SP

Stainless steel submersible pumps 4", 6", 8", and 10"

Installation and operating instructions

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Original installation and operating instructions

CONTENTS

WARNING

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

Keep this booklet with the pump for future reference and information regarding its operation.

WARNING

The installation of this product requires experience with and knowledge of the product.

Persons with reduced physical, sensory or mental capabilities must not use this product, unless they are under supervision or have been instructed in the use of the product by a person responsible for their safety. Children must not use or play with this product.

1. Limited warranty

Products manufactured by GRUNDFOS PUMPS CORPORATION (Grundfos) are warranted to the original user only to be free of defects in material and workmanship for a period of 24 months from date of installation, but not more than 30 months from date of manufacture. Grundfos' liability under this warranty shall be limited to repairing or replacing at Grundfos' option, without charge, FOB Grundfos' factory or authorized service station, any product of Grundfos' manufacture. Grundfos will not be liable for any costs of removal, installation, transportation, or any other charges which may arise in connection with a warranty claim. Products which are sold but not manufactured by Grundfos are subject to the warranty provided by the manufacturer of said products and not by Grundfos' warranty. Grundfos will not be liable for damage or wear to products caused by abnormal operating conditions, accident, abuse, misuse, unauthorized alteration or repair, or if the product was not installed in accordance with Grundfos' printed installation and operating instructions.

To obtain service under this warranty, the defective product must be returned to the distributor or dealer of Grundfos' products from which it was purchased together with proof of purchase and installation date, failure date, and supporting installation data. Unless otherwise provided, the distributor or dealer will contact Grundfos or an authorized service station for instructions. Any defective product to be returned to Grundfos or a service station must be sent freight prepaid; documentation supporting the warranty claim and/or a Return Material Authorization must be included if so instructed.

GRUNDFOS WILL NOT BE LIABLE FOR ANY INCIDENTAL OR CONSEQUENTIAL DAMAGES, LOSSES, OR EXPENSES ARISING FROM INSTALLATION, USE, OR ANY OTHER CAUSES. THERE ARE NO EXPRESS OR IMPLIED WARRANTIES, INCLUDING MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE, WHICH EXTEND BEYOND THOSE WARRANTIES DESCRIBED OR REFERRED TO ABOVE.

Some jurisdictions do not allow the exclusion or limitation of incidental or consequential damages and some jurisdictions do not allow limit actions on how long implied warranties may last. Therefore, the above limitations or exclusions may not apply to you. This warranty gives you specific legal rights and you may also have other rights which vary from jurisdiction to jurisdiction.

2. 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

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.

3. Product description

3.1 Introduction

Your Grundfos SP submersible pump is of the highest quality. Combined with proper installation, your Grundfos pump will give you many years of reliable service.

To ensure the proper installation of the pump, carefully read the complete manual before attempting to install the pump.

3.2 Applications

Grundfos SP submersible pumps are suitable for the following applications:

- groundwater supply to waterworks
- irrigation in horticulture and agriculture
- groundwater lowering (dewatering)
- pressure boosting
- industrial applications
- domestic water supply.

3.3 Features and benefits

- State-of-the-art hydraulics provide high efficiency and low operating costs
- 100 % stainless steel components inside and outside for long service life
- sand resistant
- resistant to aggressive water
- monitoring, protection, and communication via protection unit MP 204, and GO remote control.

3.4 Type key

Example **475 S 500 - 5 - A B**

- 475: Rated flow rate in gpm
- S: Type range
  Stainless steel parts of material
  S = AISI 304
  N = AISI 316
  R = AISI 904L
- 500: Hp of motor
- 5: Number of impellers
- A: First reduced-diameter impeller (A, B or C)
- B: Second reduced-diameter impeller (A, B or C)

4. Delivery, handling and storage

4.1 Delivery

CAUTION

Caution Keep the pump in the shipping carton until it is placed in the vertical position during installation.

Handle the pump with care.

Examine the components carefully to make sure no damage has occurred to the pump end, motor, cable or control box during shipment.

4.2 Handling

Keep the pump in the shipping carton until it is ready to be installed. The shipping carton is specially designed to protect it from damage. During unpacking and prior to installation, make sure that the pump is not dropped or mishandled.

Do not expose the pump to unnecessary impact and shocks.

The motor is equipped with a power cable.

CAUTION

Caution Never use the power cable to support the weight of the pump.

You will find a loose nameplate with an adhesive backing with the pump. If the nameplate is blank, complete it in pen and attach it to the control box.

Note Fix the extra nameplate supplied with the pump at the installation site.

4.3 Storage

4.3.1 Storage temperature

Pump: -4 - +140 °F (-20 - +60 °C).

Motor: -4 - +158 °F (-20 - +70 °C).

Store the motors in a closed, dry and well ventilated room.

CAUTION

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.

Do not expose the pump to direct sunlight.

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

During storage, the pump can be supported as shown in fig. 1.

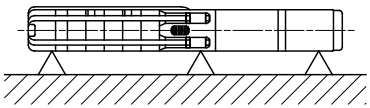

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Fig. 1 Pump position during storage

4.3.2 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.

5. Operating conditions

Flow rate, Q:		Up to 1400 gpm (318 m^3/h)
Head, H:		Up to 2657 ft (810 m)
Liquid temperature:		32-140 °F (0-60 °C)
Maximum submersible depth:	MS 402	492 ft (150 m) (213 psi)
	MS 4000	1969 ft (600 m) (852 psi)
	MS 6000	1969 ft (600 m) (852 psi)
	All MMS	1969 ft (600 m) (852 psi)

6. Installation

Install products in accordance with the local code of the authority having jurisdiction. Installation must be carried out by a qualified person.

WARNING

Risk of electric shock. Do not remove cord and strain relief. Do not connect conduit to pump.

6.1 Pre-installation checklist

Make the following checks before beginning installation:

- condition of the well
- condition of the water
- installation depth
- power supply
- cable type.

These checks are all critical for the proper installation of this submersible pump.

6.1.1 Condition of the well

If the pump is to be installed in a new well, make sure that the well is fully developed and bailed or blown free of cuttings, drillings and sand. The stainless steel construction of the Grundfos submersible pump makes it resistant to abrasion; however, no pump, made of any material, can forever withstand the destructive wear that occurs when constantly pumping sandy water.

If this pump is used to replace an oil-filled submersible or oil-lubricated line-shaft turbine pump in an existing well, the well must be blown or bailed clear of oil.

Determine the maximum depth of the well, and the draw-down level at the pump's maximum capacity. Use this data for pump selection and to determine installation depth.

Check the inside diameter of the well casing to ensure that it is larger than the size of the pump and motor.

6.2 Positional requirements

WARNING

Leave the inlet screen in place if the pump installation is accessible to human touch.

Depending on the 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 *6.2.1 Motors suitable for horizontal installation*.

If the pump is installed horizontally, make sure that the outlet port never falls below the horizontal plane. See fig. 2.

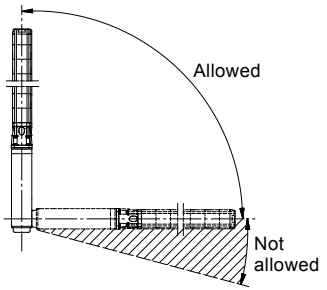

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Fig. 2 Positional requirements

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

6.2.1 Motors suitable for horizontal installation

Motor	Output power 60 Hz	Output power 50 Hz
	[Hp (kW)]	[Hp (kW)]
MS	0.5 - 40 (0.37 - 30)	All
MMS6	50-60 (37 - 44.7)	5-50 (3.7 - 37)
MMS 8000	30-150 (22-112)	30-150 (22-112)
MMS 10000	100-250 (75-190)	100-250 (75-190)

CAUTION

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 of 104-140 °F (40-60 °C), make sure that persons cannot come into contact with the pump and the installation, e.g. by installing a guard.

6.2.2 Pumped liquids

CAUTION

Caution

This pump has been tested for use with water only. Water temperature should not exceed rated motor temperature. SP pumps can withstand water temperatures up to 140°F (60°C). Water temperature that exceeds motor rated temperature directly shortens the motor life. The suitability of this pump for use with liquids other than water is the responsibility of the end user.

Submersible pumps are designed for pumping the following liquids:

- clear and cold water that is free of air and gasses
- clean, thin, non-explosive liquids without solid particles or fibers.

Decreased pump performance and life expectancy can occur if the water is not cold and clear or contains air and gasses.

See the flow velocity table in section *10.1 Motor cooling requirements*.

Flow rate, Q:	0.44 - 1475 gpm (0.1 - 335 m^3/h)
Head, H:	Maximum 2657 ft (810 m)

When the pump and motor are used for pumping water above the rated temperatures of the motor, pay special attention to minimum water flow past the motor for cooling. Water temperature that exceeds motor rated temperature directly shortens the motor life.

The Grundfos stainless steel submersible pump is highly resistant to the normal corrosive environment found in some water wells. If water well tests show that the water has an excessive or unusual corrosive quality, or exceeds the motor temperature rating, contact your Grundfos representative for information concerning specially designed pumps for these applications.

6.3 Preparation

WARNING

Before starting work on the pump, make sure that the power supply has been switched off and that it cannot be accidentally switched on.

6.3.1 Checking of liquid in motor

The MS submersible motors are factory-filled with SML-3 liquid, which is frost-proof down to -4 °F (-20 °C).

Note

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

CAUTION

Caution

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

Carry out refilling of liquid as described below.

6.3.2 Grundfos submersible motors MS 4000 and MS 402

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. 3.
   Make sure that the filling screw is 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 as shown in fig. 3 until the liquid runs back out of the filling hole.
4. Replace the screw in the filling hole and tighten securely before changing the position of the pump.

Torques:

MS 4000: 2.2 ft-lbs (3.0 Nm).

MS 402: 1.5 ft-lbs (2.0 Nm).

The submersible pump is now ready for installation.

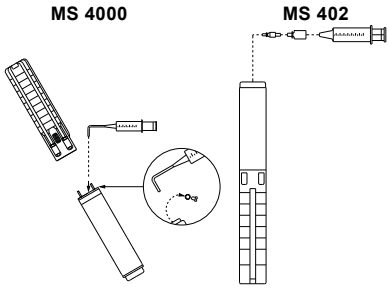

Fig. 3 Pump position during filling, MS 4000 and MS 402

6.3.3 Grundfos submersible motors, MS 6000C

- If the motor is delivered from stock, the liquid level must be checked before the motor is fitted to the pump. See fig. 4.
- On pumps delivered directly from Grundfos, the liquid level has already been checked.
- In the case of service, the liquid level must be checked. See fig. 4.

Filling procedure:

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

1. Position the submersible pump as shown in fig. 4.
   Make sure that the filling screw is 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 (see fig. 4) until the liquid runs back out of the filling hole.
4. Replace the screw in the filling hole and tighten securely before changing the position of the motor.

Torque: 2.2 ft-lbs (3.0 Nm).

The submersible pump is now ready for installation.

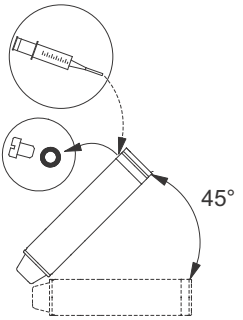

Fig. 4 Motor position during filling, MS 6000C

6.3.4 Grundfos submersible motors, MMS6, MMS 8000, and MMS 10000

Filling procedure:

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

CAUTION

Caution

Do not use motor liquid as it contains oil.

4. Remove the funnel and refit the plug A.

CAUTION

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.

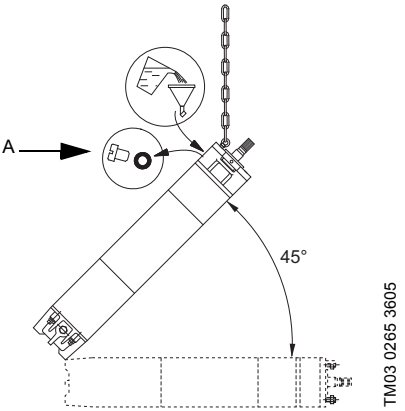

Fig. 5 Motor position during filling, MMS

6.3.5 Installation depth

Make sure that the installation depth of the pump is always at least 3 ft (1 m) below the maximum draw-down level of the well. For flow rates exceeding 100 gpm (22.7 m^3/h), refer to performance curves for recommended minimum submergence.

Never install the pump so that the bottom of the motor is lower than the top of the well screen or within five feet of the well bottom.

If the pump is to be installed in a lake, pond, tank or large diameter well, make sure that the water velocity passing over the motor is sufficient to ensure proper motor cooling. The minimum recommended water flow rates ensuring proper cooling are listed in section *10.1 Motor cooling requirements*.

6.3.6 Power supply

Check the motor voltage, phase number and frequency indicated on the motor nameplate against the actual power supply.

6.3.7 Power cable type

The power cable used between the pump and control box or control panel must be approved for submersible pump applications. Conductors may be solid or stranded. The cable may consist of individually insulated conductors twisted together, insulated conductors molded side by side in one flat cable or insulated conductors with a round overall jacket.

The conductor insulation must be type RW, RUW, TW, TWU or equivalent and must be suitable for use with submersible pumps. An equivalent Canadian Standards Association (CSA) certified cable may also be used. See section *10.4 Submersible drop cable selection charts (60 Hz)* for recommended cable lengths.

6.4 Removing and fitting the cable guard

If the cable guard is attached with screws, remove the screws to loosen the cable guard. To fit the cable guard on the pump, tighten the screws to fit the cable guard securely to the pump.

CAUTION

Caution When the cable guard has been fitted, make sure that the pump chambers are aligned.

6.5 Splicing the motor cable

Note A good cable splice is critical to proper operation of the submersible pump and must be done with extreme care.

If the splice is carefully made, it will work as well as any other portion of the cable, and will be completely watertight. Grundfos recommends that you use a heat shrink splice kit. Make the splice in accordance with the kit manufacturer's instructions. Typically a heat shrink splice can be made as follows:

1. Examine the motor cable and the submersible drop cable carefully for damage.
2. Cut the motor leads off in a staggered manner. Cut the ends of the drop cable so that the ends match up with the motor leads. See fig. 6. On single-phase motors, be sure to match the colors.
3. Strip back and trim off 1/2 inch of insulation from each lead, making sure to scrape the wire bare to obtain a good connection. Be careful not to damage the copper conductor when stripping off the insulation.
4. Slide the heat shrink tubing on to each lead. Insert a properly sized "Sta-Kon" type connector on each lead, making sure that lead colors are matched. Using "Sta-Kon" crimping pliers, indent the lugs. See fig. 7. Be sure to squeeze hard on the pliers, particularly in the case of a large cable.
5. Center the heat shrink tubing over the connector. Using a propane torch, lighter, or electric heat gun, uniformly heat the tubing starting first in the center working towards the ends. See fig. 8.
6. Continue to apply the heat to the tubing taking care not to let the flame directly contact the tubing. When the tubing shrinks and the sealant flows from the ends of the tubing, the splice is complete. See fig. 9.

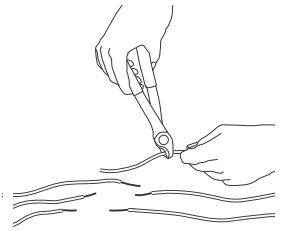

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Fig. 6 Cutting and stripping the motor leads

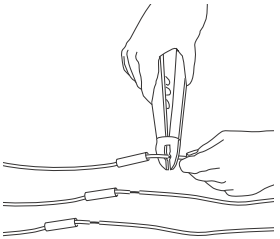

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Fig. 7 Crimping the connectors

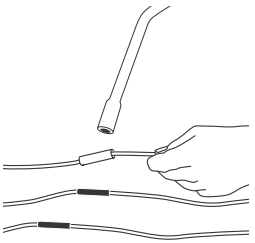

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Fig. 8 Applying heat to the connector

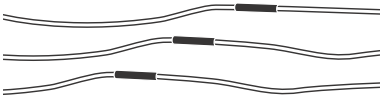

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Fig. 9 Completed splices

6.6 Riser pipe

Note Make sure that the riser pipe or hose are properly sized and selected on the basis of estimated flow rates and friction-loss factors.

6.6.1 If an adapter is required

We recommend that you first install the riser pipe to the pipe adapter. Then install the riser pipe with the adapter to the pump outlet port.

Use a back-up wrench when attaching the riser pipe to the pump. Make sure that the pump is gripped only by the flats on the top of the outlet chamber. The body of the pump, cable guard or motor must not be gripped under any circumstance.

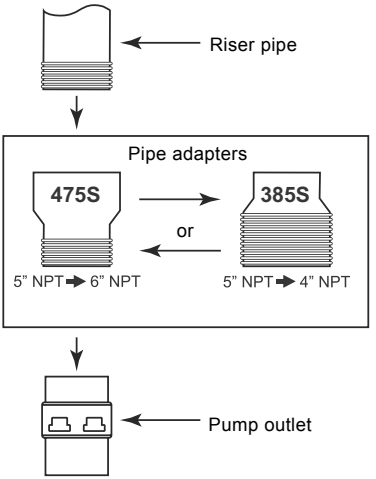

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Fig. 10 Pipe adapters

6.6.2 If a steel riser pipe is used

We recommend that you always use steel riser pipes with the large submersible pumps. Use an approved pipe thread compound on all joints. Make sure the joints are adequately tightened in order to prevent the joints from coming loose when the motor starts and stops.

When tightened, make sure that the first section of the riser pipe does not come in contact with the check valve retainer.

After the first section of the riser pipe has been attached to the pump, clamp the lifting wire to the pump, if there is a provision on the pump for a lifting wire. If not, clamp the lifting wire to the first section of the riser pipe.

When raising the pump and riser pipe section to upright position, be careful not to place bending stress on the pump by picking it up by the pump end only.

Make sure that the power cables are not cut or damaged in any way when the pump is being lowered in the well.

Fasten the submersible drop cable to the riser pipe at frequent intervals to prevent sagging, looping or possible cable damage. Nylon cable clips or waterproof tape may be used. Protect the cable splice by securing it with clips or tape just above and below the splice.

6.6.3 If a plastic or flexible riser pipe is used

We recommend that you use plastic type riser pipes only with the smaller domestic submersible pumps.

CAUTION

Caution When a plastic riser pipe is used, we recommend that you attach a safety cable to the pump to lower and raise it.

Note Important: Plastic and flexible pipes tend to stretch under load. Take this stretching into account when securing the cable to the riser pipe. Leave 3 to 4 inches of slack between clips or taped points to allow for this stretching. This tendency for plastic and flexible pipe to stretch also affects the calculation of the pump installation depth. As a general rule, you can estimate that plastic pipe stretches to approximately 2 % of its length. For example, if you installed 200 feet (61 m) of plastic riser pipe, the pump may actually be down 204 feet (62 m). If the installation depth is critical, check with the manufacturer of the pipe to determine how to compensate for pipe stretch.

Contact the pipe manufacturer or representative to ensure that the pipe type and physical characteristics are suitable for this use.

Use the correct joint compound recommended by the pipe manufacturer. In addition to making sure that joints are securely fastened, we recommend that you use a torque arrester when using a plastic pipe.

Do not connect the first plastic or flexible riser pipe section directly to the pump. Always attach a metallic nipple or adapter into the valve casing at the top of the pump. When tightened, make sure that the threaded end of the nipple or adapter does not come in contact with the check valve retainer.

Fasten the submersible drop cable to the riser pipe at frequent intervals to prevent sagging, looping and possible cable damage. Grundfos nylon cable clips or waterproof tape may be used. Protect the cable splice by securing it with Grundfos cable clips or tape just above each joint.

Check valves

Always install a check valve at the top of the well. In addition, for installations deeper than 200 feet (61 m), install check valves at no more than 200 ft (61 m) intervals.

Protect the well from contamination

To protect against surface water entering the well and contaminating the water source, make sure that the well is finished off above grade and that a locally approved well seal or pitless adapter unit is utilized.

6.7 Electrical and variable-frequency drive information

WARNING

USA: All electrical work must be performed by a qualified electrician and installed in accordance with the National Electrical Code, local codes and regulations.

WARNING

Canada: All electrical work must be performed by a qualified electrician and installed in accordance with the Canadian Electrical Code, local codes and regulations.

WARNING

Provide acceptable grounding in order to reduce the risk of electric shock during operation of this pump. If the means of connection to the box connected to the power supply is other than a grounded metal conduit, ground the pump by connecting a copper conductor, at least the size of the circuit supplying the pump, to the grounding screw provided within the terminal box.

Make sure that the voltage, phase number and frequency of the power supply match those of the motor. Motor voltage, phase number, frequency and full-load current information can be found on the nameplate attached to the motor.

Motor electrical data can be found in section *10.6.1 Grundfos submersible motors, 60 Hz*.

WARNING

If voltage variations are larger than ± 10 %, do not operate the pump.

Direct-on-line starting is used due to the extremely short run-up time of the motor (maximum 0.1 second), and the low moment of inertia of the pump and motor. Direct-on-line starting current (locked rotor current) is between 4 and 6.5 times the full-load current.

If direct-on-line starting is not acceptable and reduced starting current is required, use an autotransformer or resistant starters for 5 to 30 hp motors, depending on the cable length. For motors over 30 hp, use autotransformer starters.

6.7.1 Engine-driven generators

If the submersible pump is going to be operated by an engine driven generator, we suggest that you contact the manufacturer of the generator to ensure the proper generator is selected and used. See section *10.2 Guide for engine-driven generators in submersible pump applications* for generator sizing guide.

If power is going to be supplied through transformers, section *10.3 Transformer capacity required for three-phase submersible motors* outlines the minimum KVA rating and capacity required for satisfactory pump operation.

6.7.2 Control box or panel wiring

Single-phase motors

Connect single-phase motors as indicated in the motor control box.

A typical single-phase wiring diagram using a Grundfos control box is shown in fig. 11.

CAUTION

Caution Motor burnout protection via CUE, CU331SP, or MP 204.

Use approved dry-run protection such as with MP 204.

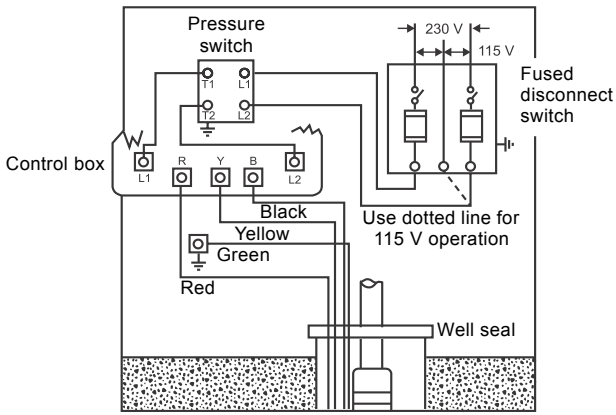

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Fig. 11 Single-phase wiring diagram for Grundfos control boxes

Three-phase motors

Use three-phase motors with the proper size and type of motor starter to ensure the motor is protected against damage from low voltage, phase failure, current imbalance and overload current.

Use a properly sized starter with ambient-compensated, class 10, extra quick-trip overload relays or an MP204 to give the best possible motor winding protection.

Each of the three motor legs must be protected with overloads. The thermal overloads must trip in less than 10 seconds at locked rotor (starting) current. A three-phase motor wiring diagram is shown in fig. 12.

CAUTION

Caution

Ensure that the pump is totally submerged before you check the direction of rotation. Severe damage may be caused to the pump and motor if they are run dry.

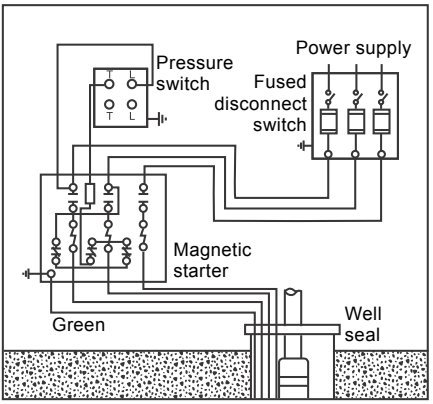

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Fig. 12 Three-phase wiring diagram for Grundfos motors and other motor manufacturers

6.7.3 Variable-frequency drive operation

Grundfos motors

Three-phase Grundfos motors can be connected to a variable frequency drive (VFD).

Note

If a Grundfos MS motor with temperature transmitter is connected to a variable frequency drive, a fuse incorporated in the transmitter will melt, and the transmitter will be inactive. The transmitter cannot be reactivated. This means that from that point on, the motor will operate like a motor without a temperature transmitter.

If a new temperature transmitter is required, a Pt100/1000 sensor for fitting to the submersible motor can be ordered from Grundfos.

During variable-frequency drive operation, we recommend that you do not run the motor at a frequency higher than the nominal frequency (50 or 60 Hz) and not lower than 30 Hz. In connection with pump operation, it is important never to reduce the frequency (and consequently the speed) to such a low level that the necessary flow of cooling liquid past the motor is no longer ensured.

To avoid damage to the pump, make sure that the motor stops when the pump flow falls below 0.1 x rated flow.

Depending on the type of variable frequency drive, it may expose the motor to detrimental voltage peaks.

The variable frequency drive must have some kind of output sine-wave filter to limit voltage peaks (Upeak) and to reduce dU/dt (or dV/dt) which causes stress on the insulation of the submersible motor. For sine-wave filter location placement within the system, see fig. 13.

CAUTION

Caution

We recommend that you protect your motor from voltage peaks (Upeak) and excess dU/dt (or dV/dt) by using a sine-wave filter if one or more of the following conditions are present:

- The motor nameplate voltage is above 379 V.
- The variable frequency drive (VFD) uses pulse width modulation (PWM) and/or IGBT-BJT switches.
- The VFD voltage rise time is less than 2 msec (NEMA MG 1-2011).
- The power cable length from the VFD to the submersible motor terminals is 0 to 1500 ft (0 to 457 m).
- The power quality is not stable.
- Keep the motor peak voltage (U_{peak}) and dU/dt within the limits listed in the table below.

For recommended best practice, use a resistor-inductor-capacitor (RLC) type sine-wave filter. An equivalent type LC sine-wave filter is acceptable.

Consult the VFD manufacturer for specific sine-wave filter recommendation.

Maximum peak voltage and dU/dt for Grundfos submersible motors		
Motor series	**Maximum U_{peak} voltage**	**Maximum dU/dt**
MS 402	650 V phase-phase	2000 V/micro s.
MS 4000	850 V phase-phase	2000 V/micro s.
MS6 / MS 6000C	850 V phase-phase	2000 V/micro s.
MMS6 / MMS 6000	850 V phase-ground	500 V/micro s.
MMS 8000	850 V phase-ground	500 V/micro s.
MMS 10000	850 V phase-ground	500 V/micro s.

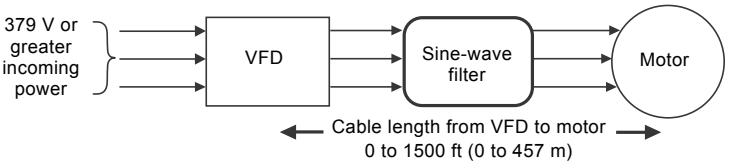


Fig. 13 Location of the sine-wave filter in the system

For further details, contact your VFD supplier or Grundfos.

6.7.4 High-voltage surge arresters

Use a high-voltage surge arrester to protect the motor against lightning and switching surges.

Lightning voltage surges in power lines are caused when lightning strikes somewhere in the area.

Switching surges are caused by the opening and closing of switches on the main high-voltage distribution power lines.

Install the correct voltage-rated surge arrester on the supply side of the control box. See fig. 14 and fig. 15. The arrester must be grounded in accordance with the National Electrical Code and local codes and regulations.

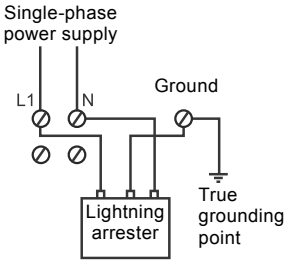


Fig. 14 Single-phase installation

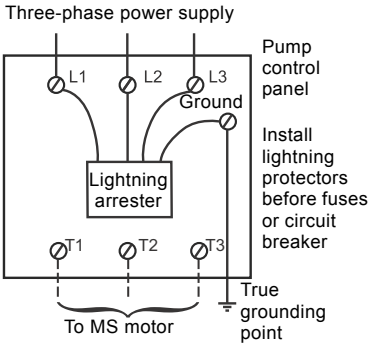


Fig. 15 Three-phase installation

The warranty on all three-phase submersible motors becomes void in these cases:

Note

- The motor is operated with single-phase power through a phase converter.
- Three-leg ambient compensated, extra quick-trip overload protectors are not used.
- Three-phase current imbalance is not checked and recorded. See section *7. Startup*.
- High-voltage surge arresters are not installed.

6.7.5 Control box or panel grounding

WARNING

The control box or control panel must be permanently grounded in accordance with the National Electrical Code and local codes or regulations.

The ground wire must be a bare copper conductor at least the same size as the submersible drop cable wire size.

Run the ground wire as short a distance as possible and fasten it securely to a true grounding point.

True grounding points are considered to be one of the following:

- a grounding rod driven into the water strata
- a steel well casing submerged into the water lower than the pump installation depth
- steel outlet pipes without insulating couplings.

If plastic outlet pipe and well casing are used or if a grounding wire is required by local codes, connect a properly sized, bare copper wire to a stud on the motor and run to the control panel.

WARNING

Do not ground to a gas supply line. Connect the grounding wire to the ground point first and then to the terminal in the control box or control panel.

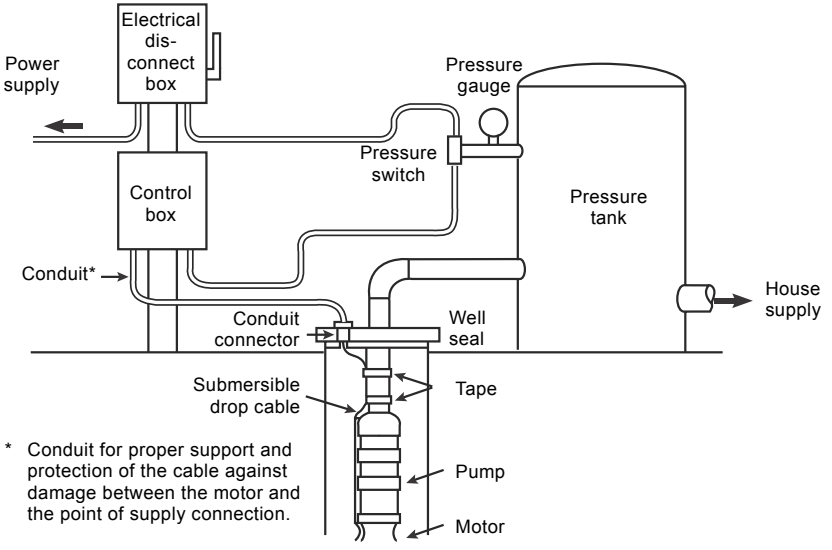


Fig. 16 Wiring and installation diagram

6.7.6 Wiring checks and installation

Before making the final surface wiring connection of the submersible drop cable to the control box or control panel, it is a good practice to check the insulation resistance to ensure that the cable and splice are good. Measurements for a new installation must be at least 200 megaohms. See the table in section *6.7.7 Insulation resistance and ohm value chart*.

If the insulation resistance of the cable and splice is measured at higher than 200 megaohms, run the submersible drop cable through the well seal by means of a conduit connector to prevent foreign matter from entering the well casing.

Always protect the submersible drop cable with conduit from the pump to the control box or control panel. See fig. 16.

Finish the wiring and verify that all electrical connections are made in accordance with the wiring diagram.

Check to ensure that the control box or control panel and high-voltage surge arrester have been grounded.

Route conductors properly such as in conduit where called for by Local Code to protect the conductors.

6.7.7 Insulation resistance and ohm value chart

Insulation resistance in a submersible pumping system is a measure of the ability of the motors and/or cables to withstand normal voltage and transient voltage without breakdown and failure. An "adequate" level of insulation resistance is not a constant value, but depends on the installation voltage and conditions, and whether the measured resistance is lowered by a specific weak point or by widely distributed conductance such as in cable insulation material itself. For this reason, values for acceptable resistance cannot be specific.

Insulation resistance measurements

Measure insulation resistance at the time of initial motor installation and periodically thereafter. In deep set submersible installations, take measurements throughout the installation process to detect potential cable insulation or connection damage before the unit is completely installed. The insulation resistance table in this section describes the condition of the insulation system for a submersible motor system of 600 V or less, based on megohmmeter readings.

Note Measure the insulation resistance in accordance with local codes and regulations.

The table below shows suggested values of insulation resistance and the test voltage in relation to the rated voltage of the motor.

Rated voltage	**≤ 500 [V]**	**> 500 [V]**
Condition of motor and cable	[MΩ]	[MΩ]
New motor without submersible drop cable	≥ 200	≥ 200
Used motor which can be re-installed in well	≥ 10	≥ 10
New motor in well	≥ 20	≥ 20
Motor in good condition in well	≥ 0.5	≥ 1
Damaged insulation	< 0.5	< 1

If the rated motor voltage is less than or equal to 500 V, the insulation resistance must be measured at a test voltage of 500 VDC.

If the rated motor voltage is greater than 500 V, the insulation resistance must be measured at a test voltage of 1000 VDC.

7. Startup

After the pump has been set into the well and the wiring connections have been made, go through the following procedures:

1. Attach a temporary horizontal length of pipe with installed gate valve to the riser pipe.
2. Adjust the gate valve one-third of the way open.
3. On three-phase units, check direction of rotation and current imbalance according to the instructions below. For single-phase units proceed directly to *7.1.3 Developing the well*.
4. Do not operate the pump with the outlet valve closed. This can result in motor and pump damage due to overheating. Install a properly sized relief valve at the well head to prevent the pump from running against a closed valve.

7.1 Startup with three-phase motors

7.1.1 Check the direction of rotation

Three-phase motors can run in either direction depending on how they are connected to the power supply. When the three cable leads are first connected to the power supply, there is a 50 % chance that the motor will run in the proper direction. To make sure the motor is running in the proper direction, carefully follow these procedures:

1. Start the pump and check the water quantity and pressure developed.
2. Stop the pump and interchange any two leads.
3. Start the pump and again check the water quantity and pressure.
4. Compare the results observed. The wire connection which gave the highest pressure and largest water quantity is the correct connection.

7.1.2 Check for current imbalance

Current imbalance causes the motor to have reduced starting torque, overload tripping, excessive vibration and poor performance which can result in early motor failure. It is very important that current imbalance be checked in all three-phase systems.

Note Make sure that the current imbalance between the phases do not exceed 5 % under normal operating conditions.

Determine if the supply power service is a two-transformer or three-transformer system. If two transformers are present, the system is an "open" delta or wye. If three transformers are present, the system is true three-phase.

Make sure the transformer ratings in kilovolt amps (KVA) is sufficient for the motor load. See section *10.3 Transformer capacity required for three-phase submersible motors*.

The percentage of current imbalance can be calculated by means of the following formulas and procedures:

$$\text{Average current} = \frac{\text{Total of current values measured on each leg}}{3}$$

$$\text{\% current imbalance} = \frac{\text{Greatest amp difference from the average}}{\text{Average current}} \times 100$$

To determine the percentage of current imbalance:

1. Measure and record current readings in amps for each leg (hookup 1). Disconnect power.
2. Shift or roll the motor leads from left to right so the submersible drop cable lead that was on terminal 1 is now on 2, lead on 2 is now on 3, and lead on 3 is now on 1 (hookup 2). Rolling the motor leads in this manner will not reverse the motor rotation. Start the pump, measure and record current reading on each leg. Disconnect power.
3. Again shift submersible drop cable leads from left to right so the lead on terminal 1 goes to 2, 2 to 3 and 3 to 1 (hookup 3). Start pump, measure and record current reading on each leg. Disconnect power.
4. Add the values for each hookup.
5. Divide the total by 3 to obtain the average.
6. Compare each single leg reading from the average to obtain the greatest amp difference from the average.
7. Divide this difference by the average to obtain the percentage of imbalance.

Use the wiring hookup which provides the lowest percentage of imbalance. See section *10.6.3 Correcting for three-phase current imbalance* for a specific example of correcting for three-phase current imbalance.

7.1.3 Developing the well

After proper rotation and current imbalance have been checked, start the pump and let it operate until the water runs clear of sand, silt and other impurities.

Slowly open the valve in small increments as the water clears until the desired flow rate is reached. Do not operate the pump beyond its maximum flow rating.

Note Do not stop the pump until the water runs clear.

If the water is clean and clear when the pump is first started, open the valve slowly until the desired flow rate is reached. As the valve is being opened, check the drawdown to ensure that the pump is always submerged.

Note Make sure that the dynamic water level is always more than 3 feet (0.9 m) above the suction interconnector of the pump.

Disconnect the temporary piping arrangements and complete the final piping connections.

CAUTION

Caution Do not operate the pump with the outlet valve closed. This can result in motor and pump damage due to overheating. Install a properly sized relief valve at the well head to prevent the pump from running against a closed valve.

Start the pump and test the system. Check and record the voltage and current draw on each motor lead.

8. Operation

Check the pump and system periodically for water quantity, pressure, drawdown, periods of cycling and operation of controls.

If the pump fails to operate, or there is a loss of performance, refer to section *9. Troubleshooting*.

8.1 Minimum flow rate

To ensure the necessary cooling of the motor, do not set the pump flow rate so low that the cooling requirements specified in section *6.2.2 Pumped liquids* cannot be met.

8.1.1 Frequency of starts and stops

Motor type		Number of starts
MS 402		• Minimum 1 per year is recommended. • Maximum 100 per hour. • Maximum 300 per day.
MS 4000		• Minimum 1 per year is recommended. • Maximum 100 per hour. • Maximum 300 per day.
MS 6000C		• Minimum 1 per year is recommended. • Maximum 30 per hour. • Maximum 300 per day.
MMS6	PVC windings	• Minimum 1 per year is recommended. • Maximum 3 per hour. • Maximum 40 per day.
	PE/PA windings	• Minimum 1 per year is recommended. • Maximum 10 per hour. • Maximum 70 per day.
MMS 8000	PVC windings	• Minimum 1 per year is recommended. • Maximum 3 per hour. • Maximum 30 per day.
	PE/PA windings	• Minimum 1 per year is recommended. • Maximum 8 per hour. • Maximum 60 per day.
MMS 10000	PVC windings	• Minimum 1 per year is recommended. • Maximum 2 per hour. • Maximum 20 per day.
	PE/PA windings	• Minimum 1 per year is recommended. • Maximum 6 per hour. • Maximum 50 per day.

8.2 Soft starter

The starting voltage is minimum 55 % of the value stamped on the nameplate.

If a high locked-rotor torque is required or if the power supply is not optimal, the starting voltage must be higher.

Run-up time (until voltage stamped on nameplate is reached): Maximum 3 seconds. Run-out time: Maximum 3 seconds.

If the above-mentioned run-up and run-out ramps are followed, unnecessary heating of the motor is avoided.

If the soft starter is fitted with bypass contacts, the soft starter will only be in operation during run-up and run-out.

Do not use the soft starter in connection with operation via a generator.

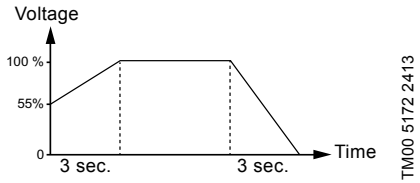


Fig. 17 Operation with a soft starter

8.3 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 center.

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.

9. Troubleshooting

The majority of problems that develop with submersible pumps are electrical, and most of these problems can be corrected without pulling the pump from the well. The following chart covers most of the submersible service work. As with any troubleshooting procedure, start with the simplest solution first; always make all the above-ground checks before pulling the pump from the well.

Usually only two instruments are needed:

- a combination of voltmeter and ammeter
- an ohmmeter.

These are relatively inexpensive and can be obtained from most water systems suppliers.

WARNING

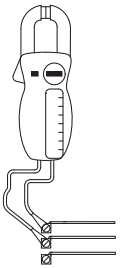
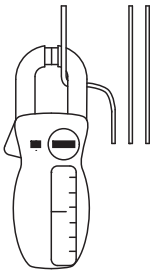
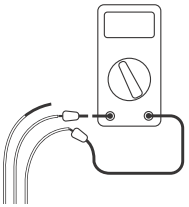
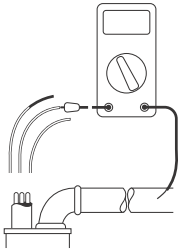
When working with electrical circuits, use caution to avoid electric shock.

We recommend that you use rubber gloves and boots and that you take care to have metal control boxes and motors grounded to power supply ground or steel drop pipe or casing extending into the well.

WARNING

Submersible motors are intended for operation in a well. When not operated in a well, failure to connect motor frame to power supply ground may result in serious electric shock.

9.1 Preliminary tests

Test	How to measure	What it means
Supply voltage  TM00 1371 5092	By means of a voltmeter set to the proper scale, measure the voltage at the control box or starter. • On single-phase units, measure between line and neutral. • On three-phase units, measure between the legs (phases).	When the motor is under load, the voltage must be within ± 10 % of the nameplate voltage. Larger voltage variation may cause winding damage. Large variations in the voltage indicate a poor power supply and the pump must not be operated until these variations have been corrected. If the voltage constantly remains high or low, the motor must be changed to the correct supply voltage.
Current  TM00 1372 5082	• By means of an ammeter set to the proper scale, measure the current on each power lead at the control box or starter. See section *10.6 Electrical data* for motor amp draw information. • Current must be measured when the pump is operating at a constant outlet pressure with the motor fully loaded.	If the amp draw exceeds the listed service factor amps (SFA), or if the current imbalance is greater than 5 % between each leg on three-phase units, check for the following: • Burnt contacts on motor-protective circuit breaker. • Loose terminals in starter or control box or possible cable defect. Check winding and insulation resistances. • Supply voltage too high or low. • Motor windings are shortened. • Pump is damaged, causing a motor overload.
Winding resistance  TM05 0028 0511	• Turn off power and disconnect the submersible drop cable leads in the control box or starter. • By means of an ohmmeter, set the scale selectors to Rx1 for values under 10 ohms and Rx10 for values over 10 ohms. • Zero-adjust the ohmmeter and measure the resistance between leads. Record the values. • Motor resistance values can be found in section *10.6 Electrical data*. Cable resistance values are in section *6.7.7 Insulation resistance and ohm value chart*.	If all the ohm values are normal, and the cable colors correct, the windings are not damaged. If any one ohm value is less than normal, the motors may be shorted. If any one ohm value is greater than normal, there is a poor cable connection or joint. The windings or cable may also be open. If some of the ohm values are greater than normal and some less, the submersible drop cable leads are mixed. To verify lead colors, see resistance values in section *10.6 Electrical data*.
Insulation resistance  TM05 0029 0511	• Turn off power and disconnect the submersible drop cable leads in the control box or starter. • By means of an ohmmeter or megohmmeter, set the scale selector to Rx 100K and zero adjust the meter. • Measure the resistance between the lead and ground (discharge pipe or well casing, if steel).	For ohm values, refer to section *9.2 Checking pump performance*. Motors of all hp, voltage, phase and cycle duties have the same value of insulation resistance.

9.2 Checking pump performance

The troubleshooting chart on page 26 may require that you test the pump's performance against its curve. To do so, perform these steps:

1. Install pressure gauge.
2. Start pump.
3. Gradually close the outlet valve.
4. Read pressure at shut-off.
5. After taking reading, open valve to its previous position.
6. To calculate pump performance, first convert psi reading to feet.
   For water: psi x 2.31 = ____ feet.
7. Add this to the total vertical distance from the pressure gauge to the water level in the well while the pump is running.
8. Refer to the specific pump curve for the shut-off head (pressure) for that pump model. If the measured head is close to the curve, pump is probably OK.

9.3 Troubleshooting chart

Problem	Possible cause and/or how to check	Possible remedy
1. The pump does not run.	a) There is no power at the pump control panel. How to check: Check for voltage at the control panel.	If there is no voltage at the control panel, check the feeder panel for tripped circuits.
	b) The fuses are blown or the circuit breakers are tripped. How to check: Remove the fuses and check for continuity with the ohmmeter.	Replace blown fuses or reset the circuit breaker. If new fuses blow or the circuit breaker trips, the electrical installation and motor must be checked.
	c) The motor starter overloads are burnt or have tripped out (three-phase only). How to check: Check for voltage on the line or load side of the motor starter.	Replace burnt heaters or reset. Inspect the starter for other damage. If the heater trips again, check the supply voltage and the starter holding coil.
	d) The starter does not energize (three-phase only). How to check: Energize the control circuit and check for voltage at the holding coil.	If there is no voltage, check the control circuit. If there is voltage, check the holding coil for short circuits. Replace bad coil.
	e) The controls are defective. How to check: Check all safety and pressure switches for operation. Inspect contacts in control devices.	Replace worn or defective parts.
	f) The motor and/or cable are defective. How to check: Turn off the power. Disconnect the motor leads from the control box. Measure the lead-to-lead resistances with the ohmmeter (Rx1). Measure the lead-to-ground values with an ohmmeter (Rx100K). Record the measured values.	If an open motor winding or ground is found, pull the pump from the well and recheck values at the surface. Repair or replace the motor or cable.
	g) The capacitor is defective (single-phase only). How to check: Turn off the power, then the capacitor. Check with an ohmmeter (Rx100K). When the meter is connected, look for the needle to jump forward and slowly drift back.	If there is no ohmmeter needle movement, replace the capacitor.

Problem	Possible cause and/or how to check	Possible remedy
2. The pump runs but does not deliver water.	a) The groundwater level in the well is too low or the well is collapsed. How to check: Check the well drawdown. The water level must be at least three feet above the suction interconnector during operation.	If the water level is not at least three feet above the suction interconnector during operation, then lower the pump if possible, or throttle back the outlet valve and install a water level control.
	b) The integral pump check valve is blocked. How to check: Check the pump performance against the pump curve. See section *9.2 Checking pump performance*.	If the pump is not operating close to the pump curve, pull the pump from the well and inspect the outlet section. Remove the blockage, repair the valve and valve seat, if necessary. Check for other damage. Rinse out the pump and re-install.
	c) The inlet strainer is clogged. How to check: Check the pump performance against the pump curve. See section *9.2 Checking pump performance*.	If the pump is not operating close to the pump curve, pull the pump from the well and inspect. Clean the inlet strainer, inspect the integral check valve for blockage, rinse out the pump and re-install.
	d) The pump is damaged. How to check: Check the pump performance against the pump curve. See section *9.2 Checking pump performance*.	If the pump is damaged, repair as necessary. Rinse out the pump and re-install.
3. The pump runs, but at reduced capacity.	a) The direction of rotation is wrong (three-phase only). How to check: Check for proper electrical connection in the control panel.	Correct the wiring and change the leads as required.
	b) The drawdown is larger than anticipated. Check the drawdown during pump operation.	Lower the pump, if possible. If not, throttle back the outlet valve and install a water level control.
	c) The outlet piping or valve are leaking. How to check: Examine the system for leaks.	Repair leaks.
	d) The pump inlet strainer or check valve are clogged. How to check: Check the pump performance against the pump curve. See section *9.2 Checking pump performance*.	If the pump performance is not close to the pump curve, pull the pump from the well and inspect. Clean the strainer, inspect the integral check valve for blockage, rinse out the pump and re-install.
	e) The pump is worn. How to check: Check the pump performance against the pump curve. See section *9.2 Checking pump performance*.	If the pump performance is not close to the pump curve, pull the pump from the well and inspect.

Problem	Possible cause and/or how to check	Possible remedy
4. The pump cycles too much.	a) The pressure switch is not properly adjusted or is defective. How to check: Check the pressure setting on switch and operation. Check the voltage across closed contacts.	Re-adjust the switch or replace it if it is defective.
	b) The level control is not properly set or is defective. How to check: Check the setting and operation.	Re-adjust the setting; refer to the manufacturer data. Replace the level control if it is defective.
	c) The pressure in the diaphragm tank is insufficient or the tank or piping is leaking. How to check: Pump air into the tank or diaphragm chamber. Check the diaphragm for leaks. Check the tank and piping for leaks with soap and water solution. Check the air to water volume.	Repair or replace any damaged components.
	d) The snifter valve or bleed orifice are plugged. How to check: Examine the valve and orifice for dirt or corrosion.	Clean and/or replace any defective snifter valve or bleed orifice.
	e) The tank is too small. How to check: Check the tank size. We recommend that the tank volume is approximately 10 gallons for each gpm or pump capacity.	If the tank is too small, replace it with a proper size tank.

Problem	Possible cause and/or how to check	Possible remedy
5. Fuses blow or circuit breakers trip.	a) The voltage is too high or low. How to check: Check the voltage at the pump control panel. If not within ± 10 %, check the cable size and length of run to pump control panel.	If the cable size is correct, contact the power company. If not, correct and/or replace as necessary.
	b) The three-phase current imbalance is too high or low. How to check: Check the current draw on each lead. The imbalance must be within ± 5 %.	If current imbalance is not within ± 5 %, contact the power supply company.
	c) The control box wiring and components are incorrect or defective (single-phase only). How to check: Check that the control box parts match the parts list. Check to see that the wiring matches the wiring diagram. Check for loose or broken wires or terminals.	Correct as required.
	d) The capacitor is defective (single-phase only). How to check: Turn off the power, then the capacitor. Check by means of an ohmmeter (Rx100K). When the ohmmeter is connected, look for the needle to jump forward and slowly drift back.	If there is no ohmmeter needle movement, replace the capacitor.
	e) The starting relay is defective (certain types of single-phase only). How to check: Check the resistance of the relay coil by means of an ohmmeter (Rx1000K). Check the contacts for wear.	Replace any defective starting relay.

10. Technical data

10.1 Motor cooling requirements

10.1.1 Maximum water temperature - minimum velocity/flow past the motor

Maximum water temperature - minimum velocity/flow past the motor

Motor type	Minimum well casing or sleeve diameter	Minimum velocity	Minimum flow	Maximum temperature of pumped liquid	
				Vertical installation	Horizontal installation
	[in. (mm)]	[ft/s (m/s)]	[gpm (m^3/h)]	[°F (°C)]	[°F (°C)]
MS 402 / MS 4000	4 (102)	0.00 (0.00)	0.0 (0.0)	86 (30)	Flow sleeve recommended*
MS 402 / MS 4000	4 (102)	0.25 (0.08)	1.2 (0.27)	104 (40)	104 (40)
MS 6000C (T40)	6 (152)	0.50 (0.15)	9 (2)	104 (40)	104 (40)
MS 6000C (T60)	6 (152)	3.30 (1.00)	30 (6.8)	140 (60)	140 (60)
MMS 6 (T30)	6 (152)	0.15 (0.05)	13 (3)	86 (30)	86 (30)
MMS 6 (T50)	6 (152)	0.15 (0.05)	13 (3)	122 (50)	122 (50)
MMS 8000 (T30)	8 (203)	0.50 (0.15)	25 (5.7)	86 (30)	86 (30)
MMS 6 (T50)	8 (203)	0.50 (0.15)	25 (5.7)	122 (50)	122 (50)
MS 10000 (175, 200 hp)	10 (254)	0.50 (0.15)	55 (12.5)	86 (30)	86 (30)
MS 10000 (250 hp)	10 (254)	0.50 (0.15)	41 (9.3)	68 (20)	68 (20)

ft/s = feet per second

* A flow inducer or flow sleeve must be used if the water enters the well above the motor or if there is insufficient water flow past the motor.

Note: For MMS6, 50 hp and MMS 8000, 150 hp, the maximum liquid temperature is 9 °F (5 °C) lower than the values stated in the table. For MMS 10000, 250 hp, the temperature is 18 °F (10 °C) lower.

10.2 Guide for engine-driven generators in submersible pump applications

1- or 3-phase motor [Hp]	Generator [kW]	
	Externally regulated	Internally regulated
0.33	1.5	1.2
0.5	2.0	1.5
0.75	3.0	2.0
1	4.0	2.5
1.5	5.0	3.0
2	7.5	4.0
3	10.0	5.0
5.0	15.0	7.5
7.5	20.0	10.0
10.0	30.0	15.0
15.0	40.0	20.0
20.0	60.0	25.0
25.0	75.0	30.0
30.0	100.0	40.0
40.0	100.0	50.0
50.0	150.0	60.0
60.0	175.0	75.0
75.0	250.0	100.0
100.0	300.0	150.0
125.0	375.0	175.0
150.0	450.0	200.0
200.0	600.0	275.0

Note:

- The table is based on typical +176 °F (+80 °C) rise continuous duty generators with 35 % maximum voltage dip during startup of single-phase and three-phase motors.
- Contact the manufacturer of the generator to make sure the unit has adequate capacity to run the submersible motor.
- If the generator rating is in KVA instead of kilowatts, multiply the above ratings by 1.25 to obtain KVA.

10.3 Transformer capacity required for three-phase submersible motors

3-phase motor [Hp]	Minimum total KVA required*	Minimum KVA rating for each transformer	
		Two transformers Open Delta or Wye	Three transformers Delta or Wye
1.5	3	2	1
2	4	2	1.5
3	5	3	2
5	7.5	5	3
7.5	10	7.5	5
10	15	10	5
15	20	15	7.5
20	25	15	10
25	30	20	10
30	40	25	15
40	50	30	20
50	60	35	20
60	75	40	25
75	90	50	30
100	120	65	40
125	150	85	50
150	175	100	60
200	230	130	75

* Pump motor KVA requirements only, and does not include allowances for other loads.

10.4 Submersible drop cable selection charts (60 Hz)

The following tables list the recommended copper conductor sizes and various cable lengths for submersible motors.

These tables comply with the 1978 edition of the National Electric Table 310-16, Column 2 for +167 °F (+75 °C) wire. The ampacity (current carrying properties of a conductor) have been divided by 1.25 per the N.E.C., Article 430-22, for motor branch circuits based on motor amps at rated horsepower.

To ensure adequate starting torque, the maximum cable lengths are calculated to maintain 95 % of the service entrance voltage at the motor when the motor is running at maximum nameplate amps. Cable sizes larger than specified may always be used and will reduce power consumption.

CAUTION

Caution

The use of cables smaller than the recommended sizes will void the warranty. Smaller cable sizes will cause reduced starting torque and poor motor operation.

10.4.1 115 V and 230 V, 1-phase, 60 Hz

Maximum submersible power cable length (maximum cable length in feet, starter to motor)

Motor rating	[Hp]	AWG copper wire size [ft (m)]												
		14	**12**	**10**	**8**	**6**	**4**	**3**	**2**	**1**	**0**	**00**	**000**	**0000**
115 V 1-ph 60 Hz	0.33	130 (40)	210 (64)	340 (104)	540 (165)	840 (256)	1300 (396)	1610 (491)	1960 (597)	2390 (728)	2910 (887)	3540 (1079)	4210 (1283)	5060 (1542)
	0.5	100 (30)	160 (49)	250 (76)	390 (119)	620 (189)	960 (293)	1190 (363)	1460 (445)	1780 (543)	2160 (658)	2630 (802)	3140 (957)	3770 (1149)
230 V 1-ph 60 Hz	0.33	550 (168)	880 (268)	1390 (424)	2190 (668)	3400 (1036)	5250 (1600)	6520 (1987)	7960 (2426)	9690 (2954)	11770 (3587)	14320 (4365)	17050 (5197)	20460 (6236)
	0.5	400 (122)	650 (198)	1020 (311)	1610 (491)	2510 (765)	3880 (1183)	4810 (1466)	5880 (1792)	7170 (2185)	8720 (2658)	10620 (3237)	12660 (3859)	15210 (4636)
	0.75	300 (91)	480 (146)	760 (232)	1200 (366)	1870 (570)	2890 (881)	3580 (1091)	4370 (1332)	5330 (1625)	6470 (1972)	7870 (2399)	9380 (2859)	11250 (3429)
	1	250 (76)	400 (122)	630 (192)	990 (302)	1540 (469)	2380 (725)	2960 (902)	3610 (1100)	4410 (1344)	5360 (1634)	6520 (1987)	7780 (2371)	9350 (2850)
	1.5	190 (58)	310 (94)	480 (146)	770 (235)	1200 (366)	1870 (570)	2320 (707)	2850 (869)	3500 (1067)	4280 (1305)	5240 (1597)	6300 (1920)	7620 (2323)
	2	150 (46)	250 (76)	390 (119)	620 (189)	970 (296)	1530 (466)	1910 (582)	2360 (719)	2930 (893)	3620 (1103)	4480 (1366)	5470 (1667)	6700 (2042)
	3	120 (37)	190 (58)	300 (91)	470 (143)	750 (229)	1190 (363)	1490 (454)	1850 (564)	2320 (707)	2890 (881)	3610 (1100)	4470 (1362)	5550 (1692)
	5	-	110* (34*)	180 (55)	280 (85)	450 (137)	710 (216)	890 (271)	1110 (338)	1390 (424)	1740 (530)	2170 (661)	2680 (817)	3330 (1015)
	7.5	-	-	120* (37*)	200 (61)	310 (94)	490 (149)	610 (186)	750 (229)	930 (283)	1140 (347)	1410 (430)	1720 (524)	2100 (640)
	10	-	-	-	160* (49*)	250 (76)	390 (119)	490 (149)	600 (183)	750 (229)	930 (283)	1160 (354)	1430 (436)	1760 (536)
	15	-	-	-	-	170* (52*)	270 (82)	340 (104)	430 (131)	530 (162)	660 (201)	820 (250)	1020 (311)	1260 (384)

Note:

* Indicates single conductor only (not jacketed).

No asterisk indicates both jacketed cable and single conductor cables.

- The table is based on copper wire. If aluminum wire is used, multiply lengths by 0.5.
  The maximum allowable length of aluminum is considerably shorter than copper wire of same size.
- Make sure that the portion of the total cable which is between the service entrance and a motor starter/controller does not exceed 25 % of the total maximum length to ensure reliable starter operation. Single-phase control boxes may be connected at any point of the total cable length.
- The table is based on maintaining motor terminal voltage at 95 % of the service entrance voltage, running at maximum nameplate amperes. In general, a voltage drop must be maintained at 3 V / 100 ft or less.
- 1 foot = 0.305 meter (1 meter = 3.28 feet).

10.4.2 200-208 V, 3-phase, 60 Hz

Maximum submersible power cable length (maximum cable length in feet, starter to motor)

Motor rating	[Hp]	AWG copper wire size [ft (m)]												
		14	12	10	8	6	4	3	2	1	0	00	000	0000
200-208 V 3-ph 60 Hz	.5	710 (216)	1140 (347)	1800 (549)	2840 (866)	4420 (1347)	-	-	-	-	-	-	-	-
	.75	510 (155)	810 (245)	1280 (390)	2030 (619)	3160 (963)	-	-	-	-	-	-	-	-
	1	430 (131)	690 (210)	1080 (329)	1710 (521)	2670 (814)	4140 (1262)	5140 (1567)	-	-	-	-	-	-
	1.5	310 (94)	500 (152)	790 (241)	1260 (384)	1960 (597)	3050 (930)	3780 (1152)	-	-	-	-	-	-
	2	240 (73)	390 (119)	610 (186)	970 (296)	1520 (463)	2360 (719)	2940 (896)	3610 (1100)	4430 (1350)	5420 (1652)	-	-	-
	3	180 (55)	290 (88)	470 (143)	740 (226)	1160 (354)	1810 (552)	2250 (686)	2760 (841)	3390 (1033)	4130 (1259)	-	-	-
	5	110* (34*)	170 (52)	280 (85)	440 (134)	690 (210)	1080 (329)	1350 (411)	1660 (506)	2040 (622)	2490 (759)	3050 (930)	3670 (1119)	4440 (1353)
	7.5	-	-	200 (61)	310 (94)	490 (149)	770 (235)	960 (293)	1180 (360)	1450 (442)	1770 (539)	2170 (661)	2600 (792)	3150 (960)
	10	-	-	-	230* (70*)	370 (113)	570 (174)	720 (219)	880 (268)	1090 (332)	1330 (405)	1640 (500)	1970 (600)	2390 (728)
	15	-	-	-	160* (49*)	250* (76*)	390 (119)	490 (149)	600 (183)	740 (226)	910 (277)	1110 (338)	1340 (408)	1630 (497)
	20	-	-	-	-	190* (58*)	300* (91*)	380 (116)	460 (140)	570 (174)	700 (213)	860 (262)	1050 (320)	1270 (387)
	25	-	-	-	-	-	240* (73*)	300* (91*)	370* (113*)	460 (140)	570 (174)	700 (213)	840 (256)	1030 (314)
	30	-	-	-	-	-	-	250* (76*)	310* (94*)	380* (116*)	470 (143)	580 (177)	700 (213)	850 (259)

Note:

* Indicates single conductor only (not jacketed).

No asterisk indicates both jacketed cable and single conductor cables.

- The table is based on copper wire. If aluminum wire is used, multiply lengths by 0.5.
  The maximum allowable length of aluminum is considerably shorter than copper wire of same size.
- Make sure that the portion of the total cable which is between the service entrance and a motor starter/controller does not exceed 25 % of the total maximum length to ensure reliable starter operation. Single-phase control boxes may be connected at any point of the total cable length.
- The table is based on maintaining motor terminal voltage at 95 % of service entrance voltage, running at maximum nameplate amperes. In general, a voltage drop must be maintained at 3 V / 100 ft or less.
- 1 foot = 0.305 meter (1 meter = 3.28 feet).

10.4.3 230 V, 3-phase, 60 Hz

Maximum submersible power cable length (maximum cable length in feet, starter to motor)

Motor rating	[Hp]	AWG copper wire size [ft (m)]												
		14	12	10	8	6	4	3	2	1	0	00	000	0000
230 V 3-ph 60 Hz	.5	930 (283)	1490 (454)	2350 (716)	3700 (1128)	5760 (1756)	8910 (2716)	-	-	-	-	-	-	-
	.75	670 (204)	1080 (329)	1700 (518)	2580 (786)	4190 (1277)	6490 (1978)	8060 (2457)	9860 (3005)	-	-	-	-	-
	1	560 (171)	910 (277)	1430 (436)	2260 (689)	3520 (1073)	5460 (1664)	6780 (2067)	8290 (2527)	-	-	-	-	-
	1.5	420 (128)	670 (204)	1060 (323)	1670 (509)	2610 (796)	4050 (1234)	5030 (1533)	6160 (1878)	7530 (2295)	9170 (2795)	-	-	-
	2	320 (98)	510 (155)	810 (247)	1280 (390)	2010 (613)	3130 (954)	3890 (1186)	4770 (1454)	5860 (1786)	7170 (2185)	8780 (2676)	-	-
	3	240 (73)	390 (119)	620 (189)	990 (302)	1540 (469)	2400 (732)	2980 (908)	3660 (1116)	4480 (1366)	5470 (1667)	6690 (2039)	8020 (2444)	9680 (2950)
	5	140* (43*)	230 (70)	370 (113)	590 (180)	920 (280)	1430 (436)	1790 (546)	2190 (668)	2690 (820)	3290 (1003)	4030 (1228)	4850 (1478)	5870 (1789)
	7.5	-	160* (49*)	260 (79)	420 (128)	650 (198)	1020 (311)	1270 (387)	1560 (475)	1920 (585)	2340 (713)	2870 (875)	3440 (1049)	4160 (1268)
	10	-	-	190* (58*)	310 (94)	490 (149)	760 (232)	950 (290)	1170 (357)	1440 (439)	1760 (536)	2160 (658)	2610 (796)	3160 (963)
	15	-	-	-	210* (64*)	330 (101)	520 (158)	650 (198)	800 (244)	980 (299)	1200 (366)	1470 (448)	1780 (543)	2150 (655)
	20	-	-	-	-	250* (76*)	400 (122)	500 (152)	610 (186)	760 (232)	930 (283)	1140 (347)	1380 (421)	1680 (512)
	25	-	-	-	-	-	320* (98*)	400 (122)	500 (152)	610 (186)	750 (229)	920 (280)	1120 (341)	1360 (415)
	30	-	-	-	-	-	260* (79*)	330* (101*)	410* (125*)	510 (155)	620 (189)	760 (232)	930 (283)	1130 (344)

Note:

* Indicates single conductor only (not jacketed).

No asterisk indicates both jacketed cable and single-conductor cables.

- The table is based on copper wire. If aluminum wire is used, multiply lengths by 0.5.
  The maximum permissible length of aluminum is considerably shorter than copper wire of same size.
- Make sure that the portion of the total cable which is between the service entrance and a motor starter/controller does not exceed 25 % of the total maximum length to ensure reliable starter operation. Single-phase control boxes may be connected at any point of the total cable length.
- The table is based on maintaining motor terminal voltage at 95 % of service entrance voltage, running at maximum nameplate amperes. In general, a voltage drop must be maintained at 3 V / 100 ft or less.
- 1 foot = 0.305 meter (1 meter = 3.28 feet).

10.4.4 460 V, 3-phase, 60 Hz

Maximum submersible power cable length (maximum cable length in feet, starter to motor)

Motor rating	[Hp]	AWG copper wire size [ft (m)]												
		14	12	10	8	6	4	3	2	1	0	00	000	0000
460 V 3-ph 60 Hz	.5	3770 (1149)	6020 (1835)	9460 (2883)	-	-	-	-	-	-	-	-	-	-
	.75	2730 (832)	4350 (1326)	6850 (2088)	-	-	-	-	-	-	-	-	-	-
	1	2300 (701)	3670 (1119)	5770 (1759)	9070 (2765)	-	-	-	-	-	-	-	-	-
	1.5	1700 (518)	2710 (826)	4270 (1301)	6730 (2051)	-	-	-	-	-	-	-	-	-
	2	1300 (396)	2070 (631)	3270 (997)	5150 (1570)	8050 (2454)	-	-	-	-	-	-	-	-
	3	1000 (305)	1600 (488)	2520 (768)	3970 (1210)	6200 (1890)	-	-	-	-	-	-	-	-
	5	590 (180)	950 (290)	1500 (457)	2360 (719)	3700 (1128)	5750 (1753)	-	-	-	-	-	-	-
	7.5	420 (128)	680 (207)	1070 (326)	1690 (515)	2640 (805)	4100 (1250)	5100 (1554)	6260 (1908)	7680 (2341)	-	-	-	-
	10	310 (94)	500 (152)	790 (241)	1250 (381)	1960 (597)	3050 (930)	3800 (1158)	4680 (1426)	5750 (1753)	7050 (2149)	-	-	-
	15	-	340* (104*)	540 (165)	850 (259)	1340 (408)	2090 (637)	2600 (792)	3200 (975)	3930 (1198)	4810 (1466)	5900 (1798)	7110 (2167)	-
	20	-	-	410 (125)	650 (198)	1030 (314)	1610 (491)	2000 (610)	2470 (753)	3040 (927)	3730 (1137)	4580 (1396)	5530 (1686)	-
	25	-	-	330* (101*)	530 (162)	830 (253)	1300 (396)	1620 (494)	1990 (607)	2450 (747)	3010 (917)	3700 (1128)	4470 (1362)	5430 (1655)
	30	-	-	270* (82*)	430 (131)	680 (207)	1070 (326)	1330 (405)	1640 (500)	2030 (619)	2490 (759)	3060 (933)	3700 (1128)	4500 (1372)
	40	-	-	-	320* (98*)	500* (152*)	790 (241)	980 (299)	1210 (369)	1490 (454)	1830 (558)	2250 (686)	2710 (826)	3290 (1003)
	50	-	-	-	-	410* (125*)	640 (195)	800 (244)	980 (299)	1210 (369)	1480 (451)	1810 (552)	2190 (668)	2650 (808)
	60	-	-	-	-	-	540* (165*)	670* (204*)	830 (253)	1020 (311)	1250 (381)	1540 (469)	1850 (564)	2240 (683)
	75	-	-	-	-	-	440* (134*)	550* (168*)	680* (207*)	840 (256)	1030 (314)	1260 (384)	1520 (463)	1850 (564)
	100	-	-	-	-	-	-	-	500* (152*)	620 (189*)	760* (232*)	940 (287)	1130 (344)	1380 (421)
	125	-	-	-	-	-	-	-	-	-	600* (183*)	740* (226*)	890* (271*)	1000 (305)
	150	-	-	-	-	-	-	-	-	-	-	630* (192*)	760* (232*)	920* (280*)
	175	-	-	-	-	-	-	-	-	-	-	-	670* (204*)	810* (247*)
	200	-	-	-	-	-	-	-	-	-	-	-	590* (180*)	710* (216*)

Note:

* Indicates single conductor only (not jacketed).

No asterisk indicates both jacketed cable and single-conductor cables.

- The table is based on copper wire. If aluminum wire is used, multiply lengths by 0.5.
  The maximum permissible length of aluminum is considerably shorter than copper wire of same size.
- Make sure that the portion of the total cable which is between the service entrance and a motor starter/controller does not exceed 25 % of the total maximum length to ensure reliable starter operation. Single-phase control boxes may be connected at any point of the total cable length.
- The table is based on maintaining motor terminal voltage at 95 % of service entrance voltage, running at maximum nameplate amperes. In general, a voltage drop must be maintained at 3 V/100 ft or less.
- 1 foot = 0.305 meter (1 meter = 3.28 feet).

10.4.5 575 V, 3-phase, 60 Hz

Maximum submersible power cable length (maximum cable length in feet, starter to motor)

Motor rating	[Hp]	AWG copper wire size [ft (m)]												
		14	12	10	8	6	4	3	2	1	0	00	000	0000
575 V 3-ph 60 Hz	5	5900 (1798)	9410 (2868)	-	-	-	-	-	-	-	-	-	-	-
	.75	4270 (1301)	6810 (2076)	-	-	-	-	-	-	-	-	-	-	-
	1	3630 (1106)	5800 (1768)	9120 (2780)	-	-	-	-	-	-	-	-	-	-
	1.5	2620 (799)	4180 (1274)	6580 (2006)	-	-	-	-	-	-	-	-	-	-
	2	2030 (619)	3250 (991)	5110 (1558)	8060 (2457)	-	-	-	-	-	-	-	-	-
	3	1580 (482)	2530 (771)	3980 (1213)	6270 (1911)	-	-	-	-	-	-	-	-	-
	5	920 (280)	1480 (451)	2330 (710)	3680 (1122)	5750 (1753)	-	-	-	-	-	-	-	-
	7.5	660 (201)	1060 (323)	1680 (512)	2650 (808)	4150 (1265)	-	-	-	-	-	-	-	-
	10	490 (149)	780 (238)	1240 (378)	1950 (594)	3060 (933)	4770 (1454)	5940 (1811)	-	-	-	-	-	-
	15	330* (101*)	530 (162)	850 (259)	1340 (408)	2090 (637)	3260 (994)	4060 (1237)	-	-	-	-	-	-
	20	-	410* (125*)	650 (198)	1030 (314)	1610 (491)	2520 (768)	3140 (957)	3860 (1177)	4760 (1451)	5830 (1777)	-	-	-
	25	-	-	520 (158)	830 (253)	1300 (396)	2030 (619)	2530 (771)	3110 (948)	3840 (1170)	4710 (1436)	-	-	-
	30	-	-	430* (131*)	680 (207)	1070 (326)	1670 (509)	2080 (634)	2560 (780)	3160 (963)	3880 (1183)	4770 (1454)	5780 (1762)	7030 (2143)
	40	-	-	-	500* (152*)	790 (241)	1240 (378)	1540 (469)	1900 (579)	2330 (710)	2860 (872)	3510 (1070)	4230 (1289)	5140 (1567)
	50	-	-	-	410* (125*)	640* (195*)	1000 (305)	1250 (381)	1540 (469)	1890 (576)	2310 (704)	2840 (866)	3420 (1042)	4140 (1262)
	60	-	-	-	-	540* (165*)	850 (259)	1060 (323)	1300 (396)	1600 (488)	1960 (597)	2400 (732)	2890 (881)	3500 (1067)
	75	-	-	-	-	-	690* (210*)	860 (262)	1060 (323)	1310 (399)	1600 (488)	1970 (600)	2380 (725)	2890 (881)
	100	-	-	-	-	-	-	640* (195*)	790* (241*)	970 (296)	1190 (363)	1460 (445)	1770 (539)	2150 (655)
	125	-	-	-	-	-	-	-	630* (192*)	770* (235*)	950 (290)	1160 (354)	1400 (427)	1690 (515)
	150	-	-	-	-	-	-	-		660* (202*)	800* (244*)	990* (302*)	1190 (363)	1440 (439)
	175	-	-	-	-	-	-	-	-	-	700* (214*)	870* (265*)	1050* (320*)	1270 (387)
	200	-	-	-	-	-	-	-	-	-	-	760* (232*)	920* (280*)	1110* (338*)

Note:

* Indicates single conductor only (not jacketed).

No asterisk indicates both jacketed cable and single-conductor cables.

- The table is based on copper wire. If aluminum wire is used, multiply lengths by 0.5.
  The maximum permissible length of aluminum is considerably shorter than copper wire of same size.
- Make sure that the portion of the total cable which is between the service entrance and a motor starter/controller does not exceed 25 % of the total maximum length to ensure reliable starter operation. Single-phase control boxes may be connected at any point of the total cable length.
- The table is based on maintaining motor terminal voltage at 95 % of service entrance voltage, running at maximum nameplate amperes. In general, a voltage drop must be maintained at 3 V/100 ft or less.
- 1 foot = 0.305 meter (1 meter = 3.28 feet).

10.5 Approvals

<table>
<tr><td>SP 4"</td><td colspan="3"></td></tr>
<tr><td>SP 4" pump end (5S - 77S)</td><td colspan="3">WATER QUALITY
Drinking Water System Component
NSF/ANSI 61
MH26400
NSF/ANSI 372</td></tr>
<tr><td>MS 6000C motor</td><td>Submersible Motor
NSF/ANSI 372
MH26400</td><td rowspan="3"></td><td rowspan="2"></td></tr>
<tr><td>MS 4000 motor</td><td></td></tr>
<tr><td>MS 402 motor</td><td></td><td>IAPMO
File 6591
0.25 % lead</td></tr>
</table>

The Grundfos SP pumps are certified when driven by a certified motor provided with suitable overheating protection.

10.6 Electrical data

10.6.1 Grundfos submersible motors, 60 Hz

Grundfos submersible motors, 60 Hz										
Hp	Ph	Volt [V]	SF	Circuit breaker or fuses		Amperage		Full load		Max. thrust [lbs]
				Std.	Delay	Start [A]	Max. [A]	Eff. [%]	Power factor	
4-inch, single-phase, 2-wire motors (control box not required)										
0.5	1	115	1.60	35	15	55.0	12.0	62	76	900
0.5	1	230	1.60	15	7	34.5	6.0	62	76	900
0.75	1	230	1.50	20	9	40.5	8.4	62	75	900
1	1	230	1.40	25	12	48.4	9.8	63	82	900
1.5	1	230	1.30	35	15	62.0	13.1	64	85	900
4-inch, single-phase, 3-wire motors										
0.5	1	115	1.60	35	15	42.5	12.0	61	76	900
0.5	1	230	1.60	15	7	21.5	6.0	62	76	900
0.75	1	230	1.50	20	9	31.4	8.4	62	75	900
1	1	230	1.40	25	12	37.0	9.8	63	82	900
1.5	1	230	1.30	35	15	45.9	11.6	69	89	900
2	1	230	1.25	35	20	57.0	13.2	72	86	1500
3	1	230	1.15	45	30	77.0	17.0	74	93	1500
5	1	230	1.15	70	45	110.0	27.5	77	92	1500
4-inch, three-phase, 3-wire motors										
1.5	3	230	1.30	15	8	40.3	7.3	75	72	900
1.5	3	460	1.30	10	4	20.1	3.7	75	72	900
1.5	3	575	1.30	10	4	16.1	2.9	75	72	900
2	3	230	1.25	20	10	48	8.7	76	75	900
2	3	460	1.25	10	5	24	4.4	76	75	900
2	3	575	1.25	10	4	19.2	3.5	76	75	900
3	3	230	1.15	30	15	56	12.2	77	75	1500
3	3	460	1.15	15	7	28	6.1	77	75	1500
3	3	575	1.15	15	6	22	4.8	77	75	1500
5	3	230	1.15	40	25	108	19.8	80	82	1500
5	3	460	1.15	20	12	54	9.9	80	82	1500
5	3	575	1.15	15	9	54	7.9	80	82	1500
7.5	3	230	1.15	60	30	130	25.0	81	82	1500
7.5	3	460	1.15	35	15	67	13.2	81	82	1500
7.5	3	575	1.15	30	15	67	10.6	81	82	1500
10	3	460	1.15	50	30	90	18	81	80	1500

CAUTION

Caution

Single-phase motors (thermally protected): Use with approved motor control that matches motor input in full load amperes.

CAUTION

Caution

Three-phase motors: Use with approved motor control that matches motor input in full load amperes with overload element(s) selected or adjusted in accordance with control instructions.

Grundfos submersible motors, 60 Hz										
Hp	Ph	Volt [V]	SF	Circuit breaker or fuses		Amperage		Full load		Max. thrust [lbs]
				Std.	Delay	Start [A]	Max. [A]	Eff. [%]	Power factor	
6-inch, three-phase motors										
7.5	3	208-230	1.15	65	40	114-130	23.4 - 27.5	81	85-84	6070
7.5	3	460	1.15	30	17	68	13.2	81	85	6070
7.5	3	575	1.15	30	17	51	10.2	81	85	6070
10	3	208-230	1.15	90	50	126-142	30.0 - 37.5	82	86-84	6070
10	3	460	1.15	40	25	75	17.4	82	85	6070
10	3	575	1.15	40	25	56.5	13.4	82	85	6070
15	3	208-230	1.15	130	75	198-224	44.5 - 53.5	83	86-84	6070
15	3	460	1.15	60	35	112	25	83	84	6070
15	3	575	1.15	60	35	84	19.4	83	84	6070
20	3	208-230	1.15	175	100	310-350	57.5 - 71.5	84	86-84	6070
20	3	460	1.15	80	45	186	33.5	84	84	6070
20	3	575	1.15	80	45	144	26	84	84	6070
25	3	208-230	1.15	200	125	395-445	71-87	84	87-84	6070
25	3	460	1.15	100	60	236	41	84	84	6070
25	3	575	1.15	100	60	180	32	84	84	6070
30	3	208-230	1.15	250	150	445-500	81-104	84	87-84	6070
30	3	460	1.15	125	70	265	48	85	85	6070
30	3	575	1.15	125	70	194	37	85	85	6070
40	3	460	1.15	170	90	330	65	85	84	6070
40	3	575	1.15	170	90	250	49.5	85	84	6070
50	3	460	1.15	225	125	405	73.0	83	83	6182
8-inch, three-phase motors										
40	3	460	1.15	175	100	380	55.7	83	85	13000
50	3	460	1.15	225	125	550	67.8	84	85	13000
60	3	460	1.15	250	150	640	80.4	86	85	13000
75	3	460	1.15	300	175	580	97.4	86	86	13000
100	3	460	1.15	400	225	570	130.4	87	86	13000
125	3	460	1.15	500	300	600	160.0	87	87	13000
150	3	460	1.15	600	350	580	191.3	86	87	13000
10-inch, three-phase motors										
175	3	460	1.15	700	400	570	230.4	88	85	13000
200	3	460	1.15	800	500	620	265.2	87	82	13000
250	3	460	1.15	1100	600	610	352.2	87	79	13000

10.6.2 Other motor manufacturers

Refer to the other motor manufacturers' application maintenance manual.

10.6.3 Correcting for three-phase current imbalance

Example: Check for current imbalance for a 230 volt, three-phase, 60 Hz submersible motor, 18.6 full load amps.

Solution: Steps 1 to 3 measure and record amps on each submersible drop cable lead for hookups 1, 2 and 3.

Observe that hookup 3 must be used since it shows the least amount of current imbalance. Therefore, the motor will operate at maximum efficiency and reliability.

By comparing the current values recorded on each leg, you will note the highest value was always on the same leg, L_3. This indicates the imbalance is in the power source. If the high current values were on a different leg each time the leads were changed, the imbalance would be caused by the motor or a poor connection.

If the current imbalance is greater than 5 %, contact your power supply company for help.

For a detailed explanation of three-phase balance procedures, see section *7.1 Startup with three-phase motors*.

	Step 1 (hookup 1)	Step 2 (hookup 2)	Step 3 (hookup 3)
(T_1)	DL_1 = 25.5 amps	DL_3 = 25 amps	DL_2 = 25.0 amps
(T_2)	DL_2 = 23.0 amps	DL_1 = 24 amps	DL_3 = 24.5 amps
(T_3)	DL_3 = 26.5 amps	DL_2 = 26 amps	DL_1 = 25.5 amps
Step 4	Total = 75 amps	Total = 75 amps	Total = 75 amps
Step 5	Average current =	$\frac{\text{total current}}{\text{3 readings}}$ =	$\frac{75}{3}$ = 25 amps
Step 6	Greatest amp difference from the average:	(hookup 1) = 25 - 23 = 2 (hookup 2) = 26 - 25 = 1 (hookup 3) = 25.5 - 25 = 0.5	
Step 7	% imbalance	(hookup 1) = 2/25 x 100 = 8 (hookup 2) = 1/25 x 100 = 4 (hookup 3) = 0.5/25 x 100 = 2	

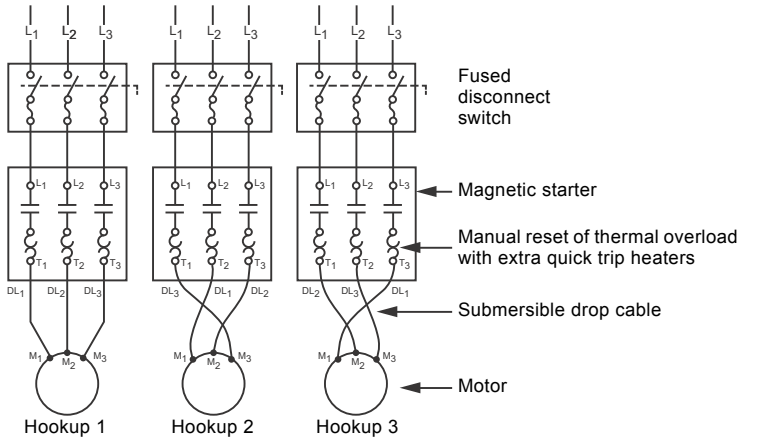


Fig. 18 Correcting for three-phase current imbalance

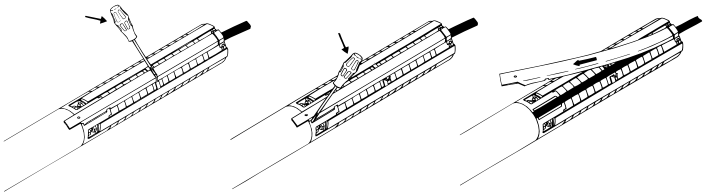
11. Disposal

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

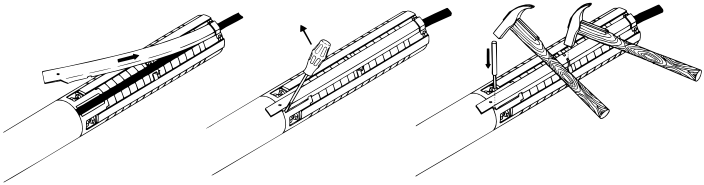
1. Use the public or private waste collection service.
2. If this is not possible, contact the nearest Grundfos company or service workshop.

Removal and fitting of cable guard

Removing cable guard



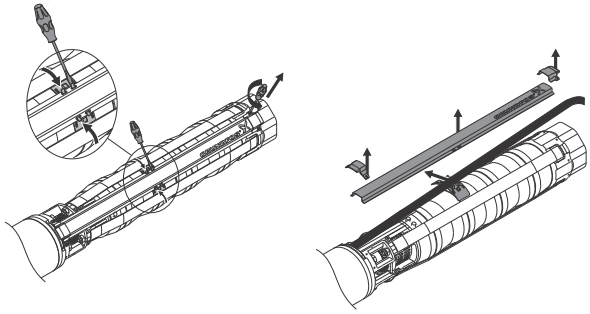
Fitting cable guard



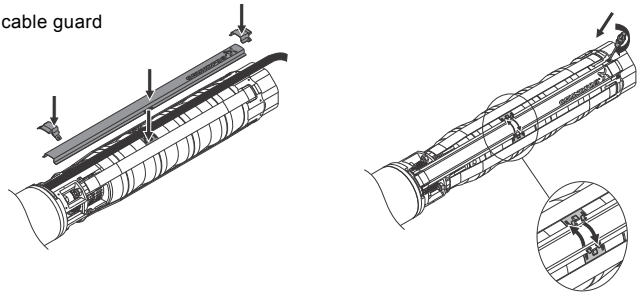
TM00 1323 0603

Fig. 1 Removal and fitting of cable guard for SP 5S, 7S, 10S, 16S, and 25S (smooth shaft)

Removing cable guard

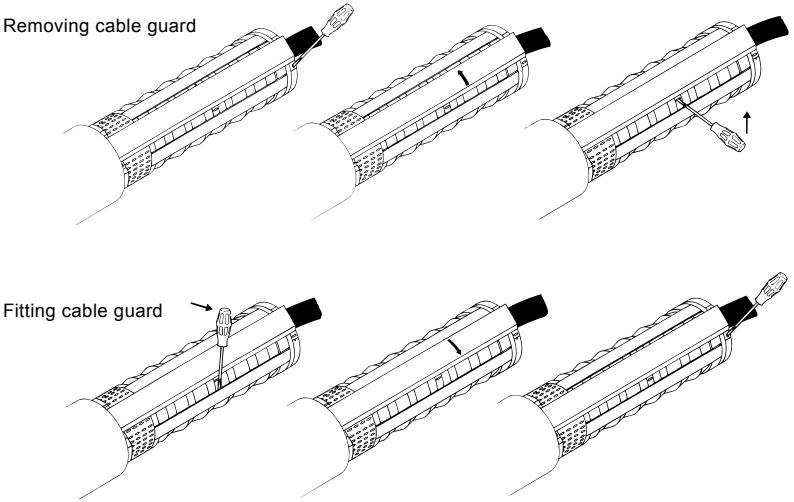


Fitting cable guard



TM06 0693 0814

Fig. 2 Removal and fitting of cable guard for SP 35S, 45S, 62S, 77S, 150S, 230S, and 300S

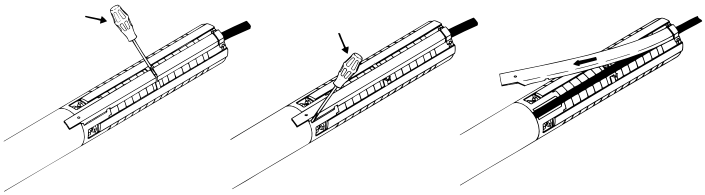


TM00 1326 0603

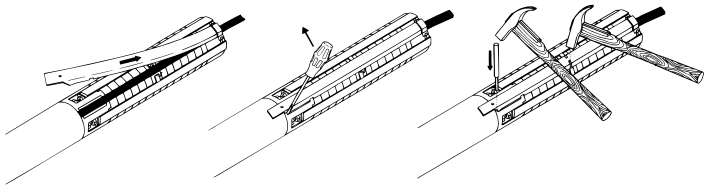
Fig. 3 Removal and fitting of cable guard for SP 385S, 475S, 625S, 800S, and 1100S

Dépose et fixation du protège-câble

Dépose du protège-câble



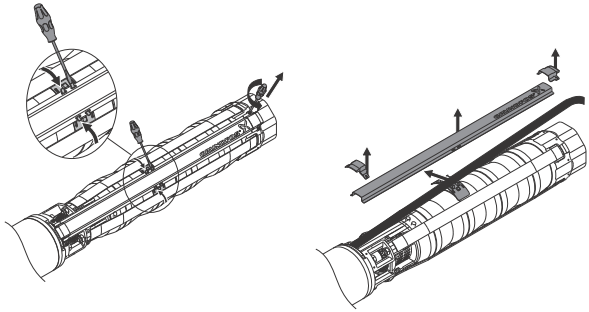
Fixation du protège-câble



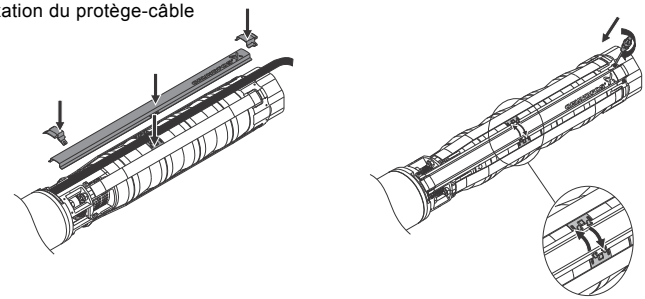
TM00 1323 0603

Fig. 1 Dépose et fixation du protège-câble pour SP 5S, 7S, 10S, 16S, et 25S (arbre lisse)

Dépose du protège-câble

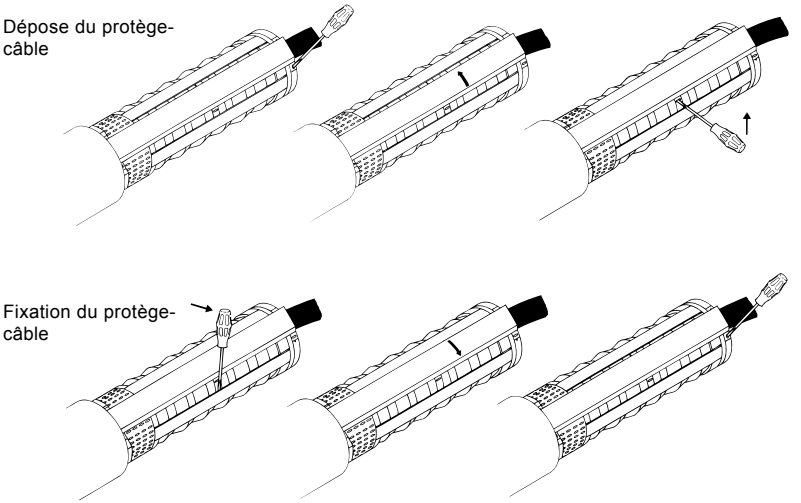


Fixation du protège-câble



TM06 0693 0814

Fig. 2 Dépose et fixation du protège-câble pour SP 35S, 45S, 62S, 77S, 150S, 230S, et 300S

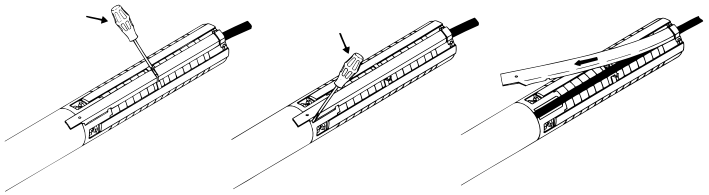


TM00 1326 0603

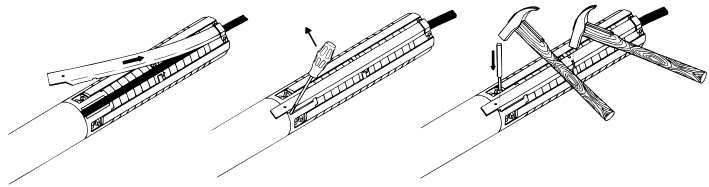
Fig. 3 Dépose et fixation du protège-câble pour SP 385S, 475S, 625S, 800S, et 1100S

Desmontaje e instalación de la cubierta del cable

Desmontaje de la cubierta del cable



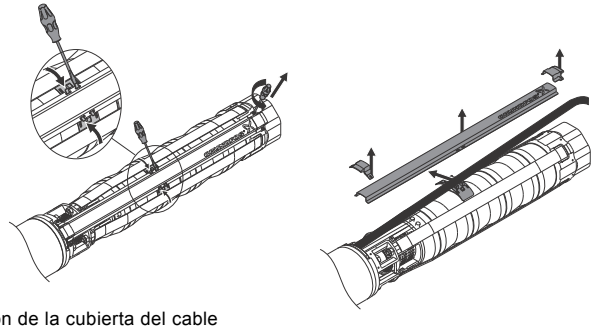
Instalación de la cubierta del cable



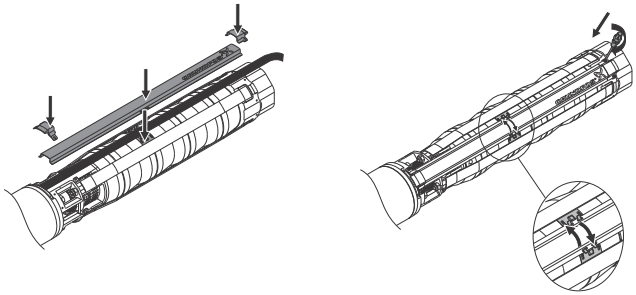
TM00 1323 0603

Fig. 1 Desmontaje e instalación de la cubierta del cable para bombas SP 5S, 7S, 10S, 16S y 25S (eje flexible)

Desmontaje de la cubierta del cable

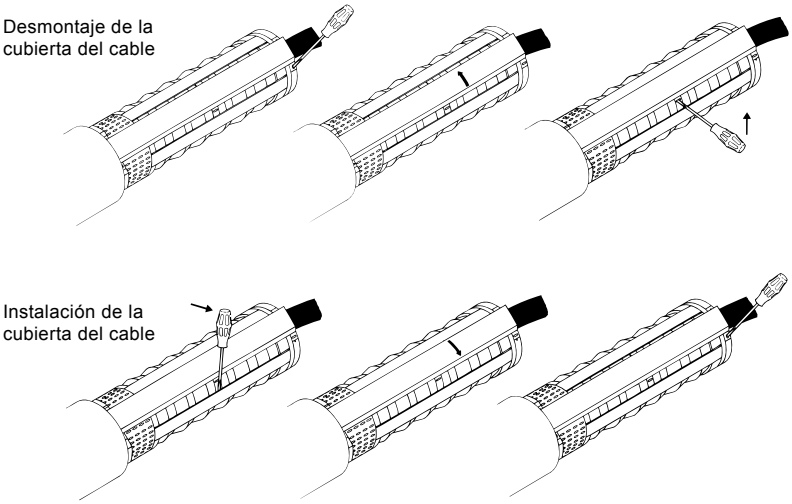


Instalación de la cubierta del cable



TM06 0693 0814

Fig. 2 Desmontaje e instalación de la cubierta del cable para bombas SP 35S, 45S, 62S, 77S, 150S, 230S, y 300S



TM00 1326 0603

Fig. 3 Desmontaje e instalación de la cubierta del cable para bombas SP 385S, 475S, 625S, 800S y 1100S

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