

MS6000

Submersible motors 50/60 Hz



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1. Product description

The Grundfos MS6000 product range is a complete range of asynchronous submersible motors 4 kW up to 30 kW in 50 and 60 Hz versions and synchronous submersible motors from 4 Kw to 45 kW in 3000 RPM and 3600 RPM versions.

The following 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 conforming to the NEMA standards, therefore, they can be fitted on all Grundfos SP pumps without adapters. The motors are also available with a flange extension allowing pump ends from other pump manufactures to be fitted.

General characteristics of the MS6000 motor:

- outside Diameter (OD): 6 in (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 with demineralised water
- built-in temperature transmitter (Tempcon) on the asynchronous motors.

The motor temperature can also be monitored via a Pt100 or Pt1000 sensor (used for frequency controlled installations).



GR-1015370

MS6000 motor without flange extension



GR-1015371

MS6000 motor with flange extension

Features and benefits

The Grundfos MS6000 standard asynchronous and MS6000P synchronous submersible motors offer 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. The motor efficiency of synchronous motors is approximately 10% higher than the efficiency of asynchronous motors.
- **Sealing system**
All motors are equipped with mechanical shaft seals.
- **High reliability**
State-of-the-art shaft seal design and materials offer high wear resistance, long operating life, improved sticking and dry-running capabilities.
- **Super stainless steel versions**
The super stainless steel version EN 1.4539 (AISI 904 L) with silicon carbide based (SiC/SiC) mechanical shaft sealing system and FKM rubber parts allow for application in seawater and slightly contaminated environment that might contain hydrocarbons.
- **Worldwide usage**
With different voltage and frequency combinations, the product range is available worldwide.
- **Highly reliable thrust bearing**
Fitted with sturdy Michell thrust bearing, the motors offer highly reliable operation.
- **Monitoring of motor temperature**
To achieve maximum protection of the motor against burnout, the asynchronous motor is available with a built-in Tempcon temperature sensor with power-line communication. In combination with motor protection (MP204), the sensor offers optimal protection of the motor.
This type of temperature monitoring can only be used for asynchronous motors, it is not available for use with a VFD.
- **Additional monitoring of motor temperature**
As over-temperature protection, a Pt100 or Pt1000 sensor can be connected to the MS6000 motor to monitor the temperature. This solution is used in combination with frequency-controlled motors, including MS6000P.

Applications

Grundfos MS6000 and MS6000P submersible motors are designed for a wide range of applications such as the following:

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

Application variants

The MS6000 asynchronous submersible motor is available in a wide range of variants for different applications:

- **MS6000T40**
For operation in normal groundwater with temperatures up to 40 °C. Elastomer is NBR.
- **MS6000XT40**
For operation in normal groundwater with temperatures up to 40 °C. The motor is without Tempcon sensor. Elastomer is NBR.
- **MS6000WT40**
For applications where horizontal operation is common and turbine operation may occur. The motor has tungsten carbide/SiC bearings. Elastomer is NBR.
- **MS6000REST40**
For operation in aggressive liquids with abrasive particles. Elastomer is FKM.
- **MS6000RESWT40**
For operation in aggressive liquids with abrasive particles in applications where horizontal operation is common and turbine operation may occur. Elastomer is FKM.
- **MS6000RESDT40**
For applications where a high degree of process control is required, for example, in chip manufacturing. The motor is factory-filled with demineralised water. Elastomer is FKM.
- **MS6000EST40**
For operation in neutral liquids with low content of hydrocarbons and dissolved gasses. Elastomer is FKM.
- **MS6000QFT40**
For operation in normal groundwater with temperatures up to 40 °C. The motor contains a SiC/SiC shaft seal with nitrile rubber (NBR) parts, therefore, it is approved for drinking water. Furthermore, it is mounted with an extension flange for the US market. Elastomer is NBR.
- **MS6000T60**
For operation in normal groundwater with temperatures up to 60 °C. Elastomer is NBR.

- MS6000ET60
For operation in neutral liquids with low content of hydrocarbons and dissolved gasses. Elastomer is FKM.
- MS6000QXT60
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. The motor contains a SiC/SiC shaft seal with nitrile rubber (NBR) parts, therefore, it is approved for drinking water. The motor is without Tempcon sensor. Elastomer is FKM.
- MS6000QXFT60
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. The motor contains a SiC/SiC shaft seal with nitrile rubber (NBR), therefore, it is approved for drinking water. Furthermore, it is mounted with an extension flange for the US market. The motor is without Tempcon sensor. Elastomer is FKM.
- MS6000REST60
For operation in aggressive liquids with temperatures up to 60 °C. Elastomer is FKM.
- MS6000RESXT60
For operation in aggressive liquids with temperatures up to 60 °C. The motor is without Tempcon sensor. Elastomer is FKM.
- 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. Elastomer is FKM.

The MS6000 P synchronous submersible motor is available in a wide range of variants for different applications:

- MS6000PQXT60
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. The motor contains a SiC/SiC shaft seal with nitrile rubber (NBR) parts, therefore, it is approved for drinking water. The motor is without Tempcon sensor. Elastomer is FKM.
- MS6000PQXFT60
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. The motor contains a SiC/SiC shaft seal with nitrile rubber (NBR), therefore, it is approved for drinking water. Furthermore, it is mounted with an extension flange for the US market. The motor is without Tempcon sensor. Elastomer is FKM.
- MS6000PRESXT60
For operation in aggressive liquids with temperatures up to 60 °C. The motor is without Tempcon sensor. Elastomer is FKM.

2. Identification

Type key

Example	MS6000	R	E	S	W	D	F	X	T40	3 x 400/50 460/60	SD	18.5 kW
Pos.	1	2	3	4	5	6	7	8	9	10	11	12

Pos.	Description
1	Motor type
-	= MS6000 asynchronous motor
P	= MS6000P synchronous motor
2	Material type
-	= EN 1.4301
R	= EN 1.4539
3	Rubber
-	= NBR
E	= FKM
4	Shaft seal
-	= Ceramic/carbon BXPFF/NBR
S	= SiC/SiC Q1Q1VFF/FKM
Q	= SiC/SiC Q1Q1PFF/NBR
5	Radial bearings
-	= Ceramic/hard metal
W	= SiC/Tungsten carbide
6	Motor liquid
-	= SML-3
D	= Demineralised water
H	= Glycol 60 vol % HTF
7	Flange extension
-	= Without
F	= With
8	Tempcon
-	= With
X	= Without
9	Max. liquid temperature
T40	= 40 °C
T60	= 60 °C
10	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
3x350/100 410/120	= 3 x 350 V, 100 Hz 3 x 410 V, 120 Hz

11	Method of starting	
	-	= DOL
	SD	= SD
12	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
	37 kW	50 hp
	45 kW	60 hp

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

3. Operating conditions

Pumped liquid

For usage in different liquids, the MS6000 and MS6000P motors are produced of the following material versions:

- MS6000 or MS6000P made of stainless steel EN 1.4301 - for use in groundwater
- MS6000 RE or MS6000P RESXT60 made of stainless steel EN 1.4539 with rubber parts made of FKM - for use in aggressive and slightly contaminated liquids.

If in doubt, analyse the liquid and contact Grundfos.

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

Ambient pressure

Maximum ambient pressure: 60 bar ~ 6.0 MPa.

Grundfos does not recommend that you operate the motor in a vacuum. If it cannot be avoided, contact Grundfos.

Cooling

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

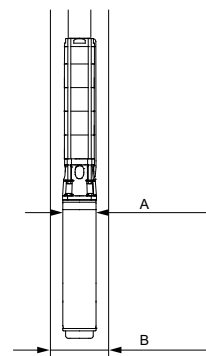
Motor	Installation	
	Flow past the motor	Vertical and Horizontal
MS6000 (T40 versions)	0.15 m/s (0.5 ft/s)	40 °C (~ 104 °F)
MS6000P	0.15 m/s (0.5 ft/s)	60 °C (~ 140 °F)
MS6000 (T60 versions)	1 m/s (3.3 ft/s)	60 °C (~ 140 °F)

Calculation of the flow velocity

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

Legend

v	flow velocity past the motor [m/s]
Q	rated flow [m³/h]
353	constant
D_{borehole}^2	internal borehole diameter [mm]
d_{motor}^2	outer motor diameter [mm]



TM022269

Diameter of motor and borehole

A = d_{motor}
B = D_{borehole}

Example

Water temperature	40 °C
Q	40 m³/h
d_{motor}^2	138 mm (6")
D_{borehole}^2	203 mm (8")

Calculation of the flow velocity past the motor:

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

$$v = 0.64 \quad [\text{m/s}]$$

Recommendations for optimal cooling

It is recommended that you install the motor above the well screen to achieve proper motor cooling.

If the stated liquid velocity cannot be achieved, a flow sleeve must be installed.

If there is a risk of sediment buildup, such as sand, around the motor, a flow sleeve should be used to ensure proper cooling of the motor. If a flow sleeve is used, the motor can be placed in the well screen.

Frequency of starts and stops

The motor is designed for continuous operation, S1 duty.

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.

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

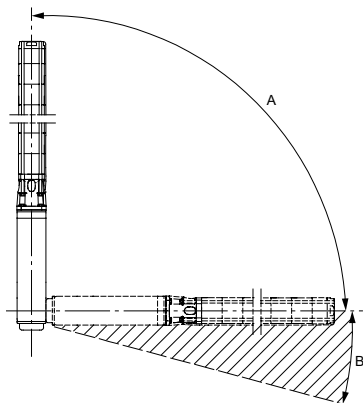
4. Installation

Mechanical installation

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

Horizontal installation

If the motor is installed horizontally, the shaft end must not fall below the horizontal level, and the use of a flow sleeve is recommended.



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Positional requirements

A = Allowed
B = Not allowed

Vertical installation

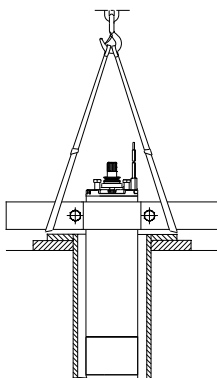
Installation depth below water level

Maximum installation depth allowed: 600 m.

Fitting the motor to the pump

Follow the steps below to fit the motor to the pump:

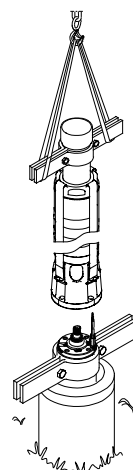
1. Use pipe clamps when handling the motor.
2. Place the motor in vertical position at the wellhead seal, as illustrated in fig. Motor in vertical position.



TM060536

Motor in vertical position

3. Lift the pump part with pipe clamps fitted to the extension pipe, as illustrated in fig. Lifting the pump into position.



TM060544

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

Lowering the motor

1. Before lowering the motor, check the borehole with an inside calliper to ensure unobstructed passage.
2. Carefully lower the motor into the borehole so as not to damage the motor cable or the submersible drop cable.
Caution: Do not lower or lift the motor by the motor cable!

Electrical installation

Electrical installation must comply with local legislation.

Supply requirements

The MS6000 asynchronous motor has the following requirements regarding the rated voltage stamped on the motor:

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

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

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

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

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

Determining direction of rotation

Once the motor is connected to the electricity supply, confirm that the direction of rotation is correct.

1. Start the motor for a short period and check the direction of rotation by watching the motor shaft.
2. Confirm that the direction of rotation corresponds to the demand of the pump.
3. Interchange two of the phase connections if 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 counterclockwise as seen from the shaft end.



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

Frequency converter operation MS6000 asynchronous motor

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.

If the motor is operated via a frequency converter, it will cause a fuse in the temperature transmitter (Tempcon) to melt. The fuse cannot be replaced and the temperature of the motor cannot be monitored via the built-in Tempcon temperature sensor and the MP 204 motor protection unit.

To monitor motor temperature, Grundfos recommends that you install a Pt100 or Pt1000 sensor together with a PR 5714 relay.

The rated frequency must not be exceeded!

The permissible frequency ranges are the following:

- 30-50 Hz
- 30-60 Hz.

At reduced frequency, the flow past the motor decreases, thus cooling efficiency is also reduced. It is therefore important never to decrease the frequency (and thus the pump speed and the flow), as there must be a sufficient flow of pumped liquid past the motor. The motor must cut out if the pump stops pumping water. For the minimum permissible flow, see the table on page 7.

Ramp times:

Start and stop ramps must not exceed 3 seconds for 0-30 Hz and 30-0 Hz.

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 diminished by installing an LC filter or a sinus filter between the frequency converter and the motor.

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

Frequency converter operation MS6000P synchronous motor

The motor needs to be connected to a frequency converter that is able to handle IPM type synchronous motors.

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 at given output. To monitor motor temperature, Grundfos recommends that you install a Pt100 or Pt1000 sensor in the motor.

The rated frequency must not be exceeded.

The permissible frequency ranges are the following:

- 55-100 Hz
- 55-120 Hz.

At reduced frequency, the flow past the motor decreases, thus cooling efficiency is also reduced. It is therefore important never to decrease the frequency (and thus the pump speed and the flow), as there must be a sufficient flow of pumped liquid past the motor. The minimum permissible flow is 0.15 m/s. The motor must cut out if the pump stops pumping water.

Ramp times:

Start and stop ramps must not exceed 3 seconds for 0-55 Hz and 55-0 Hz.

Using variable frequency drives of other brands

The following parameters are relevant when using variable frequency drives of other brands

Data for 3 x 350V/100 Hz, 3 x 410V/120 Hz motor voltage

	Power range [kW]			
	7.5	18.5	30	45
PM back EMF at 100 Hz [V]	266	206	270	246
PM back EMF at 120 Hz [V]	320	312	324	295
PM d-axis inductance (Ld) [mH]	11	4.6	3.4	2.1
PM q-axis inductance (Lq) [mH]	26.4	11.7	8.0	4.7
PM type designation	IPM			
Number of poles	4			

Sine wave filter

The MS6000P synchronous motor is designed for the use of a sine wave filter between the VFD and the motor.

Output filter requirements

Motor type	Max Upeak voltage	Max. dU/dt
MS6000	850 V phase-phase	2000 V/μs
MS6000P	850 V phase-phase	2000 V/μs

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

Soft starter for MS6000 asynchronous motor

Grundfos recommends that you only use soft starters with a bypass switch, controlling the voltage on all three phases.

Ramp times:

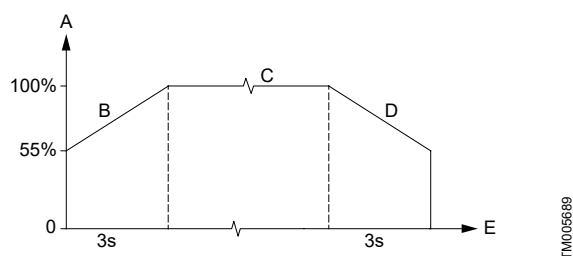
- Ramp-up time (to reach the voltage stated on the nameplate): 3 seconds.
- Ramp-down time: 3 seconds.

Complying with ramp-up and ramp-down times prevents unnecessary heating of the motor.

Soft starter with bypass switch

Soft starters with bypass switch only operate during ramp-up and ramp-down. This reduces the load on the soft starter as well as the energy consumption.

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



Soft starter

A = [V]
B = Start
C = Operation
D = Stop
E = Time [s]

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, contact your soft starter supplier or Grundfos.

Service factor (60 Hz and 120 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. For example, a motor with a rated power of 10 hp and a SF of 1.15 is designed to provide 11.5 hp under continuous load. Grundfos submersible motors are designed to run continuously at a service factor load. SF is stated on the nameplate.

5. Construction

Material specification

Pos.	Description				
		MS6000XT40 MS6000T40 MS6000T60 MS6000WT40	MS6000QFT40 MS6000ET60 MS6000EST60 MS6000QXT60 MS6000QFXT60 MS6000PQXT60 MS6000PQFXT60	MS6000REST40 MS6000RESDT40 MS6000REST60 MS6000RESWT40 MS6000RESWT60 MS6000RESXT60 MS6000PRESXT60	
27	Sand shield	EN 1.4301 ¹ NBR ¹	-	-	
27a	Spacer for sand shield	SS 316 ¹	-	-	
25a	Flange extension	SS 304 H* ¹	-	-	
22	Screw	SS 316 ¹	-	-	
21	Washer	EN 1.4162 ¹	-	-	
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 NBR	EN 1.4301 NBR	EN 1.4539 FKM	
22	Screw	A4	A4	EN 1.4539	
22a	Screw and washer	A4 PA66	A4 PA66	EN 1.4539 PA66	
50	Screw	A4	A4	EN 1.4539	
33	Shaft seal stationary	Ceramic	SIC	SIC	
34	Shaft seal rotating	Carbon NBR	SIC NBR	SIC FKM	
28	Washer	EN 1.4301	EN 1.4301	EN 1.4301	
1a	Valve	EN 1.4435 NBR	EN 1.4435 NBR	- -	
5	Bearing DE	bearing retainer	EN 1.4308	EN 1.4308	EN 1.4308
		stationary bush ²	Carbon graphite	Carbon graphite	-
		stationary bush ³	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 ²	EN 1.4057	EN 1.4057	EN 1.4057
		bearing bush ³	WC 74 % Cr 20 % Ni 6 %	-	WC.74 % Cr 20 % Ni 6 %
		rotor cladding ⁴	Hastelloy C4	Hastelloy C4	Hastelloy C4
1	Stator housing	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 ²	Carbon graphite	Carbon graphite	-
		stationary bush ³	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

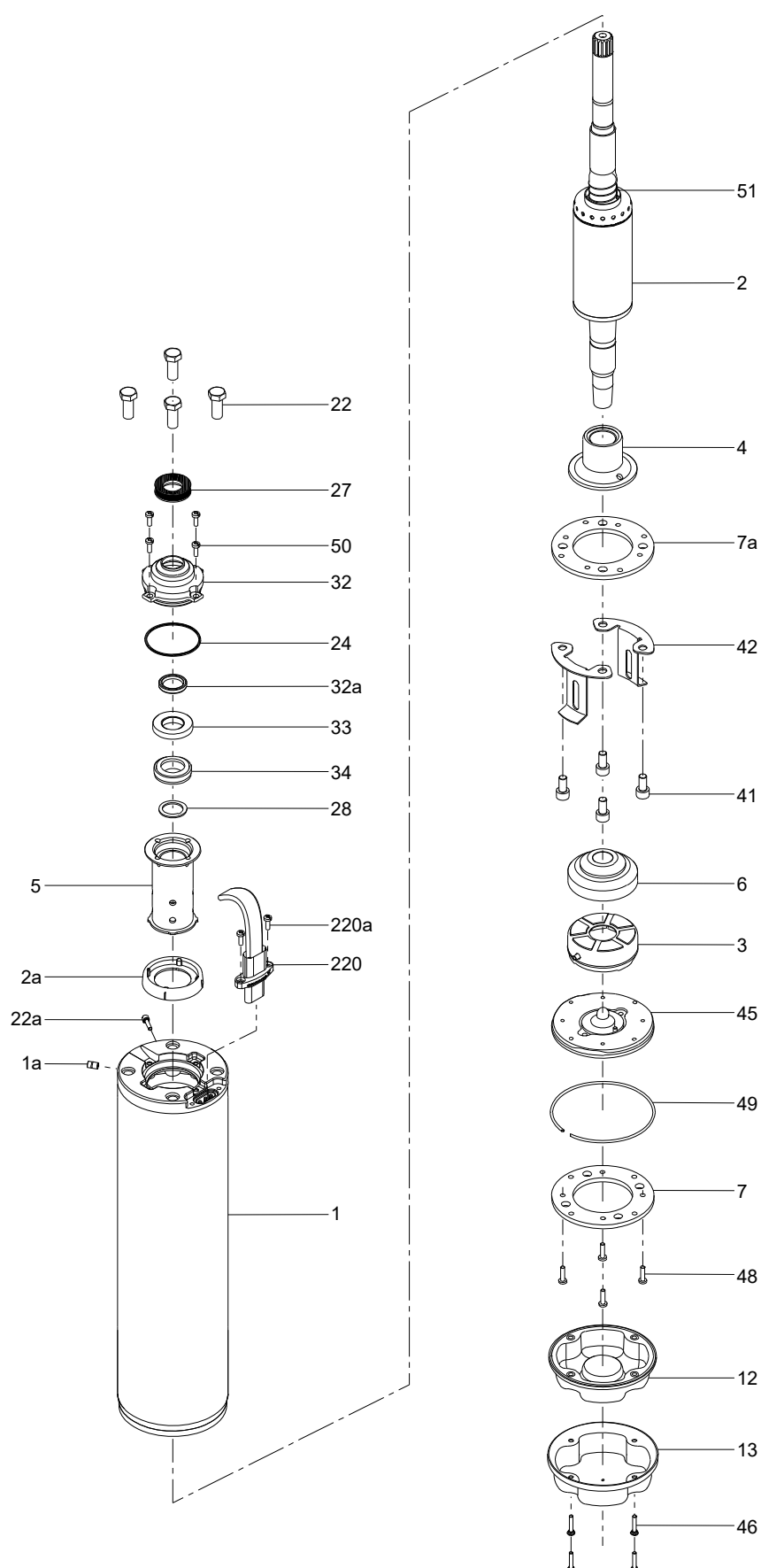
¹ Motor with flange extension

² Motor with soft radial bearing (stainless steel/carbon graphite)

³ Motor with hard radial bearing (tungsten carbide/SiC)

⁴ MS6000P synchronous motor only

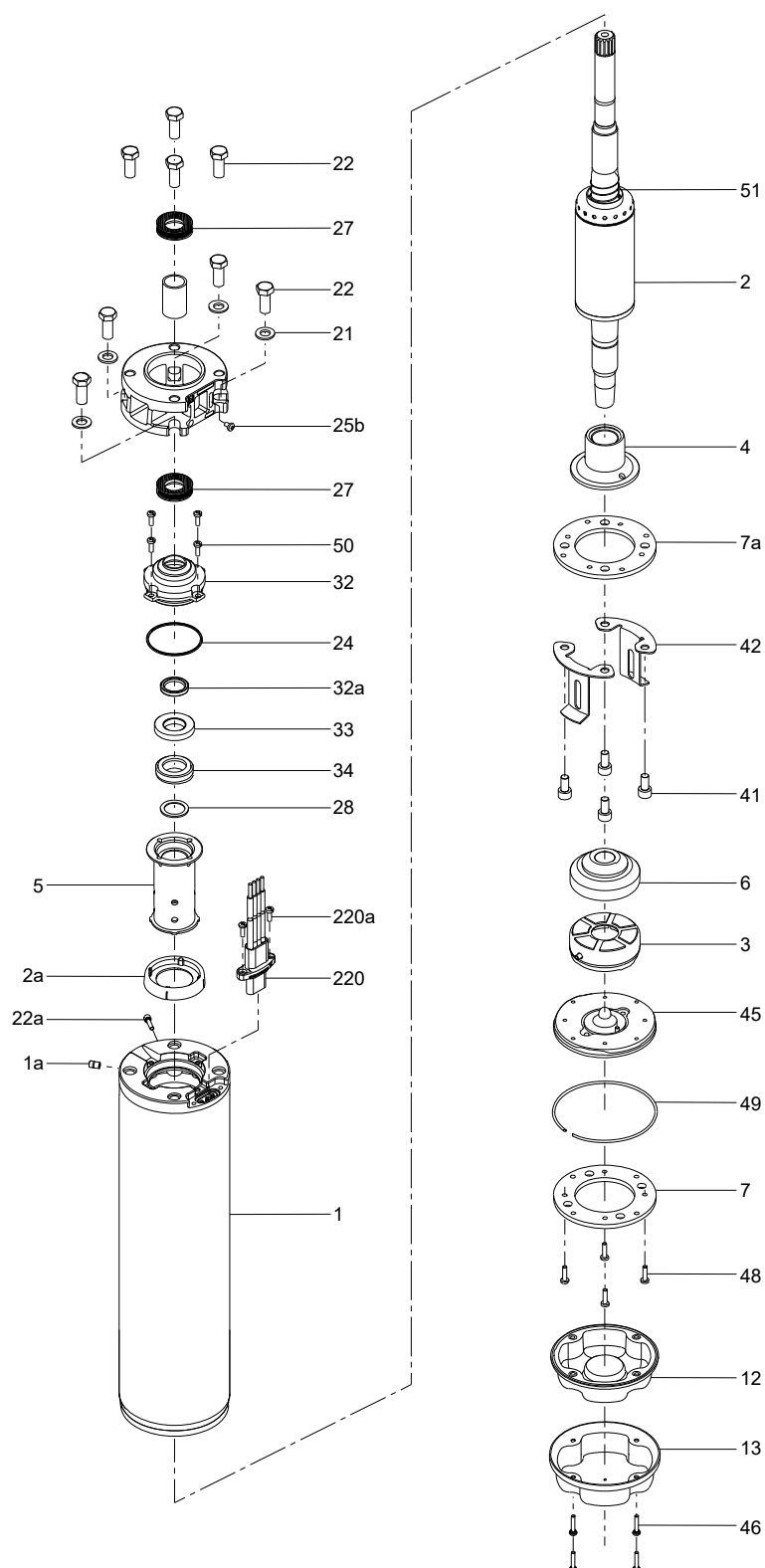
Exploded drawing of MS6000



TM060554

Exploded drawing of the MS6000 motor

Exploded drawing of MS6000 (with flange extension)



TM060555

Exploded drawing of the MS6000

Description of construction

The MS6000 motor is a 2-pole, asynchronous squirrel-cage submersible motor.

The MS6000P motor is a 4-pole, synchronous squirrel-cage, internal-permanent-magnet-type 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 through a special motor cable approved for usage in drinking water.

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

Motors for star-delta starting, and two-plug motor versions are fitted with two cables displaced by 90°.

- CE marked motors are equipped with a 6 mm² or 10 mm² flat blue jacketed motor cable.
- cCSAus marked motors are equipped with four single leads XLPE AWG8.

Motor D-end connection

The motor has standardised D-end according to NEMA standard MG1-18.413, with four pieces of 1/2-20 UNF machine screws for mounting of the pump.

Shaft

The stainless steel, splined shaft end fulfills ANSI B92.1, 1970, class 5. The motor has a 15-teeth module. The pressure angle is 30°.

Shaft seal

The MS6000 asynchronous motor is fitted with a standard mechanical shaft seal made of ceramic against carbon graphite for good dry-running capabilities, and optionally SiC/SiC faces for abrasive conditions.

The shaft seal is available for different applications in the following variants:

- 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).

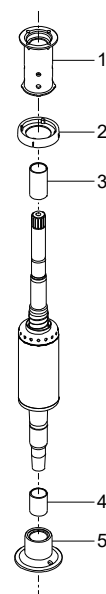
The MS6000P synchronous motor is fitted with a standard mechanical shaft seal of silicon carbide against silicon carbide with NBR rubber parts (approved for drinking water).

MS6000P R-version is available with 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 the bottom. The radial bearings are available in soft or hard versions.

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



TMD59626

Bottom and top radial bearings

1 =	Bearing retainer (DE) EN 1.4308
2 =	Upthrust ring
3 =	Bearing bush
4 =	Bearing bush
5 =	Bearing retainer (NDE) EN 1.0335

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 is stopped by the upper radial bearing retainer as seen in figure Bottom and top radial bearings.

Rotor

The MS6000 asynchronous rotor is a squirrel-cage copper rotor interference-fitted on the shaft.

The MS6000P synchronous rotor is a rotor with internal permanent magnets interference-fitted on the shaft.

At both rotor types, the upper short-circuit ring is equipped with a small impeller, ensuring internal circulation of liquid in the rotor chamber, thus providing optimum lubrication.

Stator

The stator is hermetically encapsulated in stainless steel, and the windings are embedded in polymer compound. This results in high mechanical stability and

optimal cooling, and eliminates the risk of short circuits in the windings caused by condensing water. MS6000 is a 2-pole, while MS6000P is a 4-pole winding.

Thrust bearing

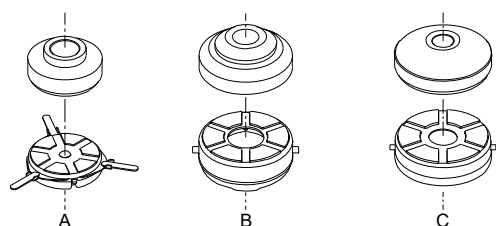
The thrust bearing is Michell type, a very simple and highly efficient bearing. It fulfills the requirements specified in the NEMA standards.

The thrust bearing consists of the following parts:

- a ceramic rotating part with precision-ground and polished sliding surface for optimum surface finish
- a stationary part which has six movable, specially ground carbon shoes for all sizes. It can be positioned so that all tolerances are absorbed, thus the bearing achieves optimal thrust capacity and minimum friction.

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

The thrust bearings are available in three sizes, depending on the pump load and the temperature of the pumped liquid. These bearings are dimensioned for axial load rated to 7.5, 27 and 40 kN, as seen on the figure Thrust bearings.



TM059625

Thrust bearings

A = 7.5 kN

B = 27 kN

C = 40 kN

Motor type	Motor power [kW (hp)]		Size of thrust bearing [kN]
	Min.	Max.	
MS6000T40	5.5 (7.5)	7.5 (10)	7.5
	9.2 (15)	30 (40)	27
MS6000T60	5.5 (7.5)	7.5 (10)	27
	9.2 (15)	22 (25)	40
MS6000PT60	4.0 (5.5)	7.5 (10)	7.5
	9.2 (15)	18.5 (25)	27
	22 (30)	30 (40)	27
	37 (20)	45 (60)	40

The motor can always be upgraded with a larger thrust bearing, as stated in the table above, but it must not be downgraded with a smaller thrust bearing.

Diaphragm

The rubber diaphragm fitted between the stator and the motor end shield is dimensioned to equalize volume variations caused by the temperature rise resulting from intermittent operation.

Motor liquid

For MS6000 motors, SML-3 motor liquid is used, containing monopropylene glycol which is frost-proof down to -20 °C.

The motor liquid also contains anti-corrosive and lubricating additives.

For some applications, monopropylene glycol-containing motor liquid must not be used. In such case, the motor can be filled with clean tap water.

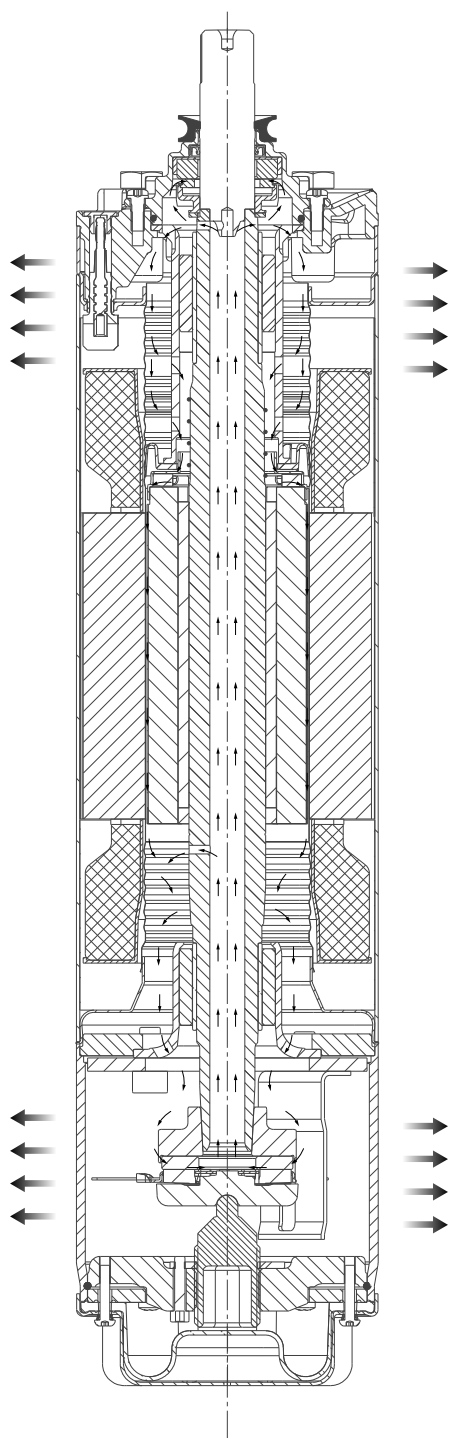
The table below lists the freezing points according to the percentage of Monopropylene Glycol (MPG) content of the motor liquid.

MPG content of the motor liquid [%]	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 transport heat via the motor liquid from the rotor and bearings to the outer surface of the motor.

The temperature of the pumped liquid and its flow velocity past the motor are essential to the life-span of the motor. See cooling requirements in the Operating conditions.

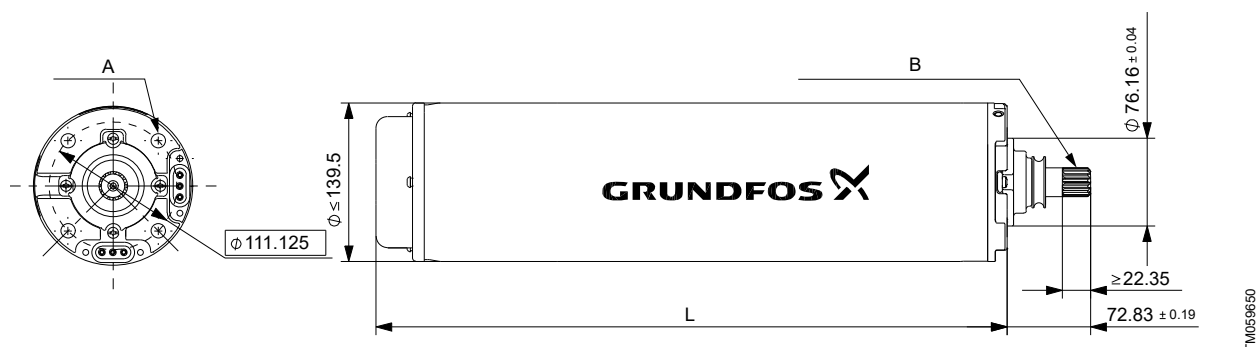


Liquid circulation inside the motor

TM060511

6. Technical data

Dimensional drawings



Dimensional drawing of MS6000 and MS6000P

A = 1/2-20UNF

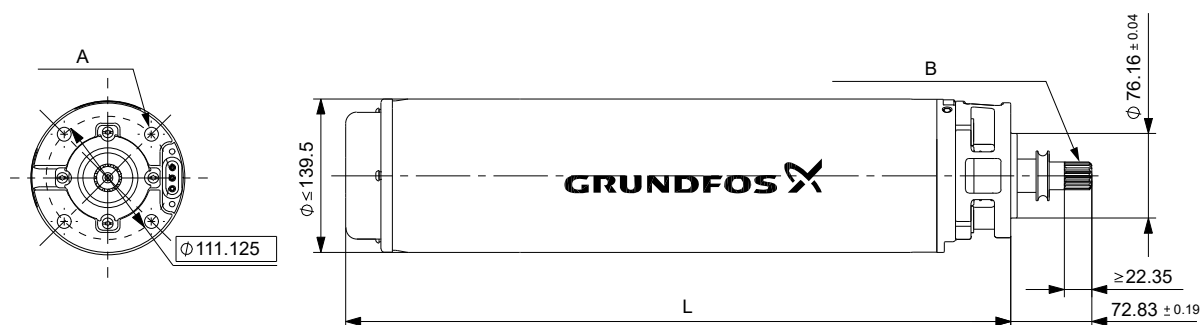
B = Spline 15x16/32 ANSI B92.

MS6000

Motor power, P ₂ [kW]	L [mm]		Weight [kg]		Shipping volume [m ³]	
	T40	T60	T40	T60	T40	T60
5.5	547	607	34.0	43.0	0.012	0.013
7.5	577	637	37.0	46.0	0.013	0.014
9.2	607	667	43.0	49.0	0.013	0.015
11	637	702	46.0	53.0	0.014	0.015
13	667	757	49.0	57.5	0.015	0.017
15	702	817	53.0	64.5	0.015	0.017
18.5	757	877	57.5	70.5	0.017	0.018
22	817	947	64.5	78.0	0.017	0.020
26	877	-	70.5	-	0.018	-
30	947	-	78.0	-	0.020	-

MS6000P

Motor power, P ₂ [kW]	L [mm]	Weight [kg]	Shipping volume [m ³]
	T60		
4			
5.5	547	32.9	0.012
7.5			
9.2			
11			
13	667	46.3	0.015
15			
18.5			
22			
26	817	61.3	0.017
30			
37			
45	947	76.2	0.020



TM059651

Dimensional drawing of MS6000 and MS6000P with flange extension

A = 1/2-20UNF

B = Spline 15x16/32 ANSI B92.

MS6000three-phase

Motor power, P_2 [hp]	L [mm]		Weight [kg]		Shipping volume [m ³]	
	T40	T60	T40	T60	T40	T60
5	597	627	36.5	39.5	0.013	0.014
7.5	597	687	36.5	48.5	0.013	0.015
10	627	752	39.5	55.5	0.014	0.015
15	687	807	48.5	60.0	0.015	0.017
20	752	867	55.5	67.0	0.015	0.017
25	807	997	60.0	80.5	0.017	0.020
30	867	-	67.0	-	0.017	-
40	997	-	80.5	-	0.020	-

MS6000single-phase

Motor power, P_2 [hp]	L [m]	Weight [kg]	Shipping volume [m ³]
	T40		
5	627	39.5	0.014
7.5	687	48.5	0.015
10	752	55.5	0.015
15	807	60.0	0.017

MS6000P

Motor power, P_2 [hp]	L [mm]	Weight [kg]	Shipping volume [m ³]
	T60		
5	597	37.0	0.013
7.5			
10			
12.5			
15	717	49.0	0.014
18			
20			
25			
30	867	64.0	0.017
35			
40			
50			
50	997	76.2	0.020

Motor cables

The MS6000 asynchronous motors are available with four types of motor cables, depending 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
3 x 1 G 8 AWG single XLPE (Booster applications)	

Motor	50 Hz		3 x 2220-230 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	-

The MS6000P synchronous motors are available with four types of motor cables, depending 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
3 x 1 G 8 AWG single XLPE (Booster applications)	

Motor power, P ₂ [kW]	3 x 350 V 3000RPM (100 Hz)	
	Designation	Number of cables
4		
5.5		
7.5		
9.2	6	1
11		
13		
15		
18.5		
22	10	1
26		
30		
37	10	2
45		

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 and MS6000P	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 and MS6000P for booster applications	5	-	-	-	96164225
	8	-	-	-	96164226
MS6000R and MS6000PR	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 and MS6000PR for booster applications	5	-	-	-	96300133
	8	-	-	-	96300134

The sizing of the motor cable requires that it is submerged in water. For longer cables and cable connection for extension, please see Electrical accessories.

7. Electrical data

Overview

MS6000 asynchronous motor

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	-	CE	
	3 x 440-460-480 V, 60 Hz		1.15		
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	SD	1.00	CE	Japan
	3 x 200-220 V, 60 Hz				
64	3 x 400 V, 50 Hz	DOL	1.00	CE	Japan
	3 x 400-440 V, 60 Hz				
	3 x 400 V, 50 Hz	SD	1.00	CE	Japan
	3 x 400-440 V, 60 Hz				
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	

MS6000P synchronous motor

Voltage code	Supply voltage	Service factor	Approvals	Comment
20	3 x 350 V, 100 Hz, 3 x 415 V, 120 Hz	1.0	CE	Synchronous
37	3 x 350 V, 100 Hz, 3 x 415 V, 120 Hz	1.15	cCSAus	Synchronous

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]	a	Moment of inertia [kg·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]	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·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]	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·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·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·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·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

Voltage code 20, 37

3 x 350 V, 100 Hz, T60

Power [kW]	Rated current $I_{1/1}$ [A]	Motor efficiency η [%]			Cos φ			n [min ⁻¹]	Rated torque [Nm]
		100 %	75 %	50 %	100 %	75 %	50 %		
4	9.6	89.2	87.4	83.6	0.92	0.96	0.98	3000	12.7
5.5	12.6	90.3	89.3	86.8	0.92	0.94	0.97		17.5
7.5	16.6	90.5	90.3	88.9	0.88	0.92	0.95		23.9
9.2	21.4	91.8	90.8	88.2	0.94	0.96	0.98		29.3
11	25.0	92.2	91.6	89.6	0.93	0.95	0.97		35.0
13	29.2	92.4	92.0	90.6	0.92	0.94	0.96		41.4
15	33.4	92.4	92.2	91.2	0.88	0.91	0.94		47.7
18.5	40.6	92.0	92.4	91.8	0.88	0.91	0.94		58.9
22	46.2	92.8	92.7	91.6	0.91	0.93	0.96		70.0
26	54.0	92.6	92.8	92.2	0.90	0.92	0.95		82.8
30	61.8	92.4	93.2	92.5	0.90	0.91	0.94		95.5
37	85.6	92.2	92.3	91.5	0.86	0.89	0.92		117.8
45	103.0	91.9	92.3	92.0	0.85	0.87	0.90		143.2

3 x 410 V, 120 Hz, T60

Power [kW]	Power [hp]	Rated current $I_{1/1}$ [A]	Service factor	Nameplate current I_{SF} [A]	Motor efficiency η [%]				Cos φ			
					115 % (SF)	100 %	75 %	50 %	115 % (SF)	100 %	75 %	50 %
4.0	5.5	8.4	1.15	9.4	0.95	0.96	0.97	0.98	87.7	86.7	84.0	78.8
5.5	7.5	11.0	1.15	12.4	89.4	88.8	87.0	83.1	0.92	0.94	0.96	0.97
7.5	10	14.4	1.15	16.2	90.1	89.9	88.9	86.2	0.88	0.90	0.94	0.96
9.2	12	18.2	1.15	20.6	0.95	0.96	0.97	0.98	91.6	91.0	89.2	85.4
11	15	21.4	1.15	24.2	0.94	0.95	0.96	0.98	92.4	91.8	90.4	87.2
13	18	24.8	1.15	28.2	0.92	0.93	0.95	0.97	92.8	92.4	91.4	88.8
15	20	28.2	1.15	32.2	0.91	0.92	0.94	0.97	92.8	92.8	92.0	89.8
18.5	25	34.2	1.15	39.0	0.88	0.90	0.93	0.96	93.0	93.0	92.6	91.0
22	30	39.4	1.15	44.8	0.92	0.93	0.94	0.97	93.0	92.8	92.0	89.8
26	35	46.0	1.15	52.4	0.91	0.92	0.93	0.96	93.1	93.1	92.6	90.9
30	40	52.6	1.15	60.0	0.91	0.91	0.93	0.96	93.0	93.1	92.9	91.6
37	50	72.6	1.15	82.6	0.86	0.87	0.90	0.93	92.5	92.4	91.8	89.9
45	60	87.0	1.15	99.2	0.85	0.86	0.88	0.92	92.5	92.5	92.3	91.0

Power [kW]	Power [hp]	n [min ⁻¹]	Moment of inertia [kg·m ²]	Rated torque [Nm]
4.0	5.5	3600	0.00287	10.6
5.5	7.5			14.6
7.5	10			19.9
9.2	12			24.4
11	15		0.00496	29.2
13	18			34.5
15	20			39.8
18.5	25			49.1
22	30		0.00758	58.4
26	35			69.0
30	40			79.6
37	50			98.1
45	60		0.00984	119.4

8. Electrical accessories

CUE frequency converter



GRA4404

The CUE range

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

CUE offers quick and easy setup and commissioning compared to a standard frequency converter, due to the startup guide. Type in application-specific variables, such as motor data, pump family, control function (for example constant pressure), sensor type and setpoint, on the display panel, and the CUE will automatically set all necessary parameters.

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.

When a CUE is installed, the motor requires no further overload protection. If needed, Pt100 or Pt1000 together with the MCB 114 provides overheat protection for the motor windings.

If the motor has a built-in Tempcon sensor, this sensor is disconnected when it is exposed to the frequency converter drive. An internal fuse in the motor melts and it cannot be replaced. The motor works 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			•	•			

CUE is available in two enclosure classes:

- IP20/21
- IP54/55.

RFI filters

To meet the EMC requirements, CUE includes the following types of built-in radio frequency interference filters (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	
	0.55 - 90	C1	Domestic/ industry
3 x 380-500	110 - 50	C2	
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 the following:

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

Features

The CUE offers the following features:

- Startup guide
CUE incorporates an innovative startup guide for the general setting of the CUE, including the setting of the correct direction of rotation. The startup guide displays the first time CUE is connected to the power supply.
The startup guide is accessed when the CUE is first connected to the power supply.
- Checking of the direction of rotation
- Duty or 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:

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

Output filters

Output filters are primarily used for protecting the motor against overvoltage and increased operating temperature. However, output filters can also be used for reducing acoustic noise from the motor.

Grundfos offers sine-wave filters as a CUE accessory.

Sensors

The following sensors can be used with the CUE:

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

All sensors are with 4-20 mA output signal.

Installation

Use of output filters

The table below shows when an output filter is required, and which type should be used.

The selection depends on the following factors:

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

Pump type	Typical shaft power, P ₂	Sine-wave filter
SP connected to net supply of 380 V motor and up	All sizes	0-300 m

The lengths stated apply to the motor cable.

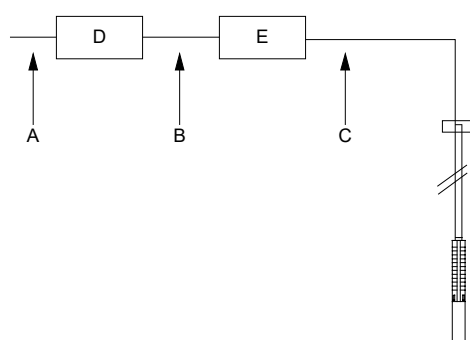
Cables used in CUE installations

When the CUE is installed for SP pumps, two types of installations are distinguished:

- installation in EMC-insensitive sites
- installation in EMC-sensitive sites.

The two types of installation differ in the use of screened cable.

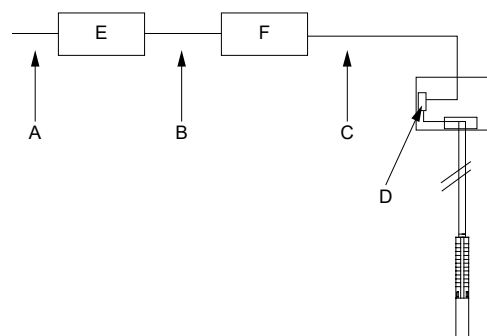
Drop cables are always unscreened.



TM044296

Example of installation in EMC-insensitive sites

A =	Mains cable, unscreened
B =	Screened cable
C =	Drop cable, unscreened
D =	CUE
E =	Filter



TM044295

Example of installation in EMC-sensitive sites

A =	Mains cable, unscreened
B =	Screened cable
C =	Drop cable, unscreened
D =	Connection box
E =	CUE
F =	Filter

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 fulfills all the basic expectations.

The CUE has a startup guide that takes the installer through all the necessary settings.

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

Issues to be considered	Explanation
Observe the ramp times (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 causes low insulation resistance, which results in sensitivity to voltage peaks. Tempcon sensors do not work with frequency converter operation.

Issues to be considered	Explanation
Reduce peak voltages (max. 800 V peaks).	Never exceed peak voltages of 850 V at motor leads.
For MS and MMS, Grundfos recommends that you 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 the output filter.	Cables act as an amplifier, thus measure peaks at the motor.
Rise time (dU/dt) must be limited to a maximum of 1000 V/ μ s. The rise time is determined by the equipment in the CUE.	Time between switches is an expression of losses, therefore, 1000 V/ μ s must not be exceeded. Filter in the output from the CUE, instead of applying higher insulation of the motor.
Keep constant operation at minimum 30 Hz. Use a 60-Hz motor for larger ranges.	Too low speed results in low flow and thereby poor lubrication of journal bearings.
Size the CUE with respect to the current, not the power output.	Too small CUE should be avoided.
Size cooling provision for stator tube at duty point with the lowest flow rate.	Minimum flow along the stator housing must be taken into consideration.
Ensure that the pump is used within the range of the pump curve.	Focus on outlet pressure and sufficient NPSH, as vibrations will damage the motor.

For further information about frequency converters, see the CUE documentation available at <http://product-selection.grundfos.com>.

Grundfos offering, easy selection

MS6000P			CUE (100 Hz)			Sine-wave filter (100 Hz)		Motor cable (5 m)
Motor voltage 3 x 350 V (3000 RPM)			3 x 380-440 V			3 x 200-500 V		
Part number	Output [kW]	Current [A]	Part number	Output [kW]	Current [A]	Part number	Current [A]	Part number
76207712	4.0	9.6	99616713	4.0	10	96754976	13	96164209 ¹
	5.5	12.6	99616714	5.5	13			
	7.5	16.6				96754977	18	
76207717	9.2	21.4	99616716	11	24	96754978	26.5	
	11	25						
	13	29.2	99616717	15	32			
	15	33.4	99616718	18.5	37.5	96755019	36	
	18.5	40.6	99616719	22	44	96755021	46.5	
76207720	22	46.2						96164214 ²
	26	54.0	99616720	30	61	96755032	56	
	30	61.8	99616721	37	73	97774436	86	
76207722	3	85.6	99616722	45	90			2 x 96164215 ³
	45	103.0	99616723	55	106	97775142	135	

¹ 96164209: 4 G 6.0 mm² (5 m)² 96164214: 4 G 10 mm² (5 m)³ 96164215: 4 G 10 mm² (10 m)

The power to MS6000P is supplied through a sine-wave filter.

For more information, see *Electrical data*.

MP 204 motor protector for MS6000 asynchronous motor



MP 204 motor protector

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

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

MP 204 operates with the following limits:

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

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

You can also read warnings with Grundfos GO Remote.

If one of the trip limits is exceeded, the trip relay stops the motor. At the same time, the signal relay indicates that the limit has been exceeded.

Applications

The applications of the MP 204 are the following:

- stand-alone motor protector
- protection of the motor by measuring the motor current via a true RMS measurement.

The MP 204 can be monitored by Grundfos GENIbus.

It 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 the following benefits:

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

Monitoring options of MP 204

The MP 204 monitors the following parameters:

- insulation resistance before start-up

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



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

There are five sizes of single-turn transformers, in the range of 120-999 A.



TM032033

Single-turn transformers

Technical data, MP 204

Enclosure class	IP20
Ambient temperature	-20 °C to +60 °C
Relative 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 MI 301	98046408
Single-turn transformers:	
Current transformer ratio: 200:5, $I_{max.} = 120\text{ A}$	96095274
Current transformer ratio: 300:5, $I_{max.} = 300\text{ A}$	96095275

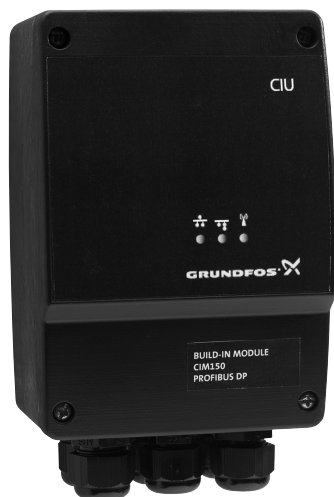
Product	Product number
Current transformer ratio: 500:5, $I_{max.} = 500\text{ A}$	96095276
Current transformer ratio: 750:5, $I_{max.} = 750\text{ A}$	96095277
Current transformer ratio: 1000:5, $I_{max.} = 1000\text{ A}$	96095278

For further information about motor protection, see the MP 204 documentation available at Grundfos Product Center at <http://product-selection.grundfos.com>.

Control MP 204

Product	Description	Product number
	The Control MP 204 units are supplied with all necessary components. Depending on functions and starting method, three types of control cabinets are available. The control cabinets are designed for installation in outdoor cabinets. The Control MP 204 units 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.	Further information at http://product-selection.grundfos.com .

CIU communication interface units



Grundfos CIU communication interface unit

For complete control of pump systems, the Communication Interface Unit (CIU) enables data communication through open and interoperable networks, such as the following:

- PROFIBUS/PROFINET
- Modbus RTU
- Modbus TCP

- LONWorks
- BACnet
- BACnet IP
- EtherNet/IP
- Cellular data connection.

Applications

The range of Grundfos CIU offers easy 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 enables communication of operating data, such as measured values and setpoints, between pumps and PLCs, SCADA system and building management system.

Benefits

The CIU offers the following 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 installation
- possibility for DIN rail or wall mounting.

For data communication between an SP pump and a main network, a CIU has to be used with a CUE frequency converter or an MP 204 motor protector.



MP 204 motor protector



CUE frequency converter

The following table shows Fieldbus support for CIU products:

CIU	Fieldbus protocol	CUE	MP 204
CIU 100	LonWorks	•	
CIU 150	PROFIBUS DP	•	•
CIU 200	Modbus RTU	•	•
CIU 260	Cellular connection	•	•
CIU 280	GiC/GRM ¹	•	•
CIU 281	GiC/GRM ¹ + extra I/O	•	•
CIU 300	BACnet MS/TP	•	
	PROFINET IO	•	•
	Modbus TCP	•	•
CIU 500	BACnet IP	•	
	EtherNet/IP	•	
	GiC/GRM ¹	•	•

¹ Grundfos iSOLUTIONS Cloud (GiC) and Grundfos Remote Management (GRM) are easy-to-install low cost solutions for wireless monitoring and management of Grundfos products.

Product numbers

CIU	Product numbers to order
CIU 100	CIU 900 (99448387) + CIM 100 (96824797)
CIU 150	CIU 900 (99448387) + CIM 150 (96824793)
CIU 200	CIU 900 (99448387) + CIM 200 (96824796)
CIU 260 EU	CIU 900 (99448387) + CIM 260 EU (99439302)
CIU 260 US	CIU 900 (99448387) + CIM 260 US (99439306)
CIU 280 EU	CIU 900 (99448387) + CIM 280 EU (99439724)
CIU 280 US	CIU 900 (99448387) + CIM 280 US (99439725)
CIU 281 EU	CIU 900 (99448387) + CIM 280 EU (99439724)
CIU 281 US	CIU 900 (99448387) + CIM 280 US (99439725)
CIU 300	CIU 900 (99448387) + CIM 300 (96893770)
CIU 500	CIU 900 (99448387) + CIM 500 (98301408)

Mount CIM module inside CIU upon installation.

Antennas for CIU 260 and 280

Accessories	Product number	Description
Antenna for CIM 260/280 EU	99518079	puc antenna, 1.5 m cable
Optional battery for CIM 260/280 EU/US	99499908	to get alarm in case of power break

For further information about data communication via CIU and fieldbus protocols, see the CIU documentation available at <http://product-selection.grundfos.com>.

SA-SPM starter boxes

SA-SPM starter boxes are used as starting units only for 60 Hz, single-phase, 3-wire motors, types MS6000.



SA-SPM

Product numbers

Product	HP	Product number	I _N	Supply voltage	CS	CR
			[A]	[V]	[μF]	[μF]
SA-SPM MS6000	5HP	99053535		230	297	8
	7.5HP	99053536			534	45
	10HP	99053537			682	70
	15HP	99053538			770	135

PR 5714 with Pt100 or Pt1000 sensor

The PR 5714 with Pt100 or Pt1000 sensor offers the following features:

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

Protecting the motor against too high motor temperature preserves motor life. The Pt100 or Pt1000 sensor can be used to indicate when it is time for preventive service.

When using a CUE frequency converter, PR 5714 is not necessary as the CUE can do the monitoring.

Monitoring with a Pt100 or Pt1000 sensor requires the following parts:

- Pt100 or Pt1000 sensor
- PR 5714 relay
- cable.

The default temperature limits are the following:

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

To set the warning limit, observe the temperature at normal operation and add 5 °C. To set the stop limit, observe the temperature at normal operation and add 10 °C.

Technical data

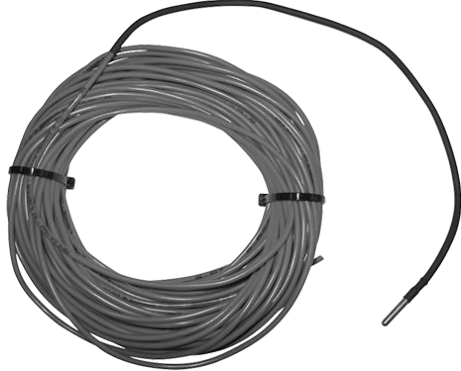
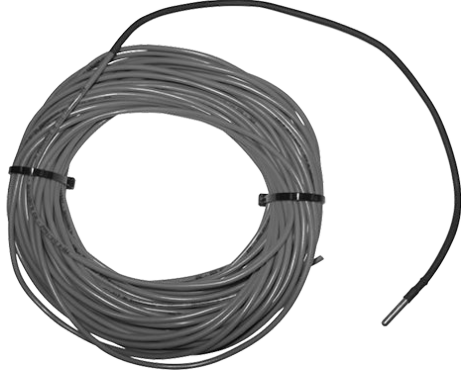
	PR 5714
Enclosure class	IP65 (fitted in a control panel)
Ambient temperature	-20 °C to +60 °C
Relative air humidity	95 % (condensating)
Voltage variation	1 x 24-230 VAC ± 10 %, 50-60 Hz 24-250 VDC ± 20 %
Approvals	UL, DNV
Marking	CE

PR 5714 relay with Pt100 sensor and staybolt	Cable length [m]	Material	Product number
	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
	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
	20	96913237
	40	96913253
	60	96913256
	80	96913260
	100	96913263

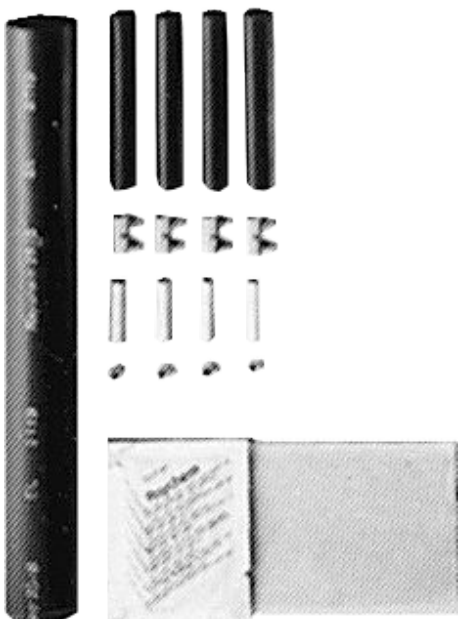
GRA3190

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

TM043563

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

GRA3191

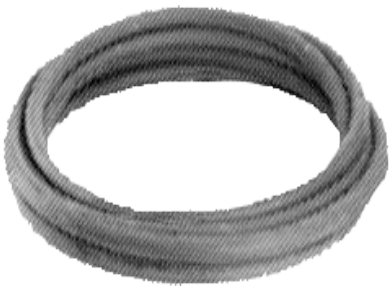
Extension kit for sensor cable for Pt100 and Pt1000	Description	Product number
	Extension kit for Pt100 and Pt1000 sensor cable. ¹ For watertight shrink-joining of the sensor cable	96571480

¹ Extra sensor cable must be ordered separately.

Sensor cable	Description	Product number
	Drop cable for extension: 4#1 mm² Maximum recommended length: 350 m. ¹	RM5271

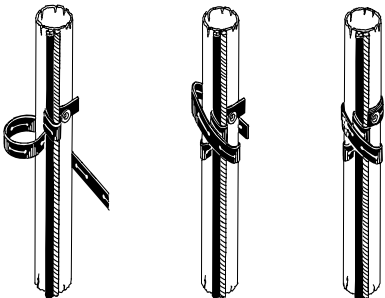
¹ Mention length when ordering.

Submersible drop cable

Product	Description			
	Number of leads and nominal cross-section [mm ²]	Outer cable diameter min./max. [mm] ¹	Weight [kg/m]	Product number
	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

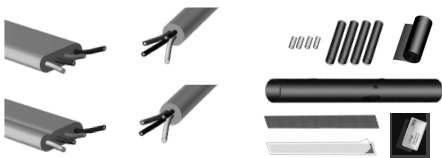
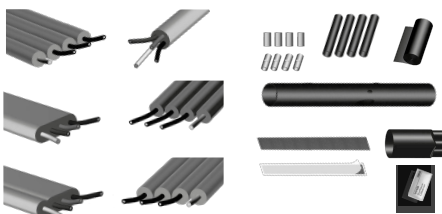
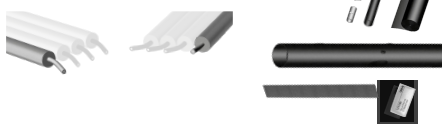
¹ Further cable sizes are available on request.

Cable clips

Product	Description	Product number
	The clips are for fastening cable and straining wire to the riser pipe: • fitted every 3 metres • one set for approx. 45 m of riser pipe • 16 cable buttons • 7.5 m rubber band.	115016

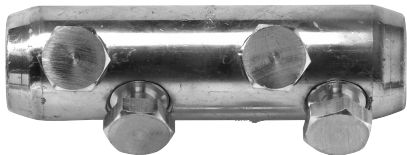
Cable termination kit, type KM

For instruction on how to make the cable termination between motor cable and drop cable, please see the KM quick guide available at Grundfos Product Center at <http://product-selection.grundfos.com>.

Possible cable termination		Content of kit	Motor cable	Drop cable	Number of leads	Product number
Motor cable	Drop cable		[mm ²]	[mm ²]		
			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	Drop cable	Number of leads	Product number
Motor cable	Drop cable		[mm ²]	[mm ²]		
			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	Drop cable	Number of leads	Product number
Motor cable	Drop cable		[mm ²]	[mm ²]		
			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
			A KM termination kit for single leads includes material for only 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		
		Type	Diameter of cable joint [mm]	Outer cable diameter [mm]
	The joint is for watertight joining of motor cable and submersible drop cable. It is encapsulated in the glue which is part of the kit. When ordering this cable termination kit, please note that screw connectors are not included. For ordering suitable screw connectors, see the table below.	M0	Ø40	Ø6 - Ø15
		M1	Ø46	Ø9 - Ø23
		M2	Ø52	Ø17 - Ø31
		M3	Ø77	Ø26 - Ø44
		M4	Ø97	Ø29 - Ø55
				Product number
				00ID8903
				00ID8904
				00ID8905
				00ID8906
				91070700



Accessories for cable kits M0 to M4
Screw connectors only

GRA8251

Cross-section of leads [mm ²]	Number of connectors	Product number
6-25	4	96626021
16-95		96626022
35-185		96626023
70-240		96626028

9. Cable Sizing

Cable types

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

The submersible drop cable is chosen according to application and type of installation.

With the standard version for drinking water approval (TML-B), the maximum liquid temperature is +70 °C, and for short periods up to +90 °C.

Table indicating cable dimension in borehole

Table titled Cable lengths at 3 x 400 V, 50 Hz, DOL indicates the maximum length of drop cables from motor starter to pump, expressed in metres, at direct-on-line starting at different cable dimensions.

In case of star-delta starting, the current is reduced by 0.58 times of the rated current (I), which means that the cable length can be longer than indicated in the tables, namely 1.73 times.

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 minimize operating losses, the cable cross-section can 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 following formulas:

Maximum cable length of a single-phase submersible pump:

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

Maximum cable length of a three-phase submersible pump:

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

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 x mm²]

q = Cross-section of submersible drop cable [mm²]

sin φ = √1-cos²φ

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 lengths at 3 x 400 V, 50 Hz, DOL

Voltage drop: 3 %.

Maximum cable length from motor starter to pump, expressed in metres:

kW	I _n [A]	Cos φ 100 %	Dimensions [mm ²]															
			1.5	2.5	4	6	10	16	25	35	50	70	95	120	150	185	240	300
4.0	9.2	0.82	55	91	146	218	359	566	867									
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] at 30 °C ambient temperature			23	30	41	53	74	99	131	162	202	250	301	352	404	461	547	633

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

Cable lengths at 3 x 350 V, 100 Hz motor supply, valid for use of TML-B cables.

Voltage drop: 3 %.

Maximum cable length from sine wave filter to pump, expressed in metres:

kW	I _n [A]	Cos φ 100 %	Dimensions [mm ²]															
			1.5	2.5	4	6	10	16	25	35	50	70	95	120	150	185	240	300
4.0	9.6	0.95	40	66	106	158	283	417	645									
5.5	12.6	0.92	31	52	83	125	207	328	507	700	982							
7.5	16.6	0.88	25	41	66	99	163	259	399	549	766							
9.2	21.4	0.94	18	30	48	72	119	190	293	406	571	783						
11	25.0	0.93	26	42	62	103	164	253	350	492	673	888						
13	29.2	0.92	23	36	54	89	142	219	302	424	579	762	935					
15	33.4	0.88		33	49	81	129	198	273	381	517	676	825	989				
18.5	40.6	0.88			27	40	67	106	163	225	313	425	557	678	814	958		
22	46.2	0.91				34	57	90	139	193	270	368	483	592	714	846		
26	54.0	0.90					49	78	120	166	232	316	415	507	611	722	880	
30	61.8	0.90					43	68	105	145	203	276	363	443	534	631	769	901
37*	85.6	0.86						88	136	187	260	352	459	558	668	784	945	
45*	103.0	0.85							114	157	218	295	384	466	556	651	784	908
Max. current for cable [A] at 30 °C ambient temperature			23	30	41	53	74	99	131	162	202	250	301	352	404	461	547	633

*For 37 and 45 kW, the calculated lengths are for parallel cabling.

For other voltages, see the cable sizing tool at <http://product-selection.grundfos.com>.

Calculation and selection

Calculation of cable cross-section

Formula designations

U = Rated voltage [V]

ΔU = Voltage drop [%]

I = Rated current of the motor [A]

$\cos \varphi$ = Power factor

$\rho = 1/\chi$ Materials of cable: Copper: $\chi = 40 \text{ m}/\Omega \times \text{mm}^2$

Aluminium: $\chi = 35 \text{ m}/\Omega \times \text{mm}^2$

q = Cross-section [mm^2]

$\sin \varphi = \sqrt{1 - \cos^2 \varphi}$

X_L = Inductive resistance $0.078 \times 10^{-3} [\Omega/\text{m}]$

L = Length of cable [m]

Δp = Power loss [W]

For calculation of the cross-section of the submersible drop cable, use the following formulas:

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

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

For the values of the rated current (I) and the power factor ($\cos \varphi$), see Electrical data.

Calculation of the power loss

For calculation of the power loss in the submersible drop cable, use the following 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 choices

A:	3 x 150 mm^2
B:	3 x 185 mm^2

Cable selection

Choice A

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

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

$\Delta p_A = 745 \text{ W}$.

Choice B

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

$\Delta p_B = 604 \text{ W}$.

Savings

Operating hours/year: h = 4000

Annual saving (A):

$A = (\Delta p_A - \Delta p_B) \times h = (745 \text{ W} - 604 \text{ W}) \times 4000 = 564,000 \text{ Wh} = 564 \text{ kWh}$

By choosing 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}):

$A_{10} = A \times 10 = 564 \times 10 = 5640 \text{ kWh}$

The saved amount must be calculated in the local currency.

Grundfos Product Center

Online search and sizing tool to help you make the right choice.

<http://product-selection.grundfos.com>

All the information you need in one place

Performance curves, technical specifications, pictures, dimensional drawings, motor curves, wiring diagrams, spare parts, service kits, 3D drawings, documents, system parts. The Product Center displays any recent and saved items - including complete projects - right on the main page.

Downloads

On the product pages, you can download installation and operating instructions, data booklets, service instructions, etc. in PDF format.



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The screenshot shows the Grundfos Product Center website. At the top, there's a navigation bar with 'GRUNDFOS' and 'PRODUCT CENTER' logos, and links for 'Services' and 'Sign in'. Below this is a secondary navigation bar with 'HOME', 'FIND PRODUCT', 'COMPARE', 'YOUR PROJECTS', 'SAVED ITEMS', 'TOOLS', and 'HELP'. The main content area is titled 'Find products and solutions'. It features a search bar (1) with a dropdown menu set to 'Products'. Below the search bar are four large tiles: 'Sizing' (2) with the subtext 'Enter pump sizing', 'Catalogue' (3) with 'Products and services', 'Replacement' (4) with 'Replace an old pump with a new', and 'Liquids' (5) with 'Find pump by liquid'. At the bottom, there's a 'Quick sizing' section with tabs for 'Quick sizing', 'Advanced sizing by application', and 'Guided selection'. The 'Quick sizing' tab is active, showing input fields for 'Flow (Q)*' and 'Head (H)*' with units 'm³/h' and 'm' respectively, and a 'Select what to size by' section with radio buttons for 'Size by application', 'Size by pump design', and 'Size by pump family'. A 'START SIZING' button is located to the right of these options.

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Pos.	Description
1	This drop-down menu enables you to set the search function to "Products" or "Literature".
2	SIZING enables you to size a pump based on entered data and selection choices.
3	CATALOGUE gives you access to the Grundfos product catalogue.
4	REPLACEMENT enables you to find a replacement product. Search results will include information on - the lowest purchase price - the lowest energy consumption - the lowest total life-cycle cost.
5	LIQUIDS enables you to find pumps designed for aggressive, flammable or other special liquids.

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