/cooling](#).

### 4.2 Sound pressure level

The sound pressure level has been measured in accordance with the rules laid down in the EC machinery directive 2006/42/EC.

#### Sound pressure level of pumps

The values apply to pumps submerged in water, without external regulating valve.

Pump type	$\bar{L}_{pA}$ [dB(A)]
SP 1A	< 70
SP 2A	< 70
SP 3A	< 70
SP 5A	< 70
SP 7	< 70
SP 9	< 70
SP 11	< 70
SP 14	< 70
SP 17	< 70
SP 30	< 70
SP 46	< 70
SP 60	< 70
SP 77	< 70
SP 95	< 70
SP 125	79
SP 160	79
SP 215	82

#### Sound pressure level of motors

The sound pressure level of Grundfos MS and MMS motors is lower than 70 dB(A).

Other motor makes: See installation and operating instructions for these motors.

## 5. Preparations before installation



### Warning

Before starting work on the product, switch off the power supply. Make sure that the power supply cannot be accidentally switched on.

### 5.1 Checking the motor liquid

The motors are factory-filled with a special non-poisonous liquid which is frost-proof down to  $-20 \text{ }^\circ\text{C}$ .

#### Note

Check the level of motor liquid and refill if required. Use clean water.

#### Caution

If frost protection is required, special Grundfos liquid must be used to refill the motor. Otherwise clean water may be used for refilling (however, never use distilled water).

Refill liquid as described below.

#### 5.1.1 Grundfos MS 4000 and MS 402 motors

The filling hole for motor liquid is placed in the following positions:

- MS 4000: in the top of the motor.
  - MS 402: in the bottom of the motor.
1. Position the submersible pump as shown in [fig. 2](#). The filling screw must be at the highest point of the motor.
  2. Remove the screw from the filling hole.
  3. Inject liquid into the motor with the filling syringe until the liquid runs back out of the filling hole. See [fig. 2](#).
  4. Replace the screw in the filling hole and tighten securely before changing the position of the pump.

#### Torques

- MS 4000: 3.0 Nm.
- MS 402: 2.0 Nm.

The submersible pump is now ready for installation.

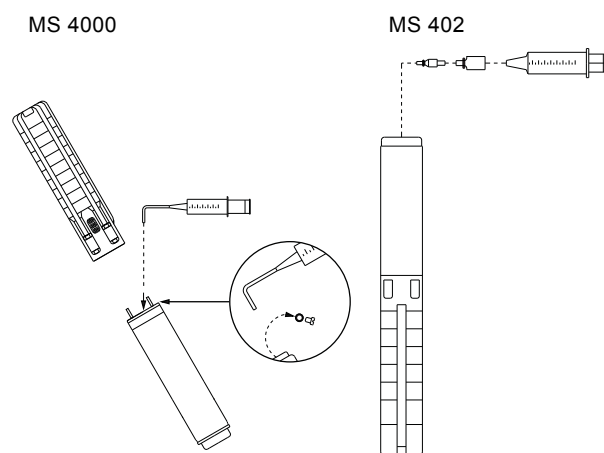


Fig. 2 Motor position during filling - MS 4000 and MS 402

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**5.1.2 Grundfos MS 6000 motors**

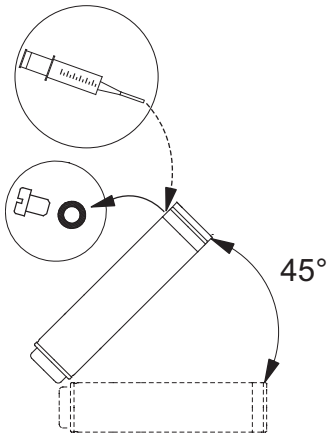
- If the motor is delivered from stock, check the level of motor liquid before fitting the motor to the pump. See fig. 3.
- When pumps are delivered direct from Grundfos, the level has already been checked.
- Check the level in connection with service. See fig. 3.

The filling hole for motor liquid is placed at the top of the motor.

1. Position the submersible pump as shown in fig. 3. The filling screw must be at the highest point of the motor.
2. Remove the screw from the filling hole.
3. Inject liquid into the motor with the filling syringe until the liquid runs back out of the filling hole. See fig. 3.
4. Replace the screw in the filling hole and tighten securely before changing the position of the pump.

Torque: 3.0 Nm.

The submersible pump is now ready for installation.



**Fig. 3** Motor position during filling - MS 6000

**5.1.3 Grundfos MMS 6, MMS 8000, MMS 10000 and MMS 12000 motors**

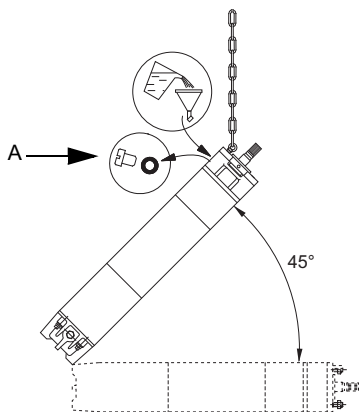
1. Place the motor at a 45° angle with the top of the motor upwards. See fig. 4.
2. Unscrew the plug A and place a funnel in the hole.
3. Pour tap water into the motor until the motor liquid inside the motor starts running out of A.

**Caution** Do not use motor liquid as it contains oil.

4. Remove the funnel and refit the plug A.

**Caution** Before fitting the motor to a pump after a long period of storage, lubricate the shaft seal by adding a few drops of water and turning the shaft.

The submersible pump is now ready for installation.



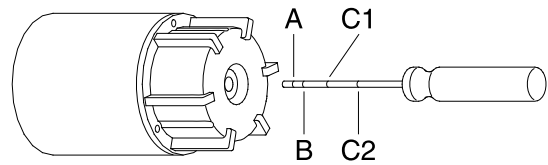
**Fig. 4** Motor position during filling - MMS

**5.1.4 Franklin motors from 3 kW and up**

Check the level of motor liquid in Franklin 4" and 6" motors by measuring the distance from the bottom plate to the built-in rubber diaphragm. The distance can be measured by inserting a

rule or a small rod through the hole until it touches the diaphragm. See fig. 5.

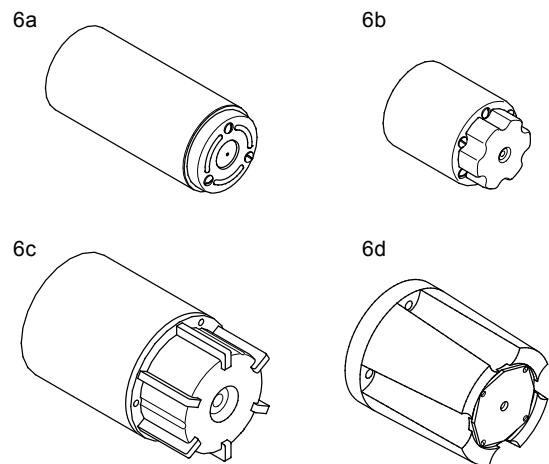
**Caution** Take care not to damage the diaphragm.



**Fig. 5** Measuring the distance from bottom plate to diaphragm

The table below shows the correct distance from the outside of the bottom plate to the diaphragm:

Motor	Dimension	Distance [mm]
Franklin 4", 0.25 - 3 kW (fig. 6a)	A	8
Franklin 4", 3 - 7.5 kW (fig. 6b)	B	16
Franklin 6", 4-45 kW (fig. 6c)	C1	35
Franklin 6", 4-22 kW (fig. 6d)	C2	59



**Fig. 6** Franklin motors

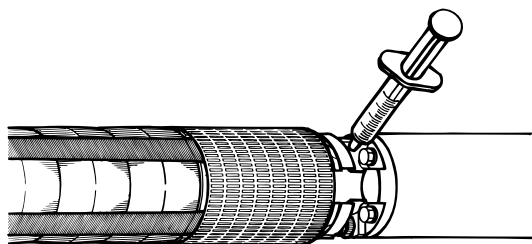
If the distance is not correct, carry out an adjustment as described in section 5.1.5 Franklin motors.

### 5.1.5 Franklin motors

Check the level of motor liquid in Franklin 8" motors as follows:

1. Press out the filter in front of the valve at the top of the motor using a screwdriver. If the filter is slotted, unscrew. Figure 7 shows the position of the filling valve.
2. Press the filling syringe against the valve and inject the liquid. See fig. 7. If the valve cone is depressed too far, it may be damaged thus causing the valve to leak.
3. Remove any air in the motor by pressing the point of the filling syringe lightly against the valve.
4. Repeat the process of injecting liquid and releasing air until the liquid starts running out or the diaphragm is in its correct position (Franklin 4" and 6").
5. Refit the filter.

The submersible pump is now ready for installation.



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Fig. 7 Position of filling valve

### 5.2 Positional requirements

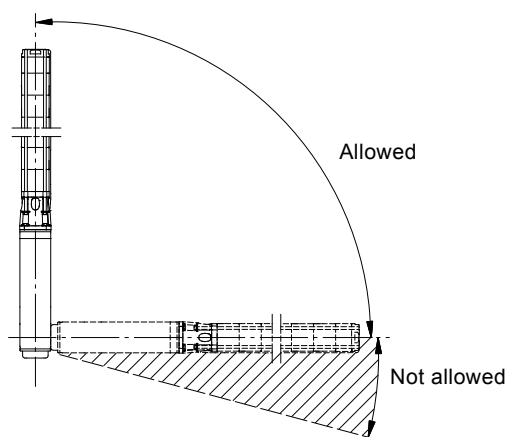


#### Warning

If the pump is to be installed in a position where it is accessible, the coupling must be suitably isolated from human touch. The pump can for instance be built into a flow sleeve.

Depending on motor type, the pump can be installed either vertically or horizontally. A complete list of motor types suitable for horizontal installation is shown in section [5.2.1 Motors suitable for horizontal installation](#).

If the pump is installed horizontally, the discharge port should never fall below the horizontal plane. See fig. 8.



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Fig. 8 Positional requirements

If the pump is installed horizontally, e.g. in a tank, we recommend that you fit it in a flow sleeve.

### 5.2.1 Motors suitable for horizontal installation

Motor	Output power 50 Hz	Output power 60 Hz
	[kW]	[kW]
MS	All	All
MMS 6	5.5 - 37	5.5 - 37
MMS 8000	22-110	22-110
MMS 10000	75-190	75-190
MMS 12000	147-250	147-250

When Franklin 4" motors up to and including 2.2 kW are started more than 10 times a day, we recommend that you incline the motor at least 15 ° above the horizontal plane in order to minimise wearing of the upthrust disc.

**Caution** During operation, the suction interconnector of the pump must always be completely submerged in the liquid. Make sure that the NPSH values are fulfilled.



#### Warning

If the pump is used for pumping hot liquids (40 to 60 °C), make sure that persons cannot come into contact with the pump and the installation, e.g. by installing a guard.

### 5.3 Pump/motor diameter

We recommend that you check the borehole with an inside calliper to ensure unobstructed passage.

### 5.4 Liquid temperatures/cooling

The maximum liquid temperature and the minimum flow velocity past the motor appear from the table below.

We recommend that you install the motor above the well screen in order to achieve proper motor cooling.

**Caution** In cases where the stated flow velocity cannot be achieved, a flow sleeve must be installed.

If there is a risk of sediment build-up, such as sand, around the motor, use a flow sleeve in order to ensure proper cooling of the motor.

### 5.4.1 Maximum liquid temperature

Out of consideration for the rubber parts in pump and motor, the liquid temperature must not exceed 40 °C (~ 105 °F). See also the table below.

The pump can operate at liquid temperatures between 40 °C and 60 °C (~ 105 °F and 140 °F) provided that all rubber parts are replaced every third year.

Motor	Installation		
	Flow past the motor	Vertical	Horizontal
Grundfos MS 402 MS 4000 MS 6000	0.15 m/s	40 °C (~ 105 °F)	40 °C (~ 105 °F)
Grundfos MS 4000I*	0.15 m/s	60 °C (~ 140 °F)	60 °C (~ 140 °F)
Grundfos MS 6000I*	1.00 m/s	Flow sleeve recommended	Flow sleeve recommended
Grundfos MMS	0.15 m/s	25 °C (~ 77 °F)	25 °C (~ 77 °F)
	0.50 m/s	30 °C (~ 86 °F)	30 °C (~ 86 °F)
Franklin 4"	0.08 m/s	30 °C (~ 85 °F)	30 °C (~ 85 °F)
Franklin 6" and 8"	0.16 m/s	30 °C (~ 85 °F)	30 °C (~ 85 °F)

\* At an ambient pressure of minimum 1 bar (1 MPa).

37 kW MMS 6, 110 kW MMS 8000 and 170 kW MMS 10000: The maximum operational liquid temperature is 5 °C lower than the values stated in the above table.

190 kW MMS 10000: The temperature is 10 °C lower.

**Note**

### 5.5 Pipe connection

If noise may be transmitted to the building through the pipework, we recommend that you use plastic pipes.

**Note**

We recommend plastic pipes for 4" pumps only.

When using plastic pipes, secure the pump by an unloaded straining wire.



**Warning**  
Make sure that the plastic pipes are suitable for the actual liquid temperature and the pump pressure.

When connecting plastic pipes, use a compression coupling between the pump and the first pipe section.

### 6. Electrical connection



**Warning**  
During electrical installation, make sure that the power supply cannot be accidentally switched on.



**Warning**  
The electrical installation should be carried out by an authorised person in accordance with local regulations.

The supply voltage, rated maximum current and cos φ appear from the loose data plate which must be fitted close to the installation site.

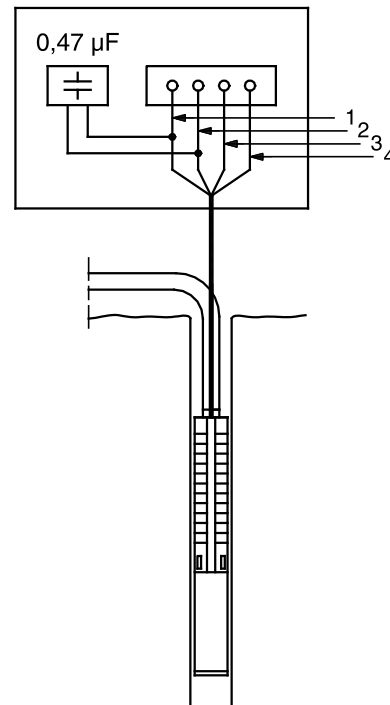
The required voltage quality for MS and MMS motors, measured at the motor terminals, is - 10 %/+ 6 % of the nominal voltage during continuous operation (including variation in the supply voltage and losses in cables).

Check also that there is voltage symmetry in the power supply lines, i.e. same difference of voltage between the individual phases. See section 11. *Checking motor and cable*, item 2.



**Warning**  
The pump must be earthed.  
The pump must be connected to an external mains switch with a minimum contact gap of 3 mm in all poles.

If MS motors with a built-in temperature transmitter (Tempcon) are not installed together with a MP 204 or similar Grundfos motor protection, they must be connected to a 0.47 µF capacitor approved for phase-phase operation (IEC 384-14) to meet the EC EMC directive (2004/108/EC). The capacitor must be connected to the two phases to which the temperature transmitter is connected. See fig. 9.



**Fig. 9** Connection of capacitor

Lead	Colours of the leads	
	Flat cable	Single leads
1 = L1	Brown	Black
2 = L2	Black	Yellow
3 = L3	Grey	Red
4 = PE	Yellow/green	Green

The motors are wound for direct-on-line starting or star-delta starting, and the starting current is between four and six times the rated current of the motor.

The run-up time of the pump is only about 0.1 second. Direct-on-line starting is therefore normally approved by the power supply company.

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## 6.1 Frequency converter operation

### 6.1.1 Grundfos motors

Three-phase Grundfos motors can be connected to a frequency converter.

**Caution** If an MS motor with temperature transmitter is connected to a frequency converter, a fuse incorporated in the transmitter will melt and the transmitter will be inactive. The transmitter cannot be reactivated. This means that the motor will operate like a motor without a temperature transmitter.

If a temperature transmitter is required, Grundfos offers a Pt100 or Pt1000 sensor for the submersible motor.

**Caution** The motor should not run at a frequency higher than the rated frequency (50 or 60 Hz) during frequency converter operation. In connection with pump operation, never reduce the frequency (and consequently the speed) to such a level that the necessary flow of cooling liquid past the motor is no longer ensured.

To avoid damage to the pump part, the motor must stop when the pump flow falls below 0.1 x nominal flow.

Depending on the frequency converter type, it may expose the motor to detrimental voltage peaks.



#### Warning

MS 402 motors for supply voltages up to and including 440 V (see motor nameplate) must be protected against voltage peaks higher than 650 V (peak value) between the supply terminals.

We recommend that you protect other motors against voltage peaks higher than 850 V.

The above disturbance can be abated by installing an RC filter between the frequency converter and the motor.

Possible increased acoustic noise from the motor can be abated by installing an LC filter which will also eliminate voltage peaks from the frequency converter.

We recommend that you install an LC filter when using a frequency converter. See section [6.7.6 Frequency converter operation](#).

For further details, contact your frequency converter supplier or Grundfos.

### 6.1.2 Other motor makes than Grundfos

Contact Grundfos or the motor manufacturer.

## 6.2 Motor protection

### 6.2.1 Single-phase motors

Single-phase MS 402 motors incorporate a thermal switch and require no additional motor protection.



#### Warning

When the motor has been thermally switched off, the motor terminals are still live. When the motor has cooled sufficiently, it will restart automatically.

Single-phase MS 4000 motors must be protected. A protective device can either be incorporated in a control box or be separate. Franklin 4" PSC motors must be connected to a motor-protective circuit breaker.

### 6.2.2 Three-phase motors

MS motors are available with or without a built-in temperature transmitter.

The following motors must be protected by a motor-protective circuit breaker with thermal relay, or a MP 204 and contactor(s):

- motors with a built-in and intact temperature transmitter
- motors with or without a defective temperature transmitter
- motors with or without a Pt100 sensor.

MMS motors have no built-in temperature transmitter. The Pt100 and the Pt1000 sensor are available as an accessory.

### 6.2.3 Required settings of motor-protective circuit breaker

For cold motors, the tripping time of the motor-protective circuit breaker must be less than 10 seconds at 5 times the rated maximum current of the motor. During normal operating conditions the motor must be running at full speed in less than 3 seconds.



#### Caution

If this requirement is not met, the motor warranty will be invalidated.

In order to ensure optimum motor protection, the motor-protective circuit breaker should be set as follows:

1. Set the motor-protective circuit breaker to the rated maximum current of the motor.
2. Start the pump and let it run for half an hour at normal performance.
3. Slowly grade down the scale indicator until the motor trip point is reached.
4. Increase the setting by 5 %.

The highest permissible setting is the rated maximum current of the motor.

For motors wound for star-delta starting, the motor-protective circuit breaker should be set as above, but the maximum setting should be rated maximum current x 0.58.

The highest permissible startup time for star-delta starting or autotransformer starting is 2 seconds.

### 6.3 Lightning protection

The installation can be fitted with a special overvoltage protective device to protect the motor from voltage surges in the power supply lines when lightning strikes somewhere in the area. See fig. 10.

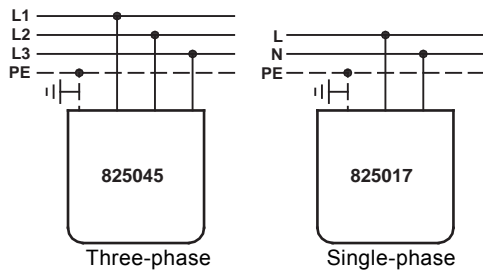


Fig. 10 Fitting an overvoltage protective device

The overvoltage protective device will not, however, protect the motor against a direct stroke of lightning.

The overvoltage protective device should be connected to the installation as close as possible to the motor and always in accordance with local regulations. Ask Grundfos for lightning protective devices.

MS 402 motors, however, require no further lightning protection as they are highly insulated.

A special cable termination kit with a built-in overvoltage protective device is available for Grundfos 4" motors (product No 799911 or 799912).

### 6.4 Cable sizing

**Caution**

Submersible motor cables are dimensioned for submersion in liquid, and will not necessarily have sufficient cross-section to be in free air.

Make sure that the submersible drop cable can withstand permanent submersion in the actual liquid and at the actual temperature.

The cross-section (q) of the cable must meet the following requirements:

The submersible drop cable must be sized to the rated maximum current (I<sub>n</sub>) of the motor.

The cross-section must be sufficient to make a voltage drop over the cable acceptable.

Grundfos supplies submersible drop cables for a wide range of installations. For correct cable sizing, Grundfos offers a cable sizing tool on the USB stick supplied with the motor.

Voltage drop in % for a one, three or four core flexible Grundfos drop cable												
CALCULATE GRUNDFOS DROP CABLE VOLTAGE DROP - Direct On Line												
Length of cable [m]	Rated voltage [V]		Operating current [A]		Power factor		Temperature		Cross section in mm <sup>2</sup>			
	U <sub>N</sub>	U <sub>e</sub>	I <sub>N</sub>	I <sub>e</sub>	cos φ	sin φ	20°C	30°C	16	25	35	50
20	230	230	10	10	0.85	0.53	20	20	16	25	35	50
30	230	230	15	15	0.85	0.53	20	20	16	25	35	50
40	230	230	20	20	0.85	0.53	20	20	16	25	35	50
50	230	230	25	25	0.85	0.53	20	20	16	25	35	50
60	230	230	30	30	0.85	0.53	20	20	16	25	35	50
70	230	230	35	35	0.85	0.53	20	20	16	25	35	50
80	230	230	40	40	0.85	0.53	20	20	16	25	35	50
90	230	230	45	45	0.85	0.53	20	20	16	25	35	50
100	230	230	50	50	0.85	0.53	20	20	16	25	35	50
110	230	230	55	55	0.85	0.53	20	20	16	25	35	50
120	230	230	60	60	0.85	0.53	20	20	16	25	35	50
130	230	230	65	65	0.85	0.53	20	20	16	25	35	50
140	230	230	70	70	0.85	0.53	20	20	16	25	35	50
150	230	230	75	75	0.85	0.53	20	20	16	25	35	50
160	230	230	80	80	0.85	0.53	20	20	16	25	35	50
170	230	230	85	85	0.85	0.53	20	20	16	25	35	50
180	230	230	90	90	0.85	0.53	20	20	16	25	35	50
190	230	230	95	95	0.85	0.53	20	20	16	25	35	50
200	230	230	100	100	0.85	0.53	20	20	16	25	35	50
210	230	230	105	105	0.85	0.53	20	20	16	25	35	50
220	230	230	110	110	0.85	0.53	20	20	16	25	35	50
230	230	230	115	115	0.85	0.53	20	20	16	25	35	50
240	230	230	120	120	0.85	0.53	20	20	16	25	35	50
250	230	230	125	125	0.85	0.53	20	20	16	25	35	50
260	230	230	130	130	0.85	0.53	20	20	16	25	35	50
270	230	230	135	135	0.85	0.53	20	20	16	25	35	50
280	230	230	140	140	0.85	0.53	20	20	16	25	35	50
290	230	230	145	145	0.85	0.53	20	20	16	25	35	50
300	230	230	150	150	0.85	0.53	20	20	16	25	35	50

Fig. 11 Cable sizing tool

The sizing tool provides an accurate calculation of the voltage drop at a given cross-section on the basis of the following parameters:

- cable length
- operating voltage
- full-load current
- power factor
- ambient temperature.

You can calculate the voltage drop both for direct-on-line and star-delta starting.

In order to minimise operating losses, the cable cross-section may be increased. This is only cost-efficient if the borehole provides the necessary space, and if the operating time of the pump is long. The cable sizing tool also provides a power loss calculator that shows the potential savings of an increased cross-section.

As an alternative to the cable sizing tool, select the cross-section on the basis of the current values of the given cables.

The cross-section of the submersible drop cable must be large enough to meet the voltage quality requirements specified in section 6. *Electrical connection*.

Determine the voltage drop for the cross-section of the submersible drop cable by means of the diagrams on pages 17 to 20.

Use the following formula:

I = Rated maximum current of the motor.

For star-delta starting, I = rated maximum current of the motor x 0.58.

Lx = Length of cable converted to a voltage drop of 1 % of the nominal voltage.

$$Lx = \frac{\text{length of drop cable}}{\text{permissible voltage drop in \%}}$$

q = Cross-section of submersible drop cable.

Draw a straight line between the actual I-value and the Lx-value. Where the line intersects the q-axis, select the cross-section that lies right above the intersection.

The diagrams are made on the basis of the formulas:

**Single-phase submersible motor**

$$L = \frac{U \times \Delta U}{I \times 2 \times 100 \times \left( \cos \phi \times \frac{\rho}{q} + \sin \phi \times Xl \right)}$$

**Three-phase submersible motor**

$$L = \frac{U \times \Delta U}{I \times 1.73 \times 100 \times \left( \cos \phi \times \frac{\rho}{q} + \sin \phi \times Xl \right)}$$

L = Length of submersible drop cable [m]

U = Rated voltage [V]

ΔU = Voltage drop [%]

I = Rated maximum current of the motor [A]

cos φ = 0.9

ρ = Specific resistance: 0.02 [Ωmm<sup>2</sup>/m]

q = Cross-section of submersible drop cable [mm<sup>2</sup>]

sin φ = 0.436

Xl = Inductive resistance: 0.078 x 10<sup>-3</sup> [Ω/m].

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### 6.5 Control of single-phase MS 402 motors



**Warning**

The single-phase MS 402 motor incorporates motor protection which cuts out the motor in case of excessive winding temperatures while the motor is still supplied with voltage. Allow for this, when the motor forms part of a control system.

If a compressor is included in a control system together with an ochre filter, the compressor will run continuously once the motor protection has cut out the motor, unless other special precautions have been taken.

### 6.6 Connection of single-phase motors

#### 6.6.1 2-wire motors

MS 402 2-wire motors incorporate motor protection and a starter device and can therefore be connected direct to the mains. See fig. 12.

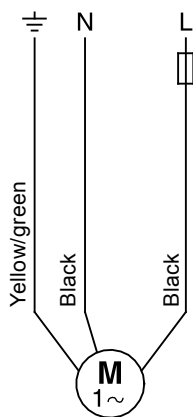


Fig. 12 2-wire motors

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#### 6.6.2 PSC motors

The PSC motors are connected to the mains via a run capacitor which should be sized for continuous operation. Select the correct capacitor size from the table below:

Motor [kW]	Capacitor [ $\mu$ F] 400 V, 50 Hz
0.25	12.5
0.37	16
0.55	20
0.75	30
1.10	40
1.50	50
2.20	75

MS 402 PSC motors incorporate motor protection and should be connected to the mains as shown in fig. 13.

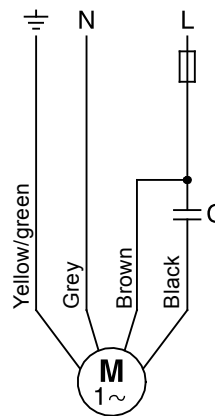


Fig. 13 PSC motors

See [www.franklin-electric.com](http://www.franklin-electric.com) and fig. 14.

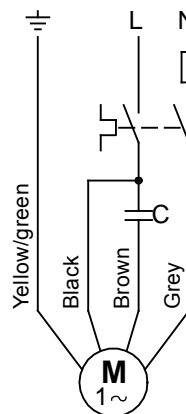


Fig. 14 Franklin motors

#### 6.6.3 3-wire motors

MS 4000 3-wire motors must be connected to the mains via a Grundfos SA-SPM 5 (60 Hz), 7 or 8 (50 Hz) control box incorporating motor protection.

MS 402 3-wire motors incorporate motor protection and should be connected to the mains via a Grundfos control box SA-SPM 2, 3 or 5 (60 Hz), 7 or 8 (50 Hz) without motor protection.

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### 6.7 Connection of three-phase motors

Three-phase motors must be protected.  
See section 6.2.2 *Three-phase motors*.

For electrical connection via the MP 204, see the separate installation and operating instructions for this unit.

When a conventional motor-protective circuit breaker is being used, the electrical connection should be carried out as described below.

#### 6.7.1 Checking the direction of rotation

**Caution** The pump must not be started until the suction interconnector has been completely submerged in the liquid.

When the pump has been connected to the power supply, check the direction of rotation:

1. Start the pump and measure quantity of water and head.
2. Stop the pump and interchange two phases.
3. Start the pump and measure quantity of water and head.
4. Stop the pump.
5. Compare the two results. The connection giving the larger quantity of water and the higher head is the correct one.

#### 6.7.2 Grundfos motors - direct-on-line starting

The connection of Grundfos motors wound for direct-on-line starting appears from the table below and fig. 15.

Mains	Cable/connection
	<b>Grundfos 4" and 6" motors</b>
PE	PE (yellow/green)
L1	U (brown)
L2	V (black)
L3	W (grey)

Check the direction of rotation as described in section 6.7.1 *Checking the direction of rotation*.

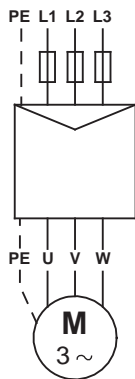


Fig. 15 Grundfos motors - direct-on-line starting

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#### 6.7.3 Grundfos motors - star-delta starting

The connection of Grundfos motors wound for star-delta starting appears from the table below and fig. 16.

Connection	Grundfos 6" motors
PE	Yellow/green
U1	Brown
V1	Black
W1	Grey
W2	Brown
U2	Black
V2	Grey

Check the direction of rotation as described in section 6.7.1 *Checking the direction of rotation*.

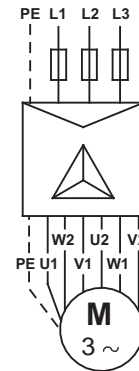


Fig. 16 Grundfos motors wound for star-delta starting

If direct-on-line starting is required, the motors should be connected as shown in fig. 17.

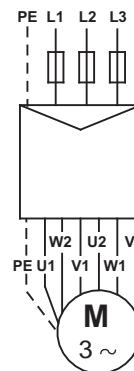


Fig. 17 Grundfos motors wound for star-delta starting - direct-on-line starting

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### 6.7.4 Connection in the case of unidentified cable marking/connection (Franklin motors)

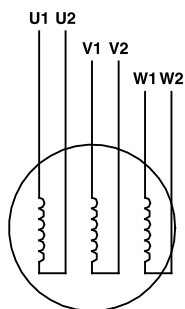
If you do not know where the individual leads are to be connected to the mains in order to ensure the correct direction of rotation, proceed as follows:

#### Motors wound for direct-on-line starting

Connect the pump to the mains as is expected to be right. Then check the direction of rotation as described in section 6.7.1 *Checking the direction of rotation*.

#### Motors wound for star-delta starting

Determine the windings of the motor by means of an ohmmeter and name the lead sets for the individual windings accordingly: U1-U2, V1-V2, W1-W2. See fig. 18.



**Fig. 18** Unidentified cable marking/connection - motors wound for star-delta starting

If star-delta starting is required, connect the leads as shown in fig. 16.

If direct-on-line starting is required, connect the leads as shown in fig. 17.

Then check the direction of rotation as described in section 6.7.1 *Checking the direction of rotation*.

### 6.7.5 Soft starter

We only recommend the use of soft starters which control the voltage on all three phases and which are provided with a bypass switch.

Ramp times: Maximum 3 seconds.

For further details, contact your soft starter supplier or Grundfos.

### 6.7.6 Frequency converter operation

Three-phase MS motors can be connected to a frequency converter.

**Note** To enable the monitoring of the motor temperature, we recommend that you install a Pt100/Pt1000 sensor together with a PR5714 or CU 220 (50 Hz).

Permissible frequency ranges: 30-50 Hz and 30-60 Hz.

Ramp times: Maximum 3 seconds for start and stop.

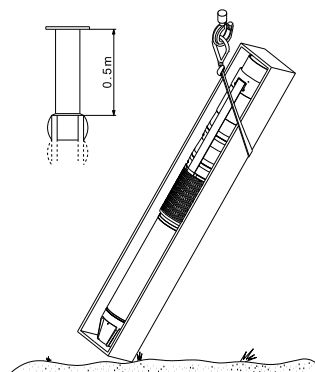
Depending on the type, the frequency converter may cause increased acoustic noise from the motor. Furthermore, it may expose the motor to detrimental voltage peaks. This can be abated by installing an LC filter between the frequency converter and the motor.

For further details, contact your frequency converter supplier or Grundfos.

## 7. Installation

We recommend that you first fit a 50 cm long pipe to the pump to facilitate handling of the pump during installation.

**Caution** Lift the pump to vertical position before removing it from the wooden box.

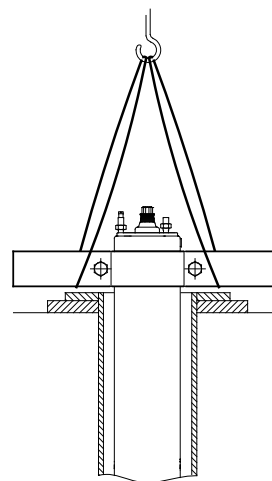


**Fig. 19** Lifting the pump into vertical position

### 7.1 Fitting the motor to the pump

When the pump part and the motor are supplied as separate units (long pumps), fit the motor to the pump as follows:

1. Use pipe clamps when handling the motor.
2. Place the motor in vertical position at the borehole seal. See fig. 20.



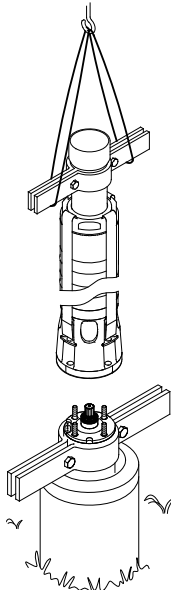
**Fig. 20** Motor in vertical position

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- Lift the pump part by means of pipe clamps fitted to the extension pipe. See fig. 21.



**Fig. 21** Lifting the pump into position

- Place the pump part on top of the motor.
- Fit and tighten the nuts. See table below.

**Caution** Make sure that the coupling between the pump and motor engages properly.

The bolts and nuts securing the straps to the pump must be cross-tightened to the following torques:

Bolt/nut	Torque [Nm]
M8	18
M10	35
M12	45
M16	120
SP 215, 50 Hz, with more than 8 stages	150
SP 215, 60 Hz, with more than 5 stages	150

When fitting the motor to the pump part, cross-tighten the nuts to the following torques:

Staybolt diameter	Torque [Nm]
5/16 UNF	18
1/2 UNF	50
M8	18
M12	70
M16	150
M20	280

**Caution** Make sure that the pump chambers are aligned when assembly has been completed.

### 7.2 Removing and fitting the cable guard

If the cable guard is screwed on to the pump, it should be removed and fitted by means of screws.

**Caution** Make sure that the pump chambers are aligned when the cable guard has been fitted.

## 7.3 Connecting the submersible drop cable

### 7.3.1 Grundfos motors

Before connecting the submersible drop cable to the motor, make sure that the cable socket is clean and dry.

To facilitate the connection of the cable, lubricate the rubber parts of the cable plug with non-conducting silicone paste.

Tighten the screws holding the cable to these torques [Nm]:

MS 402:	2.0
MS 4000:	3.0
MS 6000:	4.5
MMS 6:	20
MMS 8000:	18
MMS 10000:	18
MMS 12000:	15

### 7.4 Riser pipe

If a tool, e.g. a chain pipe wrench, is used when the riser pipe is fitted to the pump, the pump must only be gripped by the pump discharge chamber.

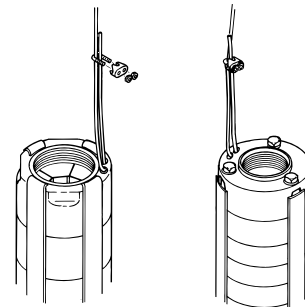
The threaded joints on the riser pipe must all be well cut and fit together to ensure that they do not work loose when subjected to torque reaction caused by the starting and stopping of the pump.

The thread on the first section of the riser pipe which is to be screwed into the pump should not be longer than the threads in the pump.

If noise may be transmitted to the building through the pipework, we recommend that you use plastic pipes.

**Note** We recommend plastic pipes for 4" pumps only.

When plastic pipes are used, secure the pump by an unloaded straining wire to be fastened to the discharge chamber of the pump. See fig. 22.



**Fig. 22** Fixing the straining wire

When connecting plastic pipes, use a compression coupling between the pump and the first pipe section.

Where flanged pipes are used, the flanges should be slotted to take the submersible drop cable and a water indicator hose, if fitted.

### 7.5 Maximum installation depth below water level [m]

Grundfos MS 402:	150
Grundfos MS 4000:	600
Grundfos MS 6000:	600
Grundfos MMS:	600
Franklin motors:	350

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## 7.6 Cable clips

Fit cable clips every 3 metres to fix the submersible drop cable and the straining wire, if fitted, to the riser pipe of the pump.

Grundfos supplies cable clip sets on request.

1. Cut off the rubber band so that the piece with no slit becomes as long as possible.
2. Insert a button in the first slit.
3. Position the wire alongside the submersible drop cable as shown in fig. 23.

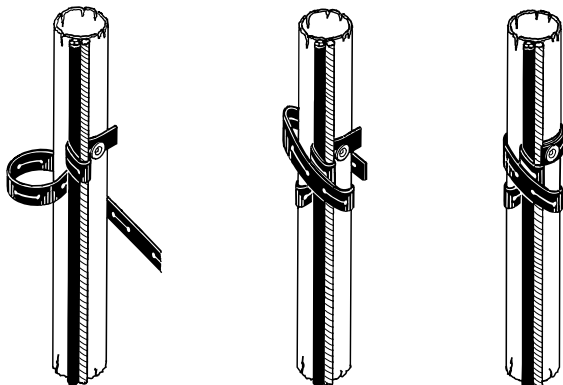


Fig. 23 Fitting the cable clips

4. Wind the band once around the wire and the cable. Then wind it tightly at least twice around the pipe, wire and the cable.
5. Push the slit over the button and cut off the band.

Where large cable cross-sections are used, it will be necessary to wind the band several times.

Where plastic pipes are used, some slackness must be left between each cable clip as plastic pipes expand when loaded.

When flanged pipes are used, the cable clips should be fitted above and below each joint.

## 7.7 Lowering the pump

We recommend that you check the borehole by means of an inside calliper before lowering the pump to ensure unobstructed passage.

Lower the pump carefully into the borehole, taking care not to damage the motor cable and the submersible drop cable.

**Caution** Do not lower or lift the pump by means of the motor cable.

## 7.8 Installation depth

The dynamic water level should always be above the suction interconnector of the pump. See section 5.2 *Positional requirements* and fig. 24.

Minimum inlet pressure is indicated in the NPSH curve for the pump. The minimum safety margin should be 1 metre head.

We recommend that you install the pump so that the motor part is above the well screen in order to ensure optimum cooling. See section 5.4 *Liquid temperatures/cooling*.

When the pump has been installed to the required depth, the installation should be finished by means of a borehole seal.

Slacken the straining wire so that it becomes unloaded and lock it to the borehole seal by means of wire locks.

**Note**

For pumps fitted with plastic pipes, the expansion of the pipes when loaded should be taken into consideration, when deciding on the installation depth of the pump.

## 8. Startup and operation

### 8.1 Startup

When the pump has been connected correctly and it is submerged in the liquid to be pumped, it should be started with the discharge valve closed off to approximately 1/3 of its maximum volume of water.

Check the direction of rotation as described in section 6.7.1 *Checking the direction of rotation*.

If there are impurities in the water, open the valve gradually as the water becomes clearer. Do not stop the pump until the water is completely clean, as otherwise the pump parts and the non-return valve may become blocked.

As the valve is being opened, check the drawdown of the water level to ensure that the pump always remains submerged.

The dynamic water level should always be above the suction interconnector of the pump. See section 5.2 *Positional requirements* and fig. 24.

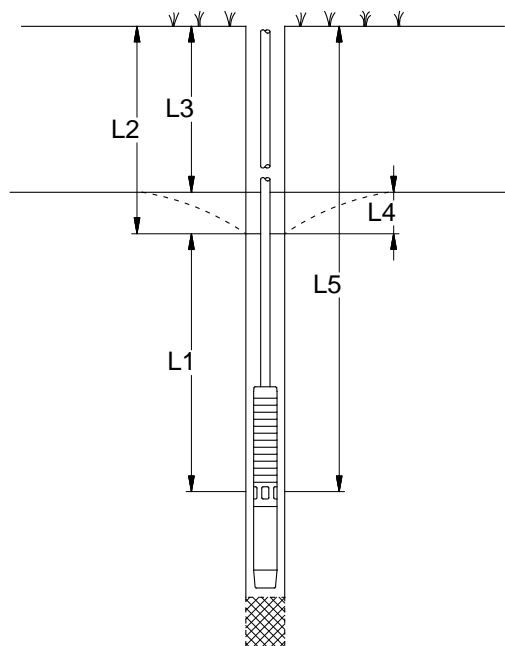


Fig. 24 Comparison of various water levels

- L1: Minimum installation depth below dynamic water level. We recommend minimum 1 metre.
- L2: Depth to dynamic water level.
- L3: Depth to static water level.
- L4: Drawdown. This is the difference between the dynamic and the static water levels.
- L5: Installation depth.

If the pump can pump more than yielded by the well, we recommend that you install the Grundfos MP 204 motor protector or some other type of dry-running protection.

If no water level electrodes or level switches are installed, the water level may be drawn down to the suction interconnector of the pump and the pump will then draw in air.

**Caution**

Long time of operation with water containing air may damage the pump and cause insufficient cooling of the motor.

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## 8.2 Operation

### 8.2.1 Minimum flow rate

To ensure the necessary cooling of the motor, the pump flow rate should never be set so low that the cooling requirements in section [5.4 Liquid temperatures/cooling](#) cannot be met.

### 8.2.2 Frequency of starts and stops

Motor type	Number of starts
MS 402	<ul style="list-style-type: none"> <li>• Minimum 1 per year is recommended.</li> <li>• Maximum 100 per hour.</li> <li>• Maximum 300 per day.</li> </ul>
MS 4000	<ul style="list-style-type: none"> <li>• Minimum 1 per year is recommended.</li> <li>• Maximum 100 per hour.</li> <li>• Maximum 300 per day.</li> </ul>
MS 6000	<ul style="list-style-type: none"> <li>• Minimum 1 per year is recommended.</li> <li>• Maximum 30 per hour.</li> <li>• Maximum 300 per day.</li> </ul>
MMS6	PVC windings <ul style="list-style-type: none"> <li>• Minimum 1 per year is recommended.</li> <li>• Maximum 3 per hour.</li> <li>• Maximum 40 per day.</li> </ul>
	PE/PA windings <ul style="list-style-type: none"> <li>• Minimum 1 per year is recommended.</li> <li>• Maximum 10 per hour.</li> <li>• Maximum 70 per day.</li> </ul>
MMS 8000	PVC windings <ul style="list-style-type: none"> <li>• Minimum 1 per year is recommended.</li> <li>• Maximum 3 per hour.</li> <li>• Maximum 30 per day.</li> </ul>
	PE/PA windings <ul style="list-style-type: none"> <li>• Minimum 1 per year is recommended.</li> <li>• Maximum 8 per hour.</li> <li>• Maximum 60 per day.</li> </ul>
MMS 10000	PVC windings <ul style="list-style-type: none"> <li>• Minimum 1 per year is recommended.</li> <li>• Maximum 2 per hour.</li> <li>• Maximum 20 per day.</li> </ul>
	PE/PA windings <ul style="list-style-type: none"> <li>• Minimum 1 per year is recommended.</li> <li>• Maximum 6 per hour.</li> <li>• Maximum 50 per day.</li> </ul>
MMS 12000	PVC windings <ul style="list-style-type: none"> <li>• Minimum 1 per year is recommended.</li> <li>• Maximum 2 per hour.</li> <li>• Maximum 15 per day.</li> </ul>
	PE/PA windings <ul style="list-style-type: none"> <li>• Minimum 1 per year is recommended.</li> <li>• Maximum 5 per hour.</li> <li>• Maximum 40 per day.</li> </ul>

## 9. Maintenance and service

All pumps are easy to service.

Service kits and service tools are available from Grundfos.

The pumps can be serviced at a Grundfos service centre.



#### Warning

If a pump has been used for a liquid which is injurious to health or toxic, the pump will be classified as contaminated.

If Grundfos is requested to service the pump, Grundfos must be contacted with details about the pumped liquid, etc. before the pump is returned for service. Otherwise Grundfos can refuse to accept the pump for service.

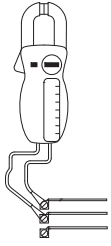
Possible costs of returning the pump are paid by the customer.

## 10. Fault finding

Fault	Cause	Remedy
1. The pump does not run.	a) The fuses are blown.	Replace the blown fuses. If the new ones blow too, check the electric installation and the submersible drop cable.
	b) The ELCB or the voltage-operated ELCB has tripped.	Cut in the circuit breaker.
	c) No power supply.	Contact the power supply company.
	d) The motor-protective circuit breaker has tripped.	Reset the motor-protective circuit breaker (automatically or possibly manually). Check the voltage if it trips again. If the voltage is okay, see items 1e to 1h.
	e) The motor-protective circuit breaker/contactors is defective.	Replace the motor-protective circuit breaker/contactors.
	f) Starter device is defective.	Repair or replace the starter device.
	g) The control circuit has been interrupted or is defective.	Check the electric installation.
	h) The dry-running protection has cut off the power supply to the pump due to low water level.	Check the water level. If it is okay, check the water level electrodes/level switch.
	i) The pump/submersible drop cable is defective.	Repair or replace the pump/cable.
2. The pump runs but gives no water.	a) The discharge valve is closed.	Open the valve.
	b) No water or too low water level in borehole.	See item 3a.
	c) The non-return valve is stuck in closed position.	Pull out the pump and clean or replace the valve.
	d) The suction strainer is blocked.	Pull out the pump and clean the strainer.
	e) The pump is defective.	Repair or replace the pump.
3. The pump runs at reduced performance.	a) The drawdown is larger than anticipated.	Increase the installation depth of the pump, throttle the pump or install a pump with a smaller performance.
	b) Wrong direction of rotation.	See section <a href="#">6.7.1 Checking the direction of rotation</a> .
	c) The valves in the discharge pipe are partly closed/blocked.	Clean or replace the valves.
	d) The discharge pipe is partly blocked by impurities (ochre).	Clean or replace the pipe.
	e) The non-return valve of the pump is partly blocked.	Pull out the pump and clean or replace the valve.
	f) The pump and the riser pipe are partly blocked by impurities (ochre).	Pull out the pump and clean or replace it. Clean the pipes.
	g) The pump is defective.	Repair or replace the pump.
	h) Leakage in the pipework.	Check and repair the pipework.
	i) The riser pipe is defective.	Replace the pipe.
4. Frequent starts and stops.	a) The differential of the pressure switch between the start and stop pressures is too small.	Increase the differential. The stop pressure must not exceed the operating pressure of the pressure tank, and the start pressure should be high enough to ensure sufficient water supply.
	b) The water level electrodes or level switches in the reservoir have not been installed correctly.	Adjust the intervals of the electrodes/level switches to ensure suitable time between the cutting-in and cutting-out of the pump. See installation and operating instructions for the electrodes/level switches. If the intervals between stop/start cannot be changed via the automatics, the pump performance may be reduced by throttling the discharge valve.
	c) The non-return valve is leaking or stuck half-open.	Pull out the pump and clean or replace the valve.
	d) The tank precharge pressure is too small.	Adjust the tank precharge pressure in accordance with its installation and operating instructions.
	e) The tank is too small.	Increase the capacity of the tank by replacing or supplementing with another tank.
	f) The diaphragm of the tank is defective.	Check the diaphragm tank.

## 11. Checking motor and cable

### 1. Supply voltage

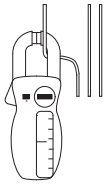


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Measure the voltage between the phases by means of a voltmeter. On single-phase motors, measure between phase and neutral or between two phases, depending on the type of supply. Connect the voltmeter to the terminals in the motor-protective circuit breaker.

The voltage should, when the motor is loaded, be within the range specified in section 6. *Electrical connection*. The motor may burn if there are larger variations in voltage. Large variations in voltage indicate poor power supply, and the pump should be stopped until the defect has been remedied.

### 2. Current consumption



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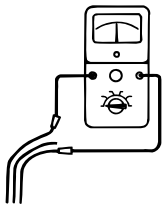
Measure the amps of each phase while the pump is operating at a constant discharge head (if possible, at the performance where the motor is most heavily loaded). For maximum operating current, see nameplate.

On three-phase motors, the difference between the current in the phase with the highest consumption and the current in the phase with the lowest consumption should not exceed 5 %. If so, or if the current exceeds the rated current, there are the following possible faults:

- The contacts of the motor-protective circuit breaker are burnt. Replace the contacts or the control box for single-phase operation.
- Poor connection in leads, possibly in the cable joint. See item 3.
- Too high or too low supply voltage. See item 1.
- The motor windings are short-circuited or partly disjointed. See item 3.
- Damaged pump is causing the motor to be overloaded. Pull out the pump for overhaul.
- The resistance value of the motor windings deviates too much (three-phase). Move the phases in phase order to a more uniform load. If this does not help, see item 3.

Items 3 and 4: Measurement is not necessary when the supply voltage and the current consumption are normal.

### 3. Winding resistance

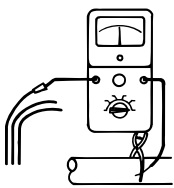


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Disconnect the submersible drop cable from the motor-protective circuit breaker. Measure the winding resistance between the leads of the drop cable.

For three-phase motors, the deviation between the highest and the lowest value should not exceed 10 %. If the deviation is higher, pull out the pump. Measure motor, motor cable and drop cable separately, and repair or replace defective parts. **Note:** The operating winding of single-phase 3-wire motors will assume the lowest resistance value.

### 4. Insulation resistance



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Disconnect the submersible drop cable from the motor-protective circuit breaker. Measure the insulation resistance from each phase to earth (frame). Make sure that the earth connection was made carefully.

If the insulation resistance is less than 0.5 MΩ, the pump should be pulled out for motor or cable repair. Local regulations may specify other values for the insulation resistance.

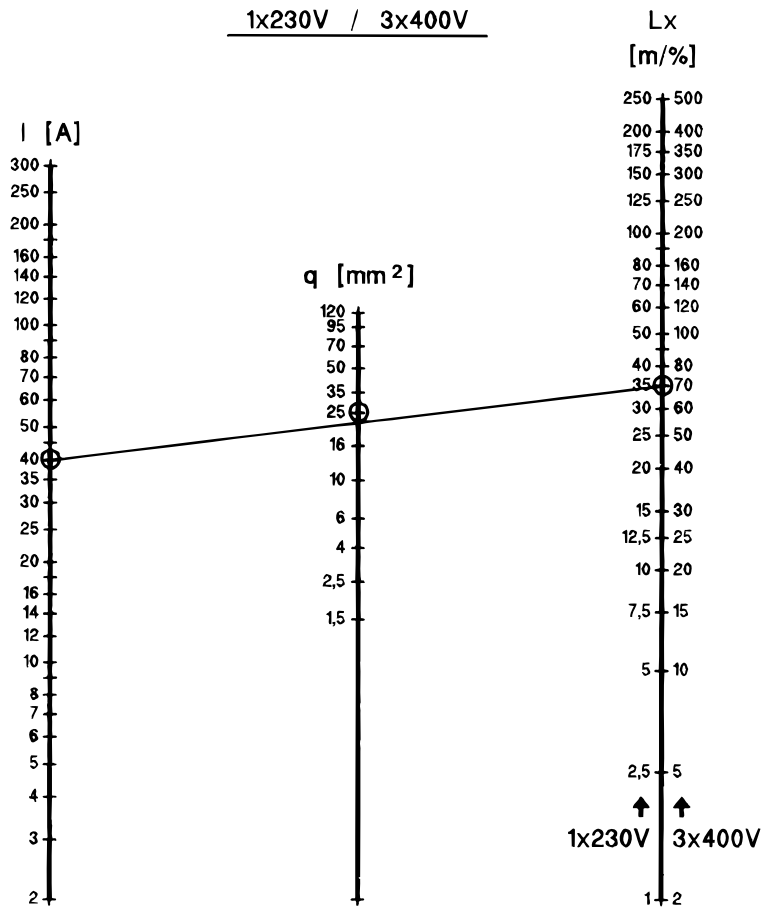
## 12. Disposal

This product or parts of it must be disposed of in an environmentally sound way:

1. Use the public or private waste collection service.
2. If this is not possible, contact the nearest Grundfos company or service workshop.

Subject to alterations.





**Example:**

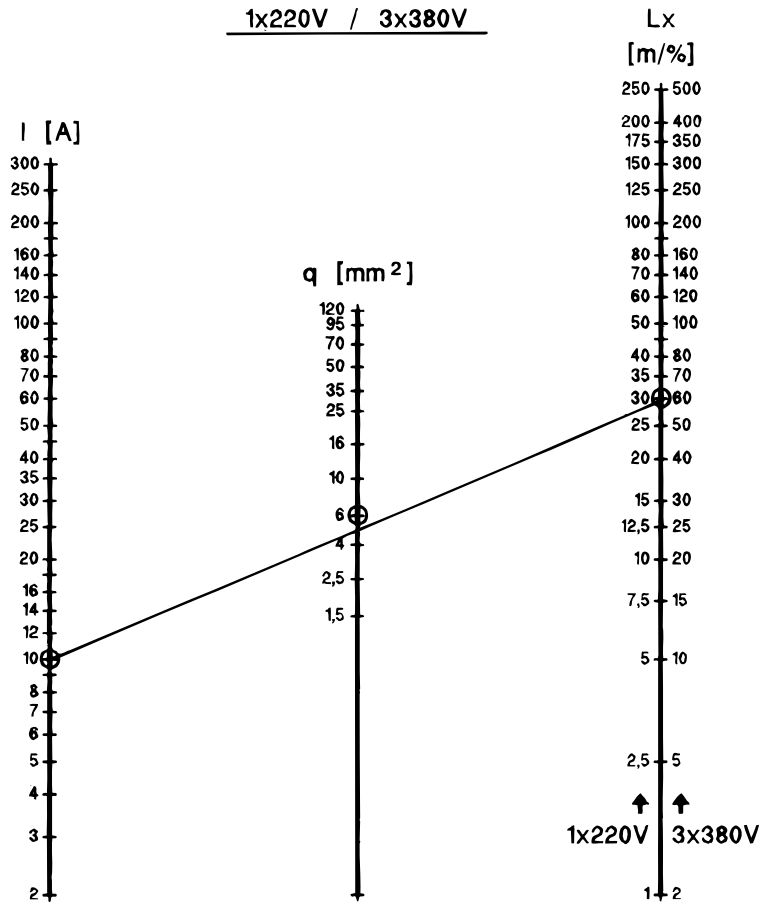
$U = 3 \times 400 \text{ V}$   
 $I = 40 \text{ A}$   
 $L = 140 \text{ m}$   
 $\Delta U = 2 \%$

$Lx = \frac{L}{\Delta U} = \frac{140}{2\%} = 70 \text{ m} = q \Rightarrow 25 \text{ mm}^2$

$U = 3 \times 400 \text{ V}$   
 $I = 40 \text{ A}$   
 $\Delta U = 2 \%$   
 $L = 140 \text{ m}$

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1x220V / 3x380V



**Example:**

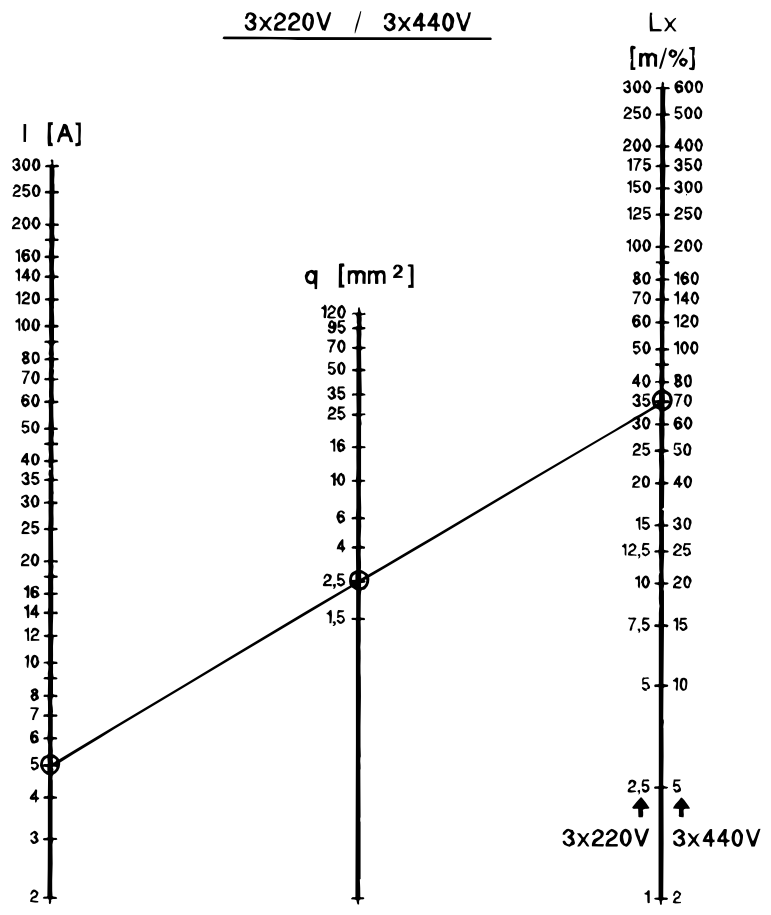
$U = 3 \times 380 \text{ V}$   
 $I = 10 \text{ A}$   
 $L = 120 \text{ m}$   
 $\Delta U = 2 \%$

$Lx = \frac{L}{\Delta U} = \frac{120}{2\%} = 60 \text{ m} = q \Rightarrow 6 \text{ mm}^2$

The diagram shows a vertical line representing a cable. At the top, it is labeled 'U = 3 x 380 V'. A circle with an 'A' inside is connected to the line, labeled 'I = 10 A'. A horizontal dimension line indicates a length 'L = 120 m'. A percentage symbol '%' is shown next to the length dimension, indicating a voltage drop. The bottom of the line is connected to a terminal block.

TIM00 1345 5092

3x220V / 3x440V



**Example:**

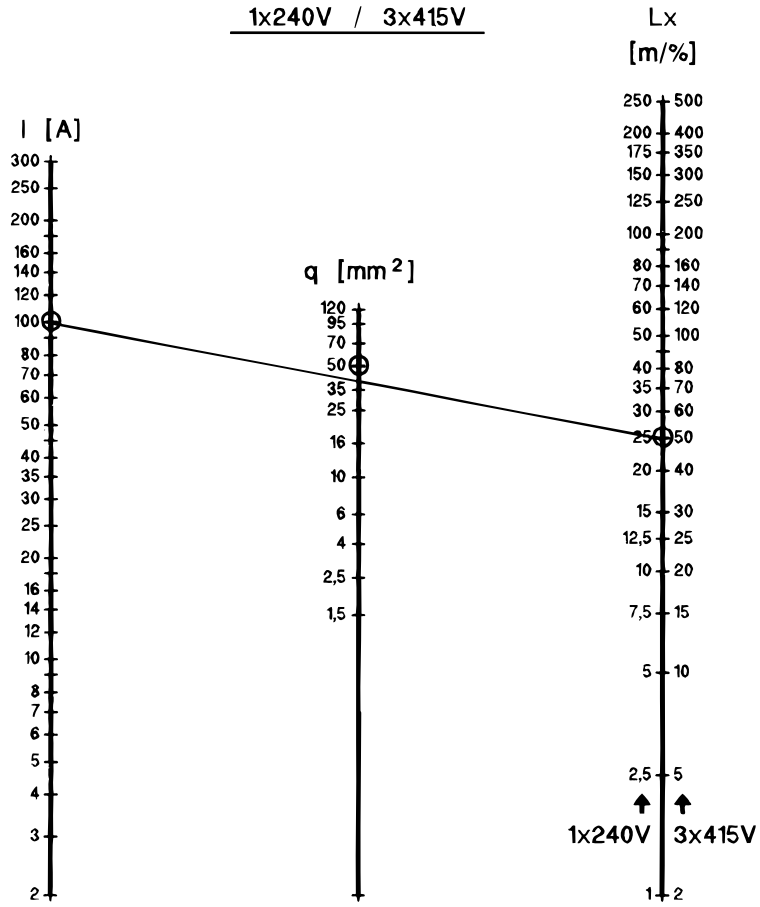
$U = 3 \times 220 \text{ V}$   
 $I = 5 \text{ A}$   
 $L = 105 \text{ m}$   
 $\Delta U = 3 \%$

$Lx = \frac{L}{\Delta U} = \frac{105}{3\%} = 35 \text{ m} = q \Rightarrow 2,5 \text{ mm}^2$

The diagram shows a three-phase supply system with a voltage  $U = 3 \times 220 \text{ V}$  and a current  $I = 5 \text{ A}$ . The length of the cable is  $L = 105 \text{ m}$ . A percentage symbol  $\%$  is shown next to the length, indicating the voltage drop. A small schematic of a cable cross-section is also shown.

TM00 1348 5092

1x240V / 3x415V



**Example:**

$U = 3 \times 415 \text{ V}$   
 $I = 100 \text{ A}$   
 $L = 150 \text{ m}$   
 $\Delta U = 3 \%$

$L_x = \frac{L}{\Delta U} = \frac{150}{3\%} = 50 \text{ m} = q \Rightarrow 50 \text{ mm}^2$

The diagram shows a three-phase supply system with a voltage  $U = 3 \times 415 \text{ V}$  and a current  $I = 100 \text{ A}$ . The length of the cable is  $L = 150 \text{ m}$ . The voltage drop is  $\Delta U = 3 \%$ . The diagram includes a circuit breaker and a cable connection to a terminal block.

TM00 1347 5092

SP1 - SP 2 - SP 3 - SP 5

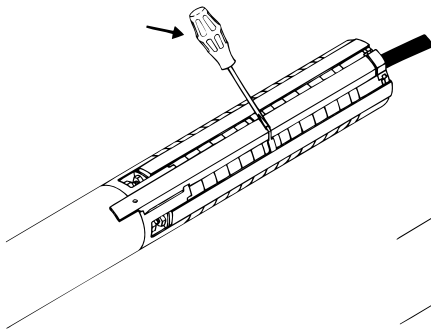


Fig. 1

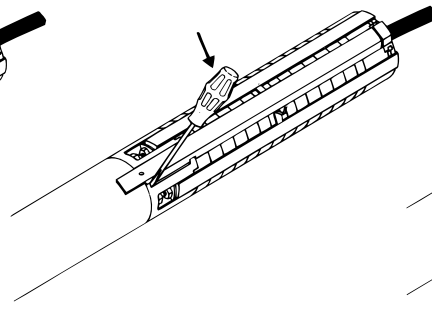


Fig. 2

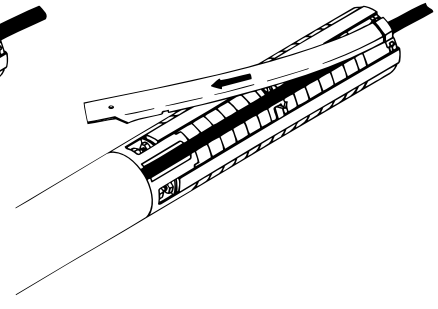


Fig. 3

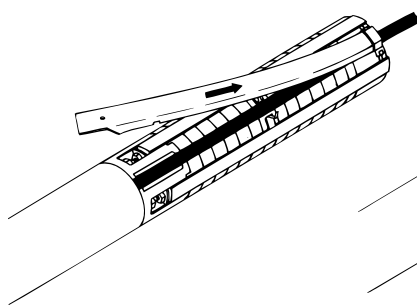


Fig. 1

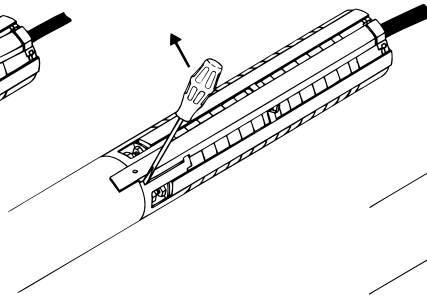


Fig. 2

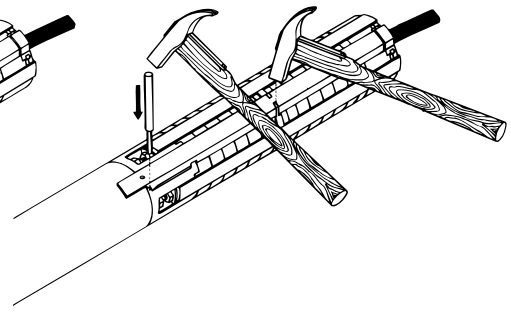


Fig. 3

TM00 1323 5092

SP 7 - SP 9 - SP 11 - SP 14 - SP 17 - SP 30 - SP 46 - SP 60

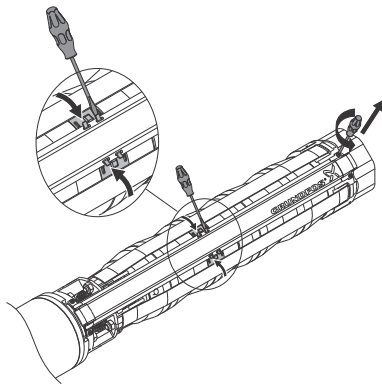


Fig. 1

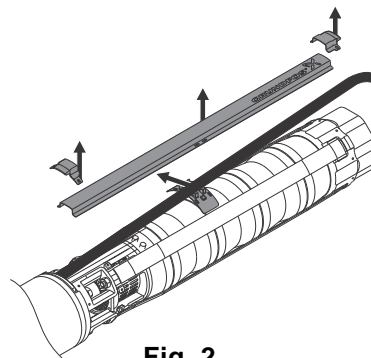


Fig. 2

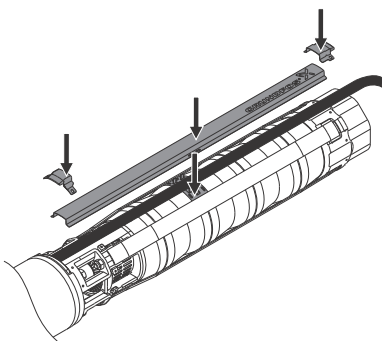


Fig. 1

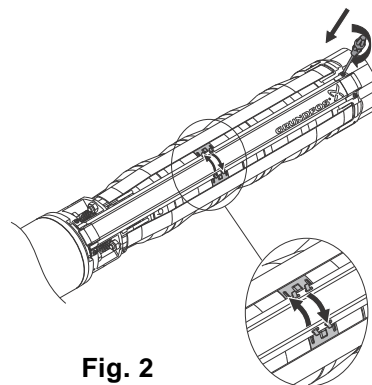


Fig. 2

TM06 0693 0614

SP 77 - SP 95 - SP 125 - SP 160 - SP 215

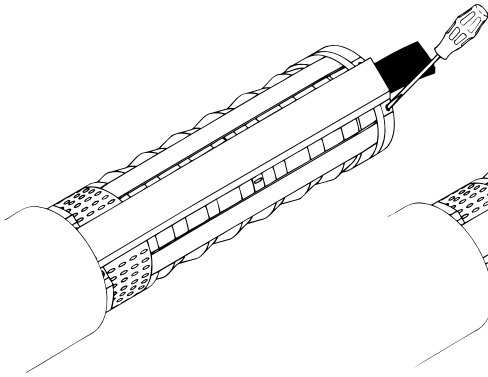


Fig. 1

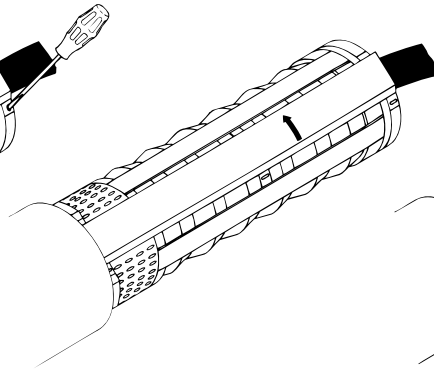


Fig. 2

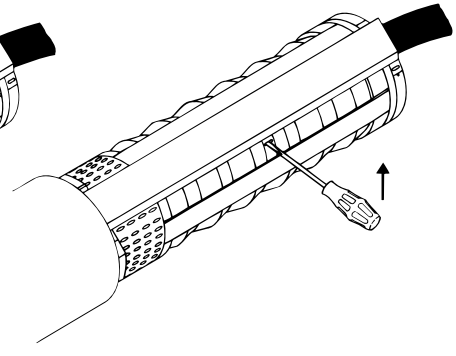


Fig. 3

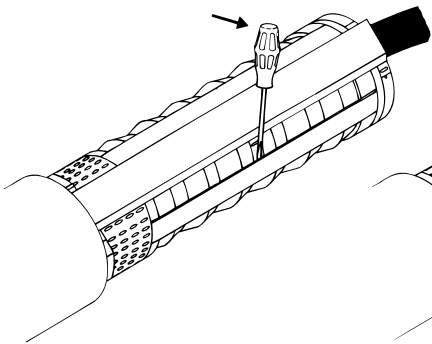


Fig. 1

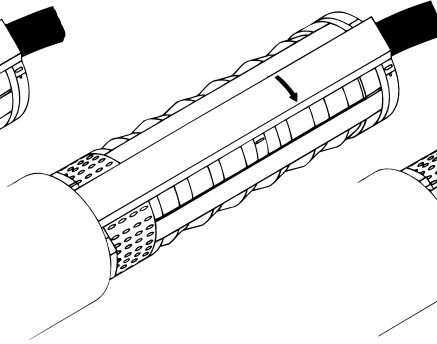


Fig. 2

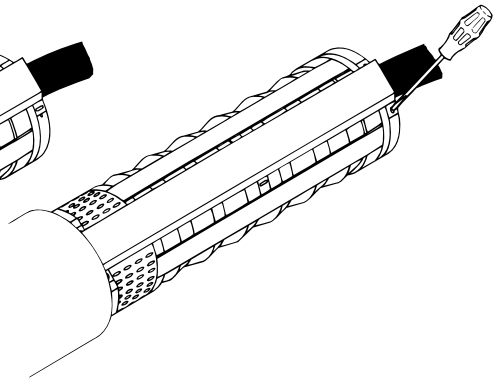


Fig. 3

TM00 1326 5092

**Argentina**

Bombas GRUNDFOS de Argentina S.A.  
Ruta Panamericana km. 37.500 Centro  
Industrial Garin  
1619 Garin Pcia. de B.A.  
Phone: +54-3327 414 444  
Telefax: +54-3327 45 3190

**Australia**

GRUNDFOS Pumps Pty. Ltd.  
P.O. Box 2040  
Regency Park  
South Australia 5942  
Phone: +61-8-8461-4611  
Telefax: +61-8-8340 0155

**Austria**

GRUNDFOS Pumpen Vertrieb Ges.m.b.H.  
Grundfosstraße 2  
A-5082 Grödig/Salzburg  
Tel.: +43-6246-883-0  
Telefax: +43-6246-883-30

**Belgium**

N.V. GRUNDFOS Bellux S.A.  
Boomssesteenweg 81-83  
B-2630 Aartselaar  
Tél.: +32-3-870 7300  
Télécopie: +32-3-870 7301

**Belarus**

Представительство ГРУНДФОС в  
Минске  
220125, Минск  
ул. Шафарьянская, 11, оф. 56, БЦ  
«Порт»  
Тел.: +7 (375 17) 286 39 72/73  
Факс: +7 (375 17) 286 39 71  
E-mail: minsk@grundfos.com

**Bosna and Herzegovina**

GRUNDFOS Sarajevo  
Zmaja od Bosne 7-7A,  
BH-71000 Sarajevo  
Phone: +387 33 592 480  
Telefax: +387 33 590 465  
www.ba.grundfos.com  
e-mail: grundfos@bih.net.ba

**Brazil**

BOMBAS GRUNDFOS DO BRASIL  
Av. Humberto de Alencar Castelo Branco,  
630  
CEP 09850 - 300  
São Bernardo do Campo - SP  
Phone: +55-11 4393 5533  
Telefax: +55-11 4343 5015

**Bulgaria**

Grundfos Bulgaria EOOD  
Slatina District  
Iztochna Tangenta street no. 100  
BG - 1592 Sofia  
Tel. +359 2 49 22 200  
Fax. +359 2 49 22 201  
email: bulgaria@grundfos.bg

**Canada**

GRUNDFOS Canada Inc.  
2941 Brighton Road  
Oakville, Ontario  
L6H 6C9  
Phone: +1-905 829 9533  
Telefax: +1-905 829 9512

**China**

GRUNDFOS Pumps (Shanghai) Co. Ltd.  
10F The Hub, No. 33 Suhong Road  
Minhang District  
Shanghai 201106  
PRC  
Phone: +86 21 612 252 22  
Telefax: +86 21 612 253 33

**Croatia**

GRUNDFOS CROATIA d.o.o.  
Buzinski prilaz 38, Buzin  
HR-10010 Zagreb  
Phone: +385 1 6595 400  
Telefax: +385 1 6595 499  
www.hr.grundfos.com

**Czech Republic**

GRUNDFOS s.r.o.  
Čajkovského 21  
779 00 Olomouc  
Phone: +420-585-716 111  
Telefax: +420-585-716 299

**Denmark**

GRUNDFOS DK A/S  
Martin Bachs Vej 3  
DK-8850 Bjerringbro  
Tlf.: +45-87 50 50 50  
Telefax: +45-87 50 51 51  
E-mail: info\_GDK@grundfos.com  
www.grundfos.com/DK

**Estonia**

GRUNDFOS Pumps Eesti OÜ  
Peterburi tee 92G  
11415 Tallinn  
Tel: + 372 606 1690  
Fax: + 372 606 1691

**Finland**

OY GRUNDFOS Pumput AB  
Trukkikuja 1  
FI-01360 Vantaa  
Phone: +358-(0) 207 889 500  
Telefax: +358-(0) 207 889 550

**France**

Pompes GRUNDFOS Distribution S.A.  
Parc d'Activités de Chesnes  
57, rue de Malacombe  
F-38290 St. Quentin Fallavier (Lyon)  
Tél.: +33-4 74 82 15 15  
Télécopie: +33-4 74 94 10 51

**Germany**

GRUNDFOS GMBH  
Schlüterstr. 33  
40699 Erkrath  
Tel.: +49-(0) 211 929 69-0  
Telefax: +49-(0) 211 929 69-3799  
e-mail: infoservice@grundfos.de  
Service in Deutschland:  
e-mail: kundendienst@grundfos.de

**Greece**

GRUNDFOS Hellas A.E.B.E.  
20th km. Athinon-Markopoulou Av.  
P.O. Box 71  
GR-19002 Peania  
Phone: +0030-210-66 83 400  
Telefax: +0030-210-66 46 273

**Hong Kong**

GRUNDFOS Pumps (Hong Kong) Ltd.  
Unit 1, Ground floor  
Siu Wai Industrial Centre  
29-33 Wing Hong Street &  
68 King Lam Street, Cheung Sha Wan  
Kowloon  
Phone: +852-27861706 / 27861741  
Telefax: +852-27858664

**Hungary**

GRUNDFOS Hungária Kft.  
Park u. 8  
H-2045 Törökbálint,  
Phone: +36-23 511 110  
Telefax: +36-23 511 111

**India**

GRUNDFOS Pumps India Private Limited  
118 Old Mahabalipuram Road  
Thoraiakkam  
Chennai 600 096  
Phone: +91-44 2496 6800

**Indonesia**

PT. GRUNDFOS POMPA  
Graha Intirub Lt. 2 & 3  
Jln. Cililitan Besar No.454. Makasar,  
Jakarta Timur  
ID-Jakarta 13650  
Phone: +62 21-469-51900  
Telefax: +62 21-460 6910 / 460 6901

**Ireland**

GRUNDFOS (Ireland) Ltd.  
Unit A, Merrywell Business Park  
Ballymount Road Lower  
Dublin 12  
Phone: +353-1-4089 800  
Telefax: +353-1-4089 830

**Italy**

GRUNDFOS Pompe Italia S.r.l.  
Via Gran Sasso 4  
I-20060 Truccazzano (Milano)  
Tel.: +39-02-95838112  
Telefax: +39-02-95309290 / 95838461

**Japan**

GRUNDFOS Pumps K.K.  
Gotanda Metalion Bldg., 5F,  
5-21-15, Higashi-gotanda  
Shiagawa-ku, Tokyo  
141-0022 Japan  
Phone: +81 35 448 1391  
Telefax: +81 35 448 9619

**Korea**

GRUNDFOS Pumps Korea Ltd.  
6th Floor, Aju Building 679-5  
Yeoksam-dong, Kangnam-ku, 135-916  
Seoul, Korea  
Phone: +82-2-5317 600  
Telefax: +82-2-5633 725

**Latvia**

SIA GRUNDFOS Pumps Latvia  
Deglava biznesa centrs  
Augusta Deglava ielā 60, LV-1035, Rīga,  
Tālr.: + 371 714 9640, 7 149 641  
Fakss: + 371 914 9646

**Lithuania**

GRUNDFOS Pumps UAB  
Smolensko g. 6  
LT-03201 Vilnius  
Tel: + 370 52 395 430  
Fax: + 370 52 395 431

**Malaysia**

GRUNDFOS Pumps Sdn. Bhd.  
7 Jalan Peguam U1/25  
Glenmarie Industrial Park  
40150 Shah Alam  
Selangor  
Phone: +60-3-5569 2922  
Telefax: +60-3-5569 2866

**Mexico**

Bombas GRUNDFOS de México S.A. de  
C.V.  
Boulevard TLC No. 15  
Parque Industrial Stiva Aeropuerto  
Apodaca, N.L. 66600  
Phone: +52-81-8144 4000  
Telefax: +52-81-8144 4010

**Netherlands**

GRUNDFOS Netherlands  
Veluwezoom 35  
1326 AE Almere  
Postbus 22015  
1302 CA ALMERE  
Tel.: +31-88-478 6336  
Telefax: +31-88-478 6332  
E-mail: info\_gnl@grundfos.com

**New Zealand**

GRUNDFOS Pumps NZ Ltd.  
17 Beatrice Tinsley Crescent  
North Harbour Industrial Estate  
Albany, Auckland  
Phone: +64-9-415 3240  
Telefax: +64-9-415 3250

**Norway**

GRUNDFOS Pumper A/S  
Strømsveien 344  
Postboks 235, Leirdal  
N-1011 Oslo  
Tlf.: +47-22 90 47 00  
Telefax: +47-22 32 21 50

**Poland**

GRUNDFOS Pompy Sp. z o.o.  
ul. Klonowa 23  
Baranowo k. Poznania  
PL-62-081 Przeźmierowo  
Tel: (+48-61) 650 13 00  
Fax: (+48-61) 650 13 50

**Portugal**

Bombas GRUNDFOS Portugal, S.A.  
Rua Calvet de Magalhães, 241  
Apartado 1079  
P-2770-153 Paço de Arcos  
Tel.: +351-21-440 76 00  
Telefax: +351-21-440 76 90

**Romania**

GRUNDFOS Pompe România SRL  
Bd. Biruintei, nr 103  
Pantelimon county Ilfov  
Phone: +40 21 200 4100  
Telefax: +40 21 200 4101  
E-mail: romania@grundfos.ro

**Russia**  
ООО Грундфос Россия  
109544, г. Москва, ул. Школьная, 39-41,  
стр. 1  
Тел. (+7) 495 564-88-00 (495) 737-30-00  
Факс (+7) 495 564 88 11  
E-mail grundfos.moscow@grundfos.com

**Serbia**

Grundfos Srbija d.o.o.  
Omladinskih brigada 90b  
11070 Novi Beograd  
Phone: +381 11 2258 740  
Telefax: +381 11 2281 769  
www.rs.grundfos.com

**Singapore**

GRUNDFOS (Singapore) Pte. Ltd.  
25 Jalan Tukang  
Singapore 619264  
Phone: +65-6681 9688  
Telefax: +65-6681 9689

**Slovakia**

GRUNDFOS s.r.o.  
Prievozská 4D  
821 09 BRATISLAVA  
Phona: +421 2 5020 1426  
sk.grundfos.com

**Slovenia**

GRUNDFOS LJUBLJANA, d.o.o.  
Leskoškova 9e, 1122 Ljubljana  
Phone: +386 (0) 1 568 06 10  
Telefax: +386 (0)1 568 06 19  
E-mail: tehnika-si@grundfos.com

**South Africa**

GRUNDFOS (PTY) LTD  
Corner Mountjoy and George Allen Roads  
Wilbart Ext. 2  
Bedfordview 2008  
Phone: (+27) 11 579 4800  
Fax: (+27) 11 455 6066  
E-mail: lsmart@grundfos.com

**Spain**

Bombas GRUNDFOS España S.A.  
Camino de la Fuentecilla, s/n  
E-28110 Algete (Madrid)  
Tel.: +34-91-848 8800  
Telefax: +34-91-628 0465

**Sweden**

GRUNDFOS AB  
Box 333 (Lunnagårdsgatan 6)  
431 24 Mölndal  
Tel.: +46 31 332 23 000  
Telefax: +46 31 331 94 60

**Switzerland**

GRUNDFOS Pumpen AG  
Bruggacherstrasse 10  
CH-8117 Fällanden/ZH  
Tel.: +41-44-806 8111  
Telefax: +41-44-806 8115

**Taiwan**

GRUNDFOS Pumps (Taiwan) Ltd.  
7 Floor, 219 Min-Chuan Road  
Taichung, Taiwan, R.O.C.  
Phone: +886-4-2305 0868  
Telefax: +886-4-2305 0878

**Thailand**

GRUNDFOS (Thailand) Ltd.  
92 Chaloom Phrakiat Rama 9 Road,  
Dokmai, Pravej, Bangkok 10250  
Phone: +66-2-725 8999  
Telefax: +66-2-725 8998

**Turkey**

GRUNDFOS POMPA San. ve Tic. Ltd. Sti.  
Gezbe Organize Sanayi Bölgesi  
Ihsan dede Caddesi,  
2. yol 200, Sokak No. 204  
41490 Gezbe/ Kocaeli  
Phone: +90 - 262-679 7979  
Telefax: +90 - 262-679 7905  
E-mail: satis@grundfos.com

**Ukraine**

Бізнес Центр Європа  
Столичне шосе, 103  
м. Київ, 03131, Україна  
Телефон: (+38 044) 237 04 00  
Факс: (+38 044) 237 04 01  
E-mail: ukraine@grundfos.com

**United Arab Emirates**

GRUNDFOS Gulf Distribution  
P.O. Box 16768  
Jebel Ali Free Zone  
Dubai  
Phone: +971 4 8815 166  
Telefax: +971 4 8815 136

**United Kingdom**

GRUNDFOS Pumps Ltd.  
Grovebury Road  
Leighton Buzzard/Beds. LU7 4TL  
Phone: +44-1525-850000  
Telefax: +44-1525-850011

**U.S.A.**

GRUNDFOS Pumps Corporation  
17100 West 118th Terrace  
Olathe, Kansas 66061  
Phone: +1-913-227-3400  
Telefax: +1-913-227-3500

**Uzbekistan**

Grundfos Tashkent, Uzbekistan The Repre-  
sentative Office of Grundfos Kazakhstan in  
Uzbekistan  
38a, Oybek street, Tashkent  
Телефон: (+998) 71 150 3290 / 71 150  
3291  
Факс: (+998) 71 150 3292

Addresses Revised 25.01.2016

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