MS6000

Submersible motors

50/60 Hz

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1. Product description

The Grundfos MS6000 product range is a complete range of submersible motors available in 50 Hz and 60 Hz versions from 5.5 kW up to 30 kW.

Two material versions are available:

- A standard version made of stainless steel EN 1.4301 (AISI 304).
- An R-version made of stainless steel EN 1.4539 (AISI 904L) for aggressive liquids such as seawater and mine water.

Grundfos MS6000 submersible motors are designed according to market standards. All Grundfos MS6000 motors are designed to fit pump ends manufactured according to NEMA standards, and therefore they can be fitted on all Grundfos SP pumps without the need for adapters. The motors are also available with a flange extension in order to fit pump ends from other pump manufactures. See fig. 1.

General characteristics of the MS6000 motor:

- 6" diameter (OD = 139.5 mm).
- high efficiency.
- stator completely encapsulated in stainless steel.
- cooled by pumped liquid.
- hermetically sealed, canned motor with a dry stator.
- enclosure class IP68.
- factory filled with Grundfos motor liquid SML-3, alternatively filled with demineralized water.
- built-in temperature transmitter (Tempcon).
- motor temperature can also be monitored via a Pt100 or Pt1000 sensor (used for frequency controlled installations).

Fig. 1 MS6000 motors with and without flange extension

Features and benefits

The Grundfos MS6000 submersible motor offers the following features and benefits:

High motor efficiency

The complete motor range is characterized by high efficiency which contributes to improved economy of the entire pump system.

Sealing system

All motors are with mechanical shaft seals.

High reliability

New state-of-the-art shaft seal design and materials offering high wear resistance, long operating life, improved sticking and dry-running capabilities.

Super stainless steel versions

Super stainless steel version EN 1.4539 (AISI 904 L) with silicon carbide based (SiC/SiC) mechanical shaft sealing system and FKM rubber parts for applications in seawater and slightly contaminated environment which might contain hydrocarbons.

Worldwide usage

With different voltage and frequency combinations, the product range covers markets worldwide.

Highly reliable thrust bearing

Fitted with a sturdy MICHELL thrust bearing, the motors offers high reliable operation.

Monitoring of motor temperature

In order to achieve maximum protection of the motor against burnout, the motor has a built-in Tempcon temperature sensor with power line communication. In combination with motor protection (MP204), the sensor offers optimal protection of the motor.

Additional monitoring of motor temperature

As over-temperature protection, the MS6000 motors also offer the possibility of connecting a Pt100 or Pt1000sensor to monitor the temperature.

This solution is used in combination with frequency controlled motors.

Applications

Grundfos submersible motors are designed for a wide range of applications such as these:

- deep well water supply
- irrigation
- groundwater regulation
- pressure boosting
- industrial water transfer and similar applications
- fountains
- dewatering.

The MS6000 motor is available in a wide range of variants to suit these different kinds of applications:

MS6000T40

For operation in normal groundwater with temperatures up to 40 °C.

MS6000XT40

For operation in normal groundwater with temperatures up to 40 °C. The motor is without Tempcon sensor.

MS6000WT40

For applications where horizontal operation is common and turbine operation may occur. The motor contains tungsten carbide/SiC bearings

MS6000REST40

For operation in aggressive liquids with abrasive particles

MS6000RESWT40

For operation in aggressive liquids with abrasive particles in applications where horizontal operation is common and turbine operation may occur.

MS6000RESDT40

For applications where a high degree of process control is required, e.g. in chip manufacturing. The motor is factory-filled with demineralised water.

MS6000EST40

For operation in neutral liquids with low content of hydrocarbons and dissolved gasses.

MS6000QFT40

For operation in normal groundwater with temperatures up to 40 °C. The motor contains a SiC/SiC shaft seal with rubber parts of NBR, and therefore it is approved for drinking water. Furthermore, it is mounted with an extension flange for the US market.

MS6000T60

For operation in normal groundwater with temperatures up to 60 °C

MS6000REST60

For operation in aggressive liquids with temperatures up to 60 °C.

MS6000RESWT60

For operation in aggressive liquids with temperatures up to 60 °C and with abrasive particles in applications where horizontal operation is common and turbine operation may occur.

2. Identification

Type key

Description	MS6000	R	E	S	W	D	F	X	T40	3 x 400/50 460/60	SD	18.5 kW

Motor type

Material type

	=	EN 1.4301
R	=	EN 1.4539

Rubber

	=	NBR
E	=	FKM

Shaft seal

	=	Ceramic/carbon	BXPFF/NBR
S	=	SiC/SiC	Q1Q1VFF/FKM
Q	=	SiC/SiC	Q1Q1PFF/NBR

Radial bearings

	=	Ceramic/hard metal
W	=	SIC/Tungsten carbide

Motor liquid

	=	SML-3
D	=	Demineralised water
H	=	Glycol 60 vol % HTF

Flange extension

	=	Without
F	=	With

Tempcon

	=	With
X	=	Without

Max. liquid temperature

T40	=	40 °C
T60	=	60 °C

Voltage

3 x 340-380/50 440/60		3 x 340-380 V, 50 Hz 3 x 440 V, 60 Hz
3 x 200/50 200-220/60	=	3 x 200 V, 50 Hz 3 x 200-220 V, 60 Hz
3 x 220-230/50	=	3 x 220-230 V, 50 Hz
3 x 400/50 460/60	=	3 x 380-400-415 V, 50 Hz 3 x 440-460-480 V, 60 Hz
3 x 400/50 400-440/60	=	3 x 400 V, 50 Hz 3 x 400-440 V, 60 Hz
3 x 690/50	=	3 x 690 V, 50 Hz
3 x 208-220-230/60	=	3 x 208-220-230 V, 60 Hz
3 x 380-400/60	=	3 x 380-400 V 60 Hz
3 x 500/50 575/60	=	3 x 500-525 V, 50 Hz 3 x 575 V, 60 Hz
3 x 690/60		3 x 690 V, 60 Hz

Method of starting

	=	DOL
SD	=	SD

Motor power

5.5 kW	7.5 hp
7.5 kW	10 hp
9.2 kW	12 hp
11 kW	15 hp
13 kW	18 hp
15 kW	20 hp
18.5 kW	25 hp
22 kW	30 hp
26 kW	35 hp
30 kW	40 hp

Note: The type key cannot be used for ordering as not all combinations are possible.

3. Operating conditions

Pumped liquids

The MS6000 motors are produced in two material versions to enable use in various liquids.

- We recommend MS6000 for use in groundwater. It is made of stainless steel EN 1.4301.
- We recommend MS6000 RE for use in aggressive and slightly contaminated liquids. It is made of stainless steel EN1.4539, and the rubber parts are made from FKM.

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

The motors are designed for use in applications with a maximum permissible abrasive content in the pumped liquid of 200 ppm. If the pumped liquids contain abrasives, Grundfos recommends a motor with SiC/SiC shaft seal.

Ambient pressure

Maximum 60 bar ~ 6.0 MPa.

We do not recommend that you use the motor for operation in a vacuum. If this cannot be avoided, please contact Grundfos for guidance.

Cooling

The cooling of the motor depends on the temperature and the flow velocity of the pumped liquid past the motor. It is important that the values for maximum temperature of the pumped liquid and its minimum velocity past the motor are retained to ensure sufficient cooling of the motor. See the table below.

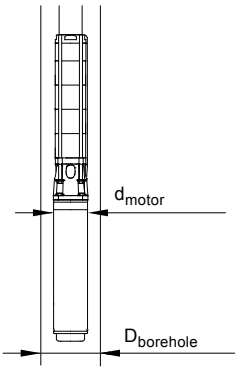
Motor	Installation		
	Flow past the motor	Vertical	Horizontal
MS6000 (T40 versions)	0.15 m/s (0.5 ft/s)	40 °C (~ 104 °F)	40 °C (~ 104 °F)
MS6000 (T60 versions)	1 m/s (3.3 ft/s)	60 °C (~ 140 °F)	60 °C (~ 140 °F)

Calculation of the flow velocity

$$v = \frac{Q \times 353}{D_{borehole}^2 - d_{motor}^2} [m/s]$$

Legends

v	=	flow velocity past the motor [m/s]
Q	=	rated flow [m/h]
353	=	constant
$D_{borehole}^2$	=	internal borehole diameter [mm]
d_{motor}^2	=	outer motor diameter [mm].



TM02 1322 3601

Fig. 2 Diameter of motor and borehole

Example

Water temperature	=	40 °C
Q	=	40 m^3/h
d_{motor}^2	=	138 mm (6")
$D_{borehole}^2$	=	203 mm (8")

Calculation of the flow velocity past the motor:

$$v = \frac{40 \times 353}{203^2 - 138^2} [m/s]$$

$$v = 0.64 [m/s]$$

Recommendations for optimum cooling

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

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

If there is a risk of sediment build-up, such as sand around the motor, a flow sleeve should be used in order to ensure proper cooling of the motor. If a flow sleeve is used, the motor can be placed in the well screen. See section *Flow sleeves* page 45.

Start/stop frequency per hour

The motor is designed for continuous as well as intermittent operation.

Frequency of starts and stops

Minimum number of starts: 1 per year is recommended (alternatively the shaft can be turned by hand)

Maximum number of starts: 30 per hour

300 per day.

Note: The maximum number of starts applies only to the motor. The maximum number of starts may be limited by the pump design.

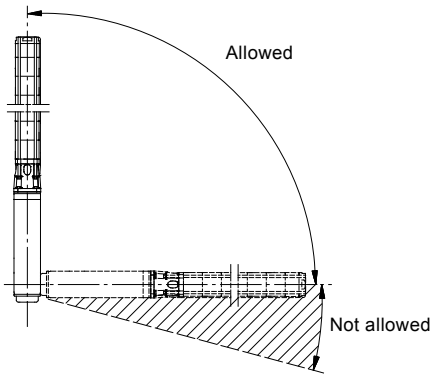
4. Installation

Mechanical installation

The motor must be fully submerged in the pumped liquid during operation to ensure sufficient cooling and it can be installed either horizontally or vertically.

Horizontal installation

If the motor is installed horizontally, the shaft end must not fall below the horizontal level. We always recommend that you use a flow sleeve when the motor is installed horizontally.



TM00 1355 5092

Fig. 3 Positional requirements

Vertical installation

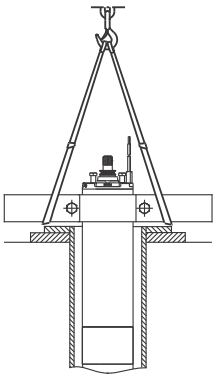
Installation depth below water level

Maximum 600 m.

Fitting the motor to the pump

Fit the motor to the pump as follows:

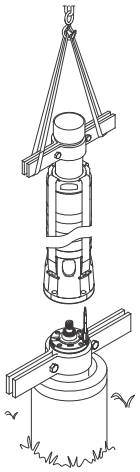
1. Use pipe clamps when handling the motor.
2. Place the motor in vertical position at the wellhead seal, see fig. 4



TM06 0536 0414

Fig. 4 Motor in vertical position

3. Lift the pump part by means of pipe clamps fitted to the extension pipe, see fig. 5.



TM06 0544 0414

Fig. 5 Lifting the pump into position

4. Place the pump part on top of the motor and tighten the screws.
5. Fit the cable along the chamber stack, and mount the cable guard.

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

Lowering the motor

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

Lower the motor carefully into the borehole and be careful not to damage the motor cable and the submersible drop cable.

Note: Do not lower or lift the motor by means of the motor cable.

Electrical installation

Electrical installation must comply with local legislation.

Supply requirements

The motor requires the following voltage quality requirements in relation to the rated voltage stamped on the motor:

- Voltage range motors: + 6 %/- 10 %
- Fixed voltage motors: + 10 %/- 10 %

The voltage is either measured at the motor terminals or calculated. The tolerance covers variations in the mains supply and losses in the cables.

There must be voltage symmetry in the supply network, i.e. there must be the same voltage difference between the individual phase leads. When the motor is operating there must be current symmetry, i.e. the three phases must be evenly loaded.

The voltage and current unbalance between the phases must be within the limits below:

- maximum voltage unbalance: 2 %
- maximum current unbalance: 5 %.

Direction of rotation

When the motor has been connected to the electricity supply, determine the correct direction of rotation as follows:

1. Energise the motor for a short period and check the direction of rotation by watching the motor shaft.
2. Compare the result from point 1 with the demand of the pump.
3. Interchange two of the phase connections in case the direction of rotation is wrong.

If the motor is fitted to a Grundfos SP or SPA submersible pump, the correct direction of rotation is counter-clockwise as seen from the shaft end.

Note: If the motor is started without being connected to a pump, the shaft end must be shielded.

Frequency converter operation

The motor can be connected to a frequency converter.

Generally, the motor must be protected against overload by adjusting the current limiter of the frequency converter to the same value as the rated current or the maximum actual current of the submersible motor.

Note: If the motor is operated via a frequency converter this will cause a fuse in the temperature transmitter (Tempcon) to melt and you will not be able to monitor the temperature of the motor via the built-in Tempcon temperature sensor and the MP 204 motor protection unit.

The fuse cannot be replaced!

Note: To enable monitoring of the motor temperature, Grundfos recommends installing a Pt100 or Pt1000 sensor together with a PR 5714 relay.

The rated frequency must not be exceeded.

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

A reduction of the frequency will often result in an increased generation of heat in the motor even if the motor load is reduced. The reason is that the reduction of the power input will only be very small as the major part of the power input of a submersible motor is consumed to overcome the static head. Besides, the flow past the motor will be reduced, i.e. the cooling will be poor. It is therefore important never to adjust the frequency (and thus the pump speed and the flow) to a lower level, as there must still be a sufficient flow of pumped liquid past the motor. The minimum permissible flow is 0.15 m/s. The motor must still cut out immediately if the pump stops pumping water.

Ramp times: Maximum 3 seconds for start and stop.

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

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

Soft starter

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

Ramp times:

- Ramp-up time (until the voltage stated on the nameplate is reached): 3 seconds.
- Ramp-down time: 3 seconds.

If the ramp-up and ramp-down times are followed, unnecessary heating of the motor is avoided.

Soft starter with bypass switch

Soft starters with bypass switch will only be in operation during ramp-up and ramp-down.
This reduces both the load on the soft starter and the energy consumption in comparison with operation without bypass switch.

The soft starter must not be used in connection with operation via a generator.

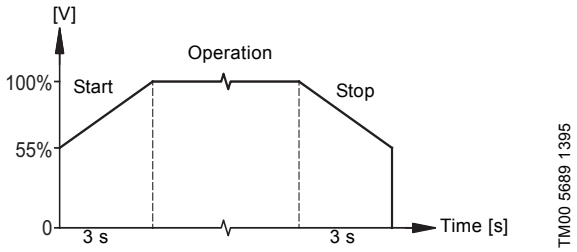


Fig. 6 Soft starter

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

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

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

Service factor (60 Hz motors only)

The service factor (SF) allows the motor to provide power under optimum conditions at the nameplate rated power P2 times the SF. At rated conditions (i.e. 10 hp motor with a SF of 1.15 is designed to provide 11.5 hp under continuous load).
Grundfos submersible motors are designed to run continuous at a service factor load. SF is stated on the nameplate.

5. Construction

Material specification

Pos.	Description		MS6000XT40	MS6000T40	MS6000T60	MS6000WT40	MS6000ET60	MS6000REST40	MS6000RESDT40	MS6000REST60	MS6000RESWT40	MS6000RESWT60
27	Sand shield			EN 1.4301*			-			-		
				NBR*			-			-		
27a	Spacer for sand shield			SS 316*			-			-		
25a	Flange extension			SS 304 H*			-			-		
22	Screw			SS 316*			-			-		
21	Washer			EN 1.4162*			-			-		
32	Shaft seal housing			EN 1.4308			EN 1.4308			EN 1.4517		
24	O-ring			NBR			NBR			FKM		
32a	Lip seal			-			-			EN 1.4301		
										FKM		
27	Sand shield			EN 1.4301			EN 1.4301			EN 1.4539		
				NBR			NBR			FKM		
22	Screw			A4			A4			EN 1.4539		
22a	Screw and washer			A4			A4			EN 1.4539		
				PA66			PA66			PA66		
50	Screw			A4			A4			EN 1.4539		
33	Shaft seal stationary			Ceramic			SIC			SIC		
34	Shaft seal rotating			Carbon			SIC			SIC		
				NBR			NBR			FKM		
28	Washer			EN 1.4301			EN 1.4301			EN 1.4301		
1a	Valve			EN 1.4435			EN 1.4435			-		
				NBR			NBR			-		
5	Bearing DE	bearing retainer		EN 1.4308			EN 1.4308			EN 1.4308		
		stationary bush**		Carbon graphite			Carbon graphite			-		
		stationary bush***		SiC			-			SiC		
2a	Upthrust ring			PEEK+PTFE20			PEEK+PTFE20			PEEK+PTFE20		
2	Shaft with rotor	shaft extension		EN 1.4460			EN 1.4460			EN 1.4462		
		bearing bush**		EN 1.4057			EN 1.4057			EN 1.4057		
		bearing bush***		WC 74 % Cr 20 % Ni 6 %			-			WC.74 % Cr 20 % Ni 6 %		
1	Stator outer encapsulation			EN 1.4301			EN 1.4301			EN 1.4539		
				EN 1.4408			EN 1.4408			EN 1.4584		
4	Bearing NDE	bearing retainer		EN 1.0335			EN 1.0335			EN 1.0335		
		stationary bush**		Carbon graphite			Carbon graphite			-		
		stationary bush***		SiC			-			SiC		
7a	Clamping flange			EN 1.0976			EN 1.0976			EN 1.0976		
41	Screw			Steel			Steel			Steel		
42	Stop for bearing			EN 1.0330.3			EN 1.0330			EN 1.0330.3		
6	Thrust bearing rotating			EN 1.0715			EN 1.0715			GJS / EN 1.0715		
				Ceramic			Ceramic			Ceramic		
3	Thrust bearing stationary			EN 1.0715			EN 1.0715			GJS / EN 1.0715		
				Carbon			Carbon			Carbon		
45	Shaft adjustment unit			EN 1.7139			EN 1.7139			GJS / EN 1.7139		
49	Lock ring			EN 1.4301			EN 1.4301			EN 1.4301		
7	Clamping flange			EN 1.0976			EN 1.0976			EN 1.0976		
48	Screw and washer			A2 ≈ EN 1.4301			A2 ≈ EN 1.4301			EN 1.4539		
				PA66			PA66			PA66		
46	Screw			Steel			Steel			Steel		
12	Diaphragm			NBR			NBR			FKM		
13	Bottom cover			EN 1.4301			EN 1.4301			EN 1.4539		
220	Flat cable			EPR TML-B			EPR TML-B			EPR TML-B		

* Motors with extension flange
** Motor with soft radial bearings (stainless steel/carbon graphite)
*** Motor with hard radial bearing (tungsten carbide/SiC)

Exploded drawing of MS6000

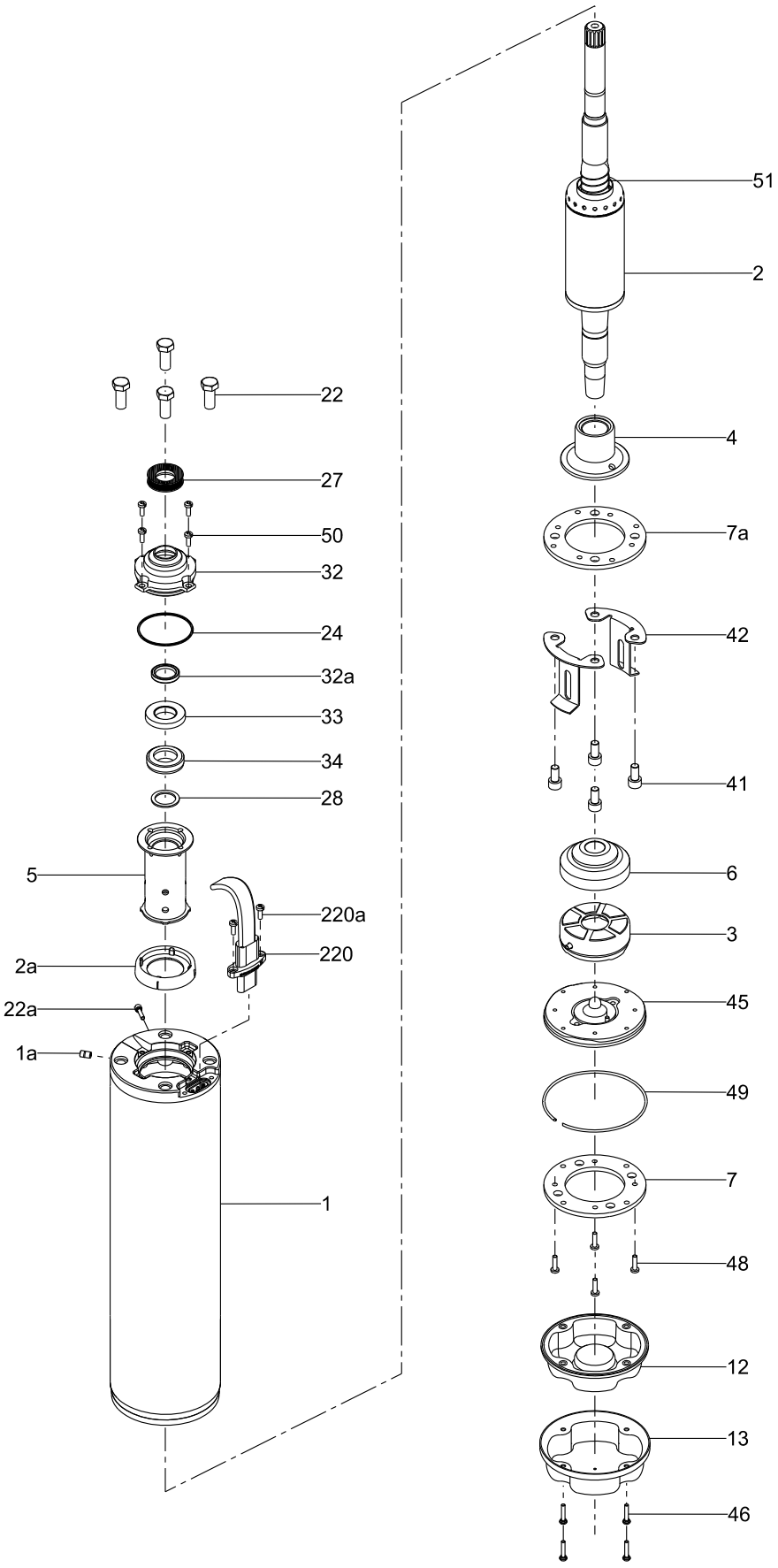


Fig. 7 Exploded drawing of the MS6000 motor

Exploded drawing of MS6000F (with flange extension)

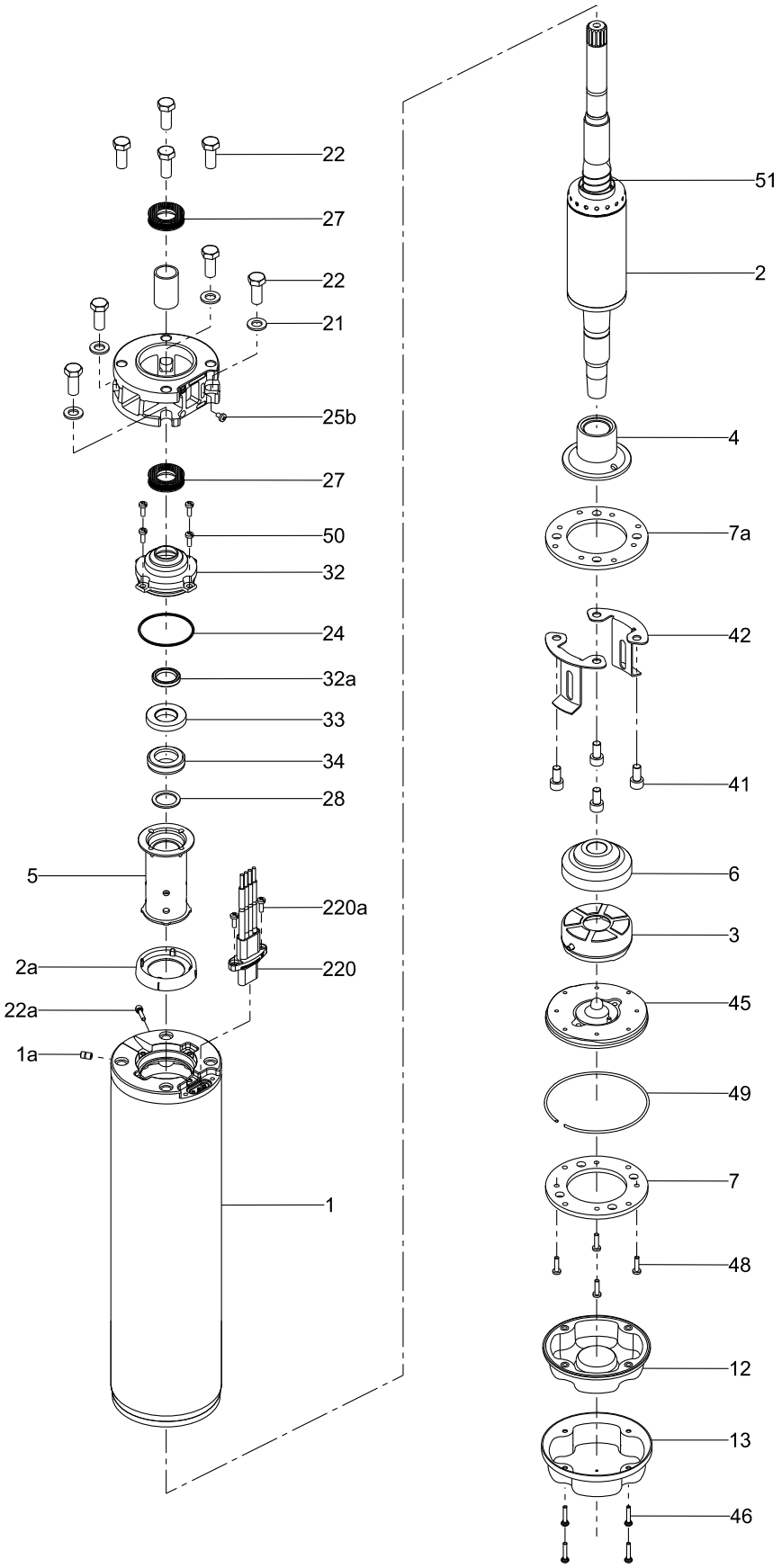


Fig. 8 Exploded drawing of the MS6000F

Description of construction

The motor is a 2-pole, asynchronous squirrel-cage submersible motor:

- enclosure class: IP68 according to IEC 60034-5
- insulation class: F according to IEC 60034-1

The entire surface is stainless steel which means that all external components have uniform corrosion resistance.

Cable connection

The motor is connected to the drop cable via a special motor cable which is approved drinking water usage.

The motor cable cannot be fitted/removed when the motor and pump are assembled.

Motors for star-delta starting are fitted with two cables displaced by 90 °.

- CE marked motors are equipped with a flat blue jacketed motor cable in 6 mm^2 or 10 mm^2
- cCSAus marked motors are equipped with four single leads XLPE AWG8

Motor D-end connection

The motor has standardized D-end according to NEMA standard MG1-18.413 with 4 pcs 1/2-20 UNF machine screws for mounting of the pump.

Shaft

The stainless steel splined shaft end fulfils ANSI B92.1, 1970, class 5. The motor have a 15-teeth module. Pressure angle 30 °.

Shaft seal

The motor is fitted with a standard mechanical shaft seal of ceramic carbon for good dry running capabilities. As optional SiC/SiC faces for abrasive conditions.

The shaft seal is available in three variants for different applications:

- Ceramic against carbon graphite with NBR rubber parts (standard, approved for drinking water).
- Silicon carbide against silicon carbide with NBR rubber parts (approved for drinking water).
- Silicon carbide against silicon carbide with FKM rubber parts (suitable for high temperatures and liquids containing hydrocarbons).

Radial bearing

The shaft accommodates the rotating parts of the radial bearing both at the top and bottom. The radial bearings are available as a soft or hard version.

- Soft radial bearing (standard)
  The rotating bearing bush is made of stainless steel (EN 1.4057) fixed to the shaft by interference fit. It runs against the static bush made of carbon graphite fixed to the bearing retainer by interference fit.
- Hard radial bearing (W)
  The rotating bearing bush is made of tungsten carbide sprayed to the shaft. It runs against the static bush made of silicon carbide fixed to the bearing retainer by interference fit (recommended for use in horizontal booster applications).

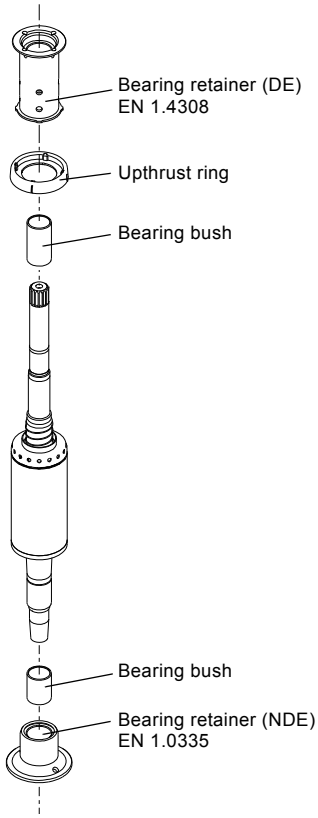


Fig. 9 Bottom and top radial bearings

Upthrust ring

The upthrust ring prevents damage in case of upthrust. It is designed as a thrust ring limiting the upward axial movement of the motor shaft. In case of upward axial movement, the upthrust ring will be stopped by the upper radial bearing retainer. See fig. 9.

Rotor

The rotor is a squirrel cage copper rotor which has been interference fitted on the shaft. The upper short-circuit ring is equipped with a small impeller ensuring internal circulation of liquid in the rotor chamber and thus optimum cooling.

Stator

The stator is hermetically encapsulated in stainless steel. The stator windings are embedded in polymer compound. This results in high mechanical stability, optimum cooling and eliminates the risk of short circuits in the windings caused by condensing water.

Thrust bearing

The thrust bearing is of MICHELL type, a very simple but highly efficient bearing. It fulfils the requirements specified in the NEMA standards.

The thrust bearing consist of:

- A ceramic rotating part with precision-ground and polished sliding surface for optimum surface finish.
- A stationary part which has 6 moveable, specially ground carbon shoes for all sizes. It is moveable in such way that all tolerances are absorbed and thus the bearing achieves optimum thrust capacity and minimum friction.

As the thrust bearing is made for bidirectional rotation, the motor can operate both clockwise and counterclockwise.

The thrust bearing are available in three sizes depending on pump load and temperature of the pumped liquid. These bearings are dimensioned for axial load rated to 7.5, 27 and 40 kN. See fig. 10.

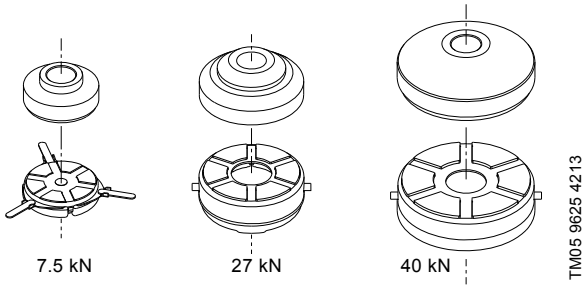


Fig. 10 Thrust bearings

Motor type	Motor power [kW (hp)]		Size of thrust bearing
	Min.	Max.	[kN]
T40	5.5 (7.5)	7.5 (10)	7.5
	9.2 (15)	30 (40)	27
T60	5.5 (7.5)	7.5 (10)	27
	9.2 (15)	22 (25)	40

Note: The motor can always be upgraded with a larger thrust bearing, as stated in the table above. But the motor must not be downgraded with a smaller thrust bearing than stated.

Diaphragm

The rubber diaphragm fitted between the stator and the motor end shield is dimensioned to equalize volume variations caused by the temperature rises in connection with intermittent operation.

Motor liquid

The motor liquid which is used is SML-3 containing monopropylene glycol, which is frost-proof down to -20 °C.

The motor liquid contains anti-corrosive and lubricating additives.

For some applications you are not allowed to use the monopropylene glycol-containing motor liquid mixed with water. In this case motor can be filled with clean tap water.

The table below indicates the freezing points which can be obtained with various percentages of monopropylene glycol-containing motor liquid.

Monopropylene glycol-containing motor liquid % volume	Freezing point [°C]
31.6	-15
37.3	-20
42.0	-25
46.0	-30
49.3	-35
52.2	-40
54.7	-45
57.0	-50

Motor cooling

The motor has cooling chambers at the top and bottom. An efficient internal circulation system helps transporting the heat from the rotor and bearings via the motor liquid to the outer surface of the motor.

Heat generated in the motor is carried away to the surrounding pumped liquid via the outer surface of the motor.

This is the reason why the temperature of the pumped liquid and its flow velocity past the motor are of vital importance to the life of the motor. See cooling requirements in section *3. Operating conditions*.

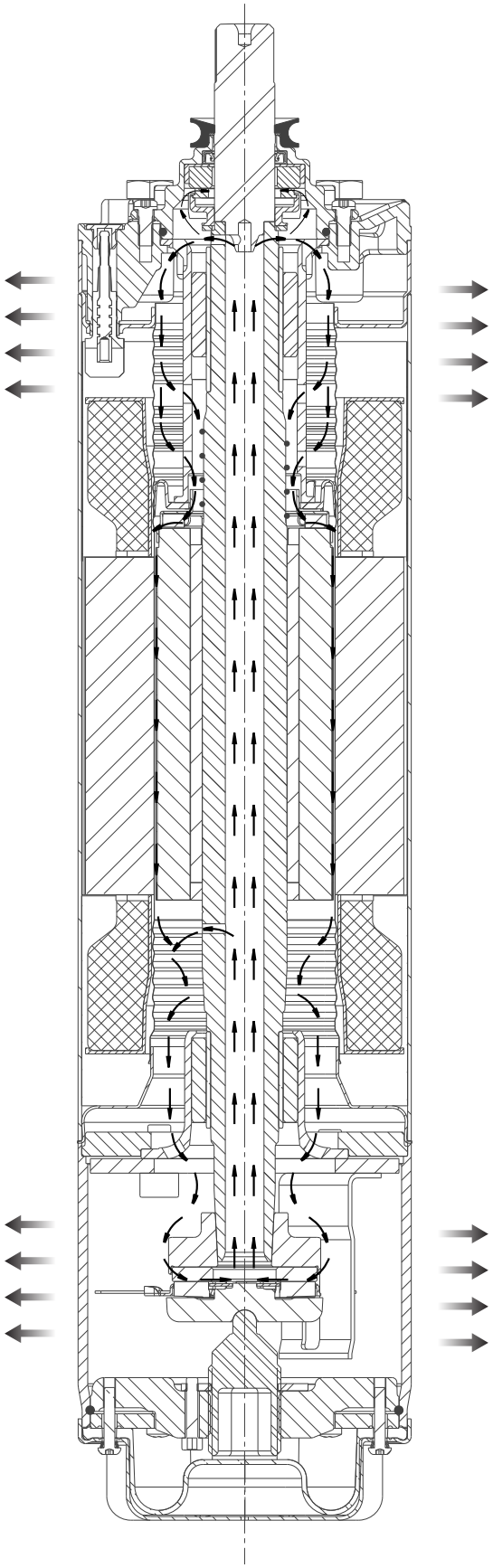


Fig. 11 Liquid circulation inside motor

6. Technical data

MS6000

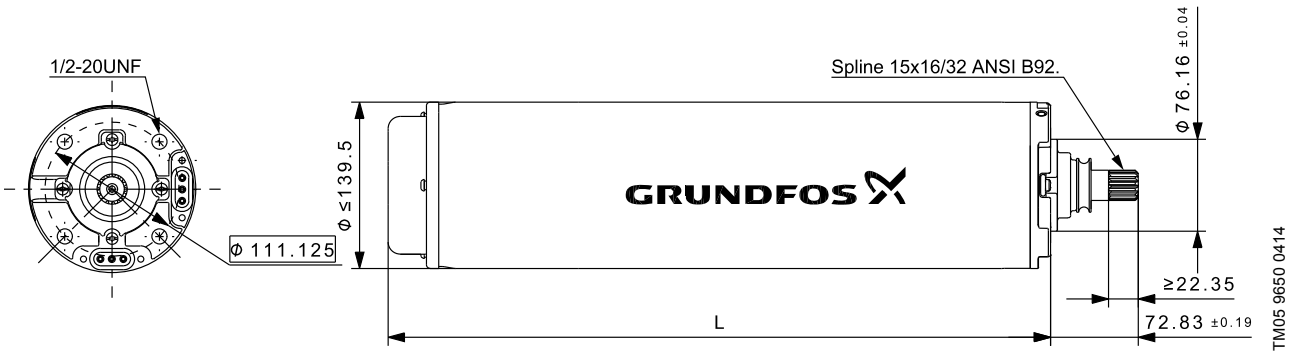


Fig. 12 Dimensional drawing of MS6000

Motor power, P_2 [kW]	L [mm]		Weight [kg]	Shipping volume [m^3]
	T40	T60		
5.5	547	607	34.0	0.040
7.5	577	637	37.0	0.040
9.2	607	667	43.0	0.043
11	637	702	46.0	0.043
13	667	757	49.0	0.046
15	702	817	53.0	0.046
18.5	757	877	57.5	0.052
22	817	947	64.5	0.052
26	877	-	70.5	0.058
30	947	-	78.0	0.058

MS6000 with flange extension

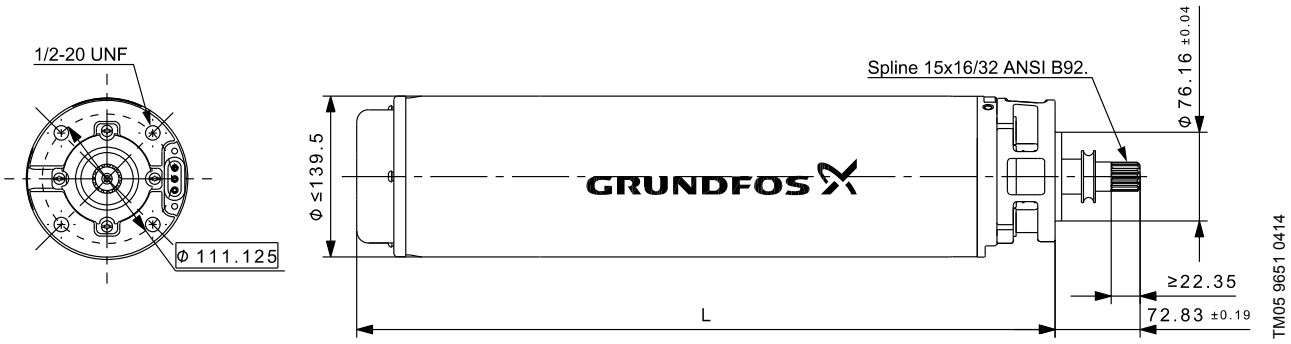


Fig. 13 Dimensional drawing of MS6000 with extension flange

Motor power, P_2 [hp]	L [mm]		Weight [kg]	Shipping volume [m^3]
	T40	T60		
7.5	597	657	36.5	0.043
10	627	687	39.5	0.043
12.5	657	717	45.5	0.046
15	687	752	48.5	0.046
17.5	717	807	51.5	0.052
20	752	867	55.5	0.052
25	807	927	60.0	0.052
30	867	997	67.0	0.058
35	927	-	73.0	0.058
40	997	-	80.5	0.063

Motor cables

The motors are available with three types of motor cables, depended on motor size and approval marking.

Cable type	Designation
4 G 6 mm^2 (jacketed cable)	6
4 G 10 mm^2 (jacketed cable)	10
4 x 1 G 8 AWG single XLPE	8

Motor		50 Hz	3 x 220-230 V		-		3 x 340-380 V		-		3 x 380-400-415 V		3 x 500-525 V	
		60 Hz	-		3 x 208-220-230 V		3 x 440 V		3 x 380-400 V		3 x 440-460-480 V		3 x 575 V	
		Approval	CE		CE		CE		CE		CE		CE	
kW	hp		DOL	SD	DOL	SD	DOL	SD	DOL	SD	DOL	SD	DOL	SD
5.5	7.5		6	6	6	6	6	-	6	6	6	6	6	-
7.5	10		6	6	6	6	6	-	6	6	6	6	6	-
9.2	12		6	6	10	6	6	-	6	6	6	6	6	-
11	15		10	6	10	6	6	-	6	6	6	6	6	-
13	18		10	6	10	6	6	-	6	6	6	6	6	-
15	20		10	6	10	6	6	-	6	6	6	6	6	-
18.5	25		10	6	10	10	10	-	10	6	6	6	6	-
22	30		10	10	10	10	10	-	10	6	10	6	6	-
26	35		-	10	-	10	10	-	10	6	10	6	6	-
30	40		-	10	-	10	10	-	10	6	10	6	10	-

Motor		50 Hz	3 x 200 V		3 x 400 V		-		3 x 380-400-415 V		3 x 500-525 V	
		60 Hz	3 x 200-220 V		3 x 400-440 V		3 x 208-220-230 V		3 x 440-460-480 V		3 x 575 V	
		Approval	CE		CE		cCSAus		cCSAus		cCSAus	
kW	hp		DOL	SD	DOL	SD	DOL	SD	DOL	SD	DOL	SD
5.5	7.5		6	-	6	-	8	-	8	-	8	-
7.5	10		6	-	6	-	8	-	8	-	8	-
9.2	12		6	-	6	-	-	-	-	-	-	-
11	15		-	6	-	6	8	-	8	-	8	-
13	18		-	6	-	6	-	-	-	-	-	-
15	20		-	6	-	6	8	-	8	-	8	-
18.5	25		-	10	-	6	8	-	8	-	8	-
22	30		-	10	-	6	8	-	8	-	8	-
26	35		-	-	-	-	-	-	-	-	-	-
30	40		-	-	-	-	-	-	8	-	8	-

Product numbers for motor cables

Motor type	Length [m]	Flat cable (for CE marked motors, not allowed for cCSAus marked motors)		Single leads	
		EPDR rubber		XLPE rubber	
		4 G 6 mm^2	4 G 10 mm^2	4 x 1 G 8AWG	3 x 1 x 8AWG
MS6000	3	-	-	96164227	-
	5	96164209	96164214	96164228	-
	8	96164210	-	-	-
	10	96164211	96164215	-	-
	20	96164212	96164216	-	-
	30	96164213	96164217	-	-
	31	-	-	96164229	-
	50	-	96164218	-	-
	65	-	96164219	-	-
	67	-	-	96164230	-
	100	-	96164220	-	-
MS6000 with flange extension	3	-	-	96164221	-
	5	-	-	96164222	-
	31	-	-	96164223	-
	67	-	-	96164224	-
MS6000 for booster applications	5	-	-	-	96164225
	8	-	-	-	96164226
MS6000R	3	-	-	96300135	-
	5	96300112	96300123	96300136	-
	10	96300113	96300124	-	-
	15	96300114	96300125	-	-
	20	96300115	96300126	-	-
	25	96300116	96300127	-	-
	30	96300117	96300128	96300137	-
	40	96300118	96300129	-	-
	50	-	96300130	-	-
	60	96300119	-	96300138	-
	70	-	96300131	-	-
	90	96300120	-	-	-
	100	96300121	96300132	-	-
MS6000R for booster applications	5	-	-	-	96300133
	8	-	-	-	96300134

Note: Sizing of the motor cable requires that it is submerged in water. For longer cables and cable connection for extension, please see section *8. Electrical accessories*.

7. Electrical data

Overview

Voltage code	Supply voltage	Method of starting	Service factor	Approvals	Comment
08	3 x 340-380 V, 50 Hz	DOL	-	CE	Low voltage
	3 x 440 V, 60 Hz		1.15		
09	3 x 200 V, 50 Hz	DOL	1.00	CE	Japan
	3 x 200-220 V, 60 Hz				
10	3 x 220-230 V, 50 Hz	DOL	-	CE	
19	3 x 380-400-415 V, 50 Hz	DOL	-		
	3 x 440-460-480 V, 60 Hz		1.15	CE	
35	3 x 380-400-415 V, 50 Hz	DOL	-	cCSAus	
	3 x 440-460-480 V, 60 Hz		1.15		
60	3 x 220-230 V, 50 Hz	SD	-	CE	
63	3 x 200 V, 50 Hz 3 x 200-220 V, 60 Hz	SD	1.00	CE	Japan
64	3 x 400 V, 50 Hz 3 x 400-440 V, 60 Hz	DOL	1.00	CE	Japan
	3 x 400 V, 50 Hz 3 x 400-440 V, 60 Hz	SD	1.00	CE	Japan
69	3 x 380-400-415 V, 50 Hz	SD	-	CE	
	3 x 440-460-480 V, 60 Hz		1.15		
91	3 x 690 V, 50 Hz	DOL	-	CE	
28	3 x 208-220-230 V, 60 Hz	DOL	1.15	CE	
30	3 x 208-220-230 V, 60 Hz	DOL	1.15	cCSAus	
33	3 x 380-400 V, 60 Hz	DOL	1.15	CE	
18	3 x 500-525 V, 50 Hz	DOL	-	CE	
	3 x 575 V, 60 Hz		1.15		
39	3 x 500-525 V, 50 Hz	DOL	-	cCSAus	
	3 x 575 V, 60 Hz		1.15		
80	3 x 208-220-230 V, 60 Hz	SD	1.15	CE	
83	3 x 380-400 V, 60 Hz	SD	1.15	CE	
90	3 x 690 V, 60 Hz	DOL	1.15	CE	

Voltage code 10, 60

3 x 220 V, 50 Hz, T40

Power [kW]	Rated current $I_{1/1}$ [A]	Motor efficiency η [%]			Cos φ			n [min^{-1}]	Rated torque [Nm]	LRC [%]	LRT [%]	BT [%]
		100 %	75 %	50 %	100 %	75 %	50 %					
5.5	24.4	80.3	79.9	76.4	0.78	0.70	0.57	2880	18.2	510	170	280
7.5	31.0	81.0	81.6	79.3	0.82	0.77	0.65	2870	25.0	500	160	250
9.2	38.5	81.1	81.4	78.8	0.81	0.74	0.61	2880	30.5	530	180	270
11	46.0	82.2	82.4	80.0	0.80	0.73	0.60	2880	36.5	530	180	290
13	52.5	82.3	83.2	81.5	0.83	0.78	0.67	2870	43.5	530	160	270
15	59.5	82.6	83.6	82.2	0.84	0.79	0.68	2860	50.0	520	150	260
18.5	74.0	83.2	84.0	82.4	0.83	0.78	0.66	2870	61.5	540	160	270
22	86.5	83.4	84.4	83.0	0.84	0.79	0.68	2870	73.0	540	160	260
26	100	83.4	84.6	83.4	0.85	0.81	0.70	2870	86.5	530	160	260
30	116	83.9	85.0	83.8	0.85	0.81	0.71	2870	100.0	520	160	270

3 x 230 V, 50 Hz, T40

Power [kW]	Rated current $I_{1/1}$ [A]	Motor efficiency η [%]			Cos φ			n [min^{-1}]	Rated torque [Nm]	LRC [%]	LRT [%]	BT [%]
		100 %	75 %	50 %	100 %	75 %	50 %					
5.5	24.8	80.0	78.8	74.4	0.73	0.64	0.51	2900	18.2	530	180	310
7.5	31.0	81.2	81.1	78.0	0.79	0.71	0.58	2880	25.0	530	180	280
9.2	39.0	81.1	80.6	77.1	0.77	0.68	0.55	2890	30.5	550	200	300
11	46.5	82.2	81.7	78.3	0.76	0.67	0.54	2890	36.5	560	200	320
13	52.0	82.6	82.7	80.2	0.80	0.72	0.59	2880	43.5	560	180	300
15	59.0	83.0	83.3	81.0	0.81	0.74	0.61	2880	50.0	560	170	290
18.5	73.5	83.5	83.5	81.0	0.80	0.71	0.58	2890	61.5	570	180	300
22	85.5	83.8	84.0	81.8	0.81	0.73	0.60	2890	73.0	570	180	300
26	99.5	83.9	84.2	82.3	0.82	0.76	0.63	2880	86.5	560	180	290
30	114	84.3	84.6	82.7	0.82	0.76	0.64	2880	100.0	560	180	300

Voltage code 08

3 x 340 V, 50 Hz, T40, Undervoltage motors

Power [kW]	Rated current $I_{1/1}$ [A]	Motor efficiency η [%]			Cos φ			n [min^{-1}]	Rated torque [Nm]	LRC [%]	LRT [%]	BT [%]
		100 %	75 %	50 %	100 %	75 %	50 %					
5.5	15.0	80.2	80.9	78.6	0.82	0.77	0.66	2860	18.4	470	140	240
7.5	20.0	78.9	81.3	80.4	0.84	0.82	0.73	2840	25.5	430	130	210
9.2	24.4	78.9	81.5	80.9	0.85	0.82	0.75	2830	31.0	440	140	210
11	29.0	79.7	82.3	81.9	0.85	0.82	0.73	2830	37.0	430	130	220
13	33.5	81.0	83.2	82.5	0.85	0.82	0.73	2840	43.5	470	140	240
15	38.5	80.7	83.2	83.0	0.85	0.83	0.76	2830	50.5	450	130	220
18.5	47.0	81.8	83.9	83.4	0.86	0.82	0.74	2850	62.0	480	140	230
22	55.5	82.2	84.6	84.4	0.86	0.84	0.77	2840	74.0	470	140	220
26	66.5	80.2	83.7	84.5	0.87	0.86	0.81	2820	88.0	410	120	200
30	74.5	81.9	84.6	84.8	0.88	0.86	0.80	2840	100	430	130	220

3 x 380 V, 50 Hz, T40, Undervoltage motors

Power [kW]	Rated current $I_{1/1}$ [A]	Motor efficiency η [%]			Cos φ			n [min^{-1}]	Rated torque [Nm]	LRC [%]	LRT [%]	BT [%]
		100 %	75 %	50 %	100 %	75 %	50 %					
5.5	15.2	80.3	79.0	74.5	0.72	0.63	0.50	2900	18.4	530	190	310
7.5	18.6	81.1	81.0	77.9	0.79	0.72	0.59	2880	25.5	530	180	270
9.2	22.6	81.3	81.4	78.5	0.80	0.72	0.59	2880	31.0	540	180	280
11	27.0	82.1	82.2	79.7	0.80	0.72	0.59	2880	37.0	540	180	290
13	32.0	82.6	82.6	79.8	0.79	0.70	0.57	2880	43.5	570	190	320
15	36.0	82.9	83.2	80.8	0.81	0.73	0.61	2880	50.5	560	170	290
18.5	45.0	83.3	83.4	80.8	0.79	0.71	0.57	2890	62.0	570	180	300
22	51.5	84.2	84.5	82.4	0.81	0.74	0.61	2880	74.0	570	180	300
26	58.5	83.7	84.7	83.3	0.85	0.80	0.69	2870	88.0	530	160	260
30	68.0	84.2	84.7	82.9	0.83	0.77	0.65	2880	100	550	180	290

Voltage code 19, 69, 35

3 x 380 V, 50 Hz, T40

Power [kW]	Rated current $I_{1/1}$ [A]	Motor efficiency η [%]			Cos φ			n [min^{-1}]	Rated torque [Nm]	LRC [%]	LRT [%]	BT [%]
		100 %	75 %	50 %	100 %	75 %	50 %					
5.5	13.6	79.8	80.4	78.0	0.82	0.76	0.65	2870	18.4	470	140	240
7.5	17.8	80.1	81.6	80.1	0.84	0.80	0.70	2850	25.0	460	140	230
9.2	21.8	80.3	81.9	80.4	0.84	0.80	0.69	2850	31.0	480	150	230
11	26.0	81.1	82.7	81.7	0.84	0.80	0.70	2850	37.0	470	150	240
13	30.0	81.5	83.2	82.2	0.85	0.81	0.71	2850	43.5	490	150	250
15	34.5	81.9	83.5	82.4	0.85	0.81	0.71	2860	50.0	490	140	240
18.5	42.0	82.7	84.1	83.1	0.85	0.81	0.70	2860	61.5	510	150	240
22	49.5	82.2	84.4	84.1	0.86	0.83	0.75	2850	74.0	480	140	230
26	58.0	82.4	84.5	84.2	0.87	0.84	0.76	2850	87.0	480	140	230
30	66.5	82.5	84.7	84.5	0.87	0.84	0.77	2850	100	450	140	230

3 x 400 V, 50 Hz, T40

Power [kW]	Rated current $I_{1/1}$ [A]	Motor efficiency η [%]			Cos φ			n [min^{-1}]	Rated torque [Nm]	LRC [%]	LRT [%]	BT [%]
		100 %	75 %	50 %	100 %	75 %	50 %					
5.5	13.4	80.2	79.8	76.4	0.78	0.70	0.57	2880	18.4	510	160	270
7.5	17.2	81.1	81.4	78.9	0.82	0.75	0.63	2870	25.0	510	160	260
9.2	21.2	81.2	81.7	79.2	0.82	0.75	0.63	2870	31.0	520	170	270
11	25.0	82.1	82.7	80.7	0.82	0.76	0.64	2870	37.0	520	170	270
13	29.0	82.4	83.1	81.1	0.82	0.76	0.64	2870	43.5	540	170	280
15	33.5	82.7	83.3	81.3	0.82	0.76	0.64	2870	50.0	540	170	280
18.5	41.0	83.4	83.9	81.9	0.82	0.75	0.63	2880	61.5	560	170	280
22	47.5	83.5	84.6	83.3	0.84	0.80	0.69	2870	74.0	530	160	260
26	55.5	83.6	84.7	83.4	0.85	0.80	0.69	2870	87.0	530	160	260
30	64.0	83.7	84.7	83.7	0.85	0.81	0.69	2870	100	500	160	260

3 x 415 V, 50 Hz, T40

Power [kW]	Rated current $I_{1/1}$ [A]	Motor efficiency η [%]			Cos φ			n [min^{-1}]	Rated torque [Nm]	LRC [%]	LRT [%]	BT [%]
		100 %	75 %	50 %	100 %	75 %	50 %					
5.5	13.6	80.0	79.0	74.8	0.75	0.66	0.53	2890	18.4	520	180	300
7.5	17.2	81.2	80.9	77.7	0.79	0.70	0.57	2880	25.0	530	180	280
9.2	21.2	81.4	81.1	77.9	0.78	0.70	0.57	2880	31.0	550	190	290
11	24.8	82.3	82.3	79.6	0.79	0.71	0.57	2880	37.0	540	180	300
13	29.0	82.6	82.6	79.9	0.79	0.71	0.58	2880	43.5	560	180	310
15	33.5	82.9	82.8	80.1	0.79	0.71	0.58	2880	50.0	570	180	310
18.5	41.5	83.4	83.4	80.7	0.79	0.70	0.57	2890	61.5	580	190	310
22	46.5	83.9	84.3	82.4	0.82	0.76	0.63	2880	74.0	560	180	290
26	55.0	84.0	84.4	82.4	0.82	0.76	0.64	2880	87.0	560	180	290
30	63.0	84.0	84.4	82.7	0.82	0.76	0.64	2880	100	530	170	290

Voltage code 18, 39

3 x 500 V, 50 Hz, T40

Power [kW]	Rated current $I_{1/1}$ [A]	Motor efficiency η [%]			Cos φ			n [min^{-1}]	Rated torque [Nm]	LRC [%]	LRT [%]	BT [%]
		100 %	75 %	50 %	100 %	75 %	50 %					
5.5	10.6	80.2	79.9	76.6	0.79	0.71	0.58	2880	18.2	500	160	270
7.5	13.8	80.5	81.0	78.5	0.82	0.76	0.64	2870	25.0	500	160	250
9.2	16.8	81.1	81.5	79.1	0.82	0.75	0.63	2870	30.5	520	170	260
11	19.8	81.9	82.7	80.7	0.82	0.76	0.64	2870	36.5	510	160	270
13	23.6	82.4	82.9	80.7	0.82	0.75	0.62	2870	43.0	550	170	290
15	27.0	82.5	83.0	80.7	0.82	0.75	0.62	2880	50.0	550	170	280
18.5	33.0	82.8	83.3	81.1	0.82	0.75	0.63	2880	61.5	560	170	280
22	37.5	83.0	84.5	83.6	0.85	0.81	0.71	2860	73.5	520	150	250
26	44.0	83.4	84.7	83.6	0.85	0.81	0.70	2870	86.5	520	160	260
30	50.5	83.8	84.9	83.8	0.86	0.82	0.71	2870	100.0	520	160	260

3 x 525 V, 50 Hz, T40

Power [kW]	Rated current $I_{1/1}$ [A]	Motor efficiency η [%]			Cos φ			n [min^{-1}]	Rated torque [Nm]	LRC [%]	LRT [%]	BT [%]
		100 %	75 %	50 %	100 %	75 %	50 %					
5.5	10.8	79.9	78.8	74.5	0.73	0.65	0.52	2890	18.2	520	180	300
7.5	13.8	80.6	80.2	76.8	0.78	0.69	0.56	2880	25.0	530	180	280
9.2	17.0	81.1	80.7	77.3	0.77	0.69	0.55	2890	30.5	550	200	300
11	19.8	82.2	82.1	79.2	0.78	0.70	0.57	2880	36.5	550	190	300
13	23.8	82.4	82.0	78.8	0.77	0.68	0.54	2890	43.0	570	200	330
15	27.5	82.4	81.9	78.8	0.77	0.68	0.54	2890	50.0	570	190	320
18.5	33.5	82.7	82.4	79.2	0.77	0.68	0.55	2890	61.5	580	190	310
22	36.5	83.7	84.3	82.5	0.82	0.76	0.64	2880	73.5	560	170	280
26	43.5	84.0	84.3	82.4	0.82	0.76	0.63	2880	86.5	560	180	290
30	50.0	84.2	84.5	82.6	0.82	0.76	0.64	2880	100.0	560	180	300

Voltage code 09, 63

3 x 200 V, 50 Hz, T60

Power [kW]	Rated current $I_{1/1}$ [A]	Motor efficiency η [%]			Cos φ			n [min^{-1}]	Rated torque [Nm]	LRC [%]	LRT [%]	BT [%]
		100 %	75 %	50 %	100 %	75 %	50 %					
5.5	26.0	82.2	81.0	77.0	0.81	0.75	0.65	2910	18.0	650	190	320
7.5	34.5	82.5	82.1	79.0	0.83	0.78	0.68	2890	24.8	550	170	280
9.2	41.0	83.1	82.8	79.9	0.84	0.80	0.69	2890	30.5	560	180	270
11	47.5	83.5	83.6	81.2	0.85	0.81	0.72	2890	36.5	540	170	260
13	57.0	84.1	83.9	81.3	0.84	0.79	0.69	2900	43.0	570	180	300
15	66.0	84.2	84.1	81.4	0.84	0.79	0.68	2900	49.5	570	180	300
18.5	78.5	84.3	84.5	82.3	0.85	0.81	0.71	2890	61.0	560	180	280
22	94.5	84.3	84.6	82.4	0.85	0.81	0.70	2890	72.5	570	180	280

Voltage code 18, 69, 35

3 x 380 V, 50 Hz, T60

Power [kW]	Rated current $I_{1/1}$ [A]	Motor efficiency η [%]			Cos φ			n [min^{-1}]	Rated torque [Nm]	LRC [%]	LRT [%]	BT [%]
		100 %	75 %	50 %	100 %	75 %	50 %					
5.5	13.4	81.9	81.1	77.5	0.83	0.78	0.68	2900	18.0	610	170	300
7.5	17.8	82.3	82.2	79.6	0.84	0.80	0.70	2890	24.8	530	160	260
9.2	21.2	82.4	82.8	80.6	0.86	0.82	0.75	2880	30.5	500	150	240
11	25.0	82.3	83.2	81.6	0.86	0.84	0.77	2870	36.5	470	140	230
13	29.5	83.4	83.9	82.0	0.86	0.82	0.74	2880	43.0	520	160	260
15	34.0	83.6	84.0	82.0	0.86	0.82	0.73	2880	49.5	520	160	270
18.5	41.0	83.4	84.3	82.9	0.87	0.84	0.77	2870	61.5	500	150	250
22	49.5	83.5	84.4	83.0	0.87	0.84	0.76	2870	73.0	510	160	250

3 x 400 V, 50 Hz, T60

Power [kW]	Rated current $I_{1/1}$ [A]	Motor efficiency η [%]			Cos φ			n [min^{-1}]	Rated torque [Nm]	LRC [%]	LRT [%]	BT [%]
		100 %	75 %	50 %	100 %	75 %	50 %					
5.5	13.2	82.2	80.8	76.5	0.80	0.73	0.62	2910	18.0	660	200	330
7.5	17.2	82.8	82.2	78.9	0.82	0.76	0.65	2900	24.8	580	180	290
9.2	20.4	83.2	83.0	80.1	0.84	0.80	0.69	2890	30.5	560	180	270
11	23.8	83.3	83.5	81.2	0.85	0.81	0.72	2890	36.5	530	160	260
13	28.5	84.2	84.0	81.5	0.84	0.79	0.69	2900	43.0	570	180	300
15	33.0	84.2	84.0	81.3	0.84	0.79	0.68	2900	49.5	580	180	310
18.5	39.5	84.3	84.5	82.3	0.85	0.81	0.71	2890	61.5	560	180	280
22	47.5	84.3	84.6	82.4	0.85	0.81	0.70	2890	73.0	560	180	280

3 x 415 V, 50 Hz, T60

Power [kW]	Rated current $I_{1/1}$ [A]	Motor efficiency η [%]			Cos φ			n [min^{-1}]	Rated torque [Nm]	LRC [%]	LRT [%]	BT [%]
		100 %	75 %	50 %	100 %	75 %	50 %					
5.5	13.2	82.1	80.3	75.5	0.77	0.69	0.57	2920	18.0	690	220	360
7.5	17.2	83.0	81.9	78.2	0.80	0.72	0.60	2910	24.8	610	190	320
9.2	20.0	83.5	82.8	79.5	0.82	0.76	0.65	2900	30.5	590	190	290
11	23.4	83.7	83.5	80.7	0.83	0.79	0.68	2900	36.5	570	180	280
13	28.5	84.4	83.8	80.8	0.82	0.76	0.64	2910	43.0	610	200	330
15	33.0	84.4	83.7	80.5	0.81	0.75	0.63	2910	49.5	610	200	330
18.5	38.5	84.6	84.4	81.7	0.83	0.78	0.67	2900	61.5	590	190	310
22	46.5	84.7	84.4	81.7	0.83	0.77	0.66	2900	73.0	600	200	310

Voltage code 18

3 x 500 V, 50 Hz, T60

Power [kW]	Rated current $I_{1/1}$ [A]	Motor efficiency η [%]			Cos φ			n [min^{-1}]	Rated torque [Nm]	LRC [%]	LRT [%]	BT [%]
		100 %	75 %	50 %	100 %	75 %	50 %					
5.5	10.6	82.1	80.7	76.4	0.80	0.73	0.61	2920	18.0	660	200	330
7.5	13.8	82.7	82.1	78.9	0.82	0.77	0.66	2900	24.8	570	170	290
9.2	16.4	83.2	82.9	79.9	0.84	0.79	0.68	2900	30.5	570	180	270
11	19.0	83.2	83.5	81.4	0.86	0.82	0.73	2880	36.5	520	160	250
13	22.8	84.0	83.9	81.4	0.84	0.79	0.69	2900	43.0	570	180	300
15	26.0	84.2	84.1	81.4	0.84	0.80	0.69	2900	49.5	580	180	300
18.5	31.5	84.4	84.5	82.2	0.85	0.80	0.70	2890	61.0	570	180	290
22	38.0	84.3	84.5	82.4	0.85	0.81	0.70	2890	72.5	560	180	280

3 x 525 V, 50 Hz, T60

Power [kW]	Rated current $I_{1/1}$ [A]	Motor efficiency η [%]			Cos φ			n [min^{-1}]	Rated torque [Nm]	LRC [%]	LRT [%]	BT [%]
		100 %	75 %	50 %	100 %	75 %	50 %					
5.5	10.6	81.9	79.9	74.9	0.76	0.67	0.55	2920	18.0	700	230	380
7.5	13.6	82.9	81.8	77.9	0.79	0.71	0.59	2910	24.8	610	200	320
9.2	16.2	83.5	82.5	78.9	0.81	0.73	0.61	2910	30.5	610	200	310
11	18.4	83.8	83.6	80.8	0.83	0.78	0.68	2900	36.5	570	180	280
13	22.6	84.3	83.6	80.4	0.81	0.74	0.62	2910	43.0	610	200	330
15	26.0	84.5	83.7	80.5	0.81	0.74	0.62	2910	49.5	630	210	340
18.5	31.0	84.7	84.2	81.3	0.82	0.75	0.64	2900	61.0	610	210	330
22	37.5	84.6	84.2	81.4	0.82	0.76	0.64	2900	72.5	610	210	320

Voltage code 64

3 x 400 V, 50 Hz, T60

Power [kW]	Rated current $I_{1/1}$ [A]	Motor efficiency η [%]			Cos φ			n [min^{-1}]	Moment of inertia [kg•m^2]	Rated torque [Nm]	LRC [%]	LRT [%]	BT [%]
		100 %	75 %	50 %	100 %	75 %	50 %						
5.5	13.2	82.1	80.7	76.4	0.80	0.73	0.62	2910		18.0	660	200	330
7.5	17.4	82.7	82.1	78.7	0.82	0.76	0.65	2900		24.6	580	180	290
9.2	20.4	83.1	82.8	79.9	0.84	0.80	0.69	2890		30.5	560	180	270
11	23.8	83.3	83.4	81.1	0.85	0.81	0.72	2890		36.5	530	170	260
13	28.5	84.1	83.9	81.3	0.84	0.79	0.69	2900		43.0	570	180	300
15	33.0	84.2	84.1	81.4	0.84	0.79	0.68	2900		49.5	570	180	300
18.5	39.5	84.3	84.5	82.3	0.85	0.81	0.71	2890		61.0	560	180	280
22	47.5	84.3	84.6	82.4	0.85	0.81	0.70	2890		72.5	570	180	280

Voltage code 28, 80, 30

3 x 208 V, 60 Hz, T40

Power [kW]	Power [hp]	Rated current $I_{1/1}$ [A]	Service factor	Nameplate current I_{SF} [A]	Motor efficiency η [%]				Cos φ				LRC [%of I_{SF}]
					115 % (SF)	100 %	75 %	50 %	115 % (SF)	100 %	75 %	50 %	
5.5	7.5	24.2	1.15	27.5	79.4	80.2	79.8	76.5	0.83	0.82	0.79	0.70	430
7.5	10	32.0	1.15	37.5	79.2	80.5	80.8	78.3	0.85	0.84	0.82	0.75	350
9.2	12	39.0	1.15	45.5	79.8	81.1	81.5	79.1	0.85	0.85	0.82	0.75	320
11	15	46.5	1.15	53.5	81.1	82.1	82.3	80.0	0.85	0.84	0.81	0.72	390
13	18	53.5	1.15	62.5	80.9	82.1	82.8	80.8	0.86	0.86	0.83	0.76	450
15	20	61.5	1.15	71.5	81.5	82.7	83.4	81.6	0.86	0.86	0.83	0.76	460
18.5	25	75.0	1.15	87.0	82.3	83.4	84.1	82.4	0.86	0.86	0.83	0.76	470
22	30	88.0	1.15	104	81.8	83.3	84.6	83.6	0.87	0.87	0.85	0.79	450
26	35	104	1.15	122	81.9	83.4	84.7	83.7	0.88	0.88	0.86	0.80	460
30	40	118	1.15	138	82.9	84.1	85.1	83.8	0.88	0.88	0.86	0.80	440

Power [kW]	Power [hp]	n [min^{-1}]	Moment of inertia [kg•m^2]	Rated torque [Nm]	LRT [%]	BT [%]
5.5	7.5	3450	0.00372	17.6	120	220
7.5	10	3420	0.00441	24.0	120	210
9.2	12	3430	0.00507	29.5	120	220
11	15	3430	0.00567	35.0	130	230
13	18	3420	0.00639	41.5	130	230
15	20	3430	0.00716	48.0	120	220
18.5	25	3430	0.00836	59.0	120	230
22	30	3420	0.00968	70.5	110	210
26	35	3420	0.0110	83.5	100	210
30	40	3430	0.0125	96.0	130	230

3 x 220 V, 60 Hz, T40

Power [kW]	Power [hp]	Rated current $I_{1/1}$ [A]	Service factor	Nameplate current I_{SF} [A]	Motor efficiency η [%]				Cos φ				LRC [%of I_{SF}]
					115 % (SF)	100 %	75 %	50 %	115 % (SF)	100 %	75 %	50 %	
5.5	7.5	23.4	1.15	26.5	80.5	80.6	79.5	75.4	0.82	0.81	0.75	0.64	490
7.5	10	30.5	1.15	35.0	80.8	81.4	81.0	77.6	0.84	0.83	0.79	0.69	400
9.2	12	37.0	1.15	42.5	81.3	82.0	81.6	78.4	0.84	0.83	0.79	0.69	370
11	15	44.5	1.15	50.5	82.4	82.8	82.3	79.2	0.83	0.82	0.77	0.66	440
13	18	51.0	1.15	58.5	82.4	83.1	83.0	80.2	0.85	0.84	0.80	0.70	510
15	20	58.5	1.15	67.0	82.9	83.7	83.5	80.9	0.85	0.84	0.80	0.70	520
18.5	25	71.5	1.15	82.0	83.6	84.3	84.2	81.6	0.85	0.84	0.80	0.69	540
22	30	83.0	1.15	96.5	83.5	84.5	85.0	83.1	0.87	0.86	0.83	0.74	520
26	35	97.5	1.15	112	83.6	84.5	85.1	83.2	0.88	0.86	0.83	0.76	530
30	40	112	1.15	130	84.4	85.2	85.3	83.2	0.88	0.86	0.83	0.74	510

Power [kW]	Power [hp]	n [min^{-1}]	Moment of inertia [$kg•m^2$]	Rated torque [Nm]	LRT [%]	BT [%]
5.5	7.5	3470	0.00372	17.6	140	260
7.5	10	3450	0.00441	24.0	140	240
9.2	12	3450	0.00507	29.5	140	250
11	15	3460	0.00567	35.0	150	270
13	18	3450	0.00639	41.5	150	260
15	20	3450	0.00716	48.0	140	260
18.5	25	3460	0.00836	59.0	140	260
22	30	3450	0.00968	70.5	120	240
26	35	3450	0.0110	83.5	120	240
30	40	3460	0.0125	96.0	150	260

3 x 230 V, 60 Hz, T40

Power [kW]	Power [hp]	Rated current $I_{1/1}$ [A]	Service factor	Nameplate current I_{SF} [A]	Motor efficiency η [%]				Cos φ				LRC [%of I_{SF}]
					115 % (SF)	100 %	75 %	50 %	115 % (SF)	100 %	75 %	50 %	
5.5	7.5	23.4	1.15	26.0	80.8	80.6	78.9	74.2	0.80	0.77	0.70	0.58	520
7.5	10	30.0	1.15	33.5	81.5	81.7	80.7	76.7	0.83	0.81	0.75	0.64	440
9.2	12	36.5	1.15	41.0	82.1	82.3	81.3	77.5	0.82	0.81	0.75	0.63	400
11	15	44.5	1.15	49.5	82.9	83.0	81.9	78.2	0.82	0.79	0.72	0.60	480
13	18	50.0	1.15	56.5	83.2	83.5	82.7	79.3	0.84	0.82	0.76	0.65	560
15	20	57.5	1.15	65.0	83.7	84.0	83.3	80.0	0.84	0.82	0.76	0.65	570
18.5	25	71.0	1.15	80.0	84.3	84.6	83.9	80.7	0.83	0.81	0.75	0.64	590
22	30	81.0	1.15	92.0	84.4	85.1	84.9	82.5	0.85	0.84	0.79	0.69	570
26	35	95.0	1.15	108	84.6	85.2	85.0	82.5	0.86	0.84	0.80	0.69	580
30	40	110	1.15	124	85.1	85.4	85.1	82.4	0.85	0.84	0.79	0.68	560

Power [kW]	Power [hp]	n [min^{-1}]	Moment of inertia [$kg•m^2$]	Rated torque [Nm]	LRT [%]	BT [%]
5.5	7.5	3480	0.00372	17.6	160	280
7.5	10	3470	0.00441	24.0	150	260
9.2	12	3470	0.00507	29.5	150	280
11	15	3470	0.00567	35.0	170	300
13	18	3470	0.00639	41.5	160	290
15	20	3470	0.00716	48.0	160	290
18.5	25	3480	0.00836	59.0	160	290
22	30	3470	0.00968	70.5	140	270
26	35	3460	0.0110	83.5	140	270
30	40	3470	0.0125	96.0	170	290

Voltage code 33, 83

3 x 380 V, 60 Hz, T40

Power [kW]	Power [hp]	Rated current $I_{1/1}$ [A]	Service factor	Nameplate current I_{SF} [A]	Motor efficiency η [%]				Cos φ				LRC [% of I_{SF}]
					115 % (SF)	100 %	75 %	50 %	115 % (SF)	100 %	75 %	50 %	
5.5	7.5	14.2	1.15	15.8	81.0	80.8	79.0	74.2	0.80	0.77	0.69	0.57	530
7.5	10	18.0	1.15	20.4	81.7	81.8	80.8	76.8	0.83	0.81	0.75	0.64	440
9.2	12	22.4	1.15	25.0	82.3	82.4	81.3	77.3	0.82	0.80	0.73	0.61	410
11	15	26.5	1.15	29.5	82.7	83.0	82.1	78.7	0.82	0.81	0.74	0.63	460
13	18	30.5	1.15	34.5	83.1	83.4	82.6	79.2	0.83	0.82	0.76	0.64	570
15	20	34.5	1.15	39.0	83.4	83.8	83.2	80.1	0.84	0.82	0.77	0.66	560
18.5	25	42.5	1.15	48.0	84.1	84.5	84.0	81.1	0.84	0.82	0.77	0.66	570
22	30	49.0	1.15	56.0	84.4	85.0	84.7	82.2	0.85	0.83	0.79	0.68	590
26	35	58.0	1.15	66.0	84.6	85.1	84.8	82.2	0.86	0.84	0.79	0.68	600
30	40	65.5	1.15	75.0	84.7	85.2	85.1	82.7	0.87	0.85	0.81	0.71	540

Power [kW]	Power [hp]	n [min^{-1}]	Moment of inertia [$kg \cdot m^2$]	Rated torque [Nm]	LRT [%]	BT [%]
5.5	7.5	3480	0.00372	17.4	160	290
7.5	10	3470	0.00441	23.8	150	260
9.2	12	3470	0.00507	29.0	160	280
11	15	3470	0.00567	35.0	160	280
13	18	3470	0.00639	41.0	170	290
15	20	3470	0.00716	47.5	150	280
18.5	25	3470	0.00836	58.5	150	280
22	30	3470	0.00968	69.5	140	270
26	35	3470	0.0110	82.5	140	280
30	40	3470	0.0125	95.0	160	280

3 x 400 V, 60 Hz, T40

Power [kW]	Power [hp]	Rated current $I_{1/1}$ [A]	Service factor	Nameplate current I_{SF} [A]	Motor efficiency η [%]				Cos φ				LRC [% of I_{SF}]
					115 % (SF)	100 %	75 %	50 %	115 % (SF)	100 %	75 %	50 %	
5.5	7.5	14.6	1.15	15.8	80.8	80.2	77.8	72.2	0.75	0.71	0.63	0.50	560
7.5	10	18.2	1.15	20.2	81.9	81.7	80.0	75.3	0.80	0.77	0.69	0.57	480
9.2	12	22.8	1.15	25.0	82.3	82.1	80.4	75.7	0.78	0.75	0.66	0.54	430
11	15	26.5	1.15	29.5	83.0	82.8	81.4	77.2	0.79	0.76	0.68	0.55	500
13	18	31.0	1.15	34.0	83.3	83.3	81.9	77.7	0.80	0.77	0.69	0.56	610
15	20	35.0	1.15	38.5	83.7	83.7	82.5	78.7	0.81	0.78	0.70	0.57	600
18.5	25	42.5	1.15	47.0	84.4	84.3	83.3	79.7	0.81	0.78	0.70	0.58	620
22	30	49.5	1.15	55.0	84.9	84.9	84.2	80.9	0.82	0.80	0.72	0.59	630
26	35	58.0	1.15	64.5	84.9	85.0	84.2	80.8	0.82	0.80	0.72	0.59	650
30	40	65.5	1.15	73.0	85.2	85.3	84.7	81.6	0.84	0.82	0.75	0.63	590

Power [kW]	Power [hp]	n [min^{-1}]	Moment of inertia [$kg \cdot m^2$]	Rated torque [Nm]	LRT [%]	BT [%]
5.5	7.5	3500	0.00372	17.4	180	320
7.5	10	3480	0.00441	23.8	180	300
9.2	12	3490	0.00507	29.0	180	320
11	15	3480	0.00567	35.0	190	320
13	18	3480	0.00639	41.0	190	330
15	20	3480	0.00716	47.5	170	310
18.5	25	3490	0.00836	58.5	170	310
22	30	3480	0.00968	69.5	160	310
26	35	3480	0.0110	82.5	160	310
30	40	3480	0.0125	95.0	190	310

Voltage code 08

3 x 440 V, 60 Hz, T40, Undervoltage motors

Power [kW]	Power [hp]	Rated current $I_{1/1}$ [A]	Service factor	Nameplate current I_{SF} [A]	Motor efficiency η [%]				Cos φ				LRC [% of I_{SF}]
					115 % (SF)	100 %	75 %	50 %	115 % (SF)	100 %	75 %	50 %	
5.5	7.5	13.4	1.15	14.4	81.0	80.3	77.9	72.3	0.75	0.70	0.62	0.50	560
7.5	10	16.2	1.15	18.0	81.8	81.7	80.2	75.8	0.81	0.78	0.71	0.59	470
9.2	12	19.6	1.15	21.8	82.2	82.2	80.9	76.8	0.81	0.79	0.71	0.59	420
11	15	23.4	1.15	26.0	83.0	83.0	81.8	77.9	0.81	0.78	0.71	0.58	480
13	18	28.0	1.15	31.0	83.5	83.4	82.1	78.0	0.81	0.77	0.69	0.57	610
15	20	31.0	1.15	34.5	83.9	84.0	83.0	79.4	0.82	0.80	0.72	0.60	590
18.5	25	39.0	1.15	43.0	84.3	84.2	83.2	79.5	0.81	0.78	0.70	0.57	620
22	30	44.0	1.15	49.5	85.3	85.4	84.6	81.5	0.83	0.80	0.73	0.60	640
26	35	50.0	1.15	56.5	84.7	85.3	84.9	82.4	0.86	0.84	0.79	0.68	600
30	40	58.5	1.15	66.0	85.2	85.4	84.9	81.9	0.84	0.82	0.76	0.65	580

Power [kW]	Power [hp]	n [min^{-1}]	Moment of inertia [$kg•m^2$]	Rated torque [Nm]	LRT [%]	BT [%]
5.5	7.5	3500	0.00372	17.2	190	330
7.5	10	3480	0.00441	23.6	170	290
9.2	12	3480	0.00507	29.0	170	290
11	15	3480	0.00567	34.5	180	300
13	18	3480	0.00639	41.0	190	320
15	20	3480	0.00716	47.5	170	300
18.5	25	3490	0.00836	58.5	170	310
22	30	3480	0.00968	69.5	170	310
26	35	3470	0.0110	82.5	140	280
30	40	3480	0.0125	94.5	180	310

Voltage code 19, 69, 35

3 x 440 V, 60 Hz, T40

Power [kW]	Power [hp]	Rated current $I_{1/1}$ [A]	Service factor	Nameplate current I_{SF} [A]	Motor efficiency η [%]				Cos φ				LRC [% of I_{SF}]
					115 % (SF)	100 %	75 %	50 %	115 % (SF)	100 %	75 %	50 %	
5.5	7.5	11.6	1.15	13.2	80.4	80.6	79.5	75.4	0.82	0.81	0.75	0.64	490
7.5	10	15.2	1.15	17.4	81.0	81.5	81.1	77.7	0.84	0.83	0.79	0.69	410
9.2	12	18.6	1.15	21.2	81.3	82.0	81.6	78.4	0.84	0.83	0.79	0.69	370
11	15	22.0	1.15	25.0	82.1	82.8	82.6	79.7	0.84	0.83	0.79	0.69	420
13	18	25.5	1.15	29.5	82.4	83.1	83.0	80.2	0.85	0.84	0.80	0.70	520
15	20	29.0	1.15	33.5	82.9	83.7	83.5	80.9	0.85	0.84	0.80	0.70	520
18.5	25	36.0	1.15	41.0	83.6	84.3	84.2	81.6	0.85	0.84	0.80	0.69	540
22	30	41.5	1.15	48.0	83.5	84.5	85.0	83.1	0.87	0.86	0.83	0.74	520
26	35	48.5	1.15	56.5	83.6	84.5	85.1	83.2	0.88	0.86	0.83	0.76	530
30	40	56.0	1.15	65.0	83.6	84.7	85.3	83.5	0.88	0.87	0.84	0.76	470

Power [kW]	Power [hp]	n [min^{-1}]	Moment of inertia [$kg•m^2$]	Rated torque [Nm]	LRT [%]	BT [%]
5.5	7.5	3470	0.00372	17.4	140	260
7.5	10	3450	0.00441	23.8	140	240
9.2	12	3450	0.00507	29.5	140	250
11	15	3450	0.00567	35.0	140	250
13	18	3450	0.00639	41.5	150	260
15	20	3450	0.00716	47.5	140	260
18.5	25	3460	0.00836	58.5	140	260
22	30	3450	0.00968	70.0	130	240
26	35	3450	0.0110	83.0	120	240
30	40	3440	0.0125	95.5	140	240

3 x 460 V, 60 Hz, T40

Power [kW]	Power [hp]	Rated current $I_{1/1}$ [A]	Service factor	Nameplate current I_{SF} [A]	Motor efficiency η [%]				Cos φ				LRC [% of I_{SF}]
					115 % (SF)	100 %	75 %	50 %	115 % (SF)	100 %	75 %	50 %	
5.5	7.5	11.6	1.15	13.0	80.8	80.6	78.9	74.1	0.80	0.77	0.70	0.58	520
7.5	10	15.0	1.15	16.8	81.7	81.8	80.8	76.8	0.83	0.81	0.75	0.64	440
9.2	12	18.2	1.15	20.6	82.1	82.3	81.3	77.5	0.82	0.81	0.75	0.63	400
11	15	21.6	1.15	24.4	82.8	83.1	82.4	78.9	0.83	0.81	0.75	0.64	460
13	18	25.0	1.15	28.5	83.2	83.5	82.7	79.3	0.84	0.82	0.76	0.65	560
15	20	29.0	1.15	32.5	83.7	84.0	83.3	80.0	0.84	0.82	0.76	0.65	570
18.5	25	35.5	1.15	40.0	84.3	84.6	83.9	80.7	0.83	0.81	0.75	0.64	590
22	30	40.5	1.15	46.0	84.4	85.1	84.9	82.5	0.85	0.84	0.79	0.69	570
26	35	47.5	1.15	54.0	84.6	85.2	85.0	82.5	0.86	0.84	0.80	0.69	580
30	40	54.5	1.15	62.0	84.7	85.2	85.2	82.8	0.86	0.85	0.80	0.70	520

Power [kW]	Power [hp]	n [min^{-1}]	Moment of inertia [$kg•m^2$]	Rated torque [Nm]	LRT [%]	BT [%]
5.5	7.5	3480	0.00372	17.4	160	280
7.5	10	3470	0.00441	23.8	150	260
9.2	12	3470	0.00507	29.5	150	280
11	15	3470	0.00567	35.0	160	280
13	18	3470	0.00639	41.5	160	290
15	20	3470	0.00716	47.5	160	290
18.5	25	3480	0.00836	58.5	160	290
22	30	3470	0.00968	70.0	140	270
26	35	3460	0.0110	83.0	140	270
30	40	3460	0.0125	95.5	160	270

3 x 480 V, 60 Hz, T40

Power [kW]	Power [hp]	Rated current $I_{1/1}$ [A]	Service factor	Nameplate current I_{SF} [A]	Motor efficiency η [%]				Cos φ				LRC [% of I_{SF}]
					115 % (SF)	100 %	75 %	50 %	115 % (SF)	100 %	75 %	50 %	
5.5	7.5	12.0	1.15	13.0	80.7	80.2	78.0	72.6	0.77	0.73	0.65	0.52	550
7.5	10	15.0	1.15	16.6	82.0	81.8	80.2	75.6	0.80	0.77	0.69	0.57	470
9.2	12	18.4	1.15	20.4	82.4	82.2	80.7	76.3	0.80	0.77	0.69	0.57	430
11	15	21.6	1.15	24.0	83.2	83.1	81.8	77.8	0.80	0.77	0.69	0.57	490
13	18	25.5	1.15	28.0	83.4	83.4	82.1	78.2	0.81	0.78	0.70	0.58	600
15	20	29.0	1.15	32.0	83.9	83.9	82.7	78.8	0.81	0.78	0.70	0.57	610
18.5	25	36.0	1.15	39.5	84.4	84.3	83.2	79.4	0.80	0.77	0.69	0.57	620
22	30	40.0	1.15	45.0	85.0	85.2	84.6	81.5	0.83	0.81	0.75	0.63	620
26	35	47.0	1.15	53.0	85.0	85.2	84.6	81.6	0.84	0.82	0.75	0.63	630
30	40	54.5	1.15	61.0	85.1	85.3	84.8	81.8	0.84	0.82	0.75	0.63	560

Power [kW]	Power [hp]	n [min^{-1}]	Moment of inertia [$kg•m^2$]	Rated torque [Nm]	LRT [%]	BT [%]
5.5	7.5	3490	0.00372	17.4	180	310
7.5	10	3480	0.00441	23.8	170	290
9.2	12	3480	0.00507	29.5	170	310
11	15	3480	0.00567	35.0	180	310
13	18	3480	0.00639	41.5	180	320
15	20	3480	0.00716	47.5	180	320
18.5	25	3490	0.00836	58.5	170	320
22	30	3480	0.00968	70.0	160	300
26	35	3480	0.0110	83.0	150	300
30	40	3480	0.0125	95.5	180	300

Voltage code 18, 39

3 x 575 V, 60 Hz, T40

Power [kW]	Power [hp]	Rated current $I_{1/1}$ [A]	Service factor	Nameplate current I_{SF} [A]	Motor efficiency η [%]				Cos φ				LRC [% of I_{SF}]
					115 % (SF)	100 %	75 %	50 %	115 % (SF)	100 %	75 %	50 %	
5.5	7.5	9.25	1.15	10.2	80.8	80.6	79.0	74.3	0.81	0.78	0.71	0.59	520
7.5	10	12.0	1.15	13.4	81.2	81.4	80.5	76.6	0.83	0.81	0.76	0.64	440
9.2	12	14.6	1.15	16.4	82.0	82.2	81.2	77.4	0.83	0.81	0.75	0.63	400
11	15	17.2	1.15	19.4	82.7	83.0	82.3	79.0	0.83	0.81	0.76	0.65	450
13	18	20.4	1.15	22.8	83.2	83.4	82.5	79.0	0.83	0.81	0.75	0.63	570
15	20	23.4	1.15	26.0	83.5	83.8	83.0	79.5	0.83	0.81	0.75	0.63	580
18.5	25	28.5	1.15	32.0	83.7	84.0	83.2	79.9	0.83	0.82	0.75	0.63	590
22	30	32.0	1.15	37.0	84.0	84.8	84.9	82.7	0.86	0.85	0.81	0.71	550
26	35	37.5	1.15	43.0	84.3	85.1	85.1	82.7	0.86	0.85	0.81	0.71	580
30	40	43.5	1.15	49.5	84.7	85.2	85.2	82.8	0.87	0.85	0.81	0.71	530

Power [kW]	Power [hp]	n [min^{-1}]	Moment of inertia [$kg \cdot m^2$]	Rated torque [Nm]	LRT [%]	BT [%]
5.5	7.5	3480	0.00372	17.4	160	280
7.5	10	3470	0.00441	23.8	150	260
9.2	12	3470	0.00507	29.0	150	270
11	15	3460	0.00567	35.0	160	280
13	18	3470	0.00639	41.0	170	300
15	20	3480	0.00716	47.5	160	290
18.5	25	3480	0.00842	58.5	160	290
22	30	3460	0.00968	70.0	130	260
26	35	3460	0.0110	82.5	140	260
30	40	3470	0.0125	95.0	160	270

Voltage code 09, 63

3 x 200 V, 60 Hz, T60

Power [kW]	Power [hp]	Rated current $I_{1/1}$ [A]	Service factor	Nameplate current I_{SF} [A]	Motor efficiency η [%]				Cos φ				LRC [% of I_{SF}]
					115 % (SF)	100 %	75 %	50 %	115 % (SF)	100 %	75 %	50 %	
5.5	7.5	24.2	1.00	24.4	81.2	81.2	80.4	76.7	0.86	0.86	0.83	0.76	610
7.5	10	32.5	1.00	33.0	80.9	80.9	80.9	78.0	0.88	0.87	0.84	0.78	510
9.2	12	39.0	1.00	39.5	81.3	81.3	81.3	78.3	0.89	0.89	0.86	0.81	500
11	15	46.0	1.00	46.5	82.0	82.0	82.5	80.1	0.89	0.89	0.87	0.82	470
13	18	54.5	1.00	55.0	82.9	82.9	83.2	80.6	0.89	0.89	0.86	0.81	500
15	20	62.0	1.00	62.5	83.3	83.3	83.3	80.8	0.89	0.89	0.87	0.82	510
18.5	25	75.5	1.00	76.0	83.3	83.3	83.8	81.8	0.90	0.90	0.88	0.83	490
22	30	90.0	1.00	91.0	83.3	83.4	83.9	81.9	0.90	0.90	0.88	0.83	510

Power [kW]	Power [hp]	n [min^{-1}]	Moment of inertia [$kg \cdot m^2$]	Rated torque [Nm]	LRT [%]	BT [%]
5.5	7.5	3490	0.00507	15.0	150	270
7.5	10	3470	0.00567	20.6	130	220
9.2	12	3470	0.00639	25.5	130	210
11	15	3460	0.00716	30.5	130	210
13	18	3470	0.00836	35.5	160	260
15	20	3470	0.00961	41.5	130	260
18.5	25	3460	0.0110	51.0	130	240
22	30	3460	0.0125	60.5	120	240

3 x 220 V, 60 Hz, T60

Power [kW]	Power [hp]	Rated current $I_{1/1}$ [A]	Service factor	Nameplate current I_{SF} [A]	Motor efficiency η [%]				Cos φ				LRC [% of I_{SF}]
					115 % (SF)	100 %	75 %	50 %	115 % (SF)	100 %	75 %	50 %	
5.5	7.5	22.6	1.00	22.6	82.1	82.1	80.4	75.8	0.83	0.83	0.79	0.69	740
7.5	10	30.0	1.00	30.0	82.4	82.4	81.4	77.6	0.85	0.85	0.81	0.72	620
9.2	12	36.0	1.00	36.0	82.8	82.8	81.8	78.0	0.87	0.87	0.83	0.76	620
11	15	42.0	1.00	42.0	83.7	83.7	83.0	79.8	0.88	0.88	0.84	0.77	590
13	18	50.0	1.00	50.0	84.3	84.3	83.4	80.1	0.87	0.87	0.83	0.75	620
15	20	57.0	1.00	57.0	84.5	84.5	83.6	80.2	0.87	0.87	0.83	0.76	630
18.5	25	68.5	1.00	68.5	84.8	84.8	84.3	81.4	0.88	0.88	0.85	0.78	620
22	30	82.0	1.00	82.0	84.8	84.8	84.3	81.4	0.89	0.89	0.85	0.78	630

Power [kW]	Power [hp]	n [min^{-1}]	Moment of inertia [$kg \cdot m^2$]	Rated torque [Nm]	LRT [%]	BT [%]
5.5	7.5	3510	0.00507	15.0	190	340
7.5	10	3500	0.00567	20.6	160	280
9.2	12	3500	0.00639	25.5	170	260
11	15	3490	0.00716	30.5	170	260
13	18	3500	0.00836	35.5	210	320
15	20	3500	0.00961	41.5	170	320
18.5	25	3490	0.0110	51.0	160	300
22	30	3490	0.0125	60.5	160	300

Voltage code 64

3 x 400 V, 60 Hz, T60

Power [kW]	Power [hp]	Rated current $I_{1/1}$ [A]	Service factor	Nameplate current I_{SF} [A]	Motor efficiency η [%]				Cos φ				LRC [% of I_{SF}]
					115 % (SF)	100 %	75 %	50 %	115 % (SF)	100 %	75 %	50 %	
5.5	7.5	12.2	1.00	12.2	81.3	81.3	80.3	76.5	0.86	0.86	0.82	0.75	630
7.5	10	16.4	1.00	16.4	81.4	81.4	81.1	78.0	0.87	0.87	0.84	0.77	540
9.2	12	19.6	1.00	19.8	81.3	81.3	81.3	78.3	0.89	0.89	0.86	0.81	500
11	15	23.2	1.00	23.4	81.7	81.8	82.3	80.0	0.89	0.89	0.88	0.82	470
13	18	27.0	1.00	27.5	82.9	82.9	83.2	80.6	0.89	0.89	0.86	0.81	500
15	20	31.0	1.00	31.5	83.3	83.3	83.3	80.8	0.89	0.89	0.87	0.82	510
18.5	25	37.5	1.00	38.0	83.3	83.3	83.8	81.8	0.90	0.90	0.88	0.83	490
22	30	45.0	1.00	45.5	83.3	83.4	83.9	81.9	0.90	0.90	0.88	0.83	510

Power [kW]	Power [hp]	n [min^{-1}]	Moment of inertia [$kg \cdot m^2$]	Rated torque [Nm]	LRT [%]	BT [%]
5.5	7.5	3490	0.00507	15.0	160	290
7.5	10	3470	0.00567	20.6	130	240
9.2	12	3470	0.00639	25.5	130	210
11	15	3460	0.00716	30.5	130	210
13	18	3470	0.00836	35.5	160	260
15	20	3470	0.00961	41.5	130	260
18.5	25	3460	0.0110	51.0	130	240
22	30	3460	0.0125	60.5	120	240

3 x 440 V, 60 Hz, T60

Power [kW]	Power [hp]	Rated current $I_{1/1}$ [A]	Service factor	Nameplate current I_{SF} [A]	Motor efficiency η [%]				Cos φ				LRC [% of I_{SF}]
					115 % (SF)	100 %	75 %	50 %	115 % (SF)	100 %	75 %	50 %	
5.5	7.5	11.4	1.00	11.4	82.1	82.1	80.3	75.5	0.83	0.83	0.78	0.67	760
7.5	10	15.2	1.00	15.2	82.7	82.7	81.4	77.4	0.84	0.84	0.80	0.70	650
9.2	12	18.0	1.00	18.0	82.8	82.8	81.8	78.0	0.87	0.87	0.83	0.76	620
11	15	21.0	1.00	21.0	83.5	83.5	82.9	79.7	0.88	0.88	0.84	0.77	590
13	18	25.0	1.00	25.0	84.3	84.3	83.4	80.1	0.87	0.87	0.83	0.75	620
15	20	28.5	1.00	28.5	84.5	84.5	83.6	80.2	0.87	0.87	0.83	0.76	630
18.5	25	34.5	1.00	34.5	84.8	84.8	84.3	81.4	0.88	0.88	0.85	0.78	620
22	30	41.0	1.00	41.0	84.8	84.8	84.3	81.4	0.89	0.89	0.85	0.78	630

Power [kW]	Power [hp]	n [min^{-1}]	Moment of inertia [$kg•m^2$]	Rated torque [Nm]	LRT [%]	BT [%]
5.5	7.5	3520	0.00507	15.0	200	350
7.5	10	3500	0.00567	20.6	170	300
9.2	12	3500	0.00639	25.5	170	260
11	15	3490	0.00716	30.5	170	260
13	18	3500	0.00836	35.5	210	320
15	20	3500	0.00961	41.5	170	320
18.5	25	3490	0.0110	51.0	160	300
22	30	3490	0.0125	60.5	160	300

Voltage code 19, 69

3 x 440 V, 60 Hz, T60

Power [kW]	Power [hp]	Rated current $I_{1/1}$ [A]	Service factor	Nameplate current I_{SF} [A]	Motor efficiency η [%]				Cos φ				LRC [% of I_{SF}]
					115 % (SF)	100 %	75 %	50 %	115 % (SF)	100 %	75 %	50 %	
5.5	7.5	11.8	1.15	13.2	81.6	81.1	79.0	73.8	0.83	0.82	0.77	0.67	610
7.5	10	15.6	1.15	17.4	82.2	82.0	80.5	76.1	0.84	0.83	0.79	0.69	520
9.2	12	18.2	1.15	20.8	82.2	82.2	80.9	76.9	0.87	0.86	0.82	0.74	500
11	15	21.4	1.15	24.6	82.4	82.7	81.9	78.4	0.88	0.86	0.83	0.76	470
13	18	25.5	1.15	29.0	83.5	83.6	82.5	79.0	0.87	0.86	0.82	0.73	510
15	20	29.5	1.15	33.5	83.6	83.6	82.5	78.8	0.87	0.85	0.82	0.73	530
18.5	25	35.0	1.15	40.0	83.9	84.2	83.5	80.5	0.88	0.86	0.83	0.76	510
22	30	42.0	1.15	48.0	84.0	84.2	83.6	80.6	0.88	0.86	0.83	0.76	520

Power [kW]	Power [hp]	n [min^{-1}]	Moment of inertia [$kg•m^2$]	Rated torque [Nm]	LRT [%]	BT [%]
5.5	7.5	3500	0.00507	17.2	150	270
7.5	10	3480	0.00567	23.6	130	230
9.2	12	3480	0.00639	29.0	120	200
11	15	3470	0.00716	35.0	130	220
13	18	3480	0.00836	41.0	170	270
15	20	3480	0.00961	47.5	150	280
18.5	25	3470	0.0110	58.5	130	260
22	30	3470	0.0125	69.5	130	260

3 x 460 V, 60 Hz, T60

Power [kW]	Power [hp]	Rated current $I_{1/1}$ [A]	Service factor	Nameplate current I_{SF} [A]	Motor efficiency η [%]				Cos φ				LRC [% of I_{SF}]
					115 % (SF)	100 %	75 %	50 %	115 % (SF)	100 %	75 %	50 %	
5.5	7.5	11.6	1.15	12.8	81.8	81.1	78.6	73.0	0.82	0.80	0.73	0.63	660
7.5	10	15.2	1.15	17.0	82.6	82.2	80.3	75.5	0.83	0.81	0.76	0.65	570
9.2	12	17.8	1.15	20.0	82.7	82.5	80.9	76.5	0.86	0.84	0.80	0.70	550
11	15	20.8	1.15	23.6	83.1	83.1	81.9	78.0	0.86	0.85	0.81	0.72	510
13	18	24.8	1.15	28.0	84.0	83.8	82.5	78.4	0.86	0.84	0.79	0.69	560
15	20	28.5	1.15	32.5	84.1	83.8	82.4	78.2	0.85	0.83	0.79	0.69	580
18.5	25	34.0	1.15	38.5	84.5	84.5	83.5	80.0	0.86	0.85	0.81	0.71	560
22	30	41.0	1.15	46.5	84.6	84.6	83.6	80.1	0.86	0.85	0.81	0.71	660

Power [kW]	Power [hp]	n [min^{-1}]	Moment of inertia [$kg•m^2$]	Rated torque [Nm]	LRT [%]	BT [%]
5.5	7.5	3510	0.00507	17.2	160	290
7.5	10	3500	0.00567	23.6	140	250
9.2	12	3490	0.00639	29.0	140	220
11	15	3480	0.00716	35.0	150	240
13	18	3490	0.00836	41.0	190	300
15	20	3490	0.00961	47.5	170	310
18.5	25	3480	0.0110	58.5	150	280
22	30	3480	0.0125	69.5	160	290

3 x 480 V, 60 Hz, T60

Power [kW]	Power [hp]	Rated current $I_{1/1}$ [A]	Service factor	Nameplate current I_{SF} [A]	Motor efficiency η [%]				Cos φ				LRC [% of I_{SF}]
					115 % (SF)	100 %	75 %	50 %	115 % (SF)	100 %	75 %	50 %	
5.5	7.5	11.6	1.15	12.6	81.8	80.9	78.0	72.1	0.79	0.76	0.69	0.57	700
7.5	10	15.0	1.15	16.6	82.8	82.2	79.9	74.8	0.81	0.79	0.71	0.60	610
9.2	12	17.6	1.15	19.6	83.1	82.7	80.7	75.8	0.84	0.82	0.76	0.65	590
11	15	20.4	1.15	22.8	83.6	83.3	81.8	77.5	0.85	0.83	0.78	0.68	560
13	18	24.6	1.15	27.5	84.3	83.9	82.1	77.7	0.83	0.82	0.75	0.64	610
15	20	28.5	1.15	31.5	84.3	83.9	82.0	77.5	0.83	0.81	0.75	0.63	620
18.5	25	33.5	1.15	37.5	84.9	84.7	83.3	79.4	0.85	0.83	0.78	0.67	610
22	30	40.5	1.15	45.0	84.9	84.7	83.4	79.4	0.84	0.82	0.77	0.66	630

Power [kW]	Power [hp]	n [min^{-1}]	Moment of inertia [$kg•m^2$]	Rated torque [Nm]	LRT [%]	BT [%]
5.5	7.5	3520	0.00507	17.2	180	320
7.5	10	3510	0.00567	23.6	160	270
9.2	12	3500	0.00639	29.0	150	240
11	15	3490	0.00716	35.0	160	270
13	18	3510	0.00836	41.0	210	330
15	20	3500	0.00961	47.5	190	340
18.5	25	3500	0.0110	58.5	170	310
22	30	3500	0.0125	69.5	160	310

Voltage code 18

3 x 575 V, 60 Hz, T60

Power [kW]	Power [hp]	Rated current $I_{1/1}$ [A]	Service factor	Nameplate current I_{SF} [A]	Motor efficiency η [%]				Cos φ				LRC [% of I_{SF}]
					115 % (SF)	100 %	75 %	50 %	115 % (SF)	100 %	75 %	50 %	
5.5	7.5	9.30	1.15	10.2	81.7	81.0	78.5	72.9	0.82	0.79	0.72	0.62	670
7.5	10	12.0	1.15	13.6	82.4	82.1	80.3	75.5	0.83	0.82	0.76	0.66	560
9.2	12	14.2	1.15	16.0	82.7	82.5	80.8	76.3	0.85	0.83	0.79	0.69	560
11	15	16.6	1.15	18.8	83.0	83.1	81.9	78.2	0.87	0.85	0.82	0.73	500
13	18	19.8	1.15	22.4	83.9	83.7	82.4	78.3	0.86	0.84	0.79	0.69	560
15	20	22.8	1.15	25.5	84.0	83.8	82.4	78.3	0.86	0.84	0.80	0.69	580
18.5	25	27.5	1.15	31.0	84.6	84.6	83.5	79.9	0.86	0.84	0.80	0.70	570
22	30	33.0	1.15	37.0	84.5	84.5	83.6	80.1	0.86	0.85	0.81	0.71	580

Power [kW]	Power [hp]	n [min^{-1}]	Moment of inertia [$kg•m^2$]	Rated torque [Nm]	LRT [%]	BT [%]
5.5	7.5	3510	0.00507	17.2	170	300
7.5	10	3490	0.00567	23.6	140	250
9.2	12	3490	0.00639	29.0	140	220
11	15	3480	0.00716	34.5	140	230
13	18	3490	0.00836	41.0	190	300
15	20	3490	0.00968	47.0	170	300
18.5	25	3490	0.0110	58.5	150	290
22	30	3480	0.0125	69.5	140	280

8. Electrical accessories

CUE frequency converter

GrA4404 3407

Fig. 14 The CUE range

The Grundfos CUE is a series of external frequency converters designed for speed control of a wide range of Grundfos pumps.

The CUE offers quick and easy set-up and commissioning compared to a standard frequency converter because of the start-up guide. Simply key in application-specific variables such as motor data, pump family, control function (for example constant pressure), sensor type and setpoint, and the CUE will automatically set all necessary parameters.

The CUE enables gentle pumping and thereby protects the water reservoir and the rest of the distribution system, as water hammer can be avoided by adjusting ramp times up and down.

When a CUE is installed, the motor requires no further overload protection. Pt100/1000 together with the MCB 114 provides overheat protection of the motor windings, if needed.

Note: If the motor has a built-in Tempcon sensor, this sensor will be disconnected when it is exposed to the frequency converter drive. An internal fuse in the motor blows and it cannot be replaced. The motor will work without the sensor, but it is not possible to restore the functionality of the Tempcon sensor.

Overview of the CUE range

Supply voltage [V]	Power range [kW]						
	0.55	0.75	1.1	7.5	11	45	250
3 x 525-690					•	•	•
3 x 525-600		•	•	•			
3 x 380-500	•	•	•	•	•	•	•
3 x 200-240		•	•	•	•	•	
1 x 200-240			•	•			

The CUE is available in two enclosure classes:

- IP20/21
- IP54/55.

RFI filters

To meet the EMC requirements, the CUE comes with the following types of built-in radio frequency interference filter (RFI).

Voltage [V]	Typical shaft power, P2 [kW]	RFI filter type	Application
1 x 200-240	1.1 - 7.5	C1	Domestic
3 x 200-240	0.75 - 45	C1	
3 x 380-500	0.55 - 90	C1	
	110 - 50	C2	Domestic/ industry
3 x 525-600	0.75 - 7.5	C3	Industry
3 x 525-690	11 - 25	C3	

Functions

The CUE has a wide range of pump-specific functions, such as:

- constant pressure
- constant level
- constant flow rate
- constant temperature
- constant curve.

Features

- Start-up guide
  The CUE incorporates an innovative start-up guide for the general setting of the CUE including the setting of the correct direction of rotation.
  The start-up guide is started the first time the CUE is connected to the power supply.
- Check of direction of rotation.
- Duty/standby operation.
- Dry-running protection.
- Low-flow stop function.

Accessories

Grundfos offers various accessories for the CUE.

MCB 114 sensor input module

The MCB 114 offers additional analog inputs for the CUE:

- 1 analog input, 0/4-20 mA
- 2 inputs for Pt100 and Pt1000 temperature sensors.

Output filters

Output filters are used primarily to protect the motor against overvoltage and increased operating temperature. However, output filters can also be used to reduce acoustic noise from the motor.

Grundfos offers sine-wave filters as an CUE accessory.

Sensors

The following sensors can be used in connection with the CUE. All sensors are with 4-20 mA output signal.

- pressure sensors, up to 25 bar
- temperature sensors
- differential-pressure sensors
- differential-temperature sensors
- flowmeters
- potentiometer box for external setpoint setting.

Installation

Use of output filters

The table below shows in which cases an output filter is required and which type to use.

The selection depends on these factors:

- pump type
- motor cable length
- the required reduction of acoustic noise from the motor.

Pump type	Typical shaft power, P2	Sine-wave filter
SP with 380 V motor and up	All sizes	0-300 m

The lengths stated apply to the motor cable.

Cables used in CUE installations

Note: When the CUE is installed in connection with SP pumps, we distinguish between two types of installation:

- installation in EMC-insensitive sites. See fig. 15.
- installation in EMC-sensitive sites. See fig. 16.

The two types of installation are different when it comes to the use of screened cable.

Note: Drop cables are always unscreened.

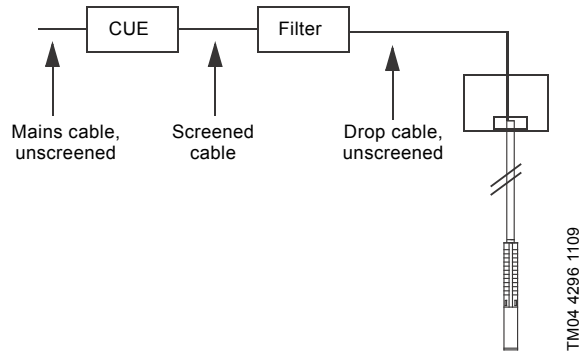


Fig. 15 Example of installation in EMC-insensitive sites

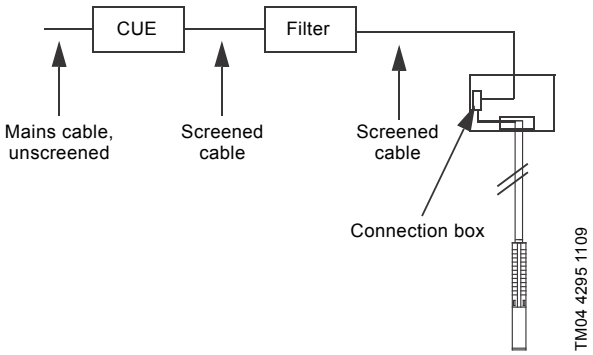


Fig. 16 Example of installation in EMC-sensitive sites

Screened cables are required in those parts of the installation where the surroundings must be protected against EMC.

The CUE is the right choice of frequency converter in SP installations as it meets all basic issues.

The CUE has a pre-installed start-up guide which takes the installer through all the necessary settings.

The table below shows the different issues to be considered when using frequency converters in SP installations.

Issues to be considered	Explanation
Ramp (up and down): Maximum 3 seconds.	The journal bearings must be lubricated in order to limit wear and overheating of windings.
Use temperature monitoring by Pt sensor.	Overheating of the motor => low insulation resistance => sensitive to voltage peaks. **Note:** Tempcon sensors do not work with frequency converter operation.
Reduce peak voltages (max. 800 V peaks).	Never exceed peak voltages of 850 V at motor leads.
For MS and MMS, we recommend to use motors with 10 % extra in given duty point. For MMS, always use motors wound PE2-PA.	Grundfos CUE with output filter is a safe solution.
Remember output filter.	Cables act as an amplifier => measure peaks at the motor.
Rise time (dU/dt) must be limited to a maximum of 1000 V/µs. Determined by the equipment in the CUE.	Time between switches is an expression of losses, so in the future, we might have to exceed the limit of 1000 V/µs. The solution is not higher insulation of the motor, but filter in the output from the CUE.
Constant operation at min. 30 Hz. Use a 60 Hz motor for larger ranges.	Too low speed => low flow and thereby poor lubrication of journal bearings.
Size the CUE in respect of the current, not the power output.	Can end up with a too small CUE.
Size cooling provision for stator tube at duty point with lowest flow rate.	Flow min. m/s along the stator housing must be considered.
Ensure that the pump is used within the range of the pump curve.	Focus on discharge pressure and sufficient NPSH, as vibrations will "kill" the motor.

For further information about frequency converters, see the CUE documentation available on www.grundfos.com (WebCAPS).

MP 204 motor protector

TM055456 3712

Fig. 17 MP 204 motor protector

The MP 204 is an electronic motor protector designed for the protection of an asynchronous motor or a pump.

The MP 204 cannot be used in installations where a frequency converter is installed.

The MP 204 operates with two sets of limits:

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

If one or more of the warning limits are exceeded, the motor will continue to run, but the warnings will appear in the MP 204 display.

You can also read-out the warning with the Grundfos R100 or Grundfos GO remote control.

If one of the trip limits is exceeded, the trip relay will stop the motor. At the same time, the signal relay is operating to indicate that the limit has been exceeded.

Applications

- The MP 204 can be used as a stand-alone motor protector.
- The MP 204 can be monitored via a Grundfos GENIbus.
- The MP 204 protects the motor primarily by measuring the motor current by means of a true RMS measurement.
- The MP 204 is designed for single- and three-phase motors. In single-phase motors, the starting and run capacitors are also measured. Cos φ is measured in both single- and three-phase systems.

Benefits

The MP 204 offers these benefits:

- suitable for both single- and three-phase motors
- dry-running protection
- overload protection
- very high accuracy
- made for submersible pumps.

The many monitoring options of the MP 204

The MP 204 monitors the following parameters:

- insulation resistance before start-up
- temperature (Tempcon, Pt sensor and PTC/thermal switch)
- overload/underload
- overvoltage/undervoltage
- phase sequence
- phase failure
- power factor
- power consumption
- harmonic distortion
- operating hours and number of starts.

Five sizes of single-turn transformers, 120-999 A.

Note: Monitoring of motor temperature is not possible when single-turn transformers are used.

TM03 2033 3505

Fig. 18 Single-turn transformers

Technical data, MP 204

Enclosure class	IP20
Ambient temperature	-20 °C to +60 °C
Relative air humidity	99 %
Voltage range	100-480 VAC
Current range	3-999 A
Frequency	50 to 60 Hz
IEC trip class	1-45
Special Grundfos trip class	0.1 to 30 s
Voltage variation	- 25 %/+ 15 % of rated voltage
Approvals	EN 60947, EN 60335, UL/CSA 508
Marking	CE, cUL, C-tick
Consumption	Max. 5 W
Plastic type	Black PC/ABS

Electrical data, MP 204

	Measuring range	Accuracy	Resolution
Current without external current transformers	3-120 A	± 1 %	0.1 A
Current with external current transformers	120-999 A	± 1 %	1 A
Phase-to-phase voltage	80-610 VAC	± 1 %	1 V
Frequency	47-63 Hz	± 1 %	0.5 Hz
Power	0-1 MW	± 2 %	1 W
Power factor	0 - 0.99	± 2 %	0.01
Energy consumption	0-4 x 10^9 kWh	± 5 %	1 kWh

Product numbers, MP 204

Product	Product number
MP 204	96079927
Grundfos Go Remote variants	
Grundfos MI 201	98140638
Grundfos MI 202	98046376
Grundfos MI 204	98424092
Grundfos MI 301	98046408
Single-turn transformers	
Current transformer ratio: 200:5, $I_{max.}$ = 120 A	96095274
Current transformer ratio: 300:5, $I_{max.}$ = 300 A	96095275
Current transformer ratio: 500:5, $I_{max.}$ = 500 A	96095276
Current transformer ratio: 750:5, $I_{max.}$ = 750 A	96095277
Current transformer ratio: 1000:5, $I_{max.}$ = 1000 A	96095278

For further information about motor protection via MP 204, see the MP 204 documentation available on www.grundfos.com (WebCAPS).

IO 112 module

Product	Description	Product number
 TM03 5811 3906	The IO 112 is a measuring module and a single-channel protection unit for use in connection with the MP 204 motor protector. The module can be used for protection of the pump against other factors than the electrical conditions, for instance dry running. It can also be used as a stand-alone protection module. The IO 112 interface has three inputs for measured values, one potentiometer for setting of limits and indicator lights indicating the following: • measured value of the input • value of the limit set • alarm source • pump status. **Electrical data** • Supply voltage: 24 VAC ± 10 %, 50/60 Hz or 24 VDC ± 10 %. • Supply current: Min. 2.4 A, max. 8 A. • Power consumption: Max. 5 W. • Ambient temperature: -25 °C to +65 °C. • Enclosure class: IP20.	96651601

Control MP 204

Product	Description	Product number
 TM05 3695 1612	The Control MP 204 control cabinets are supplied with all necessary components. Three types of control cabinets are available, depending on functions and starting method. The control cabinets are designed for installation in a control cabinet for outdoor use. The Control MP 204 control cabinets have a built-in main switch and a thermal magnetic circuit breaker. **Functions:** **Digital input** • Float switch or pressure relay (if no IO 112 is used). **Analog input** • Too high motor temperature (Tempcon) • thermistor/PTC, pump • pressure sensor, 4-20 mA (with IO 112). **Relay output** • Pump alarm. **Communication** • Grundfos Remote Management. • GSM/GPRS (IO 112 not supported) • Modbus RTU wired (IO 112 not supported) • Profibus DP (IO 112 not supported). **Protection** • Protects the pump against short-circuit.	Consult WebCAPS on www.grundfos.com > Accessories > Electrical accessories.

CIU communication interface units

GrA6118 3908

Fig. 19 Grundfos CIU communication interface unit

The Communication Interface Unit (CIU) enables data communication via open and interoperable networks, such as Profibus DP, Modbus RTU, LonWorks, BACnet MS/TP, GSM/GPRS or Grundfos Remote Management (GRM) for complete control of pump systems.

Applications

The range of Grundfos CIU communication interface units offers ease of installation and commissioning as well as user-friendliness. All units are based on standard functional profiles for an easy integration into the network.

The CIU units enable communication of operating data, such as measured values and setpoints, between pumps and PLCs, SCADA system and building management system.

Benefits

The CIU offers these benefits:

- open communication standards
- complete process control
- one concept for Grundfos products
- 24-240 VAC/DC power supply in CIU modules
- simple configuration and easy to install
- prepared for DIN rail or wall mounting.

For data communication between an SP pump and a main network, a CIU unit together with a CUE frequency converter or an MP 204 motor protector is required.

TM05 5456 3712 - GrA4 412 3307

Fig. 20 MP 204 motor protector and CUE frequency converter

Fieldbus support for these products is shown in the following table:

CIU unit	Fieldbus protocol	CUE	MP 204
CIU 100	LonWorks	●	-
CIU 150	Profibus DP	●	●
CIU 200	Modbus RTU	●	●
CIU 250	GSM/GPRS	●	●
CIU 270/271*	GRM	●	●
CIU 300	BACnet MS/TP	●	-

* Grundfos Remote Management (GRM) is an easy-to-install low-cost solution for wireless monitoring and management of Grundfos products.

Product numbers

CIU unit	Fieldbus protocol	Product number
CIU 100	LonWorks	96753735
CIU 150	Profibus DP	96753081
CIU 200	Modbus RTU	96753082
CIU 250*	GSM/GPRS	96787106
CIU 270*	GRM	98176136
CIU 271*	GRM	96898819
CIU 300	BACnet MS/TP	96893769

* Antenna not included. See below.

Antennas for CIU 250 and 270/271

Description	Product number
Antenna for roof	97631956
Antenna for desk	97631957

For further information about data communication via CIU units and fieldbus protocols, see the CIU documentation available on www.grundfos.com (WebCAPS).

SA-SPM control boxes

TM05 2214 4611

Fig. 21 SA-SPM

SA-SPM control boxes are used as starting units for single-phase, 3-wire motors, types MS 402B and MS 4000.

Product numbers

Product	Product number	I_N	Supply voltage	CS	CR	PSC
		[A]	[V]	[µF]	[µF]	[µF]
SA-SPM 7 - GSIR - 0.37 kW, 50 Hz	96802243	4.0	220-240	63-80	-	-
SA-SPM 7 - CSIR - 0.55 kW, 50 Hz	96786467	6.0		80-100	-	-
SA-SPM 7 - CSIR - 0.75 kW, 50 Hz	96786468	7.5		100-125	-	-
SA-SPM 8 - CSCR - 1.1 kW, 50 Hz	96786469	7.5		125-160	40	-
SA-SPM 8 - CSCR - 1.5 kW, 50 Hz	96786470	10.4		160-200	50	-
SA-SPM 8 - CSCR - 2.2 kW, 50 Hz	96786471	14.8		250-315	60	-
SA-SPM 9 - PSC - 0.37 kW, 50 Hz	96786482	3.0		-	-	16
SA-SPM 9 - PSC - 0.55 kW, 50 Hz	96786483	4.5		-	-	20
SA-SPM 9 - PSC - 0.75 kW, 50 Hz	96786484	6.0		-	-	30
SA-SPM 9 - PSC - 1.1 kW, 50 Hz	96786485	8.5		-	-	40

PR 5714 with Pt100 sensor

The PR 5714 with Pt100 sensor offers these features:

- continuous monitoring of the motor temperature
- protection against too high motor temperature.

Protecting the motor against too high motor temperature is the simplest and cheapest way of avoiding that the motor life is reduced. The Pt100 sensor ensures that the operating conditions are not exceeded and indicates when it is time for service of the motor.

Monitoring and protection by means of a Pt100 require the following parts:

- Pt100 sensor
- PR 5714 relay
- cable.

The following temperature limits are preset on delivery:

- 60 °C warning limit
- 75 °C stop limit.

To set the warning limit, observe the temperature at normal operation and add 10 °C. To set the stop limit, observe the temperature at normal operation and add additional 10 °C.

Technical data

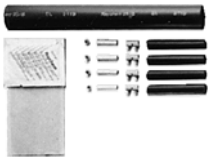
	PR 5714
Enclosure class	IP65 (fitted in a control panel)
Ambient temperature	-20 °C to +60 °C
Relative air humidity	95 % (condensating)
Voltage variation	• 1 x 24-230 VAC ± 10 %, 50-60 Hz • 24-250 VDC ± 20 %
Approvals	UL, DNV
Marking	CE

PR 5714 relay with Pt100 sensor and staybolt		Cable length [m]	Material	Product number
	GrA3187 3607	20	N-version	96408953
		40		96408681
		60		96408954
		80		96408955
		100		96408956
		20	R-version	98085606
		40		98086123
		60		98086128
		80		98086146
		100		98086153

PR 5714 relay		Voltage	Product number
	GrA3186 0407	24-230 VAC, 50/60 Hz / 24-250 VDC	96913234

Pt100 sensor, including cable for standard-, N- and R-versions		Cable length [m]	Product number
	GrA3190 0407	20	96913237
		40	96913253
		60	96913256
		80	96913260
		100	96913263

Staybolt kits for Pt100		Description	Product number
	GrA3191 0407	Staybolt kit for Pt100/Pt1000. Material: EN 1.4401/AISI 316.	97550639
		Staybolt kit for Pt100. Material: EN 1.4539/AISI 90L.	96803373

Extension kit for sensor cable for Pt100		Description	Product number
	TM00 7885 2296	Extension kit for Pt100 sensor cable. For watertight shrink-joining of the sensor cable. Extra sensor cable must be ordered separately.	96571480

Sensor cable		Description	Product number
	TM00 7882 2296	Drop cable for extension: 4#1 mm^2 Mention length when ordering. Maximum recommended length: 350 m.	RM5271

CU 220 with Pt1000 sensor

The CU 220 with Pt1000 sensor offers these features:

- continuous monitoring of the motor temperature
- protection against too high motor temperature.

Protecting the motor against too high motor temperature is the simplest and cheapest way of avoiding that the motor life is reduced. The Pt1000 sensor ensures that the operating conditions are not exceeded and indicates when it is time for service of the motor.

Monitoring and protection by means of a Pt1000 require the following parts:

- Pt1000 sensor
- CU 220 control unit
- cable
- staybolt kit for Pt1000.

The following temperature limits are preset on delivery:

- 50 °C warning limit
- 60 °C stop limit.

The Pt1000 sensor works within the temperature range of -60 °C to +120 °C.

Technical data

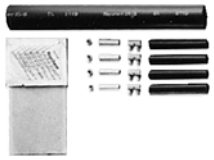
	CU 220
Enclosure class	IP65 (fitted in a control panel)
Ambient temperature	0 °C to +55 °C
Relative air humidity	20 to 80 % (condensating)
Voltage variation	1 x 230 V - 15 %/+ 10 %, 50 Hz
Approvals	UR
Marking	CE

CU 220 control unit with Pt1000 sensor, cable and staybolt or insertion probe		Cable length [m]	Material	Product number
	TM04 3561 4508 - TM04 3562 4508	20	N-version	96803207
		40		96803241
		60		96803254
		80		96803258
		100		96803301
	TM04 3563 4508 - TM04 3560 4508	20	R-version	98085486
		40		98085489
		60		98085579
		80		98085601
		100		98085602

CU 220 control unit		Voltage	Product number
	TM04 3561 4508	1 x 230 V - 15 %/+ 10 %, 50 Hz	96797484

Pt1000 sensor, including cable		Cable length [m]	Product number
	TM04 3563 4508	20	96804042
		40	96804044
		60	96804064
		80	96804065
		100	96804067

Staybolt kits for Pt1000		Description	Product number
	GrA3191 0407	Staybolt kit for Pt100/Pt1000. Material: EN 1.4401/AISI 316.	97550639
		Staybolt kit for Pt100/Pt1000. Material: EN 1.4539/AISI 904L.	96803373

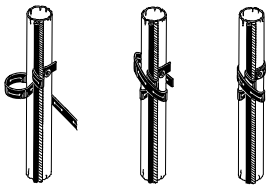
Extension kit for sensor cable for Pt1000		Description	Product number
	TM00 7885 2296	Extension kit for Pt100/Pt1000 sensor cable. For watertight shrink-joining of the sensor cable. Extra sensor cable must be ordered separately.	96571480

Sensor cable		Description	Product number
	TM00 7882 2296	Drop cable for extension: 4#1 mm^2 Mention length when ordering. Maximum recommended length: 350 m.	RM5271

Submersible drop cable

Product	Description	Number of leads and nominal cross-section [mm^2]	Outer cable diameter min./max. [mm]	Weight [kg/m]	Product number
 TM00 7882 2296	Suitable for these applications: • continuous application in groundwater and potable water (approved for potable-water applications) • connection of electrical equipment, such as submersible motors • installation depths up to 600 metres and average loads. Insulation and sheath of special EPR-based elastomer materials adapted to applications in water. Maximum permissible water temperature: 70 °C. Maximum permissible lead service temperature: 90 °C. Further cable sizes are available on request.	1 x 25	12.5 / 16.5	0.410	ID4072
		1 x 35	14.0 / 18.5	0.560	ID4073
		1 x 50	16.5 / 21.0	0.740	ID4074
		1 x 70	18.5 / 23.5	1.000	ID4075
		1 x 95	21.0 / 26.5	1.300	ID4076
		1 x 120	23.5 / 28.5	1.650	ID4077
		1 x 150	26.0 / 31.5	2.000	ID4078
		1 x 185	27.5 / 34.5	2.500	ID4079
		4G1.5	10.5 / 13.5	0.190	ID4063
		4G2.5	12.5 / 15.5	0.280	ID4064
		4G4.0	14.5 / 18.0	0.390	ID4065
		4G6.0	16.5 / 22.0	0.520	ID4066
		4G10	22.5 / 24.5	0.950	ID4067
		4G16	26.5 / 28.5	1.400	ID4068
		4G25	32.0 / 34.0	1.950	ID4069
		4G35	33.0 / 42.5	2.700	96432949
		4G50	38.0 / 48.5	3.600	96432950
		4G70	43.0 / 54.5	4.900	96432951

Cable clips

Product	Description	Product number
 TM00 1369 5092	For fastening of cable and straining wire to the riser pipe. The clips should be fitted every 3 metres. One set for approx. 45 m riser pipe. • 16 cable buttons. • 7.5 m rubber band.	115016

Cable termination kit, type KM

For instruction on how to make the cable termination between motor cable and drop cable, please see the KM quick guide available on www.grundfos.com (WebCAPS).

Possible cable termination		Content of kit	Motor cable [mm²]	Drop cable [mm²]	Number of leads	Product number
Motor cable	Drop cable					
			KM kits with pressed connections:			
			1.5 - 6	1.5 - 6	4	00116251
			6 - 16	6 - 16	4	00116252
			10 - 25	10 - 25	4	00116255
			KM kits with screw connectors:			
			6 - 35	6 - 35	4	96636867
			25 - 70	25 - 70	4	96636868

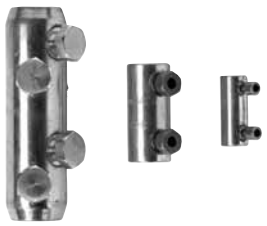
Possible cable termination		Content of kit	Motor cable [mm²]	Drop cable [mm²]	Number of leads	Product number
Motor cable	Drop cable					
			KM kits with pressed connections:			
			1.5 - 6	1.5 - 6	4	00116257
			6 - 16	6 - 16	4	00116258
			10 - 50	10 - 50	4	96637330
			16 - 70	16 - 70	4	96637332
			1.5 - 6	1.5 - 6	3	00116253
			10 - 25	10 - 25	3	00116254
			10 - 50	10 - 50	3	96637318
			16 - 70	16 - 70	3	96637331

Possible cable termination		Content of kit	Motor cable [mm²]	Drop cable [mm²]	Number of leads	Product number
Motor cable	Drop cable					
			KM kits with pressed connections:			
			10-70	10-70	1	96828296
			32-120	32-120	1	00116256
			KM kits with screw connectors:			
			70-240	70-240	1	96637279

Note: A KM termination kit for single leads only consist of material for one connection. When ordering, keep in mind how many kits are needed for a complete cable termination.

Cable termination kit, types M0 to M4

Product	Description	Version			Product number
		Type	Diameter of cable joint [mm]	Outer cable diameter [mm]	
 TM04 4981 2309	For watertight joining of motor cable and submersible drop cable. The joint is encapsulated by the glue which is part of the kit. **Note:** When ordering this cable termination kit, please notice that screw connectors are not included. For ordering suitable screw connectors, see table below.	M0	∅40	∅6 - ∅15	00ID8903
		M1	∅46	∅9 - ∅23	00ID8904
		M2	∅52	∅17 - ∅31	00ID8905
		M3	∅77	∅26 - ∅44	00ID8906
		M4	∅97	∅29 - ∅55	91070700

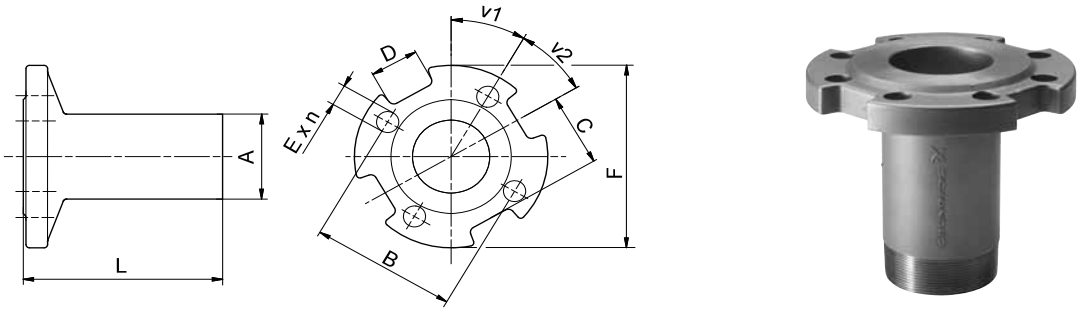
		Cross-section of leads [mm²]	Number of connectors	Product number
 GrA8251 2209	Accessories for cable kits M0 to M4. Screw connectors only.	6-25	4	96626021
		16-95		96626022
		35-185		96626023
		70-240		96626028

9. Mechanical accessories

Connecting pieces

The tables below show the range of connecting pieces for connection of thread-to-flange and thread-to-thread.

Thread-to-flange (standard flange to EN 1092-1)



TM01 2396 4508 - GrA2552 3706

Fig. 22 Dimensional sketch and photo of the connecting piece thread-to-flange

Type	Pump outlet	Connecting piece	Thread-to-flange									Product number	
			A	Dimensions [mm]						v1	v2	n	
				B	C	D	E	F	L				EN 1.4308	EN 1.4517
		R 2 1/2 → DN 50 PN 16/40	R 2 1/2	125	65	40	∅19	∅165	170	60	90	4	120125	120911
SP 17	Rp 2 1/2	R 2 1/2 → DN 65 PN 16/40	R 2 1/2	145	71	30	∅19	∅185	170	22.5	45	8	120126	120910
		R 2 1/2 → DN 80 PN 16/40	R 2 1/2	160	82.5	40	∅19	∅200	170	22.5	45	8	120127	120909
		R 3 → DN 65 PN 16/40	R3 3	145	71	30	∅19	∅185	170	22.5	45	8	130187	130920
SP 30	Rp 3	R 3 → DN 80 PN 16/40	R 3	160	82.5	40	∅19	∅200	170	22.5	45	8	130188	130921
		R 3 → DN 100 PN 16/40	R 3	180/190	100	40	∅19/∅23	Ø235	170	22.5	45	8	130189	130922
		R 3 → DN 65 PN 16/40	R 3	145	71	30	∅19	∅185	170	22.5	45	8	130187	130920
SP 46	Rp 3	R 3 → DN 80 PN 16/40	R 3	160	82.5	40	∅19	∅200	170	22.5	45	8	130188	130921
SP 60	Rp 4	R 3 → DN 100 PN 16/40	R 3	180/190	100	40	∅19/∅23	∅235	170	22.5	45	8	130189	130922
		R 4 → DN 100 PN 16/40	R 4	180/190	100	40	∅19/∅23	∅235	180	22.5	45	8	140071	140577
		R 5 → DN 100 PN 16/40	R 5	180/190	82	35	∅19/∅23	∅235	195	22.5	45	8	160148	160646
SP 77	Rp 5	R 5 → DN 125 PN 16/40	R 5	210/220	99	37	∅19/∅28	∅270	195	22.5	45	8	160149	160647
SP 95		R 5 → DN 150 PN 16/40	R 5	240/250	115	36	∅23/∅28	∅300	195	22.5	45	8	160150	160648
		R 6 → DN 125 PN 16/40	R 6	210/220	99	36	∅19/∅28	∅270	195	22.5	45	8	170159	170596
SP 125		R 6 → DN 150 PN 16/40	R 6	240/250	114	36	∅23/∅28	∅300	195	22.5	45	8	170160	170597
SP 160	Rp 6	R 6 → DN 200 PN 16	R 6	295	134	36	∅23	∅340	195	15	30	12	170161	170598
SP 215		R 6 → DN 200 PN 40	R 6	320	151	36	∅31	∅375	200	15	30	12	170162	170599

Thread-to-thread

TM01 2397 1698 - GrA2555 3706

Fig. 23 Dimensional sketch and photo of the connecting piece thread-to-thread

Type	Pump outlet	Connecting piece	Dimensions			Product number		
			Thread-to-thread		L [mm]			
			A	B		EN 1.4301	EN 1.4401	EN 1.4539
	Rp 5	R 5 → Rp 4	R 5	Rp 4	121	190063	190585	96917293
SP 77		R 5 → Rp 6	R 5	Rp 6	150	190069	190591	96917296
SP 95	5" NPT	5" NPT → 4" NPT	5" NPT	4" NPT	121	190064	190586	-
		5" NPT → 6" NPT	5" NPT	6" NPT	150	190070	190592	-
SP 125 **SP 160** **SP 215**	Rp 6	R 6 → Rp 5	R 6	Rp 5	150	200130	200640	200971
	6" NPT	6" NPT → 5" NPT	6" NPT	5" NPT	150	200135	200645	-

Zinc anodes

Cathodic protection by means of zinc can be used for corrosion protection of SP pumps in chloride-containing liquids, such as brackish water and seawater.

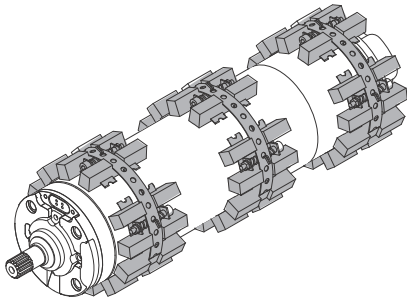
Chloride-containing liquids are very aggressive to stainless steel. Especially in stagnant liquids, stainless steel will be exposed to corrosive attack in the form of localised corrosion, such as pitting and crevice corrosion.

When sacrificial zinc anodes are fitted on the outside of the pump, the pump will be protected against corrosive attack. The size of the zinc anodes will be reduced over time. Therefore, the anodes must be replaced at regular intervals through-out the lifetime of the pump.

The zinc anodes can be used in the following cases:

- On Grundfos pumps made in N or R version.
- On Grundfos motors made in N or R version.
- Water containing more than 1500 ppm chloride at temperatures up to 35 °C.
- In liquids with pH value higher than 6.

Sacrificial anodes are placed on the outside of the pump and motor as protection against corrosion. See fig. 24.



TM05 9668 4313

Fig. 24 Submersible motor fitted with anode strings

The number of anodes required depends on the pump and motor in question.

More information about zinc anodes is available on request.

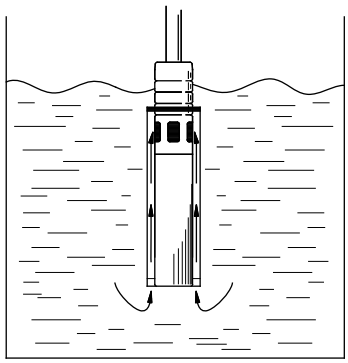
Flow sleeves

Grundfos offers a complete range of stainless-steel flow sleeves for both vertical and horizontal operation. Flow sleeves are recommended for all applications in which motor cooling is insufficient. The result is a general extension of motor life.

TM01 0751 2197 - TM01 0750 2197

Fig. 25 Flow sleeves

The flow sleeve is fitted to the submersible motor so that the liquid passes close by the motor on its way towards the pump suction interconnector thus ensuring optimum cooling of the motor. See fig. 26.



TM01 0509 1297

Fig. 26 Flow sleeve function

Flow sleeves are to be fitted in these cases:

- If the submersible pump is exposed to high thermal load such as current unbalance, dry running, overload, high ambient temperature and bad cooling conditions.
- If aggressive liquids are pumped, since corrosion is doubled for every 10 °C the temperature rises.
- If sedimentation or deposits occur around and/or on the motor.

More information about flow sleeves is available on request.

10. Cable Sizing

Cables

Grundfos offers submersible drop cables for all applications: 4-core cable, single leads.

Cables for Grundfos 4" submersible motors are available with or without plugs. The submersible drop cable is chosen according to application and type of installation.

Standard version:

Max. liquid temperature +70 °C, for short periods up to +90 °C.

Table indicating cable dimension in borehole

The table on page 47 indicate the maximum length of drop cables in metres from motor starter to pump at direct-on-line starting at different cable dimensions.

If star-delta starting is used, the current will be reduced by $\sqrt{3}$ (I x 0.58), meaning that the cable length may be $\sqrt{3}$ longer (L x 1.73) than indicated in the tables.

If, for example, the operating current is 10 % lower than the full-load current, the cable may be 10 % longer than indicated in the tables.

The calculation of the cable length is based on a maximum voltage drop of 1 % to 3 % of the rated voltage and a water temperature of maximum 30 °C.

In order to minimise operating losses, the cable cross-section may be increased compared to what is indicated in the tables. This is only economical if the borehole provides the necessary space, and if the operational time of the pump is long, especially if the operating voltage is below the rated voltage.

The table values are calculated on the basis of the formula:

Max. cable length of a single-phase submersible pump:

$$L = \frac{U \times \Delta U}{I \times 2 \times 100 \times (\cos\varphi \times \frac{\rho}{q} + \sin\varphi \times X_L)} \text{ [m]}$$

Max. cable length of a three-phase submersible pump:

$$L = \frac{U \times \Delta U}{I \times 1.73 \times 100 \times (\cos\varphi \times \frac{\rho}{q} + \sin\varphi \times X_L)} \text{ [m]}$$

Formula designations

U = Rated voltage [V]

ΔU = Voltage drop [%]

I = Rated current of the motor [A]

cos φ = Power factor

ρ = Specific resistance: 0.025 [Ω•mm^2]

q = Cross-section of submersible drop cable [mm^2]

sin φ = $\sqrt{1 - \cos^2\varphi}$

X_L = Inductive resistance: 0.078 x 10-3 [Ω/m].

Example

Motor size:	30 kW, MMS 8000
Starting method:	Direct on line
Rated voltage (U):	3 x 400 V, 50 Hz
Voltage drop (ΔU):	3 %
Rated current (I):	64.0 A
Power factor (cos φ):	0.85
Specific resistance (ρ):	0.025
Cross-section (q):	25 mm^2
sin φ:	0.54
Inductive resistance (X_L):	0.078 x 10^{-3} [Ω/m]

$$L = \frac{400 \times 3}{64.0 \times 1.73 \times 100 \times (0.85 \times \frac{0.025}{25} + 0.54 \times 0.078 \times 10^{-3})}$$

L = 120 m.

Cable dimensions at 3 x 400 V, 50 Hz, DOL

Voltage drop: 3 %

kW	I_n [A]	Cos φ 100 %	Dimensions [mm²]															
			1.5	2.5	4	6	10	16	25	35	50	70	95	120	150	185	240	300
5.5	13.6	0.77	40	66	105	157	258	407	622	850								
7.5	17.6	0.8	29	49	78	117	193	304	465	637	882							
9.2	21.8	0.81	23	39	62	93	154	243	372	510	706	950						
11	24.8	0.83		34	53	80	132	209	320	440	610	823						
13	30	0.81		28	45	68	112	176	270	370	513	690	893					
15	34	0.82			39	59	97	154	236	324	449	604	783	947				
18.5	42	0.81				48	80	126	193	265	366	493	638	770	914			
22	48	0.84				41	67	107	164	225	313	422	549	665	793	927		
26	57	0.84					57	90	138	189	263	355	462	560	667	781	937	
30	66.5	0.83					49	78	119	164	227	307	398	482	574	670	803	926
Max. current for cable [A]*			23	30	41	53	74	99	131	162	202	250	301	352	404	461	547	633

* At particularly favourable heat dissipation conditions. Maximum cable length in metres from motor starter to pump.

For motors with star-delta starting, the cable length can be calculated by multiplying the relevant cable length from the above table by $\sqrt{3}$.

Sizing of cable

Calculation of cable cross-section

Formula designations

U = Rated voltage [V]

ΔU = Voltage drop [%]

I = Rated current of the motor [A]

cos φ = Power factor

ρ = 1/χ
Materials of cable:
Copper: χ = 40 m/Ω x mm^2
Aluminium: χ = 35 m/Ω x mm^2

q = Cross-section [mm^2]

sin φ = $\sqrt{1 - \cos^2\varphi}$

X_L = Inductive resistance 0.078 x 10^{-3} [Ω/m]

L = Length of cable [m]

Δp = Power loss [W]

For calculation of the cross-section of the submersible drop cable, use this formula:

Direct on line

$$q = \frac{I \times 1.73 \times 100 \times L \times \rho \times \cos\varphi}{U \times \Delta U - (I \times 1.73 \times 100 \times L \times X_L \times \sin\varphi)}$$

Star-delta

$$q = \frac{I \times 100 \times L \times \rho \times \cos\varphi}{U \times \Delta U - (I \times 100 \times L \times X_L \times \sin\varphi)}$$

The values of the rated current (I) and the power factor (cos φ) can be read in the tables on pages 19 to 32.

Calculation of the power loss

For calculation of the power loss in the submersible drop cable, use this formula:

$$\Delta p = \frac{3 \times L \times \rho \times I^2}{q}$$

Example

Motor size:	45 kW, MMS 8000
Voltage:	3 x 400 V, 50 Hz
Starting method:	Direct on line
Rated current (I_n):	96.5 A
Required cable length (L):	200 m
Water temperature:	30 °C

Cable selection

Choice A: 3 x 150 mm^2

Choice B: 3 x 185 mm^2

Calculation of power loss

Choice A

$$\Delta p_A = \frac{3 \times L \times \rho \times I^2}{q}$$

$$\Delta p_A = \frac{3 \times 200 \times 0.02 \times 96.5^2}{150}$$

Δp_A = 745 W.

Choice B

$$\Delta p_B = \frac{3 \times 200 \times 0.02 \times 96.5^2}{185}$$

Δp_B = 604 W.

Savings

Operating hours/year: h = 4000.

Annual saving (A):

A = (Δp_A - Δp_B) x h = (745 W - 604 W) x 4000 = 564,000 Wh = 564 kWh.

By choosing the cable size 3 x 185 mm^2 instead of 3 x 150 mm^2, an annual saving of 564 kWh is achieved.

Operating time: 10 years.

Saving after 10 years (A_{10}):

A_{10} = A x 10 = 564 x 10 = 5640 kWh.

The saved amount must be calculated in the local currency.

11. Table of head losses

Head losses in ordinary water pipes

Upper figures indicate the velocity of water in m/sec.

Lower figures indicate head loss in metres per 100 metres of straight pipes.

Quantity of water			Head losses in ordinary water pipes											
			Nominal pipe diameter in inches and internal diameter in [mm]											
m^3/h	Litres/min.	Litres/sec.	1/2" 15.75	3/4" 21.25	1" 27.00	1 1/4" 35.75	1 1/2" 41.25	2" 52.50	2 1/2" 68.00	3" 80.25	3 1/2" 92.50	4" 105.0	5" 130.0	6" 155.5
0.6	10	0.16	0.855 9.910	0.470 2.407	0.292 0.784									
0.9	15	0.25	1.282 20.11	0.705 4.862	0.438 1.570	0.249 0.416								
1.2	20	0.33	1.710 33.53	0.940 8.035	0.584 2.588	0.331 0.677	0.249 0.346							
1.5	25	0.42	2.138 49.93	1.174 11.91	0.730 3.834	0.415 1.004	0.312 0.510							
1.8	30	0.50	2.565 69.34	1.409 16.50	0.876 5.277	0.498 1.379	0.374 0.700	0.231 0.223						
2.1	35	0.58	2.993 91.54	1.644 21.75	1.022 6.949	0.581 1.811	0.436 0.914	0.269 0.291						
2.4	40	0.67		1.879 27.66	1.168 8.820	0.664 2.290	0.499 1.160	0.308 0.368						
3.0	50	0.83		2.349 41.40	1.460 13.14	0.830 3.403	0.623 1.719	0.385 0.544	0.229 0.159					
3.6	60	1.00		2.819 57.74	1.751 18.28	0.996 4.718	0.748 2.375	0.462 0.751	0.275 0.218					
4.2	70	1.12		3.288 76.49	2.043 24.18	1.162 6.231	0.873 3.132	0.539 0.988	0.321 0.287	0.231 0.131				
4.8	80	1.33			2.335 30.87	1.328 7.940	0.997 3.988	0.616 1.254	0.367 0.363	0.263 6.164				
5.4	90	1.50			2.627 38.30	1.494 9.828	1.122 4.927	0.693 1.551	0.413 0.449	0.269 0.203				
6.0	100	1.67			2.919 46.49	1.660 11.90	1.247 5.972	0.770 1.875	0.459 0.542	0.329 0.244	0.248 0.124			
7.5	125	2.08			3.649 70.41	2.075 17.93	1.558 8.967	0.962 2.802	0.574 0.809	0.412 0.365	0.310 0.185	0.241 0.101		
9.0	150	2.50				2.490 25.11	1.870 12.53	1.154 3.903	0.668 1.124	0.494 0.506	0.372 0.256	0.289 0.140		
10.5	175	2.92				2.904 33.32	2.182 16.66	1.347 5.179	0.803 1.488	0.576 0.670	0.434 0.338	0.337 0.184		
12	200	3.33				3.319 42.75	2.493 21.36	1.539 6.624	0.918 1.901	0.659 0.855	0.496 0.431	0.385 0.234	0.251 0.084	
15	250	4.17				4.149 64.86	3.117 32.32	1.924 10.03	1.147 2.860	0.823 1.282	0.620 0.646	0.481 0.350	0.314 0.126	
18	300	5.00					3.740 45.52	2.309 14.04	1.377 4.009	0.988 1.792	0.744 0.903	0.577 0.488	0.377 0.175	0.263 0.074
24	400	6.67					4.987 78.17	3.078 24.04	1.836 6.828	1.317 3.053	0.992 1.530	0.770 0.829	0.502 0.294	0.351 0.124
30	500	8.33						3.848 36.71	2.295 10.40	1.647 4.622	1.240 2.315	0.962 1.254	0.628 0.445	0.439 0.187
36	600	10.0						4.618 51.84	2.753 14.62	1.976 6.505	1.488 3.261	1.155 1.757	0.753 0.623	0.526 0.260
42	700	11.7							3.212 19.52	2.306 8.693	1.736 4.356	1.347 2.345	0.879 0.831	0.614 0.347
48	800	13.3							3.671 25.20	2.635 11.18	1.984 5.582	1.540 3.009	1.005 1.066	0.702 0.445
54	900	15.0							4.130 31.51	2.964 13.97	2.232 6.983	1.732 3.762	1.130 1.328	0.790 0.555
60	1000	16.7							4.589 38.43	3.294 17.06	2.480 8.521	1.925 4.595	1.256 1.616	0.877 0.674
75	1250	20.8								4.117 26.10	3.100 13.00	2.406 7.010	1.570 2.458	1.097 1.027
90	1500	25.0								4.941 36.97	3.720 18.42	2.887 9.892	1.883 3.468	1.316 1.444
105	1750	29.2									4.340 24.76	3.368 13.30	2.197 4.665	1.535 1.934
120	2000	33.3									4.960 31.94	3.850 17.16	2.511 5.995	1.754 2.496
150	2500	41.7										4.812 26.26	3.139 9.216	2.193 3.807
180	3000	50.0											3.767 13.05	2.632 5.417
240	4000	66.7											5.023 22.72	3.509 8.926
300	5000	83.3												4.386 14.42
90 ° bends, slide valves			1.0	1.0	1.1	1.2	1.3	1.4	1.5	1.6	1.6	1.7	2.0	2.5
T-pieces, non-return valves			4.0	4.0	4.0	5.0	5.0	5.0	6.0	6.0	6.0	7.0	8.0	9.0

The table is calculated in accordance with H. Lang's new formula a = 0.02 and for a water temperature of 10 °C.
The head loss in bends, slide valves, T-pieces and non-return valves is equivalent to the metres of straight pipes stated in the last two lines of the table.
To find the head loss in foot valves, multiply the loss in T-pieces by two.

Head losses in plastic pipes

Upper figures indicate the velocity of water in m/sec.

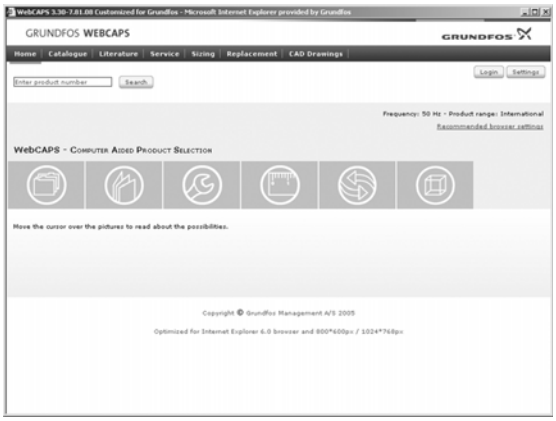
Lower figures indicate head loss in metres per 100 metres of straight pipes.

Quantity of water			PELM/PEH PN 10											
			PELM						PEH					
m^3/h	Litres/min.	Litres/sec.	25 20.4	32 26.2	40 32.6	50 40.8	63 51.4	75 61.4	90 73.6	110 90.0	125 102.2	140 114.6	160 130.8	180 147.2
0.6	10	0.16	0.49 1.8	0.30 0.66	0.19 0.27	0.12 0.085								
0.9	15	0.25	0.76 4.0	0.46 1.14	0.3 0.6	0.19 0.18	0.12 0.63							
1.2	20	0.33	1.0 6.4	0.61 2.2	0.39 0.9	0.25 0.28	0.16 0.11							
1.5	25	0.42	1.3 10.0	0.78 3.5	0.5 1.4	0.32 0.43	0.2 0.17	0.14 0.074						
1.8	30	0.50	1.53 13.0	0.93 4.6	0.6 1.9	0.38 0.57	0.24 0.22	0.17 0.092						
2.1	35	0.58	1.77 16.0	1.08 6.0	0.69 2.0	0.44 0.70	0.28 0.27	0.2 0.12						
2.4	40	0.67	2.05 22.0	1.24 7.5	0.80 3.3	0.51 0.93	0.32 0.35	0.23 0.16	0.16 0.063					
3.0	50	0.83	2.54 37.0	1.54 11.0	0.99 4.8	0.63 1.40	0.4 0.50	0.28 0.22	0.2 0.09					
3.6	60	1.00	3.06 43.0	1.85 15.0	1.2 6.5	0.76 1.90	0.48 0.70	0.34 0.32	0.24 0.13	0.16 0.050				
4.2	70	1.12	3.43 50.0	2.08 18.0	1.34 8.0	0.86 2.50	0.54 0.83	0.38 0.38	0.26 0.17	0.18 0.068				
4.8	80	1.33		2.47 25.0	1.59 10.5	1.02 3.00	0.64 1.20	0.45 0.50	0.31 0.22	0.2 0.084				
5.4	90	1.50		2.78 30.0	1.8 12.0	1.15 3.50	0.72 1.30	0.51 0.57	0.35 0.26	0.24 0.092	0.18 0.05			
6.0	100	1.67		3.1 39.0	2.0 16.0	1.28 4.6	0.8 1.80	0.56 0.73	0.39 0.30	0.26 0.12	0.2 0.07			
7.5	125	2.08		3.86 50.0	2.49 24.0	1.59 6.6	1.00 2.50	0.70 1.10	0.49 0.50	0.33 0.18	0.25 0.10	0.20 0.055		
9.0	150	2.50			3.00 33.0	1.91 8.6	1.20 3.5	0.84 1.40	0.59 0.63	0.39 0.24	0.30 0.13	0.24 0.075		
10.5	175	2.92			3.5 38.0	2.23 11.0	1.41 4.3	0.99 1.80	0.69 0.78	0.46 0.30	0.36 0.18	0.28 0.09		
12	200	3.33			3.99 50.0	2.55 14.0	1.60 5.5	1.12 2.40	0.78 1.0	0.52 0.40	0.41 0.22	0.32 0.12	0.25 0.065	
15	250	4.17				3.19 21.0	2.01 8.0	1.41 3.70	0.98 1.50	0.66 0.57	0.51 0.34	0.40 0.18	0.31 0.105	0.25 0.06
18	300	5.00				3.82 28.0	2.41 10.5	1.69 4.60	1.18 1.95	0.78 0.77	0.61 0.45	0.48 0.25	0.37 0.13	0.29 0.085
24	400	6.67					3.21 19.0	2.25 8.0	1.57 3.60	1.05 1.40	0.81 0.78	0.65 0.44	0.50 0.23	0.39 0.15
30	500	8.33					4.01 28.0	2.81 11.5	1.96 5.0	1.31 2.0	1.02 1.20	0.81 0.63	0.62 0.33	0.49 0.21
36	600	10.0					4.82 37.0	3.38 15.0	2.35 6.6	1.57 2.60	1.22 1.50	0.97 0.82	0.74 0.45	0.59 0.28
42	700	11.7					5.64 47.0	3.95 24.0	2.75 8.0	1.84 3.50	1.43 1.90	1.13 1.10	0.87 0.60	0.69 0.40
48	800	13.3						4.49 26.0	3.13 11.0	2.09 4.5	1.62 2.60	1.29 1.40	0.99 0.81	0.78 0.48
54	900	15.0						5.07 33.0	3.53 13.5	2.36 5.5	1.83 3.20	1.45 1.70	1.12 0.95	0.08 0.58
60	1000	16.7						5.64 40.0	3.93 16.0	2.63 6.7	2.04 3.90	1.62 2.2	1.24 1.2	0.96 0.75
75	1250	20.8							4.89 25.0	3.27 9.0	2.54 5.0	2.02 3.0	1.55 1.6	1.22 0.95
90	1500	25.0							5.88 33.0	3.93 13.0	3.05 8.0	2.42 4.1	1.86 2.3	1.47 1.40
105	1750	29.2							6.86 44.0	4.59 17.5	3.56 9.7	2.83 5.7	2.17 3.2	1.72 1.9
120	2000	33.3								5.23 23.0	4.06 13.0	3.23 7.0	2.48 4.0	1.96 2.4
150	2500	41.7								6.55 34.0	5.08 18.0	4.04 10.5	3.10 6.0	2.45 3.5
180	3000	50.0								7.86 45.0	6.1 27.0	4.85 14.0	3.72 7.6	2.94 4.4
240	4000	66.7									8.13 43.0	6.47 24.0	4.96 13.0	3.92 7.5
300	5000	83.3										8.08 33.0	6.2 18.0	4.89 11.0

The table is based on a nomogram.
Roughness: K = 0.01 mm.
Water temperature: t = 10 °C.

12. Further product information

WebCAPS

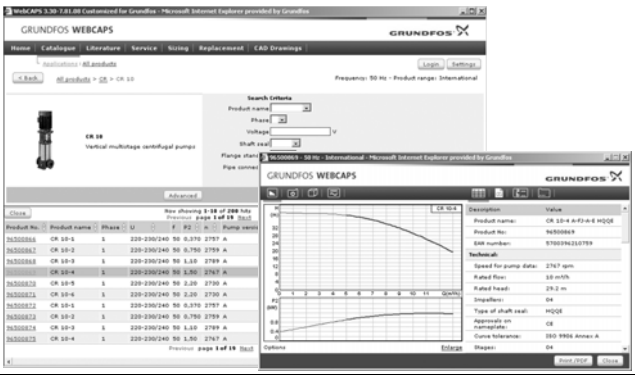


WebCAPS is a **Web**-based **C**omputer **A**ided **P**roduct **S**election program available on www.grundfos.com.

WebCAPS contains detailed information on more than 220,000 Grundfos products in more than 30 languages.

Information in WebCAPS is divided into six sections:

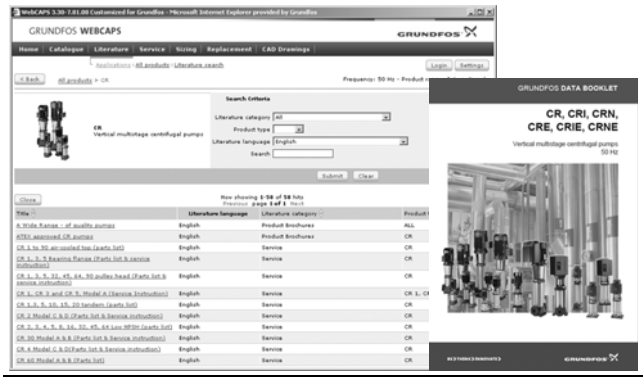
- Catalogue
- Literature
- Service
- Sizing
- Replacement
- CAD drawings.



Catalogue

Based on fields of application and pump types, this section contains the following:

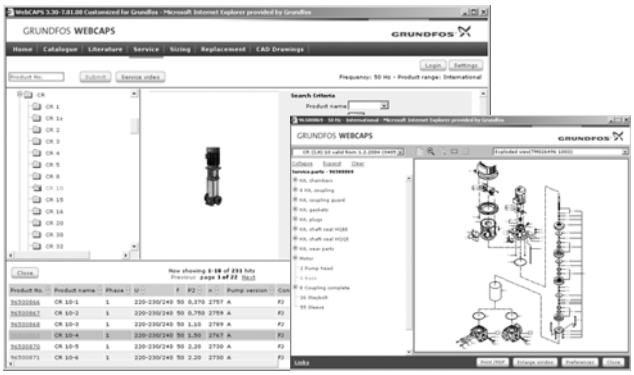
- technical data
- curves (QH, Eta, P1, P2, etc.) which can be adapted to the density and viscosity of the pumped liquid and show the number of pumps in operation
- product photos
- dimensional drawings
- wiring diagrams
- quotation texts, etc.



Literature

This section contains all the latest documents of a given pump, such as

- data booklets
- installation and operating instructions
- service documentation, such as Service kit catalogue and Service kit instructions
- quick guides
- product brochures.



Service

This section contains an easy-to-use interactive service catalogue. Here you can find and identify service parts of both existing and discontinued Grundfos pumps.
Furthermore, the section contains service videos showing you how to replace service parts.

Sizing

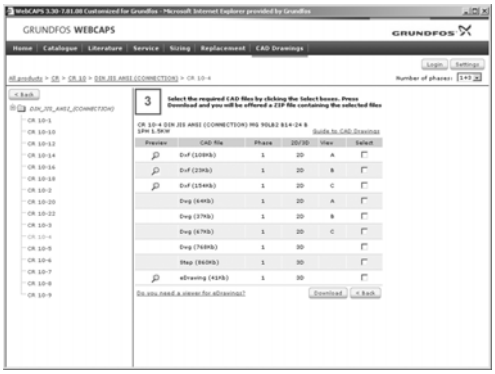
This section is based on different fields of application and installation examples and gives easy step-by-step instructions in how to size a product:

- Select the most suitable and efficient pump for your installation.
- Carry out advanced calculations based on energy, consumption, payback periods, load profiles, life cycle costs, etc.
- Analyse your selected pump via the built-in life cycle cost tool.
- Determine the flow velocity in wastewater applications, etc.

Replacement

In this section you find a guide to selecting and comparing replacement data of an installed pump in order to replace the pump with a more efficient Grundfos pump.
The section contains replacement data of a wide range of pumps produced by other manufacturers than Grundfos.

Based on an easy step-by-step guide, you can compare Grundfos pumps with the one you have installed on your site. When you have specified the installed pump, the guide will suggest a number of Grundfos pumps which can improve both comfort and efficiency.



CAD drawings

In this section, it is possible to download 2-dimensional (2D) and 3-dimensional (3D) CAD drawings of most Grundfos pumps.

These formats are available in WebCAPS:

2-dimensional drawings:

- .dxf, wireframe drawings
- .dwg, wireframe drawings.

3-dimensional drawings:

- .dwg, wireframe drawings (without surfaces)
- .stp, solid drawings (with surfaces)
- .eprt, E-drawings.

WinCAPS

Fig. 27 WinCAPS DVD

WinCAPS is a **Win**dows-based **C**omputer **A**ided **P**roduct **S**election program containing detailed information on more than 220,000 Grundfos products in more than 30 languages.

The program contains the same features and functions as WebCAPS, but is an ideal solution if no internet connection is available.

WinCAPS is available on DVD and updated once a year.

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