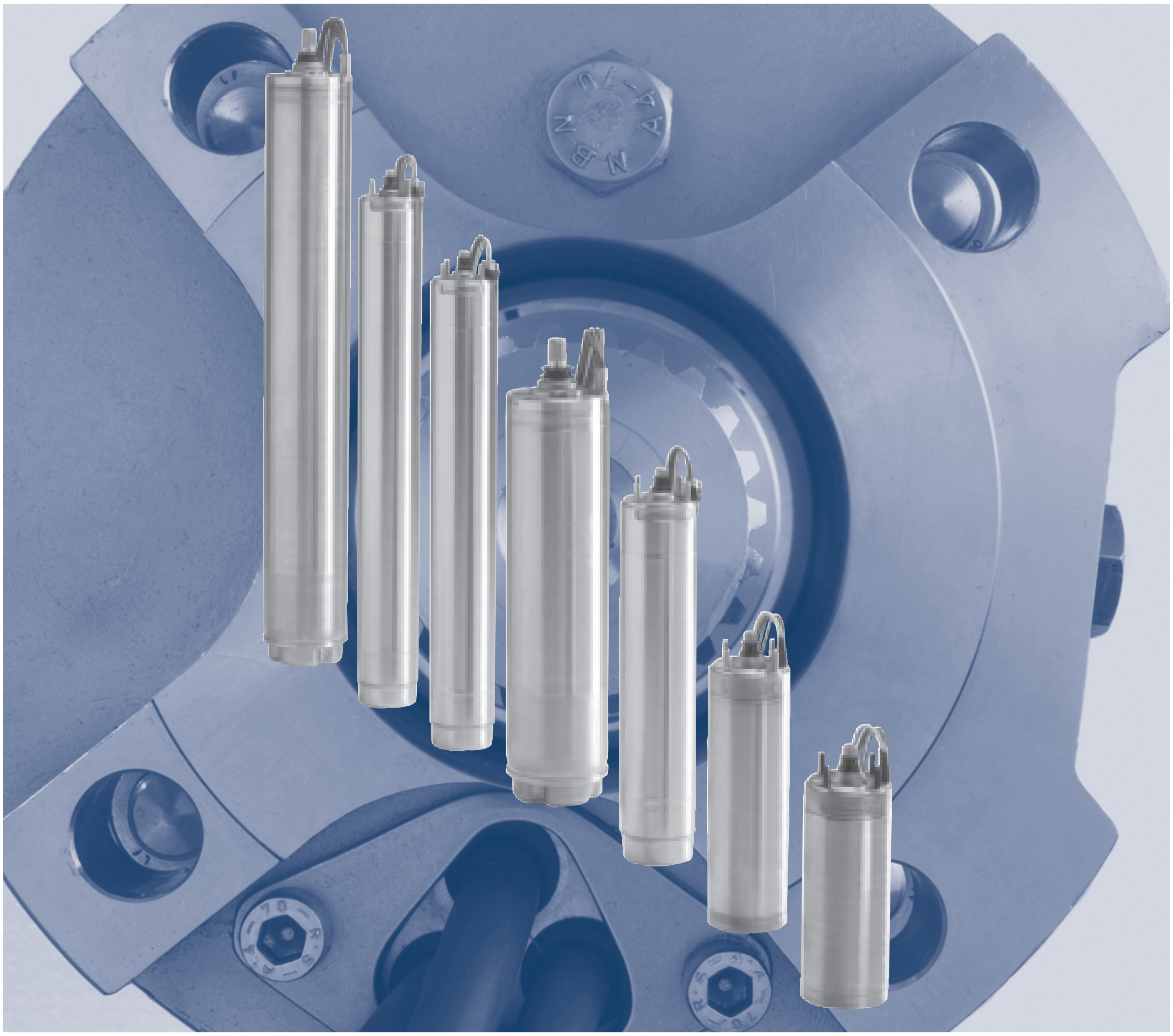
GRUNDFOS **PRODUCT GUIDE**

MS

Submersible motors
60 Hz



BE > THINK > INNOVATE >

GRUNDFOS

Contents

Mission

- to successfully develop, produce, and sell high quality pumps and pumping systems worldwide, contributing to a better quality of life and healthier environment

GBJ - Bjerringbro, Denmark

GMU - Fresno, California

GPU - Olathe, Kansas

GMX - Monterrey, Mexico

GPA - Allentown, Pennsylvania

GCA - Oakville, Ontario

- One of the 3 largest pump companies in the world
- World headquarters in Denmark
- North American headquarters in Kansas City - Manufacturing in Fresno, California
- 60 companies in 40 countries
- More than 10 million pumps produced annually worldwide
- North American companies operating in USA, Canada and Mexico
- Continuous reinvestment in growth and development enables the company to **BE** responsible, **THINK** ahead, and **INNOVATE**

Product data

Introduction

Grundfos MS motors introduction

Grundfos submersible motors are designed specifically for operation in and under water.

The motor and power cable are designed and sealed to prevent water from contacting any part of the electrical circuit.

The motors are equipped with a high-capacity thrust bearing to support the total thrust of the pumping unit.

The Grundfos submersible motor depends on surrounding water to carry away heat; most require a specified flow of water for adequate cooling.

MS motor selection

Selecting the best submersible motor for a particular pump application requires careful consideration of several factors. The motor must match the pump in mounting dimensions, and must also have adequate Hp load rating and thrust rating to support the pump over its entire operating range. Grundfos 4" and 6" submersible motors are built to NEMA standards, which define their physical dimensions, electrical ratings, and thrust ratings. The motor must be capable of operation at the water temperature and velocity presented by the installation.

Grundfos literature specifies the maximum water temperature and minimum required velocity past the motor. Motor operation in water that exceeds the rated temperature may be allowable at reduced loading, depending on the particular motor.

If the installation does not assure the specified velocity past the motor- because of well diameter, well inflow above the pump or other reasons - a sleeve over the motor should be used to induce the required velocity.

Product range

Motor size	MS 402 4"		MS 4000 (R) 4"		MS 6000 (R) 6"	
	Hp	Kw	Hp	Kw	Hp	Kw
Power range, direct-on-line						
- 1 x 115 V	.50	.37	-	-	-	-
- 1 x 230 V	.33 - 1.50	.25 - 1.1	2.0 - 5.0	1.5 - 4.0	-	-
- 3 x 230 V	.50 - 2.0	.37 - 1.50	3.0 - 7.5	2.2 - 5.5	7.5 - 30.0	5.5 - 22.0
- 3 x 460 V	.50 - 2.0	.37 - 1.50	3.0 - 10.0	2.2 - 7.5	7.5 - 40.0	5.5 - 30.0
- 3 x 575 V	.50 - 2.0	.37 - 1.50	3.0 - 10.0	2.2 - 7.5	7.5 - 40.0	5.5 - 30.0
Allowed installation						
- Vertical	.33 - 2.0	.25 - 1.5	2.0 - 10.0	1.5 - 7.5	7.5 - 40.0	5.5 - 30.0
- Horizontal	.33 - 2.0	.25 - 1.5	2.0 - 10.0	1.5 - 7.5	7.5 - 40.0	5.5 - 30.0

Model designation

MS 402

Example	MS	4	02
Motor submersible	MS		
Min. borehole diameter in inches		4	
Generation			02
- = Stainless steel AISI 304			

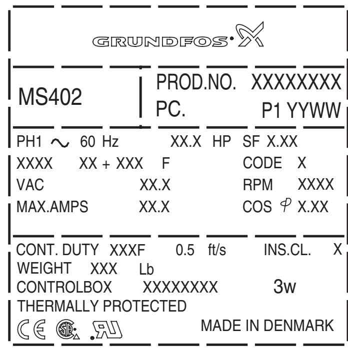
MS 4000

Example	MS	4	000	R
Motor submersible	MS			
Min. borehole diameter in inches		4		
Generation			000	
- = Stainless steel AISI 304 R = Stainless steel AISI 904L I = Stainless steel AISI 304 + De-rated RE = Stainless steel AISI 904 L + FKM EI = Stainless steel AISI 304 + De-rated + FKM				R

MS 6000

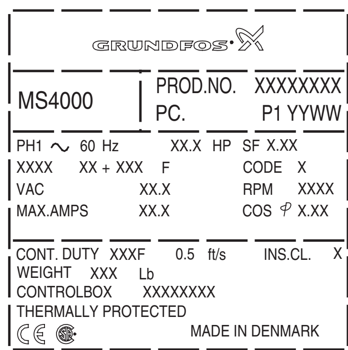
Example	MS	6	000	R
Motor submersible	MS			
Min. borehole diameter in inches		6		
Generation			000	
- = Stainless steel AISI 304 R = Stainless steel AISI 904L I = Stainless steel AISI 304 + De-rated RE = Stainless steel AISI 904 L + FKM EI = Stainless steel AISI 304 + De-rated + FKM				R

Nameplate



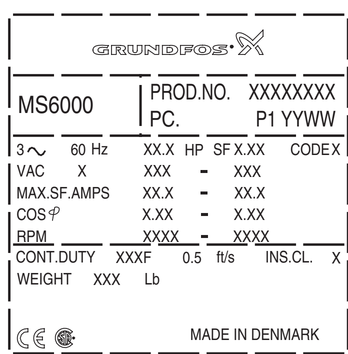
TM03 0542 0502

Fig. 1 MS402



TM03 0543 0502

Fig. 2 MS4000



TM03 0544 0502

Fig. 3 MS6000

MS 402

65495 0205

- Complete range of motors from 1/3 - 2 Hp 1 ph, 2-wire ; 3-wire and 3 Ph.
- Designed for 4" and larger wells
- Corrosion resistance all stainless steel exterior construction
- Cast stainless steel machined top
- Stainless steel splined shaft
- Stator windings hermetically encapsulated in stainless steel
- Polyurethane self healing resin
- 900 lb. thrust rating
- Water lubricated
- Internal water circulation system enhances motor cooling
- No cooling sleeve needed up to 85°F
- Rated up to 104°F with 1/2 ft./sec. flow past the motor
- Filter check valve
- Michell type carbon/ceramic thrust bearing
- Pressure equalization diaphragm
- Sand slinger
- Bellows type shaft-seal
- Epoxy coated bearing support
- Built-in surge protection
- Replaceable motor lead
- NEMA mounting dimensions
- UL recognized .33HP - 1.5HP 1ph
- CSA certified

★ 2-wire motors are only available up to 1.5 Hp

MS 4000

65492 0205

- Complete range of motors from 3 - 10HP 1 Ph, 3-wire and 3 Ph.
- Designed for 4" and larger wells
- Corrosion resistance all stainless steel exterior construction
- Cast stainless steel machined top
- Stainless steel splined shaft
- Stator windings hermetically encapsulated in stainless steel
- Water lubricated
- Internal water circulation system enhances motor cooling
- No cooling sleeve needed up to 85°F
- Rated up to 104°F with 1/2 ft./sec. flow past the motor
- Filter check valve
- Michell type carbon/ceramic thrust bearing
- 1500 lb. thrust rating
- Pressure equalization diaphragm
- Sand slinger
- Tungsten carbide/ceramic shaft-seal, for long life in sandy applications
- Steel bearing support
- 7 1/2 and 10HP equipped with Tempcon temperature sensor
- 3 Ph motors work with MTP 75 and CU 3 motor protection system
- Replaceable motor lead
- NEMA mounting dimensions
- CSA certified

Special construction features

- Available in a 904L grade of stainless steel and/or FKM, for aggressive applications
- Available in an industrial version for industrial applications
- Designed for long life and lower operating costs.

★ Tempcon optional on 3HP and 5HP

Features

MS 6000

GR7291

- Complete range of motors from 7 1/2 - 40HP 3 Ph
- Designed for 6" and larger wells
- Corrosion resistance all stainless steel exterior construction
- Stainless steel splined shaft
- Stator windings hermetically encapsulated in stainless steel
- Water lubricated
- Internal water circulation system enhances motor cooling
- No cooling sleeve needed up to 85°F
- Rated up to 104°F with 1/2 ft./sec. flow past the motor
- Filtered check valve
- Michell type carbon/ceramic thrust bearing
- 7000 lb. thrust rating
- Pressure equalization diaphragm
- Sand slinger
- Tungsten carbide/ceramic shaft-seal, standard
- Optional silicon/carbide shaft-seal, for long life in sandy applications
- Steel bearing support
- Equipped with Tempcon temperature sensor as standard
- Work with MTP 75 and CU 3 motor protection system
- Replaceable motor lead
- NEMA mounting dimensions
- CSA certified

Special Construction Features

- Available in a 904L Grade of Stainless Steel and/or FKM, for aggressive Applications
- Available In an Industrial Version for Industrial Applications
- Designed for Long Life and Lower operating Costs.

Operating conditions

Cooling

The cooling of the motor depends on the temperature and the flow velocity of the pumped liquid past the motor.

To ensure sufficient cooling, the values for maximum temperature of the pumped liquid and its flow velocity must be kept.

It is reccomended always to ensure a minimum cooling flow of 0.50 f/s.

Free convection

Free convection is achieved when the diameter of the borehole is at least 2" (~ 50 mm) bigger than the outer diameter of the motor.

The motor should always be installed above the borehole screen. If a flow sleeve is used, the motor can be placed in the screen.

Calculation of the flow velocity:

$$v = \frac{Q_{min}}{2826 \times (D_i^2 - d_A^2)} f/s$$

Required data:

Q_{min}: Flow in gpm
D_i: Borehole diameter in inches
d_A: Motor diameter in inches

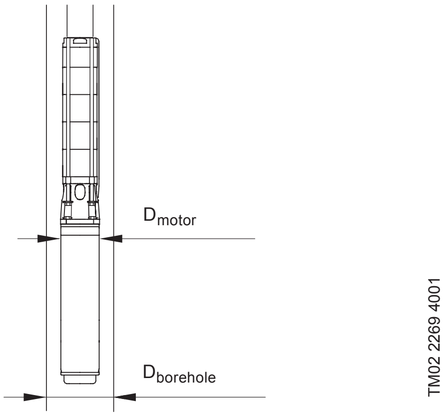


Fig. 4 Drawing for cooling flow

Operating conditions

MS 402

Pumped liquids

MS 402 is generally recommended for operation in water without any appreciable amount of chloride at common groundwater temperatures.

- MS402 is made of 304 stainless steel AISI

Sand content

Max. sand content in pumped liquid: 50 ppm.

Ambient pressure

Max. 20 bar ~ 290 psi.

It is generally not recommended to install the motor for operation in a vacuum.

Cooling

Cooling of the motor depends on temperature and velocity of flow of the pumped liquid past the motor. In order to ensure sufficient cooling, the values for max. temperature of the pumped liquid and its velocity of flow past the motor stated in the table to the right must be kept.

Note: The temperature limits are based on the condition that the other operating conditions are as specified in this Product Guide.

In case the actual temperature of the pumped liquid is higher than the one stated in the table, or if the operating conditions are especially unfavourable, please contact Grundfos.

Free convection

Free convection is achieved when the diameter of the borehole is at least 2" (~ 50 mm) bigger than the outer diameter of the motor, or if the motor is installed in the borehole screen.

Velocity of flow past the motor	Max. temperature of pumped liquid	
	Vertical installation	Horizontal installation
0.0 f/s (Free convection)	30°C (86°F)	Flow sleeve recommended
Min. 0.25 f/s	40°C (104°F)	40°C (104°F)

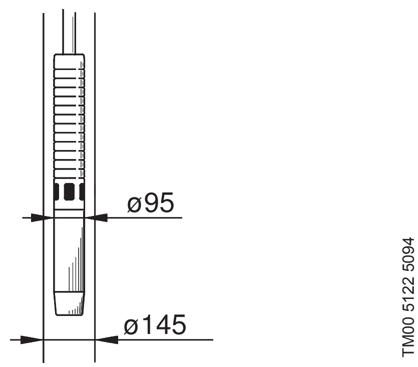


Fig. 5 Free convection

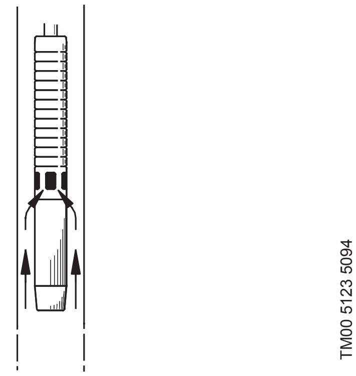


Fig. 6 Flow of pumped liquid past the motor

Operating conditions

MS 4000

Pumped liquids

The MS 4000 motors are available in several versions to enable use in various liquids.

- MS 4000 is generally recommended for use in water without chloride.
  MS 4000 is made of 304 stainless steel AISI
- MS 4000 R is recommended for use in aggressive liquids.
  MS 4000 R is made of 904L stainless steel AISI
- MS 4000 RE is recommended for use in aggressive and slightly contaminated liquids.
  MS 4000 RE is made of 904L stainless steel AISI, and the original rubber parts have been replaced with FKM.

In cases of doubt, please make an analysis of the liquid and contact Grundfos.

Sand content

Max. sand content in pumped liquid: 50 ppm.

Ambient pressure

Max. 60 bar ~ 870 psi.

It is generally not recommended to install the motor for operation in a vacuum.

Cooling

Cooling of the motor depends on temperature and velocity of flow of the pumped liquid past the motor. In order to ensure sufficient cooling, the values for max. temperature of the pumped liquid and its velocity of flow past the motor stated in the table to the right must be kept.

It is recommended to always install the motor above the borehole screen.

Note: The temperature limits are based on the condition that the other operating conditions are as specified in this Product Guide.

In case the actual temperature of the pumped liquid is higher than the one stated in the table, or if the operating conditions are especially unfavourable, please contact Grundfos.

Free convection

Free convection is achieved when the diameter of the borehole is at least 2" (~ 50 mm) bigger than the outer diameter of the motor, or if the motor is installed in the borehole screen.

Velocity of flow past the motor	Max. temperature of pumped liquid	
	Vertical installation	Horizontal installation
0.0 f/s (Free convection)	30°C (86°F)	Flow sleeve recommended
Min. 0.25 f/s	40°C (104°F)	40°C (104°F)

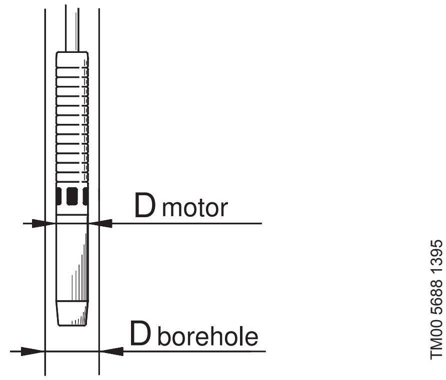


Fig. 7 Free convection

MS 6000

Pumped liquids

The MS 6000 motors are available in several versions to enable use in various liquids.

- MS 6000 is generally recommended for use in common groundwater.
  MS 6000 is made of 304 stainless steel AISI.
- MS 6000 R is recommended for use in aggressive liquids.
  MS 6000 R is made of 904L stainless steel AISI.
- MS 6000 RE is recommended for use in aggressive and slightly contaminated liquids.
  MS 4000 RE is made of 904 stainless steel AISI, and the rubber parts are made of FKM.

In cases of doubt, please make an analysis of the liquid and contact Grundfos.

Sand content

Max. sand content in pumped liquid: 50 ppm.

Ambient pressure

Max. 60 bar ~ 870 psi.

It is generally not recommendable to install the motor for operation in a vacuum.

If this cannot be avoided, please contact Grundfos for guidance.

Cooling

Cooling of the motor depends on temperature and velocity of flow of the pumped liquid past the motor. In order to ensure sufficient cooling, the values for max. temperature of the pumped liquid and its velocity of flow past the motor stated in the table to the right must be kept.

Free convection

Free convection is achieved when the diameter of the borehole is at least 2" (~ 50 mm) bigger than the outer diameter of the motor.

Velocity of flow past the motor	Max. temperature of pumped liquid	
	Vertical installation	Horizontal installation
0.0 f/s (Free convection)	30°C (86°F)	Flow sleeve recommended
Min. 0.25 f/s	40°C (104°F)	40°C (104°F)

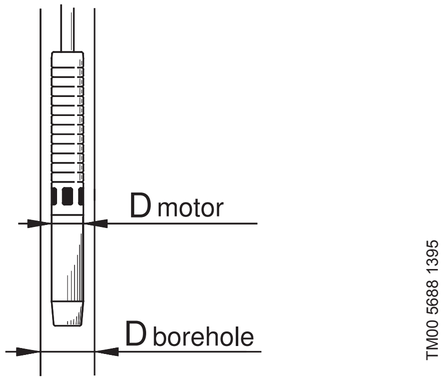


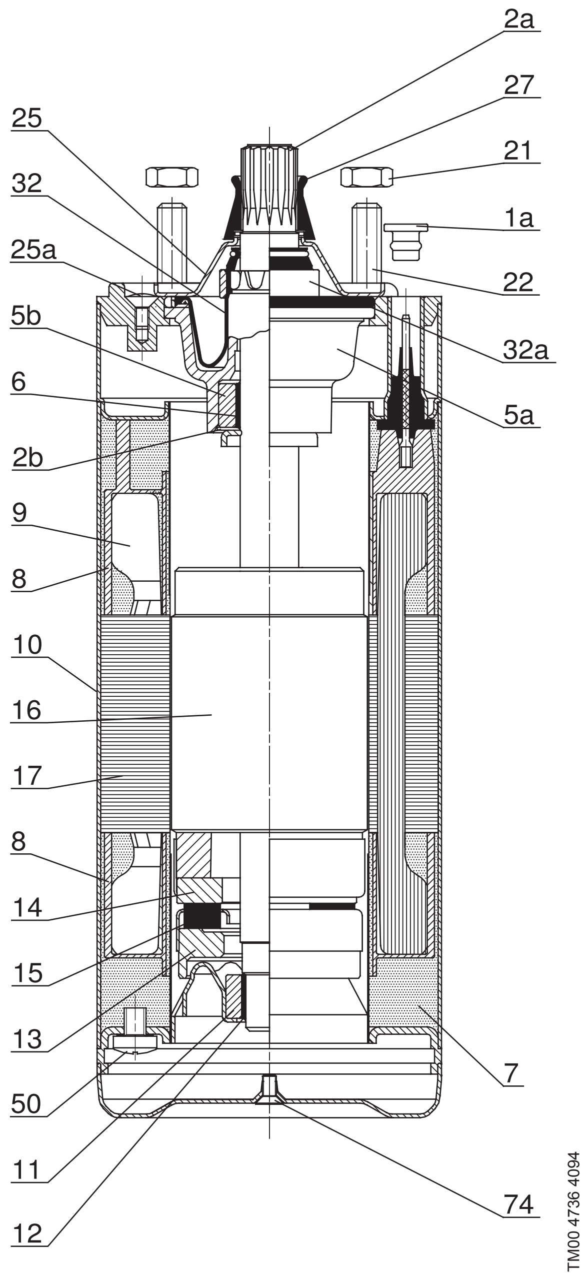
Fig. 8 Free convection

Material specification for MS 402

Standard version

Pos.	Component	Material	AISI
1a	Plug	Plastics, PELD	
2	Shaft	Stainless steel	431
2a	Stop ring (upthrust)	Polyethylene, PP	
5c	Housing for radial bearing	Silumin	
5b	Radial bearing, stationary	Ceramic	
6	Bearing journal	Tungsten carbide	
7	Filling compound	Polyurethane	
8	Stator sleeve	Plastics, PET	
9	Stator winding	Copper wire	
10	Stator housing	Stainless steel	403
11	Radial bearing, stationary	Ceramic	
12	Bearing journal	Tungsten carbide	
13	Intermediate ring	Sintered steel	
14	Thrust bearing ring, rotating	Ceramic	
15	Thrust bearing shoes. stationary	Carbon	
16	Rotor lamination	Magnetic sheet steel	
17	Stator lamination	Magnetic sheet steel	
21	Nut	Stainless steel	304
22	Staybolt	Stainless steel	304
25	Cover plate	Stainless steel	304
25a	Screw	Stainless steel	304
27	Sand shield	NBR rubber	
32	Bellows seal	NBR rubber	
32a	Lock ring	Composite PPS	
50, 74	Screw	Stainless steel	304
	Rotor rods	Cast aluminium or copper	
	Motor liquid	SML-2	

Example: MS 402



Construction

Material specification for MS 4000

Standard version

Pos.	Component	Material	AISI
1	Stator	Stainless steel	304
2	Rotor	Stainless steel	431
3	Thrust bearing, (stationary)	Carbon	
4	Radial bearing, complete	Ceramic	
5	Bearing pipe, complete	Cast iron GG20	
6	Thrust bearing, (rotating)	Ceramic	
7	Clamping ring		
10	Bearing retainer		
11	Adjusting screw		
12	Diaphragm	NBR rubber	
13	Motor end shield	Stainless steel	304
15	Nut (special)		
16	Lock washer		
18/ 21	Nut	Stainless steel	316
20	Motor cable		
22	Staybolt	Stainless steel	316
22a	Staybolt complete	Stainless steel	316
24	O-ring		
25	Shaft seal housing	Stainless steel	304
27	Spline protector	NBR rubber	
28	Supporting ring for 27		
29	Sand shield	NBR rubber	
30	Spring		
31	Supporting ring		
32	Seal ring, upper (stationary)	NBR rubber Tungsten carbide	
33	O-ring		
34	Seal ring, lower (rotating)	Tungsten carbide	
70	Motor liquid	SML-2	

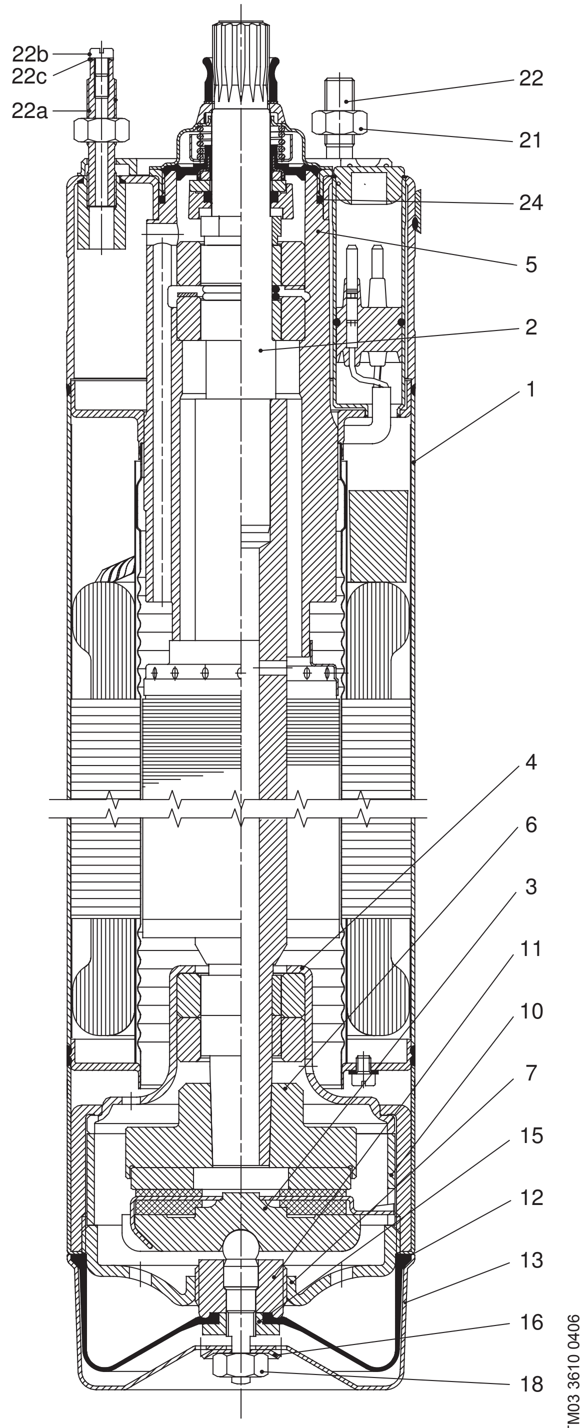
R-version

Pos.	Component	Material	AISI
1	Stator	Stainless steel	904L
13	Motor end shield	Stainless steel	904L
18/ 21	Nut	Stainless steel	904L
22	Staybolt	Stainless steel	904L
22a	Staybolt complete	Stainless steel	904L 316
25	Shaft seal housing	Stainless steel	904L

RE-version

Pos.	Component	Material	AISI
12	Diaphragm	FKM	
27	Spline protector	FKM	
29	Sand shield	FKM	
32	Seal ring upper, (stationary)	FKM ceramic	
34	Seal ring lower, (rotating)	FKM ceramic	

Example: MS 4000



Material specification for MS 6000

Standard version

Pos.	Component	Material	AISI
1	Stator	Stainless steel	304
2	Rotor		
2a	Stop ring	PTFE	
3	Thrust bearing, (stationary)	Carbon	
4	Radial bearing, lower	Ceramic/tungsten carbide	
5	Radial bearing, upper	Ceramic/tungsten carbide	
6	Thrust bearing (rotating)		
7	Clamping flange	Steel	
10	Thrust cover	Steel	
11	Adjusting screw	Steel	
12	Diaphragm	NBR rubber	
13	Motor end shield	Stainless steel	304
22	Bolt	Stainless steel	904L
22a	Priming screw	Stainless steel	316
27	Sand shield	NBR rubber	
28	Retaining bolts	Stainless steel	
29	Shaft seal housing	Stainless steel	304
30	Spring	Stainless steel	
32	Seal ring complete (stationary)	NBR Ceramic	
33	O-ring		
34	Seal ring complete (rotating)	Tungsten carbide	
42	Stop for bearing	Steel	
46	Hex socket screw	Stainless steel	304
46a	Washer	Nyltite	
47	Screw	Steel	
49	Retaining spring	Steel	
50	Screw for motor cable	Stainless steel	304
70	Motor liquid	SML-2	

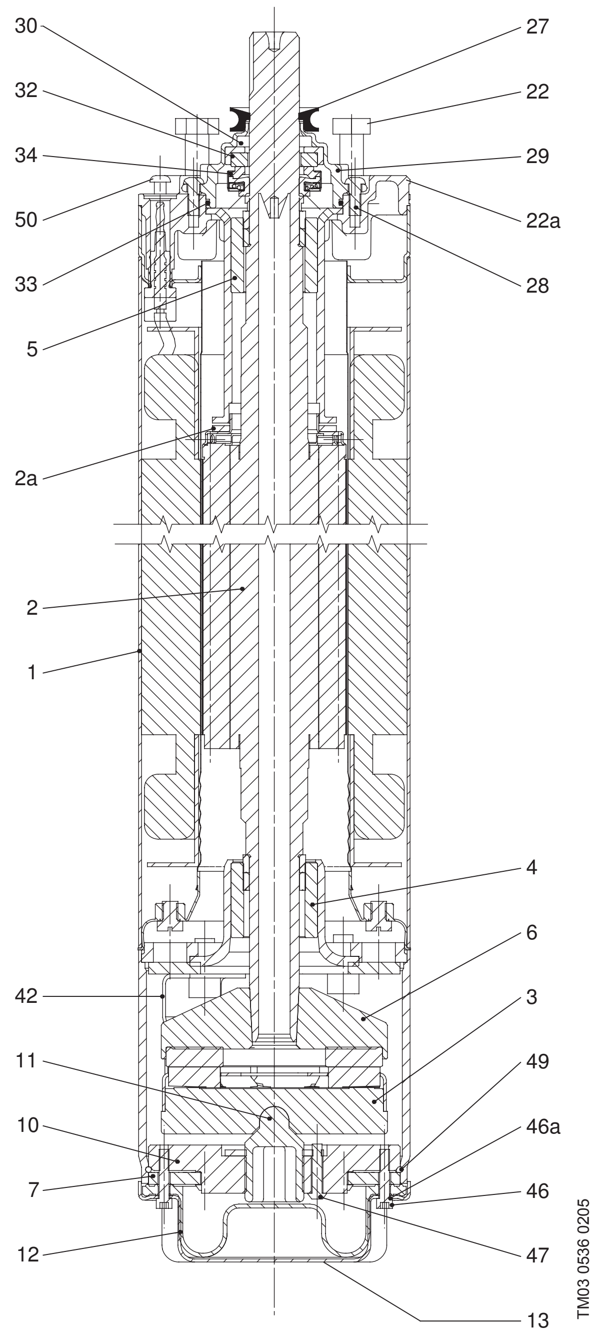
R-version

Pos.	Component	Material	AISI
1	Stator	Stainless steel	904L
13	Motor end shield	Stainless steel	904L
22	Bolt	Stainless steel	904L
22a	Priming screw	Stainless steel	904L
46	Hex socket screw	Stainless steel	904L
50	Screw for motor cable	Stainless steel	904L

RE-version

Pos.	Component	Material	AISI
12	Diaphargm	FKM	
27	Sand shield	FKM	
32	Seal ring complete (stationary)	FKM Ceramic	

Example: MS 6000



Motor operation

Most deep well submersible type pumps are powered by electric motors. The optimum power unit used is dependent on several physical and environmental factors, which include the horsepower required for pumping, the annual hours of operation and the availability and cost of energy.

How does a motor "know" what horsepower to deliver? Electric motors draw power in proportion to the applied load. Although a motor is rated for a certain output power (this is the number stamped on the nameplate), that motor can deliver a wide range of power depending on the voltage and frequency provided and the torque demanded by the shaft load.

Power is the rate of energy use. Input power to a electrical motor is measured in kW, the motor converts that electric power into mechanical power.
Output power is the product of speed (rpm) and torque (ft.-lb.). For a given voltage and frequency combination, the motor will always operate at a point on a specific torque vs. speed curve.

The units of both output power and torque are generally specified as a percentage of the motors full load rated value on the manufactures performance curve.

A small change in speed produce large changes in available torque near the normal (close to rated) operating speed.

Thus as load torque increases, the rotational speed will drop slightly (increased slip) as the motor load increases.

As soon as voltage is supplied to the motor, the motor “knows” the power to deliver by speeding up until it puts out exactly the same torque as the load requires at that speed.

At start-up, the motor produces torque higher than the torque required by the driven load, accelerating the pump shaft to full load speed.

A submersible pump is a centrifugal device which exhibits variable torque load characteristics, it takes very little torque to accelerate the load at low speed.

A centrifugal pump requires torque approximately proportional to the square of its speed. The maximum speed of a induction motor is a function of the number of poles and line frequency.

Typical speeds associated with submersible motors, based on the number of poles and a line frequency of 60 Hz are; 2p - 3600 rpm (sync.)/ 3450 rpm (@ full load) and 4p - 1800 rpm (sync.)/ 1760 (@ full load).

The synchronous speed on any motor can be calculated when the number of poles and operating frequency is known, using the formula below:

N = f x 120/P where; N = sync. speed (rpm), **P** = poles, **f** = frequency (Hz)
Note: Actual induction motor speed at full load will be 2-5% less than the synchronous speed calculated using the formula above.

A pump driven by two different motors of the same nominal speed (rpm), but different Hp ratings, will draw approximately the same power.

Under steady-state conditions the speed of operation does not change significantly, unless the motor is too small and stalls.

Motor loading, failure and lifetime

Motor load is commonly expressed as the percentage of output power to rated output. Because output power (load) is difficult to measure in the field, motor load is usually estimated by measuring input power (kWI) and assuming an efficiency.

It can also be estimated by measuring kVA and assuming both power factor and efficiency. Failure of a motor occurs when insulation breaks down from heat and mechanical stresses.

The temperature of the windings are primarily dependent on the current (amps) draw through them and the ability of motor to dissipate the heat generated to the ambient environment. The higher the temperature, the shorter the life. A 10°C(50F) rise can halve motor life.

Motor current draw increases with load; as a result, motors that operate outside established load and temperature ratings, will operate fewer hours before failure.

The voltage supplied to the motor terminals have a significant impact on motor life.

Motors are designed to operate at a utilization voltage level or range, which is generally lower than the electrical system distribution voltage provided to the utility meter. Motors can operate within a range of voltages; but above a certain voltage, destructive arcing and insulation deterioration can occur.

Conversely, as voltage drops, more current is needed to maintain torque and power; so the motor runs hotter and its life is shortened.

In addition to the overall voltage provided to the motor, voltage unbalance must be considered. If the voltages on the three phases to the motor are not well balanced, one winding will carry more current and may over heat and fail.

Most electrical utilities guarantees voltages to a +/-5 percent standard; for "480" service voltage will be between 456 V and 504 V at the meter; for "240" service, the voltages must be between 228 V and 252 V.

If a motor is damaged as a result of over or under voltage outside the service limits, the utility may be liable for damages.

Because motors will operate cooler with higher voltages, reasonable over voltage levels rarely causes problems. There are only small variations in power factor and efficiency near rated conditions, volt- amps for a particular load can be assumed constant over the range of voltage guarantee by the utility.

The maximum continuous load sustained by a motor is indicated by the service factor. A motor with a service factor of 1.15 can maintain a 115% overload; provided voltages are at the rated level and well balanced and the insulation system can be maintained at or below rated temperature. The actual motor load percentage can be calculated using the formula listed below:

$$\%\ \text{Motor Load} = \frac{\text{EM} \times \text{IHp}}{\text{Rated HP}} \times 100$$

where; **Em** = motor efficiency
IHp = Input Horsepower

Motor design and economic criteria have forced motor manufactures to build less service factor (SF) into motors.

The SF allows the motor to provide power under optimal conditions at the nameplate rated power times the SF. At rated conditions, (ie. 100 Hp motor with a SF of 1.15 is designed to provide 115 HP under continuos load).

A 1982 survey of motor manufacturers showed six of seven respondents recommending loading at 100 percent of rated power or less while only one still suggests loading up to SF rating.

For this reason, it is recommended that motor loading not exceed 100% of the nameplate horsepower rating. It is best to consider the SF as a contingency against over loading as a result of low voltage, current imbalance and/or adverse ambient conditions.

Motor efficiency

An electric motor operates at a relatively constant efficiency and speed over a wide range of loadings.

Efficiency does not change significantly with age of the motor or the load applied to it.

Motor efficiency is practically constant at motor loads between 50 and 100%.

Reducing motor size for the sake of energy conservation, as a result of efficiency increases associated with loading the motor closer to full magnetic saturation (100% load) is not recommended.

As a general rule, a bigger motor that is underloaded (down to 50 percent) is more efficient than a fully loaded smaller motor driving the same load. Submersible pump motors will have slightly lower efficiencies than surface motor as a result of the compact design requirements and the need for internal cooling/lubricating fluid.

Most submersible motors have an efficiency stamped on the nameplate. The average or nominal efficiency values associated with "canned/ hermetically sealed" type submersible motors are listed in the Electrical Data Section.

Application and selection issues

The term application not only refers to the end use of the product but also the parameters which affect the selection of the correct submersible motor and pump products. The primary considerations involved with the selection of submersible motors are discussed as follows:

- **The insulation system.** The insulation system is the key to long motor life. The life of the insulation system is affected by three major factors: Load, Duty Cycle, and Temperature Rise. The load of a motor is described in horsepower or kilowatts and is defined as the work required to perform a function. The load created by pumps is a result of the rotation of impeller(s) to create a pressure forcing fluid through a system. The duty cycle is the time period, which the motor is operating. It is continuous or intermittent. Temperature rise is the difference between the operating temperature of the windings and the temperature of the medium to cool the motor. The rise of the motor is directly affected by the load and duty cycle. Extra load in the form of a service factor increases the temperature rise of the winding.

The total temperature must never exceed the maximum capacity of the insulation system. Submersible motors used for water well service normally employ class “F” insulation (150°F rise), but are designed for a class A temperature rise (60°F).

- **Cooling.** Submersible motors are no different than conventional motors, in that the heat generated within the motor must be dissipated. The temperature rise within the motor is limited to a value which when added to the temperature of the external cooling medium does not exceed the maximum temperature capacity of the insulation system. The ability to dissipate the heat depends on two factors: (1) The temperature of the cooling medium (ambient) and (2) the rate of cooling medium flow past the motor external surfaces. Excess ambient temperature and reduced flow rate both require derating of the load capability of the unit. The derating of the load reduces the temperature rise of the winding within the limits set by the heat dissipation capacity of the cooling medium.
- **Materials of construction.** Submersible pumps and motors are also selected based on the chemical and physical make-up of the water in which they will be submerged. Sea water applications require specialized construction due to the corrosive water encountered. A standard motor will not survive highly corrosive water submergence, while a specially designed motor will.
- **Design factors.** Other factors, which affect submersible motor selection, are voltage, depth of installation, thrust and controls. It is necessary that the voltage and frequency variations be within the limits set in NEMA MGI-18 (submersible motors for deep well pumps). The maximum recommended depth for most submersible motors relates to 290 psi on the unit (approx. 2000 feet). The thrust delivered by the pump must be less than the capacity of the thrust bearing of the submersible motor. Controls must be quick trip, ambient compensated type to quickly pull an improperly applied or defective motor off the line so that no damage occurs.

Submersible construction and design for 4"and 6" sizes are covered by NEMA standards.

Submersible motor cooling

The key to long submersible motor life is good cooling. Most submersible pumps rely on moving heat away from the motor by forced convection. The ambient/produced fluid is typically drawn by the motor in the course of pumping to accomplish this task. Grundfos Submersible Motors are designed to operate at full load in water up to 30°C (86°F) free convection, and 40C (104F) provided the flow velocity can be maintained at a minimum of 0.25 feet per second (fps).

Required cooling flow and velocity

AWWA specifications state the maximum motor diameter and the minimum inside diameter of the well shall be in such relationship that under any operating condition the water velocity past the motor shall not exceed 12 fps (3.7 m/s) nor be less than 0.5 fps (0.15 m/s). The AWWA specifications are principally applicable to motors 6-inch and larger, as most 4-inch motor designs are based on a minimum cooling flow velocity of 0.25 fps (0.08 m/s) at rated ambient temperature. Table 1 relates flow, casing and motor size requirements to accomplish minimum cooling velocity.

(Table 1) Minimum submersible cooling flow requirements

Casing/Sleeve I.D. (inches)	4" Motor (0.25 fps)	6" Motor (0.5 fps)
4	1.2	-
5	7.0	-
6	13	9
7	20	25
8	30	45
10	50	90
12	80	140
14	110	200
16	150	280
18	-	380

Note: At the velocity specified in the table the temperature differential between the motor surface and ambient water will range from 5° - 15°C (10-30°F).

Grundfos Submersible Motors require no cooling fluid flow past the motor, when the produced fluid temperature is 30°C (86°F) or less. Cooling by free convection in such cases, is contingent on no adverse operating conditions present such as; poor power, high stop/start frequency, presence of incrustating deposits on the motor surface, etc. Detramental operating conditions are difficult to identify or predict, and for this reason, the minimum cooling flow should be provided whenever possible - regardless of the ambient fluid temperature.

Water temperature and motor derating

As previously stated, the full motor capacity is a function of ambient fluid temperature and flow past the motor.

When the ambient temperature exceeds the temperature at which the motor performance is based, the motor must be derated and/or cooling velocity increased. Table 2 provides typical derating criteria for hermetically sealed/canned type submersible motors. Such motors should not be used in applications which exceed 60°C (140°F) regardless of any special provisions incorporated into the system. AWWA specifications state that the motor temperature shall not exceed the allowable operating temperature of the motor thrust and radial bearings, and in no case shall it exceed the temperature rating of the motor insulation system.

When the service duty exceeds 40°C (104°F) pumps and motors fitted with NBR rubber components are subject to reduced life if not replaced on a regular basis. A minimum replacement interval of three years is recommended.

FKM elastomers (rubber compounds) are recommended any time the normal ambient fluid temperature exceeds 104°F. Allowable % Max. Namplate Amps Derated for Ambient Water Temp. @ .5 fps

(Table 2) Allowable % max nameplate amps derated. for ambient water temp at .50 fps.

Water Temp.	0 - 3 Hp	5 - 15 Hp	20 - 40 Hp
30°C (86°F)	100%	100%	100%
35°C (95°F)	100%	100%	90%
40°C (104°F)	100%	90%	80%
45°C (113°F)	90%	80%	70%
50°C (122°F)	80%	70%	60%
55°C (130°F)	70%	60%	45%
60°C (140°F)	50%	-	-

Note: Derating % is based on an ambient fluid temperature of 30°C (86°F) @ 0.5 fps, consult motor manufacture for specific maximum full-load cooling water temperature without derating. Typical base abient fluid temperature rating for various manufactures of submersible motors used in the water supply industry range from 25°C to 40°C, with 30°C being the most prominent.

Shroud/Flow inducer Sleeve/Cooling sleeve

On some installations it is necessary to use a shroud to insure that all, or some portion of the produced fluid pass by the motor in order to carry away the heat generated.

In some cases, the shroud is used to increase velocity (create turbulent flow) in order to prevent the formation of deposit and inhibit corrosion.

A shroudshould be used/ considered under the following operating scenarios:

1. Top-feeding (cascading) wells can feed the water directly into the pump without its flowing past the motor if the well is not cased to below the motor, or casing is perforated above the motor.
2. Flow may be inadequate when the motor is in a large body of water or a casing much larger than the motor, or if delivery is very low, or in sump/wet pit tank applications.
3. If the groundwater is aggressive or contains chloride, the corrosion rate will double for every 15°C (56F) increase in temperature between the motor metallic housing and water. The motor housing is generally 5-15°C (41-56F)warmer than the produced water. A cooling sleeve will therefore reduce the risk of motor corrosion by keeping the exterior motor surface temperature lower during operation.
4. If the well water contains a significant amount of iron (iron bacteria), manganese and calcium. These substances will be oxidized and deposited on the motor surface. In case of low flow past the motor, incrustation build-up forms a heat insulating layer of oxidized minerals, which may result in hot spots in the motor winding insulation. This temperature increase may reach values, that impare the insulating system, and consequently the motor life.

A cooling sleeve will insure turbulent flow past the motor prohibiting incrustation build-up and optimize cooling.

A cooling sleeve/shroud should be selected so as to keep the maximum fluid velocity past the motor to 15 fps (12 fps by AWWA specs.).

At the higher velocities, erosion can be significantly accelerated in the presence of abrasives and increase intake losses can impare pump performance.

Head loss for various motor O.D. and casing/shroud I.D. combinations are listed in Table 3, and should be considered under marginal submergence and suction conditions.

A fluid velocity of 3 fps is generally considered optimum and 0.5 fps is the minimum cooling velocity value.

The actual fluid velocity past the motor can be calculated using the formula:

Velocity (past motor) = gpm/2.45 (ID casting)^2 - (OD motor)^2.
where; Casing or shroud ID and motor OD values are in inches, and velocity(past the motor is in fps.

(Table 3) Annular space head loss (Hf) from flow past motor (ft. of water)

Motor (nominal)		4"	4"	4"	6"	6"	6"
Casing I.D.		4.25"	5"	6"	6"	7"	8"
gpm	25	0.3					
	50	1.2					
	100	4.7	0.3		1.7		
	150	10.2	0.6	0.2	3.7		
	200		1.1	0.4	6.3	0.5	
	250		1.8	0.7	9.6	0.8	
	300		2.5	1.0	13.6	1.2	0.2
	400				23.7	2.0	0.4
	500					3.1	0.7
	600					4.4	1.0

Note: The tabulated friction loss values assume maximum motor length for the specified nominal motor size and a smooth casing/sleeve ID, and include entry and exit losses.

Typical cooling sleeve/shroud configurations. The motor shroud is generally of the next nominal diameter of standard pipe larger than the motor or the pump, depending on the shroud configuration used. The tubular/pipe material can be plastic or thin walled steel (corrosion resistant materials preferred). The cap/top must accommodate power cable without damage and provide a snug fit, so that only a very small amount of fluid can be pulled through the top of the shroud. The fit should not be completely water tight as ventilation is often required to allow escape of the air or gas that might accumulate. The shroud body should be stabilized to prevent rotation and maintain the motor centered within the shroud. The shroud length should extend to a length of 1-2 times the shroud diameter beyond the bottom of the motor when possible. Shrouds are typically attached immediately above the pump intake or at the pump/column correction.

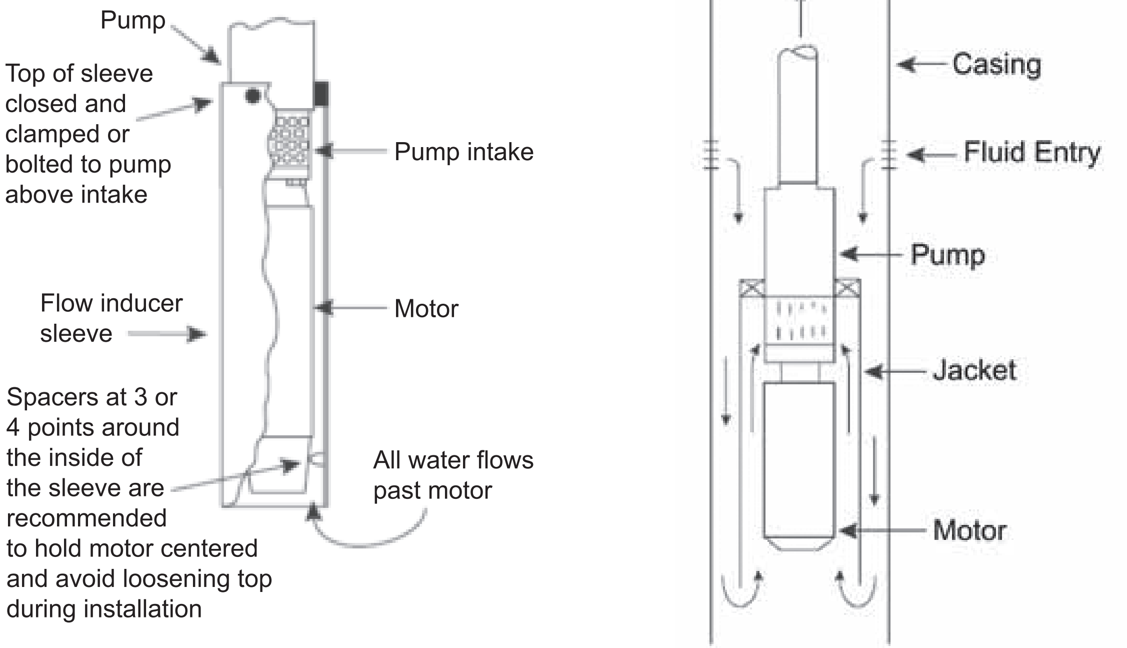
A typical motor sleeve/shroud selection example is sited below and illustrated in Figure 6:

Example 1:
A six-inch motor and pump that delivers 60 gpm will be installed in a 10" well, 90 gpm past the motor is required assuming 10" ID well (from Table 1). An 8" or smaller sleeve must be added to the pump to provide a cooling flow velocity of 0.5 fps or greater.

If a well feeds water from above the pump, has a casing/chamber too small to allow a motor jacket/sleeve on the pump, and does not have adequate level and flow to allow raising the pump above the inflow, it is difficult to properly cool the motor. When possible, the casing depth should be increased to allow flow to come from below the motor. If this is not practical, adequate flow past the motor can usually be attained by employing a motor jacket with a stringer pipe or by using a jet tube as shown in Figure 6.

Typical motor jacket installation scenarios

Typical flow inducer sleeve cutaway view



TM03 3458 0406 - TM03 3459 0406

Fig. 9 Motor jacket installation

The table shows the recommended number of starts of intermittent operation:

Special (non water well) applications

A cooling shroud should be used in all static horizontal and vertical installations where water can directly enter the pump intake, without crossing the motor surface. In addition to focusing the pumped fluid to dissipate motor heat, a motor shroud can be used to improve suction conditions by reducing vortices. Such applications include fountains and pump-out tanks, where the ambient fluid temperature is often higher than groundwater temperatures.

In such installations; motor submergence-temperature considerations, as well as pump intake requirement must be carefully considered.

Intermittent operation

Motor type	Recommended number of starts
MS 402 - 4"	Min. 1 pr. year
MS 4000 - 4"	-
MS 6000 - 6"	Max. 300 pr. day

A typical horizontal pump out tank application is illustrated in Figure 7. Vertical application should be handled as illustrated in Figure 8, which is analogues to top feeding water well application.

Cooling sleeve - horizontally installed motor in a tank

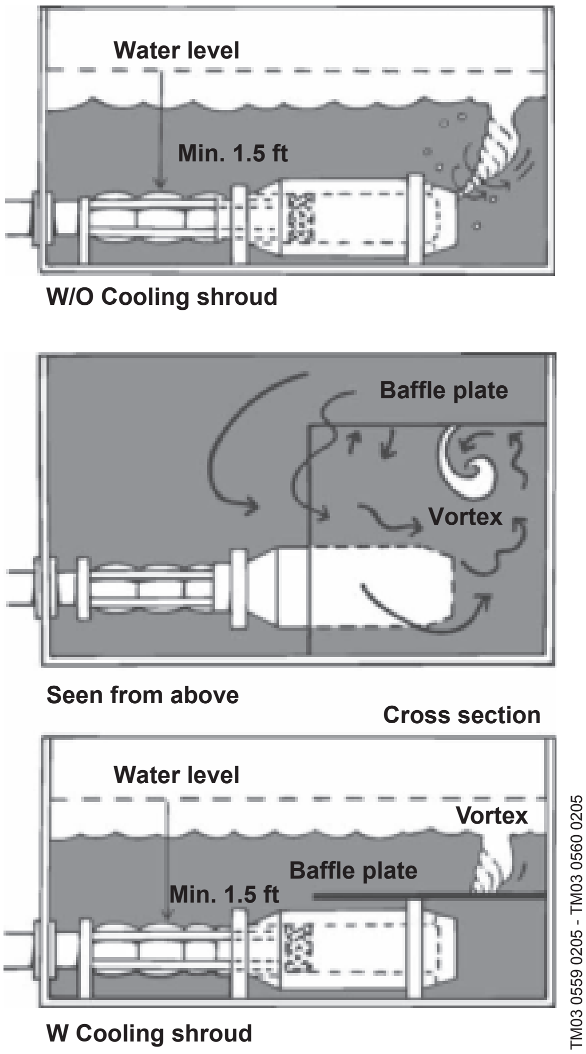


Fig. 10 Horizontal installation

Cooling sleeve - vertically insulated motor in tank

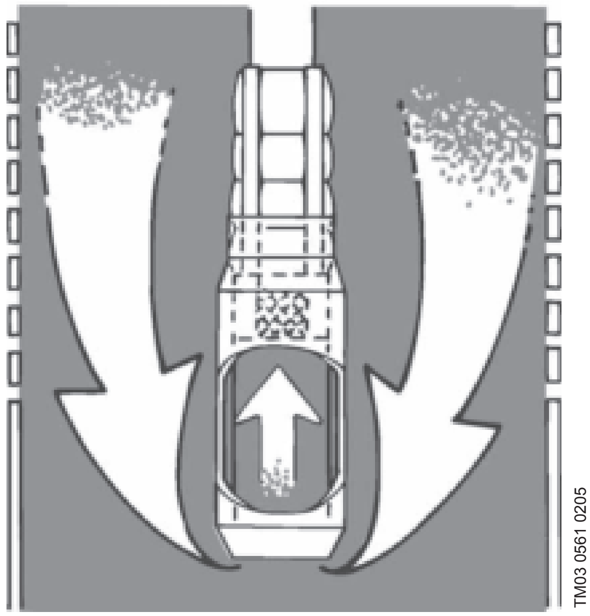


Fig. 11 Vertical Flow

Submersible power cable

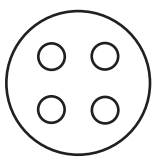
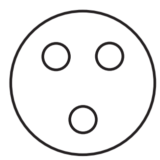
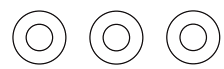
Power is transmitted from the starter/controller to the submersible motor through a marine duty power cable, typically consisting of three flexible stranded conductors of the proper size to carry the motor full load amperes (FLA) at its rated voltage. AWWA standards require a separate ground wire to be provided (ie. 3-wire cable systems are equipped with three power conductors and a ground wire of the same size).

Proper cable selection is a function of motor load, voltage, available space, length (setting depth) and environment.

Typical conductor insulation materials are synthetic rubber (RW, RUW, TW, etc.), plastic (PVC, XPLE, etc.) or special polymer (FPE, hypalin, EPR - EPDM, etc.). Special cable insulations are often recommended or required for sever duty or special applications such as; gas, hydro - carbon, heat, variable frequency, etc.

Cable can be provided as three or more separate individual or, twisted conductors, molded side by side in a flat cable configuration or three conductors with a round common jacket. Refer to Table 4 for general submersible power cable physical data (weight and diameter). Armored cable is also available for special applications, but is typically not employed in the water supply industry. Cable is supported and attached to column/drop pipe by means of cable clamps, tape or bands. One extra foot of cable for each fifty feet of length should be allowed plus an additional ten to fifty feet for surface connections.

(Table 4) Typical submersible power cable physical data

Cable size	600 Volt (115, 208, 230, 460 and 575 Volt motors)				5000 Volt (2300 Volt Motors)			
	Type I		Type II		Type III		Type IV	
	3 conductors and ground in a common jacket (4 wire total)		3 conductors and ground in separate jackets (4 wire total)		3 conductors in a common jacket (3 wire total)		3 conductors in separate jackets (3 wire total)	
								
AWG MCM	O.D. (in)	Wt. (lbs./ft.)	O.D. (in) per cable	Wt. (lbs./ft.) for 4 cables	O.D. (in)	Wt. (lbs./ft.)	O.D. (in) per cable	Wt. (lbs./ft.) for 3 cables
14	.39	.16	.19	.10				
12	.43	.20	.21	.13				
10	.64	.32	.27	.18				
8	.76	.44	.31	.29	1.02	.69	.39	.43
6	.91	.65	.36	.43	1.10	.85	.43	.52
4	1.02	.90	.42	.64	1.21	1.12	.47	.71
2	1.15	1.26	.48	.97	1.33	1.46	.53	.99
1	1.34	1.68	.58	1.26	-	-	-	-
0	1.43	2.0	.62	1.54	1.51	2.09	.62	1.49
00	1.53	2.41	.67	1.91	1.61	2.56	.66	1.87
000	1.64	2.89	.72	2.36	-	-	-	-
0000	1.80	3.58	.78	2.93	1.82	3.40	-	-
250	1.97	5.88	.90	4.82	-	-	-	-
300	2.09	6.60	.95	5.62	-	-	-	-
350	2.20	7.34	1.00	6.50	2.51	4.8	-	-
400	2.34	8.18	1.05	7.25	-	-	-	-
500	2.25	9.30	1.13	8.87	-	-	-	-

1. Types I and II cables are typically insulated and jacketed with synthetic rubber, PVC or XLPE.
2. Types II and IV are often supplied paralleled in a flat cable configuration, or in a twisted configuration for smaller sizes. Type I and II cable include 3 power conductors and a ground conductor.
3. AWWA minimum stranding and insulation requirements; No. 10 and smaller - 7 strand/ Class B, No. 9 through No. 2 - 19 strand/ Class C, No. 1 through 4/0 - 19 strand/ Class B. Minimum conductor area to meet minimum ICEA (Insulated Cable Engineers Association) code for operation in free air.
4. Verity actual cable weight per foot with manufacture for greater accuracy, as weight and diameter will very with insulation system and manufacture.

Cable selection

Maximum cable lengths are generally calculated to maintain 95% of service entrance voltage at the motor running at maximum nameplate amps, and to maintain adequate starting torque. Calculations take into account basic cable resistance, reactance, power factor and temperature rise cable larger than specified may always be used, and will reduce power consumption. The wire sizing chart in the Electrical Data section tabulates copper cable sizes for various cable lengths vs motor size. The use of power cables smaller than the minimum sizes as permitted by code or recommended by Grundfos will generally void the motor warranty. Understized cable sizes will cause reduced starting torque and poor motor operation.

Mixed cable

In a submersible pump installation any combination of cables sizes may be used provided they do not exceed the individual maximum conductor ampacity limit and the aggregate voltage drop does not exceed 5% of the motor nameplate voltage while operating at full load. Mixed cable sizes are most often encountered when a pump is being replaced with a larger horsepower unit.

Cable splice

When the downhole power cable (drop cable) must be spliced or connected to the motor leads, it is necessary that the splice be water tight. Under normal service conditions, the splice can be made using commercially available potting compounds, heat shrink or tape. Each type of splicing methods is affective when made by competent personnel, potted or head shrink splices are recommended when submergence pressures exceeds 25 psi (60’). A cable splice should exhibit a minimum insulation resistance of 10 megohms, measured in a submerged state after 24 hours in water. A typical low voltage (< 600V) tape splice is illustrated below in Figure 9.

When three conductors are encased in a single outer shealth, tape individual conductors as described, staggering joints. Total thickness of tape should be no less than the thickness of the conductor insulation.

Motor lead

Most manufactures will provide a factory motor lead assembly, pre-potted and designed to provide a water tight connection between it and the motor terminals. Typical motor lead length range from 48" to 150" and are generally spliced to the drop cable immediately above the pump. Minimum wire sizes (AWG) for factory provided motor lead assemblies, by nominal motor size are; 4" - #14 to #12, 6" - #10 to #8, 8" - #4 and 10" - #2.

In general, a motor lead assembly should not be reused as rubber compounds typically used in there construction will set with time, making a water tight connection difficult. Grundfos installation instructions, which includes pot head connecting torque values and lubrication requirements, should be strictly observed.

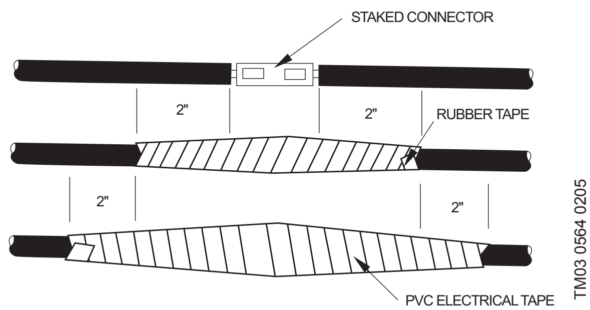
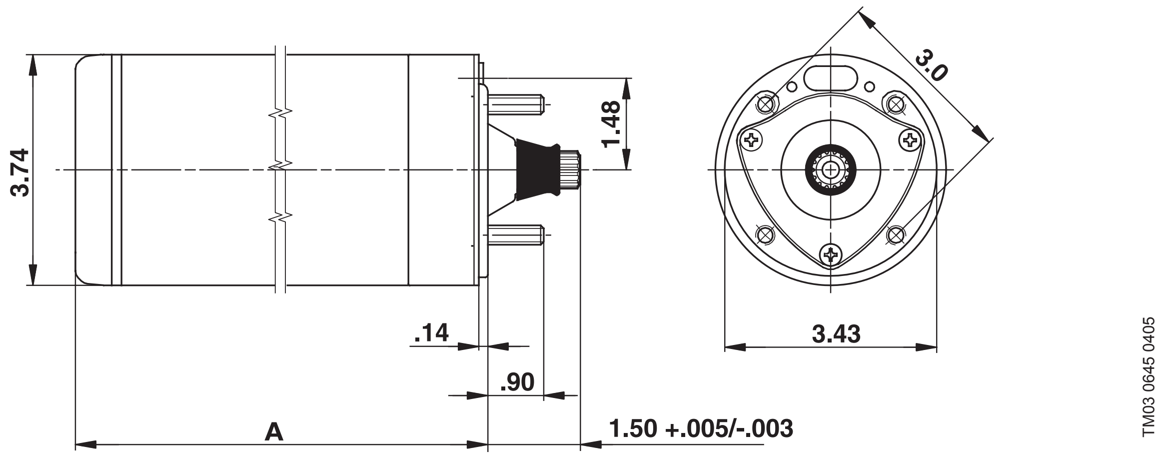


Fig. 12 Tape splice

Outline drawing MS 402

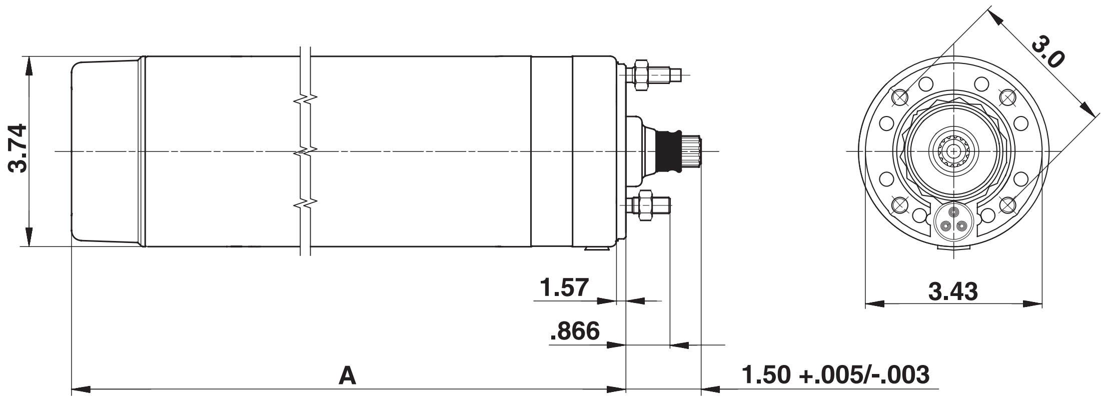


Dimensions and weights MS 402

Output Standard motors P₂ [HP]	Output Standard motors P₂ [kW]	Phases	Frequency [Hz]	A-dimension [in]	Net weight [lbs]	Gross weight [lbs]	Shipping volume ★ [f³]
.33	.25	1	60	10.2	14.9	17.4	.0953
.50	.37	1	60	11.0	14.9	17.4	.1017
.75	.55	1	50/60	11.6	18.0	19.8	.1062
1.0	.75	1	50/60	12.2	19.6	22.9	.1112
1.5	1.1	1	50/60	13.7	23.1	26.4	.1239
2.0	1.5	1	50/60	13.7	24.2	27.6	.1239
.50	.37	3	50/60	9.0	12.1	14.3	.0858
.75	.55	3	50/60	9.6	13.8	16.1	.0904
1.0	.75	3	50/60	11.0	18.0	19.4	.1017
1.5	1.1	3	50/60	12.2	19.6	22.9	.1112
2.0	1.5	3	50/60	13.7	23.1	26.4	.1239
3.0	2.2	3	50/60	13.7	24.2	29.5	.1239

Technical data

Outline drawing MS 4000

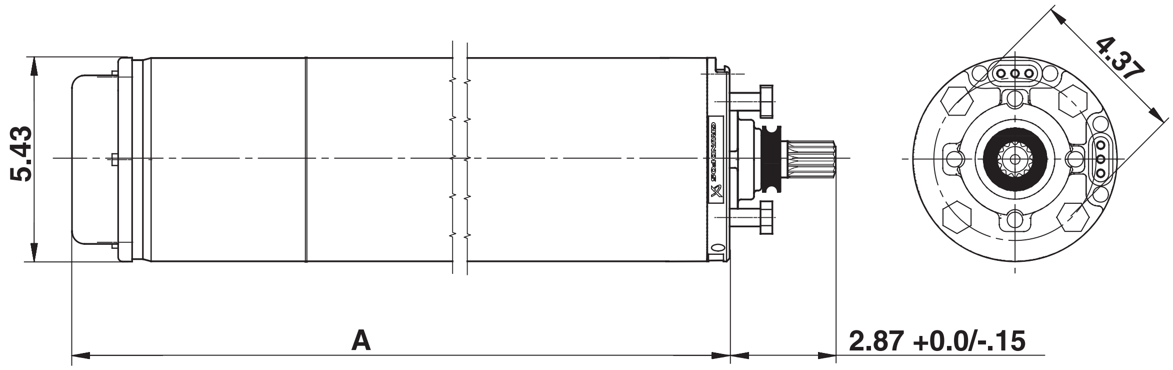


Dimensions and weights MS 4000

Output Standard motors		Phases	Frequency [Hz]	A-dimension [in]	Net weight [lbs]	Gross weight [lbs]	Shipping volume ★ [f^3]
P_2 [HP]	P_2 [kW]						
2	1.5	1	50/60	19.5	37.2	39.5	.4415
3	2.2	1	50/60	22.6	44.3	47.5	.4415
5	3.7	1	50/60	26.6	56.2	58.5	.4415
3.0	2.2	3	50/60	18.0	35.2	37.5	.4415
5.0	3.7	3	50/60	22.7	46.2	48.5	.4415
7.5	5.5	3	50/60	26.6	57.3	59.5	.4415
10	7.5	3	50/60	30.6	68.3	70.5	.4415

Technical data

Outline drawing MS 6000



Dimensions and weights MS 6000

Output Standard motors		Phases	Frequency [Hz]	A-dimension [in]	Net weight [lbs]	Gross weight [klbs]	Shipping volume ★ [f^3]
P_2 [HP]	P_2 kWp]						
7.5	5.5	3	50/60	21.4	73.8	80.4	1.412
10	7.5	3	50/60	22.6	81.5	88.2	1.412
15	11.0	3	50/60	25.0	100.3	109.1	1.871
20	15.0	3	50/60	27.5	115.7	124.5	1.871
25	18.5	3	50/60	29.7	127.8	136.6	1.871
30	22.0	3	50/60	32.0	141.0	149.9	1.871
40	30.0	3	50/60	37.2	170.8	179.6	1.871

Grundfos motors specifications

1- Phase motors

HP	Ph	Volt	Service factor	Amperage		Full load		Max. thrust (lbs)	Line-to-Line resistance (Ω)		KVA code ★★★	Nameplate no.
				SF	Start	Eff. (%)	Pwr fact.		Blk-Yel	Red-Yel		
4-inch, single phase, 2-wire motors (control box not required)												
1/3	1	230	1.75	4.6	25.7	59	77	900	6.8-8.2		S	79952101
1/2	1	115	1.60	12.0	55	62	76	900	1.1-1.3		R	79922102
1/2	1	230	1.60	6.0	34.5	62	76	900	5.2-6.3		R	79952102
3/4	1	230	1.50	8.4	40.5	62	75	900	3.2-3.8		N	79952103
1	1	230	1.40	9.8	48.4	63	82	900	2.5-3.1		M	79952104
1 1/2	1	230	1.30	13.1	62	64	85	900	1.9-2.3		L	79952105
4-inch, single phase, 3-wire motors												
1/3	1	115	1.75	9.0	29	59	77	900	1.55-1.9	2.4-3	M	79423101
1/3	1	230	1.75	4.6	14	59	77	900	6.8-8.3	17.3-21.1	L	79453101
1/2	1	115	1.60	12.0	42.5	61	76	900	0.9-1.1	1.9-2.35	L	79423102
1/2	1	230	1.60	6.0	21.5	62	76	900	4.7-5.7	15.8-19.6	L	79453102
3/4	1	230	1.50	8.4	31.4	62	75	900	3.2-3.9	14-17.2	L	79453103
1	1	230	1.40	9.8	37	63	82	900	2.6-3.1	10.3-12.5	K	79453104
1.5	1	230	1.30	11.6	45.9	69	89	900	1.9-2.3	7.8-9.6	H	79453105
2	1	230	1.25	13.2	57	72	86	1500	1.5-1.8	3.4-4.1	G	79454506
3	1	230	1.15	17.0	77	74	93	1500	1.2-1.4	2.45-3	F	79454507
5	1	230	1.15	27.5	110	77	92	1500	0.65-0.85	2.1-2.6	F	79454509

3-Phase motors

HP	Ph	Volt	Service factor	Amperage		Full load		Max. thrust (lbs)	Line-to-Line resistance (Ω)		KVA code ★★★	Nameplate no.
				SF	Start.	Eff. (%)	Pwr fact.		Blk-Yel	Red-Yel		
4-inch, three phase, 3-wire motors												
1 1/2	3	230	1.30	7.3	40.3	75	72	900	3.9		K	79302005
		460	1.30	3.7	20.1	75	72	900	15.9		K	79362005
		575	1.30	2.9	16.1	75	72	900	25.2		K	79392005
2	3	230	1.25	8.7	48	76	75	900	3.0		J	79302006
		460	1.25	4.4	24	76	75	900	12.1		J	79362006
		575	1.25	3.5	19.2	76	75	900	18.8		J	79392006
3	3	208/230	1.15	11.6/12.2	56	77	75	900	2.2		H	79302006
		440/460	1.15	5.65/6.1	28	77	75	900	9.0		H	79362007
		575	1.15	4.8	22	77	75	900	13.0		H	79395507
5	3	208/230	1.15	18.6/17.4	108	80	82	1500	1.2		H	79304509
		440/460	1.15	8.65/8.65	54	80	82	1500	5.0		H	79354509
		575	1.15	7.9	54	80	82	1500	7.3		H	79394509
7 1/2	3	208/230	1.15	27.0/25.0	130	81	82	1500	0.84		H	79305511
		440/460	1.15	12.8/12.6	67	81	82	1500	3.24		J	79355511
		575	1.15	10.6	53	81	82	1500	5.2		J	79395511
10	3	440/460	1.15	18.0/18.6	90	81	80	1500	1.16		H	79355512
		575	1.15	14.4	72	81	80	1500	1.84		H	79395512

Electrical data

HP	Ph	Volt	Service factor	Amperage		Full load		Max. thrust (lbs)	Line-to-Line resistance (Ω)		KVA code ★★★	Nameplate no.
				SF	Start	Eff. (%)	Pwr fact.		Blk-Yel	Red-Yel		
6-inch, three phase, 3-wire motors												
7 1/2	3	208/230	1.15	27.5/27.5	119	80.5	76	1500	0.63		H	78305511
		440/460	1.15	13.2/13.2	59	80.5	76	1500	2.4		G	78355511
		575	1.15	10.6	48	80.5	76	1500	4.07		H	78395511
10	3	208/230	1.15	36.5/35.5	156	82.5	79	1500	0.41		G	78305512
		440/460	1.15	17.4/17.0	78	82	79	1500	1.8		G	78355512
		575	1.15	13.6	63	82	79	1500	3.1		G	78395512
15	3	208/230	1.15	54.0/50.5	230	82.5	82	7000	0.25		G	78305514
		440/460	1.15	25.5/24.5	115	82.5	82	7000	1.16		F	78355514
		575	1.15	19.6	92	82.5	82	7000	1.9		G	78395514
20	3	208/230	1.15	70.0/67.5	343	84	81	7000	0.20		H	78305516
		440/460	1.15	33.5/33.0	172	84	82	7000	0.80		H	78355516
		575	1.15	26.4	137	84	82	7000	1.32		H	78395516
25	3	440/460	1.15	42.0/41.0	217	84.5	80	7000	0.62		H	78355517
		575	1.15	33.0	175	84.5	80	7000	1.04		H	78395517
30	3	440/460	1.15	48.0/46.5	237	85	83	7000	0.55		G	78355518
		575	1.15	37.0	189	84.5	83	7000	0.92		G	78395518
40	3	440/460	1.15	66.5/64.0	320	64.0	82	7000	0.39		H	78355520

Transformer capacity

Required for three-phase motors

Submersible		Smallest KVA rating - Each transformer	
Three-phase Motor HP rating	Total effective KVA required★	Open WYE or DELTA 2 transformers	WYE or DELTA 3 transformers
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
175	200	115	70
200	230	130	75

★ Pump motor KVA requirements only - does not include allowances for other loads.

★★ This is also the KVA required for single phase motors.

Engine-driven generators

Required for submersible motors

Sub motor HP Single or three phase	Minimum kW rating of generator			
	Externally kW	Regulated KVA	Internally kW	Regulated KVA
1/3 Hp	1.5	1.0	1.2	1.5
1/2 Hp	2.0	2.5	1.5	1.9
3/4 Hp	3.0	3.8	2.0	2.5
1 Hp	4.0	5.0	2.5	3.13
1 1/2 Hp	5.0	6.25	3.0	3.8
2 Hp	7.5	9.4	4.0	5.0
3 Hp	10.0	12.5	5.0	6.25
5 Hp	15.0	18.75	7.5	9.4
7 1/2 Hp	20.0	25.0	10.0	12.5
10 Hp	30.0	37.5	15.0	18.75
15 Hp	40.0	50.0	20.0	25.0
20 Hp	60.0	75.0	25.0	31.0
25 Hp	75.0	94.0	30.0	37.5
30 Hp	100.0	125.0	40.0	50.0
40 Hp	100.0	125.0	50.0	62.5
50 Hp	150.0	188.0	60.0	75.0
60 Hp	175.0	220.0	75.0	94.0
75 Hp	250.0	313.0	100.0	125.0
100 Hp	300.0	375.0	150.0	188.0
125 Hp	375.0	469.0	175.0	219.0
150 Hp	450.0	563.0	200.0	250.0
175 Hp	525.0	656.0	250.0	313.0
200 Hp	600.0	750.0	275.0	344.0

1. Figures shown are based on typical 80°C rise continuous duty generators with 35% maximum voltage dip during start-up of single-phase and three-phase motors.

2. Contact the manufacturer of the generator to assure the unit has adequate capacity to run the submersible motor.

Electrical data

Motor protection chart

1- Phase motors

HP	Ph	Volt	Circ. brkr or fuses		Three phase overload protection		Nameplate
			Std.	Delay	Starter size	Furnas amb. comp	
4-inch, single phase, 2-wire motors (control box not required)							
1/3	1	230	15	5	-	-	79952101
1/2	1	115	30	15	-	-	79922102
1/2	1	230	15	7	-	-	79952102
3/4	1	230	20	9	-	-	79952103
1	1	230	25	12	-	-	79952104
1 1/2	1	230	35	15	-	-	79952105
4-inch, single phase, 3-wire motors							
1/3	1	115	25	10	-	-	79423101
1/3	1	230	15	5	-	-	79453101
1/2	1	115	30	15	-	-	79423102
1/2	1	230	15	7	-	-	79453102
3/4	1	230	20	9	-	-	79453103
1	1	230	25	12	-	-	79453104
1.5	1	230	30	15	-	-	79453105
2	1	230	30	15	-	-	79454506
3	1	230	45	20	-	-	79454507
5	1	230	70	30	-	-	79454509

3-Phase motors

HP	Ph	Volt	Circ. brkr or fuses		Three phase overload protection		Nameplate
			Std.	Delay	Starter size	Furnas amb. comp	
4-inch, three phase, 3-wire motors							
1 1/2	3	230	15	8	0	K41	79302005
		460	10	4	0	K32	79362005
		575	10	4	0	K28	79392005
2	3	230	20	10	0	K50	79302006
		460	10	5	0	K34	79362006
		575	10	4	0	K31	79392006
3	3	230	30	15	0	K54	79302006
		460	15	7	0	K37	79362007
		575	15	6	0	K36	79395507
5	3	230	40	25	1	K61	79304509
		460	20	12	0	K50	79354509
		575	15	9	0	K43	79394509
7 1/2	3	230	60	30	1	K67	79305511
		460	35	15	1	K56	79355511
		575	30	15	1	K53	79395511
10	3	460	50	25	1	K61	79355512
		575	40	20	1	K58	79395512

Electrical data

HP	Ph	Volt	Circ. brkr or fuses		Three phase overload protection		Nameplate
			Std.	Delay	Starter size	Furnas amb. comp	
6-inch, three phase, 3-wire motors							
7 1/2	3	230	60	35	1	K67	78305511
		460	30	15	1	K56	78355511
		575	25	12	1	K53	78395511
10	3	230	80	45	1 3/4	K70	78305512
		460	40	20	1	K60	78355512
		575	35	15	1	K57	78395512
15	3	230	125	60	2 1/2	k76	78305514
		460	60	30	1 3/4	K67	78355514
		575	50	25	1 3/4	k62	78395514
20	3	230	150	80	3	k79	78305516
		460	80	40	2	k68	78355516
		575	70	30	2	k67	78395516
25	3	460	100	50	2	K73	78355517
		575	80	40	2	K70	78395517
30	3	460	110	60	2 1/2	K76	78355518
		575	100	40	2 1/2	K72	78395518
40	3	460	150	80	3	K78	78355520

Motor cable selection chart (Motor service to entrance)

Single phase, 60 Hz

Motor rating		Copper wire size												
Volts	HP	14	12	10	8	6	4	2	0	00	000	0000	250	300
115	1/3	130	210	340	540	840	1300	1960	2910	-	-	-	-	-
	1/2	100	160	250	390	620	960	1460	2160	-	-	-	-	-
230	1/3	550	880	1390	2190	3400	5250	7960	-	-	-	-	-	-
	1/2	400	650	1020	1610	2510	3880	5880	-	-	-	-	-	-
	3/4	300	480	760	1200	1870	2890	4370	6470	-	-	-	-	-
	1	250	400	630	990	1540	2380	3610	5360	6520	-	-	-	-
	1 1/2	190	310	480	770	1200	1870	2850	4280	5240	-	-	-	-
	2	150	250	390	620	970	1530	2360	3620	4480	-	-	-	
	3	120	190	300	470	750	1190	1850	2890	3610	-	-	-	-
	5	-	-	180	280	450	710	1110	1740	2170	-	-	-	-
	7 1/2	-	-	-	200	310	490	750	1140	1410	-	-	-	-
	10	-	-	-	-	250	390	600	930	1160	-	-	-	-

Three phase, 60 Hz

Motor rating		Copper wire size												
Volts	HP	14	12	10	8	6	4	2	0	00	000	0000	250	300
208	1 1/2	310	500	790	1260	-	-	-	-	-	-	-	-	-
	2	240	390	610	970	1520	-	-	-	-	-	-	-	-
	3	180	290	470	740	1160	1810	-	-	-	-	-	-	-
	5	-	170	280	440	690	1080	1660	-	-	-	-	-	-
	7 1/2	-	-	200	310	490	770	1180	1770	-	-	-	-	-
	10	-	-	-	230	370	570	880	1330	1640	-	-	-	-
	15	-	-	-	-	250	390	600	910	1110	1340	-	-	-
	20	-	-	-	-	-	300	460	700	860	1050	1270	-	-
	25	-	-	-	-	-	-	370	570	700	840	1030	1170	-
	30	-	-	-	-	-	-	310	470	580	700	850	970	1110
230	1 1/2	360	580	920	1450	-	-	-	-	-	-	-	-	-
	2	280	450	700	1110	1740	-	-	-	-	-	-	-	-
	3	210	340	540	860	1340	2080	-	-	-	-	-	-	-
	5	-	200	320	510	800	1240	1900	-	-	-	-	-	-
	7 1/2	-	-	230	360	570	890	1350	2030	-	-	-	-	-
	10	-	-	-	270	420	660	1010	1520	1870	-	-	-	-
	15	-	-	-	-	290	450	690	1040	180	1540	-	-	-
	20	-	-	-	-	-	350	530	810	990	1200	1450	-	-
	25	-	-	-	-	-	280	430	650	800	970	1170	1340	-
	30	-	-	-	-	-	-	350	540	660	800	970	1110	1270

Motor rating		Copper wire size												
Volts	**HP**	**14**	**12**	**10**	**8**	**6**	**4**	**2**	**0**	**00**	**000**	**0000**	**250**	**300**
	1 1/2	1700	-	-	-	-	-	-	-	-	-	-	-	-
	2	1300	2070	-	-	-	-	-	-	-	-	-	-	-
	3	1000	1600	2520	-	-	-	-	-	-	-	-	-	-
	5	590	950	1500	2360	-	-	-	-	-	-	-	-	-
	7 1/2	420	680	1070	1690	2640	-	-	-	-	-	-	-	-
	10	310	500	790	1250	1960	3050	-	-	-	-	-	-	-
	15	-	-	540	850	1340	2090	3200	-	-	-	-	-	-
	20	-	-	410	650	1030	1610	2470	3730	-	-	-	-	-
	25	-	-	-	530	830	1300	1990	3010	3700	-	-	-	-
460	30	-	-	-	430	680	1070	1640	2490	3060	3700	-	-	-
	40	-	-	-	-	-	790	1210	1830	2250	2710	3290	-	-
	50	-	-	-	-	-	640	980	1480	1810	2190	2650	3010	-
	60	-	-	-	-	-	-	830	1250	1540	1850	2240	2540	2890
	75	-	-	-	-	-	-	-	1030	1260	1520	1850	2100	2400
	100	-	-	-	-	-	-	-	-	940	1130	1380	1560	1790
	125	-	-	-	-	-	-	-	-	-	-	1080	1220	1390
	150	-	-	-	-	-	-	-	-	-	-	-	1050	1190
	200	-	-	-	-	-	-	-	-	-	-	-	1080	1300
	250	-	-	-	-	-	-	-	-	-	-	-	-	1080
	1 1/2	2620	-	-	-	-	-	-	-	-	-	-	-	-
	2	2030	-	-	-	-	-	-	-	-	-	-	-	-
	3	1580	2530	-	-	-	-	-	-	-	-	-	-	-
	5	920	1480	2330	-	-	-	-	-	-	-	-	-	-
	7 1/2	660	1060	1680	2650	-	-	-	-	-	-	-	-	-
	10	490	780	1240	1950	-	-	-	-	-	-	-	-	-
	15	-	530	850	1340	2090	-	-	-	-	-	-	-	-
575	20	-	-	650	1030	1610	2520	-	-	-	-	-	-	-
	25	-	-	520	830	1300	2030	3110	-	-	-	-	-	-
	30	-	-	-	680	1070	1670	2560	3880	-	-	-	-	-
	40	-	-	-	-	790	1240	1900	2860	3510	-	-	-	-
	50	-	-	-	-	-	1000	1540	2310	2840	3420	-	-	-
	60	-	-	-	-	-	850	1300	1960	2400	2890	3500	-	-
	75	-	-	-	-	-	-	1060	1600	1970	2380	2890	3290	-
	100	-	-	-	-	-	-	-	1190	1460	1770	2150	2440	2790

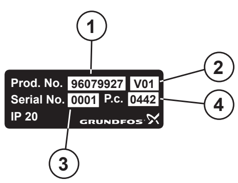
1. If aluminum conductor is used, multiply lengths by 0.5. Maximum allowable length of aluminum is considerably shorter than copper wire of same size.
2. The portion of the total cable which is between the service entrance and a 3ø motor starter should not exceed 25% of the total maximum length to assure reliable starter operation. Single-phase control boxes may be connected at any point of the total cable length.
3. Cables #14 to #0000 are AWG sizes, and 250 to 300 are MCM sizes.

MP 204

TM03 1471

Nameplates

Rating and approvals of the MP 204.



TM03 1472 2205

Fig. 13 Nameplate on front cover

These four numbers must be stated when contacting Grundfos:

Pos.	Description
1	Product number
2	Version number
3	Serial number
4	Production code

TM03 1495 3605 TM03 1496 / 1421 2205

Fig. 14 Nameplates on the side of MP 204

Product range

- MP 204
- External current transformers up to 1000 A.

Functions

- Phase-sequence monitoring
- Indication of current or temperature (user selection)
- Input for PTC/thermal switch
- Indication of temperature in °C or °F (user selection)
- 4-digit, 7-segment display
- Setting and status reading with the R100
- Setting and status reading via the GENIbus.

Tripping conditions

- Overload
- Underload (dry running)
- Temperature (Tempcon sensor, PTC/thermal switch and Pt sensor)
- Missing phase
- Phase sequence
- Overvoltage
- Undervoltage
- Power factor (cos φ)
- Current unbalance.

Warnings

- Overload
- Underload
- Temperature (Tempcon, see section , and Pt sensor)
- Overvoltage
- Undervoltage
- Power factor (cos φ)
  Note: In connection with single- and three-phase connection.
- Run capacitor (single-phase operation)
- Starting capacitor (single-phase operation)
- Loss of communication in network
- Harmonic distortion.

Learning function

- Phase sequence (three-phase operation)
- Run capacitor (single-phase operation)
- Starting capacitor (single-phase operation)
- Identification and measurement of Pt100/Pt1000 sensor circuit.

Factory settings

Current limit: 0 A

Nominal voltage: 400 V

Class: P (trip delay: 10 seconds)

Trip delay: 5 seconds

Number of phases: 3, non-earthed

Power-on delay: 2 seconds.

Learning function: Active.

Active trip limits

Overload according to class

Underload: –40%

Overvoltage: +20%

Undervoltage: –20%

Phase-sequence monitoring

Current unbalance: 10%

PTC/thermal switch.

Note: The overvoltage and undervoltage trip limits will be deactivated automatically if the temperature monitoring with Tempcon or Pt100/Pt1000 has been set to active.

Active warnings

Run capacitor, low: –50%

Starting capacitor, low: –50%.

Connection

Overview

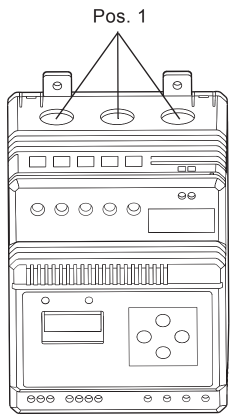


Fig. 15 Cable entries

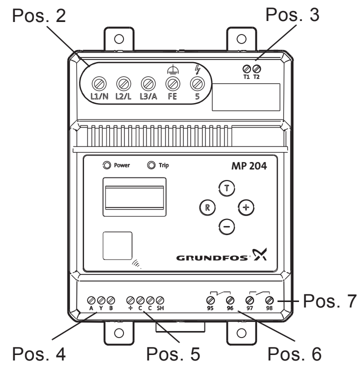


Fig. 16 Terminals

Pos.	Designation	Three-phase connection	Single-phase connection	Cable
1	I1	Entry for phase L1 to motor	Entry for neutral	Max. ø16 mm
	I2	Entry for phase L2 to motor	Entry for phase	
	I3	Entry for phase L3 to motor	Entry for auxiliary winding	
2	L1/N	Supply: L1	Supply: Neutral	Max. 6 1) mm^2
	L2/L	Supply: L2	Supply: Phase	
	L3/A	Supply: L3	Auxiliary winding	
	FE	Functional earth		
	5	Insulation measurement		
3	T1	PTC/thermal switch		Max. 2.5 2) mm^2
	T2			
4	A	GENIbus data A		
	Y	Reference/screen		
	B	GENIbus data B		
5	+	Pt100/Pt1000 sensor		
	C			
	C			
	SH	Screen		
6	95	Trip relay NC		
	96			
7	97	Signal relay NO		
	98			

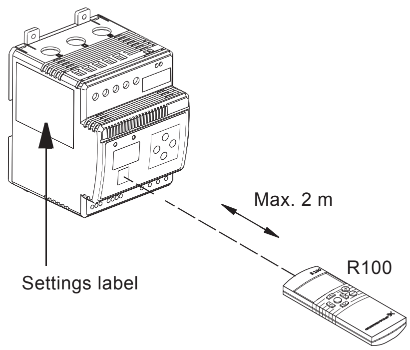
1) 10 mm^2 with cable terminal

2) 4 mm^2 with cable terminal

R100 remote control

The R100 remote control is used for wireless communication with the MP 204. The R100 communicates via infra-red light. During communication, there must be visual contact between the R100 and the MP 204. See fig. 17.

The R100 offers additional settings and status readings for the MP 204.



TM03 0178 4404

Fig. 17 R100 and label

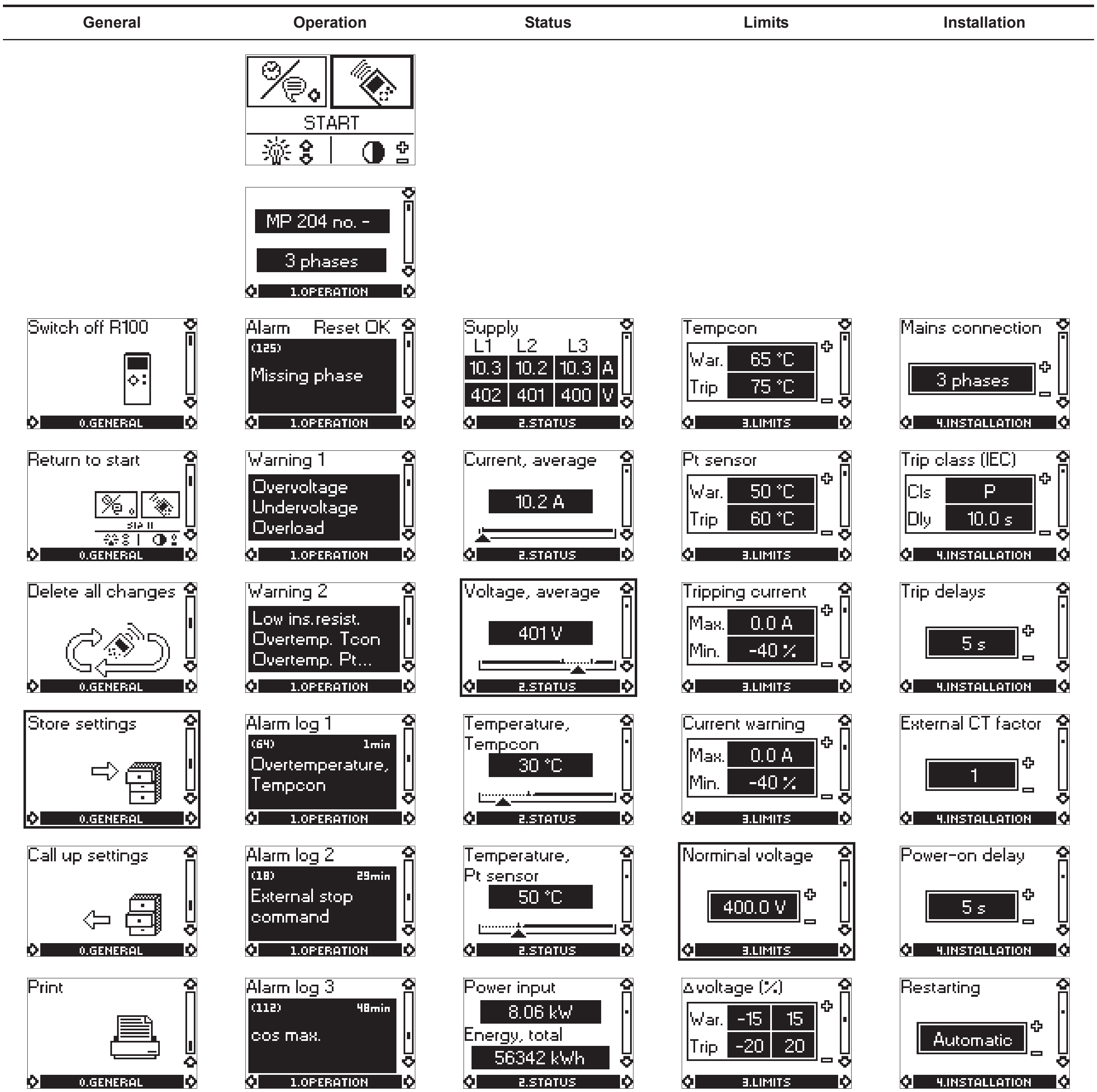
The settings label, which is enclosed, can be affixed to the MP 204 as required.

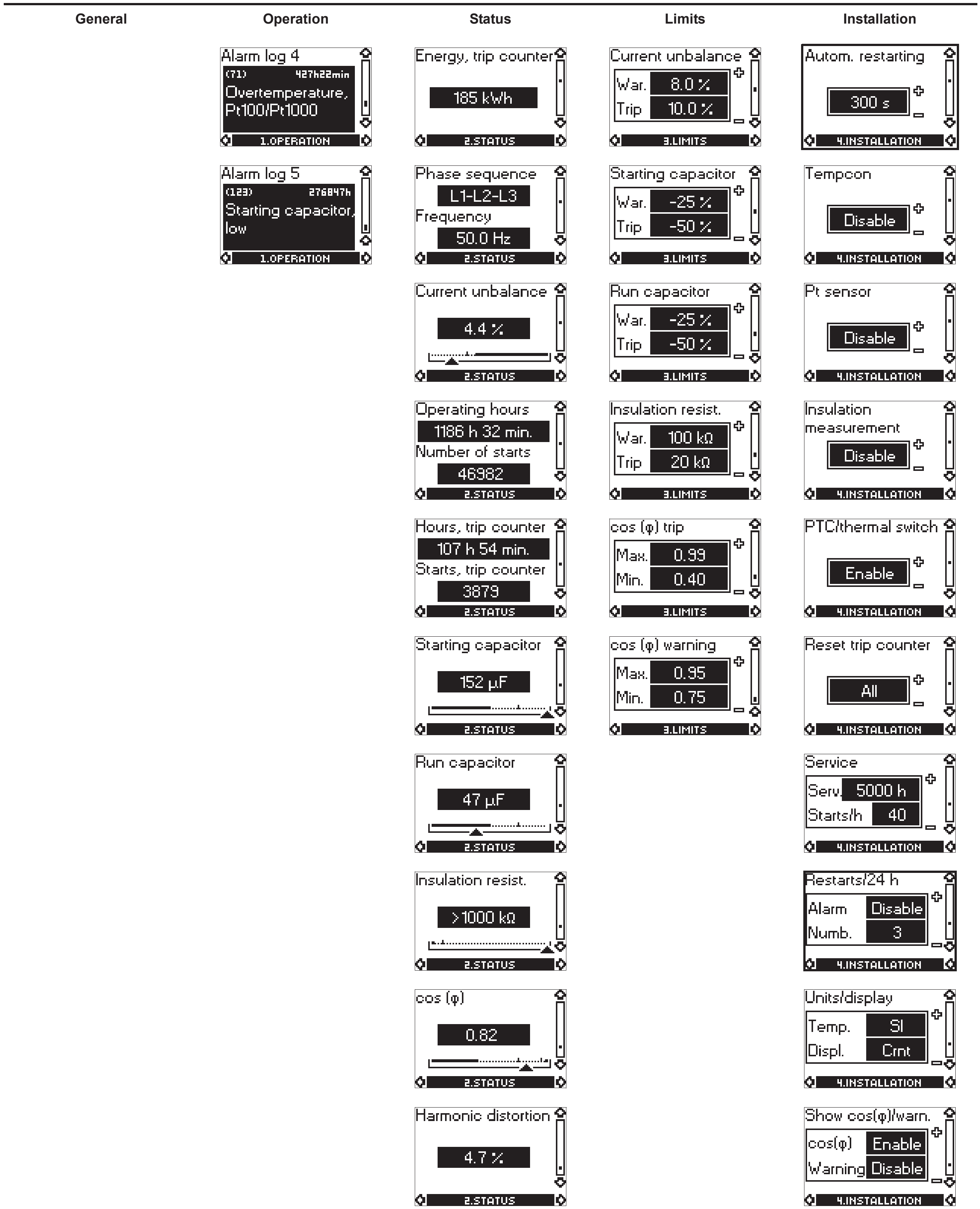
If the R100 comes into contact with more than one unit at a time, the number of the desired unit must be entered.

Below is the map for the R100 in conjunction with the MP204. This map is followed by the screen by screen procedures for setting up the MP204 protection for a Grundfos submersible motor. For a more complete and detailed use of the R100 with the MP204 for protection and monitoring of the Grundfos MS and MMS motors please see the I&O manual accompanying the MP204.

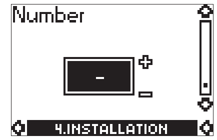
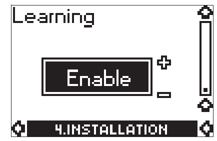
Menu structure

The menu structure for the R100 and MP 204 is divided into five parallel menus, each including a number of displays.





General
Operation
Status
Limits
Installation
Alarm log 4
(71) 427h22min
Overtemperature, Pt100/Pt1000
1.OPERATION
Alarm log 5
(123) 276847h
Starting capacitor, low
1.OPERATION
Energy, trip counter
185 kWh
2.STATUS
Phase sequence
L1-L2-L3
Frequency
50.0 Hz
2.STATUS
Current unbalance
4.4 %
2.STATUS
Operating hours
1186 h 32 min.
Number of starts
46982
2.STATUS
Hours, trip counter
107 h 54 min.
Starts, trip counter
3879
2.STATUS
Starting capacitor
152 µF
2.STATUS
Run capacitor
47 µF
2.STATUS
Insulation resist.
>1000 kΩ
2.STATUS
cos (φ)
0.82
2.STATUS
Harmonic distortion
4.7 %
2.STATUS
Current unbalance
War. 8.0 %
Trip 10.0 %
3.LIMITS
Starting capacitor
War. -25 %
Trip -50 %
3.LIMITS
Run capacitor
War. -25 %
Trip -50 %
3.LIMITS
Insulation resist.
War. 100 kΩ
Trip 20 kΩ
3.LIMITS
cos (φ) trip
Max. 0.99
Min. 0.40
3.LIMITS
cos (φ) warning
Max. 0.95
Min. 0.75
3.LIMITS
Autom. restarting
300 s
4.INSTALLATION
Tempcon
Disable
4.INSTALLATION
Pt sensor
Disable
4.INSTALLATION
Insulation measurement
Disable
4.INSTALLATION
PTC/thermal switch
Enable
4.INSTALLATION
Reset trip counter
All
4.INSTALLATION
Service
Serv. 5000 h
Starts/h 40
4.INSTALLATION
Restarts/24 h
Alarm Disable
Numb. 3
4.INSTALLATION
Units/display
Temp. SI
Displ. Crnt
4.INSTALLATION
Show cos(φ)/warn.
cos(φ) Enable
Warning Disable
4.INSTALLATION

General	Operation	Status	Limits	Installation
				
				

Menu 3. LIMITS

The MP 204 operates with two sets of limits:

- a set of warning limits and
- a set of trip limits.

Some values only have a warning limit.

If one of the trip limits is exceeded, the trip relay stops the motor. Outputs 95-96 open, causing the control current to the contactor to be disconnected. At the same time, the signal relay, terminals 97-98, is closed.

The limit values should not be changed unless the pump has stopped.

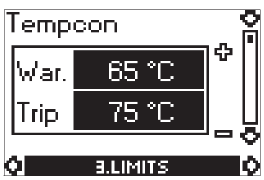
The trip limits must be set in accordance with the motor manufacturer's specifications.

The warning limits should be set to a less critical level than the trip limits.

If one or more of the warning limits are exceeded, the motor continues to run, but the warnings will appear in the MP 204 display, provided that this indication has been activated with the R100.

The warnings can also be read out with the R100.

Tempcon sensor



Set the warning and trip limits for the Tempcon sensor.

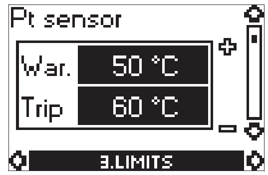
Factory setting:

- Warning: 65°C.
- Trip: 75°C.

Note: Above limits are not active until the Tempcon sensor has been activated.

Note: The overvoltage and undervoltage trip limits will be deactivated automatically if the temperature monitoring with Tempcon has been set to active.

Pt sensor



Set the warning and trip limits for the Pt sensor.

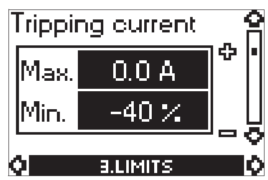
Factory setting:

- Warning: 50°C.
- Trip: 60°C.

Note: Above limits are not active until the Pt sensor has been activated.

Note: The overvoltage and undervoltage trip limits will be deactivated automatically if the temperature monitoring with Pt100/Pt1000 has been set to active.

Tripping current



Set the rated motor current in the "Max." field. (See motor nameplate.)

Factory setting:

- Max.: 0.0 A.

Set the min. current limit in the "Min." field. The min. current limit is typically a dry-running limit. The value is set in % of max. value.

Factory setting:

- Min.: –40%.

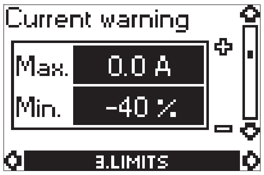
Example:

The rated motor current is 10 A.

The motor is to cut out (trip) at a current below 6 A.

Set "–40%" in the "Min." field.

Current warning



Set the warning limits for "Max." and "Min.".

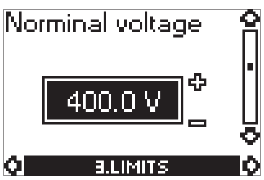
Set the max. warning limit in the "Max." field. The value is set in ampere.

Factory setting:
- Max.: 0.0 A

Set the min. warning limit in the "Min." field. The value is set in % of max. value.

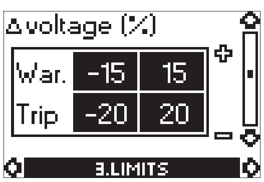
Factory setting:
- Min.: –40%.

Nominal voltage



Set the nominal supply voltage.

Voltage limits

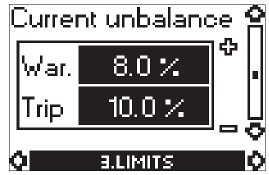


Set the warning and trip limits for under- and overvoltage.

Factory setting:
- Warning: ±15%.
- Trip: ±20%.

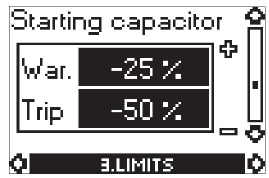
The values are set in % of nominal voltage.

Current unbalance



Set the warning and trip limits for current unbalance. Factory setting:
- Warning: 8.0%.
- Trip: 10.0%.

Starting capacitor



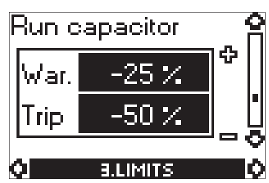
Set the warning and trip limits for the capacity of the starting capacitor.

Factory setting:
- Warning: –25%.
- Trip: –50%.

The values are set as % of the value measured by the learning function.

Note: Setting is only possible when single-phase operation has been selected.

Run capacitor



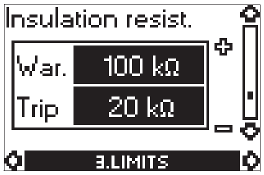
Set the warning and trip limits for the capacity of the run capacitor.

Factory setting:
- Warning: –25%.
- Trip: –50%.

The values are set as % of the value measured by the learning function.

Note: Setting is only possible when single-phase operation has been selected.

Insulation resistance



Set the warning and trip limits for the insulation resistance in the installation. The value set should be low enough to allow for an early indication of faults in the installation.

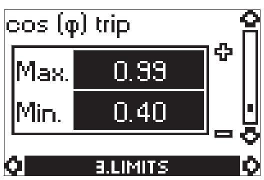
Factory setting:

- Warning: 100 kΩ.
- Trip: 20 kΩ.

Note:

- Insulation faults must be set to active to enable these limits.
- Setting is only possible when "3 phases w. FE" (functional earth) has been selected.

Cos φ trip



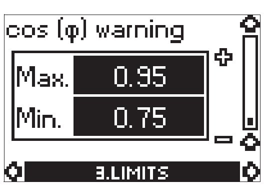
Set the trip limits for cos φ.

Factory setting:

- Max.: 0.99.
- Min.: 0.40.

This function can be used as dry-running protection when dry running cannot be detected by means of a current measurement.

Cos φ warning



Set the warning limits for cos φ.

Factory setting:

- Max.: 0.95.
- Min.: 0.75.

Menu 4. INSTALLATION

In this menu, it is possible to set a number of operating data and thus match the MP 204 to the actual installation.

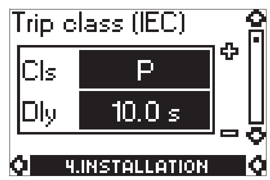
The installation values should not be changed unless the pump has stopped.

Supply mains

Set the supply mains to which the MP 204 is connected:

- 3 phases (non-earthed) (factory setting)
- 3 phases w. FE (functional earth)
- 1 phase.

Trip class



Line 1: Select IEC trip class (1 to 45).

If manual indication of trip delay in the case of overload is required, select trip class "P".

Factory setting:

- Cls (trip class): P.

Line 2: Select trip delay.

Factory setting:

- Dly (trip delay): 10 s.

Trip delay

Set the trip delay before the MP 204 trips.

Note: This does not apply to overload.

Factory setting:

- 5 s.

External current transformers

Set the external current transformer factor.

If no external current transformer is used, the factor is 1.

Factory setting:

- 1.

Note: Set the actual factor.

Example:

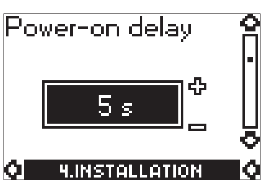
A current transformer with a 200:5 ratio is used and five windings through the MP 204 are made.

$$CT = \frac{200}{5 \bullet 5} = 8$$

Grundfos current transformers	Set CT factor
200:5	8
300:5	12
500:5	20
750:5	30
1000:5	40

Note: The above table only applies to Grundfos current transformers.

Power-on delay



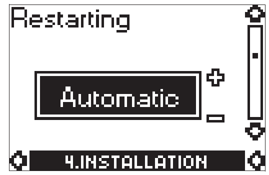
Number of seconds elapsing from the moment voltage is applied to the MP 204 until the activation of the trip relay (terminals 95-96) and signal relay (terminals 97-98).

Factory setting:

- 5 s.

Note: The motor cannot start during this delay.

Restarting



Set whether restarting after tripping is to be

- **Automatic** (factory setting)
- Manual.

Automatic restarting

Set the time after which the MP 204 is to attempt automatic restarting of motor after cut-out.

The time runs from the moment when the value which triggered the fault has returned to normal.

Factory setting:

- 300 s.

Tempcon sensor

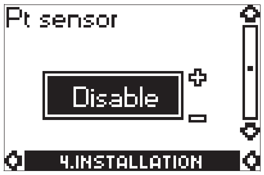
Set whether a Tempcon sensor is incorporated in the motor.

- Enable
- **Disable** (factory setting).

If the Tempcon sensor is set to active and no Tempcon signal is received from the pump, the MP 204 display shows "----" instead of Tempcon temperature.

Note: The overvoltage and undervoltage trip limits will be deactivated automatically if the temperature monitoring with Tempcon has been set to active.

Pt sensor



Set whether a Pt sensor is connected.

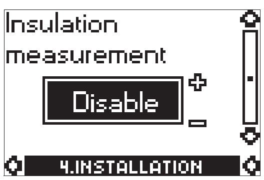
- Enable
- **Disable** (factory setting).

If the Pt sensor is set to active and no signal is received from the sensor, the MP 204 display shows "----" instead of Pt temperature.

Note: The overvoltage and undervoltage trip limits will be deactivated automatically if the temperature monitoring with Pt100/Pt1000 has been set to active.

Note: The learning function registers automatically whether a Pt100/Pt1000 sensor is connected.

Insulation resistance measurement



Set whether insulation resistance measurement is to be made.

- Enable
- **Disable** (factory setting).
- If three-phase, earthed mains is selected, this setting is automatically changed to "Enable".
- If single-phase mains is selected, this setting is automatically changed to "Disable".

Note:

- The insulation resistance can only be measured if terminal "FE" is earthed and the supply mains is set to "3 phases w. FE".
- The leakage is measured when the MP 204 is powered and the motor stopped.
- The MP 204 must be connected in front of the contactor, and terminal "5" after the contactor.

PTC/thermal switch

Set whether a PTC/thermal switch is connected.

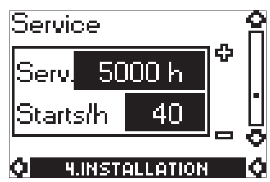
- **Enable** (factory setting)
- Disable.

Resetting of trip counters

Select the trip counters to be reset.

- **All** (all trip counters) (factory setting)
- Hours (operating hours)
- Starts (number of starts)
- Energy (energy consumption).

Service interval



Line 1: Set the number of hours of motor operation at which the MP 204 is to give a service warning in the display.

Factory setting:

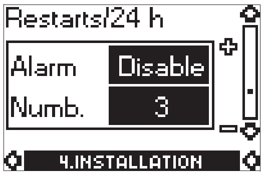
- Service: 5000 h.

Line 2: Set the number of starts allowed per hour at which the MP 204 is to give a warning in the display.

Factory setting:

- Starts/h: 40.

Number of automatic restarts



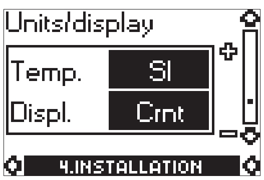
Set the number of automatic restarts that the motor is allowed to make within 24 hours before cutting out.

Alarm:
- Enable
- **Disable** (factory setting).

Number:
- 40 (factory setting).

Note: If this tripped state occurs, the motor can only be restarted manually.

Units/display



Line 1: Set unit.

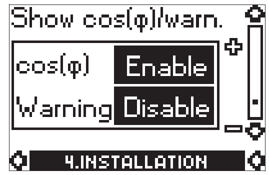
Temperature:
- **SI** (factory setting)
- US.

Note: If SI units have been selected, the temperature is indicated in degree Celcius (°C).
If US units have been selected, the temperature is indicated in Fahrenheit (°F).

Line 2: Select the MP 204 display indication during normal operation.

Display:
- **Crnt** (current) (factory setting)
- Tcon (Tempcon temperature)
- Pt sen.(Pt100/Pt1000 temperature).

MP 204 display



Line 1: Set whether the cos φ value is to be shown in the MP 204 display by means of the ⊕ button.

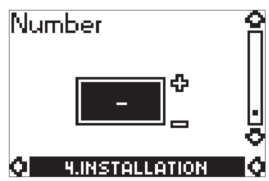
cos φ:
- **Enable** (factory setting)
- Disable.

Line 2: Set whether warnings are to be shown in the display.

Warning:
- Enable
- **Disable** (factory setting).

If display of warnings is active, the MP 204 display will switch from standard display (e.g. current) to warning code display when the limit value is exceeded. The remaining values can still be read out by means of the ⊕ button.

GENIbus ID number

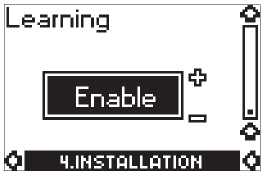


Set ID number.

If several units are connected to the same GENIbus, each unit must be assigned a unique ID number.

Factory setting:
- – (no number assigned).

Learning function



The learning function is active until the motor has been operating for a minimum of 120 seconds. The dot in the right side of the MP 204 display is flashing.

During the storing of the measured values, "LRN" appears in the MP 204 display.

Three-phase operation:

- Accepts the actual phase sequence as correct.
- If a Pt100/Pt1000 sensor is connected, the cable impedances to the sensor are measured.

Single-phase operation:

- Starting and run capacitors are measured.
- If a Pt100/Pt1000 sensor is connected, the cable impedances to the sensor are measured.

Note: The learning function changes to "not active" when the measurements have been made.

- **Active** (factory setting)
- Not active.

MP 204 with GENIbus

If several MP 204 units are connected to the same GENIbus, the connection is to be made as shown in fig. 18.

Note the connection of screen to conductive support.

If the GENIbus has been in use, and bus communication monitoring has been activated, the MP 204 will continue to monitor the bus activity. If the MP 204 does not receive GENIbus telegrams, the MP 204 presumes that the GENIbus connection has been disconnected and indicates a fault on the individual units.

Each of the units in the chain must be assigned an identification number with the R100.

For further information about the GENIbus, see WebCAPS at www.grundfos.com.

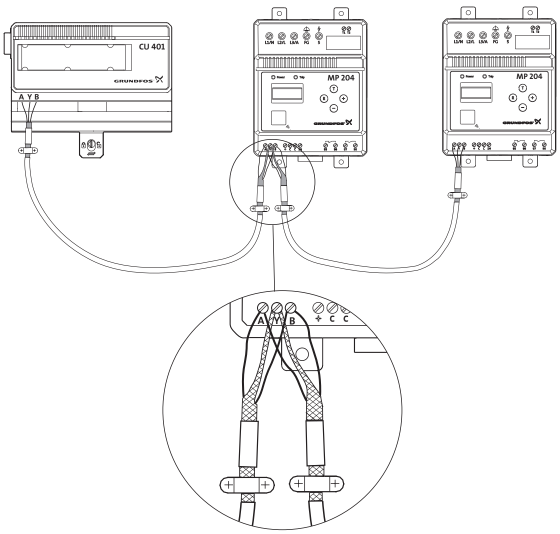


Fig. 18 GENIbus

Approvals and standards

The MP 204 conforms to:

- UL 508
- IEC 947
- IEC/EN 60335-1
- IEC/EN 61000-5-1
- IEC 61000-6-3
- IEC 61000-6-2
- EN 61000-6-3
- EN 61000-4-5
- EN 61000-4-4
- EN 61000-4-6.

Submersible pumps

Submersible pumps normally have a short start-up time. Trip class "P" can therefore be applied with advantage for these pumps. It is possible to set very short times down to for example 900 ms, used for certain specific applications.

To prevent the Tempcon signal from one submersible pump from interfering with the signal from another, cabling must be carefully made to allow measurements to be made of both pumps at the same time. The motor cables must be kept apart and not installed in the same cable tray. To avoid interference, it may be necessary to fit a filter on the supply cables. See fig. 19.

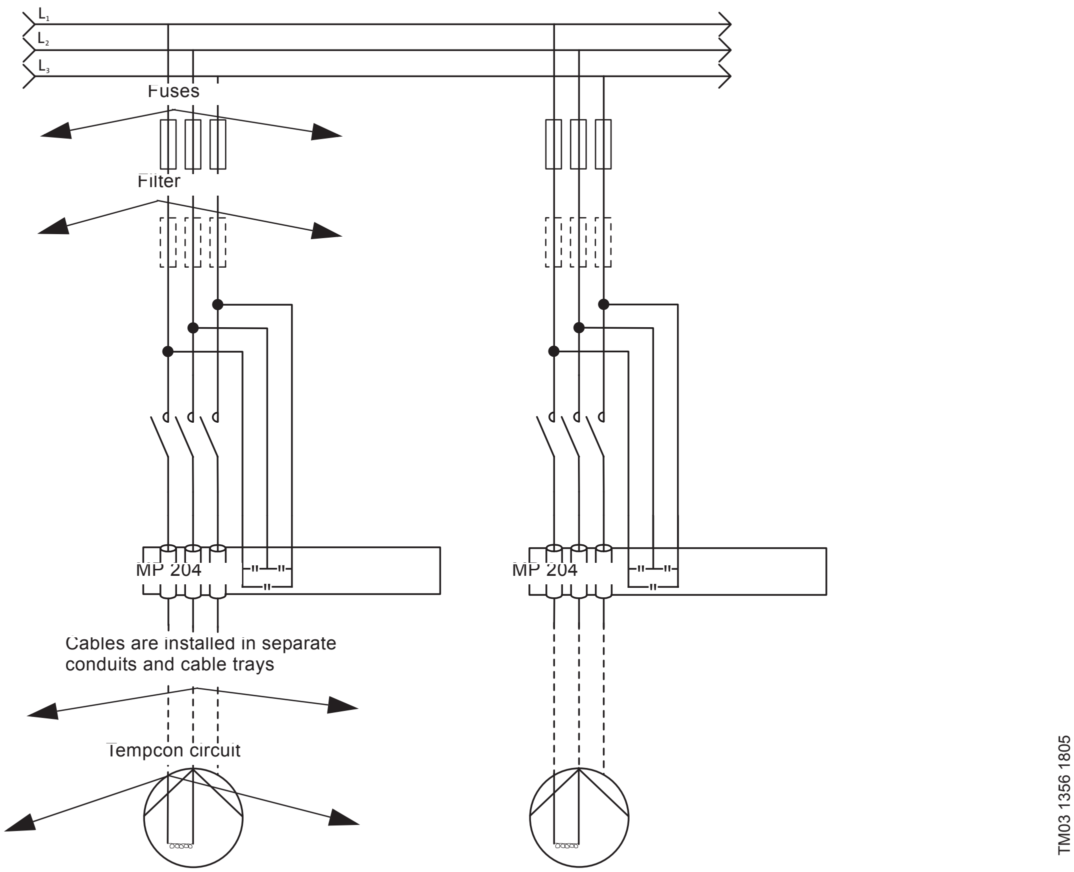


Fig. 19 Submersible pump installation with Tempcon