

# MS, MMS

Installation and operating instructions



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**GRUNDFOS** 

# English (GB) Installation and operating instructions

## Original installation and operating instructions

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Read this document before installing the product. Installation and operation must comply with local regulations and accepted codes of good practice.

These instructions apply to Grundfos MS and MMS submersible motors for submersible pumps.

These motors must not be put into service until the machine into which they are to be incorporated has been declared in conformity with the relevant directives.

## 1. General information

### 1.1 Hazard statements

The symbols and hazard statements below may appear in Grundfos installation and operating instructions, safety instructions and service instructions.

#### DANGER



Indicates a hazardous situation which, if not avoided, will result in death or serious personal injury.

#### WARNING



Indicates a hazardous situation which, if not avoided, could result in death or serious personal injury.

#### CAUTION



Indicates a hazardous situation which, if not avoided, could result in minor or moderate personal injury.

The hazard statements are structured in the following way:

#### SIGNAL WORD



#### Description of hazard

Consequence of ignoring the warning.  
- Action to avoid the hazard.

## 1.2 Notes

The symbols and notes below may appear in Grundfos installation and operating instructions, safety instructions and service instructions.



Observe these instructions for explosion-proof products.



A blue or grey circle with a white graphical symbol indicates that an action must be taken.



A red or grey circle with a diagonal bar, possibly with a black graphical symbol, indicates that an action must not be taken or must be stopped.



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



Tips and advice that make the work easier.

## 2. Delivery and storage

### 2.1 Delivery

Grundfos submersible motors are supplied from the factory in proper packing in which they should remain until they are to be installed.

### 2.2 Unpacking



Be careful not to damage the motor cable with sharp tools when unpacking the motor.



The separate nameplate supplied with the motor is intended for being visible in electric panel during installation of the pump set.

Do not expose the motor to unnecessary impact and shocks.

## 2.3 Storage and handling

### Storage temperature

-20 to +70 °C.



If an MMS motor is stored, the shaft must be turned at least once a month. If a motor is stored for more than one year before installation, the rotating parts of the motor must be dismantled and checked before use.

Do not expose the motor to direct sunlight.

### Storage

#### WARNING

##### Crushing of feet

- Death or serious personal injury
- Stack the pumps with the biggest at the bottom, and do not stack above 1 m.
- Use lifting equipment approved for the weight of the product.
- Wear personal protective equipment.



#### WARNING

##### Crushing of hands

- Death or serious personal injury
- Stack the pumps with the biggest at the bottom, and do not stack above 1 m.
- Use lifting equipment approved for the weight of the product.
- Wear personal protective equipment.

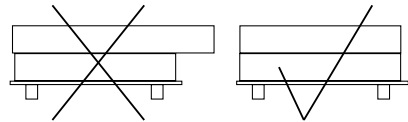


Fig. 1 Guideline for stacking of boxes

### 2.3.1 Frost protection

If the motor is to be stored after use, it must be stored at a temperature above the freezing point, or the motor liquid must be frost-proof.



Special motors factory-filled with demineralised water must be stored at a temperature above the freezing point or emptied before storage.

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### 3. General description

#### 3.1 Applications

Grundfos MS and MMS submersible motors are designed according to market standards.

All Grundfos 4", 6" and 8" MS and MMS motors are designed to fit pump ends manufactured according to NEMA standards. The motors are ideally suited for water supply pumps for irrigation, groundwater regulation, pressure boosting, industrial water transfer and similar applications.

#### 3.2 Pumped liquids

The motors are suited for use in clean, thin, non-flammable, non-combustible or non-explosive liquids not containing solid particles or fibres.

The maximum sand content of the pumped liquid must not exceed 50/100/150 g/m<sup>3</sup>.

The N, R and RE motor versions are designed for liquids with higher aggressiveness than that of drinking water.

Materials in contact with the liquid:

- MMS: cast iron DIN W.-Nr. 0.6025 and NBR rubber.
- MMS -N: stainless steel DIN W.-Nr. 1.4401 and NBR rubber.
- MS/MMS -R: stainless steel DIN W.-Nr. 1.4539 and NBR rubber.
- MS -RE: stainless steel DIN W.-Nr. 1.4539/1.4517 and FKM rubber.

The maximum liquid temperature is listed in section [4.3 Liquid temperatures/cooling](#).

#### 3.3 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.

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

### 4. Installation requirements

#### DANGER

##### Electric shock



- Death or serious personal injury
- Switch off the power supply before starting any work on the product.
- Make sure that the power supply cannot be accidentally switched on.

#### WARNING

##### Crushing of feet



- Death or serious personal injury
- During handling, use lifting equipment which is approved for the weight of the product.
- Wear personal protective equipment

#### WARNING

##### Crushing of hands



- Death or serious personal injury
- During handling, use lifting equipment which is approved for the weight of the product.
- Wear personal protective equipment

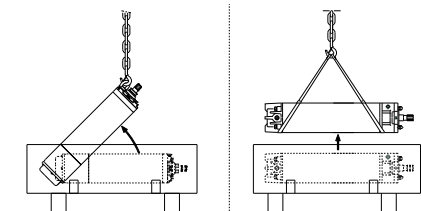


Fig. 2 Handling of the motor

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#### 4.1 Checking the motor liquid

The submersible motors are factory-filled with a special FDA-approved, non-toxic liquid which is frost-proof down to -20 °C.



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



- If frost protection is required, a special Grundfos liquid must be used to refill the motor.

Refilling of liquid is carried out as described below.

**4.1.1 Grundfos MS402 and MS4000 submersible motors**

The filling hole for motor liquid can be found in the following positions:

- MS 402: at the bottom of the motor.
- MS 4000: on the top of the motor.

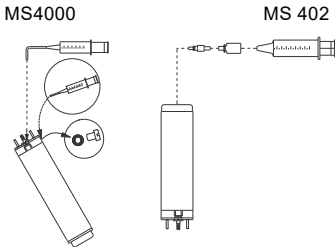
1. Position the submersible motor as shown in fig. 3. The filling screw must be at the highest point of the motor.
2. Remove the screw from the filling hole.
3. Inject liquid into the motor with the filling syringe (fig. 3) until the liquid overflows the filling hole.
4. Place the screw back in the filling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

Torques:

**MS402:** 2.0 Nm.

**MS4000:** 3.0 Nm.

The submersible motor is now ready for installation.



**Fig. 3** Motor position during filling - MS 4000 and MS 402

TM03 8128 2420

**4.1.2 Grundfos MS6000 and MS6000P submersible motors**

- If the motor is delivered from stock, the liquid level must be checked before the motor is installed. See fig. 4.
- In case of service, the liquid level must be checked. See fig. 4.

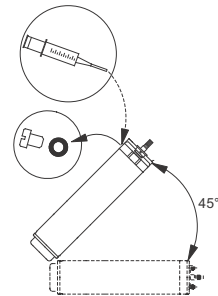
Filling procedure:

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

1. Position the submersible motor as shown in fig. 4. 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 (fig. 4) until the liquid overflows the filling hole.
4. Place the screw back in the filling hole and tighten securely before changing the position of the motor.

Torque: 3.0 Nm.

The submersible motor is now ready for installation.



**Fig. 4** Motor position during filling - MS 6000

TM03 8129 0507

#### 4.1.3 Grundfos MMS6, MMS8000, MMS10000 and MMS12000 submersible motors

Filling procedure:

Place the motor at a 45 ° angle with the top of the motor upwards. See fig. 5.

1. Unscrew the plug (A) and place a funnel in the hole.
2. Pour tap water into the motor until the motor liquid inside the motor starts overflowing the plug (A).



Do not use motor liquid that contains oil.

3. Remove the funnel and place back the plug (A).



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 motor is now ready for assembly with the pump and ready for installation.

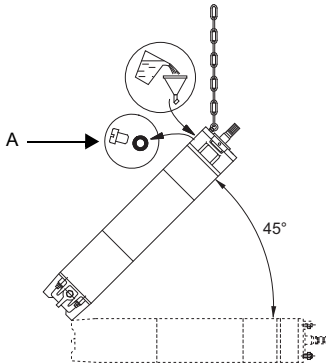


Fig. 5 Motor position during filling - MMS

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#### 4.2 Positional requirements

The motor can be installed either vertically or horizontally.

##### 4.2.1 Motors suitable for horizontal installation

Motor type	Output power 50 Hz	Output power 60 Hz
	[kW]	[kW]
<b>MS</b>	All sizes	All sizes
<b>MMS6</b>	5.5 - 37	5.5 - 37
<b>MMS8000</b>	22-92	22-92
<b>MMS10000</b>	75-170	75-170
<b>MMS12000</b>	147-190	-

#### CAUTION

##### Hot surface



Minor or moderate personal injury

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



During operation, the motor must always be completely submerged in the liquid. Make sure that the NPSH values of the mounted pump are fulfilled.

### 4.3 Liquid temperatures/cooling

The maximum liquid temperature and the minimum flow velocity past the motor are displayed in the following table.

Grundfos recommends that the motor be installed above the well screen in order to achieve proper motor cooling by liquid passing the motor.



In case the stated flow velocity cannot be achieved, a flow sleeve must be installed

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

Motor	Installation		
	Flow past the motor [m/s]	Vertical	Horizontal
<b>MS402</b> <b>MS4000 (T40)</b> <b>MS6000 (T40)</b>	0.15	40 °C (105 °F)	40 °C (105 °F)
<b>MS6000P T60</b>	0.15	60 °C (140 °F)	60 °C (140 °F)
<b>MS4000I (T60)*</b> <b>MS6000 (T60)*</b>	1.00	60 °C (140 °F) Flow sleeve recommended	60 °C (140 °F) Flow sleeve recommended
<b>MS6000 (T60)**</b>	0.15	60 °C (140 °F) Flow sleeve recommended	60 °C (140 °F) Flow sleeve recommended
<b>MMS6</b>	<b>PVC windings</b>	0.15	25 °C (86 °F)
		0.50	30 °C (95 °F)
	<b>PE/PA windings</b>	0.15	45 °C (113 °F)
		0.50	50 °C (122 °F)
<b>MMS8000 to 12000</b>	<b>PVC windings</b>	0.15	25 °C (77 °F)
		0.50	30 °C (86 °F)
	<b>PE/PA windings</b>	0.15	40 °C (104 °F)
		0.50	45 °C (113 °F)

\* At an ambient pressure of minimum 1 bar (0.1 MPa).

\*\* At an ambient pressure of minimum 2 bar (0.2 MPa).



For 37 kW MMS6 (only PVC windings), 110 kW MMS8000 and 170 kW MMS10000, the maximum liquid temperature is 5 °C lower than stated in the table above. For 190 kW MMS10000, 220-250 kW MMS12000/50 Hz and MMS12000/60 Hz, the temperature is 10 °C lower than stated.

## 5. Electrical connection

### DANGER

#### Electric shock

- Death or serious personal injury
- Switch off the power supply before starting any work on the product.
- Make sure that the power supply cannot be accidentally switched on.



### DANGER

#### Electric shock

- Death or serious personal injury
- The pump must be earthed.
- The pump must be connected to an external main switch and must be provided with means to locking it in the OFF (isolated) position. Type and requirements are specified in EN 60204-1, 5.3.2



The electrical connection must be carried out by an authorised person in accordance with local regulations.

### 5.1 General

The electrical connection must be carried out by an authorised electrician in accordance with local regulations.

The supply voltage, rated maximum current and  $\cos \varphi$  are displayed on the separate nameplate that must be fitted close to the installation site.

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

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

If MS motors with a built-in temperature transmitter (Tempcon) are not installed together with an MP 204 motor protection unit, they must be connected to a 0.47  $\mu\text{F}$  X2 capacitor (IEC 384-14) approved for the actual voltage. The capacitor must be connected to the two phases to which the temperature transmitter is connected. See fig. 6.

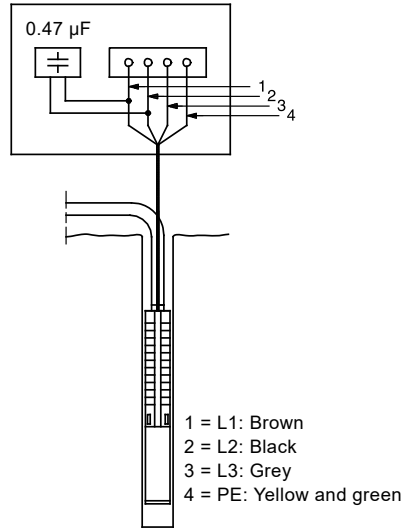


Fig. 6 Connection of capacitor

The motors are wound for direct-on-line (DOL) 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 motor is only about 0.1 second. Direct-on-line starting is therefore normally approved by the power supply company.



If an MS motor with temperature transmitter is connected to a frequency converter, the fuse melts and the transmitter becomes inactive. The transmitter can no longer be reactivated, consequently, the motor thereafter operates like one without a temperature transmitter.



To enable monitoring of the motor temperature when running at frequency converter operation, Grundfos recommends that a Pt100 or a Pt1000 sensor be installed.



During frequency converter operation, it is not advisable to run the motor at a frequency higher than the rated frequency (50 or 60 Hz). In connection with pump operation, it is important never to 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, make sure that the motor stops when the pump flow falls below 10 % of the rated flow.

Voltage peaks for Grundfos submersible motors should be limited according to the table below.

Motor type	Max. Upeak voltage	Max. dU/dt
MS402	650 V phase-phase	2000 V/ $\mu$ s
MS4000	850 V phase-phase	2000 V/ $\mu$ s
MS6000	850 V phase-phase	2000 V/ $\mu$ s
MS6000P	850 V phase-phase	2000 V/ $\mu$ s
MMS6	850 V phase-ground	500 V/ $\mu$ s
MMS8000	850 V phase-ground	500 V/ $\mu$ s
MMS10000	850 V phase-ground	500 V/ $\mu$ s
MMS12000	850 V phase-ground	500 V/ $\mu$ s

## 5.2 Motor protection

### 5.2.1 Single-phase motors

Single-phase MS402 submersible motors incorporate a thermal switch and require no additional motor protection. As an exception, the 1,1 kW (1,5 hp) MS402 requires external current protection.

#### DANGER

##### Electric shock



- Death or serious personal injury
- Switch off the power supply before starting any work on the product.
  - Make sure that the power supply cannot be accidentally switched on.

#### DANGER

##### Electric shock



- Death or serious personal injury
- The pump must be connected to protective earth.
  - Switch off the power supply before starting any work on the product.
  - Make sure that the power supply cannot be accidentally switched on.

#### DANGER

##### Electric shock



- Death or serious personal injury
- 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 MS4000 / MS6000 submersible motors are protected from overcurrent by a Grundfos starter box.

### 5.2.2 Three-phase asynchronous motors

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

Motors with a built-in and operational temperature transmitter must be protected by:

- a motor-protective circuit breaker with thermal relay or
- an MP 204 motor protection unit and contactor(s).

Motors with or without a non-operational temperature transmitter must be protected by:

- a motor-protective circuit breaker with thermal relay or
- an MP 204 motor protection unit and contactor(s).

MMS motors have no built-in temperature transmitter. A Pt100 sensor is available as an accessory.

Motors with a Pt100 sensor must be protected by the following:

- a motor-protective circuit breaker with thermal relay or
- an MP 204 motor protection unit and contactor(s).

Motors without a Pt100 sensor must be protected by the following:

- a motor-protective circuit breaker with thermal relay with max. trip class 10 according to IEC 60947-4-1 or
- an MP 204 motor protection unit and contactor(s).

### 5.2.3 Three-phase synchronous motors

Synchronous MS motors are a part of an SPE Pump system together with a suitable IPM-ready sine wave output filter and a suitable CUE frequency converter. The CUE has built-in motor protection.

### 5.2.4 Required settings of the motor-protective circuit breaker

For motors with an MP 204 motor protection unit, Grundfos recommends that a special trip curve with P-characteristics be used at a setting of  $U_n$  times 5 for 1 second.

For cold motors, the tripping time for the motor-protective circuit breaker must be less than 10 seconds at 5 times the rated maximum current of the motor.

For all Grundfos submersible MMS motors, the maximum start and stop ramp time is 3 seconds (minimum 30 Hz).



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

To ensure optimal protection of the submersible motor, set the motor-protective circuit breaker in accordance with the following guidelines:

1. Set the overload to the rated maximum current of the motor.
2. Start the motor 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 overload setting by 5 %.

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

For motors wound for star-delta starting, set the motor-protective circuit breaker as above, but the maximum setting must be 58 % of the rated maximum current.

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

## 5.3 Cable sizing



Submersible motor cables are dimensioned for submersion in the liquid, and will not necessarily have sufficient cross-section to be in 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 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. A cable sizing tool is available on Grundfos Insite at: <https://www.grundfos.com/sp-system/download-sp-app.html>.



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**Fig. 7** Cable sizing tool

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

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

The voltage drop can be calculated for both direct-on-line and star-delta starting.

To minimise operating losses, the cable cross-section may be increased. This is cost-efficient only 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 based on 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 5.1 General.

Determine the voltage drop for the cross-section of the submersible drop cable with the help of the diagrams on pages 26 and 27.

Use the following formula:

I: Rated maximum current of the motor.

For star-delta starting, I equals 58 % of the rated maximum current of the motor.

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 based on the following formulas:

**Single-phase submersible motor**

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

**Three-phase submersible motor**

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

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

XI Inductive resistance: 0.078 × 10<sup>-3</sup> [Ω/m].

**5.4 Control of single-phase MS402**

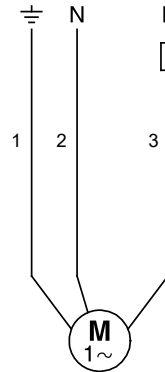


Single-phase MS402 submersible motors below 1.1 kW incorporate motor protection that cuts out the motor in case of excessive winding temperatures while the motor is still supplied with voltage. Allow for this when the motor forms part of a control system.

**5.5 Connection of single-phase motors**

**5.5.1 2-wire motors**

MS402 2-wire motors incorporate motor protection and a starter device, and can therefore be connected directly to the mains. See fig. 8.



**Fig. 8** 2-wire motors

1	Yellow and green
2	Blue
3	Brown

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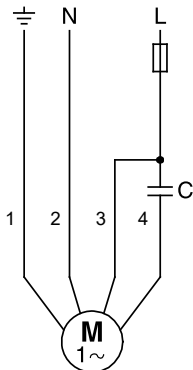
**5.5.2 PSC motors**

PSC motors are connected to the mains via a run capacitor that must be sized for continuous operation.

Select the correct capacitor size from the table below:

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

MS402 PSC motors with output power less than 1.1 kW incorporate motor protection and must be connected to the mains as shown in fig. 9.



**Fig. 9** PSC motors

1	Yellow and green
2	Grey
3	Brown
4	Black

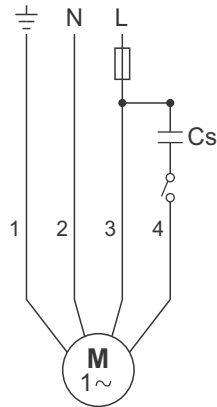
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**5.5.3 3-wire motors**

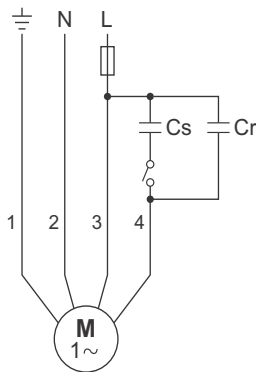
MS402 3-wire motors incorporate motor protection and must be connected to the mains via a Grundfos SA-SPM 5, 7 or 8 control box without motor protection.

MS4000, MS6000 3-wire motors must be connected to the mains via a Grundfos SA-SPM 5, 7 or 8 control box incorporating motor protection.

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



**Fig. 10** CSIR



**Fig. 11** CSCR

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TM07 4265 1219

### 5.5.4 Checking the direction of rotation of the motor

Once the motor is connected to the power supply, determine the correct direction of rotation as follows:

1. Add a few drops of water to the shaft seal before starting.
2. Start the motor and check the direction of rotation by watching the motor shaft. For Grundfos SP pumps, the direction of rotation must be counter-clockwise.
3. Interchange two of the phase connections if the direction of rotation is wrong. In case of motors wound for star-delta starting, exchange U1 by V1 and U2 by V2.

### 5.5.5 Checking the direction of rotation of the pump set



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

Once the pump is 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.

## 5.6 Connection of three-phase motors

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

The connection of Grundfos submersible motors wound for direct-on-line starting is displayed in the table below and fig. 12.

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

Check the direction of rotation as described in section 5.5.4 *Checking the direction of rotation of the motor*.

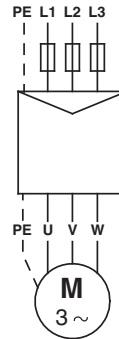


Fig. 12 Motors wound for direct-on-line starting

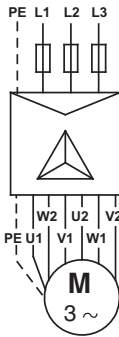
TMO3 2099 3705

**5.6.2 Motors wound for star-delta starting**

The connection of Grundfos submersible motors wound for star-delta starting is displayed in the table below and fig. 13.

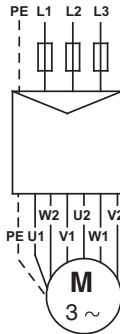
Connection	Grundfos 6" motors
PE	Yellow and green
U1	Brown
V1	Black
W1	Grey
W2	Brown
U2	Black
V2	Grey

Check the direction of rotation as described in section 5.5.4 *Checking the direction of rotation of the motor.*



**Fig. 13** Motors wound for star-delta starting

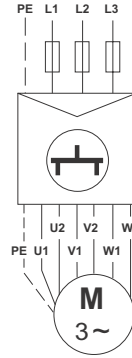
If star-delta starting is not required, but direct-on-line starting is, the submersible motors must be connected as shown in fig. 14.



**Fig. 14** Motors wound for direct-on-line starting

**5.6.3 MS6000P Synchronous motors requiring double cabling**

Connection	Grundfos MS6000P motors
PE	Yellow and green
L1	Brown
L2	Black
L3	Grey
PE	Yellow and green
L1	Brown
L2	Black
L3	Grey



**Fig. 15** Grundfos MS6000P 37 kW and 45 kW

TM03 2100 3705

TM03 2101 3705

TM07 6468 3520

### 5.6.4 Connection in the case of unidentified cable marking/connection

If it is unknown where the individual leads are to be connected to the mains in order to ensure the correct direction of rotation, proceed as follows:

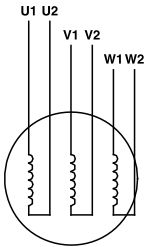
#### Motors wound for direct-on-line starting

Connect the motor to the mains as it is expected to be right.

Then check the direction of rotation as described in section [5.5.4 Checking the direction of rotation of the motor](#).

#### 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. 16.



**Fig. 16** Unidentified cable marking/connection - motors wound for star-delta starting

If star-delta starting is required, connect the leads as shown in fig. 13.

If direct-on-line starting is required, connect the leads as shown in fig. 14.

Then check the direction of rotation as described in section [5.5.4 Checking the direction of rotation of the motor](#).

#### 5.6.5 Soft starter

Grundfos only recommends the use of soft starters that control the voltage on all three phases and are provided with a bypass contact.

Ramp time: Maximum 3 seconds.

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

### 5.6.6 Frequency converter

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

Three-phase MS6000P synchronous submersible motors must be connected to a frequency converter of VSI type and an IPM-ready sine wave filter.

MMS motors with PE/PA can be connected to a frequency converter.

To avoid EMC problems, it is required to use shielded cables between the frequency converter and the sine wave filter, and in EMC sensitive installations from the sine wave filter to the entrance of the borehole.

The cable shield must be connected to the sine wave filter and the borehole lining, if the latter is conductive.

During frequency converter operation, it is not advisable to run the motor at a frequency higher than the rated frequency (50 or 60 Hz). In connection with pump operation, it is important never to 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 enable monitoring of the motor temperature, Grundfos recommends that a Pt100 or a Pt1000 be installed.

#### For asynchronous motors:

Permissible frequency ranges:

- 30-50 Hz
- 30-60 Hz.

Ramp time: Maximum 3 seconds from standstill to minimum frequency and vice versa.

#### For synchronous motors MS6000P:

Permissible frequency ranges:

- 55-100 Hz
- 55-120 Hz.

Ramp time: Maximum 3 seconds from standstill to minimum frequency and vice versa

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 prevented by installing an LC filter, or a sine wave filter between the frequency converter and the motor. Grundfos recommends that a sine wave filter be used in all SP installations with voltages above 380 V.

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

TM00 1367 509Z

## 6. Setting up the CUE frequency converter in an SPE system

The SPE system consists of the following:

- SPE pump set
- sine-wave filter
- CUE frequency converter.

The CUE has a start-up guide. Follow the instructions on the display.

Note that to compensate for the impact from long cable length, Automatic Motor Adaptation (AMA) is highly recommended to be set as described below: After completing the installation and settings, go to parameter 1-29 "Automatic Motor Adaptation (AMA)" and select [2] Enable Reduced AMA. Then press [Hand on] to start AMA.

For further information regarding safety and advanced settings see the CUE Installation and operating instruction.



**Installation and operating instructions**

<http://net.grundfos.com/qr/i/98870684>

## 7. Motor installation

Valid for all MS/MMS

### DANGER

#### Electric shock

- Death or serious personal injury
- Switch off the power supply before starting any work on the product.
  - Make sure that the power supply cannot be accidentally switched on.



Valid for MS6000P only.

### DANGER

#### Electric shock

- Death or serious personal injury
- Make sure that motor cable ends are not live before starting any work on the product.
  - Make sure that the power supply cannot be accidentally switched on.



In case of unintended flow of water through a non-energized pump, there is a risk that the moving parts of the pump and the motor will start rotating, thereby generating voltage over the terminals. The size of the voltage depends on the speed of rotation. Consequently, the motor terminals must be considered as live until proven otherwise.

## 8. Mechanical installation

### 8.1 Removing and fitting the cable guard

The cable guard is screwed onto the pump, it must be removed and fitted by means of screws. See pump installation and operating instructions.



Once the cable guard is fitted, make sure that the pump chambers are aligned.

### 8.2 Fitting of submersible drop cable and motor cable

Before fitting the motor cable to the motor, make sure that the cable socket is clean and dry.

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

Tighten the screws holding the cable to the torques stated below:

MS402:	3.1 Nm
MS4000:	3.0 Nm
MS6000:	4.5 Nm
MS6000P:	4.5 Nm
MMS6:	20 Nm
MMS8000:	18 Nm
MMS10000:	18 Nm
MMS12000:	15 Nm.

Connect the motor cable to the drop cable by original Grundfos cable termination kits, such as shrink tube type KM or cable termination kit type M0 to M4.

If necessary, shorten the motor cable to ensure that it is always covered with pump medium prior to making the cable termination as described above.

If the motor is delivered with the motor cable mounted, make sure that the screws are re-tightened to the torques specified in the table above.



### 8.3 Assembly of pump set on site

#### DANGER

##### Electric shock

- Death or serious personal injury
- Switch off the power supply before starting any work on the product.
- Make sure that the power supply cannot be accidentally switched on.
- Do not lower or lift the product by means of the motor cable.



#### WARNING

##### Crushing of hands

- Death or serious personal injury
- When the motor is to be assembled with the pump at the borehole, make sure to use suitable pipe clamps.
- Stay clear of the wire and cable while placing the motor in the borehole.



#### WARNING

##### Crushing of feet

- Death or serious personal injury
- When the motor is to be assembled with the pump at the borehole, make sure to use suitable pipe clamps.
- Stay clear of the wire and cable while placing the motor in the borehole.



1. Use pipe clamps when handling the motor.
2. Place the motor in vertical position at the borehole. See fig. 17.

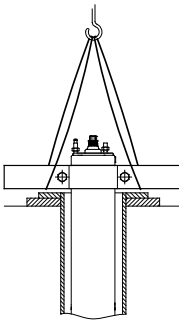


Fig. 17 Motor in vertical position

### 8.4 Fitting the pump to the motor

#### WARNING

##### Sharp element

- Death or serious personal injury
- When mounting the facilitating pipe, wear personal protective equipment to avoid cutting on sharp edges.



#### WARNING

##### Crushing of hands

- Death or serious personal injury
- Make sure to use suitable pipe clamps.
- Stay clear of the wire and cable while placing the motor in the borehole.



#### WARNING

##### Crushing of feet

- Death or serious personal injury
- Make sure to use suitable pipe clamps.
- Stay clear of the wire and cable while placing the motor in the borehole.



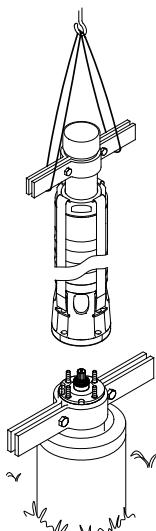
Be careful not to bend or damage long pump sets when moving them from horizontal to vertical positions.



Grundfos recommends that a maximum 30 cm long facilitating pipe be fitted to the pump to facilitate handling of the pump during installation.

TM02 5259 2402

- Lift the pump part by means of pipe clamps fitted to the facilitating pipe. See fig. 18.



**Fig. 18** Lifting the pump into position

- Place the pump part on top of the motor.
- Fit and cross-tighten the nuts to the torques stated below.



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

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

### 8.5 Maximum installation pressure [mWC]

Grundfos MS402:	150
Grundfos MS4000:	600
Grundfos MS6000:	600
Grundfos MS6000P:	600
Grundfos MMS:	600

### 8.6 Lowering the pump

#### DANGER

##### Electric shock

Death or serious personal injury



- Switch off the power supply before starting any work on the product.
- Make sure that the power supply cannot be accidentally switched on.
- Do not lower or lift the product by means of the motor cable.

#### WARNING

##### Crushing of hands

Death or serious personal injury



- When the motor is to be assembled with the pump at the borehole, make sure to use suitable pipe clamps.
- Stay clear of the wire and cable while placing the motor in the borehole.

#### WARNING

##### Crushing of feet

Death or serious personal injury



- When the motor is to be assembled with the pump at the borehole, make sure to use suitable pipe clamps.
- Stay clear of the wire and cable while placing the motor in the borehole.

Grundfos recommends that the borehole be checked by an inside calliper before lowering the pump so as to ensure unobstructed passage.

Carefully lower the pump assembly into the borehole, being cautious not to damage the motor cable and the submersible drop cable.

TM02 5263 2502

## 8.7 Frequency of starts and stops

Motor type	Number of starts
MS402	<ul style="list-style-type: none"> <li>We recommend minimum 1 per year.</li> <li>Maximum 100 per hour.</li> <li>Maximum 300 per day.</li> </ul>
	<ul style="list-style-type: none"> <li>We recommend minimum 1 per year.</li> <li>Maximum 100 per hour.</li> <li>Maximum 300 per day.</li> </ul>
MS4000	<ul style="list-style-type: none"> <li>We recommend minimum 1 per year.</li> <li>Maximum 30 per hour.</li> <li>Maximum 300 per day.</li> </ul>
	<ul style="list-style-type: none"> <li>We recommend minimum 1 per year.</li> <li>Maximum 30 per hour.</li> <li>Maximum 300 per day.</li> </ul>
MS6000	<ul style="list-style-type: none"> <li>We recommend minimum 1 per year.</li> <li>Maximum 120 per hour.</li> <li>Maximum 360 per day.</li> </ul>
	<ul style="list-style-type: none"> <li>We recommend minimum 1 per year.</li> <li>Maximum 120 per hour.</li> <li>Maximum 360 per day.</li> </ul>
MS6000P	<ul style="list-style-type: none"> <li>We recommend minimum 1 per year.</li> <li>Maximum 120 per hour.</li> <li>Maximum 360 per day.</li> </ul>
	<ul style="list-style-type: none"> <li>We recommend minimum 1 per year.</li> <li>Maximum 120 per hour.</li> <li>Maximum 360 per day.</li> </ul>
MMS6	PVC windings <ul style="list-style-type: none"> <li>We recommend minimum 1 per year.</li> <li>Maximum 3 per hour.</li> <li>Maximum 40 per day.</li> </ul>
	PE/PA windings <ul style="list-style-type: none"> <li>We recommend minimum 1 per year.</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>We recommend minimum 1 per year.</li> <li>Maximum 3 per hour.</li> <li>Maximum 30 per day.</li> </ul>
	PE/PA windings <ul style="list-style-type: none"> <li>We recommend minimum 1 per year.</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>We recommend minimum 1 per year.</li> <li>Maximum 2 per hour.</li> <li>Maximum 20 per day.</li> </ul>
	PE/PA windings <ul style="list-style-type: none"> <li>We recommend minimum 1 per year.</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>We recommend minimum 1 per year.</li> <li>Maximum 2 per hour.</li> <li>Maximum 15 per day.</li> </ul>
	PE/PA windings <ul style="list-style-type: none"> <li>We recommend minimum 1 per year.</li> <li>Maximum 5 per hour.</li> <li>Maximum 40 per day.</li> </ul>

## 9. Maintenance and service

The motors are maintenance-free.

All motors are easy to service.

Service kits and service tools are available from Grundfos.

The motors can also be serviced at a Grundfos service centre.

### DANGER



#### Electric shock

Death or serious personal injury

- Switch off the power supply before starting any work on the product.
- Make sure that the power supply cannot be accidentally switched on.

### DANGER



#### Toxic material

Death or serious personal injury

- If a pump is used for a liquid injurious to health, the pump will be classified as contaminated.

### WARNING



#### Sharp element

Death or serious personal injury

- For service, see the service instructions. Service must be performed by qualified personnel.

## 9.1 MS6000P

The following three warnings are only valid for MS6000P/SPE pump sets.

### DANGER

#### Magnetic field

Death or serious personal injury

- The rotor dismantled from the motor must never be handled by anyone with a pacemaker.



### WARNING

#### Crushing of fingers

Death or serious personal injury

- Keep the surroundings of the dismantled rotor free of magnetic objects, and be careful when placing the rotor on a magnetic surface.



### DANGER

#### Electric shock

Death or serious personal injury

- Before starting any work on the product, make sure that motor cable ends are not live.
- Make sure that the power supply cannot be accidentally switched on.



If a flow of water unintendedly goes through a non-energized pump, there is a risk that the moving parts of the pump and the motor will start rotating, thereby generating voltage over the terminals. The size of the voltage depends on the speed of rotation. Consequently, the motor terminals must be considered as live until proven otherwise.

If Grundfos is requested to service a 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

### DANGER

#### Electric shock

Death or serious personal injury

- Before starting any work on the product, make sure that motor cable ends are not live.
- Make sure that the power supply cannot be accidentally switched on.



### DANGER

#### Toxic material

Death or serious personal injury

- If a product is used for a liquid injurious to health, the pump will be classified as contaminated.



## 10.1 MS6000P

The following three warnings are only valid for MS6000P/SPE pump sets.

### DANGER

#### Magnetic field

Death or serious personal injury

- The rotor dismantled from the motor must never be handled by anyone with a pacemaker.



### WARNING

#### Crushing of hands

Death or serious personal injury

- Keep the surroundings of the dismantled rotor free of magnetic objects and be careful when placing the rotor on a magnetic surface.



### DANGER

#### Electric shock

Death or serious personal injury

- Before starting any work on the product, make sure that motor cable ends are not live.
- Make sure that the power supply cannot be accidentally switched on.



If a flow of water unintendedly goes through a non-energized pump there is a risk that the moving parts of the pump and the motor will start rotating, thereby generating voltage over the terminals. The size of the voltage depends on the speed of rotation. Consequently, the motor terminals must be considered as live until proven otherwise.

<b>Fault</b>	<b>Cause</b>	<b>Remedy</b>
1. The motor does not run.	a) The fuses are blown.	Replace the blown fuses. If the new ones blow too, check the electrical 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). If it trips again, check the voltage. If the voltage is OK, see items e) - h).
	e) Motor-protective circuit breaker/contactator is defective.	Replace the motor-protective circuit breaker/contactator.
	f) Starter device is defective.	Repair or replace the starter device.
	g) The control circuit has been interrupted or is defective.	Check the electrical installation.
	h) The pump/submersible drop cable is defective.	Repair or replace the pump/cable.

## 11. Checking the motor and cable

### DANGER

#### Electric shock



- Death or serious personal injury
- Switch off the power supply before starting any work on the product.
  - Make sure that the power supply cannot be accidentally switched on.

### 11.1 MS6000P

The following warning is only valid for MS6000P/SPE pump sets.

### DANGER

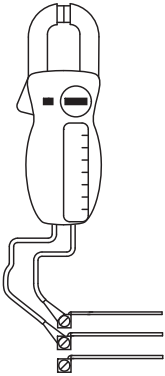
#### Electric shock



- Death or serious personal injury
- Before starting any work on the product, make sure that motor cable ends are not live.
  - Make sure that the power supply cannot be accidentally switched on.

If a flow of water unintentionally goes through a non-energized pump there is a risk that the moving parts of the pump and the motor will start rotating, thereby generating voltage over the terminals. The size of the voltage depends on the speed of rotation. Consequently, the motor terminals must be considered as live until proven otherwise.

#### 1. Supply voltage



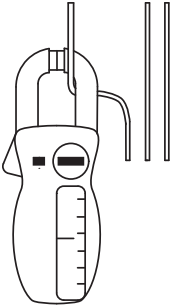
TM00 1371 5092

Measure the voltage between the phases by a voltmeter. On single-phase motors, complete measurement 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.

For the MS6000P, the supply voltage must be measured between the sine wave filter and the motor.

When the motor is loaded, the voltage should be within the range specified in section [5.1 General](#). The motor may burn if there are larger variations in voltage. Large variations in voltage indicate poor power supply, and the motor must be stopped until the defect has been corrected.

## 2. Current consumption



TM00 1372 5092

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

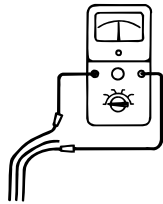
For the MS6000P, the current consumption must be measured between the sine wave filter and the motor.

On three-phase motors, the difference between the current in the phase with the highest consumption and that with the lowest consumption must not exceed 5 %. Otherwise, or if the current exceeds the rated current, the following faults may occur:

- The contacts of the motor-protective circuit breaker burn.
  - Replace the contacts or the control box for single-phase operation.
- There is poor connection in leads, possibly in the cable joint.
  - See item 3.
- The mains voltage is too low or too high.
  - 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 assembly for overhaul.
- The resistance value of the motor windings deviates too much (three-phase operation).
  - 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



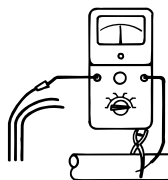
TM00 1373 5092

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

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

#### 4. Insulation resistance

##### a) Insulation resistance, MS

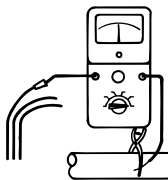


TM00 1374 5092

Disconnect the submersible drop cable from the motor-protective circuit breaker or the sine wave filter. Measure the insulation resistance from each phase to earth (frame). Earth connection has to be established carefully.

If the insulation resistance is below 0.5 MΩ, pull out the pump assembly for motor, cable or cable termination repair. Local regulations may specify other values for the insulation resistance.

##### b) Insulation resistance, MMS



TM00 1374 5092

Motors outside a well:  
Clean the motor cable end.  
Installed motors:  
Disconnect the submersible drop cable from the motor-protective circuit breaker and clean the cable end (contact points).  
Measure the insulation resistance from each phase to earth (frame) using an insulation tester (500 VDC, 2 min.).  
Earth connection has to be established carefully.

Check the value on the instrument. If the insulation resistance is lower than the values below, pull out the pump assembly for checking and repair.

The values apply to an ambient temperature of 20 °C (68 °F).

With drop cable:

- new motor: 4 MΩ.
- used motor: 2 MΩ.

Without drop cable:

- new motor: 200 MΩ.
- used motor: 20 MΩ.

## 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.

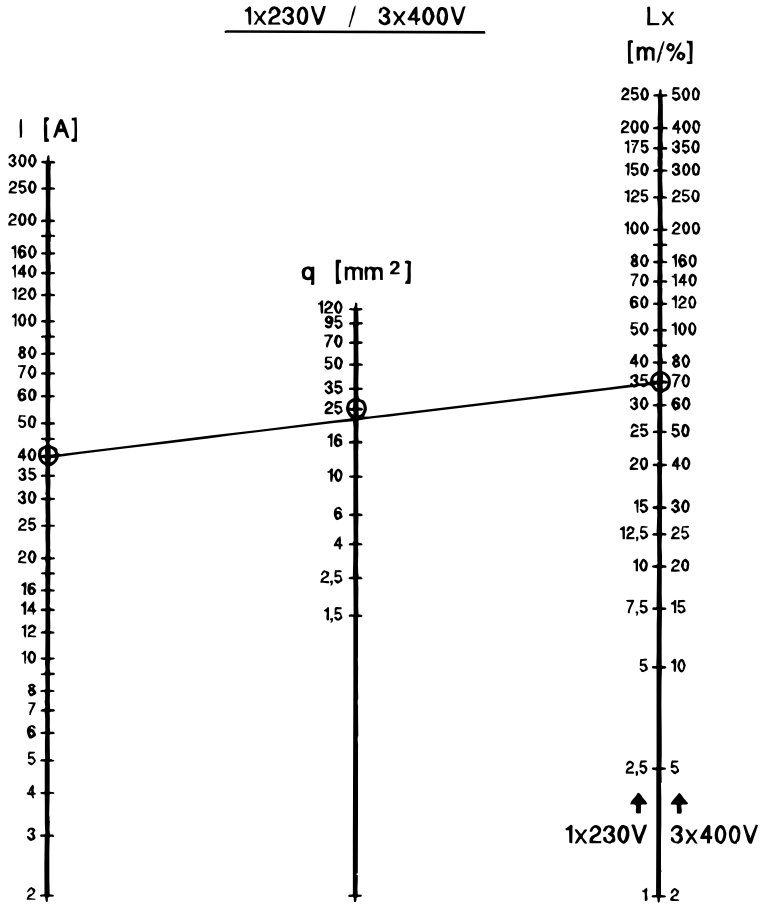


The crossed-out wheeled bin symbol on a product means that it must be disposed of separately from household waste. When a product marked with this symbol reaches its end of life, take it to a collection point designated by the local

waste disposal authorities. The separate collection and recycling of such products will help protect the environment and human health.

See also end-of-life information at [www.grundfos.com/product-recycling](http://www.grundfos.com/product-recycling).





**Example:**

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

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

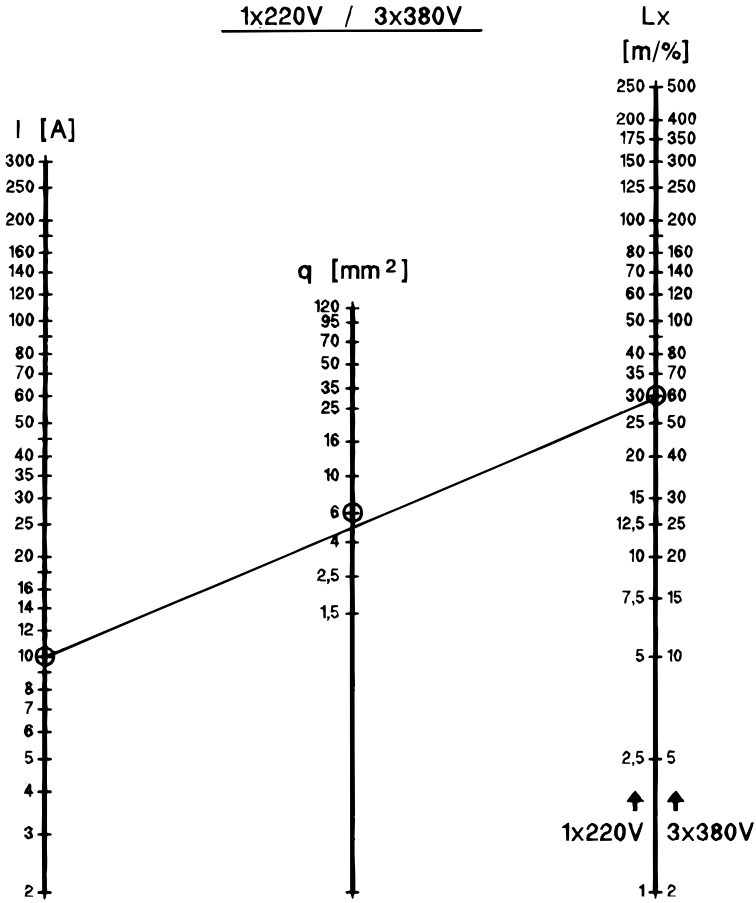
$U = 3 \times 400 \text{ V}$

$I = 40 \text{ A}$   
 $\Delta U = 2 \%$

$L = 140 \text{ m}$

TM00 1346 5092

1x220V / 3x380V



TM00 1345 5092

**Example:**

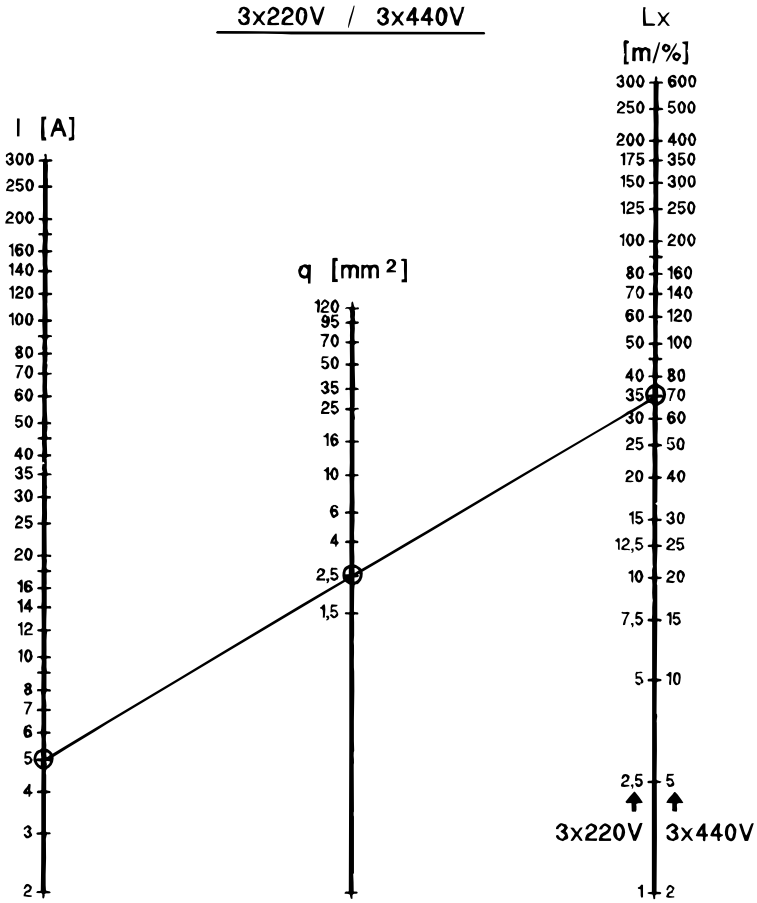
$U = 3 \times 380 \text{ V}$   
 $I = 10 \text{ A}$   
 $L = 120 \text{ m}$   
 $\Delta U = 2 \%$

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

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

$L = 120 \text{ m}$

3x220V / 3x440V



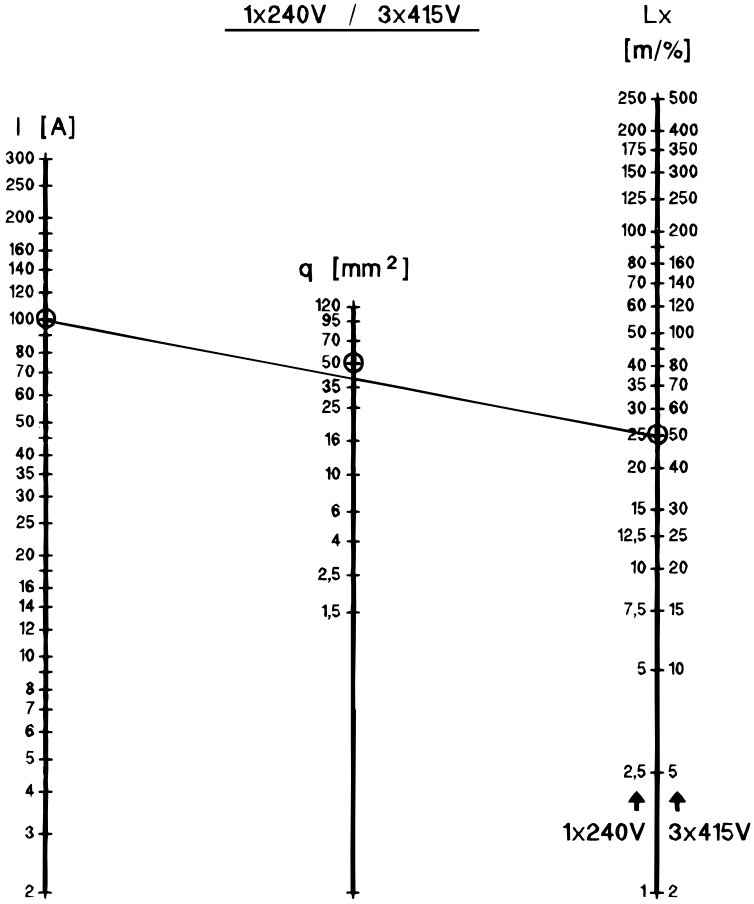
**Example:**

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

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

TM00 1348 5092

1x240V / 3x415V



TM00 1347 5092

**Example:**

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

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



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