NB, NBG, NK, NKG
NBE, NBGE, NKE, NKGE

Custom-built pumps according to EN 733 and ISO 2858

50 Hz

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Table of contents

1. Introduction

This data booklet is a supplement to the following data booklets:

- NB, NBE, NK, NKE, 50 Hz
- NB, NBE, NK, NKE, 60 Hz
- NBG, NBGE, NKG, NKGE, 50 Hz
- NBG, NBGE, NKG, NKGE, 60 Hz.

This data booklet gives an overview of custom-built solutions offered by Grundfos. If the data booklet does not provide a solution to your specific pumping needs, please contact us with a detailed description of your requirements.

This data booklet contains custom-built pumps according to either EN 733 (NB, NK) or ISO 2858 (NBG, NKG).

NB, NBG, NK, NKG custom-built pumps

We offer a wide range of custom-built variants of the NB, NBG, NK, NKG type range for a variety of demanding industrial applications.

With these single-stage end-suction pumps, based on the well-known NB, NBG, NK, NKG type range, we meet the customers' needs for pumps capable of handling these liquids:

- high-temperature liquids
- crystallising liquids
- hardening/sticky liquids
- high-viscosity liquids, such as paints and varnishes
- aggressive liquids
- abrasive liquids
- toxic liquids
- volatile liquids
- flammable liquids.

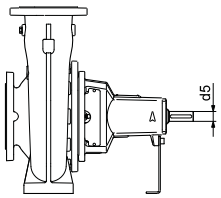
NB, NBG, NK, NKG custom-built pumps can be adapted to special installation requirements.

NB, NBG, NK, NKG custom-built pumps are available for these temperature ranges:

- water-based liquids: -45 to +200 °C
- thermal oils: -20 to +220 °C.

The pump types listed below are available as custom-built pumps.

Pump type	Pump shaft diameter d5 [mm]				
	24	32	42	48	60
NB, NBE	•	•	•	•	•
NBG, NBGE	•	•	•	•	•
NK, NKE	•	•	•	•	•
NKG, NKGE	•	•	•	•	•



• Available.

Pumps for individual requirements

The NB, NBG, NK, NKG pumps can be customised to meet individual requirements. This is due to the "mix-and-match" approach to customisation, where the many pump features and options should be regarded as modules that can be combined to create the ideal pump for the job at hand.

Motor options

NB, NBG, NK, NKG motors are available in many different configurations to meet the requirements presented by the power supply, the pumping environment and/or the pumped liquid itself.

- Power supply systems vary in terms of both frequency and voltage, and required protection methods.
- Your environment may be explosive, very hot and/or very humid. Special conditions also apply at great altitudes.
- The liquid pumped can call for a special motor solution. High or low viscosities and/or high or low densities may require non-standard motor sizes. You may also need an explosion-proof variant.
- A wide range of the pumps are available with electronically speed controlled motors.

For further information, see section *5. Motor*.

Shaft seal options

Extreme liquids sometimes call for extreme measures.

High temperatures can cause damage to the seal faces unless precautions are taken.

Safety requirements can necessitate special measures for aggressive, toxic or explosive liquids.

Liquids can cause damage to shaft seals because they crystallise, harden or are extremely abrasive.

For further information, see section *6. Shaft seals*.

Pump options

The NB, NBG, NK, NKG pump elements can handle the most demanding liquids and pressures and be adapted to suit many other requirements:

- Bearing bracket variants for applications involving high inlet pressure.
- Monitoring of bearing condition in the bearing bracket.
- Material and pump certificates can be supplied.

For further information, see section *7. Pump*.

2. Overview

Configuration options

Motors

Motors are available in many different configurations to meet the requirements presented by the power supply, the pumping environment and the pumped liquid itself.

- Power supply systems vary in terms of frequency, voltage and protection methods.
- Your environment may be explosive, very hot and/or very humid. Special conditions also apply at great altitudes.
- The liquid pumped can call for a special motor solution. High or low viscosities and/or high or low densities may require non-standard motor sizes.
- A wide range of the pumps are available with electronically speed-controlled motors.

Anti-condensation heater

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Multiplug connection

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cUR, UR and CSA approvals

Page 20

Shaft seals

A range of shaft seals suitable for different liquids, liquid temperatures and pressures are available. Single and double shaft seals comply with the EN 12756 standard. Also, stuffing boxes are available for a variety of liquids.

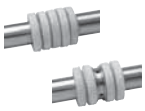
Non-cartridge solutions

Pages 26-28

Cartridge solutions

Pages 26-28

Stuffing box / gland packing



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Pump

Adaptation of the wetted parts of the pump is crucial for optimum pump life. Heavily loaded components are available of varying materials, i.e. impellers of cast iron, bronze and two stainless steel grades. Wear rings come in options combined with impellers and pump housing. Pump housings are available in cast iron and two stainless steel grades.
Combinations of different rubber parts in the pump are allowed to provide the cheapest solution for you.
For applications sensitive to downtime, a heavy-duty bearing design as well as condition monitoring of the bearings are available.

Impeller and wear ring

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Shaft

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Housing

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Other options

You can specify your Grundfos end-suction pump with a specific duty point, order it in alternative colours, with or without certificates, and with standard or spacer coupling.

ATEX-approved pumps

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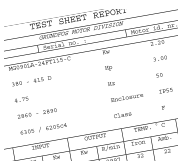
Certificates issued



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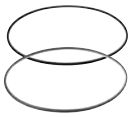
Motor protection (PTC/thermal protection)	Oversized and undersized motors	Special voltage	Enclosure class	E-pump solutions
				
Page 22	Page 24	Page 20	Page 25	Page 69

Seal face	Shaft seal rubber parts	Back-to-back seal (standard mechanical seals)	Tandem seal (standard mechanical seals)	Tandem or back-to-back seal (cartridge seal)
				
Page 29	Page 31	Pages 28, 38	Pages 28, 41	Pages 28, 38, 41

Pump rubber parts	Bearing design	Bearing monitoring	Ceramic coating	PWIS-free pumps
				
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NB, NK pump range

Pump type		d5 [mm]	Shaft seal diameter [mm]
32 -	125.1	24	28
	125	24	28
	160.1	24	28
	160	24	28
	200.1	24	28
	200	24	28
	250	24	28
40 -	125	24	28
	160	24	28
	200	24	28
	250	24	28
	315	32	38
50 -	125	24	28
	160	24	28
	200	24	28
	250	24	28
	315	32	38
65 -	125	24	28
	160	24	28
	200	24	28
	250	32	38
	315	32	38
80 -	160	24	28
	200	32	38
	250	32	38
	315	32	38
	315*	42	48
	400	42	48
100 -	160	24	28
	200	32	38
	250	32	38
	250*	42	48
	315	32	38
	315*	42	48
	400	42	48
125 -	200	32	38
	250	32	38
	250*	42	48
	315	42	48
	400	42	48
	500	60	60
150 -	200	32	38
	250	42	48
	315.2	42	48
	315	42	48
	400	42	48
	400*[1]	48	55
	500	60	60
200 -	400[2]	48	55
	450[2]	48	55
250 -	350	48	55
	400	48	55
	450[2]	60	60
	500	60	60

* Oversize pump.
1) Not available as NB.
2) Not available in stainless steel.

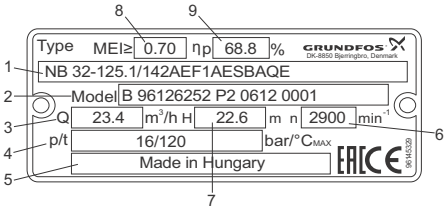
NBG, NKG pump range

Pump type		d5 [mm]	Shaft seal diameter [mm]
50 -	32 -	125.1	24	28
		125	24	28
		160.1	24	28
		160	24	28
		200.1	24	28
		200	24	28
		250	32	38
65 -	50-	125	24	28
		160	24	28
65 -	40-	200	24	28
		250	32	38
		315	32	38
80 -	65 -	125	24	28
		160	24	28
80 -	50 -	200	24	28
		250	32	38
		315	32	38
100 -	80 -	125	24	28
		160	32	38
100 -	65 -	200	32	38
		250	32	38
		315	42	48
125 -	80 -	160	32	38
		200	32	38
		250	32	38
		315	42	48
		400.1	42	48
		400	42	48
		400	48	55
		400.1	42	48
125 -	100 -	160	32	38
		200	32	38
		250	42	48
		315	42	48
		400	42	48
150 -	125 -	200	32	38
		250	42	48
		315	42	48
		400	42	48
		500	60	60
200 -	150 -	200	32	38
		250	42	48
		315.2	42	48
		315.2	48	55
		315	48	55
		400	48	55
		500	60	60
250 -	200 -	400[2]	48	55
		450[2]	48	55
300 -	250 -	350	48	55
		400	48	55
		450[2]	60	60
		500	60	60
350 -	300 -	305[2]	48	55

2) Not available in stainless steel.

3. Identification

Nameplate



TM05 6006 0119

Fig. 1 Example of nameplate for NB

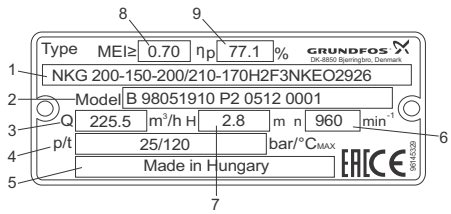


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Fig. 2 Example of nameplate for NKG

Legend

Pos.	Description	
1	Type designation	
2	Model	
	B	Model
	96126252	Product number
	P2	Production site code
	0612	Production date, year and week
	0001	Serial number
3	Rated flow rate [m^3/h]	
4	Pressure rating/maximum temperature [bar/°C]	
5	Country of origin	
6	Rated speed [min^{-1}]	
7	Pump head [m]	
8	Minimum efficiency index	
9	Hydraulic pump efficiency at best efficiency point [%]	

Type key for NB, NBE, NBG, NBGE

Model B

Example 1 - pump design according to EN 733	**NBE**		**32**	**-125**	**.1**	**/142**	**S2**	**A**	**F**	**1**	**A**	**E**	**S**	**BAQE**
Example 2 - pump design according to ISO 2858	**NBG**	**125**	**-100**	**-160**		**/160-142**		**A**	**F**	**2**	**N**	**K**	**S**	**DQQK**

Type range
- NB, NBG Pump with standard motor
- NBE, NBGE Pump with MGE motor

Nominal diameter of inlet port (DN)

Nominal diameter of outlet port (DN)

Nominal impeller diameter [mm]

Reduced performance = .1

Actual impeller diameter [mm]

Sensor version
- S1 Without factory-fitted sensor, pressure sensor is supplied with the pump
- S2 With factory-fitted differential-pressure sensor, Series 2000

Code for pump version (the codes may be combined)
- A Basic version
- B Oversize motor
- C Without motor
- D Pump housing with feet
- E With ATEX approval, certificate or test report, the second character of the code for pump version is an E
- F Design with base frame
- S With support blocks
- X Special version (in the case of further customisation than already listed)

Pipe connection
- E Table E flange
- F DIN flange
- G ANSI flange
- J JIS flange

Flange pressure rating (PN - nominal pressure)
- 1 10 bar
- 2 16 bar
- 3 25 bar
- 4 40 bar
- 5 Other pressure rating

Example 1 - pump design according to EN 733					**NBE**	**32**	**-125**	**.1**	**/142**	**S2**	**A**	**F**	**1**	**A**	**E**	**S**	**BAQE**
Example 2 - pump design according to ISO 2858					**NBG**	**125**	**-100**	**-160**	**/160-142**		**A**	**F**	**2**	**N**	**K**	**S**	**DQQK**

Materials

	Pump housing	Impeller	Wear ring	Shaft
A	EN-GJL-250	EN-GJL-200	Bronze/brass	1.4301
B	EN-GJL-250	Bronze CuSn10	Bronze/brass	1.4301
C	EN-GJL-250	EN-GJL-200	Bronze/brass	1.4401
D	EN-GJL-250	Bronze CuSn10	Bronze/brass	1.4401
E	EN-GJL-250	EN-GJL-200	EN-GJL-250	1.4301
F	EN-GJL-250	Bronze CuSn10	EN-GJL-250	1.4301
G	EN-GJL-250	EN-GJL-200	EN-GJL-250	1.4401
H	EN-GJL-250	Bronze CuSn10	EN-GJL-250	1.4401
I	1.4408	1.4408	1.4517	1.4462
J	1.4408	1.4408	Carbon-graphite-filled PTFE (Graflon®)	1.4462
K	1.4408	1.4408	1.4517	1.4401
L	1.4517	1.4517	1.4517	1.4462
M	1.4408	1.4517	1.4517	1.4401
N	1.4408	1.4408	Carbon-graphite-filled PTFE (Graflon®)	1.4401
P	1.4408	1.4517	Carbon-graphite-filled PTFE (Graflon®)	1.4401
R	1.4517	1.4517	Carbon-graphite-filled PTFE (Graflon®)	1.4462
S	EN-GJL-250	1.4408	Bronze/brass	1.4401
T	EN-GJL-250	1.4517	Bronze/brass	1.4462
U	1.4408	1.4517	1.4517	1.4462
W	1.4408	1.4517	Carbon-graphite-filled PTFE (Graflon®)	1.4462
X	Special version			

Rubber parts in pump

The letter indicates material of O-ring for pump cover

- E EPDM
- F FXM (Fluoraz®)
- K FFKM (Kalrez®)
- M FEPS (PTFE-sheathed silicone O-ring)
- X HNBR
- V FKM (Viton®)

Shaft seal arrangement

- S Single seal

Code for mechanical shaft seal and shaft seal rubber parts

Example 1 - pump design according to EN 733					**NBE**	**32**	**-125**	**.1**	**/142**	**S2**	**A**	**F**	**1**	**A**	**E**	**S**	**BAQE**
Example 2 - pump design according to ISO 2858					**NBG**	**125**	**-100**	**-160**	**/160-142**		**A**	**F**	**2**	**N**	**K**	**S**	**DQQK**

Example 1 shows an NBE 32-125.1 pump with these characteristics:

- pump with MGE motor
- reduced performance
- 142 mm impeller
- with factory-fitted differential-pressure sensor, Series 2000
- basic version
- DIN flange to EN 1092-2 pipe connection
- 10 bar flange pressure rating
- cast iron pump housing, EN-GJL-250
- cast iron impeller, EN-GJL-200
- bronze/brass wear ring
- stainless steel shaft, EN 1.4301
- EPDM O-ring for pump cover
- single-seal arrangement
- BAQE shaft seal.

Example 2 shows an NBG 125-100-160 pump with these characteristics:

- 160-142 mm conical impeller
- basic version
- DIN flange to EN 1092-2 pipe connection
- 16 bar flange pressure rating
- stainless steel pump housing, EN 1.4408
- stainless steel impeller, EN 1.4408
- carbon-graphite-filled wear ring, PTFE (Graflon®)
- stainless steel shaft, EN 1.4401
- FFKM O-ring for pump cover
- single-seal arrangement
- DQQK shaft seal.

Type key for NK, NKE, NKG, NKGE

Model B

Example 1 - pump design according to EN 733	**NKE**		**32**	**-125**	**.1**	**/142**	**S2**	**A1**	**F**	**1**	**A**	**E**	**S**	**BAQE**
Example 2 - pump design according to ISO 2858	**NKG**	**125**	**-100**	**-160**		**/160-142**		**H2**	**F**	**3**	**N**	**KE**	**O**	**2926**

Type range

NK, NKG	Pump with standard motor
NKE, NKGE	Pump with MGE motor

Nominal diameter of inlet port (DN)

Nominal diameter of outlet port (DN)

Nominal impeller diameter [mm]

Reduced performance = .1

Actual impeller diameter [mm]

Sensor version

S1	Without factory-fitted sensor, pressure sensor is supplied with the pump
S2	With factory-fitted differential-pressure sensor, Series 2000

Code for pump version (the codes may be combined)

A1	Basic version, grease-lubricated standard bearing design, standard coupling
A2	Basic version, grease-lubricated standard bearing design, spacer coupling
B	Oversize motor
E	With ATEX approval, certificate or test report, the second character of the code for pump version is an E
G1	Grease-lubricated heavy-duty bearing design, standard coupling
G2	Grease-lubricated heavy-duty bearing design, spacer coupling
H1	Oil-lubricated heavy-duty bearing design, standard coupling
H2	Oil-lubricated heavy-duty bearing design, spacer coupling
I1	Pump without motor, with grease-lubricated standard bearing design, standard coupling
I2	Pump without motor, with grease-lubricated standard bearing design, spacer coupling
J1	Pump without motor, with grease-lubricated heavy-duty bearing design, standard coupling
J2	Pump without motor, with grease-lubricated heavy-duty bearing design, spacer coupling
K1	Pump without motor, with oil-lubricated heavy-duty bearing design, standard coupling
K2	Pump without motor, with oil-lubricated heavy-duty bearing design, spacer coupling
Y1	Bare shaft pump, with grease-lubricated standard bearing design
W1	Bare shaft pump, with grease-lubricated heavy-duty bearing design
Z1	Bare shaft pump, with oil-lubricated heavy-duty bearing design
X	Special version, if further customisation than already listed

Pipe connection

E	Table E flange
F	DIN flange
G	ANSI flange
J	JIS flange

Flange pressure rating (PN - nominal pressure)

1	10 bar
2	16 bar
3	25 bar
4	40 bar
5	Other pressure rating

Materials

	Pump housing	Impeller	Wear ring	Shaft
A	EN-GJL-250	EN-GJL-200	Bronze/brass	1.4021/1.4034
B	EN-GJL-250	Bronze CuSn10	Bronze/brass	1.4021/1.4034
C	EN-GJL-250	EN-GJL-200	Bronze/brass	1.4401
D	EN-GJL-250	Bronze CuSn10	Bronze/brass	1.4401
E	EN-GJL-250	EN-GJL-200	EN-GJL-250	1.4021/1.4034
F	EN-GJL-250	Bronze CuSn10	EN-GJL-250	1.4021/1.4034
G	EN-GJL-250	EN-GJL-200	EN-GJL-250	1.4401
H	EN-GJL-250	Bronze CuSn10	EN-GJL-250	1.4401
I	1.4408	1.4408	1.4517	1.4462
J	1.4408	1.4408	Carbon-graphite-filled PTFE (Graflon®)	1.4462
K	1.4408	1.4408	1.4517	1.4401
L	1.4517	1.4517	1.4517	1.4462
M	1.4408	1.4517	1.4517	1.4401

Example 1 - pump design according to EN 733						**NKE**	**32**	**-125**	**.1**	**/142**	**S2**	**A1**	**F**	**1**	**A**	**E**	**S**	**BAQE**
Example 2 - pump design according to ISO 2858						**NKG**	**125**	**-100**	**-160**	**/160-142**		**H2**	**F**	**3**	**N**	**KE**	**O**	**2926**

N	1.4408	1.4408	Carbon-graphite-filled PTFE (Graflon®)	1.4401
P	1.4408	1.4517	Carbon-graphite-filled PTFE (Graflon®)	1.4401
R	1.4517	1.4517	Carbon-graphite-filled PTFE (Graflon®)	1.4462
S	EN-GJL-250	1.4408	Bronze/brass	1.4401
T	EN-GJL-250	1.4517	Bronze/brass	1.4462
U	1.4408	1.4517	1.4517	1.4462
W	1.4408	1.4517	Carbon-graphite-filled PTFE (Graflon®)	1.4462
X	Special version			

Rubber parts in pump

First letter indicates material of O-ring for pump cover and O-ring for seal cover (seal cover O-ring is only for double-seal arrangements)

Second letter indicates material of O-ring for seal housing

- E EPDM
- F FXM (Fluoraz®)
- K FFKM (Kalrez®)
- M FEPS (PTFE-sheathed silicone O-ring)
- V FKM (Viton®)
- X HNBR

Shaft seal arrangement

- B Stuffing box
- C Cartridge seal, single
- D Cartridge seal, double
- O Back-to-back, double seal
- P Tandem, double seal
- S Single seal

Shaft seal(s) in pump

Letter or digit code for mechanical shaft seal and shaft seal rubber parts

4 letters: Single mechanical shaft seal, such as BQQE or single cartridge seal such as HBQV.

4 digits: Double-seal solution such as 2716, where 27 is equal to DQQV (primary seal) and 16 is equal to BQQV (secondary seal)) or double cartridge seal such as 5150 is equal to where 51 is equal to HQQU (primary seal) and 50 is equal to HBQV (secondary seal))

The relation between letters and digits of the shaft seals is described on page 13.

Example 1 - pump design according to EN 733						**NKE**	**32**	**-125**	**.1**	**/142**	**S2**	**A1**	**F**	**1**	**A**	**E**	**S**	**BAQE**
Example 2 - pump design according to ISO 2858						**NKG**	**125**	**-100**	**-160**	**/160-142**		**H2**	**F**	**3**	**N**	**KE**	**O**	**2926**

Example 1 shows an NKE 32-125.1 pump with these characteristics:

- pump with MGE motor
- reduced performance
- 142 mm impeller
- with factory-fitted differential-pressure sensor, Series 2000
- grease-lubricated standard bearing design
- standard coupling
- DIN flange to EN 1092-2 pipe connection
- PN 10 flange
- cast iron pump housing, EN-GJL-250
- cast iron impeller, EN-GJL-200
- bronze/brass wear ring
- stainless steel shaft, EN 1.4021/1.4034
- EPDM O-ring for pump cover
- single-seal arrangement
- BAQE shaft seal.

Example 2 shows an NKG 125-100-160 pump with these characteristics:

- 160-142 mm conical impeller
- grease-lubricated heavy-duty bearing design
- spacer coupling
- DIN flange to EN 1092-2 pipe connection
- PN 25 flange
- stainless steel pump housing, EN 1.4408
- stainless steel impeller, EN 1.4408
- carbon-graphite-filled wear ring, PTFE (Graflon®)
- stainless steel shaft, EN 1.4401
- FFKM O-rings for pump cover and seal cover
- EPDM O-ring for seal housing
- back-to-back double-seal arrangement
- primary shaft seal: DQQK
- secondary shaft seal: DQQE.

Relation between letter and digit code of shaft seal and stuffing box description

Digits	Letters	Description
10	BAQE	Single mechanical shaft seal
11	BAQV	Single mechanical shaft seal
12	BBQE	Single mechanical shaft seal
13	BBQV	Single mechanical shaft seal
15	BQQE	Single mechanical shaft seal
16	BQQV	Single mechanical shaft seal
19	AQAE	Single mechanical shaft seal
20	AQAV	Single mechanical shaft seal
21	AQQE	Single mechanical shaft seal
22	AQQV	Single mechanical shaft seal
23	AQQX	Single mechanical shaft seal
24	AQQK	Single mechanical shaft seal
25	DAQF	Single mechanical shaft seal
26	DQQE	Single mechanical shaft seal
27	DQQV	Single mechanical shaft seal
28	DQQX	Single mechanical shaft seal
29	DQQK	Single mechanical shaft seal
50	HBQV	Cartridge seal
51	HQQU	Cartridge seal
52	HAQK	Cartridge seal
	SNEA	Stuffing box, internal barrier liquid, Buraflon® packing rings[1], EPDM O-rings in the pump housing
	SNEB	Stuffing box, internal barrier liquid, Thermoflon® packing rings[2], EPDM O-rings in the pump housing
	SNEC	Stuffing box, internal barrier liquid, Buraflon® packing rings[1], FKM O-rings in the pump housing
	SNED	Stuffing box, internal barrier liquid, Thermoflon® packing rings[2], FKM O-rings in the pump housing
	SNOA	Stuffing box, without barrier liquid, Buraflon® packing rings[1], EPDM O-rings in the pump housing
	SNOB	Stuffing box, without barrier liquid, Thermoflon® packing rings[2], EPDM O-rings in the pump housing
	SNOC	Stuffing box, without barrier liquid, Buraflon® packing rings[1], FKM O-rings in the pump housing
	SNOD	Stuffing box, without barrier liquid, Thermoflon® packing rings[2], FKM O-rings in the pump housing
	SNFA	Stuffing box, external barrier liquid, Buraflon® packing rings[1], EPDM O-rings in the pump housing
	SNFB	Stuffing box, external barrier liquid, Thermoflon® packing rings[2], EPDM O-rings in the pump housing
	SNFC	Stuffing box, external barrier liquid, Buraflon® packing rings[1], FKM O-rings in the pump housing
	SNFD	Stuffing box, external barrier liquid, Thermoflon® packing rings[2], FKM O-rings in the pump housing

[1] Buraflon® packing rings are PTFE-impregnated fibre packing rings.
[2] Thermoflon® packing rings are Graphite-PTFE compound packing rings.

Codes for shaft seals

The positions (1) - (4) cover four pieces of information about the shaft seal:

Example	(1)	(2)	(3)	(4)
Grundfos type designation				
Material, rotating seal face				
Material, stationary seat				
Material, secondary seal (rubber parts)				

The following table explains the positions (1) - (4):

Pos.	Code	Short description of seal
(1)	A	O-ring seal with fixed driver
	B	Rubber bellows seal
	D	O-ring seal, balanced
	H	Cartridge seal, balanced
Pos.	**Code**	**Material**
(2) and (3)		Synthetic carbons:
	A	Carbon, metal-impregnated (antimony (not approved for potable water))
	B	Carbon, resin-impregnated
		Carbides:
	Q	Silicon carbide
Pos.	**Code**	**Material**
(4)	E	EPDM
	V	FKM (Viton®)
	F	FXM (Fluoraz®)
	K	FFKM (Kalrez®)
	X	HNBR
	U	Dynamic FFKM O-rings and static PTFE O-rings

For a thorough description of shaft seal types and materials, see section *6. Shaft seals*.

Codes for stuffing boxes (NK, NKG)

The positions (1) - (4) cover information about the stuffing box:

Pos.	Code	Short description of stuffing box
(1)	S	Packing type stuffing box
Pos.	**Code**	**Cooling method**
(2)	N	Uncooled stuffing box
Pos.	**Code**	**Barrier liquid**
(3)	E	With internal barrier liquid
	F	With external barrier liquid
	O	Without barrier liquid
Pos.	**Code**	**Materials**
(4)	A	PTFE-impregnated fibre packing rings and EPDM O-rings in the pump housing
	B	Graphite-PTFE compound packing rings and EPDM O-ring in the pump housing
	C	PTFE-impregnated fibre packing rings and FKM O-ring in the pump housing
	D	Graphite-PTFE compound packing rings and FKM O-ring in the pump housing

4. Applications

High-temperature applications

GrA2519 - TM06 8145 4716
GrA8611 - TM06 8144 4716

Fig. 3 NB, NBG, NK, NKG pumps for high-temperature applications

The pumping of hot liquids demands much of pump parts, such as the shaft seal and rubber parts and bearing design in the bearing bracket.

An NBG, NKG pump with a single mechanical shaft seal can handle liquid temperatures up to +220 °C. The pressure ratings of these pumps is up to 16 bar for cast iron pumps and 25 bar for stainless steel pumps.

Some NKG pumps are designed for double shaft seal solutions (tandem or back-to-back) which can handle temperatures up to +180 °C. The pressure rating of these pumps is up to 16 bar for cast iron pumps and 25 bar for stainless steel pumps.

With tandem or back-to-back seal arrangements, additional life of the shaft seals can be expected due to better lubrication of the shaft seals. We also provide different seal faces to ensure a trouble-free operation at high temperatures.

For applications with an inlet pressure above 10 bar, we offer a heavy-duty bearing design for the bearing bracket.

Hot-water applications

Hot-water applications often expose pumps to a variety of extreme conditions, such as high temperatures, long operating hours, frequent starts/stops, pressure fluctuations, poor inlet conditions and high inlet pressure.

Such conditions may result in cavitation and/or cause increased wear of pump parts, such as s and shaft seal, and thus reduce pump life.

Cleaning and washing applications

These applications often call for special features such as pump housing without feet, the ability to pump pulp residues and to withstand cleaning agents. In this case, stainless steel pump versions and special O-rings in shaft seal and pump are often required.

A double shaft seal solution with flushing of the shaft seal by the pumped liquid may also be required if particles and pulp are suspended in the washing/cleaning liquid.

Further information

Information about	See page
Oversize and undersize motor	24
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Certificates and reports	135
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Applications involving temperature control

GrA2519 - GrA2520
TM06 8146 4716 - TM06 8144 4716

Fig. 4 NB, NBE, NBG, NBGE, NK, NKE, NKG, NKGE pumps with sensor

Reference applications

- Electronic data processing
- cooling towers
- industrial cooling and freezing processes.

Temperature-control systems for:

- casting and moulding tools
- oil processing.

We provide solutions for the following:

- Liquids down to -45 °C
- all kinds of coolants (glycols and brines)
- high-viscosity and high-density liquids
- high-temperature liquids (water, glycol, oil).

Liquids down to -45 °C

In applications where liquids are pumped at temperatures down to -45 °C, it is crucial for a successful operation that pump parts are made of the right materials and dimensions.

At such low temperatures, the selection of wrong materials and dimensions may cause deformation because of thermal expansion, and eventually stoppage of operation.

If the pump is installed in a very cold engine room and is operating with a frequent on/off cycle, there is a risk of buildup of condensate in the motor terminal box. To avoid this, we can incorporate an anti-condensation heater in the motor terminal box.

Coolants (glycols and brines)

Coolants are numerous but some common properties have to be considered when selecting the pump solution for this, such as:

- higher viscosity due to the lower operating temperature and density differing from that of water
- various additives to increase life of coolant and system
- crystallisation of the pumped liquid on seal faces.

For applications involving coolants, shaft seals with reduced seal faces are commonly used. We also offer different elastomer combinations in shaft seals and in the pump to adapt exactly to the pumped liquid.

For downtime sensitive applications, we offer NKG pumps with double-seal arrangements which can prevent crystallisation on the seal faces.

For applications involving brines, we offer cast iron pumps for temperatures below 0 °C and stainless steel pumps for brines at higher temperatures.

High-viscosity and high-density liquids

In applications where high-viscosity and high-density liquids are pumped, precautions must be taken to ensure that the motor is not overloaded.

The viscosity of a pumped liquid depends strongly on the liquid temperature whereas the density is less affected by the liquid temperature. When pumping liquids with viscosities higher than that of water, the pump performance will be reduced which might call for a larger pump or an oversize motor.

Further information

Information about	See page
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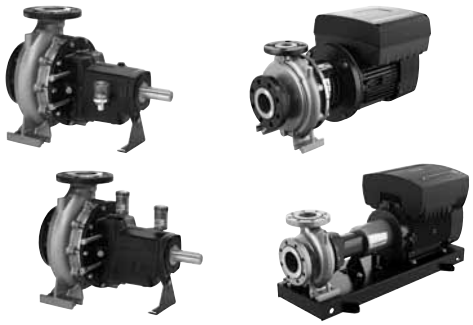
Aggressive/hazardous liquids



GrA8611 - TM06 8145 4716
GrA8612 - TM06 8144 4716

Fig. 5 NB, NBG, NK, NKG pumps for aggressive or hazardous liquids

Reference applications

- Chemical industry
- pharmaceutical industry
- refineries
- petrochemical industry
- distilling plants
- paint industry
- mining
- off-shore and maritime applications.

In industries where pumping of dangerous and aggressive liquids is an integrated part of daily production, safety is top priority. Leaking pumps pose a danger to the environment.

We provide solutions for the following:

- Aggressive and abrasive liquids
- toxic and hazardous liquids
- flammable liquids
- odorous liquids.

To ensure a safe handling of the above liquids, we offer pumps with

- tandem seal arrangement and equipment to provide flushing liquid control
- back-to-back seal arrangement and equipment to provide barrier liquid control
- a wide range of elastomers in the shaft seal and in the pump
- various materials of pump housing, wear rings, impeller and shafts
- ATEX approval.

Tandem seal arrangement (only NKG)

Pumps with tandem seal arrangements connected to a flushing device are especially suitable for crystallising liquids where it is of utmost importance to avoid buildup of deposits on the seal faces. Deposits will eventually result in a leaking shaft seal. The pumped liquid leaking through the primary seal will be flushed away by a flushing liquid.

The tandem seal arrangement is also suitable for applications where prevention of air ingress from the atmospheric side is necessary (for liquids which react with atmospheric oxygen) and where the pump is operating with a negative inlet pressure of maximum 0.6 bar.

Back-to-back seal arrangement (only NKG)

Pumps with back-to-back seal arrangements are connected to a pressurising system preventing leakage from the pump to the atmospheric side. The pressurising system must be capable of supplying a pressure of 10 % and minimum 1.5 bar above the pumped liquid pressure close to the seal.

We recommend pumps with back-to-back seal arrangements for toxic, aggressive or flammable liquids.

ATEX-approved pumps

ATEX-approved pumps are required for operation in potentially explosive atmospheres.

Explosive atmospheres consist of air and combustible material such as gases, vapours, mists or dusts in which the explosion will spread after ignition.

We offer ATEX-approved pumps with these classifications:

Group II	
Category 2	**Category 3**
2G, zone 1	3G, zone 2
2D, zone 21	3D, zone 22

Further information

Special installation requirements

GrA2520 - GrA2518
TM06 8145 4716 - GrA2511

Fig. 6 NB, NBG, NK, NKG pumps for special installations

Reference applications

- Places with limited access and space
- off-shore and maritime applications
- mobile applications
- fire protection
- earthquake-prone areas
- applications in remote areas.

Due to safety, location and arrangement requirements, some installations require pumps of another design than traditional horizontal pumps.

We provide solutions such as the following:

- Vertically mounted pumps
- bare shaft pumps (NK, NKG)
- pumps without motor (NB, NBG, NK, NKG)
- pumps with certificates.

Vertically mounted pumps

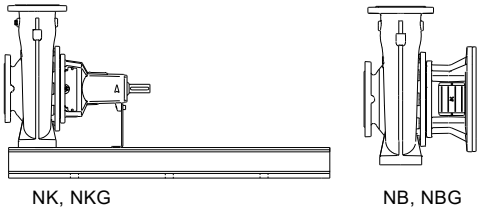
Vertically mounted pumps are often chosen for

- installations with limited access and space, for instance cabinets and compact systems
- mobile systems, for instance ships and vehicles.

The construction of vertically mounted pumps is identical to the traditional horizontal pump. Some NB and NBG pump sizes are available for vertical mounting.

Pumps without motor

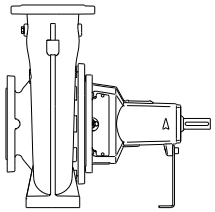
We can provide NB, NBG, NK, NKG pumps without motor: These pump are ready for mounting of motor brands differing from Grundfos supplied motors.



TM05 0953 1911

Fig. 7 Pumps without motor (update drawing, refer to NB I&O)

Bare shaft pumps



TM05 0952 1911

Fig. 8 Bare shaft NK, NKG pump

NK, NKG pumps are available as bare shaft pumps.

Bare shaft pumps are often selected for the following:

- non-electrically driven applications, for instance air-, diesel- and hydraulically driven applications
- installations requiring an alternative power supply, for instance firefighting systems and emergency pumps.

The design of bare shaft pumps is identical to that of electrically driven pumps, however, when using a combustion engine or other non-electrical drives, a pulley and belt or a clutch may be necessary.

Pumps with certificates, approvals and reports

We offer custom-built pumps and motors with a wide variety of certificates and approvals such as:

- Material inspection certificate 3.1 and 3.2
- Inspection certificate
  - Lloyds Register of Shipping (LRS)
  - Det Norske Veritas (DNV)
- ATEX-approved pump report, UL approvals
- Test report (duty-point verification), etc.

Earthquake-prone areas

For earthquake-prone areas and in mobile systems, we recommend NB, NBG, NK, NKG, NBE, NBGE, NKE, NKGE pumps in a stainless steel version. Stainless steel is more ductile than cast iron and therefore more durable in vibrating environments.

Further information

Information about	See page
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Supplementary Grundfos pumps

For installations with special requirements to a compact design, we recommend CM, CR pumps or BM booster modules.

Special applications

GrA8611 - TM06 8145 4716
TM06 8147 4716 - TM06 8144 4716

Fig. 9 NB, NBG, NK, NKG, NBE, NBGE, NKE, NKGE pumps

Reference applications

We offer customised solutions for a number of applications not mentioned on the previous pages, for instance

- off-shore and maritime applications
- pumping of liquids down to -45 °C
- painting and pre-treatment solutions (silicon reduced pumps)
- special conditions
- special requirements as to approvals, voltage, frequency, etc.

Off-shore and maritime applications

In off-shore and maritime applications, pumps must meet stringent requirements to reliability in connection with for instance cooling, firefighting, cleaning and desalination systems. These pumps are often installed in a corrosive environment.

We offer custom-built pumps with a wide variety of material certificates, inspection certificates, approvals and reports.

Furthermore, we offer custom-built pumps with a wide variety of materials, connections, enclosure classes, etc.

For the pumping of seawater, we recommend NB, NBG, NK, NKG pumps in full EN 1.4517 material version.

Liquids down to -45 °C

In applications with liquid temperatures down to -45 °C, the material of the shaft seal faces as well as other factors must meet special requirements. At such low temperatures, the selection of wrong materials and dimensions may cause deformation due to thermal expansion and, eventually, stoppage of operation.

If the pump is installed in a very cold engine room and is operating with a frequent on/off cycle there is a risk of buildup of condensate in the motor terminal box. To avoid this, we can incorporate an anti-condensation heater in the motor terminal box.

Painting and pre-treatment solutions

The painting process demands a steady and clean production with no impact from paint-wetting impairment substances (PWIS-free). See page 68.

The double shaft seal construction in our NKG pumps prevents blocking of the shaft seal and also prevents the paint, the aggressive liquid or the flammable liquid used in the pre-treatment and painting process from leaking to the environment.

We recommend stainless steel pumps in the painting and pre-treatment processes as these are corrosion resistant to the aggressive liquids used in these processes. Stainless steel pumps are also suitable for CIP cleaning (cleaning-in-place).

Grundfos offers a PWIS-free pump for this purpose. When the pump is assembled, tools and consumables like lubricants and soapy water are PWIS-free, and special handling procedures are followed.

NB, NBG and NK, NKG PWIS-free pumps are tested in the normal production test equipment.

Special conditions

Special conditions include

- installations at high altitudes (above 1000 metres)
- applications with low, high or fluctuating ambient temperatures
- the pumping of high-viscosity/high-density liquids.

In such cases, the motor may be overloaded and an oversize motor may be required.

Special requirements

We also offer custom-built pumps meeting special requirements as to approvals, voltage, frequency, etc.

Further information

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5. Motor

The Grundfos standard range of motors meets a wide variety of application demands. For special applications or operating conditions, we offer custom-built solutions.

Tropicalised motors

A tropicalised motor does not contain paper, wood or similar materials containing wood pulp.

Grundfos defines a tropicalised motor as a motor which fulfils the climate group "World-Wide" in DIN/IEC 721-2-1 and has the following characteristics:

- enamel covered windings
- double winding impregnation
- double winding insulation
- FPM V-ring
- terminal board made of polyester
- liquid sealing between frame and flange/end shield
- all outside screws made of stainless steel
- 30 µm paint layer on aluminium stator housings
- 120 µm paint layer on cast-iron stator housings
- heating element.

cURus, UR and CSA approvals

We offer Siemens motors with cURus, UR and CSA approvals.

Other motor approvals

We offer a wide range of motor approvals:

- CCC
- CEL - China Energy Label
- MEPS - Korean Efficiency Energy Label
- Inmetro approved motor for Brazilian market.

ATEX-approved motors

For ATEX-related information please refer to section *ATEX-approved pumps* on page 54.

Special voltages

We offer the pumps with the following voltages:

Frequency	Voltage [V]
Mains-operated motors	
50 Hz	3 x 220-240 Δ / 380-415 Y V
	3 x 200-220/346-380 V
	3 x 380-415 Δ V
	3 x 380-415 Δ / 660-690 Y V
60 Hz	3 x 200-230/346-400 V
	3 x 208-230/460 V
	3 x 220-255 Δ / 380-440 Y V
	3 x 220-277 Δ / 380-480 Y V
	3 x 220-277 Δ / 380-480 Y V
	3 x 380-440 Δ V
	3 x 380-480 Δ V
	3 x 380-480 Δ / 660-690 Y V
	3 x 575 Y V
Motor with integrated frequency converter	
50/60 Hz	1 x 200-240 V
	3 x 200-240 V
	3 x 380-480 V

Note: Other voltages are available on request.

Motor with multiplug

Gr7550

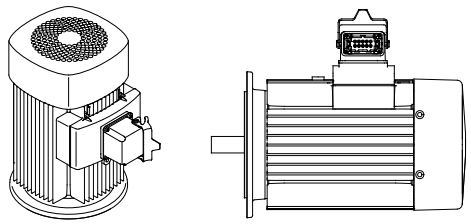
Fig. 10 Mains-operated motor with Harting® 10-pin multiplug

Mains-operated motors fitted with a Harting® 10-pin multiplug, HAN 10 ES, enable easy connection to the mains.

Note: For Grundfos motors with integrated frequency converter up to 7.5 kW, we offer the solutions shown on page 21.

The purpose of the multiplug is to make the electrical installation and service of the pump easier. The multiplug functions as a plug-and-pump device.

The drawings below show the position of the multiplug on the mains-operated motor.



TM01 8713 0700 - TM02 8518 0304

Fig. 11 Motor with multiplug

The following motor sizes are available with multiplug:

Motor power P2 [kW]	Voltage [V], starting method
0.37 - 7.5	3 x 220-240 Δ / 380-415 Y
0.37 - 7.5	3 x 380-415 Δ

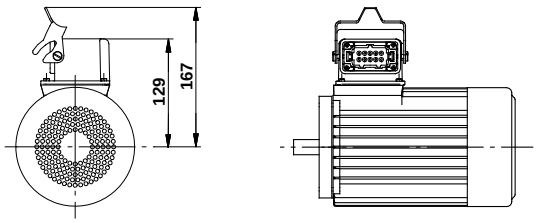
Logo for multiplug

TM02 0470 0700

Fig. 12 Logo for multiplug

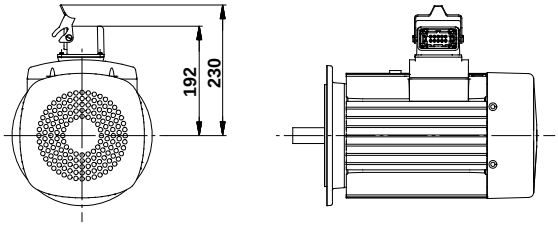
Dimensions

All dimensions are in mm.



TM01 8716 0700

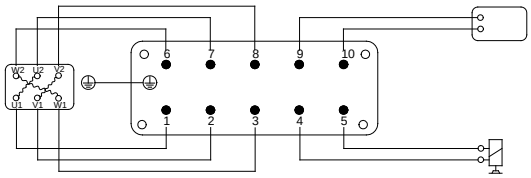
Fig. 13 Dimensions, 0.37 - 1.1 kW



TM01 8714 0700

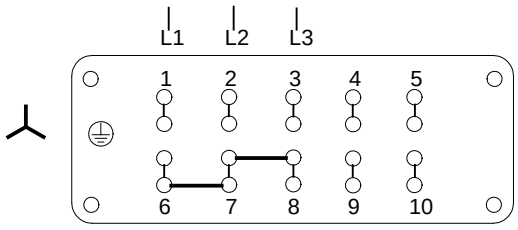
Fig. 14 Dimensions, 1.5 - 7.5 kW

Plug connections



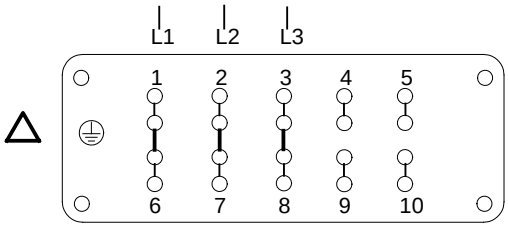
TM01 8702 0700

Fig. 15 Plug connection from motor



TM01 8703 0700

Fig. 16 Plug connection for star connection



TM01 8704 0700

Fig. 17 Plug connection for delta connection

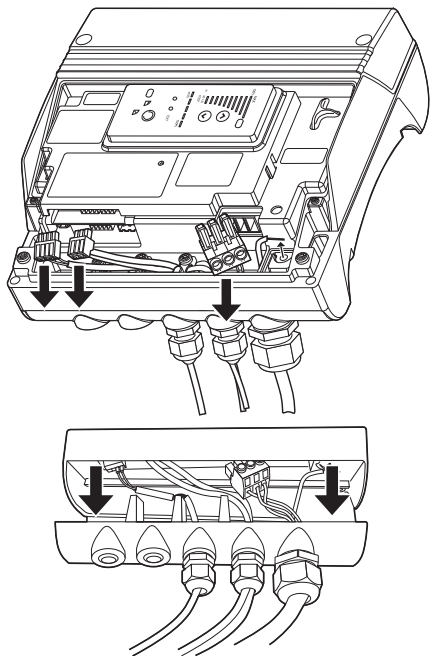
Note: Terminal connecting plates for connections are located in the plug.

Plug-and-pump solutions for E-pumps

To facilitate electrical installation and service of our three-phase E-pumps from 15-22 kW, 2-pole and 11 - 18.5 kW 4-pole, all motor terminal boxes are equipped with a detachable cable inlet bar.

When the cable inlet bar is removed, you can disconnect all electrical connections.

Figure 18 shows the location of the detachable cable inlet bar on the motor terminal box as well as plugs for mains connection, sensor and communication.



TM03 1964 3405 - TM03 1962 3405

Fig. 18 Location of the detachable cable inlet bar

Motor with anti-condensation heater

TM03 2440 4305

Fig. 19 Mains-operated motor with anti-condensation heater

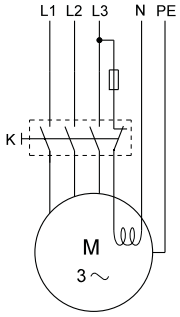
In applications where condensation in the motor may occur, we recommend that you install a motor with an anti-condensation heater on the stator coil ends. The heater keeps the motor temperature higher than the ambient temperature and prevents condensation.

High humidity may cause condensation in the motor. Slow condensation occurs as a result of a decreasing ambient temperature; rapid condensation occurs as a result of shock cooling caused by direct sunlight followed by rain. We recommend that you always use motors with anti-condensation heater in areas with ambient temperatures below 0 °C.

Note: Rapid condensation is not to be confused with the phenomenon which occurs when the pressure inside the motor is lower than the atmospheric pressure. In such cases, moisture is sucked from the atmosphere into the motor through bearings, housings etc.

In applications with constant high humidity levels above 85 %, the drain holes in the drive-end flange must be open. This changes the enclosure class to IP44. If IP55 protection is required due to operation in dusty environments, we recommend that you install a motor with anti-condensation heater.

The figure below shows a typical circuit of a three-phase motor with anti-condensation heater.



TM03 4058 1406

Fig. 20 Three-phase motor with anti-condensation heater

Key

Symbol	Designation
K	Contactor
M	Motor

Note: Connect the anti-condensation heater to the supply voltage so that it is on when the motor is switched off.

Motors from 0.37 to 355 kW are available with anti-condensation heater.

Motors with PTC sensors

TM02 7038 2403

Fig. 21 PTC sensor incorporated in winding

Built-in PTC sensors (thermistors) protect the motor against rapid as well as steady overload.

We offer motors with temperature-controlled PTC sensors in the motor windings.

Three-phase mains-operated motors from 3 kW and up have PTC sensors as standard.

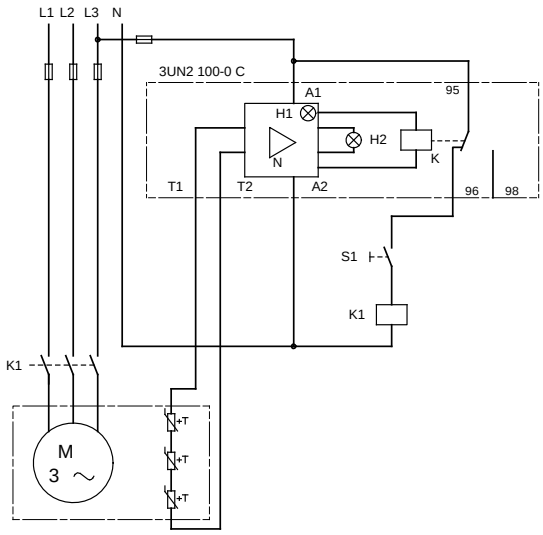
Note: Temperature-controlled PTC sensors must be connected to an external tripping unit connected to the control circuit.

Protection according to IEC 60034-11:

- TP 111 (steady overload only)
- TP 211 (steady and rapid overload).

PTC sensors comply with DIN 44 082. Maximum voltage at the terminals, U_{max} = 2.5 VDC. All tripping units available for DIN 44 082 PTC sensors meet this requirement.

The figure below shows a typical circuit of a three-phase motor with PTC sensors.



TM00 3965 1494

Fig. 22 Three-phase motor with PTC sensors

Key

Symbol	Designation
S1	On/off switch
K1	Contactor
+T	PTC sensor (thermistor) in motor
M	Motor
3UN2 100-0 C	Tripping unit with automatic reset
N	Amplifier
K	Output relay
H1	LED "Ready"
H2	LED "Tripped"
A1, A2	Connection for control voltage
T1, T2	Connection for PTC sensor loop

Motors with thermal switches

TM02 7042 2403

Fig. 23 Thermal switch incorporated in winding

Built-in thermal switches protect the motor against rapid as well as steady overload.

We offer three-phase mains-operated motors from 0.37 to 11 kW with built-in thermal switches.

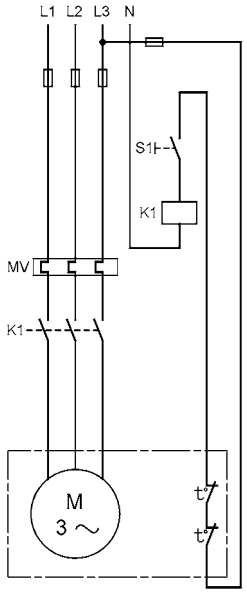
Note: Thermal switches must be connected to an external control circuit to protect the motor against steady overload. The thermal switches require no tripping unit.

Protection according to IEC 60034-11: TP 211 (steady and rapid overload). As protection against seizure, the motor must be connected to a motor-protective circuit breaker.

Thermal switches tolerate the following maximum loads:

$U_{max.}$	250 VAC
I_N	1.5 A
$I_{max.}$	5.0 A (locked-rotor and breaking current)

Figure 24 below shows a typical circuit of a three-phase motor with built-in bimetallic thermal switches.



TM00 3964 1494

Fig. 24 Three-phase motor with thermal switches

Key

Symbol	Designation
S1	On/off switch
K1	Contactor
t°	Thermal switch in motor
M	Motor
MV	Motor-protective circuit breaker

Oversize and undersize motors

Oversize motor

We recommend that you use an oversize motor if operating conditions fall much outside the operating conditions described in these data booklets:

- NB, NBE, NK, NKE, 50 Hz
- NB, NBE, NK, NKE, 60 Hz
- NBG, NBGE, NKG, NKGE, 50 Hz
- NBG, NBGE, NKG, NKGE, 60 Hz.

We especially recommend oversize motors in these cases:

- The pump is installed at an altitude above 1000 m.
- The ambient temperature exceeds +40 °C.
- The viscosity or density of the pumped liquid is higher than that of water. For precise calculation, please refer to Grundfos Product Center. See page 153.

Ambient temperature and altitude

Pump with standard motor

The ambient temperature and the installation altitude are important factors for motor life, as they affect the life of the bearings and the insulation system.

The installation altitude is the height of the installation site above sea level.

If the ambient temperature exceeds the recommended maximum ambient temperature or maximum altitude is above sea level, see fig. 25, the motor must not be fully loaded due to the low density and consequently low cooling effect of the air. In such cases it may be necessary to use a motor with a higher output.

Ambient temperature

Motor make	Motor P2 [kW]	Permissible ambient temperature [°C]
MG	0.25 - 0.55	-20 to +40
	0.75 - 22	-20 to +60
Siemens	0.75 - 462	-20 to +55
MMG-H2	0.75 - 450	-20 to +60
MMG-H3	0.75 - 200	-30 to +60

Maximum motor output in relation to ambient temperature and altitude

Motor make	Motor P2 [kW]	Derating curve
MG	0.25 - 0.55	Fig. 25, curve 1
	0.75 - 22	Fig. 25, curve 2
Siemens	0.75 - 462	Fig. 25, curve 3
MMG-H2	0.75 - 450	Fig. 25, curve 2
MMG-H3	0.75 - 200	Fig. 25, curve 2

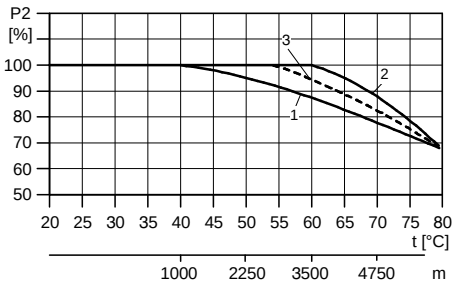


Fig. 25 Maximum motor output in relation to ambient temperature and altitude

Example with a pump with a 1.1 kW IE3 MG motor: If the pump is installed 4750 m above sea level, the motor must not be loaded more than 88 % of rated output. At an ambient temperature of 75 °C, the motor must not be loaded more that 78 % of rated output. If the pump is installed 4750 m above sea level at an ambient temperature of 75 °C, the motor must not be loaded more than 88 % x 78 % equal to 68.6 % of rated output.

Pump with Grundfos MGE motor

Ambient temperature

Motor make	Motor P2 [kW]	Number of poles	Permissible ambient temperature [°C]
Grundfos MGE	1.1 - 11	2	-20 to +50
	15-22	2	-20 to +40
	0.55 - 7.5	4	-20 to +50
	11 - 18.5	4	-20 to +40

The motor can operate with the rated power output, P2, at 50 °C, but continuous operation at higher temperatures reduces the expected product life. If the motor is to operate at ambient temperatures between 50 and 60 °C, select an oversize motor.

Contact Grundfos for further information.

Installation altitude

Motors installed up to 1000 metres above sea level can be loaded 100 %.

Motors installed more than 1000 metres above sea level must not be fully loaded due to the low density and consequent low cooling effect of the air.

See fig. 26.

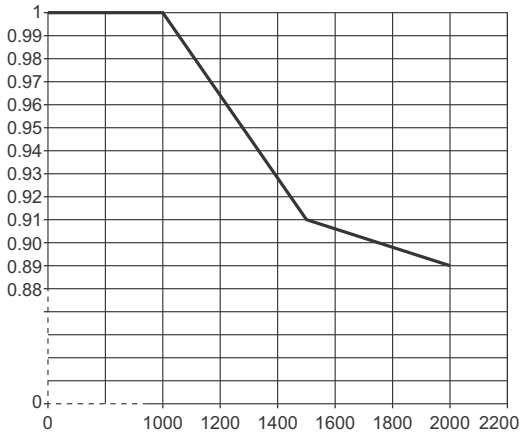


Fig. 26 Maximum motor output in relation to altitude

Undersize motor

We recommend that you use an undersize motor if operating conditions fall much inside the standard conditions described in these data booklets:

- NB, NBE, NK, NKE, 50 Hz
- NB, NBE, NK, NKE, 60 Hz
- NBG, NBGE, NKG, NKGE, 50 Hz
- NBG, NBGE, NKG, NKGE, 60 Hz.

We especially recommend undersize motors in these cases:

- The viscosity or density is lower than that of water.

The duty point of the pump is constant, and the flow rate is significantly lower than the maximum recommended flow rate. For precise calculation, please refer to Grundfos Product Center. See page 153.

Insulated bearing

Frequency converters make it possible to control the motor speed and to adapt the motor speed to varying loads.

These motors can generate stray currents that result in electrical arcing through the bearing and that can lead to bearing failure. To prevent this from happening, insulated bearings are used.

Grundfos provides insulated bearings for frequency-controlled motors. Insulated bearings are especially necessary when the frame size of a frequency-controlled motor is above 225.

Enclosure class (IP class)

The motor enclosure class complies with IEC 60034-5.

The enclosure class states the degree of protection of the motor against ingress of solid objects and water.

All motors comply with IP55 as standard.

On request, we offer motors in accordance with IP54 and IP65.

IP class	Description
IP54	• The motor is protected against the ingress of dust, i.e. harmful layers of dust. • The motor is protected against water splashing from any direction.
IP55	• The motor is protected against the ingress of dust, i.e. harmful layers of dust. • The motor is protected against water being projected by a nozzle from any direction.
IP56	• The motor is protected against the ingress of dust. • The motor is protected against heavy seas or high-pressure water jets from any direction.
IP65	• The motor is completely dust-proof. • The motor is protected against water being projected by a nozzle from any direction.

Efficiency class

The new EN standard 60034-30:2009 defines the following efficiency classes for low-voltage three-phase asynchronous motors from 0.75 to 375 kW:

- IE2
- IE3
- IE4
- IE5.

IE = International Efficiency.

Three-phase motors of NB, NBG, NK, NKG pumps are IE3 motors as standard.

NB, NBG, NK, NKG pumps with IE2, IE4 or IE5 motors are available on request.

Other motor makes

We also offer the pumps with a motor of any other make provided the installation dimensions and interfaces with pump components match the Grundfos motors used for the standard pump range.

Alternatively, Grundfos pumps can be supplied without a motor.

6. Shaft seals

Shaft seals, overview

Single mechanical shaft seals

Grundfos offers these single shaft seal variants:

Standard mechanical seals		
Rubber bellows seals	Unbalanced O-ring seals	Balanced O-ring seals
		
BAQE BAQV BBQE BBQV BQQE BQQV	AQAE AQAV AQQE AQQV AQQX AQQK	DAQF DQQE DQQV DQQX DQQK

Cartridge seal
Balanced cartridge O-seal ring

HBQV

Double mechanical shaft seals

Grundfos offers these single shaft seals to be combined into double shaft seals. The seals can be used as both primary and secondary seals.

Standard mechanical seals		
Rubber bellows seals	Unbalanced O-ring seals	Balanced O-ring seals
		
BAQE BBQE BBQV BQQE BQQV	AQQE AQQV AQQX AQQK	DAQF DQQE DQQV DQQX DQQK

Cartridge seals
Balanced cartridge O-seal rings

HBQV/HBQV HQQU/HBQV HAQK/HAQK

Common combinations of primary and secondary seals

The primary shaft seal is fitted on the liquid side of the shaft seal chamber, and the secondary shaft seal is fitted on the atmospheric side. See also fig. 30.

If other combinations are needed, contact your local Grundfos supplier.

Primary shaft seals	Secondary shaft seals
BBQE	BQQE, BBQE
BBQV	BQQV, BBQV
BQQE	AQQE, BQQE, BBQE, DQQE
BQQV	AQQV, BQQV, BBQV, DQQV
AQQE	AQQE, BQQE, BBQE, DQQE
AQQV	AQQV, BQQV, BBQV, DQQV
AQQX	AQQX, DQQX
AQQK	AQQE, BQQE, BBQE, DQQE AQQV, BQQV, BBQV, DQQV AQQK, DQQK
DAQF	BAQE, BAQV, DAQF
DQQE	AQQE, BQQE, BBQE, DQQE
DQQV	AQQV, BQQV, BBQV, DQQV
DQQX	AQQX, DQQX
DQQK	AQQE, BQQE, BBQE, DQQE AQQV, BQQV, BBQV, DQQV AQQK, DQQK
HBQV/HBQV (cartridge seal)	
HQQU/HBQV (cartridge seal)	

Stuffing boxes

Grundfos offers these stuffing box variants:

Internal barrier liquid	Without barrier liquid	External barrier liquid
		
SNEA SNEB SNEC SNED	SNOA SNOB SNOC SNOD	SNFA SNFB SNFC SNFD

See page 37 for more details about the available stuffing boxes.

Selecting a shaft seal solution

The selection of a shaft seal solution to match the needs of your application involves considering a lot of parameters, the most important being:

- operating pressure
- type of pumped liquid
- liquid temperature
- liquid concentration.

As more parameters may also have to be considered, always fill out the key application data sheets on page 149 in cooperation with a Grundfos representative.

Selection process

1. Fill out the key application data sheets in cooperation with a Grundfos representative. See page 149.
2. Select shaft seal arrangement
   – *Single-seal arrangements*, see page 27.
   – *Double-seal arrangements*, see pages 28 and 38.
   – *Stuffing boxes*, see page 28.
3. Select seal details
   – *Shaft seal types* (**X**xxx), see page 29.
   – *Shaft seal faces* (x**XX**x), see page 29.
   – *Shaft seal elastomers* (xxx**X**), see page 31.

Shaft seal arrangements, overview

Pump	Single seal		Double seal				Stuffing box
			Back-to-back		Tandem		
	Standard	Cartridge	Standard	Cartridge	Standard	Cartridge	
NB	•	-	-	-	-	-	-
NBG	•	-	-	-	-	-	-
NK	•	-	-	-	-	-	•
NKG	•	•	•	•	•	•	•

Single-seal arrangements

Standard single-seal arrangements

This seal type consists of three or more parts mounted in a single-seal arrangement. This seal arrangement is capable of handling a large variety of liquids.

NB, NBG

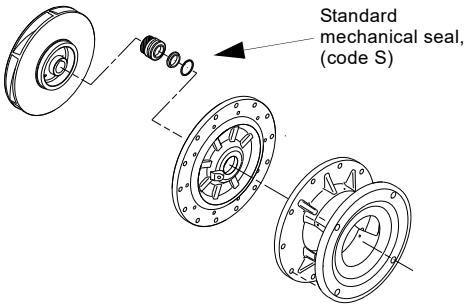


Fig. 27 NB, NBG with standard single-seal arrangement

NK, NKG

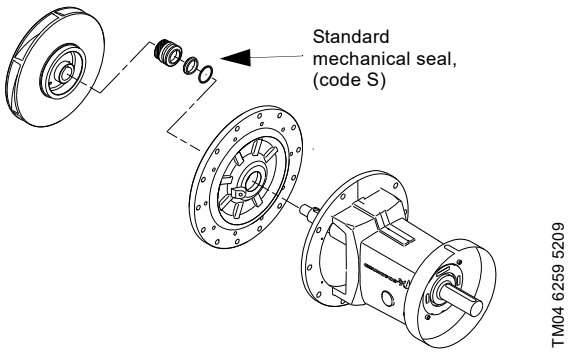
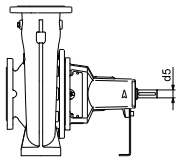


Fig. 28 NK, NKG with standard single-seal arrangement

Shaft seal arrangement code "S" is available for the following pumps.

Pump type	d5 [mm]				
	24	32	42	48	60
NB, NBE	•	•	•	•	•
NBG, NBGE	•	•	•	•	•
NK, NKE	•	•	•	•	•
NKG, NKGE	•	•	•	•	•



Single-seal arrangements as cartridge solution

NKG

Grundfos also offers a single mechanical shaft seal as a cartridge solution.

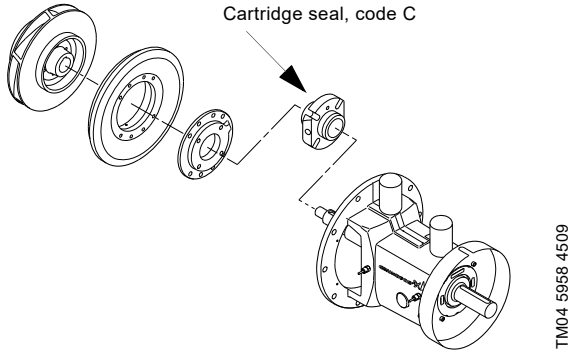
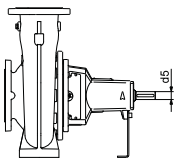


Fig. 29 Cartridge single-seal arrangement in NKG

Shaft seal arrangement code "C" is available for the following pumps.

Pump type	d5 [mm]				
	24	32	42	48	60
NB, NBE	-	-	-	-	-
NBG, NBGE	-	-	-	-	-
NK, NKE	-	-	-	-	-
NKG, NKGE	•	•	•	•	•



Double-seal arrangements

NKG

Grundfos offers two types of double-seal arrangement:

- back-to-back
- tandem.

Both arrangements are available either as standard mechanical seals or as a cartridge seal solution.

Standard double-seal arrangement

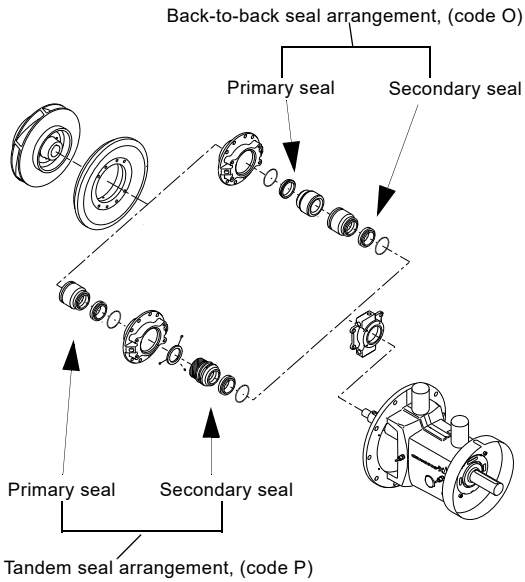


Fig. 30 NKG pump with double-seal arrangements for a standard mechanical seals arranged in back-to-back or tandem.

Double-seal arrangement as a cartridge solution

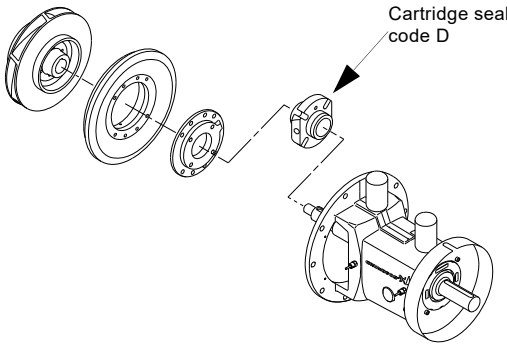
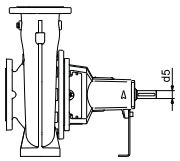


Fig. 31 NKG pump with double-seal arrangement for a cartridge seal with integrated back-to-back or tandem function.

Shaft seal arrangement code "D, O and P" are available for the following pumps.

Pump type	d5 [mm]				
	24	32	42	48	60
NB, NBE	-	-	-	-	-
NBG, NBGE	-	-	-	-	-
NK, NKE	-	-	-	-	-
NKG, NKGE	●	●	●	●	●



Stuffing boxes

NK, NKG

Various types of stuffing box are available for NK and NKG as an alternative to shaft seals. Stuffing boxes are less sensitive than shaft seals and are suitable for many different applications.

Stuffing boxes are only available for cast iron pumps.

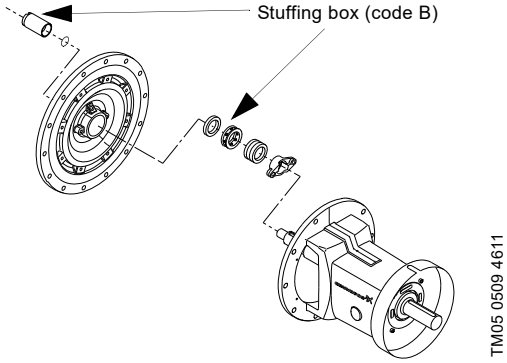
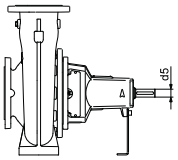


Fig. 32 NKG with stuffing box

Shaft seal arrangement code "B" is available for the following pumps. See pump range on page 8.

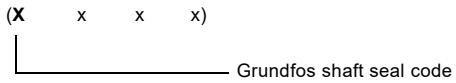
Pump type	d5 [mm]				
	24	32	42	48	60
NB, NBE	-	-	-	-	-
NBG, NBGE	-	-	-	-	-
NK, NKE	●	●	-	-	-
NKG, NKGE	●	●	-	-	-



Shaft seal details

This section contains detailed information about shaft seals used in NB, NBG, NK and NKG pumps.

Shaft seal types



Type A

Unbalanced O-ring seal

Robust O-ring seal featuring a rigid torque transmission design required for hard material pairings (SiC/SiC), even where lubrication is poor. The dynamic secondary seal is an O-ring.
This involves risk of wear on the shaft under the O-ring and of seal hang-up (blocking of axial movement of the rotating seal ring).

Type B

Rubber bellows seal

Bellows seal with torque transmission across the spring and around the bellows. Therefore it is not designed for hard material pairings in applications with poor lubrication. Due to the bellows, the seal does not wear the shaft, and the axial movement is not prevented by deposits or seizure on the shaft.

Type D

Balanced O-ring seal with spring on the atmospheric side.

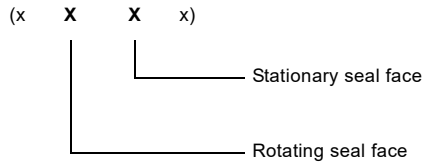
Due to the balancing, this O-ring seal type is suitable for high-pressure applications. The seal is excellent for high-viscosity, dirt- and fibre-containing liquids because the spring is located on the atmospheric side. The seal features rigid torque transmission design.

Type H

Balanced, cartridge O-ring seal

This seal type featuring a rigid torque transmission system is assembled in a cartridge unit which makes replacement safe and easy. Similar to the type D seal, the balancing makes this O-ring seal type suitable for high-pressure applications. The cartridge construction also protects the pump shaft from possible wear from a dynamic O-ring between pump shaft and shaft seal.

Shaft seal faces



The choice of seal face materials is decisive of the function and life of the mechanical shaft seal. The seal faces have to be paired to match the pumped liquid. When pairing the seal faces, consider these seal face parameters:

- dry-running properties
- corrosion resistance to the pumped liquid
- lubricating properties
- ability to withstand abrasive particles.

Seal face material pairings

x**AQ$_1$**x - (shaft seal types AQAx, BAQx, DAQx and HAQx)

Antimony-impregnated carbon graphite (A) against sintered pressureless dense SiC (Q_1) is a widely used seal face material pairing.

Note: The antimony impregnation is not approved for potable water applications.

This pairing also withstands dry running for some minutes without causing major damage to the mechanical shaft seal. Yet, dry running may cause some reduction in seal life.

Due to the favourable lubricating properties of carbon graphite, the seal is suitable for use even under poor lubricating conditions, such as hot water. The use of the carbon graphite/SiC pairing for hot-water applications may cause heavy wear on the SiC face, as grinding particles can be stuck into the carbon graphite seal face. For hot water applications the corrosion resistance is reduced.

If the pumped liquid contains hard particles, wear on the seal faces must be expected.

x**BQ_1**x - (shaft seal types BBQE, BBQV and HBQV)

Resin-impregnated carbon graphite (B) against sintered pressureless dense SiC (Q_1) is also a widely used seal face material pairing. Especially suitable for water up to +90 °C.

Note: The resin impregnation is approved for potable water applications.

The corrosion resistance of the carbon graphite/SiC pairing is very good. This pairing also withstands dry running for some minutes without causing major damage to the mechanical shaft seal. Yet, dry running may cause some reduction in seal life.

Due to the favourable lubricating properties of carbon graphite, the seal is suitable for use even under poor lubricating conditions, such as hot water. However, this condition may cause heavy wear on the seal faces and seal life will be reduced significantly.

If the pumped liquid contains abrasive particles, wear on the seal faces must be expected.

x**Q_1Q_1**x - (shaft seal types BQQx, AQQx and HQQU)

Sintered pressureless dense SiC (Q_1) against sintered pressureless dense SiC (Q_1).

This SiC/SiC material pairing is used where higher corrosion resistance is required. This material pairing has good resistance against abrasive particles due to the high hardness.

The dry friction of this combination is high. Consequently, the shaft seal material pairing has poor dry-running properties. Seal faces running completely dry may be damaged within less than one minute of running dry. The temperature in the seal rises dramatically, and the shaft seal elastomers will be damaged as well.

x**Q_6Q_6**x - (shaft seal type DQQx)

Sintered pressureless SiC with carbon (Q_6) against sintered pressureless SiC with carbon (Q_6).

This SiC/SiC material pairing is used where higher corrosion resistance is required. This material pairing has good resistance against abrasive particles due to the high hardness.

The dry friction of this combination is high. Yet, compared to the Q_1/Q_1 SiC seal face combinations, the dry friction is lower.

Due to the lower friction the Q_6/Q_6 pairing can be used continuously for water up to +120 °C.

x**Q_7Q_7**x - (shaft seal type BQQx)

Pressureless sintered porous SiC (Q_7) against pressureless sintered porous SiC (Q_7).This SiC/SiC material pairing is used where higher corrosion resistance is required, it has good resistance against abrasive particles due to the high hardness.

This material pairing can operate with water temperatures up to +120 °C, but the dry friction of this combination is high, and it is therefore important NOT to expose this seal pairing to dry-running. Seal faces running completely dry may be damaged within less than one minute of running dry. The temperature in the seal rises dramatically and the shaft seal elastomers will be damaged as well.

We recommend this material pairing for operation with glycols.

Shaft seal elastomers

(x x x **X)**

Seal elastomers

Elastomers refer to polymers with a high degree of elasticity. The material is also known under the term rubber.

The choice of materials for shaft seal elastomers, i.e. rubber components such as O-rings and bellows, is just as important as the choice of seal face combinations. Both are essential to the functioning of the mechanical shaft seal. The Grundfos seals are intended to cover a wide application field with few materials. The sections below list main material properties as regards temperature and resistance to principal liquid groups. In case of doubt and where special liquids are involved, please contact Grundfos.

For an overview of temperature and chemical resistance of elastomer materials, see the table in *Elastomers operating dynamically* on page 32.

EPDM (xxxE)

We recommend shaft seals with EPDM material for water and aqueous solutions. EPDM rubber is non-resistant to mineral oils.

- Good mechanical properties at low temperatures
- can be operated at low temperatures down to -35 °C (TR30)
- resistant to water up to +140 °C
- resistant to polar solvents (alcohols, ketones and esters)
- resistant to ozone
- resistant to glycol
- resistant to saline solutions
- partly resistant to vegetable oils at low temperatures
- not resistant to mineral oils.

Shaft seals with EPDM O-rings can be operated at these temperatures:

- low temperatures down to -35 °C
- high temperatures up to +140 °C.

Shaft seals with EPDM bellows have geometries that limit the operating range in both cold and hot applications. The shaft seals can be operated at these temperatures:

- low temperatures down to -25 °C
- high temperatures up to +120 °C.

FKM (xxxV)

We recommend shaft seals with FKM material for a wide range of temperatures and pumped liquids.

- Poor mechanical properties at low temperatures
- can be operated at low temperatures down to -10 °C
- resistant to water up to +90 °C
- resistant to mineral oils and vegetable oils up to +200 °C
- resistant to acids and saline solutions
- resistant to most solvents (toluene, petrol, trichloroethylene, etc.)
- resistant to ozone
- not resistant to certain polar solvents (e.g. alcohols, ketones and esters)
- not resistant to alkaline liquids at high temperatures
- not resistant to fluorinated compounds (e.g. HFC refrigerants).

Shaft seals with FKM O-rings can be operated at these temperatures:

- low temperatures down to -10 °C
- high temperatures up to +200 °C.

Shaft seals with FKM bellows have geometries that limit the operating range in hot applications. The shaft seals can be operated at these temperatures:

- low temperatures down to -10 °C
- high temperatures up to +120 °C.

FFKM (xxxK)

FFKM (perfluoroelastomer) is chemically resistant to a wide range of liquids. FFKM rubber corresponds to PTFE, but offers considerably better mechanical properties.

- Good mechanical properties
- can be operated at low temperatures down to -10 °C
- resistant to water up to +230 °C
- resistant to mineral oils and vegetable oils up to +230 °C
- especially suitable for use in chemical processing plants, in the production of dyes, paints, varnishes, solvents, nitric acid, etc.
- resistant to ozone
- not resistant to amines and strongly alkaline liquids at high temperatures
- not resistant to fluorinated compounds (e.g. HFC refrigerants).

Shaft seals with FFKM O-rings can be operated at these temperatures:

- low temperatures down to -10 °C
- high temperatures up to +230 °C.

FXM (xxxF)

FXM (fluorinated copolymer) is particularly suitable for extremely high temperatures and pressures as well as for use in acid liquids and gasses within oil and gas extraction (in boreholes, on land and at sea). Its resistance to chemicals and high temperatures has been considerably improved as compared to fluorinated rubber, with excellent resistance to hot water and steam.

- Elastic seal material
- not recommended at temperatures below 0 °C
- resistant to water up to +200 °C, for short periods up to +300 °C
- resistant to mineral oils and vegetable oils up to +230 °C
- resistant to sudden decompression
- resistant to alkaline liquids at high temperatures
- not resistant to certain polar solvents (e.g. ketones and esters)
- not resistant to fluorinated compounds (e.g. HFC refrigerants).

Shaft seals with FXM O-rings can be operated at these temperatures:

- low temperatures down to 0 °C
- high temperatures up to +200 °C.

HNBR (xxxX)

Widely used for all-round applications, HNBR (nitrile) rubber covers a wide range of liquids at relatively low temperatures (below +100 °C).

- Good mechanical properties at high and low temperatures
- can be operated at low temperatures down to -15 °C
- heat-resistant up to +110 °C; for short periods up to +120 °C
- resistant to water up to +110 °C
- resistant to diesel oil, various mineral oils, grease and vegetable oils
- resistant to weak acids and alkalis
- not resistant to polar solvents (alcohols, ketones and esters)
- not resistant to ozone.

Shaft seals with HNBR O-rings can be operated at these temperatures:

- low temperatures down to -15 °C
- high temperatures up to +110 °C.

Elastomers operating dynamically

The table below gives a simplified overview of fields of application for the dynamically operating elastomers of our shaft seal range. In operation these elastomers are able to move slightly on the shaft and adapt to changing temperatures and pressures.

Pumped liquid	Elastomer						
	EPDM		FKM		FFKM	FXM	HNBR
	Bellows	O-ring	Bellows	O-ring	O-ring	O-ring	O-ring
Water, max. temperature [°C]	120	140	90	90	230	200	110
Mineral oils, max. temperature [°C]	-	-	120	200	230	220	110
Lowest operating temperature [°C]	-25	-35	-10	-10	-10	0	-15
Acids	+/-		+/-		+	+/-	+/-
Alkalis	+		-		+	+	+
Glycols	+		+/-		+	+	+
Oils, fuels	-		+		+	+/-	+/-
Solvents	+/-		+/-		+	+/-	-
Abrasive particles	+		+/-		-	+/-	+

Legend:
+ = Excellent
+/- = Good under certain conditions
- = Poor

Elastomers operating statically

An elastomer operating in a fixed position regardless of temperature and pressure fluctuation has an increased range of operation. For very cold applications a shaft seal with an O-ring in a fixed position is used.

Pumped liquid	Elastomer	
	EPDM	
	Bellows	O-ring
Water, max. temperature [°C]	-	150
Mineral oils, max. temperature [°C]	-	-
Lowest operating temperature [°C]	-	-45

Operating conditions

The operating conditions of shaft seals depend on a number of factors. All these must be considered in order to find the right shaft seal for a specific application.

The following factors are always vital to take into consideration:

- operating temperature
- operating pressure.

Additional operating conditions should be stated on the "key application data sheet". These could be liquid concentration, viscosity, boiling point, particles in liquid, conductivity of the liquid, etc.

Operating range of a mechanical shaft seal

General specifications

The operating range of a shaft seal is normally specified with minimum and maximum values for temperature and maximum pressure by the supplier of the shaft seal.

Example: A shaft seal, type DQQE, is specified for a temperature range of 0 °C to +120 °C and a maximum pressure of 25 bar in water.

The maximum temperature and maximum pressure do not apply simultaneously, as this may reduce the lifetime and cause periodical noise.

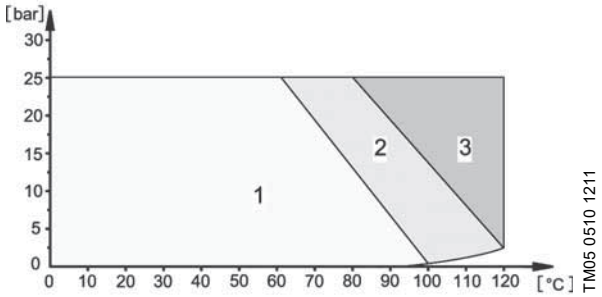


Fig. 33 Operating ranges

Pos.	Description
1	Optimum operating range
2	Risk of periodical noise in connection with startup and variations in pressure and temperature.
3	Risk of periodical noise and reduced life.

Specifications for different liquids

Due to the shaft seal design and the chemical resistance of the components, a specific shaft seal is suitable for some pumped liquids and not for others. Additionally the seal will have different operating ranges depending on the pumped liquid.

The commonly used liquids have been categorised to visualise this fact, see fig. 34 and the tables on page 34 to 36.

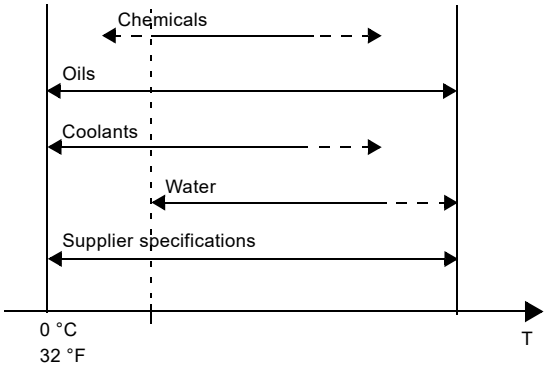


Fig. 34 Temperature operating range for a mechanical shaft seal for different categories of liquids compared with supplier specifications.

The categories of different pumped liquids illustrate this.

- A seal operating in water can operate from 0 °C (the freezing point of water) to the maximum operating temperature of the shaft seal.
- A seal operating in coolants can operate from the minimum rating of the shaft seal and to a maximum temperature depending on the properties of the coolant.
- A seal operating in oils can often be used in the whole temperature operating range as oils can be cold or very hot. Additionally the boiling point of an oil is normally above the maximum operating temperature of the shaft seal which ensures a good lubrication of the seal faces.
- A seal operating in chemicals is usually also a subject to other factors than temperature and pressure, and the operating range will sometimes be even narrower as a result of this.

Viscosity influence on a mechanical shaft seal

The leakage rate from a mechanical shaft seal depends on the viscosity of the pumped liquid.

When operating in a liquid with a higher viscosity the leakage rate will increase.

The run-in period for a mechanical shaft seal depends also on the viscosity of the liquid to be sealed. The run-in period will also increase for an increased viscosity of the pumped liquid.

Grundfos mechanical shaft seal guidelines

The following tables (fig. 35 to fig. 39) represent the liquid categories which Grundfos has defined. The tables show the operating temperature and pressure of the range of seals that are available for NB, NBG, NK, NKG pumps.

Each of the pumped liquid categories cover a number of different pumped liquids, yet the operating range of a specific liquid may be narrower than specified in the tables.

Note: The data should only be seen as a guideline for choosing the right shaft seal for an application. No guarantee can be given for a specific application unless the exact conditions of the application are known.

For a specific request, please refer to the *14. Key application data* sheets on pages 149-151.

Water

Characteristics for the category

Water covers a very broad range of liquids ranging from ultra pure water to seawater and water containing abrasive particles.

What to consider for the shaft seal selection

For ultra pure water (1-10 µs/cm) and deionised water (10-50 µs/cm) an xBQx seal face combination shall be used.

FKM (xxxV) is limited to 90 °C in water.

If abrasive particles are present, an xQQx seal face combination must be used.

TM04 6828 1210

Shaft seal code	Temperature range [°C]	Max. p [bar]	Availability: Shaft seal diameter [mm]					Pumps	
			28	38	48	55	60	NB, NBG, NK	NKG
BAQE	0 to +120	16	•	•	•	•	•	•	•
BAQV	0 to +90	16	•	•	•	•	•	•	•
BBQE	0 to +120	16	•	•	•	•	•	•	•
BBQV	0 to +90	16	•	•	•	•	•	•	•
BQBE	0 to +100	16	•	•	-	-	-	•	•
BQQE	0 to +120	16	•	•	•	•	•	•	•
BQQV	0 to +90	16	•	•	•	•	•	•	•
AQAE	0 to +120	16	•	•	•	•	•	•	•
AQAV	0 to +90	16	•	•	•	•	•	•	•
AQQE	0 to +90	16	•	•	•	•	•	•	•
AQQV	0 to +90	16	•	•	•	•	•	•	•
AQQX	0 to +90	16	•	•	•	•	•	•	•
AQQK	0 to +90	16	•	•	•	•	•	•	•
DAQF	0 to +140	25	•	•	•	•	•	•	•
DQQE	0 to +120	25	•	•	•	•	•	•	•
DQQV	0 to +90	25	•	•	•	•	•	•	•
DQQX	0 to +120	25	•	•	•	•	•	•	•
DQQK	0 to +120	25	•	•	•	•	•	•	•
HBQV	0 to +90	25	•	•	•	•	•	-	•
HBQV/HBQV	0 to +90	25	•	•	•	•	•	-	•
HQQU/HBQV	0 to +90	16	•	•	•	•	•	-	•
HAQK/HAQK	0 to +220	25	•	•	•	•	•	-	•

Fig. 35 Operating range of shaft seals in water

Examples of pumped liquids in this category:

- boiler water
- brackish water
- demineralised water
- district heating water
- seawater
- chlorinated water.

Coolants

Characteristics for the category

Coolants typically contain additives (corrosion inhibitors, descaling agents, biocides, etc.) which may result in deposits on the seal faces.

Also the viscosity is higher than for water.

What to consider for the shaft seal selection

Most deposits are avoided by using a hard seal face combination (xQQx), as such seal faces will have a "self-cleaning" effect.

Note: In case of higher viscosities, especially at low temperatures, the run-in phase of the shaft seal faces may be up to one month or in special cases even longer. In this period, the leakage rate will be higher than normal and this leakage can be visible on the pump.

TM04 6828 1210

Shaft seal code	Temperature range [°C]	Max. p [bar]	Availability: Shaft seal diameter [mm]					Pumps	
			28	38	48	55	60	NB, NBG, NK	NKG
BQQE[1)]	-25 to +120	16	•	•	•	•	•	•	•
BQQV	-10 to +90	16	•	•	•	•	•	•	•
AQQE[2)]	-25 to +90	16	•	•	•	•	•	•	•
AQQV	-10 to +90	16	•	•	•	•	•	•	•
AQQX	-15 to +90	16	•	•	•	•	•	•	•
AQQK	0 to +90	16	•	•	•	•	•	•	•
DQQE	-20 to +120	25	•	•	•	•	•	•	•
DQQV	-10 to +90	25	•	•	•	•	•	•	•
DQQX	-15 to +120	25	•	•	•	•	•	•	•
DQQK	0 to +120	25	•	•	•	•	•	•	•
HQQU/HBQV	-10 to +90	16	•	•	•	•	•	-	•

Fig. 36 Operating range of shaft seals in coolants

1) If the operation is very stable, only varying 5 °C and with a small pressure change, the allowed minimum temperature is -30 °C.
2) If the operation is very stable, only varying 5 °C and with a small pressure change, the allowed minimum temperature is -35 °C.

For temperatures lower than -35 °C, Grundfos can provide optional seals. Please contact Grundfos for more information.

Examples of pumped liquids in this category:

- ethylene glycol based liquids
- potassium formate/acetate based liquids
- propylene glycol based liquids.

Oils

Characteristics for the category

Oils typically have higher viscosities than water. Operating in an oil with a high viscosity results in a slightly increased leakage rate.

The evaporation of the pumped liquid through the seal faces is very small (insignificant) but can often be identified by a smell.

Some oils also contain impurities/abrasive particles which have to be considered for the shaft seal selection.

What to consider for the shaft seal selection

If the pumped liquid contains impurities/abrasive particles, xQQx seal face combinations must be used. The hard combination (xQQx) of the seal faces are suitable for the pumped liquid as long as the particles are softer than the seal faces. If the particles are considered harder than the seal faces, a back-to-back seal arrangement must be used to obtain an acceptable life of the seals.

Note: If water is present in the oil, the operating temperature for FKM is limited to 90 °C and 80 °C for HNBR. FKM and HNBR in a water-free oil allow a higher liquid temperature.

Note: As oil only has an insignificant evaporation through the seal faces, the leakage from the shaft seal will accumulate and be visible.

TM04 6828 1210

Shaft seal code	Temperature range [°C]	Max. p [bar]	Availability: Shaft seal diameter [mm]					Pumps	
			28	38	48	55	60	NB, NBG, NK	NKG
BAQV	-10 to +120	16	•	•	•	•	•	•	•
BBQV	-10 to +120	16	•	•	•	•	•	•	•
BQQV	-10 to +120	16	•	•	•	•	•	•	•
AQAV	-10 to +200	16	•	•	•	•	•	•	•
AQQV	-10 to +200	16	•	•	•	•	•	•	•
AQQX	-10 to +130	16	•	•	•	•	•	•	•
AQQK	0 to +220	16	•	•	•	•	•	•	•
DAQF	0 to +220	25	•	•	•	•	•	•	•
DQQV	-10 to +180	25	•	•	•	•	•	•	•
DQQX	-10 to +130	25	•	•	•	•	•	•	•
DQQK	0 to +180	25	•	•	•	•	•	•	•
HBQV	-10 to +200	25	•	•	•	•	•	-	•
HBQV/HBQV	-10 to +200	25	•	•	•	•	•	-	•
HQQU/HBQV	-10 to +200	16	•	•	•	•	•	-	•

Fig. 37 Operating range of shaft seals in oils

Examples of pumped liquids in this category:

- vegetable oils
- lubricating oil, mineral
- lubricating oil, synthetic
- oil based coolants
- heavy oil.

Silicone oil

Characteristics for the category

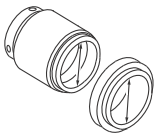
Silicone oil is characterised by being an inert oil and is available in numerous variants with varying viscosities ranging from very thin to highly viscous liquids.

What to consider for the shaft seal selection

The operating conditions for a silicone oil are to a large extent similar to those of oils. One main difference is that EPDM rubber is suitable for silicone oil.

Silicone oils with a high viscosity have the same characteristics as oils. The higher viscosity will lead to a slightly increased leakage rate for the shaft seal.

Note: As silicone oil only has an insignificant evaporation through the seal faces, the leakage from the shaft seal will accumulate and be visible.



TM04 6828 1210

Shaft seal code	Temperature range [°C]	Max. p [bar]	Availability: Shaft seal diameter [mm]					Pumps	
			28	38	48	55	60	NB, NBG, NK	NKG
BAQE	-25 to +120	16	•	•	•	•	•	•	•
BAQV	-10 to +120	16	•	•	•	•	•	•	•
BBQE	-25 to +120	16	•	•	•	•	•	•	•
BBQV	-10 to +120	16	•	•	•	•	•	•	•
BQQE	-25 to +120	16	•	•	•	•	•	•	•
BQQV	-10 to +120	16	•	•	•	•	•	•	•
AQAE	-25 to +120	16	•	•	•	•	•	•	•
AQAV	-10 to +200	16	•	•	•	•	•	•	•
AQQE	-25 to +90	16	•	•	•	•	•	•	•
AQQV	-10 to +200	16	•	•	•	•	•	•	•
AQQX	-15 to +130	16	•	•	•	•	•	•	•
AQQK	0 to +220	16	•	•	•	•	•	•	•
DAQF	0 to +220	25	•	•	•	•	•	•	•
DQQE	-20 to +120	25	•	•	•	•	•	•	•
DQQV	-10 to +180	25	•	•	•	•	•	•	•
DQQX	-15 to +130	25	•	•	•	•	•	•	•
DQQK	0 to +180	25	•	•	•	•	•	•	•
HBQV	-10 to +200	25	•	•	•	•	•	-	•
HBQV/HBQV	-10 to +200	25	•	•	•	•	•	-	•
HQQU/HBQV	-10 to +200	16	•	•	•	•	•	-	•

Fig. 38 Operating range of shaft seals in silicone oil

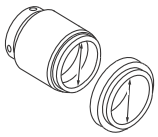
Examples of pumped liquids in this category: silicone oil.

Chemicals

Characteristics for the category

Chemicals cover a broad range of different liquids such as acids, alkalis, solvents, salts, and many more.

Therefore no general properties for chemicals can be listed.



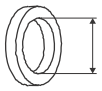
TM04 6828 1210

Shaft seal code	Temperature range [°C]	Max. p [bar]	Availability: Shaft seal diameter [mm]					Pumps	
			28	38	48	55	60	NB, NBG, NK	NKG
BAQE	-25 to +120	16	•	•	•	•	•	•	•
BAQV	-10 to +90	16	•	•	•	•	•	•	•
BBQE	-25 to +120	16	•	•	•	•	•	•	•
BBQV	-10 to +90	16	•	•	•	•	•	•	•
BQQE	-25 to +120	16	•	•	•	•	•	•	•
BQQV	-10 to +90	16	•	•	•	•	•	•	•
AQAE	-25 to +120	16	•	•	•	•	•	•	•
AQAV	-10 to +90	16	•	•	•	•	•	•	•
AQQE	-25 to +90	16	•	•	•	•	•	•	•
AQQV	-10 to +90	16	•	•	•	•	•	•	•
AQQX	-15 to +90	16	•	•	•	•	•	•	•
AQQK	0 to +90	16	•	•	•	•	•	•	•
DAQF	0 to +140	25	•	•	•	•	•	•	•
DQQE	-20 to +120	25	•	•	•	•	•	•	•
DQQV	-10 to +90	25	•	•	•	•	•	•	•
DQQX	-15 to +120	25	•	•	•	•	•	•	•
DQQK	0 to +120	25	•	•	•	•	•	•	•
HBQV	0 to +90	25	•	•	•	•	•	-	•
HBQV/HBQV	0 to +90	25	•	•	•	•	•	-	•
HQQU/HBQV	0 to +90	16	•	•	•	•	•	-	•

Fig. 39 Operating range of shaft seals in chemicals

Operating range of a stuffing box

The table below shows the stuffing boxes available. The table also shows temperature range and pressure limits for the different types.



TM05 0200 0711

Code	Temperature range [°C]	Max. p [bar]	Availability					Pumps	
			Stuffing box inner diameter [mm]					NB, NBG	NK, NKG
			28	38	48	55	60		
SNEA	-30 to +120	16	●	●	-	-	-	-	●
SNEB		16	●	●	-	-	-	-	●
SNEC		16	●	●	-	-	-	-	●
SNED		16	●	●	-	-	-	-	●
SNOA	-30 to +120	16	●	●	-	-	-	-	●
SNOB		16	●	●	-	-	-	-	●
SNOC		16	●	●	-	-	-	-	●
SNOD		16	●	●	-	-	-	-	●
SNFA	-30 to +120	16	●	●	-	-	-	-	●
SNFB		16	●	●	-	-	-	-	●
SNFC		16	●	●	-	-	-	-	●
SNFD		16	●	●	-	-	-	-	●

Fig. 40 Stuffing boxes

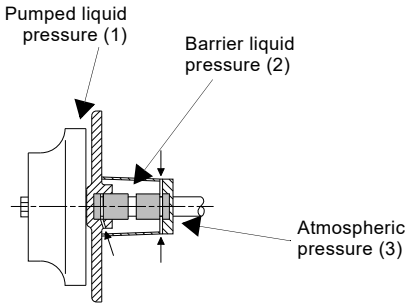
Additional operating conditions for double-seal arrangements

Pressure conditions of double shaft seal arrangements with two mechanical shaft seals

To decide which combination of shaft seals suits your application it is vital to consider the pressure conditions of both the primary and the secondary seal of tandem and back-to-back seal arrangements. Normally, there are only two situations to consider:

- normal duty
- standstill.

Back-to-back seal arrangement (type O)



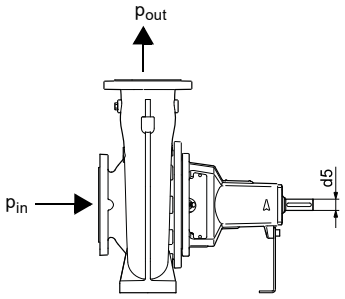
TM04 6056 4709

Fig. 41 Pressures in a back-to-back arrangement

Normal duty: During normal duty, the barrier liquid pressure (2) must be 10 % or at least 1.5 bar above the pumped liquid pressure (1). The barrier liquid pressure must not exceed 25 bar.

The primary seal will be exposed to this pressure difference. The secondary seal will be exposed to the barrier liquid pressure (2) on one side and the atmospheric pressure (3) on the other side.

This means that the p_{out} of the pump will be defined by the pressure rating of the secondary shaft seal no matter the pressure rating of the primary shaft seal.



TM03 3951 1206

Fig. 42 Maximum operating pressure for the pump (p_{out})

Example

Primary seal: DQQE (25 bar rating)

Secondary seal: BQQE (16 bar rating).

If a 25 bar rated shaft seal is used as primary seal, and a 16 bar shaft seal is used as secondary seal, the maximum pressure, p_{out} will be equal to the barrier liquid pressure minus 1.5 bar (16 - 1.5 = 14.5 bar).

Standstill: During standstill periods, both the primary and the secondary seal will be exposed to the barrier liquid pressure on one side (2). The primary seal will be exposed to the inlet pressure (1) on the other side, and the secondary seal will be exposed to atmospheric pressure (3) on the other side. The barrier liquid pressure will depend on the pressurising system connected to the back-to-back seal arrangement, but it must always be higher than the inlet pressure.

Tandem seal arrangement (type P)

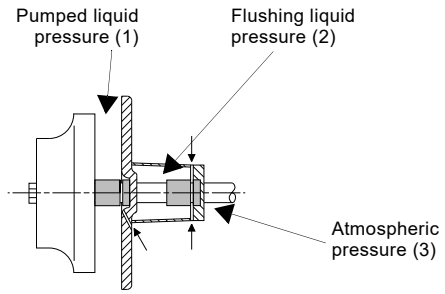


Fig. 43 Pressures in a tandem arrangement

Normal duty: During normal duty, the primary seal will be exposed to the pumped liquid pressure (1) on one side and the flushing liquid pressure (2) on the other. The secondary seal will be exposed to the flushing liquid pressure (2) on one side and atmospheric pressure (3) on the other side.

The flushing liquid pressure is normally only slightly higher than the atmospheric pressure (0.1 - 1 bar overpressure). In some cases the flushing liquid pressure can be higher in order to secure the necessary flow of flushing liquid.

If the pumped liquid pressure is lower than the flushing liquid pressure, a pressure difference of maximum 0.7 bar is allowed.

For a tandem arrangement the maximum p_{out} of the pump will be defined by the pressure rating of the primary shaft seal.

Example

Pump flange rating:25 bar

Primary seal: DQQE (25 bar rating)

Secondary seal: BQQE (16 bar rating).

As the flushing liquid normally has 0.1 bar overpressure, the pressure rating of the primary shaft seal will apply. This means that the maximum p_{out} theoretically will be 25 + 0.1 = 25.1 bar. Yet the pump flange rating is 25 bar and this pressure rating will apply.

Standstill: During standstill periods, both the primary and the secondary seal will be exposed to the flushing liquid pressure (2) on one side. The primary seal will be exposed to the inlet pressure (1) on the other side.

Selection of double-seal arrangement

Back-to-back seal

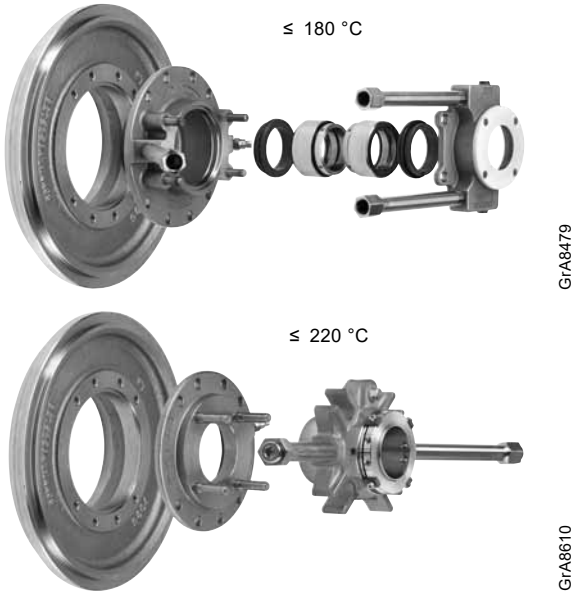


Fig. 44 Back-to-back seal arrangement as standard seal or as cartridge seal

This type of double seal consists of two shaft seals mounted in a back-to-back arrangement in a separate seal chamber or of a cartridge seal.

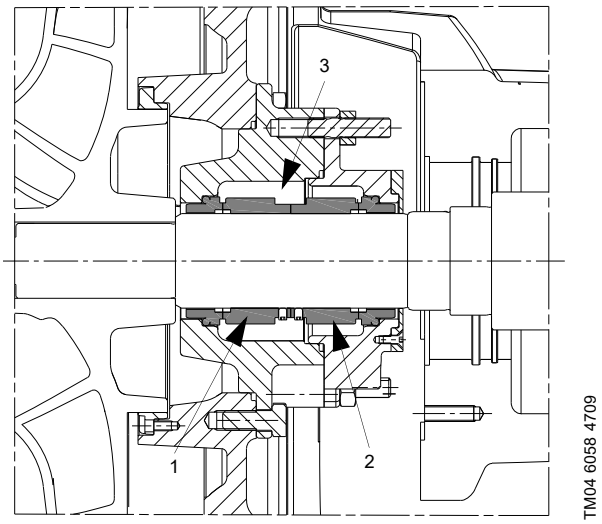


Fig. 45 Back-to-back seal arrangement consisting of two shaft seals

Pos.	Description
1	Primary shaft seal
2	Secondary shaft seal
3	Seal chamber, containing barrier liquid

The back-to-back seal arrangement is suitable for applications where leakage of the pumped liquid to the environment is unacceptable. The back-to-back double seal protects the surrounding environment and the people working near the pump.

In back-to-back seal arrangements, the pressure in the seal chamber must be higher than the pumped liquid pressure in order to prevent the pumped liquid from leaking through the shaft seal to the environment.

The back-to-back seal arrangement is particularly suitable for liquids containing abrasive particles. The seal arrangement prevents the pumped liquid from entering the seal gap and, consequently, prevents excessive wear. In this case, a single-seal arrangement would either wear out or be damaged.

Pumps with a back-to-back seal arrangement require a pressurising system providing the correct pressure to the barrier liquid in the barrier liquid chamber.

Applications

The back-to-back double-seal arrangement is the optimum solution in these cases:

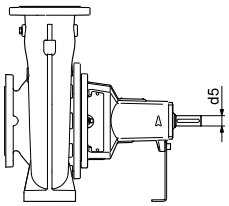
- The pump is pumping toxic and explosive liquids.
- The pump is pumping aggressive and abrasive liquids.
- The pump is pumping hardening liquids, e.g. oil products.
- The pump is pumping sticky liquids, e.g. paint and varnishes.
- The pump is operating with a negative inlet pressure (vacuum) of 0.7 - 0.9 bar compared to the pressure in the barrier liquid chamber.

The back-to-back seal arrangement can handle a pumped liquid temperature up to 180 °C (220 °C). In this case, it is very important that the evaporation point of the barrier liquid is 10-15 °C higher than the temperature of the pumped liquid. This is important in order to ensure proper liquid lubrication in the major part of the seal gap.

Pump range

The back-to-back type of shaft seal is available for pumps with these shaft sizes:

Pump type	d5 [mm]				
	24	32	42	48	60
NB, NBE	-	-	-	-	-
NBG, NBGE	-	-	-	-	-
NK, NKE	-	-	-	-	-
NKG, NKGE	●	●	●	●	●
	28	38	48	55	60
	Shaft seal diameter				



For additional information on pump range and shaft sizes, see page 8.

Barrier liquid

The barrier liquid must be clean. The barrier liquid must be suitable for the application and must not chemically attack the materials of the pump, the shaft seals or the rubber parts. The barrier liquid must have a high boiling point, good lubricating and heat transmission properties.

Examples

Application	Liquids mixed into the barrier liquid
Heat transfer or hot applications	Mono ethylene glycol without additives
Chemistry/industry	Customer wish

As the barrier liquid has a higher pressure than the pumped liquid, it serves as lubricating liquid for both primary and secondary seal faces. The barrier liquid will seep through the primary shaft seal and be mixed with the pumped liquid. Consequently, the barrier liquid chosen must always be compatible with the pumped liquid. Barrier liquid seeping through the secondary shaft seal will evaporate.

Pressure sources

The barrier liquid pressure must be 10 % and minimum 1.5 bar above the pumped liquid pressure close to the seal. The overpressure in the seal chamber (i.e. in the barrier liquid) in relation to the pumped liquid pressure can be maintained by various pressure sources:

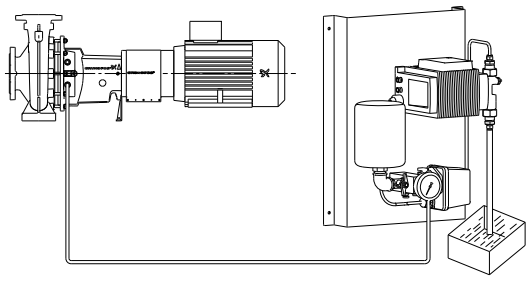
- an existing pressure source (many applications incorporate pressurised systems)
- a separate pressure source, such as a dosing pump unit
- a pressure intensifier.

1. Existing pressure source

Standard shaft seals: An existing system may provide both the barrier liquid and the overpressure. It can be either a dead-end or a circulating solution. In both cases the barrier liquid pressure must be fixed at a prescribed overpressure level.

Cartridge seal: The existing system may provide both the barrier liquid and the overpressure. The barrier liquid pressure must be fixed at a prescribed overpressure level.

2. Separate pressure source (dead-end solution)



TM04 4334 1209

Fig. 46 Pump with dosing pump unit

Standard shaft seals: The setpoint pressure of the barrier liquid can be set by means of the pressure switch on the dosing pump unit. When the pressure drops below the setpoint, the dosing pump will start and build up pressure in the buffer tank and thus maintain the overpressure in the seal chamber. This solution is mainly used in dead-end applications where cooling of the primary shaft seal is sufficient without recirculation.

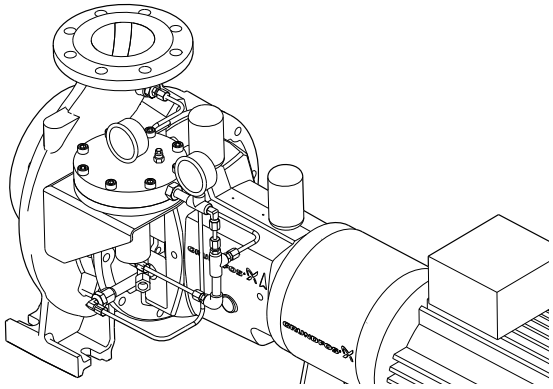
Maximum outlet pressure of the dosing pump unit: 16 bar.

Note: One dosing pump unit can supply barrier liquid to several pumps with back-to-back seal arrangements.

Note: Connecting pipes or hoses are not included.

Cartridge seal: A cartridge seal is not for use with a dead-end connection.

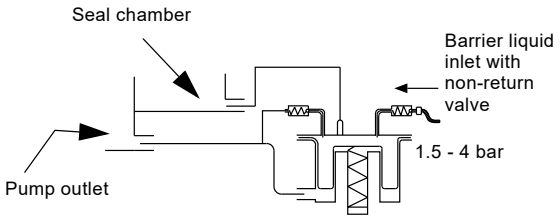
3. Pressure intensifier (dead-end solution)



TM04 4333 1209

Fig. 47 Pump with pressure intensifier

Standard shaft seals: The Grundfos pressure intensifier maintains a barrier liquid pressure that is 1.5 to 4 bar higher than the pumped liquid pressure, independent of the specific pumped liquid pressure.



TM04 4465 1309

Fig. 48 Principle sketch of intensifier connections

The pressure intensifier maintains the overpressure automatically, from standstill to maximum operating pressure, until it is empty. As the pressure intensifier has to be refilled, it requires a discontinuous working cycle. The barrier liquid inlet on the intensifier must be fitted with a non-return valve to avoid back pressure to the source.

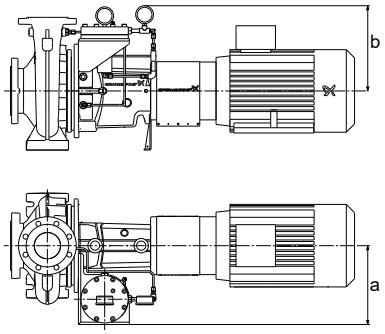
Note: One pressure intensifier can only supply one pump. The pressure intensifier is mounted on the pump from factory.

Maximum permissible outlet pressure of the pressure intensifier: 25 bar (the secondary shaft seal is exposed to the outlet pressure of the pressure intensifier).

Cartridge seal: A cartridge seal is not for use with a dead-end connection.

Dimensions of pump with pressure intensifier

	Shaft seal diameter [mm]				
	28	**38**	**48**	**55**	**60**
a [mm]	250	264	383	300	300
b [mm]	253	288	310	380	380



TM04 4335 1209

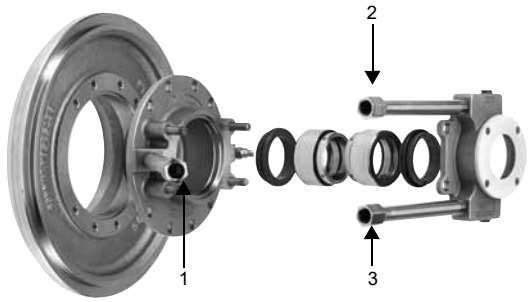
Fig. 49 Pump with pressure intensifier
Dimensions apply to all NKG pump sizes

Other pressurising arrangements

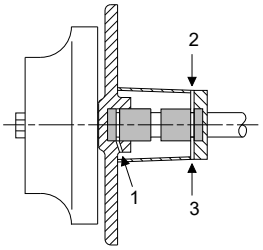
For information on alternatives to the intensifier and the dosing pump unit, please contact Grundfos.

Barrier liquid connection

In a back-to-back seal arrangement, the seal chamber has three connections close to the seal faces of the shaft seals. See fig. 50.



GrA8479



TM04 6056 4709

Fig. 50 Barrier liquid connections for the back-to-back arrangement

Dead-end solutions

Use only connection 1 or 3.

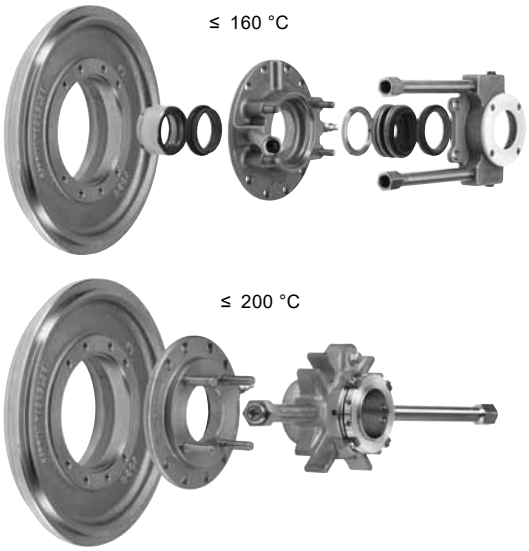
Connection 2 must be plugged.

Note: Automatic venting of the seal chamber must be considered for the application. Connection 2 can be used for this.

Circulating solutions

Use two connections. We recommend that you use connection 1 as inlet and 2 as outlet. This will create a crossflow, have a cooling effect on the shaft seals, and at the same time provide automatic venting of the seal chamber. Connection 3 must be plugged.

Tandem seal

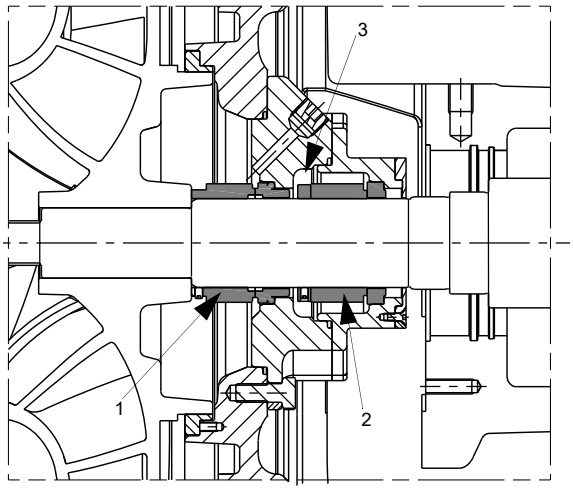


GrA8480

GrA8610

Fig. 51 Tandem seal arrangement as standard seal or as cartridge seal

This type of double seal consists of two shaft seals mounted in a tandem arrangement in a separate seal chamber or of a cartridge seal.



TM04 6059 4709

Fig. 52 Tandem seal arrangement consisting of two shaft seals

Pos.	Description
1	Primary shaft seal
2	Secondary shaft seal
3	Seal chamber, containing flushing liquid

Pumps with a tandem seal arrangement require a flushing system providing the correct flushing liquid to the seal chamber.

The pressure in the seal chamber/cartridge is normally "pressureless" (0.1 bar above atmospheric pressure). Consequently, a small quantity of the pumped liquid will seep through the primary shaft seal and be mixed with the flushing liquid.

The pumped liquid leaking via the primary seal will be flushed away by the flushing liquid.

As the primary shaft seal is in contact with liquid on both sides, there is no evaporation zone in the seal gap. This prevents buildup of crystallising deposits on the seal faces of the primary shaft seal. Deposits might otherwise lead to a failing primary shaft seal.

In hot applications, the flushing liquid additionally removes heat from the system both during operation and standstill, and thus cools the seal faces of the shaft seal.

Pumps with a tandem seal arrangement require a flushing system providing the correct flushing liquid to the flushing liquid chamber, and in some cases also monitoring of the leakage rate of the pumped liquid.

Applications

The tandem seal is the optimum solution in these cases:

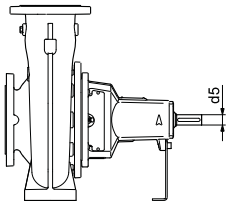
- The pump is pumping crystallising liquids, e.g. a caustic soda solution. Buildup of crystals on the atmospheric side will be avoided.
- Lubrication and cooling of shaft seals is necessary during standstill.
- Monitoring of the leakage rate from the primary shaft seal is required.
- Prevention of air ingress from the atmospheric side is necessary (for liquids which react with atmospheric oxygen).
- The pump is operating with a negative inlet pressure (vacuum) of 0 - 0.7 bar compared to the pressure in the flushing chamber.
  In this case, the flushing liquid will provide the lubricating film for the primary shaft seal.

The tandem seal arrangement can handle a pumped liquid temperature up to 160 °C (200 °C). In this case, it is very important that the evaporation point of the barrier liquid is 10-15 °C higher than the temperature of the pumped liquid. This is important in order to ensure proper liquid lubrication in the major part of the seal gap.

Pump range

The tandem type of shaft seal is available for pumps with these shaft sizes:

Pump type	d5 [mm]				
	24	**32**	**42**	**48**	**60**
NB, NBE	-	-	-	-	-
NBG, NBGE	-	-	-	-	-
NK, NKE	-	-	-	-	-
NKG, NKGE	●	●	●	●	●
	28	38	48	55	60
	Shaft seal diameter				



For additional information on pump range and shaft sizes, see page 8.

Flushing liquid

The flushing liquid must be suitable for the application and must not chemically attack the materials of the pump and the shaft seals or the rubber parts. The flushing liquid must have a high boiling point, good lubricating and heat transmission properties.

Flushing system

Typically, one of these methods of connecting the flushing liquid to the pump is used:

- circulation from a reservoir
- dead-end connection from a reservoir
- external flushing liquid.

Common for these flushing solutions is that the pressure in the seal chamber is lower than the pressure of the pumped liquid around the shaft seal.

The flushing liquid lubricates the secondary seal and ensures the presence of liquid on the seal-chamber side of the primary seal.

1. Circulation from a reservoir

Standard shaft seals

The seal chamber is connected to a reservoir by means of two pipes.

Both the primary and secondary shaft seal generates heat during operation. This heat energy is transferred to the flushing liquid. Due to natural circulation, the heated flushing liquid rises from the seal chamber to the reservoir, where it cools down. The cooled-down flushing liquid returns to the seal chamber, lubricates and cools down the seal faces.

Cartridge seal

A cartridge seal is connected to a reservoir by means of two pipes.

An internal pumping device in the shaft seal normally provides sufficient circulation of the flushing liquid to cool and lubricate the seal.

The cartridge is self-venting.

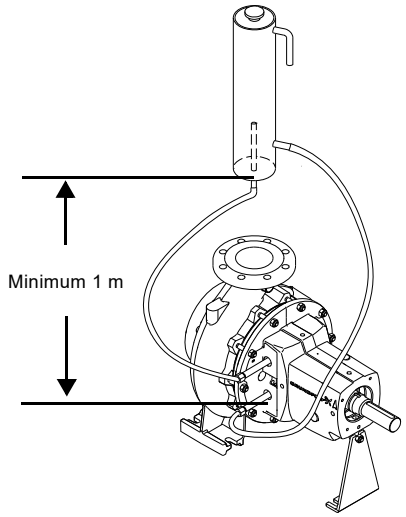
Common for standard and cartridge seals

A forced circulation can be made by a separate pump, if needed.

After a period of time the flushing liquid in the reservoir must be replaced due to contamination from the pumped liquid.

This circulating solution makes it possible to monitor the seal leakage.

The solution also makes it possible to use the temperature increase as a control parameter.



TM04 4176 1209

Fig. 53 Tandem seal arrangement with circulating flushing liquid

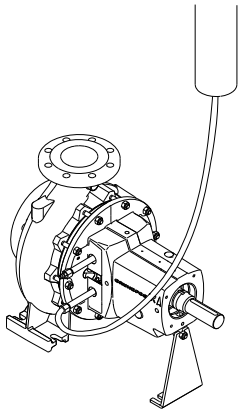
2. Dead-end connection from a reservoir

Standard shaft seals

The flushing liquid enters the seal chamber via a pipe from an elevated reservoir. The seal chamber is connected to the reservoir by means of a single pipe.

The flushing liquid lubricates the seal faces. No heat is dissipated from the system.

After a period of time the flushing liquid in the reservoir must be replaced due to contamination from the pumped liquid.



TM04 4189 1009

Fig. 54 Tandem seal arrangement with a dead-end flushing-liquid supply

Cartridge seal

A cartridge seal is not for use with a dead-end connection.

3. External flushing liquid

Standard shaft seals

The flushing liquid flushes the seal chamber and is led to a drain. The flushing liquid cools and lubricates the seal faces.

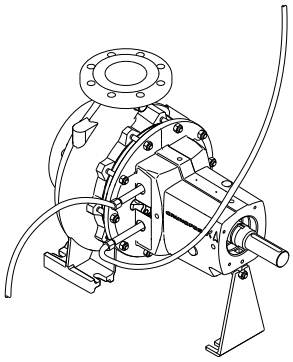
In case of leakage, the pumped liquid is washed away to the drain by the flushing liquid.

Cartridge seal

The flushing liquid flushes the cartridge seal and is led to a drain.

If the flushing liquid inlet pressure drops, the internal pumping device in the cartridge seal will provide circulation of the flushing liquid to cool and lubricate the seal faces.

The cartridge is self-venting.



TM04 4190 1009

Fig. 55 Tandem seal arrangement with flushing liquid being led away to a drain

Common for standard and cartridge seals

The flow rate of the flushing liquid must match the application. The recommended flow rate is 25-200 l/h. A temperature increase of 20 °C of the flushing liquid could also be a control parameter.

Note: The flushing-liquid supply must never be connected directly to the public water supply system. Local regulations must be observed.

Flushing liquid connection

In a tandem seal arrangement, the seal chamber has three connections. See fig. 56. One leads to the pumped liquid side of the shaft seal, and two to the seal chamber. Each connection directs the flushing liquid to the seal faces of the shaft seals.

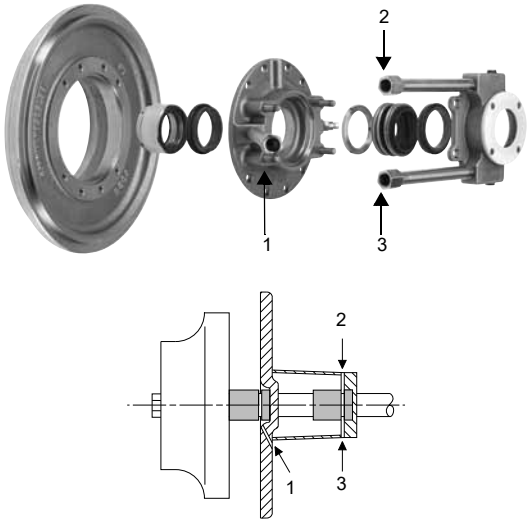


Fig. 56 Flushing connections of a tandem arrangement

Dead-end solutions

Use only connection 3 as inlet and 2 for venting. Connection 1 must be plugged.

Circulating solutions

Use connection 3 as inlet and 2 as outlet. Connection 1 must be plugged.

Separate circulation/cooling of primary shaft seal

Use connection 1. A pipe can be fitted between the pump outlet and connection 1. Alternatively, an external supply can be fitted to connection 1.

Circulation or cooling of the primary seal is commonly used in the following situations:

- to avoid accumulation of particles in the seal face area
- to increase the pressure in the seal face area resulting in a higher evaporation point
- to vent the shaft seal area in order to avoid dry running
- to provide cooling of the shaft seal. The friction between the seal faces results in a temperature increase of 10-20 °C above the pumped liquid temperature. In this case, the pumped liquid itself can provide cooling.

Dimensions

The dimensions of a pump with tandem seal are identical to the dimensions of a standard pump.

7. Pump

This chapter is a brief listing of the major pump components, materials, designs which are available for end-suction pumps.

Impeller material

GrA2535

Impellers are available in the following materials:

- cast iron (EN-GJL-200) for non-bronze application
- low-lead bronze (CuSn10)
- stainless steel in two variants: EN/DIN 1.4408 (austenitic) or 1.4517 (Duplex).

Section *3. Identification* on page 9 shows the configuration of the impeller materials in combination with pump housing, shaft and wear rings.

Wear ring material

GrA2525 - GrA2526
GrA2527 - GrA2528

Wear rings are available in the following materials:

- low-lead bronze (CuSn10) or brass
- cast iron (EN-GJL-250)
- stainless steel (EN/DIN 1.4517 (duplex))
- carbon-graphite-filled PTFE (Graflon®).

Section *3. Identification* on page 9 shows the configurations of the wear ring materials in combination with pump housing, shaft and impeller.

Note: Not all material variants are possible for all pump sizes.

Pump housing material

TM04 6261 0110

Pump housings for the NB, NBG and NK, NKG pump ranges are available in the following materials:

- cast iron (EN-GJL-250) for clean water applications
- stainless steel (EN/DIN 1.4408) for chemical liquids
- stainless steel (EN/DIN 1.4517) for seawater.

Section *3. Identification* on page 9 shows the configuration of pump housing materials in combination with impeller, shaft and wear rings.

Note: Not all material variants are possible for all pump sizes.

Shaft material

GrA2537 - GrA2538
GrA8471

For NB, NBG pumps these shaft materials are available:

- stainless steel (EN/DIN 1.4301)
- stainless steel (EN/DIN 1.4401)
- stainless steel (EN/DIN 1.4462).

For NK, NKG pumps these shaft materials are available:

- stainless steel (EN/DIN 1.4034)
- stainless steel (EN/DIN 1.4401)
- stainless steel (EN/DIN 1.4462).

Section *3. Identification* on page 9 shows the configuration of the shaft materials in combination with pump housing, wear ring and impeller.

System pressure

Depending on the pump version, the pumps are available for the following system pressures:

- 10 bar
- 16 bar
- 25 bar.

Static pump O-ring material

Depending on the shaft seal configuration the pump has one or more static O-rings (O-ring 1, 2 and 3 in fig. 57 and 58). These pump O-rings are known as static pump O-rings because they are not subject to movement during operation. The static pump O-rings are available in a number of materials.

Material combinations of shaft seal elastomers and static pump O-ring materials

The default rubber material of the static pump O-rings is set to be the same material as the elastomer of the shaft seal. If you want a different static pump O-ring material, you may select it according to the following table.

Please note that the materials available for O-ring 1 and 2 depend on the shaft seal elastomer of the primary shaft seal. The materials available for O-ring 3 depends on the shaft seal elastomer of the secondary shaft seal.

		Material of static pump O-ring					
		EPDM	FXM (Fluoraz®)	FFKM (Kalrez®)	FEPS	HNBR	FKM (Viton®)
Shaft seal elastomer		E	F	K	M	X	V
E	EPDM	●	-	-	-	-	-
F	FXM (Fluoraz®)	●	●	-	●	-	●
K	FFKM (Kalrez®)	●	-	●	●	●	●
U	Dynamic O-rings of FFKM (Kalrez®) and static O-rings of PTFE	●	-	●	●	●	●
V	FKM (Viton®)	-	-	-	-	-	●
X	HNBR	-	-	-	-	●	-

Example 1: Double-seal arrangement with standard seals

If the dynamic O-ring in the primary shaft seal is code K (FFKM), the static pump O-rings 1 and 2 can be either "E", "M", "X" or "V" instead of the default "K" O-ring.

If the dynamic O-ring in the secondary shaft seal is code E (EPDM), the default material for static pump O-ring 3 will be EPDM. No alternative rubber materials are available.

Example 2: Double-seal arrangement with cartridge seal

If the dynamic O-ring in the cartridge shaft seal is code K (FFKM), the static pump O-rings 1 and 2 in the pump can be either "E", "M", "X" or "V" instead of the default "K" O-ring.

Pump O-rings for different seal arrangements

The following sections show the O-rings in each of the supported seal arrangements. Each of the seal arrangements is represented by a code.

The code is also a part of the type designation.

Code	Shaft seal arrangement
S	Single seal
B	Stuffing box
C	Cartridge seal, single
D	Cartridge seal, double
O	Double seal, back-to-back
P	Double seal, tandem

NKG	50-32	-125	.1	A1	F	2	N	V	S	BAQV

Static pump O-rings for seal arrangements code "S and B"

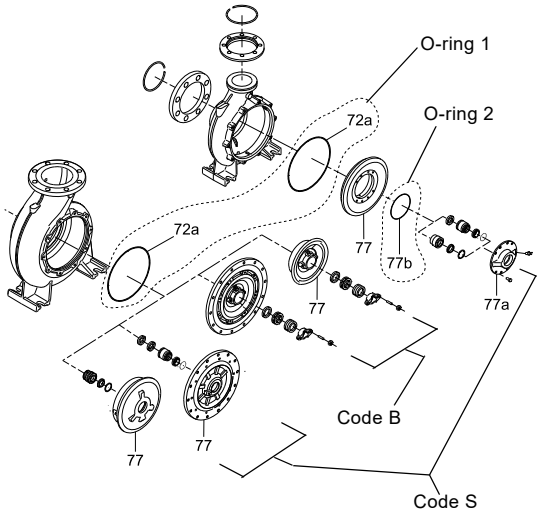


Fig. 57 Static pump O-rings for seal arrangement "S" and "B"

Static pump O-rings for seal arrangements code "C, D, O and P"

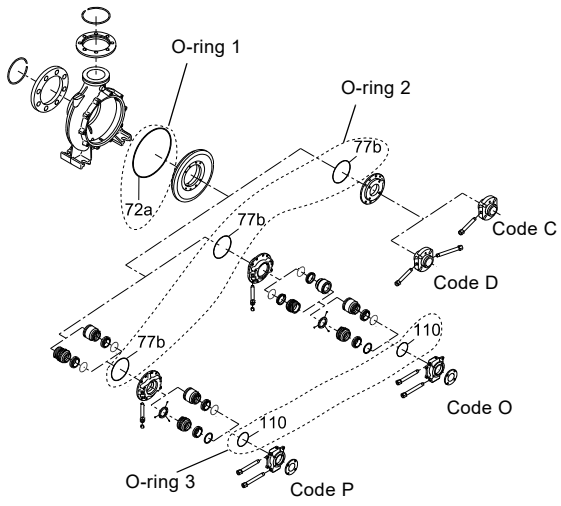
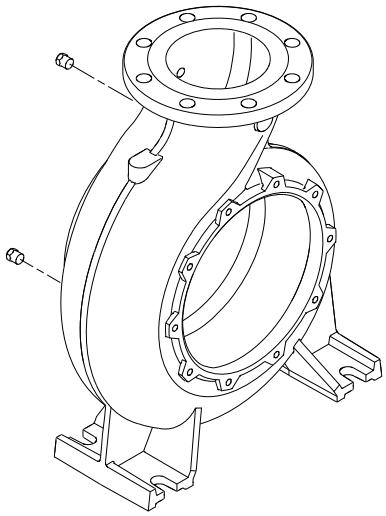


Fig. 58 Static pump O-rings for seal arrangement "C, D, O and P"

Pump plug materials



TM05 2409 5011

Fig. 59 Pump plugs

On delivery the pumps have plugs of a similar material as the pump housing. However, the sealing material depends on the pump housing material. See table below.

	Cast iron pumps	Stainless steel pumps
Sealing material	Silicone paste RTV112	PTFE packing tape

Pump bearings

GrA8471

Fig. 60 Heavy-duty bearing design

The bearings in the bearing bracket are the load carrying components of an NK, NKG pump, both when the pump is in operation and at standstill.

Forces acting on the bearings

Two types of forces are acting on the bearings; radial and axial.

The radial forces on the bearings are primarily absorbed by the bearing closest to the impeller. Both deep groove ball bearings and roller bearings are designed for radial loads, but the roller bearing with the heavy-duty bearing design is built to last longer than the deep groove ball bearing.

The axial forces are absorbed by the bearing furthest away from the impeller. The standard design ball bearing is not designed for axial loads, but the double angular-contact bearings are. So basically it is the axial forces that determine whether a standard or a heavy-duty bearing design must be chosen.

Impeller thrust - $F_{impeller\ thrust}$

The thrust acting on the impeller has been measured for the complete pump range. The thrust from the impeller can either push or pull the shaft.

Inlet force - F_{inlet}

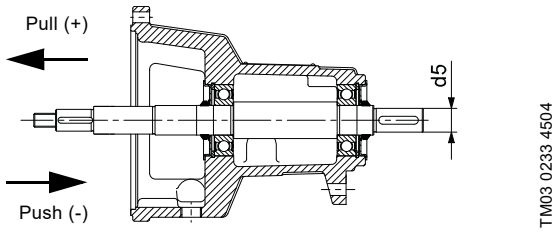
The force from the inlet pressure is the force acting on the shaft end area. See *Force from the inlet pressure* on page 51.

Axial force

The axial force is the sum of the forces from the inlet pressure and the thrust from the impeller when the pump is operating.

$$F_{axial} = F_{impeller\ thrust} + F_{inlet}$$

A positive value of F_{axial} means that the force pulls the shaft away from the motor. A negative value of F_{axial} means that the force pushes the shaft towards the motor.



TM03 0233 4504

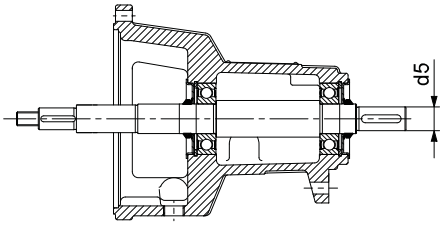
Fig. 61 Direction of the forces acting on the bearings

Bearing designs

Grundfos offers two different bearing designs.

Standard bearing design

The standard bearing design has two grease-lubricated deep-groove ball bearings (greased for life).



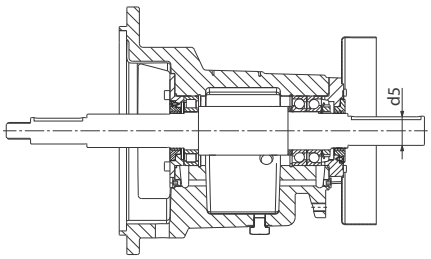
TM03 0233 4504

Fig. 62 Standard bearing design

Heavy-duty bearing design

The heavy-duty bearing design has these elements:

- cylindrical roller bearing carrying most of the radial load (bearing closest to the impeller)
- two angular-contact bearings carrying the axial thrust on the shaft.



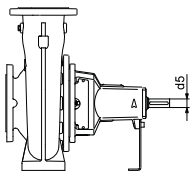
TM05 2196 1918

Fig. 63 Heavy-duty bearing design

The heavy-duty bearings can be either grease- or oil-lubricated. See figs. 64, 65, 66 and 67.

Available bearing designs for NK, NKG

d5 [mm]	Bearing design			
	Standard		Heavy duty	
	NK	NKG	NK	NKG
24	•	•	-	•
32	•	•	-	•
42	•	•	-	•
48	•	•	-	•
60	•	•	-	•



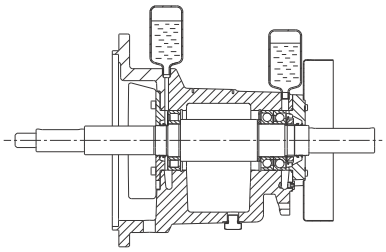
The bearing designs can be selected in Grundfos Product Center when selecting the pump.

Grease-lubricated bearings (heavy-duty design only)

Two automatic grease lubricators release the grease from the cartridges continuously over a year. When emptied, the cartridges must be replaced.

GrA8612

Fig. 64 Grease cartridges



TM04 4328 1918

Fig. 65 Bearing bracket with a cylindrical roller bearing and two angular-contact bearings lubricated by automatic grease lubricators (grease cartridges)

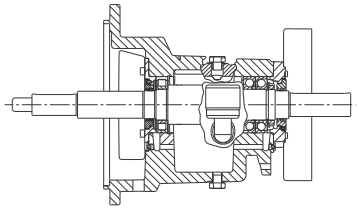
Oil-lubricated bearings

The oil level inside the bearing bracket is controlled and maintained at an always correct level by means of a constant-level oiler.

We recommend the oil-lubricated bearings solution for high-temperature applications as the oil helps transmit heat away from the bearings via the bearing bracket to the surroundings.

GrA8611

Fig. 66 Constant-level oiler



TM04 4329 1918

Fig. 67 Bearing bracket with oil-lubricated roller and double angular-contact bearings

Oil change intervals

Bearing temperature [°C]	Initial oil change	Subsequent oil changes
Up to 70	After 400 hours	Every 4400 hours
70 to 90		Every 2200 hours

Selection of pump bearing design

A number of factors play a role when selecting the bearing design. These factors are all related to the operating conditions of the pump and must be taken into consideration before the pump is installed.

Follow this procedure:

1. Identify size of the pump and number of poles.
2. Calculate the forces acting on the bearing (see below).
3. Select the right bearing design for your application by comparing the forces acting on the bearings with the force that the bearing designs can withstand.

Example 1

(1) Identify size of the pump and number of poles.

We use an NKG 50-32-125, 2-pole as example.

(2) Calculate the forces acting on the bearings.

$F_{axial} = F_{impeller\ thrust} + F_{inlet}$

Pump type	Impeller thrust [N]						Bearing model
	2-pole		4-pole		6-pole		
	Q_{min}	Q_{opt}	Q_{min}	Q_{opt}	Q_{min}	Q_{opt}	
50-32-125	912	914	248	240	-	-	6308
							NU207/7207

When determining the force of the impeller thrust from the table, select the highest value of the impeller thrust.

In this example, $F_{impeller\ thrust}$ = 914 N.

The inlet pressure is 3 bar in the application.

The 50-32-125 pump has a d5 shaft diameter of 24 mm according to the tables on page 8. The table below is a Section of table in section *Force from the inlet pressure* on page 51.

d5 [mm]	Shaft diameter [mm]	Force of inlet pressure [N]		
		1 bar	10 bar	20 bar
24	28	-62	-620	-1240

According to the table, the force from the inlet pressure is as follows:

F_{inlet} = -62 N x 3 = -186 N

This gives an F_{axial} = 914 + (-186) = 736 N.

A positive value of F_{axial} means that the force pulls the shaft away from the motor.

(3) Compare the force acting on the bearings with the force that the bearing designs can withstand.

1. Note the bearing models available.

Pump type	Impeller thrust [N]						Bearing model
	2-pole		4-pole		6-pole		
	Q_{min}	Q_{opt}	Q_{min}	Q_{opt}	Q_{min}	Q_{opt}	
50-32-125	912	914	248	240	-	-	6308
					-	-	NU207/7207

2. Find this bearing model in the table showing a relationship between the wanted service life and the related maximum axial force on the bearings. See table on page 53.

Bearing model	Standard bearing design	heavy-duty bearing design	Motor	Service life [hours]		
				17,500	50,000	100,000
				Maximum axial force [N]		
6308	•		2-pole	3150	-	-
			4-pole	3800	-	-
			6-pole	-	-	-
NU207/7207		•	2-pole	5600	4000	3150
			4-pole	6800	5000	4000
			6-pole	-	-	-

3. Compare the axial force of 736 N with the maximum axial forces for 2-pole and the values for both bearings designs.

Standard bearing design

The axial force of 736 N is lower than the maximum axial force for a service life of both 17,500 and 50,000 hours.

This indicates that standard bearings in this situation will have a service life of minimum 50,000 hours if the pump operates under ideal conditions (temperature below 70 °C, no severe vibrations in the application, good alignment of motor and pump, etc.)

In general the bearing grease deteriorates over time and reflects the operating conditions. If the operating conditions are ideal, the service life will be close to the values stated in the table. If the operating conditions are harsher, the service life will consequently be affected negatively.

Heavy-duty bearing design

The axial force of 736 N is lower than the maximum axial force for all service lives. This indicates that heavy-duty bearings in this situation can provide a very long service life of minimum 100,000 hours.

Conclusion

For the NKG 50-32-125 pump, choose the heavy-duty bearing design if the operating conditions are severe.

For pumps installed in remote areas where reliability is a key factor and service is only carried out once a year, the heavy-duty bearing design fitted with grease lubricators could also be the right solution.

If the pump is installed with easy access for scheduled service and with good operating conditions, the standard bearing design can be used in most cases.

Example 2

(1) Identify size of the pump and number of poles.

We use an NKG 200-150-315, 2-pole as example.

(2) Calculate the forces acting on the bearings.

$F_{axial} = F_{impeller\ thrust} + F_{inlet}$

Pump type	Impeller thrust [N]						Bearing model
	2-pole		4-pole		6-pole		
	Q_{min}	Q_{opt}	Q_{min}	Q_{opt}	Q_{min}	Q_{opt}	
200-150-315	9005	8529	3449	2993	3449	2993	6312 NU213/7213

When determining the force of the impeller thrust from the table, select the highest value.

In this example $F_{impeller\ thrust}$ = 9005 N.

The inlet pressure is 10 bar in the application.

The NKG 200-150-315 pump has a d5 shaft diameter of 48 mm according to the tables on page 8. The table below is a Section of table in section *Force from the inlet pressure* on page 51.

d5 [mm]	Shaft diameter [mm]	Force of inlet pressure [N]		
		1 bar	10 bar	20 bar
48	55	-237	-2370	-4740

According to the table the force from the inlet pressure is as follows:

F_{inlet} = 2370 N

This gives an F_{axial} = 9005 +(-2370) = 6635 N.

A positive value of F_{axial} means that the force pulls the shaft away from the motor.

(3) Compare the force acting on the shaft with the force that the bearing designs can withstand providing either a service life of 17,500 hours or 100,000 hours.

1. Note the bearing models available.

Pump type	Impeller thrust [N]						Bearing model
	2-pole		4-pole		6-pole		
	Q_{min}	Q_{opt}	Q_{min}	Q_{opt}	Q_{min}	Q_{opt}	
200-150-315	9005	8529	3449	2993	3449	2993	6312 NU213/7213

2. Find this bearing model in the table showing a relationship between the wanted service life and the related maximum axial force on the bearings. See the table on page 53.

Bearing model	Standard bearing design	Heavy-duty bearing design	Motor	Service life [hours]		
				17,500	50,000	100,000
				Maximum axial force [N]		
6312	•		2-pole	6250	3500	-
			4-pole	8100	4550	-
			6-pole	8750	4900	-
NU213/7213		•	2-pole	12050	8500	6750
			4-pole	15200	10600	8500
			6-pole	16300	12300	9700

3. Compare the axial force of 6635 N with the maximum axial forces for 2-pole and the values for both bearings designs.

Standard bearing design

The axial force of 6635 N is higher than the maximum axial force for a service life of both 17,500 and 50,000 hours.

This indicates that standard bearings in this situation will have a service life less than 17,500 hours.

Heavy-duty bearing design

The axial force of 6635 N is lower than the maximum axial force for all service lives. This indicates that heavy-duty bearings in this situation can provide a very long service life of minimum 100,000 hours.

Conclusion

Under ideal operating conditions, the NKG 200-150-315 pump has a high axial load, and for this reason the standard bearings will only provide a relatively short service life. Choose the heavy-duty bearing design for this application.

For pumps installed in remote areas where reliability is a key factor and service is only carried out once a year, the heavy-duty bearing design fitted with grease lubricators could be the right solution.

Data for selection of bearing design

Force from the inlet pressure

The table below explains the effect of the inlet pressure on the shaft end (push force).

d5[1)] [mm]	Shaft diameter [mm]	Force from inlet pressure [N]		
		1 bar	10 bar	20 bar
24	28	-62	-620	-1240
32	38	-115	-1150	-2300
42	48	-181	-1810	-3620
48	55	-237	-2370	-4740
60	60	-283	-2830	-5660

1) For additional information on pump range and shaft sizes, see page 8.

Impeller thrust

The thrust coming from the impeller when the pump is operating has been measured for the complete range of pumps.

Test conditions for measured thrust:

- All values are measured with an inlet pressure of 0 bar.
- Measurements are made in a test bed with a horizontal pump installation.
- All values are based on a 50 Hz frequency motor and a bearing temperature of 70 °C.

Two operating situations have been considered; minimum permissible flow rate (Q_{min}), and optimum flow rate (Q_{opt}).

Important notes:

For 60 Hz pumps, the maximum axial force is 95 % of that of 50 Hz.

Reduce the maximum axial force by 5 % for every temperature increase of 5 °C above 70 °C.

We do not recommend that you operate the pump at a bearing temperature higher than 110 °C.

Impeller thrust - NK, 50 Hz

A positive value indicates a "pull" value and a negative a "push" value. See fig. 61.

Pump type	Impeller thrust [N]						Bearing model
	2-pole		4-pole		6-pole		
	Q_{min}	Q_{opt}	Q_{min}	Q_{opt}	Q_{min}	Q_{opt}	
32-125.1	894	779	227	191	-	-	6306
32-125	912	914	248	240	-	-	6306
32-160.1	835	775	227	193	-	-	6306
32-160	211	323	55	70	-	-	6306
32-200.1	943	1033	264	285	-	-	6306
32-200	-816	-279	-225	-66	-	-	6306
32-250	-2073	-1520	-310	-212	-	-	6306
40-125	375	329	85	76	-	-	6306
40-160	463	513	88	125	-	-	6306
40-200	-248	-12	-90	1	-	-	6306
40-250	-219	27	1	69	-	-	6308
40-315	136	119	-977	-1095	-	-	6308
50-125	583	511	151	131	-	-	6306
50-160	577	673	164	190	-	-	6306
50-200	580	475	108	136	-	-	6306
50-250	488	1152	-50	67	-	-	6308
50-315	25	20	1566	1109	-	-	6308
65-125	639	710	154	170	-	-	6306
65-160	415	524	94	131	-	-	6306
65-200	110	313	60	103	-	-	6306
65-250	1840	1075	262	286	-	-	6308
65-315	1236	2454	90	104	-	-	6308
80-160	522	782	182	262	-	-	6306
80-200	-1712	-445	76	145	-	-	6308
80-250	72	321	142	209	-	-	6308
80-315	-349	723	6	198	-	-	6308
80-400	-	-	61	175	-	-	6310
100-160	1498	1568	281	285	137	154	6306
100-200	44	752	22	380	22	380	6308
100-250	3244	2732	460	490	225	241	6308
100-315	-14	1012	30	556	30	556	6308
100-400	-	-	2775	3138	1425	1816	6310
125-200	1571	2150	384	773	215	298	6308
125-250	2770	2664	765	710	765	710	6308
125-315	4933	3628	1364	1276	1364	1276	6310
125-400	-	-	2763	2859	1204	1400	6310
125-500	-	-	-2202	-521	-586	-448	6213
150-200	1185	1082	292	334	292	334	6308
150-250	11575	6852	3493	2723	1348	1098	6310
150-315.1	6438	3963	5417	3968	2156	1517	6312
150-315	-	-	3449	2993	3449	2993	6310
150-400	-	-	3546	3338	1599	1103	6310
150-500	-	-	6836	5127	2399	1568	6213
200-400	-	-	5292	3496	1784	1412	6312
200-450	-	-	6726	5984	2398	2213	6312
250-350	-	-	8039	4867	3536	2142	6312
250-400	-	-	15807	9774	4284	2842	6312
250-450	-	-	6511	4842	2667	2354	6213
250-500	-	-	11335	8069	4987	3550	6213

Impeller thrust - NKG, 50 Hz

A positive value indicates a "pull" value and a negative a "push" value. See fig. 61.

Pump type	Impeller thrust [N]						Bearing model
	2-pole		4-pole		6-pole		
	Q_{min}	Q_{opt}	Q_{min}	Q_{opt}	Q_{min}	Q_{opt}	
50-32-125.1	894	779	227	191	-	-	6308 NU207/7207
50-32-125	912	914	248	240	-	-	6308 NU207/7207
50-32-160.1	835	775	227	193	-	-	6308 NU207/7207
50-32-160	211	323	55	70	-	-	6308 NU207/7207
50-32-200.1	943	1033	264	285	-	-	6308 NU207/7207
50-32-200	-816	-279	-225	-66	-	-	6308 NU207/7207
50-32-250	-2073	-1520	-310	-212	-	-	6409 NU209/7209
65-50-125	375	329	85	76	-	-	6308 NU207/7207
60-50-160	463	513	88	125	-	-	6308 NU207/7207
65-40-200	-248	-12	-90	1	-	-	6308 NU207/7207
65-40-250	-219	27	1	69	-	-	6409 NU209/7209
65-40-315	136	119	-977	-1095	-	-	6409 NU209/7209
80-65-125	583	511	151	131	-	-	6308 NU207/7207
80-65-160	577	673	164	190	-	-	6308 NU207/7207
80-50-200	580	475	108	136	-	-	6308 NU207/7207
80-50-250	488	1152	-50	67	-	-	6409 NU209/7209
80-50-315	-684	-896	1566	1109	-	-	6409 NU209/7209
100-80-125	639	710	154	170	-	-	6308 NU207/7207
100-80-160	415	524	94	131	-	-	6409 NU209/7209
100-65-200	110	313	60	103	-	-	6409 NU209/7209
100-65-250	1840	1075	262	286	-	-	6409 NU209/7209
100-65-315	1236	2454	90	104	-	-	6311 NU211/7211
125-80-160	522	782	182	262	-	-	6409 NU209/7209
125-80-200	-1712	-445	76	145	-	-	6409 NU209/7209
125-80-250	72	321	142	209	-	-	6409 NU209/7209
125-80-315	-349	723	6	198	-	-	6311 NU211/7211
125-80-400.1	-3035	-3132	-	-	-	-	6311 NU211/7211
125-80-400	2935	1073	-	-	-	-	6312 NU213/7213
125-80-400	-	-	61	175	-	-	6311 NU211/7211
125-100-160	1498	1568	281	285	137	154	6409 NU209/7209
125-100-200	44	752	22	380	22	380	6409 NU209/7209
125-100-250	3244	2732	460	490	225	241	6311 NU211/7211
125-100-315	-14	1012	30	556	30	556	6311 NU211/7211
125-100-400	-	-	2775	3138	1425	1816	6311 NU211/7211
150-125-200	1571	2150	384	773	215	298	6409 NU209/7209
150-125-250	2770	2664	765	710	765	710	6311 NU211/7211
150-125-315	4933	3628	1364	1276	1364	1276	6311 NU211/7211
150-125-400	-	-	2763	2859	1204	1400	6311 NU211/7211
150-125-500	-	-	-2202	-521	-586	-448	6313 NU213/7213
200-150-200	1185	1082	292	334	292	334	6409 NU209/7209
200-150-250	11575	6852	3493	2723	1348	1098	6311 NU211/7211
200-150-315.1	10121	7261	5828	4081	2270	1700	6312 NU213/7213
200-150-315	9005	8529	3449	2993	3449	2993	6312 NU213/7213
200-150-400	-	-	3546	3338	1599	1103	6312 NU213/7213
200-150-500	-	-	6836	5127	2399	1568	6313 NU213/7213
250-200-400	-	-	5292	3496	1784	1412	6312 NU213/7213
250-200-450	-	-	6726	5984	2398	2213	6312 NU213/7213
300-250-350	-	-	8039	4867	3536	2142	6312 NU213/7213
300-250-400	-	-	15807	9774	4284	2842	6312 NU213/7213
300-250-450	-	-	6511	4842	2667	2354	6313 NU213/7213
300-250-500	-	-	11335	8069	4987	3550	6313 NU213/7213

Pump type	Impeller thrust [N]						Bearing model
	4-pole		6-pole		8-pole		
	Q_{min}	Q_{opt}	Q_{min}	Q_{opt}	Q_{min}	Q_{opt}	
350-300-305	15650	10950	8370	5890	5042	3552	NU213/7213

Service life of bearings in combination with the maximum axial force - 50 Hz

Bearing model	Standard bearing design	Heavy-duty bearing design	Motor	Service life [hours]		
				17,500	50,000	100,000
				Maximum axial force [N]		
6213	•		2-pole	-	-	-
			4-pole	8100	4550	-
			6-pole	8750	4900	-
6306	•		2-pole	3100	1700	-
			4-pole	3400	1900	-
			6-pole	-	-	-
6308	•		2-pole	3150	1750	-
			4-pole	3800	2100	-
			6-pole	-	-	-
6310	•		2-pole	5500	3100	-
			4-pole	7200	4050	-
			6-pole	8600	4800	-
6311	•		2-pole	5450	3000	-
			4-pole	6950	3900	-
			6-pole	7450	4200	-
6312	•		2-pole	6250	3500	-
			4-pole	8100	4550	-
			6-pole	8750	4900	-
6313	•		2-pole	-	-	-
			4-pole	8100	4550	-
			6-pole	8750	4900	-
6409	•		2-pole	5550	3100	-
			4-pole	6400	3600	-
			6-pole	-	-	-
NU207/7207		•	2-pole	5600	4000	3150
			4-pole	6800	5000	4000
			6-pole	-	-	-
NU209/7209		•	2-pole	6900	4850	3850
			4-pole	8300	6100	4850
			6-pole	-	-	-
NU211/7211		•	2-pole	8700	6150	4850
			4-pole	11000	7750	6150
			6-pole	10500	8800	7050
NU213/7213		•	2-pole	12050	8500	6750
			4-pole	15200	10600	8500
			6-pole	16300	12300	9700
			8-pole	17600	13300	10500

Bearing monitoring

Bearing damage is one of the most common mechanical machine failures. However, bearing damage does not usually happen over night but evolves over time.

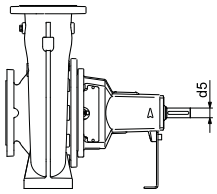
Therefore, Grundfos has designed a bearing bracket with devices for monitoring bearing conditions. The following conditions are monitored:

- vibrations by means of SPM (shock-pulse measuring)
- temperature by means of Pt100 sensors.

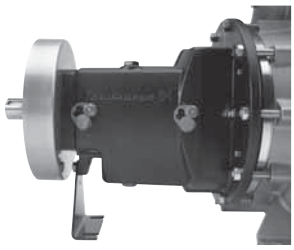
With the information from these devices, maintenance and repairs can be scheduled for an appropriate time, not causing major production losses. Thus unnecessary repair work based on experience and recommendations on running time can be avoided, and money can be saved.

The following NK, NKG pumps are available with bearing monitoring equipment:

d5 [mm]	Bearing design			
	Standard		Heavy duty	
	NK	NKG	NK	NKG
24	-	-	-	•
32	-	-	-	•
42	-	-	-	•
48	-	-	-	•
60	-	-	-	•



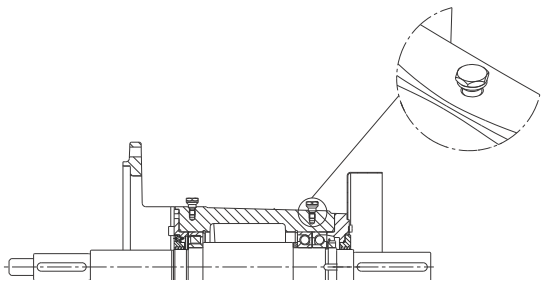
Vibration monitoring



GrA8476

Fig. 68 SPM fittings in the bearing bracket

Bearing brackets with automatic grease lubricators or constant-level oiler are prepared for vibration measurement by means of SPM. Through regular shock-pulse measurement, the development of incipient damage can be monitored.



TM04 4925 1918

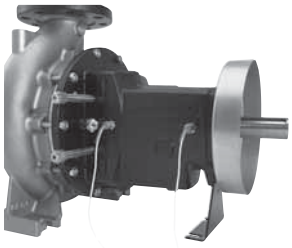
Fig. 69 Bearing bracket with SPM points

Features of the SPM design:

- The signal path between bearing and measuring point is as short and straight as possible.
- The signal path contains only one mechanical interface, i.e. the one between bearing and bearing housing.
- The measuring point is located in the load zone of the bearing.

To monitor the bearing condition, the initial vibration level, dBi (decibel initial), must be measured. It constitutes the starting point of the condition scale for a particular bearing.

Temperature monitoring



GrA8474

Fig. 70 Pt100 sensors in the bearing bracket

Bearing brackets with automatic grease lubricators or constant-level oiler have tappings for Pt100 sensors for monitoring the temperature of the bearings.

These sensors can be factory-fitted, but can also be retrofitted. A Grundfos sensor is available.

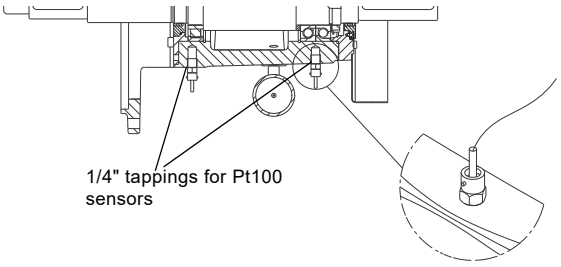


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Fig. 71 Tappings for Pt100 sensor

ATEX-approved pumps

TM01 619 4202

ATEX-approved pumps are designed for use in potentially explosive atmospheres. Explosive atmospheres consists of air and combustible matter, such as gases, vapours, mists or dusts in which the explosion spreads after ignition.

We offer explosion-proof or dust-ignition-proof motors in accordance with the EC directive 2014/34/EU, the so-called ATEX directive. The ATEX-approved pumps can be used in areas (zones) classified according to the directive 1999/92/EC. In case of doubt, consult the above-mentioned directives or contact Grundfos.

The nameplates of ATEX-approved pumps are supplied with serial number, ATEX classification, and an "X" indicating that special installation and operating instructions must be followed.

An ATEX certificate is available on request.

Scope of ATEX pumps

	NB, NBG	NK, NKG	NBE, NBGE	NKE, NKGE
Standard ATEX motor	x	x	-	-
Grundfos MGE motor with an internal frequency drive	-	-	-[1)]	-[1)]
ATEX motor with an external frequency drive	-	-	x[2)]	x[2)]

1) Not available. Grundfos MGE motors are not approved for installation in ATEX environments.

2) ATEX motors are specially approved for VFD operation with frequency drives installed outside the ATEX areas. Such motors must be specified by the customer.
Important: The frequency drive installed outside the ATEX areas must also be approved for the operation with ATEX equipment.

ATEX categories for NB, NBG, NK, NKG pumps

Directive							
2014/34/EU				1999/92/EC[1]	ATEX pumps		ATEX motors
Equipment group	Equipment category	Environment	EPL (Equipment protection level)	Zone	Shaft seal arrangement		
					Single	Double	
II	3 Pumps intended for use in areas in which an explosive atmosphere is not likely to occur in normal operation but, if it does occur, will persist for a short period only.	G	Gc	Zone 2	NB, NBG, NK, NKG[2]	NKG[2]	II 3G Ex ec IIC T3 Gc
		D	Dc	Zone 22			II 3D Ex tc IIIC T125 °C Dc
	2 Pumps intended for use in areas in which an explosive atmosphere is likely to occur in normal operation occasionally.	G	Gb	Zone 1			II 2G Ex eb IIC T3 Gb II 2G Ex db IIC T4 Gb II 2G Ex db eb IIC T4 Gb
		D	Db	Zone 21			II 2D Ex tb IIIC T125 °C Db
	1 Pumps intended for use in areas in which an explosive atmosphere present continuously or for long periods or frequently.	G	Ga	Zone 0	NA	NA	
		D	Da	Zone 20	NA	NA	
I	M Underground installations in mines liable to be endangered by explosive gasses or combustible dust.	1	Ma	NA	NA	NA	
		2	Mb	NA	NA	NA	

1) Important: The link between groups, categories and zones is explained in the 1999/92/EC directive. Please note that this is a minimum directive. Some EEC (European Economic Community) countries may therefore have stricter local rules. The user or installer is always responsible for checking that the group and category of the pump correspond to the zone classification of the installation site.

2) An NB, NBG, NK, NKG pump marked 3G/3D can be installed in group II, category 2G/2D (zone 1 and zone 21), when the requirements for 2G/2D stated in the section *Monitoring requirements* on page 58 are observed. Also make sure that the motor is valid for this category.

Explosion protection document

The combination of all "monitoring equipment" must be described in the explosion protection document according to the 1999/92/EC Directive. It is the responsibility of the installer/owner to fill out the explosion protection document.

Bare shaft pumps

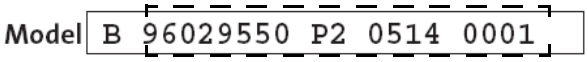
ATEX approved NB, NBG, NK, NKG bare shaft pumps are available and are supplied with an ATEX marking similar to that of the ATEX approved NB, NBG, NK, NKG pump.

How to request for an ATEX pump

1. An agreement has to be made between the customer and Grundfos on operating conditions. For this the end-user needs to provide:
   – required zone classification or equipment category or EPL
   – pumped liquid (water, water with glycol, or oil)
   – Maximum operation temperature of the pumped liquid.
   – maximum working pressure of the pump
   – requirement for speed control of the pump (if connected with a frequency converter).

The KADS (key application data sheet) must be used for this purpose. See section *14. Key application data* or get the electronic file via Grundfos Product Centre.

A copy of the KADS file is stored by Grundfos and can be traced by the product number and the serial numbers on the pump nameplate.



2. Determine whether a single seal or a double seal arrangement is required. See section *Determination of shaft seal arrangements for the ATEX applications* on page 56.
3. Send your selection to the NB, NBG, NK, NKG customer service unit who will double check the configuration of the chosen solution and make necessary arrangement for the requested ATEX motor.

Determination of shaft seal arrangements for the ATEX applications

The shaft seal defines the maximum surface temperature of the pump. The illustration below shows the maximum surface temperature of the pump as a result of maximum liquid temperature and temperature rise in the shaft seal.

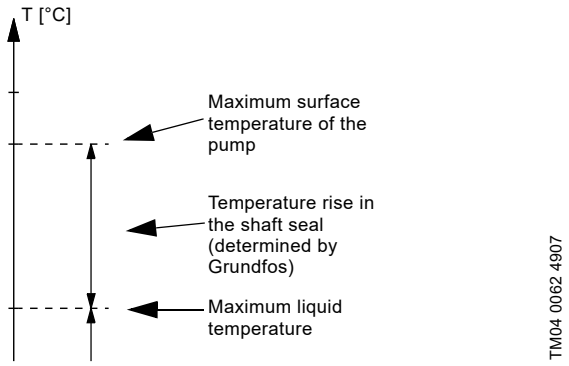


Fig. 72 Calculation of maximum surface temperature

Pump required with temperature class T3 (200 °C)

For pumps required with temperature class T3 (200 °C), the maximum temperatures of shaft seals installed in non-ATEX areas can be followed in the table below.

Shaft seal diameter [mm]						28, 38	48	55	60
Shaft seal type		Seal faces	Rubber	Code	Temperature range	Max. pressure [bar]			
	Bellows seal, type B, unbalanced	BQ_1	EPDM	BBQE	0-120 °C	16	16	16	16
		BQ_1	FKM	BBQV	0-70 °C	16	16	16	16
		Q_7Q_7	EPDM	BQQE	-25 - +120 °C	16	16	16	16
		Q_7Q_7	FKM	BQQV	-10 - +70 °C	16	16	16	16
	O-ring seal, type D, balanced	AQ_1	FXM	DAQF	0-140 °C	25	25	25	25

Pump required with temperature class T4 (135 °C)

For pumps required with temperature class T4 (135 °C), the maximum operating temperature of the shaft seal is limited compared to non-ATEX installation.

The table below indicates the maximum operating temperatures of different shaft seals at different pump speeds for single mechanical shaft seal.

Shaft seal diameter [mm]	Pump speed [rpm]	Max. temperature of pumped liquid [°C] (Water or water-glycol mixtures)			
		BQ_7Q_7E	BQ_7Q_7V	BBQ_1E	BBQ_1V
		Max. 16 bar			
28	970	100	70 *	-	70 *
	1170	98	70 *	-	70 *
	1450	95	70 *	-	70 *
	1750	93	70 *	-	70 *
	2900	89	70 *	-	70 *
	3600	87	70 *	-	70 *
38	970	95	70 *	-	70 *
	1170	91	70 *	-	70 *
	1450	87	70 *	-	70 *
	1750	85	70 *	-	70 *
	2900	80	70 *	-	70 *
	3600	80	70 *	-	70 *
48	970	80	70 *	-	70 *
	1170	78	70 *	-	70 *
	1450	76	70 *	-	70 *
	1750	75	70 *	-	70 *
	2900	72	70 *	-	70 *
	3600	71	70 *	-	70 *

* If a shaft seal with Viton is used with water, the maximum operating temperature of this seal is always 70 °C. The elastomer defines the limit here.

Ambient temperatures (up to +60 °C) are taken into consideration in the maximum temperatures of pumped liquids.

Important: Note that some seal faces can be available in different base materials. They could be XQ_1Q_1X or XQ_6Q_6X or XQ_7Q_7X. Be careful to select the seal face combination mentioned in the table above.

If the maximum operating temperature of pumped liquid informed by the customer is higher than the value in the table above, Grundfos can offer a double seal arrangement where the flushing liquid temperature close to the outer shaft seal can be controlled to live up to the zone classification.

Pump required with temperature class T5 (100 °C) or T6 (85 °C)

Contact Grundfos for a solution.

Elastomers or rubbers in the pump

Maximum operating temperature of different elastomers in ATEX installations [°C]				
Water or water-glycol mixtures			Oils	
E (EPDM)	V (FKM)	F (FXM)	V (FKM)	F (FXM)
130	70	200	180	200

Monitoring requirements

Shaft seal arrangement	Type of unit	Solution		Type of pumped liquid	Category and environment	Zone	EPL	Text code[4]
Single shaft seal	Pump unit			Non-flammable	3G/3D	2/22	Gc/Dc	1, 10
					2G/2D	1/21	Gb/Db	2, 10
				Flammable	3G/3D	2/22	Gc/Dc	2, 11
					2G/2D	1/21	Gb/Db	2, 11
Double shaft seal	Pump unit			Non-flammable	3G/3D	2/22	Gc/Dc	1, 10
					2G/2D	1/21	Gb/Db	2, 10
				Flammable	3G/3D	2/22	Gc/Dc	2, 11
					2G/2D	1/21	Gb/Db	2, 11
	Auxiliary unit	Dead-end	Pressureless[1]	Non-flammable	3G/3D	2/22	Gc/Dc	3, 10
					2G/2D	1/21	Gb/Db	3, 10
				Flammable	3G/3D	2/22	Gc/Dc	3, 10
					2G/2D	1/21	Gb/Db	4, 11
			Pressurised[2]	Non-flammable	3G/3D	2/22	Gc/Dc	5, 10
					2G/2D	1/21	Gb/Db	6, 10
				Flammable	3G/3D	2/22	Gc/Dc	5, 11
					2G/2D	1/21	Gb/Db	6, 11
		Circulating[3]	Pressureless[1]	Non-flammable	3G/3D	2/22	Gc/Dc	3, 7, 10
					2G/2D	1/21	Gb/Db	3, 7, 10
				Flammable	3G/3D	2/22	Gc/Dc	4, 8, 11
					2G/2D	1/21	Gb/Db	4, 8, 11
			Pressurised[2]	Non-flammable	3G/3D	2/22	Gc/Dc	5, 7, 10
					2G/2D	1/21	Gb/Db	6, 8, 10
				Flammable	3G/3D	2/22	Gc/Dc	5, 7, 11
					2G/2D	1/21	Gb/Db	6, 8, 11

1) Pressureless: The pumped liquid will continuously leak into the auxiliary system liquid, the maximum leakage is 1.5 ml per hour, and may fill the auxiliary system.

2) Pressurised: The barrier liquid will continuously leak into the pumped liquid, the maximum leakage is 1.5 ml per hour. The liquids must be compatible.

3) Circulating: circulating liquid.
A temperature increase of 7-10 K across the shaft seal chamber and a maximum outlet temperature of 70 °C must be maintained. This ensures correct function of the shaft seals.
If circulation is lost, the temperature of the barrier or flushing liquid will increase.

4) See the table below for text code descriptions.

Text code	Description
Monitoring	
1	No additional monitoring, for example dry-running protection, is required for the pump system.
2	If the operator cannot ensure that the pump is filled with pumped liquid during operation, appropriate monitoring, for instance dry-running protection, is required to stop the pump in case of malfunction.
3	No additional monitoring, for example dry-running protection, is required for the auxiliary unit.
4	If the operator cannot ensure that the auxiliary unit is filled with barrier or flushing liquid during operation, appropriate monitoring, for instance a level switch, is required to give an alarm in case of malfunction.
5	In case of a drop in barrier liquid pressure, a warning must be given. Check the system and remedy.
6	In case of a drop in barrier liquid pressure, an alarm must be given, and the system must shut down if the barrier liquid pressure is not brought back to the correct pressure level.
Circulating liquid	
7	If circulation of the barrier or flushing liquid is lost, a warning must be given. Check the system and remedy.
8	If circulation of the barrier or flushing liquid is lost, an alarm must be given. Check the system and remedy. The system must shut down if the circulation cannot be re-established during operation.
Ventilation	
10	Ventilation around the pump is not required.
11	The leakage rate of a normally working shaft seal is less than 36 ml for each 24 hours of operation. Ventilation around the pump is required. The minimum air exchange is 1.5 times per hour.

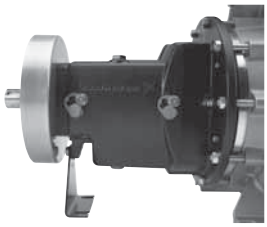
Monitoring of bearing condition

For EPL Gb/Db and Gc/Dc, bearing condition monitoring is basically not needed as failure of the bearings is considered a rare malfunction. However, local regulations may call for stricter measures with continuous monitoring of the bearing condition.

SPM nipples

For bearing brackets with grease nipples or constant-level oiler, SPM nipples are an option for vibration measurement. Through regular shock-pulse measurement, the development of incipient damage can be monitored.

The measuring point is located in the load zone of the bearing.



GrA8476

Fig. 73 SPM fitting in the bearing bracket

To monitor the bearing condition, the initial vibration level, dBi (decibel initial), must be measured. It constitutes the starting point of the condition scale for a particular bearing.

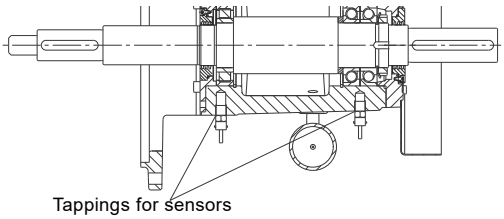
If the vibration level develops faster than it did in the first two to three months of operation, renew the bearings.

If the vibration level develops fast, also observe for other operating conditions which could cause increased vibration levels.

Mounting of sensors or transmitters

Bearing brackets with grease nipples or constant-level oiler are optionally supplied with pre-machined tappings prepared for temperature sensors or transmitters.

Thus, it becomes possible to continuously measure the temperature development of the bearings.



TM07 4995 2719

Fig. 74 Optional tappings prepared for fitting of temperature sensors or transmitters

The alarm level is the maximum surface temperature detected by the bearing temperature sensor. The temperature alarm level is set 65 K above ambient temperature, but must be lower than the temperature classification for the area. Logging interval must be set to every 10th sec.

If the alarm level is reached, the system must be stopped. The protection system must lock the pump till it is manually restarted.

Corrosive atmosphere

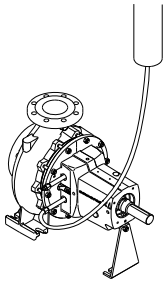
For corrosive atmosphere, pay extra attention to monitoring of bearings, as this may affect the life of the bearing. The bearing type is greased-for-life, re-greaseable or oil-lubricated.

Auxiliary unit solutions for double-seal arrangements, NKG only

Different solutions can be used as auxiliary unit if a double-seal arrangement is needed for the application.

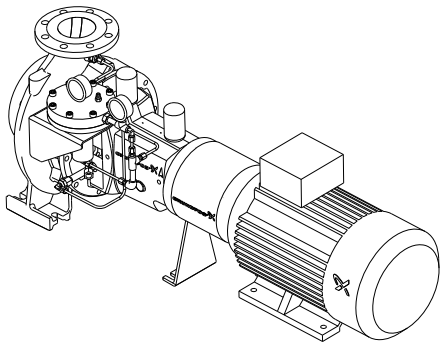
The auxiliary units below can be used together with a pump marked for ATEX use.

Dead-end solution



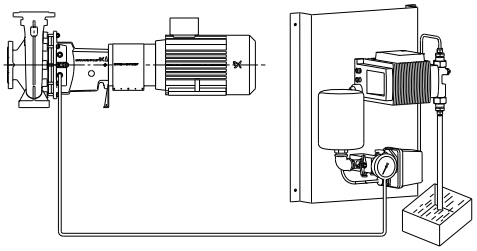
TM04 4189 1009

Fig. 75 Pressureless dead-end liquid



TM04 4333 1209

Fig. 76 Pressurized barrier liquid by means of intensifier

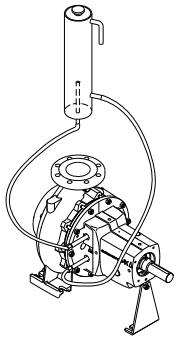


TM04 4334 1209

Fig. 77 Pressurized barrier liquid by means of dosing pump unit

Note: The dosing pump unit must be located outside the ATEX area, as the dosing pump unit is not available with an ATEX approval.

Circulating solutions



TM04 4176 1209

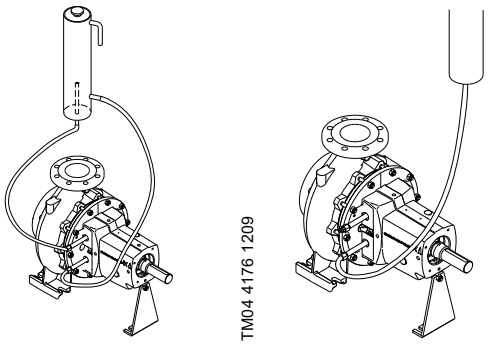
Fig. 78 Example of circulating solution

Important operating parameter for the circulating solution:

At all times, the maximum discharge temperature from the seal chamber must be kept below 70 °C, and optimally maximum 60 °C.

Delta T across the seal chamber is adjusted and set between 7 and maximum 10 K.

Vacuum operation or suction lift



TM04 4176 1209

TM04 4189 1009

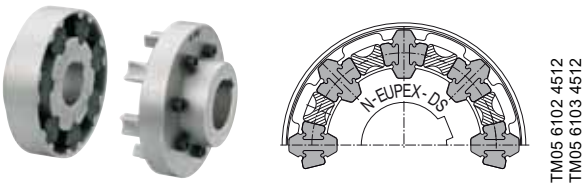
Fig. 79 Pumps with double seal arrangements connected to an elevated vessel

If vacuum operation or suction lift is a continuous or periodic operating condition for the applications shown in fig. 79, use appropriate level monitoring equipment to ensure liquid in the seal chamber. The pump must be stopped if the liquid reaches a specified low level in the supply vessel.

NK, NKG ATEX coupling

Grundfos can provide a special coupling type for ATEX applications.

The ATEX coupling is so designed that overload or advanced wear causes irreparable damage to the flexible elastomer segments. The metal parts of the coupling can then rotate freely without contact so that sparks are avoided.



TM05 6102 4512
TM05 6103 4512

Fig. 80 ATEX coupling and its sectional drawing

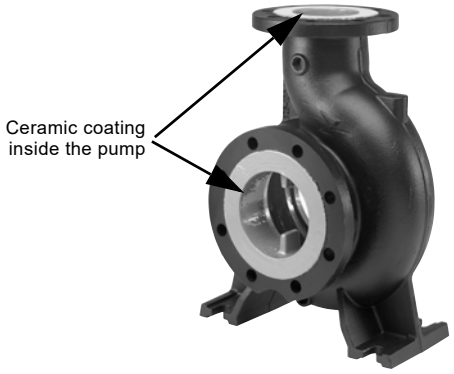
Certificate

See section *12. Certificates and reports*.

Service

Make all service and adjustments according to the service instructions for the product. For service instructions, go to Grundfos Product Center, see page 153, or contact your local Grundfos service centre.

Ceramic coating



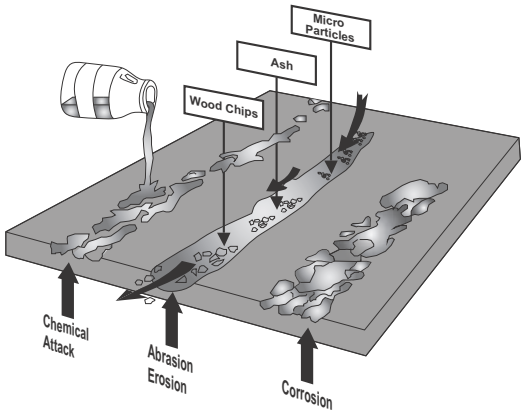
TM05 2406 5011

Fig. 81 Pump with ceramic coating

Why is coating necessary in a pump?

The purpose of coating a pump is basically to improve the "surface performance" when pumping challenging or "difficult" liquids. The general challenges are as follows:

- abrasion
- corrosion/erosion
- chemical attack.



TM06 3321 5114

Fig. 82 Impact on metal surfaces when pumping "difficult" liquids

Paint vs. coating

Paint

A liquid material containing drying oils with natural resins and pigments which, when applied to a suitable surface, will combine with oxygen from the air to form a solid, continuous film over the substrate, thus providing a weather resistant "decorative" surface. However, paints will continue to oxidise over their entire lifetime and gradually become porous to oxygen, water and ions that may be deposited on the surface. This will result in failure.

Coating

A material composed essentially of synthetic resins or inorganic silicate polymers which, when applied to a suitable base material (cast iron or stainless steel), provides a continuous coating that will resist industrial or marine environments and prevent serious breakdown of the basic structure in spite of these factors:

- abrasion
- holidays
- imperfections in the coating.

NB, NBG, NK, NKG coating

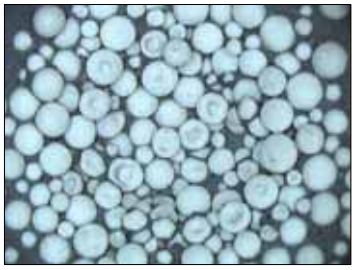
Coatings for NB, NBG, NK, NKG pumps are based on a two-phase composite, a matrix and reinforcing particles bonded in the matrix.

The matrix provides a lot of properties to the coating, such as:

- adhesion to the base material
- chemical resistance
- temperature resistance
- resistance to the transfer or penetration of ions from salts which may contact the coating
- resistance to the action of osmosis
- expansion and contraction with the underlying surface
- absorption of impacts from particles
- maintenance of a good appearance, even under extreme weather conditions.

The reinforcing particles which are bonded in the matrix provide the wear resistance of the coating. The particle size and packing density in combination determine the actual wear resistance to the specific pumped liquid.

For the wear resistant coating types, the packing density is up to 95 %.



TM06 3055 4814

Fig. 83 Example of ARC coating type with a high reinforcing particle density

A coated pump - What do you get?

Ceramic coatings add to the already very extensive NB, NBG, NK, NKG product range. It fills in a gap between cast iron and stainless steel when comparing price and resistance against the pumped liquid, and adds to the resistance where even the highest stainless steel grade must give up.

- Investing in a coated pump will increase the life of the wetted parts considerably.
- Payback of your investment will be short, as the extended pump life will save on costly service and repeated replacement of worn out pumps.
- Coated pumps have an extra external coating which will extend the life of the pump unit.
- Worn-out parts (pump housing and cover) can be refurbished as an alternative to replacing the pump.
- Only one coating supplier supplies all coating types
  – this to ensure continuous high quality of the coating.
- A ceramic-coated pump is a solution that matches even the most extreme requirements.

Range of coating solutions

Grundfos has some standard offerings as stated in the table below. Wetted pump parts are coated according to the requirements of the general application.

Grundfos standard coating solutions

Pumped liquid	Pump range covered	Top coat colour	Comment
Chlorinated water	Complete range	Grey	(1)
Seawater < 25 °C	Complete range	Black	(1)
25 °C < Seawater < 65 °C	Part of range	Black	(1)
Liquid with abrasives	Complete range	Black	(2)
Chemical liquids < 60 °C	Part of range	Light grey	(1)

(1) Light abrasives only.
(2) Moderate chemical resistance.

- **Complete range**
  The complete range of pumps is available with this coating solution. The impellers are not coated.
- **Part of range**
  Some liquids are so difficult to handle that it requires a fully coated pump to be resistant against the pumped liquid. When only "part of range" is mentioned it means that some impeller sizes cannot be coated due to narrow geometries. A larger pump at a lower speed might be the solution here - still as a coated solution.

All coated pumps include an extra top coat on all outer pump surfaces.

Typical applications

Figures 84-88 cover the range of standard coatings in relation to where it is used today. Additionally, they give you an idea when a coated pump might be a good choice compared to cast iron pumps and stainless steel pumps. The hatched area expresses an overall picture. Some pumps will deviate from the shown examples.

(RCR: Relative Corrosion Resistance)

Coating for chlorinated water

Typical applications are:

- swimming pools
- brackish water.

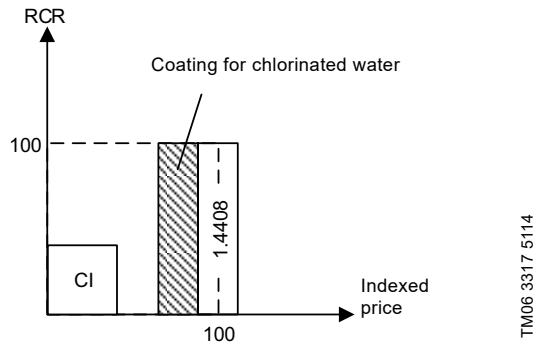


Fig. 84 Price-corrosion resistance relation between cast iron and stainless steel 1.4408

Pump part	Basic material	Coated
Pump housing + cover/motor stool	Cast iron	Yes
Impeller	Stainless steel 1.4408	No
Shaft	Stainless steel 1.4401	No
Wear ring	Bronze/brass	No

Coating for seawater up to 25 °C

Typical applications are:

- fish farming
- desalination/water treatment.

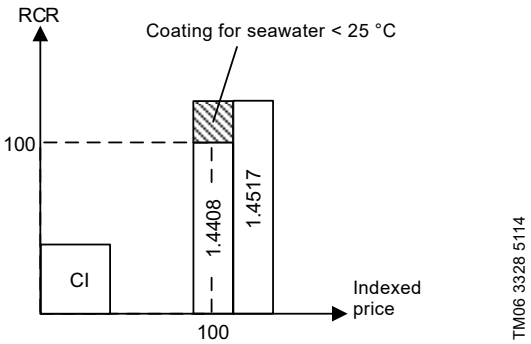


Fig. 85 Price-corrosion resistance relation between cast iron and stainless steel grades

Pump part	Basic material	Coated
Pump housing + cover/motor stool	Cast iron	Yes
Impeller	Stainless steel 1.4517	No
Shaft	Stainless steel 1.4462	No
Wear ring	Bronze/brass	Yes

Coating for chemicals up to 60 °C

Typical applications are:

- chemical industry.

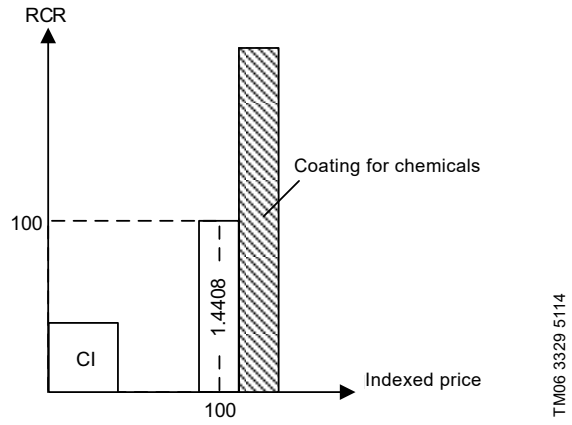


Fig. 86 Price-corrosion resistance relation between cast iron and stainless steel 1.4408

Pump part	Basic material	Coated
Pump housing + cover/motor stool	Cast iron	Yes
Impeller	Cast iron	Yes
Shaft	Stainless steel 1.4401	Yes
Wear ring	Bronze/brass	Yes

Wear resistant coating up to 110 °C

Typical applications are:

- mining
- offshore fire-fighting.

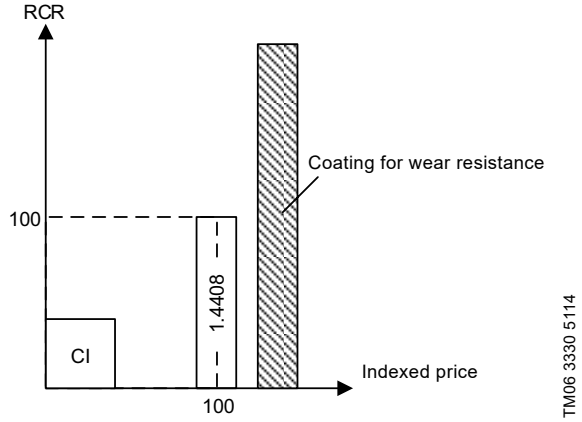


Fig. 87 Price-corrosion resistance relation between cast iron and stainless steel 1.4408

Pump part	Basic material	Coated
Pump housing + cover/motor stool	Cast iron	Yes
Impeller	Stainless steel 1.4517	No
Shaft	Stainless steel 1.4462	No
Wear ring	Bronze/brass	Yes

Coating for seawater between 25 and 65 °C

Typical applications are:

- desalination/water treatment
- mining
- offshore fire-fighting.

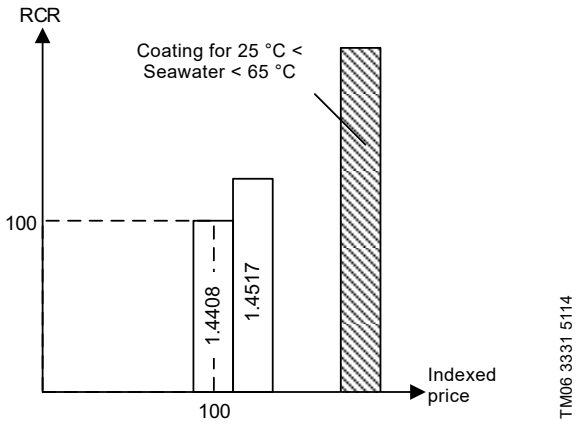


Fig. 88 Price-corrosion resistance relation between stainless steel 1.4408 and stainless steel 1.4517

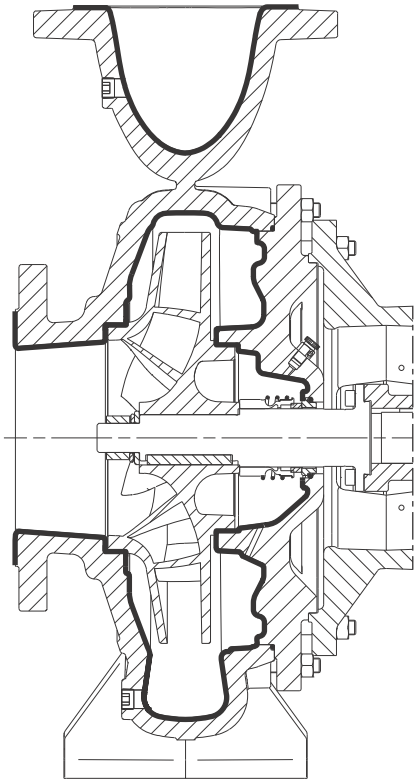
Pump part	Basic material	Coated
Pump housing + cover/motor stool	Stainless steel 1.4517	Yes
Impeller	Stainless steel 1.4517	Yes
Shaft	Stainless steel 1.4462	Yes
Wear ring	Stainless steel 1.4517	Yes

The reason for using duplex steel 1.4517 as the basic material lies in the need for safety for this type of application. If the coating is damaged, this pump will still be able to survive for some time. And if this should happen, any damaged pump parts can most likely be refurbished.

Note: If you are in doubt which coating solution to use, please contact your local customer service unit (CSU) for guidance.

Sectional views showing coating

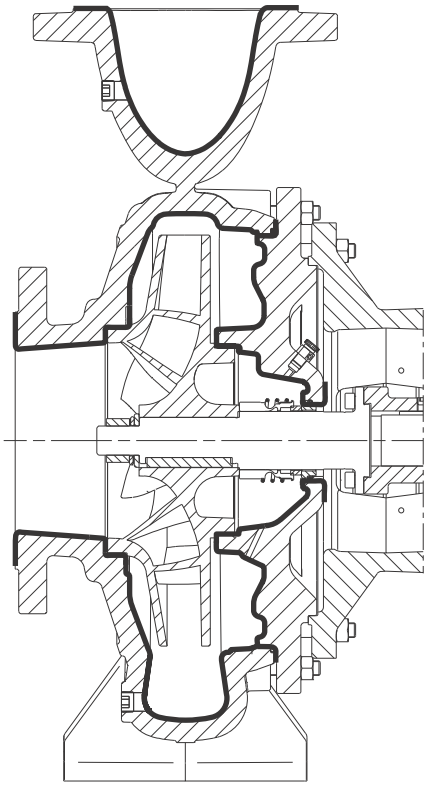
Coating for chlorinated water



TM06 3378 0115

Fig. 89 Sectional view of pump coated for chlorinated water

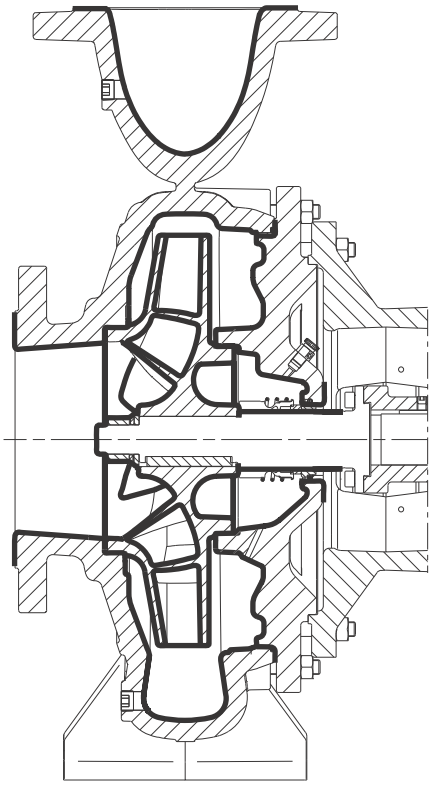
Coating for seawater up to 25 °C



TM06 3379 0115

Fig. 90 Sectional view of pump coated for seawater up to 25 °C

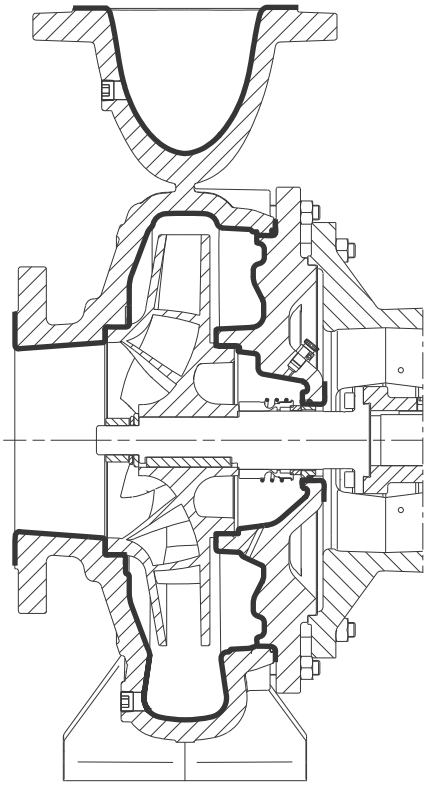
Coating for chemicals up to 60 °C



TM06 3381 0115

Fig. 91 Sectional view of pump coated for chemicals up to 60 °C

Wear resistant coating up to 110 °C



TM06 3379 0115

Fig. 92 Sectional view of pump with wear resistant coating

Coating for seawater between 25 and 65 °C

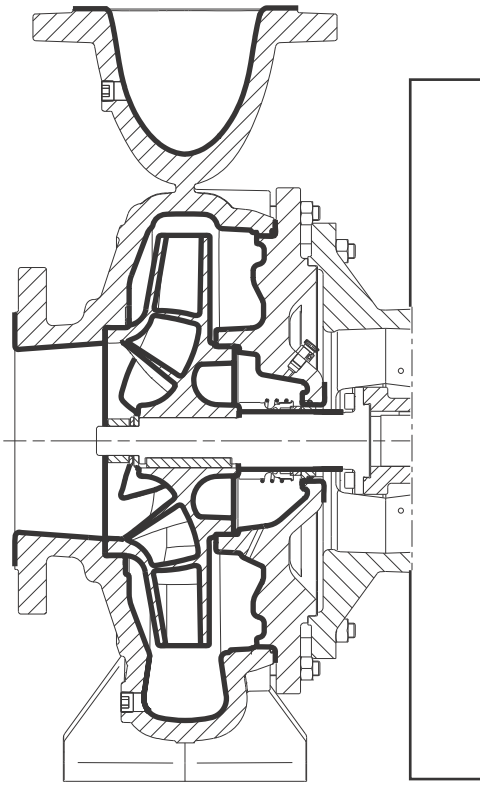


Fig. 93 Sectional view of pump coated for seawater between 25 and 65 °C

Special operating conditions

If the operating conditions differ from the ones listed in the table *Grundfos standard coating solutions* on page 62, an alternative coating might be possible. In order to determine this, Grundfos will need information on the operating conditions from the customer. Follow the *Guide to selecting the right coating* below.

Guide to selecting the right coating

In order to select the correct coating for the application, the operating conditions must be known. Grundfos Customer Service Units (CSU) will always need this information:

- type of liquid
- composition of liquid - liquid + particles etc
- operating temperature
- sizes of particles (in mm)
- weight-percentage of particles (percentage of the pumped liquid)
- density of particles (in kg/m^3)
- speed of particles (duty point of pump).

Use the section *14. Key application data* pages starting on page 149 for this purpose.

Contact Grundfos for further information.

Note: One coating solution will never be successful in all applications!

How does the coating affect the pump performance?

Tests have shown that a coating only has an insignificant effect on the pump performance. Flow, pressure and efficiency is the same as for a similar, uncoated pump. This also means that it is possible to select and size a coated pump according to the fixed-impeller range or duty point specific range in Grundfos Product Center (http://product-selection.grundfos.com).

Drinking water approvals

Some coatings used for the NB, NBG, NK, NKG pumps have a drinking water approval.

The table below shows which coating solutions that use a coating which has a drinking water approval and the type of approval.

Coating solution for...	Drinking water approval
Chlorinated water	WRAS
Seawater < 25 °C	WRAS
25 °C < Seawater < 65 °C	WRAS
Liquid with abrasives	-
Chemical liquids < 60 °C	-

Service

Information about repair kits and service instructions are available on Grundfos Product Center. Use this link: http://product-selection.grundfos.com.

Coating supplier references, qualifications and approvals

Our supplier of NB, NBG, NK, NKG coatings has the following list of references:

- A.P. Moeller: 30 years
- power plants: 20 years
- wastewater pumps: 18 years
- offshore industry: 15 years
- chemical industry: 10 years
- district heating plants: 5 years.

Qualifications/approvals:

- Sellicha prequalification
- Achilles prequalification
- Certified Frosio paint inspector.

Coatings are produced in accordance with Quality management system ISO 9001 and Environmental management standard - ISO 14001.

Pump flanges

Fig. 94 Fixed flanges

Fig. 95 Loose flanges

Pump flanges for NB, NBG, NK, NKG pumps are available with dimensions according to several standards:

- DIN flange dimensions are according to EN 1092-2.
- ANSI flange dimensions are according to ASME B16.5.
- JIS flange dimensions are according to JIS B 2210.
- The Australian table E flange dimensions are according to AS 2129 table E.

Flanges are available as fixed or loose flanges depending on the pump material. Loose flanges are only available for stainless steel pumps.

Loose flanges

Sometimes big improvements come from small things. That is the case with loose flanges, which are available in most NB, NBG, NK, NKG pumps. A loose flange is a flange which can be adjusted to fit the existing pipes, and be adapted to the required flange standard and thus facilitate installation.

Unique features

The loose flanges offer quite a few benefits compared to the standard type flanges:

- they save installation time in general.
- they make up for twisted counter flange weldings.
- they provide full adaptability to the standards DIN, ANSI and JIS.
- you will have a flange that will fit the first time you replace an old pump or another brand; loose flanges range from PN 10 to PN 40.
- you can make special installations where the flanges are turned to match limited space for service.

Years of experience with Grundfos CR customers have shown that loose flanges save on installation time and thus save money.

Turning the flanges

With loose flanges it is possible to turn the flange a few degrees if the counter flange has been twisted during installation and/or welding. The flange can be rotated to meet the connection. This will avoid stress being added to the pump and will reduce overall downtime.

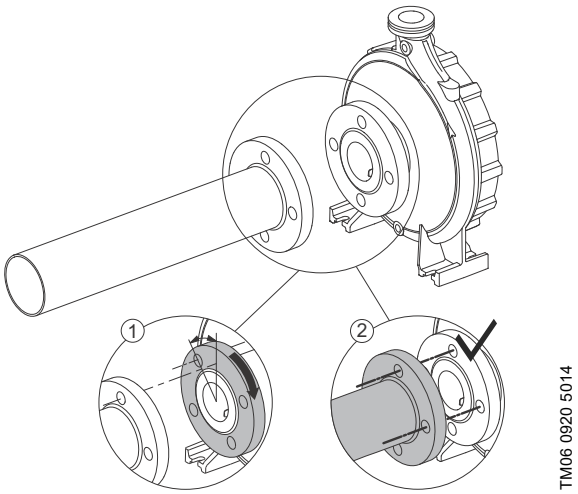


Fig. 96 Loose flange

Total adaptability

The loose flanges offer adaptability in the ordering process, too. If a pump was ordered according to a wrong flange standard, such as DIN, it is possible to order a loose flange according to the correct standard, for example ANSI, and fit that instead.

Special installation requirements

Installers often have limited space to connect and adapt pumps to suit special installation requirements. Loose flanges help solve this problem because it is possible to turn the loose flange and the counter flange. This could be especially helpful for OEM builders, who must often make complex turn-key solutions in 20-foot containers or even smaller units.

Loose flanges are available on NB, NBG, NK, NKG pumps according to the table below. The standard offering is loose flanges made of ductile iron (GGG50). Stainless steel (1.4408) loose flanges are optional.

Note: For a very limited number of pump models with loose flange option it will not be possible to turn the flange. See the table below.

NB, NBE, NK, NKE

Grundfos pump range	Cast iron pump					Stainless steel pump			
	Flange rating		Flange standard			Flange rating	Flange standard		
	PN 10	PN 16	DIN (code F)	ANSI (code G)	JIS (code J)	PN 16	DIN (code F)	ANSI (code G)	JIS (code J)
32-125.1	F	F	●	-	-	F	●	-	-
32-160.1	F	F	●	-	-	F	●	-	-
32-200.1	F	F	●	-	-	F	●	-	-
32-125	F	F	●	-	-	F	●	-	-
32-160	F	F	●	-	-	F	●	-	-
32-200	F	F	●	-	-	F	●	-	-
32-250	F	F	●	-	-	F	●	-	-
40-125	F	F	●	-	-	F	●	-	-
40-160	F	F	●	-	-	F	●	-	-
40-200	F	F	●	-	-	F	●	-	-
40-250	F	F	●	-	-	F	●	-	-
40-315	F	F	●	-	-	F	●	-	-
50-125	F	F	●	-	-	F	●	-	-
50-160	F	F	●	-	-	F	●	-	-
50-200	F	F	●	-	-	F	●	-	-
50-250	F	F	●	-	-	F	●	-	-
50-315	F	F	●	-	-	F	●	-	-
65-125	F	F	●	-	-	F	●	-	-
65-160	F	F	●	-	-	F	●	-	-
65-200	F	F	●	-	-	F	●	-	-
65-250	F	F	●	-	-	F	●	-	-
65-315	F	F	●	-	-	F	●	-	-
80-160	F	F	●	-	-	F	●	-	-
80-200	F	F	●	-	-	F	●	-	-
80-250	F	F	●	-	-	F	●	-	-
80-315	F	F	●	-	-	F	●	-	-
80-400	F	F	●	-	-	F	●	-	-
80-400.1	-	-	-	-	-	-	-	-	-
100-160	F	F	●	-	-	L	●	-	-
100-200	F	F	●	-	-	L	●	-	-
100-250	F	F	●	-	-	L	●	-	-
100-315	F	F	●	-	-	L	●	-	-
100-400	F	F	●	-	-	L	●	-	-
125-200	F	F	●	-	-	L	●	-	-
125-250	F	F	●	-	-	L	●	-	-
125-315	F	F	●	-	-	L	●	-	-
125-400	F	F	●	-	-	L	●	-	-
125-500	F	F	●	-	-	L	●	-	-
150-200	F	-	●	-	-	L	●	-	-
150-250	F	-	●	-	-	L	●	-	-
150-315	F	-	●	-	-	L	●	-	-
150-315.1	F	-	●	-	-	L	●	-	-
150-400	F	-	●	-	-	L	●	-	-
150-500	F	-	●	-	-	L	●	-	-
200-400	F	-	F	-	-	-	-	-	-
200-450	F	-	F	-	-	-	-	-	-
250-350	F	-	F	-	-	-	-	-	-
250-400	F	-	F	-	-	-	-	-	-
250-450	F	-	F	-	-	-	-	-	-
250-500	F	-	F	-	-	-	-	-	-
	F = Fixed flange. L = Loose flange, cast iron GGG50-EN-GJS-500-7 or stainless steel 1.4408.								

NBG, NBGE, NKG, NKGE

Grundfos pump range	Cast iron pump					Stainless steel pump						Code for loose flange that cannot be turned	
	Flange rating		Flange standard			Flange rating			Flange standard				
	PN 10	PN 16	DIN (code F)	ANSI (code G)	JIS (code J)	PN 16	PN 25	PN 40[1]	DIN (code F)	ANSI (code G)	JIS (code J)	Inlet	Outlet
50-32-125.1	F	F	●	-	-	F	F	F	●	●	●		
50-32-125	F	F	●	-	-	F	F	F	●	●	●		
50-32-160.1	F	F	●	-	-	F	F	F	●	●	●		
50-32-160	F	F	●	-	-	F	F	F	●	●	●		
50-32-200.1	F	F	●	-	-	F	F	F	●	●	●		
50-32-200	F	F	●	-	-	F	F	F	●	●	●		
50-32-250	F	F	●	-	-	F	F	F	●	●	●		
65-50-125	F	F	●	-	-	L	L	L	●	●	●	G+J	G+J
65-50-160	F	F	●	-	-	L	L	L	●	●	●		G+J
65-40-200	F	F	●	-	-	L	L	L	●	●	●		
65-40-250	F	F	●	-	-	L	L	L	●	●	●		
65-40-315	F	F	●	-	-	L	L	L	●	●	●		
80-65-125	F	F	●	-	-	L	L	L	●	●	●		G+J
80-65-160	F	F	●	-	-	L	L	L	●	●	●		
80-50-200	F	F	●	-	-	L	L	L	●	●	●	J	
80-50-250	F	F	●	-	-	L	L	L	●	●	●		
80-50-315	F	F	●	-	-	L	L	L	●	●	●		
100-80-125	F	F	●	-	-	L	L	L	●	●	●		G+J
100-80-160	F	F	●	-	-	L	L	L	●	●	●		
100-65-200	F	F	●	-	-	L	L	L	●	●	●		
100-65-250	F	F	●	-	-	L	L	L	●	●	●		
100-65-315	F	F	●	-	-	L	L	L	●	●	●		
125-80-160	F	F	●	-	-	L	L	L	●	●	●		G+J
125-80-200	F	F	●	-	-	L	L	L	●	●	●		
125-80-250	F	F	●	-	-	L	L	L	●	●	●		
125-80-315	F	F	●	-	-	L	L	L	●	●	●		
125-80-400.1	-	-	-	-	-	L	L	L	●	●	●		
125-80-400	F	F	●	-	-	L	L	L	●	●	●		
125-100-160	F	F	●	-	-	L	L	L	●	●	●		
125-100-200	F	F	●	-	-	L	L	L	●	●	●		
125-100-250	F	F	●	-	-	L	L	L	●	●	●		
125-100-315	F	F	●	-	-	L	L	L	●	●	●		
125-100-400	F	F	●	-	-	L	L	L	●	●	●		
150-125-200	F	F	●	-	-	L	L	L	●	●	●		
150-125-250	F	F	●	-	-	L	L	L	●	●	●		
150-125-315	F	F	●	-	-	L	L	L	●	●	●		
150-125-400	F	F	●	-	-	L	L	L	●	●	●		
150-125-500	F	F	●	-	-	L	L	L	●	●	●		
200-150-200	-	F	●	-	-	L	L	L	●	●	●		
200-150-250	-	F	●	-	-	L	L	L	●	●	●		
200-150-315.1	-	F	●	-	-	L	L	L	●	●	●		
200-150-315	-	F	●	-	-	L	L	L	●	●	●		
200-150-400	-	F	●	-	-	L	L	L	●	●	●		
200-150-500	-	F	●	-	-	L	L	L	●	●	●		
250-200-400	-	F	●	-	-	-	-	-	-	-	-		
250-200-450	-	F	●	-	-	-	-	-	-	-	-		
300-250-350	-	F	●	-	-	-	-	-	-	-	-		
300-250-400	-	F	●	-	-	-	-	-	-	-	-		
300-250-450	-	F	●	-	-	-	-	-	-	-	-		
300-250-500	-	F	●	-	-	-	-	-	-	-	-		
350-300-305	F	F	●	-	-	-	-	-	-	-	-		
	F = Fixed flange. L = Loose flange, cast iron GGG50-EN-GJS-500-7 or stainless steel 1.4408.												

[1] The maximum pressure rating for the pump is 25 bar.

PWIS-free pumps

What does PWIS mean?

PWIS means Paint-Wetting Impairment Substances.

The term is used to describe substances that inhibit or destroy the ability of paint to adhere to surfaces.

A PWIS-free environment is mainly required in the automotive industry and in paint shops.

Consequence of PWIS

The undesired consequence of the presence of PWIS is that the paint or coating fails to bond with the PWIS-contaminated sections of the work piece, resulting in dreaded circular "craters" or "pinpricks" on the painted or coated surface. A coated surface contaminated with PWIS will look like this. This is a severe example.

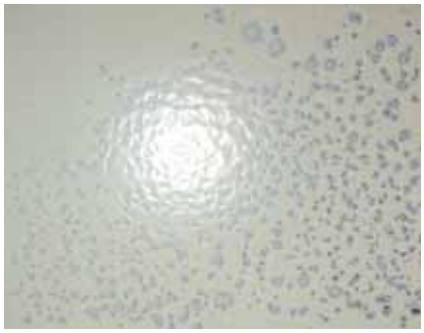


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Fig. 97 Example of coated surface contaminated with PWIS

What do customers require?

In most cases, customers simply ask for a silicone-free pump. What is actually being requested is a PWIS-free pump, as silicone is not the only substance that can impede paint or coating.

The main PWIS are silicones, paraffins, special stearates, oils and greases. Other substances can be graphite (for example from pencils), other plastics which do not contain silicones, e.g. Teflon, waxes and talc.

What does Grundfos do to make PWIS-free pumps?

Our NB, NBG, NK, NKG PWIS-free pump solutions are made to meet the same strict requirements applying in particular for the automotive industry, ensuring no intervention with critical operation and processes.

NB, NBG, NK, NKG pumps have been examined and tested for PWIS.

The following has been done:

- Wetted parts and parts in contact with air have been tested in accordance with VW norm PV 3.10.7 to check the PWIS-free condition.
- Parts found to contain PWIS or release PWIS during operation have been replaced by alternative PWIS-free components.

When the pump is assembled, tools and consumables like lubricants and soapy water are PWIS-free, and special handling procedures are followed.

NB, NBG, NK, NKG PWIS-free pumps are tested in the normal production test equipment.

The finished product is packed in closed packages or wrapped in PWIS-free plastic wraps/bags before being packed for shipment

Each PWIS-free pump is supplied with a "Certificate for PWIS-free pump" - product number 98535593.

Note: Grundfos is not liable for subsequent contamination with PWIS when the products are handled during transport, storage and further processing.

Range of PWIS-free NB, NBG, NK, NKG pumps

Pump construction	All pump sizes			
	NB	NBG	NK	NKG
Standard coupling	●	●	-	-
Spacer coupling	NA	NA	●	●
BQQV shaft seal	●	●	●	●
FKM O-ring	●	●	●	●
E-pumps	-	-	-	-
ATEX pumps	-	-	-	-
Stuffing box	NA	NA	-	-
Oil-lubricated bearing bracket	NA	NA	-	-
Intensifier chamber	NA	NA	-	-
Dosing system	NA	NA	-	-
PT 100 sensors	NA	NA	-	-

● = Yes

- = No

NA = Variant not available for this pump construction

Only Siemens IE3 motors, 50 Hz, up to and including frame size 225, fixed frequency, silicone-free motors are used.

How to order a PWIS-free pump?

NB, NBG, NK, NKG PWIS-free pumps are available via the Product Configuration System.

Service parts

The following service parts are available:

Pump construction	All pump sizes			
	NB	NBG	NK	NKG
Standard coupling	●	●	-	-
Spacer coupling	NA	NA	●	●
BQQV shaft seal	●	●	●	●
FKM O-ring	●	●	●	●

● = Yes

- = No

NA = Variant not available for this pump construction

Product numbers can be found in the Service Kit Catalogue.

8. E-pump solutions

NBE, NBGE, NKE, NKGE pumps without sensor

Fig. 98 NBE, NBGE, NKE, NKGE pumps without sensor

Performance range

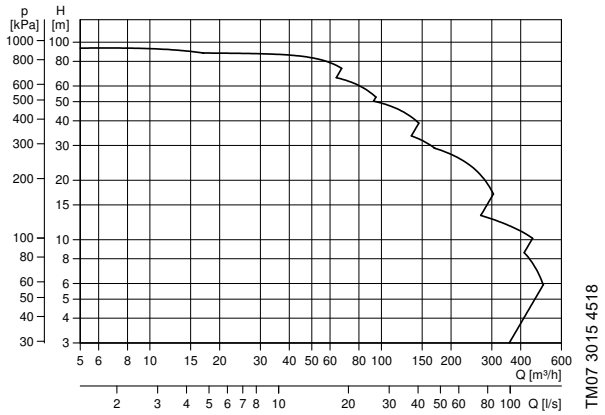


Fig. 99 E-pumps performance range

Flow rate:	Up to 500 m^3/h
Head:	Up to 90 m
Liquid temperature:	-25 to +140 °C
Maximum operating pressure:	25 bar

Construction

NBE, NBGE, NKE, NKGE pumps are based on NB, NBG, NK, NKG standard pumps. The main difference is the MGE motor. The MGE motor has a built-in frequency converter where the variable-speed operation is used for automatic adaptation of performance to current conditions.

All pumps with 2-pole motors up to 11 kW and 4-pole motors up to 7.5 kW are fitted with Grundfos permanent-magnet MGE motors that have motor efficiency class IE5 according to IEC 60034-30-2.

E-motor range (MGE motors)

Pole	IE class	P2 [kW]											
		0.55	0.75	1.1	1.5	2.2	3	4	5.5	7.5	11	15	18.5	22
2	IE2	-	-	-	-	-	-	-	-	-	-	-	-	-
	IE3	-	-	-	-	-	-	-	-	-	-	●	●	●
	IE5	-	-	●	●	●	●	●	●	●	●	-	-	-
4	IE2	-	-	-	-	-		-	-	-	-	-	●	-
	IE3	-	-	-	-	-	-	-	-	-	●	●	-	-
	IE5	●	●	●	●	●	●	●	●	●	-	-	-	-

Outside definition of IE class

Note: NBE, NBGE, NKE, NKGE pumps are not fitted with a sensor from the factory.

Features and benefits

The variable-speed motor and its features give the following benefits in pump applications:

- energy saving
- process control
- extra functions
- external motor protection not required
- high-speed enabling higher performance with a given pump than is the case for the same pump with a standard asynchronous motor
- reduced water hammer due to long ramp times
- low starting currents.

Application examples

These pumps are suitable for applications where the pressure, temperature, flow rate or another parameter is to be controlled on the basis of signals from a sensor at some point in the system.

This integrated speed control enables the pump to operate at any duty point within the range between 25 and 100 % speed. The performance is adapted to the current conditions and thus the energy consumption is kept at a minimum.

The 100 % curve corresponds to the curve of a pump with a mains-operated motor.

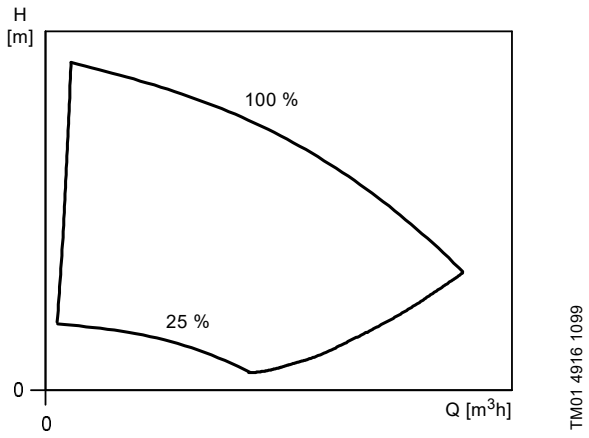


Fig. 100 Duty range of NBE, NBGE, NKE, NKGE pumps

As a part of the duty range, the pumps with an MGE motor can operate at speeds up to 110 %.

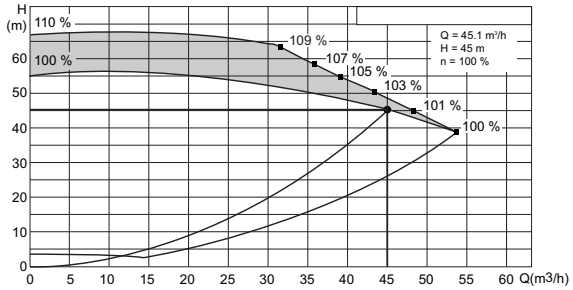


Fig. 101 Example of an extended performance range up to 110 % as a part of the operating range

The extended range is achieved by means of optimised software which utilises the MGE motor to its maximum performance in an optimum way. The result is that the E-pump is able to deliver higher head and flow with the same motor size. The curve sheets in the standard NB, NBG, NK, NKG data booklets only show the nominal 100 % QH curve of pumps with a standard motor. You may find information on the extended performance range in Grundfos Product Center.

Stabilising instable pump curves

What is a instable pump curve?

When the pump curve has a shape so it meets the same system pressure twice but at different flows, the pump curve is said to be instable. See fig. 102. This is especially problematic in systems with a flat system characteristic as it prevents the pump from being down-regulated to a flow which is lower than the flow at the top point of the pump curve.

To better understand this it might be a help to see examples of an actual case.

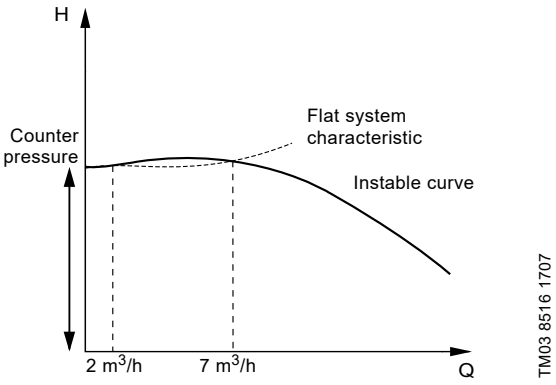


Fig. 102 The shape of the standard pump curve and a flat system characteristic will result in instable operation

How is an instable pump curve stabilised?

The E-motor can stabilise an instable pump curve in the low flow area by changing to a higher speed. Figure 103 illustrates how the pump curve is "lifted" in this area. As the flow increases, the E-motor gradually change back to normal speed and the pump performance will follow the standard pump curve.

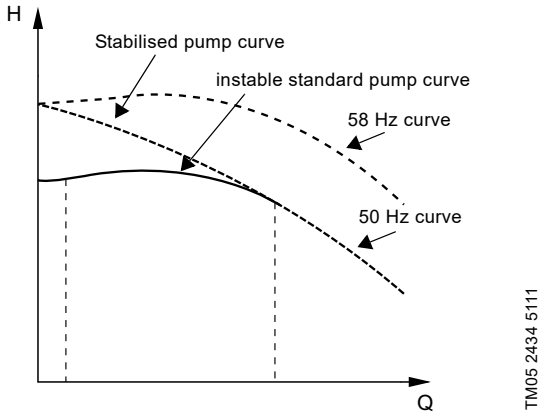


Fig. 103 Pump curve with a stabilised operating range

Figure 103 illustrates a pump with an instable operating range at 50 Hz. To stabilise operation, the E-motor increases its output frequency to e.g. 58 Hz in the low-flow area.

Purpose and benefits

The purpose of stabilising an instable pump is to enable normal regulating throughout the entire operating range. Thus fully stable operation is achieved, even in the low flow range. This enables the use of modern high-efficiency pumps in applications where this would otherwise not be possible.

Applications

As mentioned instable operation may occur in applications with a high counter pressure and a flat system characteristic, such as

- pumping of water to a water tower
- boiler feeding.

Note: The pump will be running at over synchronous speed in the low-flow area which may alter sound emission.

The function is either available in factory configured products or it can be downloaded later in form of an additional configuration file via Grundfos PC Tool E-products.

Setup

The "Stabilising instable pump curves" function can be set via a configuration file downloaded to the product via the Grundfos PC Tool E-products.

Pump operating at power limit

What is a pump operating at power limit?

When a pump in operation is running at maximum output power (P2) in the entire performance range from closed valve to maximum flow, it is said to be operating at power limit.

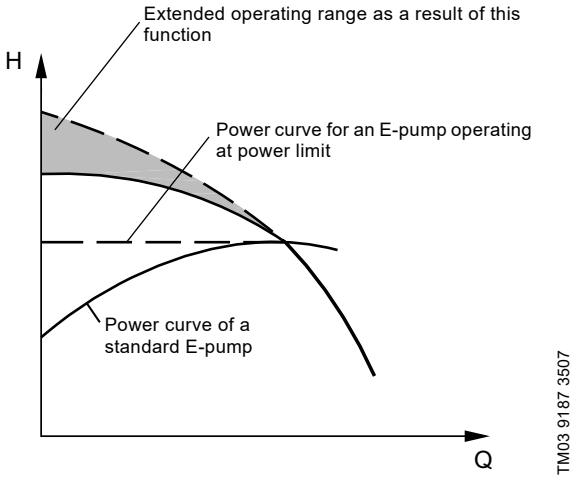


Fig. 104 Power curves of a standard pump and a pump operating at power limit

Purpose and benefits

This function utilises the fact that often a standard E-pump does not load the MGE motor fully in the entire operating range. By controlling the MGE motor to always put out maximum power, irrespective of the load, it is now possible to extend the performance range of the pump without overloading the MGE motor. See fig. 104.

In practice, this function provides these benefits:

- The pressure range of the pump can be increased at low flows without using a bigger motor, provided that the pump construction can handle the pressure.
- In some cases, the pump can be fitted with a smaller motor than the corresponding standard pump when the E-pump has a fixed operating range at low flows.

This function is available in these pump sizes:

Three-phase pumps			
2-pole [kW]		4-pole [kW]	
0.75 - 7.5	11-22	0.55 - 7.5	11 - 18.5
•	•	•	•

Note: This function is either available in factory-configured products or a configuration file can be downloaded to the product at a later stage via the Grundfos PC Tool E-products.

Applications

This function is most often used in applications with relatively low flow in relation to rated performance where at the same time the demanded maximum pressure corresponds to the maximum pressure that motor and pump can achieve.

Examples of application:

- washing and cleaning
- irrigation
- boiler feed.

Description

There are two primary fields of application for this function:

Increased pressure

Figure 105 illustrates the operating range of a standard 50 Hz E-pump with increased pressure range achieved by using the "pump operating at power limit" function.

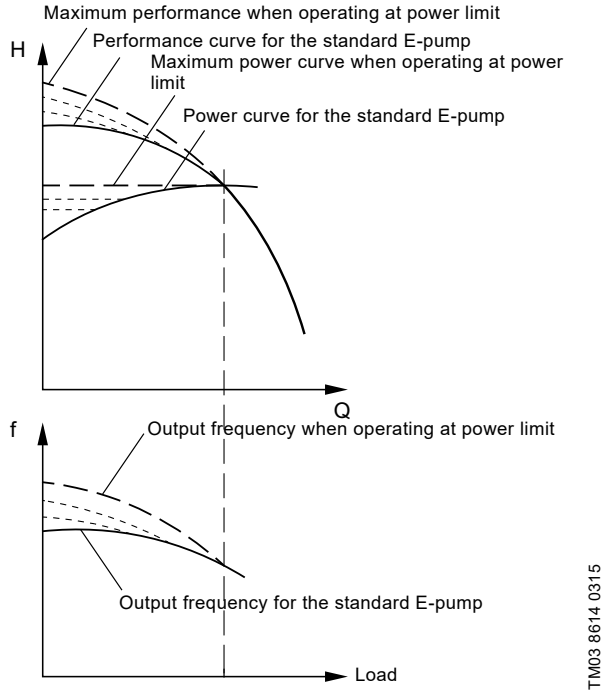


Fig. 105 Standard performance curve vs a performance curve with the "pump operating at power limit" function

The MGE motor is set to a higher speed (f_{max}) than the rated speed of the pump. This leads to a higher pressure at closed valve and low flow.

The pump will operate at a speed corresponding to the set frequency (f_{max}) until the pump reaches the flow where the motor is loaded to its full rated power. If the flow is increased further, the motor will reduce its speed so as not to exceed its rated power.

Note: The pump will be running at oversynchronous speed in the low-flow area which may alter the sound emission.

Reduced motor size

Figure 106 shows the operating range of a standard 50 Hz pump where the "pump operating at power limit" function is used to optimise pump performance in relation to the motor size.

A pump operating at low flows and relatively high pressures (1) can be fitted with a smaller motor whose power matches this operating range. At higher flows and relatively lower pressures (2), the motor will reduce its speed when the power limit is exceeded and follow a steeper curve corresponding to the power available.

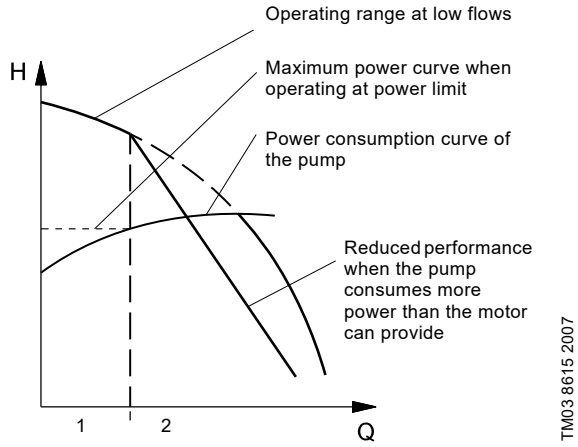


Fig. 106 Standard performance curve vs a curve operated at reduced power limit

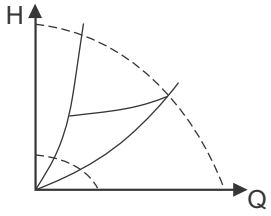
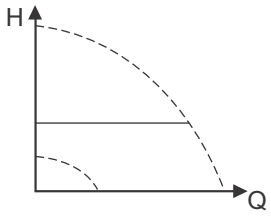
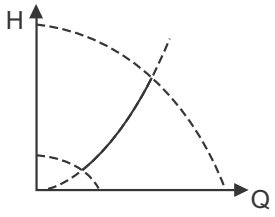
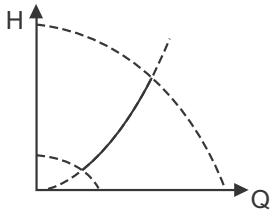
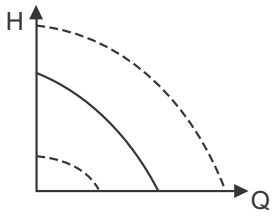
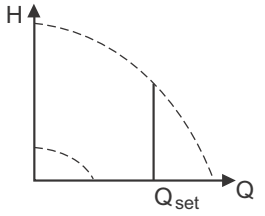
Size of pump and MGE motor

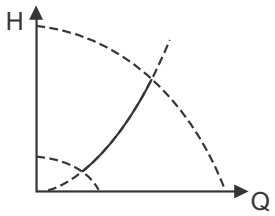
No special considerations need to be taken when sizing pump and motor. If the pump is oversized for the motor, the MGE motor will just reduce its speed and thus the pump performance according to the illustration in fig. 106.

Setup

The "pump operating at power limit" function can be set via a configuration file downloaded to the product via the Grundfos PC Tool E-products.

Other typical applications

System application	Select this control mode	Pump type
In systems with relatively large pressure losses in the distribution pipes and in air-conditioning and cooling systems. • Two-pipe heating systems with thermostatic valves and – very long distribution pipes – strongly throttled pipe balancing valves – differential-pressure regulators – large pressure losses in those parts of the system through which the total quantity of water flows (for example boiler, heat exchanger and distribution pipe up to the first branching). • Primary circuit pumps in systems with large pressure losses in the primary circuit. • Air-conditioning systems with – heat exchangers (fan coils) – cooling ceilings – cooling surfaces.	Constant differential pressure (with differential-pressure sensor located in the system) 	All
In systems with relatively small pressure losses in the distribution pipes. • Two-pipe heating systems with thermostatic valves and – dimensioned for natural circulation – small pressure losses in those parts of the system through which the total quantity of water flows (for example boiler, heat exchanger and distribution pipe up to the first branching), or – modified to a high differential temperature between flow pipe and return pipe (for example district heating). • Underfloor heating systems with thermostatic valves. • One-pipe heating systems with thermostatic valves or pipe balancing valves. • Primary circuit pumps in systems with small pressure losses in the primary circuit.	Constant differential pressure 	All
In systems with a fixed system characteristic. Examples: • one-pipe heating systems • boiler shunts • systems with three-way valves • hot water recirculation.	Constant temperature 	All
	Constant differential temperature 	1.1 - 11 kW, 2-pole 0.55 - 7.5 kW, 4-pole
If an external controller is installed, the pump is able to change from one constant curve to another, depending on the value of the external signal. The pump can also be set to operate according to the maximum or minimum curve: • The maximum curve mode can be used in periods in which a maximum flow is required. This operating mode is suitable e.g. for hot-water priority. • The minimum curve mode can be used in periods in which a minimum flow is required.	Constant curve 	All
In systems requiring a constant flow, independently of pressure drop. Examples: • chillers for air-conditioning • heating surfaces • cooling surfaces.	Constant flow rate 	All

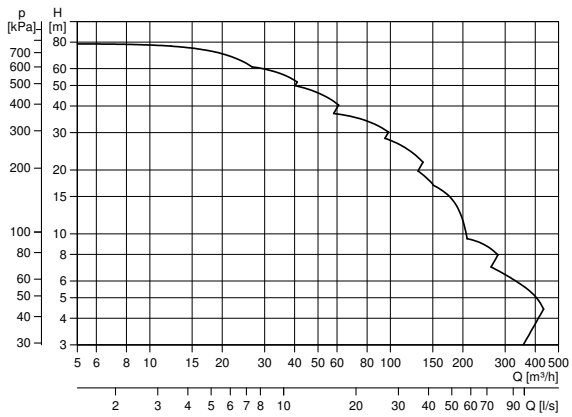
System application	Select this control mode	Pump type
In systems requiring a constant tank level, independently of the flow rate. Examples: • process water tanks • boiler condensate tanks.	Constant level  	1.1 - 11 kW, 2-pole 0.55 - 7.5 kW, 4-pole
In systems with pumps operating in parallel. The multipump function enables the control of single-head pumps connected in parallel (two to four pumps) without the use of external controllers. The pumps in a multipump system communicate with each other via the wireless GENIair connection or the wired GENI connection.	"Assist" menu, "Multipump setup"	1.1 - 11 kW, 2-pole 0.55 - 7.5 kW, 4-pole

NBE, NKE Series 2000 pumps with factory-fitted differential-pressure sensor

TM07 2518 3918
TM07 2519 3918

Fig. 107NBE, NKE Series 2000 variants

Performance range



TM07 3014 4518

Fig. 108E-pumps performance range

Flow rate:	Up to 420 m^3/h
Head:	Up to 80 m
Liquid temperature:	- 25 to +140 °C
Maximum operating pressure:	10 bar

Construction

NBE, NKE Series 2000 pumps are based on NB, NK standard pumps. The main difference is the MGE motor and the factory-fitted differential-pressure sensor for continuous adjustment of the pressure to the flow rate.

Pumps with 2-pole motors up to 11 kW and 4-pole motors up to 7.5 kW are fitted with Grundfos permanent-magnet MGE motors that have motor efficiency class IE5 according to IEC 60034-30-2.

The range is a preset solution for quick and safe installation. The pumps have a colour display for easy and intuitive pump setup and with full access to all functions.

TM05 8893 2813

Fig. 109 Example of the main display on an NBE, NKE Series 2000 with an advanced operating panel

MGE motor range

Pole	IE class	P2 [kW]											
		0.55	0.75	1.1	1.5	2.2	3	4	5.5	7.5	11	15	18.5	22
2	IE2	-	-	-	-	-	-	-	-	-	-	-	-	-
	IE3	-	-	-	-	-	-	-	-	-	-	-	-	-
	IE5	-	-	●	●	●	●	●	●	●	●	-	-	-
4	IE2	-	-	-	-	-	-	-	-	-	-	-	-	-
	IE3	-	-	-	-	-	-	-	-	-	-	-	-	-
	IE5	●	●	●	●	●	●	●	●	●	-	-	-	-

Outside definition of IE class

Features and benefits

The variable-speed motor and its features give the following benefits in pump applications:

- energy saving
- process control
- extra functions
- external motor protection not required
- high-speed enabling higher performance with a given pump than is the case for the same pump with a standard asynchronous motor
- reduced water hammer due to long ramp times
- low starting currents.

Applications

NBE, NKE Series 2000 pumps are suitable for applications requiring pressure control. The pumps are factory-set to proportional pressure control. We recommend that you use proportional pressure control in systems with relatively large pressure losses, as it is the most economical control mode.

This integrated speed control enables the pump to operate at any duty point within the range between 25 and 100 % speed. The performance is adapted to the current conditions and thus the energy consumption is kept at a minimum.

The 100 % curve corresponds to the curve of a pump with a mains-operated motor.

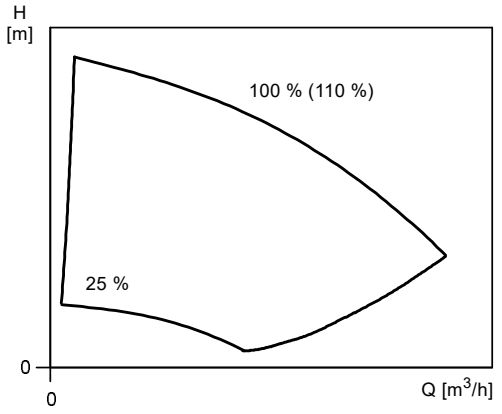


Fig. 110 Duty range of NBE, NKE Series 2000 pumps

As a part of the duty range, the pumps with an MGE motor can operate at speeds up to 110 %.

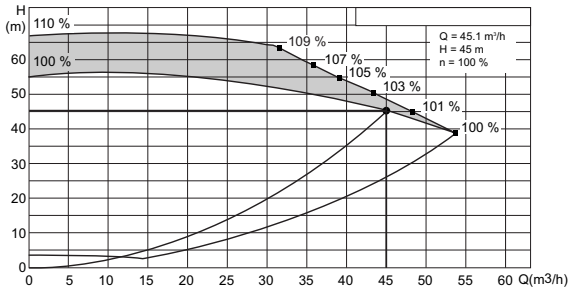
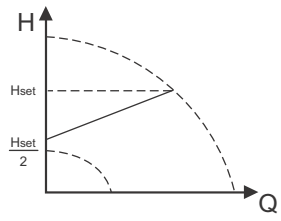
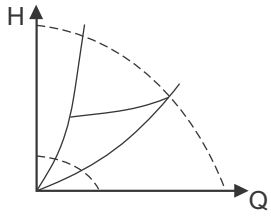
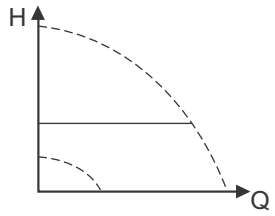
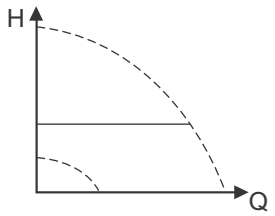
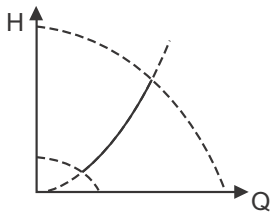
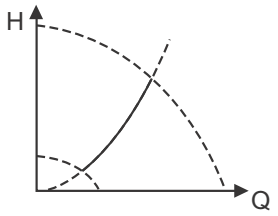
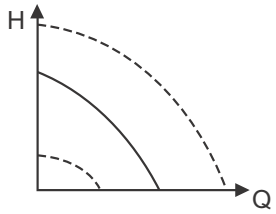
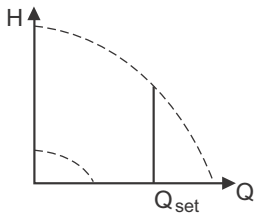
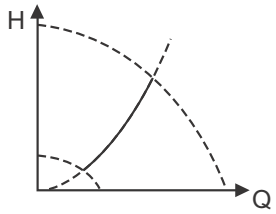


Fig. 111 Example on an extended performance range up to 110 % as part of the operating range

The extended range is achieved by means of optimised software which uses the MGE motor to its maximum performance in an optimum way. The result is that the E-pump is able to deliver higher head and flow with the same motor size. The curve sheets in the standard NB, NBG, NK, NKG data booklets only show the nominal 100 % QH curve of pumps with a standard motor. You may find information on the extended performance range in Grundfos Product Center.

The charts below show available control modes of the pumps in different applications.

System application	Select this control mode
In systems with relatively large pressure losses in the distribution pipes and in air-conditioning and cooling systems. • Two-pipe heating systems with thermostatic valves and the following: – very long distribution pipes – strongly throttled pipe-balancing valves – differential-pressure regulators – large pressure losses in those parts of the system through which the total quantity of water flows, for example a boiler, a heat exchanger and a distribution pipe up to the first branching. • Primary circuit pumps in systems with large pressure losses in the primary circuit. • Air-conditioning systems with the following: – heat exchangers (fan coils) – cooling ceilings – cooling surfaces.	**Proportional pressure** 
In systems with relatively large pressure losses in the distribution pipes and in air-conditioning and cooling systems. • Two-pipe heating systems with thermostatic valves and the following: – very long distribution pipes – strongly throttled pipe-balancing valves – differential-pressure regulators – large pressure losses in those parts of the system through which the total quantity of water flows, for example a boiler, a heat exchanger and a distribution pipe up to the first branching. • Primary circuit pumps in systems with large pressure losses in the primary circuit. • Air-conditioning systems with the following: – heat exchangers (fan coils) – cooling ceilings – cooling surfaces.	**Constant differential pressure with differential-pressure sensor located in the system** 
In systems with relatively small pressure losses in the distribution pipes. • Two-pipe heating systems with thermostatic valves and the following: – sized for natural circulation – small pressure losses in those parts of the system through which the total quantity of water flows, for example a boiler, a heat exchanger and a distribution pipe up to the first branching or modified to a high differential temperature between flow pipe and return pipe, for example district heating. • Underfloor heating systems with thermostatic valves. • One-pipe heating systems with thermostatic valves or pipe-balancing valves. • Primary circuit pumps in systems with small pressure losses in the primary circuit.	**Constant differential pressure** 
In pressure-boosting systems.	**Constant pressure** 
In systems with a fixed system characteristic. Examples: • one-pipe heating systems • boiler shunts • systems with three-way valves • hot water recirculation.	**Constant temperature**  **Constant differential temperature** 

System application	Select this control mode
If an external controller is installed, the pump is able to change from one constant curve to another, depending on the value of the external signal. The pump can also be set to operate according to the maximum or minimum curve: • Use the maximum curve mode in periods in which a maximum flow rate is required. This operating mode is for instance suitable for hot-water priority. • Use the minimum curve mode in periods in which a minimum flow rate is required.	**Constant curve** 
In systems requiring a constant flow, independently of pressure drop. Examples: • chillers for air-conditioning • heating surfaces • cooling surfaces.	**Constant flow rate** 
In systems requiring a constant tank level, independently of the flow rate. Examples: • process-water tanks • boiler-condensate tanks.	**Constant level** 
In systems with pumps operating in parallel. The multipump function enables the control of single-head pumps connected in parallel (two to four pumps) without the use of external controllers. The pumps in a multipump system communicate with each other via the wireless GENIair connection or the wired GENI connection.	**"Assist" menu, "Multipump setup"**

9. User interfaces for E-pumps

You can make pump settings by means of the following user interfaces:

Operating panels

- NBE, NBGE, NKE, NKGE, 0.12 - 11 kW, 2-pole and 0.12 - 7.5 kW, 4-pole. See page 81.
- NBE, NBGE, NKE, NKGE, 15-22 kW, 2-pole and 11 - 18.5 kW, 4-pole. See page 79.

Remote controls

- Grundfos GO.
  See *Grundfos GO* on page 85.

If the power supply to the pump is switched off, the settings will be stored.

Operating panel for NBE, NBGE, NKE, NKGE pumps, 15-22 kW, 2-pole and 11 - 18.5 kW, 4-pole

Pump variant		Fitted as standard	Option
NBE, NBGE, NKE, NKGE	0.12 - 11 kW, 2-pole 0.12 - 7.5 kW, 4-pole	-	-
	15-22 kW, 2-pole 11 - 18.5 kW, 4-pole	•	-

The operating panel incorporates the following buttons and indicator lights:

- buttons, ⊙ and ⊙, for setpoint setting
- light fields, yellow, for setpoint indication
- indicator lights, green (operation) and red (fault).

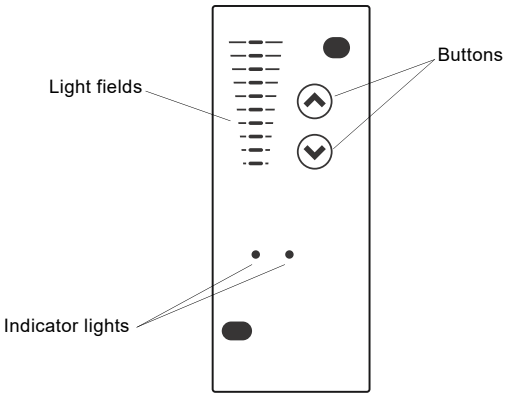


Fig. 112 Operating panel for NBE, NBGE, NKE, NKGE pumps, 15-22 kW, 2-pole and 11 - 18.5 kW, 4-pole

Setpoint setting

Note: You can only set the setpoint when the operating mode is "Normal".

Set the desired setpoint by pressing ⊙ or ⊙.

The light fields on the operating panel indicates the setpoint set.

Control mode "Differential-pressure control"

Example

Figure 113 shows that light fields 5 and 6 are activated, indicating a desired setpoint of 3.4 m. The sensor measuring range is 0 to 6 m. The setting range is equal to the sensor measuring range. See the sensor nameplate.

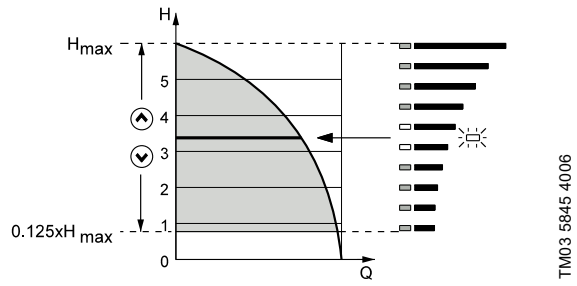


Fig. 113 Setpoint set to 3.4 m, control mode "differential-pressure control"

Control mode "Constant curve"

Example

In this control mode, the pump performance is set within the range from minimum to maximum curve. See fig. 114.

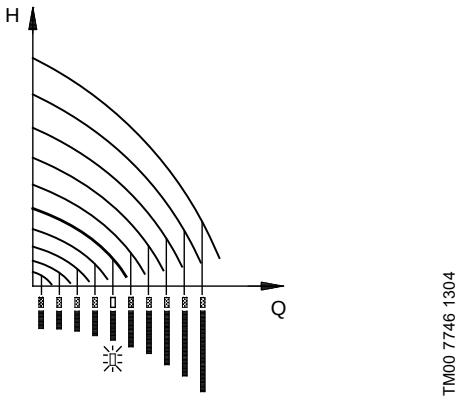


Fig. 114 Pump performance setting, control mode "Constant curve"

Setting to maximum curve duty

Press ⊙ continuously to change to the maximum curve of the pump. The top light field flashes. See fig. 115.

To change back, press ⊙ continuously until the desired setpoint is indicated.

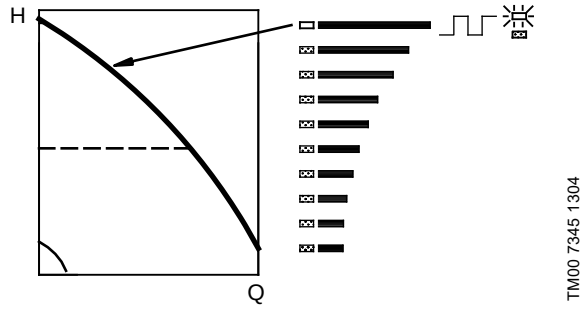


Fig. 115 Maximum curve duty

Setting to minimum curve duty

Press ⊙ continuously to change to the minimum curve of the pump. The bottom light field flashes. See fig. 116.

To change back, press ⊙ continuously until the desired setpoint is indicated.

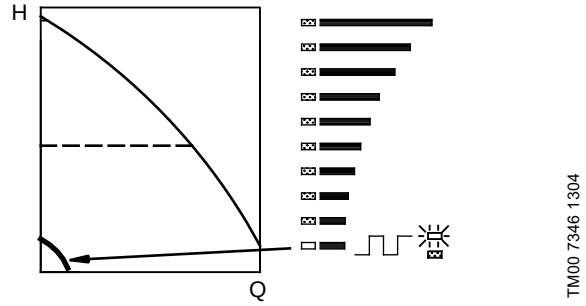


Fig. 116 Minimum curve duty

Start-stop of pump

Press ⊙ continuously until the desired setpoint is indicated to start the pump.

Stop the pump by continuously pressing ⊙ until none of the light fields are activated and the green indicator light flashes.

Advanced operating panel for NBE, NBGE, NKE, NKGE, 0.12 - 11 kW, 2-pole and 0.12 - 7.5 kW, 4-pole

Pump variant		Fitted as standard	Option
NBE, NBGE, NKE, NKGE	0.12 - 11 kW, 2-pole 0.12 - 7.5 kW, 4-pole	•	-
	15-22 kW, 2-pole 11 - 18.5 kW, 4-pole	-	-

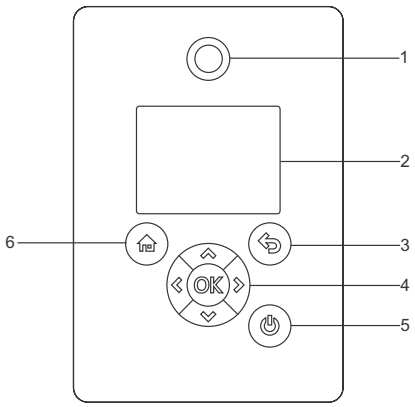


Fig. 117 Advanced operating panel

Pos.	Symbol	Description
1		Grundfos Eye The indicator light shows the operating status of the pump. See *Priority of settings* on page 118 for further information.
2	-	Graphical colour display.
3		Press the button to go one step back.
4		Press the button to navigate between main menus, displays and digits. When you change the menu, the display always shows the top display of the new menu.
		Press the buttons to navigate between submenus or change value settings. **Note:** If you have disabled the possibility to make settings with the "Enable/disable settings" function, then you can enable it again temporarily by pressing these buttons simultaneously for at least 5 seconds. See *"Buttons on product" ("Enable/disable settings")* on page 109.
	OK	Press the button to save changed values, reset alarms and expand the value field. The button enables radio communication with Grundfos GO and other products of the same type. When you try to establish radio communication between the pump and Grundfos GO or another pump, the green indicator light in Grundfos Eye flashes. A note also appears in the pump display stating that a wireless device wants to connect to the pump. Press OK on the pump operating panel to allow radio communication with Grundfos GO and other products of the same type.
5		Press the button to make the pump ready for operation or to start and stop the pump. **Start:** If you press the button when the pump is stopped, the pump will only start if no other functions with higher priority have been enabled. **Stop:** If you press the button when the pump is running, the pump is always stopped. When you stop the pump via this button, the icon appears in the bottom of the display.
6		Press the button to go to the "Home" menu.

"Home" display

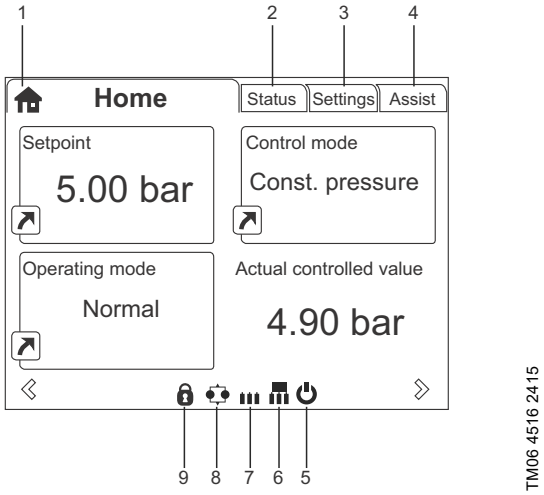


Fig. 118 Example of "Home" display

Pos.	Symbol	Description
1		"Home" This menu shows up to four user-defined parameters. You can select parameters shown as shortcut icon, and when pressing OK you go directly to the "Settings" display for the selected parameter.
2	-	"Status" This menu shows the status of the pump and system as well as warnings and alarms.
3	-	"Settings" This menu gives access to all setting parameters. You can make detailed settings of the pump in this menu. See *Description of selected functions* on page 89.
4	-	"Assist" This menu enables "Assisted Pump Setup", provides a short description of the control modes and offers fault advice. See *"Assist"* on page 112.
5		This symbol indicates that the pump has been stopped via the button.
6		This symbol indicates that the pump is functioning as master pump in a multipump system.
7		This symbol indicates that the pump is functioning as a slave pump in a multipump system.
8		This symbol indicates that the pump is operating in a multipump system. See *"Multipump setup" ("Setup of multi-pump system")* on page 114.
9		This symbol indicates that the possibility to make settings has been disabled for protective reasons. See *"Buttons on product" ("Enable/disable settings")* on page 109.

Startup guide

The pump incorporates a startup guide which is started at the first startup. See *"Run startup guide"* on page 112. After the startup guide, the main menus appear in the display.

Menu overview for advanced operating panel

Main menus

Home	NBE, NKE Series 2000 0.12 - 11 kW, 2-pole 0.12 - 7.5 kW, 4-pole	NBE, NBGE, NKE, NKGE 0.12 - 11 kW, 2-pole 0.12 - 7.5 kW, 4-pole	Multipump system
	•	•	•

Status	NBE, NKE Series 2000 0.12 - 11 kW, 2-pole 0.12 - 7.5 kW, 4-pole	NBE, NBGE, NKE, NKGE 0.12 - 11 kW, 2-pole 0.12 - 7.5 kW, 4-pole	Multipump system	Section	Page
"Operating status"	•	•	•		
"Operating mode, from"	•	•	•		
"Control mode"	•	•	•		
"Pump performance"	•	•	•		
"Actual controlled value"	•	•	•		
"Resulting setpoint"	•	•	•		
"Speed"	•	•	•		
"Acc. flow, specific energy"	•	•	•		
"Power and energy consumption"	•	•	•		
"Measured values"	•	•	•		
"Analog input 1"	•	•	•		
"Analog input 2"	•	•	•		
"Analog input 3"	•	•	•		
"Pt100/1000 input 1"	•	•	•		
"Pt100/1000 input 2"	•	•	•		
"Analog output"	•	•	•		
"Warning and alarm"	•	•	•		
"Actual warning and alarm"	•	•	•		
"Warning log"	•	•	•		
"Alarm log"	•	•	•		
"Operating log"	•	•	•		
"Operating hours"	•	•	•		
"Fitted modules"	•	•	•		
"Date and time"	•	•	•		
"Product identification"	•	•	•		
"Motor bearing monitoring"	•	•	•		
"Multipump system"			•		
"System operating status"			•		
"System performance"			•		
"System input power and energy"			•		
"Pump 1, multipump sys."			•		
"Pump 2, multipump sys."			•		
"Pump 3, multipump sys."			•		

• Available.

Settings	NBE, NKE Series 2000 0.12 - 11 kW, 2-pole 0.12 - 7.5 kW, 4-pole	NBE, NBGE, NKE, NKGE 0.12 - 11 kW, 2-pole 0.12 - 7.5 kW, 4-pole	Multipump system	Section	Page
"Setpoint"	•	•	•	*"Setpoint"*	89
"Operating mode"	•	•	•	*"Operating mode"*	89
"Set manual speed"	•	•	•	*"Set manual speed"*	89
"Set user-defined speed"	•	•	•	*"Set user-defined speed"*	89
"Control mode"	•	•	•	*"Control mode"*	89
"Analog inputs"	•	•	•	*"Analog inputs"*	95
"Analog input 1, setup"	•	•	•		
"Analog input 2, setup"	•	•	•		
"Analog input 3, setup"	•	•	•		
"Built-in Grundfos sensor"	•		•	*"Built-in Grundfos sensor"*	97
"Pt100/1000 inputs"	•	•	•	*"Pt100/1000 inputs"*	97
"Pt100/1000 input 1, setup"	•	•	•		
"Pt100/1000 input 2, setup"	•	•	•		

Settings	NBE, NKE Series 2000 0.12 - 11 kW, 2-pole 0.12 - 7.5 kW, 4-pole	NBE, NBGE, NKE, NKGE 0.12 - 11 kW, 2-pole 0.12 - 7.5 kW, 4-pole	Multipump system	Section	Page
"Digital inputs"	•	•	•		
"Digital input 1, setup"	•	•	•	*"Digital inputs"*	98
"Digital input 2, setup"	•	•	•		
"Digital inputs/outputs"	•	•	•		
"Digital input/output 3, setup"	•	•	•	*"Digital inputs/outputs"*	99
"Digital input/output 4, setup"	•	•	•		
"Relay outputs"	•	•	•		
"Relay output 1"	•	•	•	*"Signal relays 1 and 2" ("Relay outputs")*	100
"Relay output 2"	•	•	•		
"Analog output"	•	•	•		
"Output signal"	•	•	•	*"Analog output"*	101
"Function of analog output"	•	•	•		
"Controller settings"	•	•	•	*"Controller" ("Controller settings")*	102
"Operating range"	•	•	•	*"Operating range"*	103
"Setpoint influence"	•	•	•	*"Setpoint influence"*	104
"External setpoint function"	•	•	•	*"External setpoint influence"*	103
"Predefined setpoints"	•	•	•	*"Predefined setpoints"*	105
"Monitoring functions"	•	•	•		
"Motor bearing monitoring"	•	•	•	*"Motor bearing monitoring"*	107
"Motor bearing maintenance"	•	•	•	*"Time until next service" ("Motor bearing service")*	108
"Limit-exceeded function"	•	•	•	*"Limit-exceeded function"*	106
"Special functions"	•	•	•	*Special functions*	107
"Pulse flowmeter setup"	•	•	•	*"Pulse flowmeter setup"*	107
"Ramps"	•	•	•	*"Ramps"*	107
"Standstill heating"	•	•	•	*"Standstill heating"*	107
"Communication"	•	•	•	*Communication*	108
"Pump number"	•	•	•	*"Number" ("Pump number")*	108
"Enable/disable radio communication"	•	•	•	*"Radio communication" ("Enable/disable radio comm.")*	108
"General settings"	•	•	•	*General settings*	109
"Language"	•	•	•	*"Language"*	109
"Set date and time"	•	•	•	*"Date and time"*	109
"Units"	•	•	•	*"Unit configuration" ("Units")*	109
"Enable/disable settings"	•	•	•	*"Buttons on product" ("Enable/disable settings")*	109
"Delete history"	•	•	•	*"Delete history"*	110
"Define Home display"	•	•	•	*"Define Home display"*	110
"Display settings"	•	•	•	*"Display settings"*	110
"Store actual settings"	•	•	•	*"Store settings" ("Store actual settings")*	110
"Recall stored settings"	•	•	•	*"Recall settings" ("Recall stored settings")*	111
"Run startup guide"	•	•	•	*"Run startup guide"*	112

• Available.

Assist	NBE, NKE Series 2000 0.12 - 11 kW, 2-pole 0.12 - 7.5 kW, 4-pole	NBE, NBGE, NKE, NKGE 0.12 - 11 kW, 2-pole 0.12 - 7.5 kW, 4-pole	Multipump system	Section	Page
"Assisted pump setup"	•	•	•	*"Assisted pump setup"*	113
"Setup, analog input"	•	•	•	*"Setup, analog input"*	113
"Setting of date and time"	•	•	•	*"Date and time"*	109
"Multipump setup"	•	•	•	*"Multipump setup" ("Setup of multi-pump system")*	114
"Description of control mode"	•	•	•	*"Description of control mode"*	117
"Assisted fault advice"	•	•	•	*"Assisted fault advice"*	117

• Available.

Grundfos GO

The pump is designed for wireless radio or infrared communication with Grundfos GO.

Grundfos GO enables setting of functions and gives access to status overviews, technical product information and actual operating parameters.

Grundfos GO offers the following mobile interface, MI.

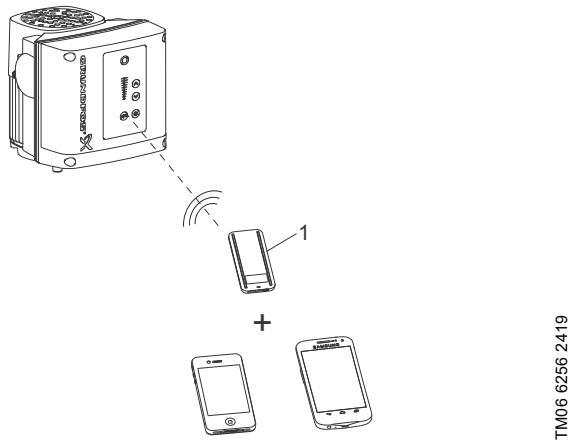


Fig. 119 Grundfos GO communicating with the pump via radio or infrared connection, IR

Pos.	Description
1	Grundfos MI 301: Separate module enabling radio or infrared communication. You can use the module in conjunction with an Android or iOS-based smart device with Bluetooth connection.

Communication

When Grundfos GO initiates communication with the pump, the indicator light in the middle of Grundfos Eye flashes green. See *Grundfos Eye* on page 119.

Furthermore, on pumps fitted with an advanced operating panel a text appears in the display saying that a wireless device is trying to establish connection. Press OK on the pump in order to establish connection with Grundfos GO or press ⌂ to reject connection.

Establish communication using one of these communication types:

- radio communication
- infrared communication.

Radio communication

Radio communication can take place at distances up to 30 metres. The first time Grundfos GO communicates with the pump, you must enable communication by pressing ((o)) or OK on the pump operating panel. Later when communication takes place, the pump is recognised by Grundfos GO and you can select the pump from the "List" menu.

Infrared communication

When communicating via infrared light, Grundfos GO must be pointed at the pump operating panel.

Menu overview for Grundfos GO

Main menus

Dashboard	NBE, NKE Series 2000 0.12 - 11 kW, 2-pole 0.12 - 7.5 kW, 4-pole	NBE, NBGE, NKE, NKGE 0.12 - 11 kW, 2-pole 0.12 - 7.5 kW, 4-pole	NBE, NBGE, NKE, NKGE 15-22 kW, 2-pole 11 - 18.5 kW, 4-pole	Multipump system[1]
	•	•	•	•

Status	NBE, NKE Series 2000 0.12 - 11 kW, 2-pole 0.12 - 7.5 kW, 4-pole	NBE, NBGE, NKE, NKGE 0.12 - 11 kW, 2-pole 0.12 - 7.5 kW, 4-pole	NBE, NBGE, NKE, NKGE 15-22 kW, 2-pole 11 - 18.5 kW, 4-pole	Multipump system[1]	Section	Page
"System mode"				•		
"Resulting setpoint"	•	•				
"Resulting system setpoint"				•		
"Actual setpoint"			•			
"External setpoint"			•			
"Actual controlled value"	•	•		•		
"Sensor value"			•			
"Motor speed (rpm. %)"	•	•	•			
"Power consumption"	•	•	•			
"Power consumption, system"				•		
"Energy consumption"	•	•	•			
"Energy consumption, system"				•		
"Acc. flow, specific energy"	•	•		•		
"Operating hours, system"				•		
"Operating hours"	•	•	•			
"Motor current"	•	•	•	•		
"Number of starts"	•	•	•	•		
"Analog input 1"	•	•				
"Analog input 2"	•	•				
"Analog input 3"	•	•				
"Pt100/1000 input 1"	•	•				
"Pt100/1000 input 2"	•	•				
"Analog output"	•	•				
"Digital input 1"	•	•				
"Digital input 2"	•	•	•			
"Digital in/output 3"	•	•				
"Digital in/output 4"	•	•				
"Motor bearing service"	•	•	•	•		
"Fitted modules"	•	•	•			
"Controlled from"			•			
"Pump1"				•		
"Pump2"				•		
"Pump3"				•		
"Pump4"				•		

[1] Pumps above 11 kW, 2-pole and 7.5 kW, 4-pole have no multipump function.

Settings	NBE, NKE Series 2000 0.12 - 11 kW, 2-pole 0.12 - 7.5 kW, 4-pole	NBE, NBGE, NKE, NKGE 0.12 - 11 kW, 2-pole 0.12 - 7.5 kW, 4-pole	NBE, NBGE, NKE, NKGE 15-22 kW, 2-pole 11 - 18.5 kW, 4-pole	Multipump system[1]	Section	Page
"Setpoint"	•	•	•	•	*"Setpoint"*	89
"Operating mode"	•	•	•	•	*"Operating mode"*	89
"Set user-defined speed"	•	•	•	•	*"Set user-defined speed"*	89
"Control mode"	•	•	•	•	*"Control mode"*	89
"Proportional-pressure setup"	•				*"Proportional-pressure setup"*	95
"Buttons on product"	•	•	•	•	*"Buttons on product" ("Enable/disable settings")*	109
"Controller"	•	•	•	•	*"Controller" ("Controller settings")*	102
"Operating range"	•	•	•	•	*"Operating range"*	103
"Ramps"	•	•			*"Ramps"*	107
"Number"	•	•	•		*"Number" ("Pump number")*	108
"Radio communication"	•	•			*"Radio communication" ("Enable/disable radio comm.")*	108
"Sensor type"			•		*"Sensor type"*	95
"Analog input 1"	•	•			*"Analog inputs"*	95
"Analog input 2"	•	•				
"Analog input 3"	•	•				
"Built-in Grundfos sensor"	•				*"Built-in Grundfos sensor"*	97
"Pt100/1000 input 1"	•	•			*"Pt100/1000 inputs"*	97
"Pt100/1000 input 2"	•	•				
"Digital input 1"	•	•			*"Digital inputs"*	98
"Digital input 2"	•	•	•			
"Digital in/output 3"	•	•			*"Digital inputs/outputs"*	99
"Digital in/output 4"	•	•				
"Pulse flowmeter"	•	•			*"Pulse flowmeter setup"*	107
"Predefined setpoint"	•	•		•	*"Predefined setpoints"*	105
"Analog output"	•	•			*"Analog output"*	101
"External setpoint funct."	•	•	•		*"External setpoint influence"*	103
"Signal relay 1"	•	•	•		*"Signal relays 1 and 2" ("Relay outputs")*	100
"Signal relay 2"	•	•	•			
"Limit 1 exceeded"	•	•		•	*"Limit-exceeded function"*	106
"Limit 2 exceeded"	•	•		•		
"Alternating operation, time"				•		
"Time for pump change over"				•		
"Standstill heating"	•	•	•		*"Standstill heating"*	107
"Motor bearing monitoring"	•	•	•		*"Motor bearing monitoring"*	107
"Service"	•	•			*"Service"*	108
"Date and time"	•	•		•	*"Date and time"*	109
"Store settings"	•	•	•		*"Store settings" ("Store actual settings")*	110
"Recall settings"	•	•	•		*"Recall settings" ("Recall stored settings")*	111
"Undo"	•	•	•	•	*"Undo"*	111
"Pump name"	•	•		•	*"Pump name"*	111
"Connection code"	•	•		•	*"Connection code"*	111
"Unit configuration"	•	•		•	*"Unit configuration" ("Units")*	109

[1] Pumps above 11 kW, 2-pole and 7.5 kW, 4-pole have no multipump function.

Alarms and warnings	NBE, NKE Series 2000 0.12 - 11 kW, 2-pole 0.12 - 7.5 kW, 4-pole	NBE, NBGE, NKE, NKGE 0.12 - 11 kW, 2-pole 0.12 - 7.5 kW, 4-pole	NBE, NBGE, NKE, NKGE 15-22 kW, 2-pole 11 - 18.5 kW, 4-pole	Multipump system[1]	Section	Page
"Alarm log"	•	•		•	*"Alarm log"*	112
"Warning log"	•	•		•	*"Warning log"*	112
"Reset alarm" button	•	•		•		

[1] Pumps above 11 kW, 2-pole and 7.5 kW, 4-pole have no multipump function.

Assist	NBE, NKE Series 2000 0.12 - 11 kW, 2-pole 0.12 - 7.5 kW, 4-pole	NBE, NBGE, NKE, NKGE 0.12 - 11 kW, 2-pole 0.12 - 7.5 kW, 4-pole	NBE, NBGE, NKE, NKGE 15-22 kW, 2-pole 11 - 18.5 kW, 4-pole	Multipump system[1]	Section	Page
"Assisted pump setup"	•	•			*"Assisted pump setup"*	113
"Assisted fault advice"	•	•		•	*"Setup, analog input"*	113
"Multipump setup"	•	•		•	*"Multipump setup" ("Setup of multi-pump system")*	114

[1] Pumps above 11 kW, 2-pole and 7.5 kW, 4-pole have no multipump function.

Description of selected functions

"Setpoint"

Pump variant		"Setpoint"
NBE, NKE Series 2000	0.12 - 11 kW, 2-pole 0.12 - 7.5 kW, 4-pole	•
NBE, NBGE, NKE, NKGE	0.12 - 11 kW, 2-pole 0.12 - 7.5 kW, 4-pole	•
	15-22 kW, 2-pole 11 - 18.5 kW, 4-pole	•

You can set the setpoint for all control modes. See *"Control mode"* on page 89.

Factory setting

See *10. Factory settings of E-pumps* on page 123.

"Operating mode"

Pump variant		"Operating mode"
NBE, NKE Series 2000	0.12 - 11 kW, 2-pole 0.12 - 7.5 kW, 4-pole	•
NBE, NBGE, NKE, NKGE	0.12 - 11 kW, 2-pole 0.12 - 7.5 kW, 4-pole	•
	15-22 kW, 2-pole 11 - 18.5 kW, 4-pole	•

Possible operating modes:

- "Normal"
  The pump runs according to the selected control mode.
- "Stop"
  The pump stops.
- "Min."
  Use the minimum-curve mode in periods in which a minimum flow is required.
  This operating mode is for instance suitable for manual night setback if you do not want to use automatic night setback.
- "Max."
  Use the maximum-curve mode in periods in which a maximum flow is required.
  This operating mode is for instance suitable for hot-water priority.
- "Manual"
  The pump is operating at a manually set speed.
  In "Manual" the setpoint via bus is overruled. See *"Set manual speed"* on page 89.
- "User-defined speed"
  The motor is operating at a speed set by the user.
  See *"Set user-defined speed"* on page 89.

All operating modes are illustrated in the fig. 120.

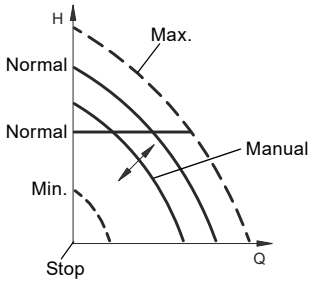


Fig. 120 Operating modes

Factory setting

See *10. Factory settings of E-pumps* on page 123.

"Set manual speed"

Pump variant		"Set manual speed"
NBE, NKE Series 2000	0.12 - 11 kW, 2-pole 0.12 - 7.5 kW, 4-pole	•
NBE, NBGE, NKE, NKGE	0.12 - 11 kW, 2-pole 0.12 - 7.5 kW, 4-pole	•
	15-22 kW, 2-pole 11 - 18.5 kW, 4-pole	-

This menu is only available in the advanced operating panel. With Grundfos GO, you set the speed via the "Setpoint" menu.

You can set the pump speed in % of the maximum speed. When you have set the operating mode to "Manual", the pump starts running at the set speed. The speed can then be changed manually via Grundfos GO or via the advanced operating panel.

"Set user-defined speed"

You can set the motor speed in % of the maximum speed. When you have set the operating mode to "User-defined speed", the motor runs at the set speed.

"Control mode"

Pump variant		"Control mode"
NBE, NKE Series 2000	0.12 - 11 kW, 2-pole 0.12 - 7.5 kW, 4-pole	•
NBE, NBGE, NKE, NKGE	0.12 - 11 kW, 2-pole 0.12 - 7.5 kW, 4-pole	•
	15-22 kW, 2-pole 11 - 18.5 kW, 4-pole	•

Note: Not all control modes are available for all pump variants.

Possible control modes:

- "Prop. press." (proportional pressure)
- "Const. pressure" (constant pressure)
- "Const. temp." (constant temperature)
- "Con. diff. press." (constant differential pressure)
- "Con. diff. temp." (constant differential temperature)
- "Const. flow rate" (constant flow rate)
- "Const. level" (constant level)
- "Const. other val." (constant other value)
- "Const. curve" (constant curve).

You can change the setpoint for all control modes, when you have selected the desired control mode.

Factory setting

See *10. Factory settings of E-pumps* on page 123.

"Proportional pressure"

Pump variant		"Proportional pressure"
NBE, NKE Series 2000	0.12 - 11 kW, 2-pole 0.12 - 7.5 kW, 4-pole	•
NBE, NBGE, NKE, NKGE	0.12 - 11 kW, 2-pole 0.12 - 7.5 kW, 4-pole	-
	15-22 kW, 2-pole 11 - 18.5 kW, 4-pole	-

The head of the pump is reduced at decreasing water demand and increased at rising water demand. See fig. 121.

This control mode is especially suitable in systems with relatively large pressure losses in the distribution pipes. The head of the pump increases proportionally to the flow in the system to compensate for the large pressure losses in the distribution pipes.

You can set the setpoint with an accuracy of 0.1 m. The head against a closed valve is half the setpoint.

For more information about settings, see *"Proportional-pressure setup"* on page 95.

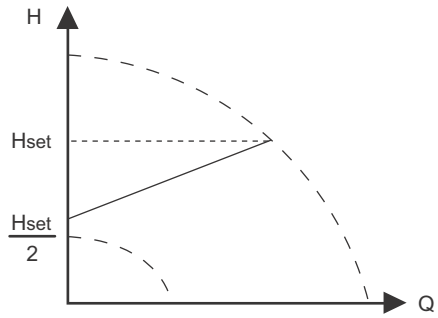


Fig. 121"Proportional pressure"

Example

- Factory-fitted differential-pressure sensor.

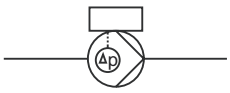


Fig. 122"Proportional pressure"

Controller settings

For recommended controller settings, see *"Controller" ("Controller settings")* on page 102.

"Constant pressure"

Pump variant		"Constant pressure"
NBE, NKE Series 2000	0.12 - 11 kW, 2-pole 0.12 - 7.5 kW, 4-pole	•
NBE, NBGE, NKE, NKGE	0.12 - 11 kW, 2-pole 0.12 - 7.5 kW, 4-pole	•
	15-22 kW, 2-pole 11 - 18.5 kW, 4-pole	•

We recommend this control mode if the pump is to deliver a constant pressure, independently of the flow in the system. The pump maintains a constant pressure independently of the flow rate. See fig. 123.

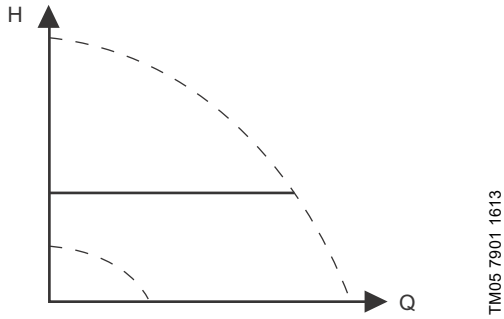


Fig. 123"Constant pressure"

This control mode requires an external pressure sensor as shown in the examples below. You can set the pressure sensor in the "Assist" menu. See *"Assisted pump setup"* on page 113.

Examples

- One external pressure sensor.

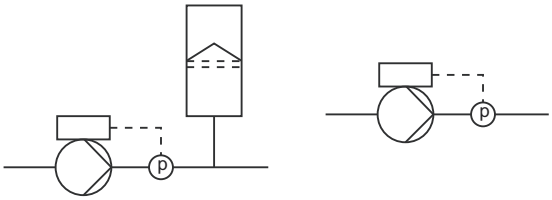


Fig. 124"Constant pressure"

Controller settings

For recommended controller settings, see *"Controller" ("Controller settings")* on page 102.

"Constant temperature"

Pump variant		"Constant temperature"
NBE, NKE Series 2000	0.12 - 11 kW, 2-pole 0.12 - 7.5 kW, 4-pole	•
NBE, NBGE, NKE, NKGE	0.12 - 11 kW, 2-pole 0.12 - 7.5 kW, 4-pole	•
	15-22 kW, 2-pole 11 - 18.5 kW, 4-pole	•

This control mode ensures a constant temperature. Constant temperature is a comfort control mode that you can use in hot-water recirculation systems to control the flow rate to maintain a fixed temperature in the system. See fig. 125.

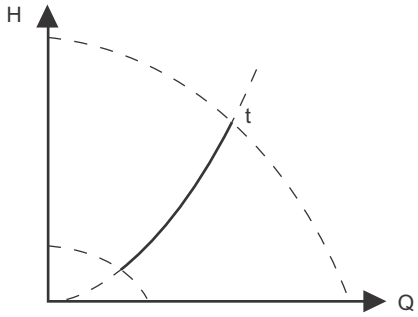


Fig. 125"Constant temperature"

This control mode requires either an internal or external temperature sensor as shown in the examples below.

Examples

- One external temperature sensor.

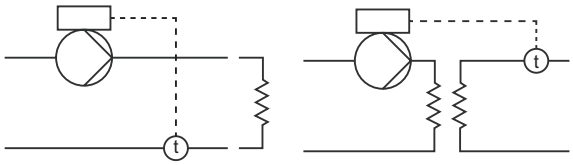


Fig. 126"Constant temperature"

Controller settings

For recommended controller settings, see *"Controller" ("Controller settings")* on page 102.

"Constant differential pressure"

Pump variant		"Constant differential pressure"
NBE, NKE Series 2000	0.12 - 11 kW, 2-pole 0.12 - 7.5 kW, 4-pole	•
NBE, NBGE, NKE, NKGE	0.12 - 11 kW, 2-pole 0.12 - 7.5 kW, 4-pole	•
	15-22 kW, 2-pole 11 - 18.5 kW, 4-pole	•

The pump maintains a constant differential pressure, independently of the flow rate in the system. See fig. 127. This control mode is primarily suitable for systems with relatively small pressure losses.

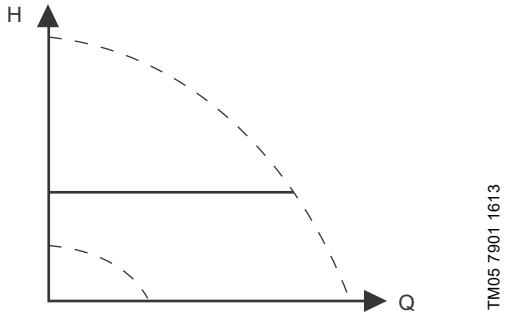
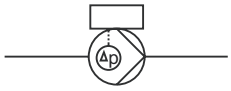


Fig. 127"Constant differential pressure"

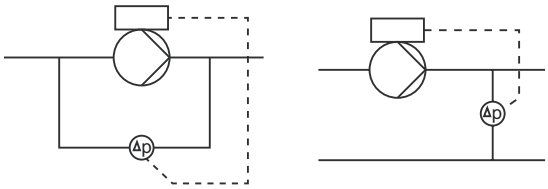
This control mode requires either an internal or external differential-pressure sensor or two external pressure sensors. See the examples below.

Examples

- Factory-fitted differential-pressure sensor, only NBE, NKE Series 2000.



- One external differential-pressure sensor.
  The pump uses the input from the sensor to control the differential pressure. You can set the sensor manually or by using the "Assist" menu. See *"Assisted pump setup"* on page 113.



- Two external pressure sensors.
  Constant differential-pressure control is achievable with two pressure sensors. The pump uses the inputs from the two sensors and calculates the differential pressure. The sensors must have the same unit and must be set as feedback sensors. You can set the sensors manually, sensor by sensor, or by using the "Assist" menu. See *"Assisted pump setup"* on page 113.

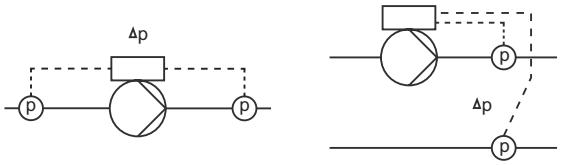


Fig. 128"Constant differential pressure"

Controller settings

For recommended controller settings, see *"Controller" ("Controller settings")* on page 102.

"Constant differential temperature"

Pump variant		"Constant differential temperature"
NBE, NKE Series 2000	0.12 - 11 kW, 2-pole 0.12 - 7.5 kW, 4-pole	•
NBE, NBGE, NKE, NKGE	0.12 - 11 kW, 2-pole 0.12 - 7.5 kW, 4-pole	•
	15-22 kW, 2-pole 11 - 18.5 kW, 4-pole	•

The pump maintains a constant differential temperature in the system and the pump performance is controlled according to this. See fig. 129.

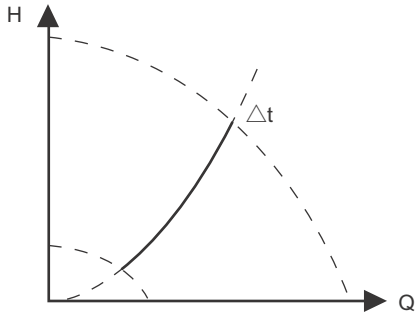


Fig. 129"Constant differential temperature"

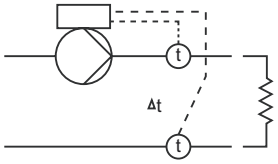
This control mode requires either two temperature sensors or one external differential-temperature sensor. See the examples below.

The temperature sensors can either be analog sensors connected to two of the analog inputs or two Pt100/Pt1000 sensors connected to the Pt100/1000 inputs, if these are available on the specific pump.

Set the sensor in the "Assist" menu under "Assisted pump setup". See *"Assisted pump setup"* on page 113.

Examples

- Two external temperature sensors. Not available for NBE, NBGE, NKE, NKGE 15-22 kW 2-pole and 11 - 18.5 kW 4-pole.
  Constant differential-temperature control is achievable with two temperature sensors. The pump uses the inputs from the two sensors and calculates the differential temperature.
  The sensors must have the same unit and must be set as feedback sensors. You can set the sensors manually, sensor by sensor, or by using the "Assist" menu. See *"Assisted pump setup"* on page 113.



- One external differential-temperature sensor.
  The pump uses the input from the sensor to control the differential temperature.
  You can set the sensor manually or by using the "Assist" menu. See *"Assisted pump setup"* on page 113.

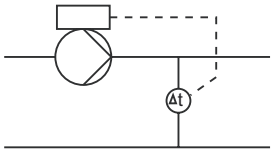


Fig. 130 Constant differential temperature

Controller settings

For recommended controller settings, see *"Controller" ("Controller settings")* on page 102.

"Constant flow rate"

Pump variant		"Constant flow rate"
NBE, NKE Series 2000	0.12 - 11 kW, 2-pole 0.12 - 7.5 kW, 4-pole	•
NBE, NBGE, NKE, NKGE	0.12 - 11 kW, 2-pole 0.12 - 7.5 kW, 4-pole	•
	15-22 kW, 2-pole 11 - 18.5 kW, 4-pole	•

The pump maintains a constant flow rate in the system, independently of the head. See fig. 131.

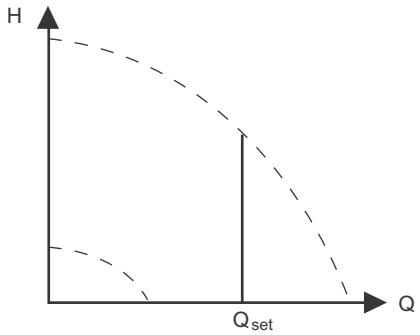


Fig. 131 Constant flow rate

This control mode requires an external flow sensor. See the example below.

Example

- One external flow sensor.

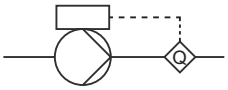


Fig. 132 Constant flow rate

Controller settings

For recommended controller settings, see *"Controller" ("Controller settings")* on page 102.

"Constant level"

Pump variant		"Constant level"
NBE, NKE Series 2000	0.12 - 11 kW, 2-pole 0.12 - 7.5 kW, 4-pole	•
NBE, NBGE, NKE, NKGE	0.12 - 11 kW, 2-pole 0.12 - 7.5 kW, 4-pole	•
	15-22 kW, 2-pole 11 - 18.5 kW, 4-pole	-

The pump maintains a constant level, independently of the flow rate. See fig. 133.

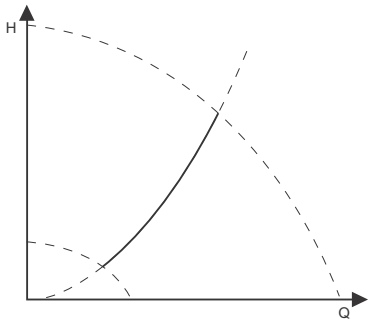


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Fig. 133"Constant level"

This control mode requires an external level sensor.

The pump can control the level in a tank in two ways:

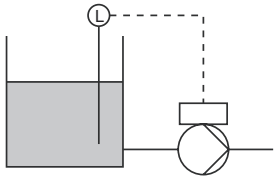
- As an emptying function where the pump draws the liquid from the tank.
- As a filling function where the pump pumps the liquid into the tank.

See fig. 134.

The type of level control function depends on the setting of the built-in controller. See *"Controller" ("Controller settings")* on page 102.

Examples

- One external level sensor.
  – emptying function.



- One external level sensor.
  – filling function.

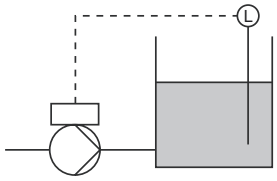


Fig. 134 Constant level

Controller settings

For recommended controller settings, see *"Controller" ("Controller settings")* on page 102.

"Constant other value"

Pump variant		"Constant other value"
NBE, NKE Series 2000	0.12 - 11 kW, 2-pole 0.12 - 7.5 kW, 4-pole	•
NBE, NBGE, NKE, NKGE	0.12 - 11 kW, 2-pole 0.12 - 7.5 kW, 4-pole	•
	15-22 kW, 2-pole 11 - 18.5 kW, 4-pole	-

Any other value is kept constant.

Use this control mode if you want to control a value which is not available in the "Control mode" menu. Connect a sensor measuring the controlled value to one of the analog inputs of the pump. The controlled value will be shown in percentage of sensor range.

"Constant curve"

Pump variant		"Constant curve"
NBE, NKE Series 2000	0.12 - 11 kW, 2-pole 0.12 - 7.5 kW, 4-pole	•
NBE, NBGE, NKE, NKGE	0.12 - 11 kW, 2-pole 0.12 - 7.5 kW, 4-pole	•
	15-22 kW, 2-pole 11 - 18.5 kW, 4-pole	•

You can set the pump to operate according to a constant curve, like an uncontrolled pump. See fig. 135.

You can set the desired speed in % of maximum speed in the range from 13 to 100 %.

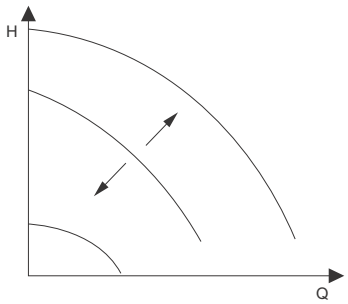


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Fig. 135"Constant curve"

Depending on the system characteristic and the duty point, the 100 % setting may be slightly smaller than the actual maximum curve of the pump even though the display shows 100 %. This is due to the power and pressure limitations built into the pump. The deviation varies according to pump type and pressure loss in the pipes.

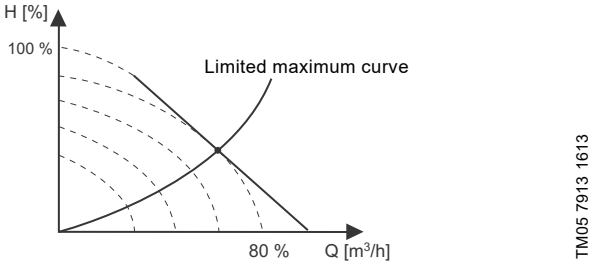


Fig. 136 Power and pressure limitations influencing the maximum curve

Controller settings

For recommended controller settings, see *"Controller" ("Controller settings")* on page 102.

"Proportional-pressure setup"

Pump variant		"Proportional-pressure setup"
NBE, NKE Series 2000	0.12 - 11 kW, 2-pole 0.12 - 7.5 kW, 4-pole	•
NBE, NBGE, NKE, NKGE	0.12 - 11 kW, 2-pole 0.12 - 7.5 kW, 4-pole	-
	15-22 kW, 2-pole 11 - 18.5 kW, 4-pole	-

"Control-curve function"

You can set the curve either to quadratic or linear.

"Zero-flow head"

You can set this value in % of the setpoint. With a setting of 100 %, the control mode is equal to constant differential pressure.

"Sensor type"

Pump variant		"Sensor type"
NBE, NKE Series 2000	0.12 - 11 kW, 2-pole 0.12 - 7.5 kW, 4-pole	-
NBE, NBGE, NKE, NKGE	0.12 - 11 kW, 2-pole 0.12 - 7.5 kW, 4-pole	-
	15-22 kW, 2-pole 11 - 18.5 kW, 4-pole	•

The setting of the sensor is only relevant in the case of controlled operation.

Select among the following values:

- Sensor output signal
  0-10 V
  0-20 mA
  4-20 mA.
- Unit of measurement of sensor:
  bar, mbar, m, kPa, psi, ft, m^3/h, m^3/s, l/s, gpm, °C, °F, %.
- Sensor measuring range.

"Analog inputs"

Pump variant		"Analog inputs"
NBE, NKE Series 2000	0.12 - 11 kW, 2-pole 0.12 - 7.5 kW, 4-pole	•
NBE, NBGE, NKE, NKGE	0.12 - 11 kW, 2-pole 0.12 - 7.5 kW, 4-pole	•
	15-22 kW, 2-pole 11 - 18.5 kW, 4-pole	-

Function	Terminals*
"Analog input 1, setup"	4
"Analog input 2, setup"	7
"Analog input 3, setup"	14

* See *Connection terminals, advanced functional module, FM 300* on page 127.

Set the analog input for a feedback sensor via the "Assisted pump setup" menu. See *"Assisted pump setup"* on page 113.

If you want to set an analog input for other purposes, you can do this manually.

You can set the analog inputs via the "Setup, analog input" menu. See *"Setup, analog input"* on page 113.

If you perform the manual setting via Grundfos GO, you need to enter the menu for the analog input under the "Settings" menu.

Function

You can set the analog inputs to these functions:

- "Not active"
- "Feedback sensor"
- "Ext. setpoint infl."
  See *"External setpoint influence"* on page 103.
- "Other function".

Measured parameter

Select one of the parameters, that is the parameter to be measured in the system by the sensor connected to the actual analog input. See fig. 137.

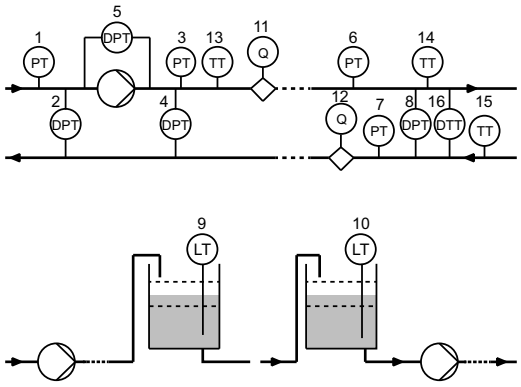


Fig. 137 Overview of sensor locations

Sensor function, measured parameter	Pos.
"Inlet pressure"	1
"Diff. press., inlet"	2
"Liquid temp."	3
"Diff. press.,outlet"	4
"Diff. press.,pump"	5
"Operating mode"	6
"Press. 2, external"	7
"Diff. press., ext."	8
"Storage tank level"	9
"Feed tank level"	10
"Pump flow"	11
"Flow, external"	12
"Liquid temp."	13
"Temperature 1"	14
"Temperature 2"	15
"Diff. temp., ext."	16
"Ambient temp."	Not shown
"Other parameter"	Not shown

"Unit"

Available measuring units:

Parameter	Possible measuring units
Pressure	bar, m, kPa, psi, ft
Level	m, ft, in
"Flow rate"	m^3/h, l/s, yd^3/h, gpm
"Liquid temp."	°C, °F
"Other parameter"	%

Electrical signal

Select signal type:

- "0.5 - 3.5 V"
- "0-5 V"
- "0-10 V"
- "0-20 mA"
- "4-20 mA".

Sensor range, minimum value

Set the minimum value of the connected sensor.

Sensor range, maximum value

Set the maximum value of the connected sensor.

Factory setting

See *10. Factory settings of E-pumps* on page 123.

Setting two sensors for differential measurement

In order to measure the difference of a parameter between two points, set the corresponding sensors as follows:

Parameter	Analog input for sensor 1	Analog input for sensor 2
Pressure, option 1	Differential pressure, inlet	Differential pressure, outlet
Pressure, option 2	Pressure 1, external	Pressure 2, external
Flow	Pump flow	Flow, external
Temperature	Temperature 1	Temperature 2

If you want to use the control mode "constant differential pressure", you must choose the function "Feedback sensor" for the analog input of both sensors.

"Built-in Grundfos sensor"

Pump variant		"Built-in Grundfos sensor"
NBE, NKE Series 2000	0.12 - 11 kW, 2-pole 0.12 - 7.5 kW, 4-pole	•
NBE, NBGE, NKE, NKGE	0.12 - 11 kW, 2-pole 0.12 - 7.5 kW, 4-pole	-
	15-22 kW, 2-pole 11 - 18.5 kW, 4-pole	-

You can select the function of the built-in sensor in the "Built-in Grundfos sensor" menu.

Set the "Built-in Grundfos sensor" via the "Assisted pump setup" menu. See *"Assisted pump setup"* on page 113.

If you perform the setting manually in the advanced operating panel, you must enter the "Analog inputs" menu under the "Settings" menu in order to access the "Built-in Grundfos sensor" menu.

If you perform the setting manually via Grundfos GO, you need to enter the menu for the "Built-in Grundfos sensor" under the "Settings" menu.

Function

You can set the built-in sensor to these functions:

- "Grundfos diff-pressure sensor"
  - "Not active"
  - "Feedback sensor"
  - "Setpoint influence"
  - "Other function".
- "Grundfos temperature sensor"
  - "Not active"
  - "Feedback sensor"
  - "Setpoint influence"
  - "Other function".

Factory setting

See *10. Factory settings of E-pumps* on page 123.

"Pt100/1000 inputs"

Pump variant		"Pt100/1000 inputs"
NBE, NKE Series 2000	0.12 - 11 kW, 2-pole 0.12 - 7.5 kW, 4-pole	•
NBE, NBGE, NKE, NKGE	0.12 - 11 kW, 2-pole 0.12 - 7.5 kW, 4-pole	•
	15-22 kW, 2-pole 11 - 18.5 kW, 4-pole	-

Function	Terminals*
"Pt100/1000 input 1, setup"	17 and 18
"Pt100/1000 input 2, setup"	18 and 19

* See *Connection terminals, advanced functional module, FM 300* on page 127.

Set the Pt100/1000 input for a feedback sensor via the "Assisted pump setup" menu. See *"Assisted pump setup"* on page 113.

If you want to set a Pt100/1000 input for other purposes, you can do this manually.

You can set the analog inputs via the "Setup, analog input" menu. See *"Setup, analog input"* on page 113.

If you perform the manual setting via Grundfos GO, you need to enter the menu for the Pt100/1000 input under the "Settings" menu.

Function

You can set the Pt100/1000 inputs to these functions:

- "Not active"
- "Feedback sensor"
- "Ext. setpoint infl."
  See *"External setpoint influence"* on page 103.
- "Other function".

Measured parameter

Select one of the parameters, such as the parameter to be measured in the system by the Pt100/1000 sensor connected to the actual Pt100/1000 input. See fig. 138.

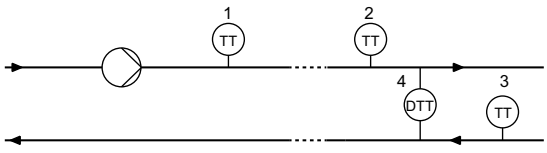


Fig. 138 Overview of Pt100/1000 sensor locations

Parameter	Pos.
"Liquid temp."	1
"Temperature 1"	2
"Temperature 2"	3
"Ambient temp."	Not shown

Measuring range

-50 to +204 °C.

Factory setting

See *10. Factory settings of E-pumps* on page 123.

"Digital inputs"

Pump variant		"Digital inputs"
NBE, NKE Series 2000	0.12 - 11 kW, 2-pole 0.12 - 7.5 kW, 4-pole	•
NBE, NBGE, NKE, NKGE	0.12 - 11 kW, 2-pole 0.12 - 7.5 kW, 4-pole	•
	15-22 kW, 2-pole 11 - 18.5 kW, 4-pole	•

NBE, NBGE, NKE, NKGE 0.12 - 11 kW, 2-pole and 0.12 - 7.5 kW, 4-pole pumps

Function	Terminals*
"Digital input 1, setup"	2 and 6
"Digital input 2, setup"	1 and 9

* See *Connection terminals, advanced functional module, FM 300* on page 127.

To set a digital input, make the settings below.

Function

Select one of these functions:

- "Not active"
  When set to "Not active", the input has no function.
- "External stop"
  When the input is deactivated, open circuit, the pump stops.
- "Min.", minimum speed
  When the input is activated, the pump runs at the set minimum speed.
- "Max.", maximum speed
  When the input is activated, the pump runs at the set maximum speed.
- "User-defined speed"
  When the input is activated. the motor runs at a speed set by the user.
- "External fault"
  When the input is activated, a timer starts. If the input is activated for more than 5 seconds, the pump stops and a fault is indicated. This function depends on input from external equipment.
- "Alarm resetting"
  When the input is activated, a possible fault indication is reset.
- "Dry running"
  When this function has been selected, lack of inlet pressure or water shortage can be detected.
  When lack of inlet pressure or water shortage, dry running, is detected, the pump stops. The pump cannot restart as long as the input is activated.
  This requires the use of an accessory, such as these:
  – a pressure switch installed on the inlet side of the pump
  – a float switch installed on the inlet side of the pump.
- "Accumulated flow"
  When this function has been selected, the accumulated flow rate can be registered. This requires the use of a flowmeter which can give a feedback signal as a pulse per defined flow of water.
  See *"Pulse flowmeter setup"* on page 107.
- "Predefined setpoint digit 1", applies only to digital input 2
  When digital inputs are set to a predefined setpoint, the pump operates according to a setpoint based on the combination of the activated digital inputs.
  See *"Predefined setpoints"* on page 105.

The priority of the selected functions in relation to each other appears from section *Priority of settings* on page 118.

A stop command always has the highest priority.

Activation delay

Pump variant		Activation delay
NBE, NKE Series 2000	0.12 - 11 kW, 2-pole 0.12 - 7.5 kW, 4-pole	•
NBE, NBGE, NKE, NKGE	0.12 - 11 kW, 2-pole 0.12 - 7.5 kW, 4-pole	•
	15-22 kW, 2-pole 11 - 18.5 kW, 4-pole	-

Select the activation delay, T1.

It is the time between the digital signal and the activation of the selected function.

Range: 0 to 6000 seconds.

Duration timer mode

Select the mode. See fig. 139.

- "Not active"
- active with interrupt, mode A
- active without interrupt, mode B
- active with after-run, mode C.

Select the duration time, T2.

It is the time which, together with the mode, determines how long the selected function is active.

Range: 0 to 15,000 seconds.

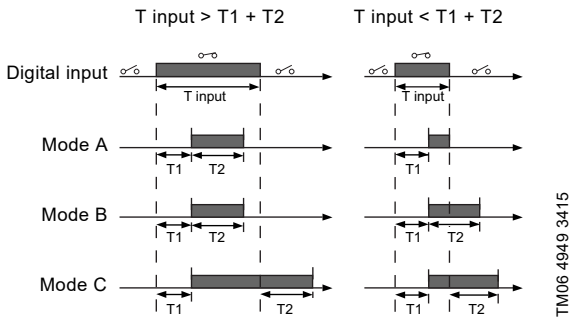


Fig. 139 Duration timer function of digital inputs

Factory setting

See *10. Factory settings of E-pumps* on page 123.

Motors from 15-22 kW, 2-pole and 11 - 18.5 kW, 4-pole

You can set the digital input of the pump to different functions. Select one of the following functions:

- "Min.", minimum curve
- "Max.", maximum curve.

You activate the selected function by closing the contact between terminals 1 and 9.

"Min."

When the input is activated, the pump operates according to the minimum curve.

"Max."

When the input is activated, the pump operates according to the maximum curve.

"Digital inputs/outputs"

Pump variant		"Digital inputs/outputs"
NBE, NKE Series 2000	0.12 - 11 kW, 2-pole 0.12 - 7.5 kW, 4-pole	•
NBE, NBGE, NKE, NKGE	0.12 - 11 kW, 2-pole 0.12 - 7.5 kW, 4-pole	•
	15-22 kW, 2-pole 11 - 18.5 kW, 4-pole	-

Function	Terminals*
"Digital input/output 3, setup"	10 and 16
"Digital input/output 4, setup"	11 and 18

* See *Connection terminals, advanced functional module, FM 300* on page 127.

You can select if the interface must be used as input or output. The output is an open collector and you can connect it to for example an external relay or controller such as a PLC.

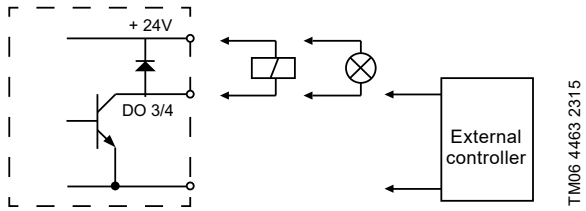


Fig. 140 Example of configurable digital inputs or outputs

To set a digital input or output, make the settings below.

Mode

You can set the digital input or output 3 and 4 to act as digital input or digital output:

- "Digital input"
- "Digital output".

Function

You can set the digital input or output 3 and 4 to the functions mentioned below.

Possible functions, digital input or output 3

"Function if input" See details in section *"Digital inputs"* on page 98	"Function if output" See details in section *"Signal relays 1 and 2" ("Relay outputs")* on page 100
• "Not active" • "External stop" • "Min." • "Max." • "User-defined speed" • "External fault" • "Alarm resetting" • "Dry running" • "Accumulated flow" • "Predefined setpoint 2"	• "Not active" • "Ready" • "Alarm" • "Operation" • "Pump running" • "Warning" • "Limit 1 exceeded" • "Limit 2 exceeded"

Possible functions, digital input or output 4

"Function if input" See details in section *"Digital inputs"* on page 98	"Function if output" See details in section *"Signal relays 1 and 2" ("Relay outputs")* on page 100
• "Not active" • "External stop" • "Min." • "Max." • "User-defined speed" • "External fault" • "Alarm resetting" • "Dry running" • "Accumulated flow" • "Predefined setpoint 3"	• "Not active" • "Ready" • "Alarm" • "Operation" • "Pump running" • "Warning" • "Limit 1 exceeded" • "Limit 2 exceeded"

Activation delay

Pump variant		Activation delay
NBE, NKE Series 2000	0.12 - 11 kW, 2-pole 0.12 - 7.5 kW, 4-pole	•
NBE, NBGE, NKE, NKGE	0.12 - 11 kW, 2-pole 0.12 - 7.5 kW, 4-pole	•
	15-22 kW, 2-pole 11 - 18.5 kW, 4-pole	-

Select the activation delay, T1.

It is the time between the digital signal and the activation of the selected function.

Range: 0 to 6000 seconds.

Duration timer mode

Select the mode. See fig. 141.

- "Not active"
- active with interrupt, mode A
- active without interrupt, mode B
- active with after-run, mode C.

Select the duration time, T2.

It is the time which, together with the mode, determines how long the selected function is active.

Range: 0 to 15,000 seconds.

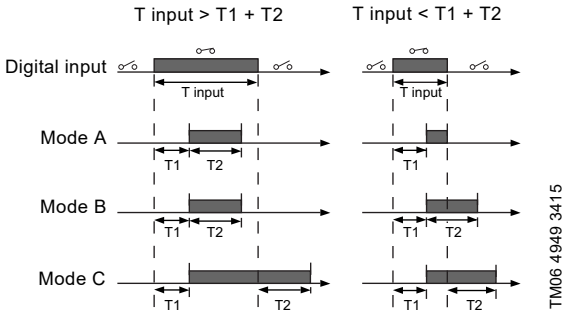


Fig. 141 Duration timer function of digital inputs

Factory setting

See *10. Factory settings of E-pumps* on page 123.

"Signal relays 1 and 2" ("Relay outputs")

Pump variant		Relay outputs	
		Signal relay 1	Signal relay 2
NBE, NKE Series 2000	0.12 - 11 kW, 2-pole 0.12 - 7.5 kW, 4-pole	•	•
NBE, NBGE, NKE, NKGE	0.12 - 11 kW, 2-pole 0.12 - 7.5 kW, 4-pole	•	•
	11-22 kW, 2-pole 11 - 18.5 kW, 4-pole	•	•

Function	Terminals*
"Relay output 1"	NC, C1, NO
"Relay output 2"	NC, C2, NO

* See *Connection terminals, advanced functional module, FM 300* on page 127.

The pump incorporates two signal relays for potential-free signalling. For further information, see *Indicator lights and signal relays* on page 120.

Function

You can configure the signal relays to be activated by one of the following incidents:

- "Not active".
- "Ready"
  The pump can be running or is ready to run and no alarms are present.
- "Alarm"
  There is an active alarm and the pump is stopped.
- "Operating" ("Operation")
  "Operating" equals "Running" but the pump is still in operation when it has been stopped due to a warning.
- "Running" ("Pump running")
- "Warning"
  There is an active warning.
- "Limit 1 exceeded"*
  When the "Limit 1 exceeded" function is activated, the signal relay is activated. See *"Limit-exceeded function"* on page 106.
- "Limit 2 exceeded"*
  When the "Limit 2 exceeded" function is activated, the signal relay is activated. See *"Limit-exceeded function"* on page 106.
- "Relubricate"
- "External fan control" ("Control of external fan")
  When you select "External fan control", the relay is activated if the internal temperature of the motor electronics reach a preset limit value.

* This function is only available for NBE, NBGE, NKE, NKGE pumps with motor sizes from 0.12 to 11 kW, 2-pole and 0.12 - 7.5 kW, 4-pole.

Factory setting

See *10. Factory settings of E-pumps* on page 123.

"Analog output"

Pump variant		"Analog output"
NBE, NKE Series 2000	0.12 - 11 kW, 2-pole 0.12 - 7.5 kW, 4-pole	•
NBE, NBGE, NKE, NKGE	0.12 - 11 kW, 2-pole 0.12 - 7.5 kW, 4-pole	•
	15-22 kW, 2-pole 11 - 18.5 kW, 4-pole	-

Function	Terminals*
"Analog output"	12

* See *Connection terminals, advanced functional module, FM 300* on page 127.

The analog output enables the transfer of certain operating data to external control systems.

To set the analog output, make the settings below.

"Output signal"

- "0-10 V"
- "0-20 mA"
- "4-20 mA".

"Function of analog output"

- "Actual speed"

Signal range [V, mA]	"Actual speed" [%]		
	0	100	200
"0-10 V"	0 V	5 V	10 V
"0-20 mA"	0 mA	10 mA	20 mA
"4-20 mA"	4 mA	12 mA	20 mA

The reading is a percentage of nominal speed.

- "Actual value"

Signal range [V, mA]	"Actual value"	
	$Sensor_{min}$	$Sensor_{max}$
"0-10 V"	0 V	10 V
"0-20 mA"	0 mA	20 mA
"4-20 mA"	4 mA	20 mA

The reading is a percentage of the range between $sensor_{min}$ and $sensor_{max}$.

- "Resulting setpoint"

Signal range [V, mA]	"Resulting setpoint" [%]	
	0	100
"0-10 V"	0 V	10 V
"0-20 mA"	0 mA	20 mA
"4-20 mA"	4 mA	20 mA

The reading is a percentage of the external setpoint range.

- "Motor load"

Signal range [V, mA]	"Motor load" [%]	
	0	100
"0-10 V"	0 V	10 V
"0-20 mA"	0 mA	20 mA
"4-20 mA"	4 mA	20 mA

The reading is a percentage of the range between 0 and 200 % of the maximum permissible load at the actual speed.

- "Motor current"

Signal range [V, mA]	"Motor current" [%]		
	0	100	200
0-10 V	0 V	5 V	10 V
0-20 mA	0 mA	10 mA	20 mA
4-20 mA	4 mA	12 mA	20 mA

The reading is a percentage of the range between 0 and 200 % of the rated current.

- "Limit 1 exceeded" and "Limit 2 exceeded"

Signal range [V, mA]	"Limit-exceed function"	
	Output not active	Output active
"0-10 V"	0 V	10 V
"0-20 mA"	0 mA	20 mA
"4-20 mA"	4 mA	20 mA

The "Limit-exceeded function" is typically used for monitoring of secondary parameters in the system. If the limit is exceeded, an output, warning or alarm is activated.

- "Flow rate"

Signal range [V, mA]	"Flow rate" [%]		
	0	100	200
"0-10 V"	0 V	5 V	10 V
"0-20 mA"	0 mA	10 mA	20 mA
"4-20 mA"	4 mA	12 mA	20 mA

The reading is a percentage of the range between 0 and 200 % of the nominal flow.

Factory setting

See *10. Factory settings of E-pumps* on page 123.

"Controller" ("Controller settings")

Pump variant		"Controller settings"
NBE, NKE Series 2000	0.12 - 11 kW, 2-pole 0.12 - 7.5 kW, 4-pole	•
NBE, NBGE, NKE, NKGE	0.12 - 11 kW, 2-pole 0.12 - 7.5 kW, 4-pole	•
	15-22 kW, 2-pole 11 - 18.5 kW, 4-pole	•

The pumps have a factory default setting of gain, K_p, and integral time, T_i.

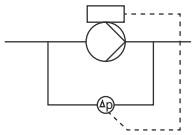
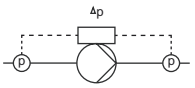
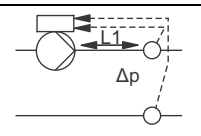
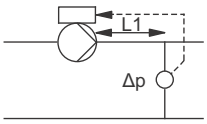
However, if the factory setting is not the optimum setting, you can change the gain and the integral time:

- Set the gain within the range from 0.1 to 20.
- Set the integral time within the range from 0.1 to 3600 seconds.
  If you select 3600 seconds, the controller functions as a P controller.

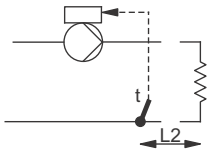
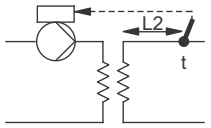
Furthermore, you can set the controller to inverse control. This means that if the setpoint is increased, the speed is reduced. In the case of inverse control, set the gain within the range from -0.1 to -20.

Guidelines for setting of PI controller

The tables below show the recommended controller settings:

"Differential-pressure control"	K_p	T_i
	0.5	0.5
		
	0.5	L1 < 5 m: 0.5 L1 > 5 m: 3 L1 > 10 m: 5
		

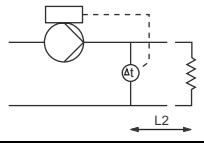
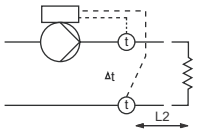
L1: Distance in metres between pump and sensor.

"Temperature control"	K_p		T_i
	Heating system[1]	Cooling system[2]	
	0.5	-0.5	10 + 5L2
	0.5	-0.5	30 + 5L2

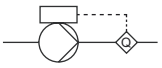
1) In heating systems, an increase in pump performance results in a rise in temperature at the sensor.

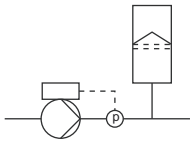
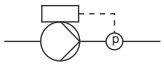
2) In cooling systems, an increase in pump performance results in a drop in temperature at the sensor.

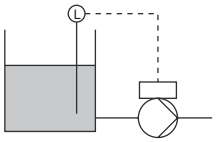
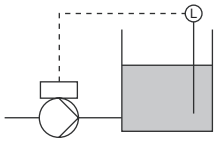
L2: Distance in metres between heat exchanger and sensor.

"Differential-temperature control"	K_p	T_i
	-0.5	10 + 5L2
		

L2: Distance in metres between heat exchanger and sensor.

"Flow control"	K_p	T_i
	0.5	0.5

"Constant-pressure control"	K_p	T_i
	0.5	0.5
	0.1	0.5

"Level control"	K_p	T_i
	-2.5	100
	2.5	100

Rules of thumb

If the controller is too slow-reacting, increase the gain.

If the controller is hunting or unstable, dampen the system by reducing the gain or increasing the integral time.

Factory setting

See *10. Factory settings of E-pumps* on page 123.

"Operating range"

Pump variant		"Operating range"
NBE, NKE Series 2000	0.12 - 11 kW, 2-pole 0.12 - 7.5 kW, 4-pole	•
NBE, NBGE, NKE, NKGE	0.12 - 11 kW, 2-pole 0.12 - 7.5 kW, 4-pole	•
	15-22 kW, 2-pole 11 - 18.5 kW, 4-pole	•

Set the operating range as follows:

- Set the minimum speed within the range from fixed minimum speed to user-set maximum speed.
- Set the maximum speed within the range from user-set minimum speed to fixed maximum speed.

The range between the user-set minimum and maximum speeds is the operating range. See fig. 142.

Note: Speeds below 25 % may result in noise from the shaft seal.

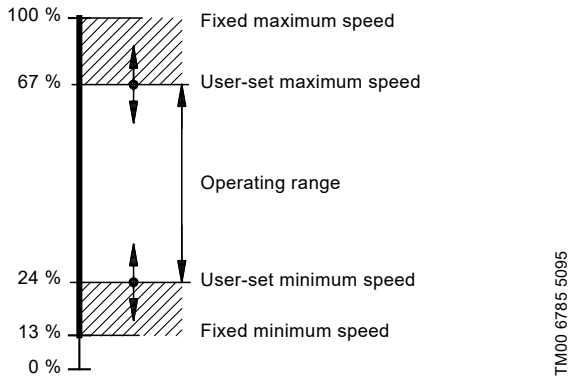


Fig. 142 Example of minimum and maximum settings

Factory setting

See *10. Factory settings of E-pumps* on page 123.

"External setpoint influence"

Pump variant		"External setpoint influence"
NBE, NKE Series 2000	0.12 - 11 kW, 2-pole 0.12 - 7.5 kW, 4-pole	•
NBE, NBGE, NKE, NKGE	0.12 - 11 kW, 2-pole 0.12 - 7.5 kW, 4-pole	•
	15-22 kW, 2-pole 11 - 18.5 kW, 4-pole	•

0.12 - 11 kW, 2-pole and 0.12 - 7.5 kW, 4-pole motors

You can influence the setpoint by an external signal, either via one of the analog inputs or, if an advanced functional module is fitted, via one of the Pt100/1000 inputs.

Note: Before you can enable the "External setpoint function", set one of the analog inputs or Pt100/1000 inputs to "Setpoint influence".

See *"Analog inputs"* on page 95 and *"Pt100/1000 inputs"* on page 97.

If more than one input has been set to "Setpoint influence", the function selects the analog input with the lowest number, for example "Analog input 2", and ignores the other inputs, for example "Analog input 3" or "Pt100/1000 input 1".

Motors from 15-22 kW, 2-pole and 11 - 18.5 kW, 4-pole

You can set the input for external setpoint signal to different signal types. Select one of the following types:

- "0-10 V"
- "0-20 mA"
- "4-20 mA"
- "Not active".

If you select one of the signal types, the actual setpoint is influenced by the signal connected to the external setpoint input.

Example with constant pressure with linear influence

Actual setpoint: actual input signal x (setpoint - sensor min.) + sensor min.

At a lower sensor value of 0 bar, a setpoint of 2 bar and an external setpoint of 60 %, the actual setpoint is 0.60 x (2 - 0) + 0 = 1.2 bar.

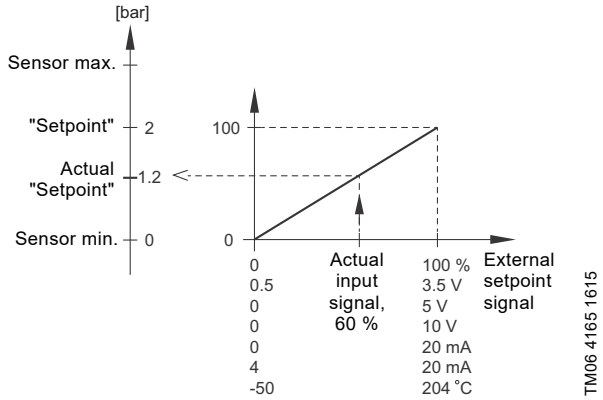


Fig. 143 Example of setpoint influence with sensor feedback

Example with constant curve with linear influence

Actual setpoint: actual input signal x (setpoint - user-set minimum speed) + user-set minimum speed.

At a user-set minimum speed of 25 %, a setpoint of 85 % and an external setpoint of 60 %, the actual setpoint is 0.60 x (85 - 25) + 25 = 61 %. See fig. 144.

In some cases, the maximum curve is limited to a lower speed. See fig. 144.

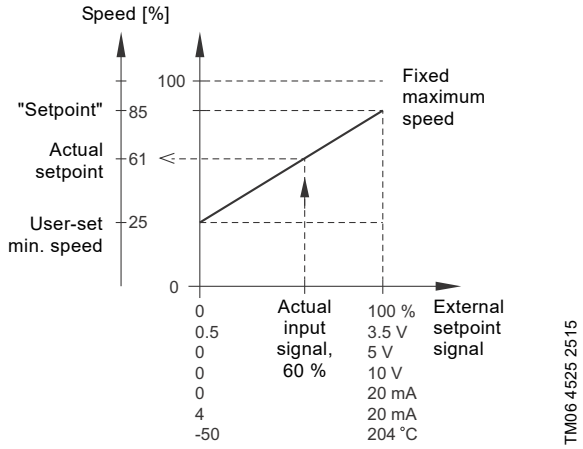


Fig. 144 Example of setpoint influence with constant curve

Factory setting

See *10. Factory settings of E-pumps* on page 123.

"Setpoint influence"

Pump variant		"Setpoint influence"
NBE, NKE Series 2000	0.12 - 11 kW, 2-pole 0.12 - 7.5 kW, 4-pole	•
NBE, NBGE, NKE, NKGE	0.12 - 11 kW, 2-pole 0.12 - 7.5 kW, 4-pole	•
	15-22 kW, 2-pole 11 - 18.5 kW, 4-pole	•

The table below gives an overview of the types of setpoint influence and the availability depending on pump type.

Type of setpoint influence	Pump type: NBE, NKE Series 2000 — 0.12 - 11 kW, 2-pole 0.12 - 7.5 kW, 4-pole	Pump type: NBE, NBGE, NKE, NKGE — 0.12 - 11 kW, 2-pole 0.12 - 7.5 kW, 4-pole	Pump type: NBE, NBGE, NKE, NKGE — 15-22 kW, 2-pole 11 - 18.5 kW, 4-pole
"Not active"	•	•	•
"Linear function"	•	•	•
"Linear with Stop"	•	•	-
"Influence table"	•	•	-

You can select these functions:

- "Not active"
  When set to "Not active", the setpoint is not influenced from any external function.
- "Linear function"
  The setpoint is influenced linearly from 0 to 100 %. See fig. 145.

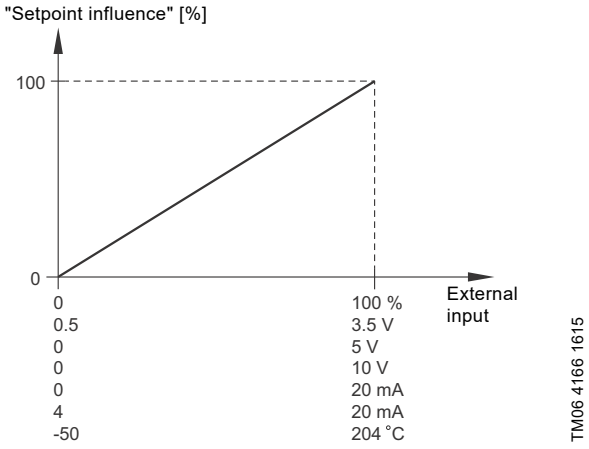


Fig. 145 "Linear function"

- "Linear with Stop"
  In the input signal range from 20 to 100 %, the setpoint is influenced linearly.
  If the input signal is below 10 %, the pump changes to operating mode "Stop".
  If the input signal is increased above 15 %, the operating mode is changed back to "Normal". See fig. 146.

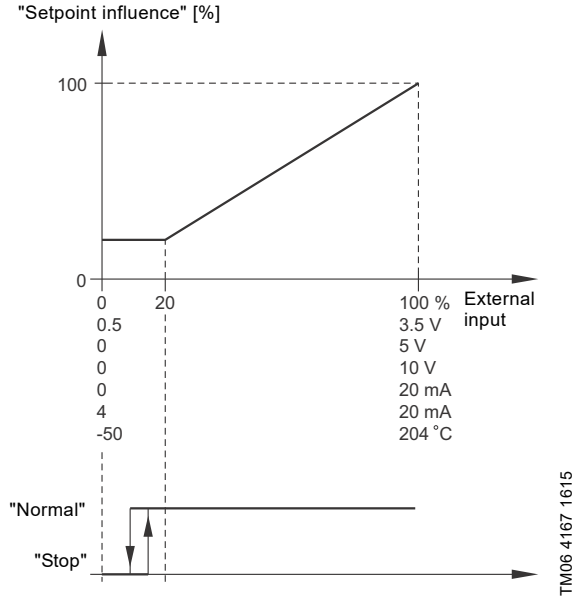


Fig. 146"Linear with Stop"

- "Influence table"
  The setpoint is influenced by a curve made out of two to eight points. There will be a straight line between the points and a horizontal line before the first point and after the last point.

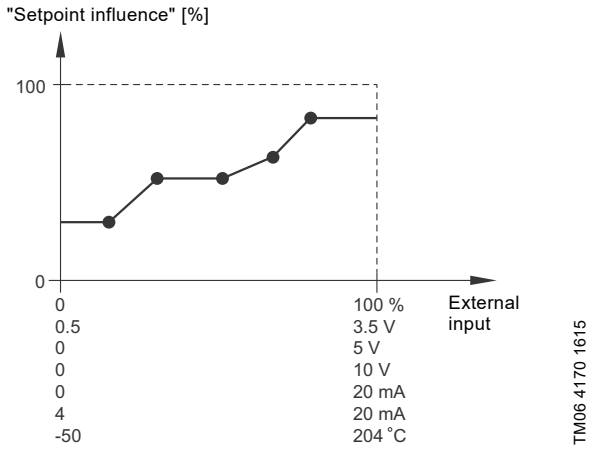


Fig. 147"Influence table", example with five points

"Predefined setpoints"

Pump variant		"Predefined setpoints"
NBE, NKE Series 2000	0.12 - 11 kW, 2-pole 0.12 - 7.5 kW, 4-pole	•
NBE, NBGE, NKE, NKGE	0.12 - 11 kW, 2-pole 0.12 - 7.5 kW, 4-pole	•
	15-22 kW, 2-pole 11 - 18.5 kW, 4-pole	-

You can set and activate seven predefined setpoints by combining the input signals to digital inputs 2, 3 and 4 as shown in the table below.

Set the digital inputs 2, 3 and 4 to "Predefined setpoints" if all seven predefined setpoints are to be used. You can also set one or two of the digital inputs to "Predefined setpoints" but this will limit the number of predefined setpoints available.

"Digital inputs"			"Setpoint"
2	**3**	**4**	
0	0	0	Normal setpoint or stop
1	0	0	Predefined setpoint 1
0	1	0	Predefined setpoint 2
1	1	0	Predefined setpoint 3
0	0	1	Predefined setpoint 4
1	0	1	Predefined setpoint 5
0	1	1	Predefined setpoint 6
1	1	1	Predefined setpoint 7

0: Open contact
1: Closed contact

Example

Figure 148 shows how you can use the digital inputs to set seven predefined setpoints. Digital input 2 is open and digital inputs 3 and 4 are closed. If you compare with the table above, you can see that "Predefined setpoint 6" is activated.

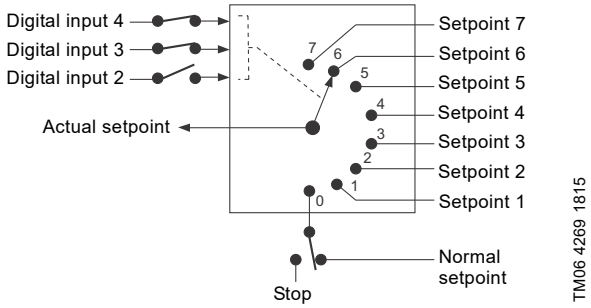


Fig. 148 Principle sketch showing how predefined setpoints function

If all digital inputs are open, the pump either stops or runs at the normal setpoint. Set the desired action with Grundfos GO or with the advanced operating panel.

Factory setting

See *10. Factory settings of E-pumps* on page 123.

"Limit-exceeded function"

Pump variant		"Limit-exceeded function"
NBE, NKE Series 2000	0.12 - 11 kW, 2-pole 0.12 - 7.5 kW, 4-pole	•
NBE, NBGE, NKE, NKGE	0.12 - 11 kW, 2-pole 0.12 - 7.5 kW, 4-pole	•
	15-22 kW, 2-pole 11 - 18.5 kW, 4-pole	-

This function can monitor a measured parameter or one of the internal values such as speed, motor load or motor current. If a set limit is reached, a selected action can take place. You can set two limit-exceeded functions meaning that you can monitor two parameters or two limits of the same parameter simultaneously.

The function requires setting of the following:

Measured

Here you set the measured parameter to be monitored.

"Limit"

Here you set the limit which activates the function.

"Hysteresis band"

Here you set the hysteresis band.

"Limit exceeded when"

Here you can set if you want the function to be activated when the selected parameter exceeds or drops below the set limit.

- "Above limit"
  The function is activated if the measured parameter exceeds the set limit.
- "Below limit"
  The function is activated if the measured parameter drops below the set limit.

Action

If the value exceeds a limit, you can define an action. You can select the following actions:

- "No action"
  The pump remains in its current state. Use this setting if you only want to have a relay output when the limit is reached. See *"Signal relays 1 and 2" ("Relay outputs")* on page 100.
- "Warning/alarm"
  There is a warning.
- "Stop"
  The pump stops.
- "Min."
  The pump reduces speed to minimum.
- "Max."
  The pump increases speed to maximum.
- "User-defined speed"
  The pump runs at a speed set by the user.

"Detection delay"

You can set a detection delay which ensures that the monitored parameter stays above or below a set limit in a set time before the function is activated.

"Resetting delay"

The resetting delay is the time from which the measured parameter differs from the set limit including the set hysteresis band and until the function is reset.

Example

The function is to monitor the outlet pressure of a pump. If the pressure is below 5 bar for more than 5 seconds, a warning must be given. If the outlet pressure is above 7 bar for more than 8 seconds, you must reset the warning.

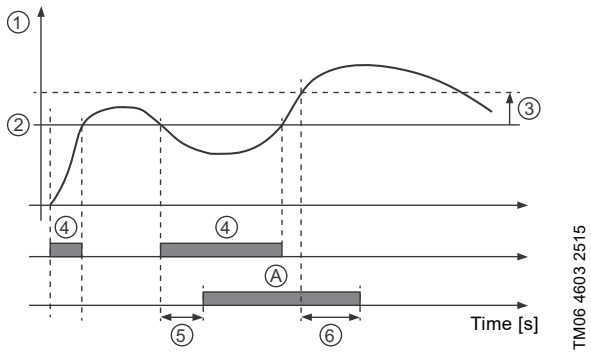


Fig. 149 Limit exceeded (example)

Pos.	Setting parameter	Setting
1	Measured	Outlet pressure
2	"Limit"	5 bar
3	"Hysteresis band"	2 bar
4	"Limit exceeded when"	Below limit
5	"Detection delay"	5 seconds
6	"Resetting delay"	8 seconds
A	Limit-exceeded function active	-
-	Action	Warning

Factory setting

See *10. Factory settings of E-pumps* on page 123.

Special functions

"Pulse flowmeter setup"

Pump variant		"Pulse flowmeter setup"
NBE, NKE Series 2000	0.12 - 11 kW, 2-pole 0.12 - 7.5 kW, 4-pole	•
NBE, NBGE, NKE, NKGE	0.12 - 11 kW, 2-pole 0.12 - 7.5 kW, 4-pole	•
	15-22 kW, 2-pole 11 - 18.5 kW, 4-pole	-

You can connect an external pulse flowmeter to one of the digital inputs in order to register the actual and accumulated flows. Based on this, you can also calculate the specific energy.

To enable a pulse flowmeter, set one of the digital inputs to "Accumulated flow" and set the pumped volume per pulse. See *"Digital inputs"* on page 98.

"Ramps"

Pump variant		"Ramps"
NBE, NKE Series 2000	0.12 - 11 kW, 2-pole 0.12 - 7.5 kW, 4-pole	•
NBE, NBGE, NKE, NKGE	0.12 - 11 kW, 2-pole 0.12 - 7.5 kW, 4-pole	•
	15-22 kW, 2-pole 11 - 18.5 kW, 4-pole	-

The ramps determine how quickly the motor can accelerate and decelerate, during start-stop or setpoint changes.

You can set the following:

- acceleration time, 0.1 to 300 seconds
- deceleration time, 0.1 to 300 seconds.

The times apply to the acceleration from 0 rpm to fixed maximum speed and the deceleration from fixed maximum speed to 0 rpm.

At short deceleration times, the deceleration of the motor may depend on load and inertia as there is no possibility of actively braking the motor.

If the power supply is switched off, the deceleration of the motor only depends on load and inertia.

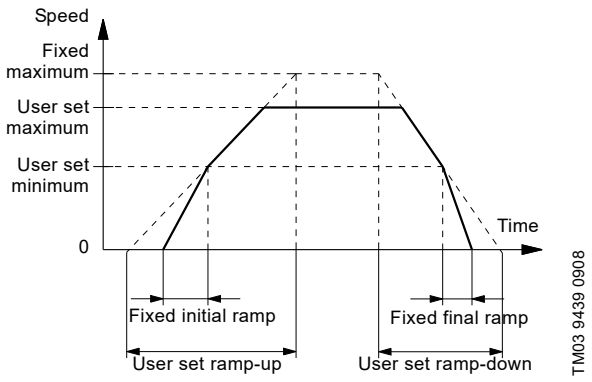


Fig. 150 Ramp-up and ramp-down

Factory setting

See *10. Factory settings of E-pumps* on page 123.

"Standstill heating"

Pump variant		"Standstill heating"
NBE, NKE Series 2000	0.12 - 11 kW, 2-pole 0.12 - 7.5 kW, 4-pole	•
NBE, NBGE, NKE, NKGE	0.12 - 11 kW, 2-pole 0.12 - 7.5 kW, 4-pole	•
	15-22 kW, 2-pole 11 - 18.5 kW, 4-pole	•

You can use this function to avoid condensation in humid environments. When you set the function to "Active" and the pump is in operating mode "Stop", a low AC voltage will be applied to the motor windings. The voltage is not high enough to make the motor rotate but ensures that sufficient heat is generated to avoid condensation in the motor including the electronic parts in the drive.

Note: Remember to remove the drain plugs and fit a cover over the motors.

Factory setting

See *10. Factory settings of E-pumps* on page 123.

"Motor bearing monitoring"

Pump variant		"Motor bearing monitoring"
NBE, NKE Series 2000	0.12 - 11 kW, 2-pole 0.12 - 7.5 kW, 4-pole	•
NBE, NBGE, NKE, NKGE	0.12 - 11 kW, 2-pole 0.12 - 7.5 kW, 4-pole	•
	15-22 kW, 2-pole 11 - 18.5 kW, 4-pole	•

You can set the motor bearing monitoring function to these values:

- "Active"
- "Not active"

When the function is set to "Active", a counter in the controller will start counting the mileage of the bearings.

The counter continues counting even if the function is changed to "Not active", but a warning is not given when it is time for replacement or relubrication.

When the function is changed to "Active again", the accumulated mileage is again used to calculate the replacement or relubrication time.

Factory setting

See *10. Factory settings of E-pumps* on page 123.

"Service"

Pump variant		"Service"
NBE, NKE Series 2000	0.12 - 11 kW, 2-pole 0.12 - 7.5 kW, 4-pole	•
NBE, NBGE, NKE, NKGE	0.12 - 11 kW, 2-pole 0.12 - 7.5 kW, 4-pole	•
	15-22 kW, 2-pole 11 - 18.5 kW, 4-pole	-

"Motor bearing monitoring" must be activated in order for the motor to indicate that bearings must be replaced or relubricated. See *"Motor bearing monitoring"* on page 107.

For motors of 7.5 kW and below, it is not possible to relubricate the bearings.

Bearings on motors of 11 kW and above can be relubricated.

"Time until next service" ("Motor bearing service")

This display shows when to replace or relubricate the motor bearings. The controller monitors the operating pattern of the motor and calculates the period between bearing replacements or relubrications.

Displayable values:

- "in 2 years"
- "in 1 year"
- "in 6 months"
- "in 3 months"
- "in 1 month"
- "in 1 week"
- "Now".

"Bearing replacements"

This display shows the number of bearing replacements that have been done during the lifetime of the motor.

"Bearings replaced" ("Motor bearing maintenance")

When the bearing monitoring function is active, the controller gives a warning when the motor bearings are to be replaced.

When you have replaced the motor bearings, confirm this action by pressing [Bearings replaced].

"Bearing relubrications"

The following applies only for 11 kW motors.

This display shows the number of bearing relubrications that have been done since the last bearing replacement.

"Bearings relubricated" ("Motor bearing maintenance")

The following applies only for 11 kW motors.

When the bearing monitoring function is active, the controller gives a warning when the motor bearings are due to be relubricated.

When you have relubricated the motor bearings, press [Bearings relubricated].

The factory-set interval between relubrications is stated on the bearing nameplate which is placed on the motor. The relubrication interval can be changed by a Grundfos service technician.

It is possible to relubricate the bearings five times according to the preset interval. When the preset interval has been reached after the fifth relubrication, a warning will be given to replace the bearings.

Communication

"Number" ("Pump number")

Pump variant		Number
NBE, NKE Series 2000	0.12 - 11 kW, 2-pole 0.12 - 7.5 kW, 4-pole	•
NBE, NBGE, NKE, NKGE	0.12 - 11 kW, 2-pole 0.12 - 7.5 kW, 4-pole	•
	15-22 kW, 2-pole 11 - 18.5 kW, 4-pole	•

You can allocate a unique number to the pump. This makes it possible to distinguish between pumps in connection with bus communication.

Factory setting

See *10. Factory settings of E-pumps* on page 123.

"Radio communication" ("Enable/disable radio comm.")

Pump variant		"Radio communication"
NBE, NKE Series 2000	0.12 - 11 kW, 2-pole 0.12 - 7.5 kW, 4-pole	•
NBE, NBGE, NKE, NKGE	0.12 - 11 kW, 2-pole 0.12 - 7.5 kW, 4-pole	•
	15-22 kW, 2-pole 11 - 18.5 kW, 4-pole	-

You can set the radio communication to either enabled or disabled. You can use this function in areas where radio communication is not allowed.

IR communication remains active.

Factory setting

See *10. Factory settings of E-pumps* on page 123.

General settings

"Language"

Pump variant		"Language"
NBE, NKE Series 2000	0.12 - 11 kW, 2-pole 0.12 - 7.5 kW, 4-pole	•
NBE, NBGE, NKE, NKGE	0.12 - 11 kW, 2-pole 0.12 - 7.5 kW, 4-pole	•
	15-22 kW, 2-pole 11 - 18.5 kW, 4-pole	-

This menu is only available in the advanced operating panel.

In this menu you can select the desired language. A number of languages are available.

"Date and time"

Pump variant		"Date and time"
NBE, NKE Series 2000	0.12 - 11 kW, 2-pole 0.12 - 7.5 kW, 4-pole	•
NBE, NBGE, NKE, NKGE	0.12 - 11 kW, 2-pole 0.12 - 7.5 kW, 4-pole	•
	15-22 kW, 2-pole 11 - 18.5 kW, 4-pole	-

You can set date and time as well as how they are to be shown in the display:

- "Select date format"
  "YYYY-MM-DD"
  "DD-MM-YYYY"
  "MM-DD-YYYY".
- "Select time format":
  "HH:MM 24-hour clock"
  "HH:MM am/pm 12-hour clock".
- "Set date"
- "Set time".

"Unit configuration" ("Units")

Pump variant		"Unit configuration"
NBE, NKE Series 2000	0.12 - 11 kW, 2-pole 0.12 - 7.5 kW, 4-pole	•
NBE, NBGE, NKE, NKGE	0.12 - 11 kW, 2-pole 0.12 - 7.5 kW, 4-pole	•
	15-22 kW, 2-pole 11 - 18.5 kW, 4-pole	-

In this menu you can select between SI and US units. The setting can be made generally for all parameters or customised for each parameter.

Factory setting

See *10. Factory settings of E-pumps* on page 123.

"Buttons on product" ("Enable/disable settings")

Pump variant		"Buttons on product"
NBE, NKE Series 2000	0.12 - 11 kW, 2-pole 0.12 - 7.5 kW, 4-pole	•
NBE, NBGE, NKE, NKGE	0.12 - 11 kW, 2-pole 0.12 - 7.5 kW, 4-pole	•
	15-22 kW, 2-pole 11 - 18.5 kW, 4-pole	•

In this display, you can disable the possibility of making settings.

Grundfos GO

If you set the buttons to "Not active", the buttons on the standard operating panel are disabled. If you set the buttons to "Not active" on pumps with an advanced operating panel, see below.

Advanced operating panel

If you have disabled the settings, you can still use the buttons to navigate through the menus but you cannot make changes in the "Settings" menu.

When you have disabled the possibility to make settings, the 🔒 symbol appears in the display.

To unlock the pump and allow settings, press ⌄ and ⌃ simultaneously for at least 5 seconds.

Standard operating panel

The 🔇 button always remains active but you can only unlock all other buttons on the pump with Grundfos GO.

"Delete history"

Pump variant		"Delete history"
NBE, NKE Series 2000	0.12 - 11 kW, 2-pole 0.12 - 7.5 kW, 4-pole	-
NBE, NBGE, NKE, NKGE	0.12 - 11 kW, 2-pole 0.12 - 7.5 kW, 4-pole	-
	15-22 kW, 2-pole 11 - 18.5 kW, 4-pole	-

This menu is only available in the advanced operating panel.

In this menu, you can delete the following historical data:

- "Delete work log."
- "Delete heat energy data"
- "Delete energy consumption".

"Define Home display"

Pump variant		"Define Home display"
NBE, NKE Series 2000	0.12 - 11 kW, 2-pole 0.12 - 7.5 kW, 4-pole	•
NBE, NBGE, NKE, NKGE	0.12 - 11 kW, 2-pole 0.12 - 7.5 kW, 4-pole	•
	15-22 kW, 2-pole 11 - 18.5 kW, 4-pole	-

This menu is only available in the advanced operating panel.

In this menu, you can set the "Home" display to show up to four user-set parameters.

"Display settings"

Pump variant		"Display settings"
NBE, NKE Series 2000	0.12 - 11 kW, 2-pole 0.12 - 7.5 kW, 4-pole	•
NBE, NBGE, NKE, NKGE	0.12 - 11 kW, 2-pole 0.12 - 7.5 kW, 4-pole	•
	15-22 kW, 2-pole 11 - 18.5 kW, 4-pole	-

This menu is only available in the advanced operating panel.

In this menu you can adjust the display brightness and set whether or not the display is to turn off if no buttons have been activated for a period of time.

"Store settings" ("Store actual settings")

Pump variant		"Store settings"
NBE, NKE Series 2000	0.12 - 11 kW, 2-pole 0.12 - 7.5 kW, 4-pole	•
NBE, NBGE, NKE, NKGE	0.12 - 11 kW, 2-pole 0.12 - 7.5 kW, 4-pole	•
	15-22 kW, 2-pole 11 - 18.5 kW, 4-pole	•

Grundfos GO

In this menu, you can store the actual settings for later use in the same pump or in other pumps of the same type.

Advanced operating panel

In this menu, you can store the actual settings for later use in the same pump.

"Recall settings" ("Recall stored settings")

Pump variant		"Recall settings"
NBE, NKE Series 2000	0.12 - 11 kW, 2-pole 0.12 - 7.5 kW, 4-pole	•
NBE, NBGE, NKE, NKGE	0.12 - 11 kW, 2-pole 0.12 - 7.5 kW, 4-pole	•
	15-22 kW, 2-pole 11 - 18.5 kW, 4-pole	•

Grundfos GO

In this menu, you can recall stored settings from a number of previously stored settings that the pump then uses.

Advanced operating panel

In this menu, you can recall the last stored settings that the pump then uses.

"Undo"

Pump variant		"Undo"
NBE, NKE Series 2000	0.12 - 11 kW, 2-pole 0.12 - 7.5 kW, 4-pole	•
NBE, NBGE, NKE, NKGE	0.12 - 11 kW, 2-pole 0.12 - 7.5 kW, 4-pole	•
	15-22 kW, 2-pole 11 - 18.5 kW, 4-pole	•

This menu is only available in Grundfos GO.

In this display, you can undo all settings that have been made with Grundfos GO in the current communication session. You cannot undo a "Recall stored settings" action.

"Pump name"

Pump variant		"Pump name"
NBE, NKE Series 2000	0.12 - 11 kW, 2-pole 0.12 - 7.5 kW, 4-pole	•
NBE, NBGE, NKE, NKGE	0.12 - 11 kW, 2-pole 0.12 - 7.5 kW, 4-pole	•
	15-22 kW, 2-pole 11 - 18.5 kW, 4-pole	-

This menu is only available in Grundfos GO.

In this display, you can give the pump a name. In this way, you can easily identify the pump when connecting with Grundfos GO.

Factory setting

See *10. Factory settings of E-pumps* on page 123.

"Connection code"

Pump variant		"Connection code"
NBE, NKE Series 2000	0.12 - 11 kW, 2-pole 0.12 - 7.5 kW, 4-pole	•
NBE, NBGE, NKE, NKGE	0.12 - 11 kW, 2-pole 0.12 - 7.5 kW, 4-pole	•
	15-22 kW, 2-pole 11 - 18.5 kW, 4-pole	-

This menu is only available in Grundfos GO.

You can set a connection code to avoid having to press the connection button each time and to restrict remote access to the product.

Setting the code in the product using Grundfos GO

1. Connect Grundfos GO to the product.
2. In the product dashboard, select "Settings".
3. Choose "Connection code".
4. Enter the wanted code and press [OK].
   The code must be a character string, ASCII. You can always modify the code. The old code is not needed.

Setting the code in Grundfos GO

You can set a default connection code in Grundfos GO so that it automatically attempts to connect to the selected product via this code.

When you select a product with the same connection code in Grundfos GO, Grundfos GO automatically connects to the product and you do not have to press the connection button on the module.

Set the default code in Grundfos GO in this way:

1. In the main menu, under "General", select "Settings".
2. Choose "Remote".
3. Enter the connection code in the field "Preset connection code". The field now says "Connection code set".

You can always modify the default connection code by pressing [Delete] and entering a new one.

If Grundfos GO fails to connect and ask you to press the connection button on the product, it means that the product has no connection code or has a different connection code. In this case, you can only establish connection via the connection button.

After setting a connection code, you must switch off the product until the light in Grundfos Eye turns off before you can use the new connection code.

Factory setting

See *10. Factory settings of E-pumps* on page 123.

"Run startup guide"

Pump variant		"Run startup guide"
NBE, NKE Series 2000	0.12 - 11 kW, 2-pole 0.12 - 7.5 kW, 4-pole	•
NBE, NBGE, NKE, NKGE	0.12 - 11 kW, 2-pole 0.12 - 7.5 kW, 4-pole	•
	15-22 kW, 2-pole 11 - 18.5 kW, 4-pole	-

This menu is only available in the advanced operating panel.

The startup guide automatically starts when you start the pump for the first time.

You can always run the startup guide later via this menu.

The startup guide guides you through the general settings of the pump.

- "Language". See *"Language"* on page 109.
- "Select date format".*
  See *"Date and time"* on page 109.
- "Set date".*
  See *"Date and time"* on page 109.
- "Select time format".*
  See *"Date and time"* on page 109.
- "Set time".*
  See *"Date and time"* on page 109.
- "Setting of pump"
  - "Go to Home"
  - "Run with Constant curve" / "Run with Constant pressure".
    See *"Control mode"* on page 89
  - "Go to Assisted pump setup".
    See *"Assisted pump setup"* on page 113.
  - "Return to factory settings".

* Applies only for pumps with advanced functional module, FM 300. For further information, see *Identification of functional module* on page 132.

"Alarm log"

Pump variant		"Alarm log"
NBE, NKE Series 2000	0.12 - 11 kW, 2-pole 0.12 - 7.5 kW, 4-pole	•
NBE, NBGE, NKE, NKGE	0.12 - 11 kW, 2-pole 0.12 - 7.5 kW, 4-pole	•
	15-22 kW, 2-pole 11 - 18.5 kW, 4-pole	-

This menu contains a list of logged alarms from the product. The log shows the name of the alarm, when the alarm occurred and when it was reset.

"Warning log"

Pump variant		"Warning log"
NBE, NKE Series 2000	0.12 - 11 kW, 2-pole 0.12 - 7.5 kW, 4-pole	•
NBE, NBGE, NKE, NKGE	0.12 - 11 kW, 2-pole 0.12 - 7.5 kW, 4-pole	•
	15-22 kW, 2-pole 11 - 18.5 kW, 4-pole	-

This menu contains a list of logged warnings from the product. The log shows the name of the warning, when the warning occurred and when it was reset.

"Assist"

Pump variant		"Assist"
NBE, NKE Series 2000	0.12 - 11 kW, 2-pole 0.12 - 7.5 kW, 4-pole	•
NBE, NBGE, NKE, NKGE	0.12 - 11 kW, 2-pole 0.12 - 7.5 kW, 4-pole	•
	15-22 kW, 2-pole 11 - 18.5 kW, 4-pole	-

The menu consist of functions which take you through the steps needed to set the pump.

"Assisted pump setup"

Pump variant		"Assisted pump setup"
NBE, NKE Series 2000	0.12 - 11 kW, 2-pole 0.12 - 7.5 kW, 4-pole	•
NBE, NBGE, NKE, NKGE	0.12 - 11 kW, 2-pole 0.12 - 7.5 kW, 4-pole	•
	15-22 kW, 2-pole 11 - 18.5 kW, 4-pole	-

The menu guides you through the following:

Setting of pump

- Selection of control mode. See page 89.
- Configuration of feedback sensors.
- Adjusting the setpoint. See page 89.
- Controller settings. See page 102.
- Summary of settings.

Example of how to use the "Assisted pump setup" for setting the pump to constant pressure:

Grundfos GO

1. Open the "Assist" menu.
2. Select "Assisted pump setup".
3. Select the control mode "Constant pressure".
4. Read the description of this control mode.
5. Select which analog input to use as sensor input.
6. Select sensor function according to where the sensor is installed in the system. See fig. 137.
7. Select electrical input signal according to the sensor specifications.
8. Select measuring unit according to the sensor specifications.
9. Set the minimum and maximum sensor values according to the sensor specifications.
10. Set the desired setpoint.
11. Set the controller settings K_p and T_i. See the recommendations in section *"Controller" ("Controller settings")* on page 102.
12. Type the pump name.
13. Check the summary of settings and confirm them.

Advanced operating panel

1. Open the "Assist" menu.
2. Select "Assisted pump setup".
3. Select the control mode "Const. pressure".
4. Select which analog input to use as sensor input.
5. Select the measured parameter to be controlled. See fig. 137.
6. Select measuring unit according to the sensor specifications.
7. Set the minimum and maximum sensor values according to the sensor specifications.
8. Select electrical input signal according to the sensor specifications.
9. Set the setpoint.
10. Set the controller settings K_p and T_i. See recommendations in section *"Controller" ("Controller settings")* on page 102.
11. Check the summary of settings and confirm them by pressing [OK].

"Setup, analog input"

Pump variant		"Setup, analog input"
NBE, NKE Series 2000	0.12 - 11 kW, 2-pole 0.12 - 7.5 kW, 4-pole	•
NBE, NBGE, NKE, NKGE	0.12 - 11 kW, 2-pole 0.12 - 7.5 kW, 4-pole	•
	15-22 kW, 2-pole 11 - 18.5 kW, 4-pole	-

This menu is only available in the advanced operating panel.

The menu guides you through the following:

"Setup, analog input"

- Analog inputs 1 to 3. See page 95.
- Pt100/1000 input 1 and 2. See page 97.
- Adjusting the setpoint. See page 89.
- Summary.

"Setting of date and time"

Pump variant		"Setting of date and time"
NBE, NKE Series 2000	0.12 - 11 kW, 2-pole 0.12 - 7.5 kW, 4-pole	•
NBE, NBGE, NKE, NKGE	0.12 - 11 kW, 2-pole 0.12 - 7.5 kW, 4-pole	•
	15-22 kW, 2-pole 11 - 18.5 kW, 4-pole	-

This menu guides you through the following:

- "Select date format". See *"Date and time"* on page 109.
- "Set date". See *"Date and time"* on page 109.
- "Select time format". See *"Date and time"* on page 109.
- "Set time". See *"Date and time"* on page 109.

"Multipump setup" ("Setup of multi-pump system")

Pump variant		"Multipump setup"
NBE, NKE Series 2000	0.12 - 11 kW, 2-pole 0.12 - 7.5 kW, 4-pole	•
NBE, NBGE, NKE, NKGE	0.12 - 11 kW, 2-pole 0.12 - 7.5 kW, 4-pole	•
	15-22 kW, 2-pole 11 - 18.5 kW, 4-pole	-

The multipump function enables the control of two pumps connected in parallel without the use of external controllers. The pumps in a multipump system communicate with each other via the wireless GENIair connection or the wired GENI connection.

A multipump system is set via a selected pump, that is the master pump, which is the first selected pump.

If two pumps in the system are configured with an outlet-pressure sensor, both pumps can function as master pumps and take over the master pump function if the other fails. This provides additional redundancy in the multipump system.

The multipump functions are described in the following sections.

Alternating operation

Alternating operation functions as a duty-standby operating mode and is possible with two pumps of same size and type connected in parallel. The main purpose of the function is to ensure an even amount of running hours and to ensure that the standby pump takes over if the running pump stops due to an alarm.

Each pump requires a non-return valve in series with the pump.

You can choose between two alternating operating modes:

- Alternating operation, time
  Pump changeover to the other is based on time.
- Alternating operation, energy
  Pump changeover to the other is based on energy consumption.

If the duty pump fails, the other pump takes over automatically.

Backup operation

Backup operation is possible with two pumps of same size and type connected in parallel. Each pump requires a non-return valve in series with the pump.

One pump is operating continuously. The backup pump is operated for a short time each day to prevent seizing up. If the duty pump stops due to a fault, the backup pump starts automatically.

Cascade operation

Cascade operation ensures that the pump performance is automatically adapted to the consumption by switching pumps on or off. The system thus runs as energy-efficiently as possible with a constant pressure and a limited number of pumps.

When a twin-head pump is running in constant-pressure control mode, the second pump head starts at 90 % and stops at 50 % performance.

All pumps in operation run at equal speed. Pump changeover is automatic and depends on energy, operating hours and fault.

Pump system:

- Twin-head pump.
- Two or four single-head pumps connected in parallel.
  The pumps must be of the same type and size.
  Each pump requires a non-return valve in series with the pump.

Set the control mode to "Const. pressure" or "Const. curve".

This function is available with up to 4 motors installed in parallel. The motors must be of the same size and the pumps must be of the same model.

- The performance is adjusted to the demand through cutting pumps in or out and through parallel control of the pumps in operation.
- The controller maintains a constant pressure through continuous adjustment of the speed of the pumps.
- Pump changeover is automatic and depends on load, operating hours and fault detection.
- All pumps in operation run at the same speed.
- The number of pumps in operation also depends on the energy consumption of the pumps. If only one pump is required, two pumps will run at a lower speed if this results in a lower energy consumption.
- If several motors in the system have a sensor, they can all function as master and take over the master function if the other fails.

Setting a multipump system

You can set a multipump system in the following ways:

- *Grundfos GO and wireless pump connection*
- *Grundfos GO and wired pump connection*
- *Advanced operating panel and wireless pump connection*
- *Advanced operating panel and wired pump connection*.

See step-by-step descriptions below.

Grundfos GO and wireless pump connection

1. Power on both pumps.
2. Establish contact to one of the pumps with Grundfos GO.
3. Set the needed analog and digital inputs via Grundfos GO according to the connected equipment and the required functionality. See *"Assisted pump setup"* on page 113.
4. Assign a pump name to the pump using Grundfos GO. See *"Pump name"* on page 111.
5. Disconnect Grundfos GO from the pump.
6. Establish contact to the other pump.
7. Set the needed analog and digital inputs via Grundfos GO according to the connected equipment and the required functionality. See *"Assisted pump setup"* on page 113.
8. Assign a pump name to the pump using Grundfos GO. See *"Pump name"* on page 111.
9. Select the "Assist" menu and "Multipump setup".
10. Select the desired multipump function. See *Alternating operation* on page 114, *Backup operation* on page 114 and *Cascade operation* on page 115.
11. Press [>] to continue.
12. Set the time for pump changeover such as the time at which the alternation between the two pumps is to take place. This step applies only if you have selected "Alternating operation, time" and if the pumps are fitted with FM 300.
13. Press [>] to continue.
14. Select "Radio" as the communication method to be used between the two pumps.
15. Press [>] to continue.
16. Press "Select pump 2".
17. Select the pump from the list.
    Use the [OK] or button to identify the pump.
18. Press [>] to continue.
19. Confirm the multipump setup by pressing [Send].
20. Press [Finish] in the "Setup complete" dialog box.
21. Wait for the green indicator light in the middle of Grundfos Eye to light up.

The multipump system has now been set.

Grundfos GO and wired pump connection

1. Connect the two pumps with each other with a 3-core screened cable between the GENIbus terminals A, Y, B.
2. Power on both pumps.
3. Establish contact to one of the pumps with Grundfos GO.
4. Set the needed analog and digital inputs via Grundfos GO according to the connected equipment and the required functionality. See *"Assisted pump setup"* on page 113.
5. Assign a pump name to the pump using Grundfos GO. See *"Pump name"* on page 111.
6. Assign pump number 1 to the pump. See *"Number" ("Pump number")* on page 108.
7. Disconnect Grundfos GO from the pump.
8. Establish contact to the other pump.
9. Set the needed analog and digital inputs via Grundfos GO according to the connected equipment and the required functionality. See *"Assisted pump setup"* on page 113.
10. Assign a pump name to the pump using Grundfos GO. See *"Pump name"* on page 111.
11. Assign pump number 2 to the pump. See *"Number" ("Pump number")* on page 108.
12. Select the "Assist" menu and choose "Multipump setup".
13. Select the desired multipump function. See *Alternating operation* on page 114, *Backup operation* on page 114 and *Cascade operation* on page 115.
14. Press [>] to continue.
15. Set the time for pump changeover such as the time at which the alternation between the two pumps is to take place. This step applies only if you have selected "Alternating operation, time" and if the pumps are fitted with FM 300.
16. Press [>] to continue.
17. Select "BUS cable" as the communication method to be used between the two pumps.
18. Press [>] to continue.
19. Press "Select pump 2".
20. Select the additional pump from the list.
    Use the [OK] or button to identify the additional pump.
21. Press [>] to continue.
22. Press [Send].
23. Press [Finish] in the "Setup complete" dialog box.
24. Wait for the green indicator light in the middle of Grundfos Eye to light up.

The multipump system has now been set.

Advanced operating panel and wireless pump connection

1. Power on both pumps.
2. On both pumps, set the needed analog and digital inputs according to the connected equipment and the required functionality. See *"Assisted pump setup"* on page 113.
3. Select the "Assist" menu on one of the pumps and choose "Setup of multi-pump system".
4. Press [>] to continue.
5. Select "Wireless" as the communication method to be used between the two pumps.
6. Press [>] to continue.
7. Select the desired multipump function. See *Alternating operation* on page 114, *Backup operation* on page 114 and *Cascade operation* on page 115.
8. Press [>] three times to continue.
9. Press [OK] to search for other pumps.
   The green indicator light in the middle of Grundfos Eye flashes on the other pumps.
10. Press the connect button on the pump which is to be added to the multipump system.
11. Press [>] to continue.
12. Set the time for pump changeover i.e. the time at which the alternation between the two pumps is to take place. This step applies only if you have selected "Alternating operation, time" and if the pumps are fitted with FM 300.
13. Press [>] to continue.
14. Press [OK].
    The multipump function icons appear in the bottom of the operating panels.

The multipump system has now been set.

Advanced operating panel and wired pump connection

1. Connect the two pumps with each other with a 3-core screened cable between the GENIbus terminals A, Y, B.
2. Set the needed analog and digital inputs according to the connected equipment and the required functionality. See *"Assisted pump setup"* on page 113.
3. Assign pump number 1 to the first pump. See *"Number" ("Pump number")* on page 108.
4. Assign pump number 2 to the other pump. See *"Number" ("Pump number")* on page 108.
5. Select the "Assist" menu on one of the pumps and choose "Setup of multi-pump system".
6. Press [>] to continue.
7. Select "Wired GENIbus" as the communication method to be used between the two pumps.
8. Press [>] twice to continue.
9. Select the desired multipump function. See *Alternating operation* on page 114, *Backup operation* on page 114 and *Cascade operation* on page 115.
10. Press [>] to continue.
11. Press [OK] to search for other pumps.
12. Select the additional pump from the list.
13. Press [>] to continue.
14. Set the time for pump changeover i.e. the time at which the alternation between the two pumps is to take place.
    This step applies only if you have selected "Alternating operation, time" and if the pumps are fitted with FM 300.
15. Press [>] to continue.
16. Press [OK].
    The multipump function icon appears in the bottom of the operating panels.

The multipump system has now been set.

Disabling the multipump function via Grundfos GO

1. Select the "Assist" menu.
2. Select "Multipump setup".
3. Select "Disable".
4. Press [>] to continue.
5. Confirm the multipump setup by pressing [Send].
6. Press [Finish].

The multipump function has now been disabled.

Disabling a multipump via advanced operating panel

1. Select the "Assist" menu.
2. Select "Setup of multi-pump system".
3. Press [>] to continue.
4. Confirm "No multi-pump function" by pressing [OK].
5. Press [>] to continue.
6. Press [OK].

The multipump system has now been disabled.

"Description of control mode"

Pump variant		"Description of control mode"
NBE, NKE Series 2000	0.12 - 11 kW, 2-pole 0.12 - 7.5 kW, 4-pole	•
NBE, NBGE, NKE, NKGE	0.12 - 11 kW, 2-pole 0.12 - 7.5 kW, 4-pole	•
	15-22 kW, 2-pole 11 - 18.5 kW, 4-pole	-

This menu is only available in the advanced operating panel.

This menu describes each of the possible control modes. See also section *"Control mode"* on page 89.

"Assisted fault advice"

Pump variant		"Assisted fault advice"
NBE, NKE Series 2000	0.12 - 11 kW, 2-pole 0.12 - 7.5 kW, 4-pole	•
NBE, NBGE, NKE, NKGE	0.12 - 11 kW, 2-pole 0.12 - 7.5 kW, 4-pole	•
	15-22 kW, 2-pole 11 - 18.5 kW, 4-pole	-

This menu gives guidance and corrective actions in case of pump failures.

Priority of settings

You can always set the pump to stop by pressing on the pump operating panel. When the pump is not in "Stop" mode, you can always stop the pump by continuously pressing . Furthermore, you can set the pump to maximum speed by continuously pressing . You can always set the pump to operation at maximum speed or to stop with Grundfos GO.

If two or more functions are enabled at the same time, the pump will operate according to the function with the highest priority.

Example

If you have set the pump to maximum speed via the digital input, the pump operating panel or Grundfos GO can only set the pump to "Manual" or "Stop".

The priority of the settings appears from the table below.

Priority	Start-stop button	Grundfos GO or operating panel on the motor	Digital input	Bus communication
1	"Stop"			
2		"Stop"*		
3		"Manual"		
4		"Max. speed"*/ "User-defined speed"		
5			"Stop"	
6			"User-defined speed"	
7				"Stop"
8				"Max. speed"
9				"Min. speed"
10				"Start"
11			"Max. speed"	
12		"Min. speed"		
13			"Min. speed"	
14			"Start"	
15		"Start"		

* "Stop" and "Max. speed" settings made with Grundfos GO or on the motor operating panel can be overruled by another operating-mode command sent from a bus, for example "Start". If the bus communication is interrupted, the motor resumes its previous operating mode, for example "Stop", selected with Grundfos GO or on the motor operating panel.

Grundfos Eye

The operating condition of the motor is indicated by Grundfos Eye on the operating panel. See fig. 151 (A).

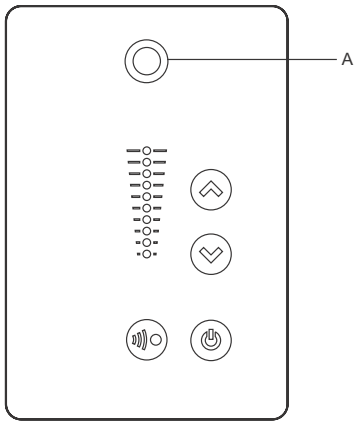


Fig. 151 Grundfos Eye

Grundfos Eye	Indication	Description
	No lights are on.	The power is off. The pump is not running.
	The two opposite green indicator lights are rotating in the direction of rotation of the pump when seen from the non-drive end.	The power is on. The pump is running.
	The two opposite green indicator lights are permanently on.	The power is on. The pump is not running.
	One yellow indicator light is rotating in the direction of rotation of the pump when seen from the non-drive end.	Warning. The pump is running.
	One yellow indicator light is permanently on.	Warning. The pump has stopped.
	The two opposite red indicator lights flash simultaneously.	Alarm. The pump has stopped.
	The green indicator light in the middle flashes quickly four times. 	This is a feedback signal which the pump gives in order to ensure identification of itself.
	The green indicator light in the middle flashes continuously. 	Grundfos GO or another pump is trying to communicate with the pump. Press on the pump operating panel to allow communication.
	The green indicator light in the middle is permanently on. 	Remote control with Grundfos GO via radio. The pump is communicating with Grundfos GO via radio connection.
	The green indicator light in the middle flashes quickly while Grundfos Go is exchanging data with the pump. It takes a few seconds. 	Remote control with Grundfos GO via infrared light. The pump is receiving data from Grundfos GO via infrared communication.

Indicator lights and signal relays

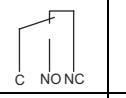
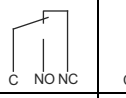
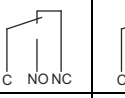
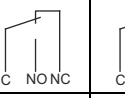
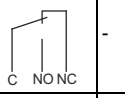
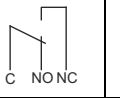
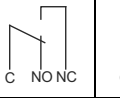
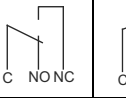
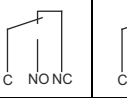
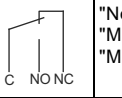
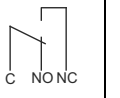
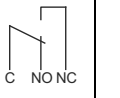
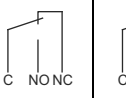
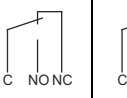
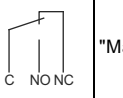
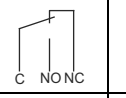
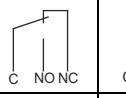
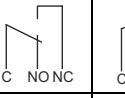
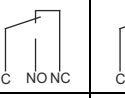
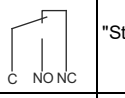
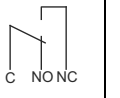
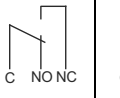
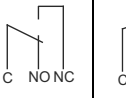
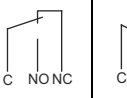
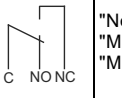
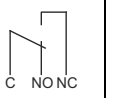
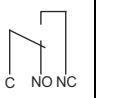
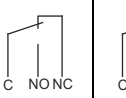
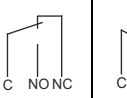
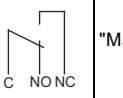
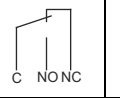
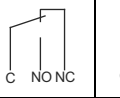
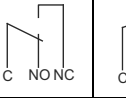
The following applies to the pumps below:

- NBE, NBGE, NKE, NKGE pumps with the following motor sizes:
  0.12 - 11 kW, 2-pole
  0.12 - 7.5 kW, 4-pole.

The pump has two outputs for potential-free signals via two internal relays.

You can set the signal outputs to "Operation", "Pump running", "Ready", "Alarm" and "Warning".

The functions of the two signal relays appear from the table below:

Description	Grundfos Eye	Contact position for signal relays when activated					"Operating mode"
		"Operation"	"Pump running"	"Ready"	"Alarm"	"Warning"	
The power is off.	 Off						-
The pump runs in "Normal" mode.	 Green, rotating						"Normal", "Min." or "Max."
The pump runs in "Manual" mode.	 Green, rotating						"Manual"
The pump is in operating mode "Stop".	 Green, steady						"Stop"
Warning, but the pump runs.	 Yellow, rotating						"Normal", "Min." or "Max."
Warning, but the pump runs in "Manual" mode.	 Yellow, rotating						"Manual"
Warning, but the pump was stopped via "Stop" command.	 Yellow, steady						"Stop"
Alarm, but the pump runs.	Red, rotating						"Normal," "Min." or "Max."
Alarm, but the pump runs in "Manual" mode.	Red, rotating						"Manual"
The pump has stopped due to an alarm.	Red, flashing						"Stop"

The following applies to the pumps below:

- NBE, NBGE, NKE, NKGE pumps with the following motor sizes:
  15-22 kW, 2-pole
  11 - 18.5 kW, 4-pole.

The operating condition of the pump is indicated by the green (A) and red (B) indicator lights on the pump operating panel and inside the terminal box. See fig. 152.

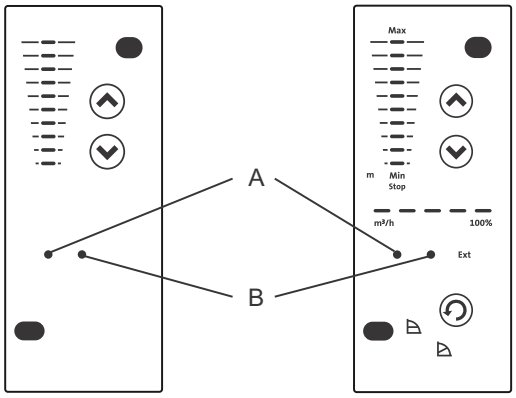


Fig. 152 Position of indicator lights

Furthermore, the pump incorporates an output for a potential-free signal via an internal relay.

The functions of the two indicator lights and the signal relay are as shown in the following table:

Indicator lights		Signal relay activated during:				
Fault red	**Operation green**	**"Fault"/"Alarm", "Warning" and "Relubricate"**	**"Operating"**	**"Ready"**	**"Pump running"**	**Description**
Off	Off					The power supply has been switched off.
Off	Permanently on					The pump runs.
Off	Flashing					The pump has been set to stop.
Permanently on	Off					The pump has stopped because of a "Fault" or "Alarm". Or the pump runs with a "Warning" or "Relubricate" indication. If the pump was stopped, restarting will be attempted. It may be necessary to restart the pump by resetting the "Fault" indication.
Permanently on	Permanently on					The pump runs, but it has or has had a "Fault" or "Alarm" allowing the pump to continue operation. Or the pump runs with a "Warning" or "Relubricate" indication. If the cause is "Sensor signal outside signal range", the pump continues to run according to the maximum curve, and you cannot reset the fault indication until the signal is inside the signal range. If the cause is "Setpoint signal outside signal range", the pump continues to run according to the minimum curve, and you cannot reset the fault indication until the signal is inside the signal range.
Permanently on	Flashing					The pump has been set to stop, but it has been stopped because of a "Fault".

Resetting of fault indication

You can reset a fault indication in one of the following ways:

- Briefly press ⌃ or ⌄ on the pump. This will not change the setting of the pump.
  A fault indication cannot be reset by means of ⌃ or ⌄ if the buttons have been locked.
- Switch off the power supply until the indicator lights are off.
- Switch the external start-stop input off and then on again.
- Use Grundfos GO.

10. Factory settings of E-pumps

- ● Function is enabled.
- ❍ Function is disabled.
- \- Function is not available.

Settings	NBE, NKE Series 2000 0.12 - 11 kW, 2-pole 0.12 - 7.5 kW, 4-pole	NBE, NBGE, NKE, NKGE 0.12 - 11 kW, 2-pole 0.12 - 7.5 kW, 4-pole	NBE, NBGE, NKE, NKGE 15-22 kW, 2-pole 11 - 18.5 kW, 4-pole	Comments	Function description
"Setpoint"	58 %	67 %	67 %		Page 89
"Operating mode"	Normal	Normal	Normal		Page 89
"Control mode"	Proportional pressure	Constant curve	Constant curve		Page 89
"Date and time"	●	●	-		Page 109
"Buttons on product"	●	●	●		
"Controller"					
"Kp"	0.5	0.5	0.5		Page 102
"Ti"	0.5	0.5	0.5		
"Operating range"					
"Min."	25 %	25 %	25 %		Page 103
"Max."	110 %	110 %	110 %		
"Ramps"	❍	❍	-		Page 107
"Pump number"	1	1	1		Page 108
"Radio communication"	●	●	-		Page 108
"Sensor type"	-	-	❍		Page 95
"Analog input 1"	❍	❍	-		Page 95
"Analog input 2"	❍	❍	-		
"Analog input 3"	❍	❍	-		
"Built-in Grundfos sensor"	●	-	-		Page 97
"Pt100/1000 input 1"	❍	❍	-		Page 97
"Pt100/1000 input 2"	❍	❍	-		
"Digital input 1"	❍	❍	-		Page 98
"Digital input 2"	❍	❍	❍		
"Digital in/output 3"	❍	❍	-		Page 99
"Digital in/output 4"	❍	❍	-		
"Pulse flowmeter"	❍	❍	-		Page 107
"Predefined setpoint"	❍	❍	-		Page 105
"Analog output"[1)]	❍	❍	-		Page 101
"External setpoint funct."	❍	❍	❍		Page 103
"Signal relay 1"	❍	❍	Alarm		Page 100
"Signal relay 2"	❍	❍	Operation		
"Limit 1 exceeded"	❍	❍	-		Page 106
"Limit 2 exceeded"	❍	❍	-		
"Standstill heating"	❍	❍	❍		Page 107
"Motor bearing monitoring"	❍	❍	❍		Page 107
"Pump name"	Grundfos	Grundfos	-		Page 111
"Connect code"	-	-	-		Page 111
"Unit configuration"	SI units	SI units	SI units		Page 109

Multipump factory setting for twin-pumps: Alternating operation on time.

Technical data, MGE motors

MGE motors, 1.1 - 11 kW, 2 pole and 0.55 - 7.5 kW, 4-pole

Supply voltage

3 x 380-500 V - 10 %/+ 10 %, 50/60 Hz, PE.

Recommended fuse size

Motor size [kW]	Minimum fuse [A]	Maximum fuse [A]
0.55 - 1.1	6	6
1.5	6	10
2.2	6	10
3	10	16
4	13	16
5.5	16	32
7.5	20	32
11	32	32

You can use standard as well as quick-blow or slow-blow fuses.

Leakage current

Speed [min^{-1}]	Power [kW]	Mains voltage [V]	Leakage current [mA]
1400-2000 1450-2200	0.55 - 1.5	≤ 400	< 3.5
		> 400	< 5
	2.2 - 4	≤ 400	< 3.5
		> 400	< 3.5
	5.5 - 7.5	≤ 400	< 3.5
		> 400	< 5
2900-4000	1.1 - 2.2	≤ 400	< 3.5
		> 400	< 5
	3 - 5.5	≤ 400	< 3.5
		> 400	< 3.5
	7.5 - 11	≤ 400	< 3.5
		> 400	< 5

The leakage currents are measured in accordance with EN 61800-5-1:2007.

Inputs/outputs

Earth reference, GND

All voltages refer to GND.

All currents return to GND.

Absolute maximum voltage and current limits

Exceeding the following electrical limits may result in severely reduced operating reliability and motor life:

Relay 1:

Maximum contact load: 250 VAC, 2 A or 30 VDC, 2 A.

Relay 2:

Maximum contact load: 30 VDC, 2 A.

GENI terminals: -5.5 to 9.0 VDC or less than 25 mADC.

Other input or output terminals: -0.5 to 26 VDC or less than 15 mADC.

Digital inputs, DI

Internal pull-up current more than10 mA at V_i equal to 0 VDC.

Internal pull-up to 5 VDC (currentless for V_i more than 5 VDC).

Certain low logic level: V_i less than 1.5 VDC.

Certain high logic level: V_i more than 3.0 VDC.

Hysteresis: No.

Screened cable: 0.5 - 1.5 mm^2, 28-16 AWG.

Maximum cable length: 500 m.

Open-collector digital outputs, OC

Current sinking capability: 75 mADC, no current sourcing.

Load types: Resistive or/and inductive.

Low-state output voltage at 75 mADC: Maximum 1.2 VDC.

Low-state output voltage at 10 mADC: Maximum 0.6 VDC.

Overcurrent protection: Yes.

Screened cable: 0.5 - 1.5 mm^2, 28-16 AWG.

Maximum cable length: 500 m.

Analog inputs, AI

Voltage signal ranges:

- 0.5 - 3.5 VDC, AL AU.
- 0-5 VDC, AU.
- 0-10 VDC, AU.

Voltage signal: R_i greater than 100 kΩ at 25 °C.

Leak currents may occur at high operating temperatures. Keep the source impedance low.

Current signal ranges:

- 0-20 mADC, AU.
- 4-20 mADC, AL AU.

Current signal: R_i equal to 292 Ω.

Current overload protection: Yes. Change to voltage signal.

Measurement tolerance: - 0/+ 3 % of full scale (maximum-point coverage).

Screened cable: 0.5 - 1.5 mm^2, 28-16 AWG.

Maximum cable length: 500 m (excl. potentiometer).

Potentiometer connected to +5 V, GND, any AI:

Use maximum 10 kΩ.

Maximum cable length: 100 m.

Analog output, AO

Current sourcing capability only.

Voltage signal:

- Range: 0-10 VDC.
- Minimum load between AO and GND: 1 kΩ.
- Short-circuit protection: Yes.

Current signal:

- Ranges: 0-20 and 4-20 mADC.
- Maximum load between AO and GND: 500 Ω.
- Open-circuit protection: Yes.

Tolerance: - 0/+ 4 % of full scale (maximum-point coverage).

Screened cable: 0.5 - 1.5 mm^2, 28-16 AWG.

Maximum cable length: 500 m.

Pt100/1000 inputs, PT

Temperature range:

- Minimum -30 °C, 88 Ω / 882 Ω.
- Maximum 180 °C, 168 Ω / 1685 Ω.

Measurement tolerance: ± 1.5 °C.

Measurement resolution: less than 0.3 °C.

Automatic range detection, Pt100 or Pt1000: Yes.

Sensor fault alarm: Yes.

Screened cable: 0.5 - 1.5 mm^2, 28-16 AWG.

Use Pt100 for short wires.

Use Pt1000 for long wires.

Power supplies

+5 V:

- Output voltage: 5 VDC - 5 %/+ 5 %.
- Maximum current: 50 mADC, sourcing only.
- Overload protection: Yes.

24 V:

- Output voltage: 24 VDC - 5 %/+ 5 %.
- Maximum current: 60 mADC, sourcing only.
- Overload protection: Yes.

Digital outputs, relays

Potential-free changeover contacts.

Minimum contact load when in use: 5 VDC, 10 mA.

Screened cable: 0.5 - 2.5 mm^2, 28-12 AWG.

Maximum cable length: 500 m.

Bus input

Grundfos GENIbus protocol, RS-485.

Screened 3-core cable: 0.5 - 1.5 mm^2, 28-16 AWG.

Maximum cable length: 500 m.

EMC, electromagnetic compatibility

Standard used: EN 61800-3.

The table below shows the emission category of the motor.

C1 fulfils the requirements for residential areas.

C3 fulfils the requirements for industrial areas.

Motor [kW]	Emission category	
	1450-2000 min^{-1}	2900-4000 min^{-1} 4000-5900 min^{-1}
0.55	C1	C1
0.75	C1	C1
1.1	C1	C1
1.5	C1	C1
2.2	C1	C1
3	C1	C1
4	C1	C1
5.5	C3/C1*	C1
7.5	C3/C1*	C3/C1*
11	-	C3/C1*

* C1, if equipped with an external Grundfos EMC filter.

Immunity: The motor fulfils the requirements for industrial areas.

Contact Grundfos for further information.

Enclosure class

Standard: IP55 (IEC 34-5).

Optional: IP66 (IEC 34-5).

Insulation class

F (IEC 85).

Standby power consumption

5-10 W.

Cable entries

Motor [kW]	Number and size of cable entries	
	1400-2000 min^{-1} 1450-2200 min^{-1}	2900-4000 min^{-1}
0.55 - 1.5	4 x M20	4 x M20
2.2	1 x M25 + 4 x M20	4 x M20
3.0 - 4.0	1 x M25 + 4 x M20	1 x M25 + 4 x M20
5.5	1 x M32 + 5 x M20	1 x M25 + 4 x M20
7.5 - 11	1 x M32 + 5 x M20	1 x M32 + 5 x M20

Sound pressure level

Motor [kW]	Maximum speed stated on nameplate [min^{-1}]	Speed [min^{-1}]	Sound pressure level ISO 3743 [dB(A)]
			3-phase motors
0.55 - 0.75	2000	1500	37
		2000	43
	4000	3000	50
		4000	60
1.1	2000	1500	37
		2000	43
	4000	3000	50
		4000	60
1.5	2000	1500	42
		2000	47
	4000	3000	57
		4000	64
2.2	2000	1500	48
		2000	55
	4000	3000	57
		4000	64
3	2000	1500	48
		2000	55
	4000	3000	60
		4000	69
4	2000	1500	48
		2000	55
	4000	3000	61
		4000	69
5.5	2000	1500	58
		2000	61
	4000	3000	61
		4000	69
7.5	2000	1500	58
		2000	61
	4000	3000	66
		4000	73
11	4000	3000	66
		4000	73

Motor protection

The motor requires no external motor protection. The motor incorporates thermal protection against slow overloading and blocking.

Additional protection

The residual-current circuit breaker must be marked with the following symbol:

The total leakage current of all the electrical equipment in the installation must be taken into account. You can find the leakage current of the motor in *Leakage current* on page 124.

This product can cause a direct current in the protective-earth conductor.

Overvoltage and undervoltage protection

Overvoltage and undervoltage may occur in case of unstable power supply or a faulty installation. The motor is stopped if the voltage falls outside the permissible voltage range. The motor restarts automatically when the voltage is again within the permissible voltage range. Therefore, no additional protection relay is required.

Note: The motor is protected against transients from the power supply according to EN 61800-3. In areas with high lightning intensity, we recommend external lightning protection.

Overload protection

If the upper load limit is exceeded, the motor automatically compensates for this by reducing the speed and stops if the overload condition persists.

The motor remains stopped for a set period. After this period, the motor automatically attempts to restart. The overload protection prevents damage to the motor. Consequently, no additional motor protection is required.

Overtemperature protection

The electronic unit has a built-in temperature sensor as an additional protection. When the temperature rises above a certain level, the motor automatically compensates for this by reducing the speed and stops if the temperature keeps rising. The motor remains stopped for a set period. After this period, the motor automatically attempts to restart.

Protection against phase unbalance

Three-phase motors must be connected to a power supply with a quality corresponding to IEC 60146-1-1, class C, to ensure correct motor operation at phase unbalance. This also ensures long life of the components.

Maximum number of starts and stops

The number of starts and stops via the power supply must not exceed four times per hour.

When switched on via the power supply, the pump starts after approximately 5 seconds.

If you want a higher number of starts and stops, use the input for external start-stop when starting or stopping the pump.

When you start the pump via an external on/off switch, the pump starts immediately.

Wiring diagrams

Three-phase supply:

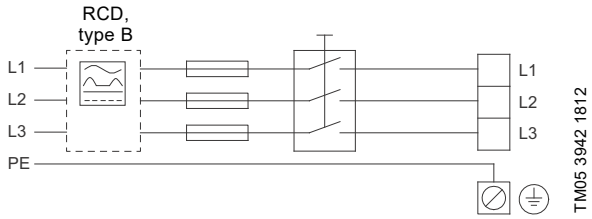


Fig. 153 Example of a mains-connected motor with a main switch, backup fuse and additional protection

Connection terminals

The descriptions and terminal overviews in this section apply to both single-phase and three-phase motors.

Connection terminals, advanced functional module, FM 300

The advanced functional module is only available as an option.

The advanced module has these connections:

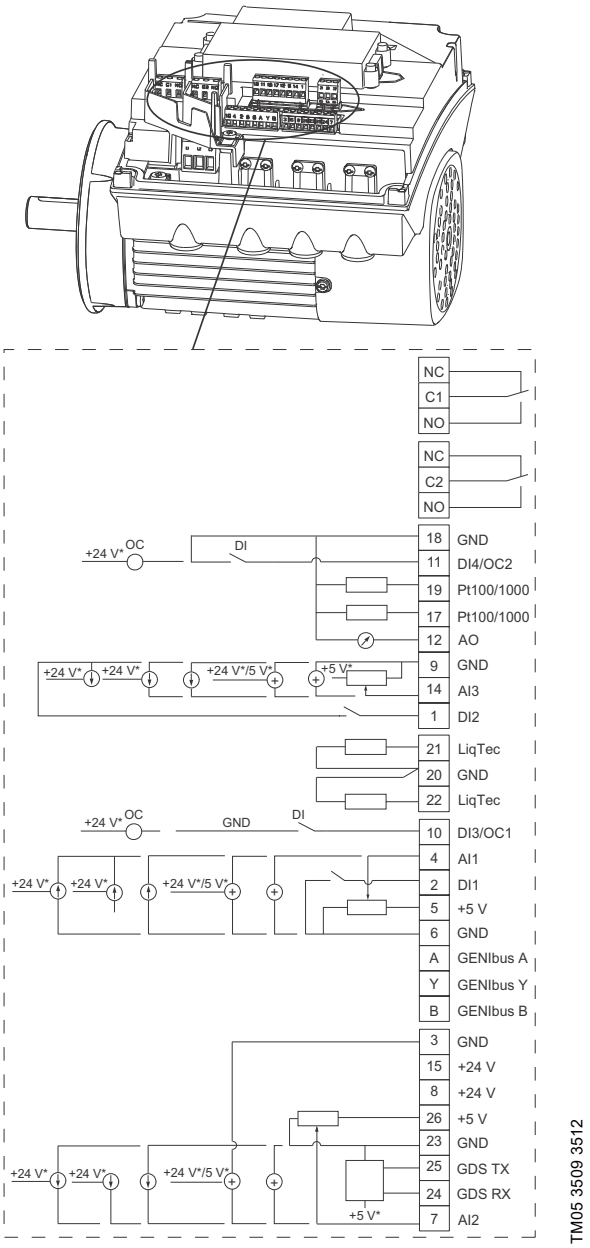
- three analog inputs
- one analog output
- two dedicated digital inputs
- two configurable digital inputs or open-collector outputs
- two Pt100/1000 inputs
- two LiqTec sensor inputs
- two signal relay outputs
- GENIbus connection.

See fig. 154.

Note: Digital input 1 is factory-set to be the start-stop input where open circuit results in stop.

A jumper has been factory-fitted between terminals 2 and 6. Remove the jumper if digital input 1 is to be used as external start-stop or any other external function.

- **Inputs and outputs**
  All inputs and outputs are internally separated from the mains-conducting parts by reinforced insulation and galvanically separated from other circuits.
  All control terminals are supplied by protective extra-low voltage, PELV, thus ensuring protection against electric shock.
- **Signal relay outputs**
  – Signal relay 1:
  LIVE:
  You can connect supply voltages up to 250 VAC.
  PELV:
  The output is galvanically separated from other circuits. Therefore, you can connect the supply voltage or protective extra-low voltage to the output as desired.
  – Signal relay 2:
  PELV:
  The output is galvanically separated from other circuits. Therefore, you can connect the supply voltage or protective extra-low voltage to the output as desired.
- **Mains supply,** terminals N, PE, L or L1, L2, L3, PE.



* If an external supply source is used, there must be a connection to GND.

Fig. 154 Connection terminals, FM 300 (option)

Terminal	Type	Function
NC	Normally closed contact	Signal relay 1 LIVE or PELV
C1	Common	
NO	Normally open contact	
NC	Normally closed contact	Signal relay 2 PELV only
C2	Common	
NO	Normally open contact	
18	GND	Earth
11	DI4/OC2	Digital input/output, configurable. Open collector: Maximum 24 V resistive or inductive.
19	Pt100/1000 input 2	Pt100/1000 sensor input
17	Pt100/1000 input 1	Pt100/1000 sensor input
12	AO	Analog output: 0-20 mA / 4-20 mA 0-10 V
9	GND	Earth
14	AI3	Analog input: 0-20 mA / 4-20 mA 0-10 V
1	DI2	Digital input, configurable
21	LiqTec sensor input 1	LiqTec sensor input White conductor
20	GND	Earth Brown and black conductors
22	LiqTec sensor input 2	LiqTec sensor input Blue conductor
10	DI3/OC1	Digital input/output, configurable. Open collector: Maximum 24 V resistive or inductive.
4	AI1	Analog input: 0-20 mA / 4-20 mA 0.5 - 3.5 V / 0-5 V / 0-10 V
2	DI1	Digital input, configurable
5	+5 V	Supply to potentiometer and sensor
6	GND	Earth
A	GENIbus, A	GENIbus, A (+)
Y	GENIbus, Y	GENIbus, GND
B	GENIbus, B	GENIbus, B (-)
3	GND	Earth
15	+24 V	Supply
8	+24 V	Supply
26	+5 V	Supply to potentiometer and sensor
23	GND	Earth
25	GDS TX	Grundfos Digital Sensor output
24	GDS RX	Grundfos Digital Sensor input
7	AI2	Analog input: 0-20 mA / 4-20 mA 0.5 - 3.5 V / 0-5 V / 0-10 V

MGE motors, 15-22 kW, 2-pole and 11 - 18.5 kW, 4-pole

Grundfos MGE 100, MGE 112, MGE 132, MGE 160 and MGE 180 motors offer these features:

- Three-phase mains connection.
- Three-phase, asynchronous squirrel-cage induction motors designed to current IEC, DIN and VDE guidelines and standards. The motors incorporate a frequency converter and PI controller.
- Used for continuously variable speed control of Grundfos E-pumps available in power sizes 15-22 kW, 2-pole and 11 - 18.5 kW, 4-pole.

Supply voltage

3 x 380-480 V - 10 %/+ 10 %, 50/60 Hz, PE.

Backup fuse

Motor size [kW]	Maximum fuse [A]
11	26
15	36
18.5	43
22	51

You can use standard as well as quick-blow or slow-blow fuses.

Leakage current

Motor size [kW]	Leakage current [mA]
11-22	> 10

The leakage currents are measured in accordance with EN 61800-5-1.

Input/output

Start/stop

- External potential-free switch.
  Voltage: 5 VDC.
  Current: less than 5 mA.
  Screened cable: 0.5 - 1.5 mm^2, 28-16 AWG.

Digital input

- External potential-free switch.
  Voltage: 5 VDC.
  Current: less than 5 mA.
  Screened cable: 0.5 - 1.5 mm^2, 28-16 AWG.

Setpoint signals

- Potentiometer
  0-10 VDC, 10 kΩ via internal voltage supply.
  Screened cable: 0.5 - 1.5 mm^2, 28-16 AWG.
  Maximum cable length: 100 m.
- Voltage signal
  0-10 VDC, R_i greater than 50 kΩ.
  Tolerance: + 0 %/- 3 % at maximum voltage signal.
  Screened cable: 0.5 - 1.5 mm^2, 28-16 AWG.
  Maximum cable length: 500 m.
- Current signal
  DC 0-20 mA / 4-20 mA, R_i equal to 175 Ω.
  Tolerance: + 0 %/- 3 % at maximum current signal.
  Screened cable: 0.5 - 1.5 mm^2, 28-16 AWG.
  Maximum cable length: 500 m.

Sensor signals

- Voltage signal
  0-10 VDC, R_i greater than 50 kΩ (via internal voltage supply).
  Tolerance: + 0 %/- 3 % at maximum voltage signal.
  Screened cable: 0.5 - 1.5 mm^2, 28-16 AWG.
  Maximum cable length: 500 m.
- Current signal
  DC 0-20 mA / 4-20 mA, R_i equal to 175 Ω.
  Tolerance: + 0 %/- 3 % at maximum current signal.
  Screened cable: 0.5 - 1.5 mm^2, 28-16 AWG.
  Maximum cable length: 500 m.
- Power supply to sensor
  +24 VDC, maximum 40 mA.

Signal output

- Potential-free changeover contact.
  Maximum contact load: 250 VAC, 2 A.
  Minimum contact load: 5 VDC, 10 mA.
  Screened cable: 0.5 - 1.5 mm^2, 28-16 AWG.
  Maximum cable length: 500 m.

Bus input

Grundfos GENIbus protocol, RS-485.

Screened cable: 0.5 - 1.5 mm^2, 28-16 AWG.

Maximum cable length: 500 m.

EMC, electromagnetic compatibility to EN 61800-3

Motor [kW]	Emission/immunity
11 15 18.5 22	**Emission:** The motors are category C3, corresponding to CISPR11, group 2, class A, and may be installed in **industrial areas** (second environment). If fitted with an external Grundfos EMC filter, the motors are category C2, corresponding to CISPR11, group 1, class A, and may be installed in **residential areas** (first environment). **Note:** **When the motors are installed in residential areas, supplementary measures may be required as the motors may cause radio interference.** **Immunity:** The motors fulfil the requirements for both the first and second environment.

For further information about EMC, see section *11. Electromagnetic compatibility, EMC*.

Enclosure class

Standard: IP55 (IEC 34-5).

Insulation class

F (IEC 85).

Ambient temperature

During operation: -20 to 40 °C.

During storage or transport: -25 to 70 °C.

Relative humidity

Maximum 95 %.

Sound pressure level

Motor [kW]	Speed stated on the nameplate [min^{-1}]	Sound pressure level [dB(A)]
11	1400-1500	54
	1700-1800	59
15	1400-1500	54
	1700-1800	59
	2800-3000	65
	3400-3600	70
18.5	1400-1500	65
	1700-1800	69
	2800-3000	69
	3400-3600	74
22	2800-3000	73
	3400-3600	78

Motor protection

The motor requires no external motor protection. The motor incorporates thermal protection against slow overloading and blocking (TP 211 to IEC 34-11).

Additional protection

The residual-current circuit breaker must be marked with the following symbol:

The total leakage current of all the electrical equipment in the installation must be taken into account. You can find the leakage current of the motor in *Leakage current* on page 129.

This product can cause a direct current in the protective-earth conductor.

Overvoltage and undervoltage protection

Overvoltage and undervoltage may occur in case of unstable power supply or a faulty installation. The motor is stopped if the voltage falls outside the permissible voltage range. The motor restarts automatically when the voltage is again within the permissible voltage range. Therefore, no additional protection relay is required.

Note: The motor is protected against transients from the power supply according to EN 61800-3. In areas with high lightning intensity, we recommend external lightning protection.

Overload protection

If the upper load limit is exceeded, the motor automatically compensates for this by reducing the speed and stops if the overload condition persists.

The motor remains stopped for a set period. After this period, the motor automatically attempts to restart. The overload protection prevents damage to the motor. Consequently, no additional motor protection is required.

Overtemperature protection

The electronic unit has a built-in temperature sensor as an additional protection. When the temperature rises above a certain level, the motor automatically compensates for this by reducing the speed and stops if the temperature keeps rising. The motor remains stopped for a set period. After this period, the motor automatically attempts to restart.

Protection against phase unbalance

Three-phase motors must be connected to a power supply with a quality corresponding to IEC 60146-1-1, class C, to ensure correct motor operation at phase unbalance. This also ensures long life of the components.

Maximum number of starts and stops

The number of starts and stops via the power supply must not exceed four times per hour.

When switched on via the power supply, the pump starts after approximately 5 seconds.

If you want a higher number of starts and stops, use the input for external start-stop when starting or stopping the pump.

When you start the pump via an external on/off switch, the pump starts immediately.

Wiring diagram, 11-22 kW

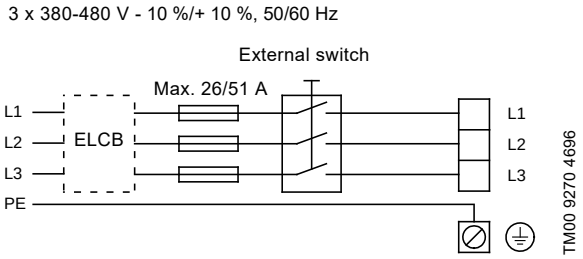


Fig. 155 Wiring diagram, three-phase MGE motors, 11-22 kW

Other connections

Note: As a precaution, the wires to be connected to the connection groups below must be separated from each other by reinforced insulation in their entire lengths.

Group 1: Inputs

- Start/stop, terminals 2 and 3
- digital input, terminals 1 and 9
- setpoint input, terminals 4, 5 and 6
- sensor input, terminals 7 and 8
- GENIbus, terminals B, Y and A.

All inputs (group 1) are internally separated from the mains-conducting parts by reinforced insulation and galvanically separated from other circuits.

All control terminals are supplied by protective extra-low voltage (PELV), thus ensuring protection against electric shock.

- **Group 2: Output** (relay signal, terminals NC, C, NO).
  The output (group 2) is galvanically separated from other circuits. Therefore, the supply voltage or protective extra-low voltage can be connected to the output as desired.
- **Group 3: Mains supply** (terminals L1, L2, L3).
  A galvanically safe separation must fulfil the requirements for reinforced insulation including creepage distances and clearances specified in EN 61800-5-1.

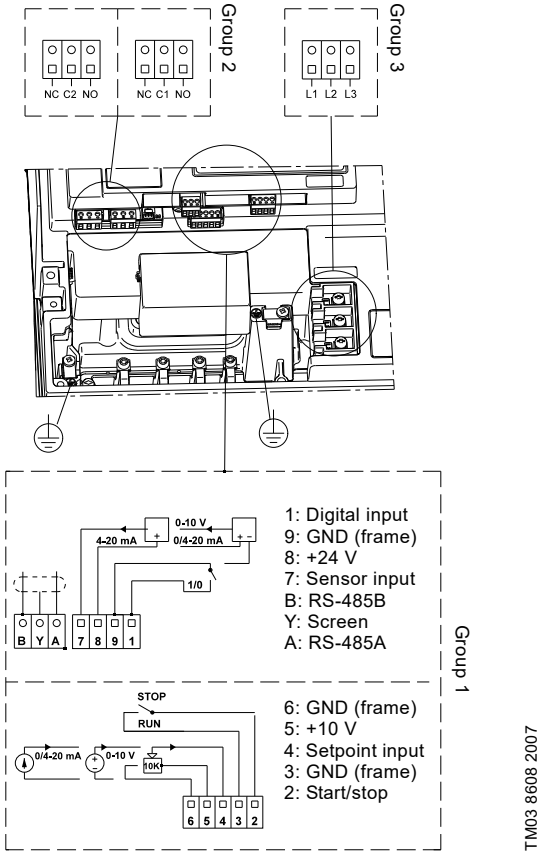


Fig. 156 Connection terminals

Identification of functional module

You can identify the module in one of the following ways:

Grundfos GO

Select the "Fitted modules" menu under "Status".

Pump display

If the pump is fitted with the advanced operating panel, select "Fitted modules" menu under "Status".

Motor nameplate

You can identify the fitted module on the motor nameplate. See fig. 157.

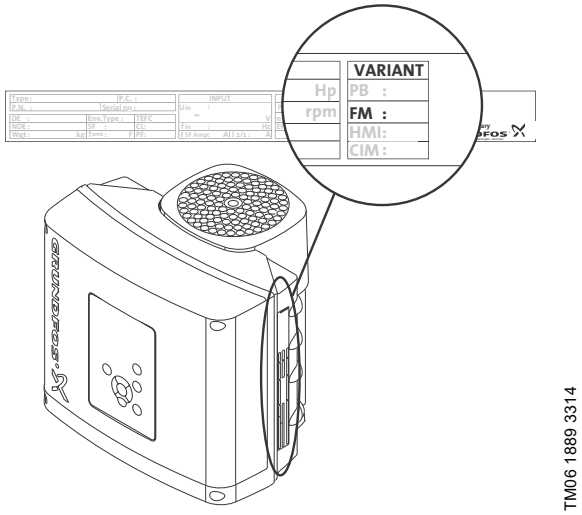


Fig. 157 Identification of functional module

Variant	Description
FM 200	Standard functional module
FM 300	Advanced functional module

11. Electromagnetic compatibility, EMC

Electromagnetic compatibility and proper installation

General information

The growing use of electric or electronic controls and electronic equipment including PLCs and computers within all business areas require these products to fulfil the existing standards within electromagnetic compatibility. Make sure that the equipment is mounted properly.

This section deals with these issues.

What is electromagnetic compatibility?

Electromagnetic compatibility is the ability of an electric or electronic device to function in a given electromagnetic environment without disturbing the surroundings and without being disturbed by other devices in the surroundings. Electromagnetic compatibility is normally split into emission and immunity.

Emission

Emission is defined as the electric or electromagnetic noise emitted by a device during operation and which can reduce the function of other devices or disturb various radio communications, including radio or TV.

Immunity

Immunity is the ability of a device to function in spite of the presence of electric or electromagnetic noise, such as sparking noise from contactors or high-frequency fields from various transmitters or mobile phones.

E-pumps and electromagnetic compatibility

All Grundfos E-pumps are CE- and C-tick-marked indicating that the product is designed to meet the EMC requirements defined by the European Union and Australia/New Zealand.

EMC and CE

All E-pumps fulfil the EMC directive 2004/108/EC and are tested according to standard EN 61800-3. All E-pumps are fitted with a radio-interference filter and varistors in the mains-supply input to protect the electronics against voltage peaks and noise present in the mains supply (immunity). At the same time, the filter limits the amount of electrical noise which the E-pump emits to the mains supply network (emission). All remaining inputs included in the electronic unit are also protected against peaks and noise which can damage or disturb the function of the unit.

On top of that, the mechanical and electronic designs are made in such a way that the unit can operate sufficiently under a certain level of radiated electromagnetic disturbance.

The limits which the E-pumps are tested against are listed in standard EN 61800-3.

Where to install E-pumps?

You can use all E-pumps with MGE motors in both residential areas (first environment) and industrial areas (second environment) within certain limitations.

What is meant by the first and the second environment?

The first environment, residential areas, includes establishments directly connected to a low-voltage power supply network which supplies domestic buildings.

The second environment, industrial areas, includes establishments which are not connected to a low-voltage network that supplies domestic buildings.

The level of electromagnetic disturbance can be much higher than in the first environment.

EMC and C-tick

All E-pumps marked with the C-tick logo fulfil the requirements for EMC in Australia and New Zealand.

The C-tick approval is based on the EN standards, and the units are therefore tested according to the European standard EN 61800-3.

Only E-pumps with MGE motors are marked with C-tick.

The C-tick only covers emission.

Electromagnetic compatibility and proper installation

With the CE and C-tick marks, the E-pumps live up to and have been tested to meet specific EMC requirements. This, however, does not mean that E-pumps are immune to all the sources of noise to which they can be exposed in practice. In some installations, the impact may exceed the level to which the product is designed and tested.

Furthermore, unproblematic operation in a noisy environment presupposes that the installation of the E-pump is made properly.

Below you will find a description of a correct E-pump installation.

Connection of mains supply in MGE

Practice shows that large cable loops are often made inside the terminal box to get some "spare cable". Of course, this can be useful. However, with regard to electromagnetic compatibility, it is a poor solution as these cable loops will function as antennas inside the terminal box.

To avoid problems with electromagnetic compatibility, the mains supply cable and its individual conductors in the terminal box of the E-pump must be as short as possible. If required, you can establish a spare cable outside the E-pump.

12. Certificates and reports

Grundfos offers a number of certificates and reports.

When a customer wants a certificate or a report, the request must be stated on the order.

The certificate or report will then be put onto the bill of materials and thus included in the product number of the pump.

Certificates or reports have to be confirmed for every order.

The certificate or report is to be ordered with the product number mentioned below.

Short description	Standard	Example
Certificate of compliance with the order	EN 10204 - 2.1	
Grundfos document certifying that the pump supplied is in compliance with the order specifications.		See page 136
Test certificate - Non-specific inspection and testing	EN 10204 - 2.2	
Certificate with inspection and test results of a non-specific pump		See page 136
Inspection certificate - Grundfos authorized department	EN 10204 - 3.1	
Grundfos document certifying that the pump supplied is in compliance with the order specifications. Inspection and test results are mentioned in the certificate.		See page 136
Inspection certificate - External classifying society	EN 10204 - 3.2	
Grundfos document certifying that the pump supplied is in compliance with the order specifications. Inspection and test results are mentioned in the certificate. Certificate from the surveyor is included:		
Lloyds Register EMEA (LR)	3.2	See page 136
Inspection certificate DNV-GL	3.2	See page 137
Bureau Veritas (BV)	3.2	See page 137
American Bureau of Shipping (ABS)	3.2	See page 137
Registro Italiano Navale Agenture (RINA)	3.2	See page 138
China Class. Society (CCS)	3.2	See page 138
Russian Maritime Register (RS)	3.2	See page 138
Biro Klas. Indonesia (BKI)	3.2	See page 138
United States Coast Guard (USCG)	3.2	See page 139
Nippon Kaiji Koykai (NKK)	3.2	See page 139
Pump performance - Curve test report	ISO 9906:2012	
Performance curve test report - Grade 3B		See page 140
Pump performance - Duty point verification report	ISO 9906:2012	
Duty point verification report - Grade 3B, Q&H		
Duty point verification report - Grade 3B, Q&H + Eta total		
Duty point verification report - Grade 3B, Q&H + P1		
Duty point verification report - Grade 2B, Q&H		
Duty point verification report - Grade 2B, Q&H + Eta total		
Duty point verification report - Grade 2B, Q&H + P1		
Duty point verification report - Grade 2U, Q&H		
Duty point verification report - Grade 2U, Q&H + Eta total		
Duty point verification report - Grade 2U, Q&H + P1		
Duty point verification report - Grade 1B, Q&H		
Duty point verification report - Grade 1B, Q&H + Eta total		See page 141
Duty point verification report - Grade 1B, Q&H + P1		
Duty point verification report - Grade 1E, Q&H		
Duty point verification report - Grade 1E, Q&H + Eta total		
Duty point verification report - Grade 1E, Q&H + P1		
Duty point verification report - Grade 1U, Q&H		
Duty point verification report - Grade 1U, Q&H + Eta total		
Duty point verification report - Grade 1U, Q&H + P1		
Other certificates/Reports		
Material specification report		See page 142
Material specification report + certificate from raw material supplier		See page 142
ATEX approved pump report		See page 142
PWIS-free certificate		See page 142
Vibration report	ISO 5199	See page 143
Vibration report	ISO 10816	See page 143
Impeller balancing report Grade 6.3	ISO 1940	See page 143

Examples of certificates

Certificate of compliance with the order

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Certificate of compliance with the order

EN 10204 2.1

Customer name	
Customer order no.	
Customer Tag no.	
GRUNDFOS order no.	
Product type	

We the undersigned hereby guarantee and certify that the materials and/or parts for the above mentioned product were manufactured, tested, inspected, and conform to the full requirements of the appropriate catalogues, drawings and/or specifications relative thereto.

GRUNDFOS
Date:

Signature:
Name:
Dept.:

Part no. 96 50 78 95/PMI/000/1135258

96507895

Test certificate

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Test certificate
Non-specific inspection and testing

EN 10204 2.2

Customer name	
Customer order no.	
Customer TAG no.	
GRUNDFOS order no.	

Pump		
Pump type		Part number
Motor make		Part number
Flow	m^3/h	
Head	m	
Max. operating pressure	bar	
Max. operating temperature	°C	
Power P2	kW	
Voltage	V	
Frequency	Hz	
Full load current	A	
Motor speed	min^{-1}	

We the undersigned hereby guarantee and certify that the materials and/or parts for the above mentioned product were manufactured, tested*1, inspected, and conform to the full requirements of the appropriate catalogues, drawings and / or specifications relative thereto.

*1) Cleaned and dried pumps and PWIS free pumps are not performance tested.

GRUNDFOS
Date:

Signature:
Name:
Dept.:

Part no. 96 50 78 96/PMI/ 000/1135258

96507896

Inspection certificate

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Inspection certificate.
EN 10204 3.1

Manufactured by	
GRUNDFOS order no.	
GRUNDFOS DUT id.	
Customer order no.	
Customer name and address	
Shipyard / factory	
Ship / new building	
Customer TAG no.	
Classifying society	**GRUNDFOS authorized department**

Pump		Motor	
Pump type		Make	
Part number		Part number	
Serial no.		Serial No.	
Flow rate (m^3/h)		P2 (kW)	
Head (m)		Voltage (V)	
Max. ope. P/t (bar / °C)		Current (A)	
	Din / W. - No.	$n(min^{-1})$	
Base/Pump head cover		Frequency (Hz)	
Impeller/guidevanes		Insulation class	
Shaft/sleeve		Power factor	

Customer's requirements			
Flow rate (m^3/h)		Head (m)	

Test result ref. requirements									
Q(m^3/h)		H(m)		$n(min^{-1})$		I(A)		P1(kW)	

Hydrostatic test		Bar – no leaks or deformation observed

GRUNDFOS
Date:

Signature:
Name:
Dept.:

Part no. 96 50 78 97/PMI/000/1135258

96507897

Inspection certificate _ Lloyds Register EMEA

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Inspection certificate.
Lloyds Register EMEA

Manufactured by	
GRUNDFOS order no.	
GRUNDFOS DUT id.	
Customer order no.	
Customer name and address	
Shipyard / factory	
Ship / new building	
Customer TAG no.	
Classifying society	**Lloyds Register EMEA (LR)**

Pump		Motor	
Pump type		Make	
Part number		Part number	
Serial no.		Serial No.	
Flow rate (m^3/h)		P2 (kW)	
Head (m)		Voltage (V)	
Max. ope. P/t (bar / °C)		Current (A)	
Service		$n(min^{-1})$	
Medium		Frequency (Hz)	
	Din / W. - No.	Insulation class	
Base/Pump head cover		Power factor	
Impeller/guidevanes			
Shaft/sleeve			

Customer's requirements			
Flow rate (m^3/h)		Head (m)	

Test result ref. requirements									
Q(m^3/h)		H(m)		$n(min^{-1})$		I(A)		P1(kW)	

Hydrostatic test		Bar – no leaks or deformation observed
The pump has been marked		

Surveyor signature:
Tested date:

GRUNDFOS
Date:

Signature:
Name:
Dept.:

Part no. 96 50 78 98/PMI/000/1135258

96507898

Inspection certificate - DNV-GL

Inspection Certificate

DNV-GL

General Info			
Customer name			
Customer order no.		GRUNDFOS order no.	
Customer TAG no.		Certificate No.	
Ship / new building			
Shipyard / factory			

Pump		Motor	
Pump type		Make	
Part No.		Part No.	
Serial No.		Serial No.	
Model		P2 [kW]	
Flow rate [m³/h]		Voltage [V]	
Head [m]		Current [A]	
Max. liquid temp [°C]		Motor speed [min-1]	
Max. opr. Press. [bar]		Frequency [Hz]	
Stamping ID		IP code	
		Max. temp. amb. [°C]	

Part according to EN 10204 - 3.1

Part	Raw material Grundfos PN	Raw material grade and standard	Vendor	Heat / Charge No.
Pump head				
Pump head cover*				
Base				
Sleeve				
Pump head*				
Seal chamber**				
THD flange***				
Blind cover (THD)***				

*) Only for CR(I/N) Back to Back, Tandem, Air cooled top
**) Only for CR(I/N) MagDrive ("Pump head cover" removed and "Pump head" included)
***) Only for CR(N) 95, 125, 155, 185, 215, 255 with base prepared for THD

Part according to EN 10204 - 2.2

Part	Material type	Raw material grade acc. to standard
Shaft		
Impeller		
Chamber		

Operational function			
Media		Application	

Required duty point			
Flow rate [m³/h]		Head [m]	

Test performance
Result of tests are attached. See test point

Declaration of compliance for the Class Society Rules
DNV GL rules for classification: Ships (RU-SHIP), Part 4

GRUNDFOS
Date:
Signature:
Name:
Dept.:

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Part no. 99171231/PMI/000/ 1249889

99171231

Inspection certificate - Bureau Veritas

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Inspection certificate.

Manufactured by	
GRUNDFOS order no.	
GRUNDFOS DUT id.	
Customer order no.	
Customer name and address	
Shipyard / factory	
Ship / new building	
Customer TAG no.	
Classifying society	**Bureau Veritas (BV)**

Pump		Motor	
Pump type		Make	
Part number		Part number	
Serial no.		Serial No.	
Flow rate (m³/h)		P2 (kW)	
Head (m)		Voltage (V)	
Max. ope. P/t (bar / °C)		Current (A)	
Service		n(min-1)	
Medium		Frequency (Hz)	
	Din / W. - No.	Insulation class	
Base/Pump head cover		Power factor	
Impeller/guidevanes			
Shaft/sleeve			

Customer's requirements			
Flow rate (m³/h)		Head (m)	

Test result ref. requirements									
Q(m³/h)		H(m)		n(min-1)		I(A)		P1(kW)	

Hydrostatic test		Bar – no leaks or deformation observed

The pump has been marked	

Surveyor signature: _____
Tested date: _____

GRUNDFOS
Date:
Signature:
Name:
Dept.:

Part no. 96 50 79 21/PMI/000/1135258

96507921

Inspection certificate - American Bureau of Shipping

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Inspection certificate.

American Bureau of Shipping

Manufactured by	
GRUNDFOS order no.	
GRUNDFOS DUT id.	
Customer order no.	
Customer name and address	
Shipyard / factory	
Ship / new building	
Customer TAG no.	
Classifying society	**American Bureau of Shipping (ABS)**

Pump		Motor	
Pump type		Make	
Part number		Part number	
Serial no.		Serial No.	
Flow rate (m³/h)		P2 (kW)	
Head (m)		Voltage (V)	
Max. ope. P/t (bar / °C)		Current (A)	
Service		n(min-1)	
Medium		Frequency (Hz)	
	Din / W. - No.	Insulation class	
Base/Pump head cover		Power factor	
Impeller/guidevanes			
Shaft/sleeve			

Customer's requirements			
Flow rate (m³/h)		Head (m)	

Test result ref. requirements									
Q(m³/h)		H(m)		n(min-1)		I(A)		P1(kW)	

Hydrostatic test		Bar – no leaks or deformation observed

The pump has been marked	

Surveyor signature: _____
Tested date: _____

GRUNDFOS
Date:
Signature:
Name:
Dept.:

Part no. 96 50 79 22/PMI/000/1135258

96507922

Inspection certificate - Registro Italiano Navale Agenture

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Inspection certificate.
Registro Italiano Navale Agenture

Manufactured by	
GRUNDFOS order no.	
GRUNDFOS DUT id.	
Customer order no.	
Customer name and address	
Shipyard / factory	
Ship / new building	
Customer TAG no.	
Classifying society	**Registro Italiano Navale Agenture (RINA)**

Pump		**Motor**	
Pump type		Make	
Part number		Part number	
Serial no.		Serial No.	
Flow rate (m^3/h)		P2 (kW)	
Head (m)		Voltage (V)	
Max. ope. P/t (bar / °C)		Current (A)	
Service		n(min^{-1})	
Medium		Frequency (Hz)	
	Din / W. - No.	Insulation class	
Base/Pump head cover		Power factor	
Impeller/guidevanes			
Shaft/sleeve			

Customer's requirements			
Flow rate (m^3/h)		Head (m)	

Test result ref. requirements									
Q(m^3/h)		H(m)		n(min^{-1})		I(A)		P1(kW)	

Hydrostatic test		Bar – no leaks or deformation observed

The pump has been marked	

Surveyor signature:
Tested date:

GRUNDFOS
Date:
Signature:
Name:
Dept.:

Part no. 96 50 79 23/PMI/000/1135258

96507923

Inspection certificate - China Classification Society

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Inspection certificate

Manufactured by	
GRUNDFOS order no.	
GRUNDFOS DUT id.	
Customer order no.	
Customer name and address	
Shipyard / factory	
Ship / new building	
Customer TAG no.	
Classifying society	**China Classification Society (CCS)**

Pump		**Motor**	
Pump type		Make	
Part number		Part number	
Serial no.		Serial No.	
Flow rate (m^3/h)		P2 (kW)	
Head (m)		Voltage (V)	
Max. ope. P/t (bar / °C)		Current (A)	
Service		n(min^{-1})	
Medium		Frequency (Hz)	
	Din / W. - No.	Insulation class	
Base/Pump head cover		Power factor	
Impeller/guidevanes			
Shaft/sleeve			

Customer's requirements			
Flow rate (m^3/h)		Head (m)	

Test result ref. requirements									
Q(m^3/h)		H(m)		n(min^{-1})		I(A)		P1(kW)	

Hydrostatic test		Bar – no leaks or deformation observed

The pump has been marked	

NOTE: The mentioned pump has been manufactured and tested in accordance with requirements' and rules of CCS.

Surveyor signature:
Tested date:

GRUNDFOS
Date:
Signature:
Name:
Dept.:

Part no. 96507924/PMI/000/1135258

96507924

Inspection certificate - Russian Maritime Register of Shipping

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Inspection certificate
Russian Maritime Register of Shipping

Manufactured by	
GRUNDFOS order no.	
GRUNDFOS DUT id.	
Customer order no.	
Customer name and address	
Shipyard / factory	
Ship / new building	
Customer TAG no.	
Classifying society	**Russian Maritime Register of Shipping (RS)**

Pump		**Motor**	
Pump type		Make	
Part number		Part number	
Serial no.		Serial No.	
Flow rate (m^3/h)		P2 (kW)	
Head (m)		Voltage (V)	
Max. ope. P/t (bar / °C)		Current (A)	
Service		n(min^{-1})	
Medium		Frequency (Hz)	
	Din / W. - No.	Insulation class	
Base/Pump head cover		Power factor	
Impeller/guidevanes			
Shaft/sleeve			

Customer's requirements			
Flow rate (m^3/h)		Head (m)	

Test result ref. requirements									
Q(m^3/h)		H(m)		n(min^{-1})		I(A)		P1(kW)	

Hydrostatic test		Bar – no leaks or deformation observed

The pump has been marked	

Surveyor signature:
Tested date:

GRUNDFOS
Date:
Signature:
Name:
Dept.:

Part no. 96 50 79 25/PMI/000/1135258

96507925

Inspection certificate - Biro Klassifikasio Indonesia

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Inspection certificate
Biro Klassifikasio Indonesia

Manufactured by	
GRUNDFOS order no.	
GRUNDFOS DUT id.	
Customer order no.	
Customer name and address	
Shipyard / factory	
Ship / new building	
Customer TAG no.	
Classifying society	**GL on behalf of Biro Klassfikasio Indonesia (BKI)**

Pump		**Motor**	
Pump type		Make	
Part number		Part number	
Serial no.		Serial No.	
Flow rate (m^3/h)		P2 (kW)	
Head (m)		Voltage (V)	
Max. ope. P/t (bar / °C)		Current (A)	
Service		n(min^{-1})	
Medium		Frequency (Hz)	
	Din / W. - No.	Insulation class	
Base/Pump head cover		Power factor	
Impeller/guidevanes			
Shaft/sleeve			

Customer's requirements			
Flow rate (m^3/h)		Head (m)	

Test result ref. requirements									
Q(m^3/h)		H(m)		n(min^{-1})		I(A)		P1(kW)	

Hydrostatic test		Bar – no leaks or deformation observed

The pump has been marked	

Surveyor signature:
Tested date:

GRUNDFOS
Date:
Signature:
Name:
Dept.:

Part no. 96 50 79 26/PMI/000/1135258

96507926

Inspection certificate - United States Coast Guard

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Inspection certificate
United States Coast Guard

Manufactured by	
GRUNDFOS order no.	
GRUNDFOS DUT id.	
Customer order no.	
Customer name and address	
Shipyard / factory	
Ship / new building	
Customer TAG no.	
Classifying society	**ABS on behalf of US Coast Guard (USCG)**

Pump		**Motor**	
Pump type		Make	
Part number		Part number	
Serial no.		Serial No.	
Flow rate (m^3/h)		P2 (kW)	
Head (m)		Voltage (V)	
Max. ope. P/t (bar / °C)		Current (A)	
Service		n(min^{-1})	
Medium		Frequency (Hz)	
	Din / W. - No.	Insulation class	
Base/Pump head cover		Power factor	
Impeller/guidevanes			
Shaft/sleeve			

Customer's requirements			
Flow rate (m^3/h)		Head (m)	

Test result ref. requirements									
Q(m^3/h)		H(m)		n(min^{-1})		I(A)		P1(kW)	

Hydrostatic test		Bar – no leaks or deformation observed

The pump has been marked	

Surveyor signature: _____
Tested date: _____

GRUNDFOS
Date:

Signature:
Name:
Dept.:

Part no. 96 50 79 27/PMI/000/1135258

96507927

Inspection certificate - Nippon Kaiji Koykai

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Inspection certificate
Nippon Kaiji Koykai

Manufactured by	
GRUNDFOS order no.	
GRUNDFOS DUT id.	
Customer order no.	
Customer name and address	
Shipyard / factory	
Ship / new building	
Customer TAG no.	
Classifying society	**Nippon Kaiji Koykai (NKK)**

Pump		**Motor**	
Pump type		Make	
Part number		Part number	
Serial no.		Serial No.	
Flow rate (m^3/h)		P2 (kW)	
Head (m)		Voltage (V)	
Max. ope. P/t (bar / °C)		Current (A)	
Service		n(min^{-1})	
Medium		Frequency (Hz)	
	Din / W. - No.	Insulation class	
Base/Pump head cover		Power factor	
Impeller/guidevanes			
Shaft/sleeve			
Drawing number			

Customer's requirements			
Flow rate (m^3/h)		Head (m)	

Test result ref. requirements									
Q(m^3/h)		H(m)		n(min^{-1})		I(A)		P1(kW)	

Hydrostatic test		Bar – no leaks or deformation observed

The pump has been marked	

Surveyor signature: _____
Tested date: _____

GRUNDFOS
Date:

Signature:
Name:
Dept.:

Part no. 96 53 11 08/PMI/000/1135258

96531108

Curve test report

Test Report - Performance curve

ISO 9906:2012 Grade 3B

General Info			
Customer name			
Customer order no.			
Customer TAG no.			
GRUNDFOS order no.			
Pump type		Part number	
Serial number		Model	

We the undersigned hereby guarantee and certify that the materials and/or parts for the above mentioned product were manufactured by GRUNDFOS, tested, inspected, and conform to the full requirements of the appropriate catalogues, drawings and/or specifications relative thereto.

The attached test result is from the above mentioned pump.

GRUNDFOS
Date:

Signature:
Name:
Dept.:

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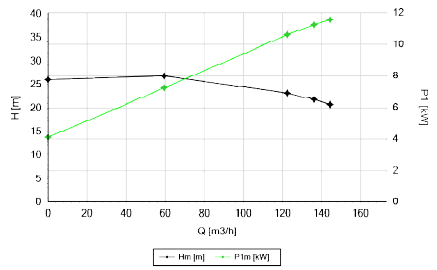
Part no. 96507930/PMI/000/1250007

96507930

Measured values for tested pump



Result	Qm [m3/h]	Hm [m]	n [1/min]	η_total [%]	p_diff [bar]	t_media [°C]
Point 1	144.39	20.76	1485	70	1.84	25.5
Point 2	136.16	21.79	1486	72	1.96	25.5
Point 3	122.46	23.15	1487	72	2.13	25.5
Point 4	59.38	26.80	1491	60	2.59	25.5
Point 5	0.00	26.01	1495	0	2.54	25.5

Result	U1 [V]	U2 [V]	U3 [V]	f [Hz]	I_Avg [A]	I1 [A]	I2 [A]	I3 [A]	Cos(ϕ)	P1m [kW]
Point 1	400.5	400.4	400.7	50	20.97	21.02	20.95	20.95	0.79	11.57
Point 2	400.6	400.5	400.8	50	20.54	20.59	20.55	20.48	0.79	11.24
Point 3	400.8	400.6	400.8	50	19.68	19.72	19.7	19.62	0.78	10.62
Point 4	400.6	400.4	400.6	50	15.3	15.35	15.29	15.25	0.68	7.24
Point 5	400.5	400.1	400.4	50	12.06	12.14	12.01	12.02	0.49	4.12

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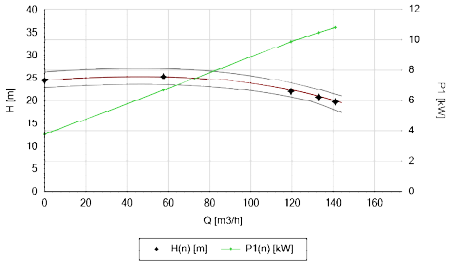
Measured values calculated to nominal speed n_nom



Result	Q(n) [m3/h]	H(n) [m]	P1(n) [kW]	n_nom [1/min]
Point 1	141.00	19.78	10.78	1450
Point 2	132.90	20.75	10.46	1450
Point 3	119.40	22.02	9.87	1450
Point 4	57.70	25.34	6.66	1450
Point 5	0.00	24.47	3.76	1450

Static High Pressure Test

A static pressure test was performed at 24.07 bar

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Explanation

Measured values

U	Voltage	Cos(ϕ)	Power factor
f	Frequency	n	Speed
I_Avg	Average current		
Qm	Measured flow	T_media	Water temperature
Hm	Measured Total Head	P_diff	Differential Pressure
P1m	Measured Motor Power Input	Q_cooling	Cooling Water Flow

Calculated values

Q(n)	Flow at nominal speed	η_total	Total Efficiency
H(n)	Total Head at nominal speed	η_pump	Pump efficiency
P1(n)	Motor Power Input at norminal speed		

Formulas

Q(n)	Qm x (n_nom/n)	H	Head_Sta + Head_Dyn + Head_Geo + Head_J
H(n)	Hm x (n_nom/n)²	Head_Static	Static Pressure head
P1(n)	P1m x (n_nom/n)³	Head_Dyn	Dynamic head
η_total	(p x Qm x Hm x g) / P1m	Head_Geo	Geometric elevation head
η_pump	η_total / η_motor	Head_J	Friction head

Legend and test conditions

- Measurements were made with airless water at approximately 20 °C (63 °F) and a kinematic viscosity of 1 mm²/s (= 1.076 × 10-5 ft²/s = 1 cSt).
- The testbed is constructed and calibrated according to requirements in ISO 9906.

Test Facility

Company	Grundfos Manufacturing Hungary Ltd.
Address	Holland fasor 15.
City	Székesfehérvár
ZIP Code	H8000
Country	Hungary
Phone	Phone:(+36) 22 801 801
Website	www.grundfos.com

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Duty point verification report

Test Report - Duty point verification

ISO 9906:2012 Grade 1B, Q&H + Eta total

General Info			
Customer name			
Customer order no.			
Customer TAG no.			
GRUNDFOS order no.			
Pump type		Part number	
Serial number		Model	

We the undersigned hereby guarantee and certify that the materials and/or parts for the above mentioned product were manufactured by GRUNDFOS, tested, inspected, and conform to the full requirements of the appropriate catalogues, drawings and/or specifications relative thereto.

The attached test result is from the above mentioned pump.

GRUNDFOS
Date:

Signature:
Name:
Dept.:

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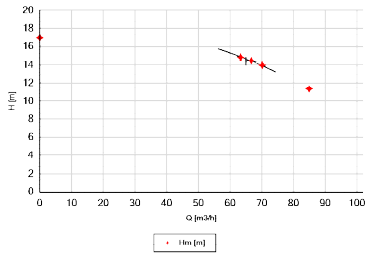
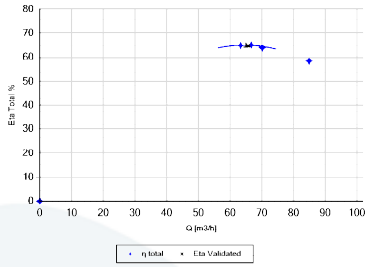
Part no. 99542673/PMI/000/1250007

99542673

Measured values for tested pump





Result	Qm [m3/h]	Hm [m]	n [1/min]	η_total [%]
Point 1	84.92	11.37	1468	58
Point 2	70.14	13.96	1471	64
Point 3	66.69	14.44	1472	65
Point 4	63.33	14.81	1473	65
Point 5	0.00	16.93	1488	0

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Result	U1 [V]	f [Hz]	I_Avg [A]	Cos(ϕ)	P1m [kW]
Point 1	400.1	50	8.03	0.81	4.49
Point 2	400.5	50	7.44	0.79	4.17
Point 3	400.5	50	7.30	0.78	4.02
Point 4	400.3	50	7.18	0.78	3.93
Point 5	400.9	50	4.56	0.55	2.45

Summary of verification

	Guaranteed values	Test Result	ISO 9906:2012 Grade 1B Lower	ISO 9906:2012 Grade 1B Upper
Flow [m3/h]	65.00	66.69	61.75	68.25
Head [m]	14.40	14.44	13.97	14.83
Eta [%]	66.00	64.73	64.02	

Static High Pressure Test

A static pressure test was performed at 24.13 bar

Explanation

Measured values

U	Voltage	Cos(ϕ)	Power factor
f	Frequency	n	Speed
I_Avg	Average current		
Qm	Measured flow	T_media	Water temperature
Hm	Measured Total Head	P_diff	Differential Pressure
P1m	Measured Motor Power Input	Q_cooling	Cooling Water Flow

Calculated values

Q(n)	Flow at nominal speed	η_total	Total Efficiency
H(n)	Total Head at nominal speed	η_pump	Pump efficiency
P1(n)	Motor Power Input at nominal speed		

Formulas

Q(n)	Qm x (n_nom/n)	H	Head_Sta + Head_Dyn + Head_Geo + Head_J
H(n)	Hm x (n_nom/n)²	Head_Static	Static Pressure head
P1(n)	P1m x (n_nom/n)³	Head_Dyn	Dynamic head
η_total	(p x Qm x Hm x g) / P1m	Head_Geo	Geometric elevation head
η_pump	η_total / η_motor	Head_J	Friction head

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Legend and test conditions

This verification of Duty Point test complies with ISO 9906:2012, section 4.4

- The black cross indicates the guaranteed Duty Point and its associated tolerances.
  The curve is a best fit QH curve based on the test result.
  If the best fit curve intersects the cross, then the Duty Point test has been successfully verified.
- Measurements were made with airless water at approximately 20 °C (63 °F) and a kinematic viscosity of 1 mm²/s (= 1.076 × 10-5 ft²/s = 1 cSt).
- The testbed is constructed and calibrated according to requirements in ISO 9906.

Test Facility

Company	Grundfos Manufacturing Hungary Ltd.
Address	Holland fasor 15.
City	Székesfehérvár
ZIP Code	H8000
Country	Hungary
Phone	Phone:(+36) 22 801 801
Website	www.grundfos.com

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Material specification report

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Material specification report

Customer name	
Customer order no.	
Customer TAG no.	
GRUNDFOS order no.	
Pump type	
GRUNDFOS DUT id.	
Part number	

Pump	Materials	DIN W.-Nr.	AISI / ASTM
Pump head			
Pump head cover			
Shaft			
Impeller			
Chamber			
Outer sleeve			
Base			

We the undersigned hereby guarantee and certify that the materials and/or parts for the above mentioned product were manufactured, tested, inspected, and conform to the full requirements of the appropriate catalogues, drawings and/or specifications relative thereto.

GRUNDFOS
Date:

Signature:
Name:
Dept.:

Part no 96 50 79 28/PMI/000/1135258

96507928

Material specification report with certificate from raw material supplier

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Material specification report with EN10204 material certificate from raw materiel supplier

Customer name	
Customer order no.	
Customer TAG no.	
GRUNDFOS order no.	
Pump type	
GRUNDFOS DUT id.	
Part number	

Pump part	EN 10204: 3.1	2.2	Raw material no.	Raw material standard	Supplier certificate no. / heat no.
Pump head					
Pump head cover					
Base					
Outer sleeve					
Shaft					
Impeller					
Chamber					

We the undersigned hereby guarantee and certify that the materials and/or parts for the above mentioned product were manufactured, tested, inspected, and conform to the full requirements of the appropriate catalogues, drawings and/or specifications relative thereto.

GRUNDFOS
Date:

Signature:
Name:
Dept.:

Part no. 96507929/PMI/000/1135258

96507929

ATEX-approved pump report

be think innovate GRUNDFOS

ATEX-approved pump

Customer name	
Customer order no.	
Customer TAG no.	
GRUNDFOS order no.	
Pump type	
GRUNDFOS DUT id.	
Part number	
Production code	
Pump serial no.	
Motor serial no.	
ATEX approval of pump	
Technical file no.	

GRUNDFOS hereby confirms that the pump mentioned above is manufactured according the ATEX directive. This means the pump is conformity with the ATEX 94/9EEC (ATEX 100) appendix VIII directive as mentioned in the "ATEX Supplement to installation and operating instructions" supplied with the pump.

GRUNDFOS
Date:

Signature:
Name:
Dept.:

Part no. 96512240/PMI/000/1135258

96512240

Certificate of PWIS-free pump

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Certificate of PWIS-free pump

PWIS: (Paint Wetting Impairment Substances)

Customer name	
Customer order no.	
Customer TAG no.	
GRUNDFOS order no.	
Pump type	
GRUNDFOS DUT id.	
Part number	
Production code	

GRUNDFOS hereby confirms that the pump mentioned above is manufactured according to the specifications mentioned in below:

- All components of the pump including shaft seal, motor, rubber materials for shaft seal, do not contain PWIS, or release PWIS.
- Consumables for assembly, like lubricants, soapy water, sprays, etc., do not contain PWIS.
- Tools for assembly do not contain PWIS, or release PWIS.
- The product is tested in the normal production test equipment.
- Finished product is packed in closed packages or wrapped in PWIS free plastic wraps/bag before being packed for shipment

GRUNDFOS
Date:

Signature:
Name:
Dept.:

Part no 98 53 55 93/1134832

98535593

Vibration report - ISO 5199

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GRUNDFOS

Vibration report for NB/NK

According to ISO 5199

Customer name	
Customer order no.	
Customer TAG no.	
GRUNDFOS order no.	
GRUNDFOS DUT id.	

Measured object			
Pump type		Part number	
P2 (kW)		Frequency (Hz)	
Number of poles		Serial no.	

Test conditions					
The pump is floor-mounted on vibration absorbers.	Voltage (V)		Frequency: (Hz)		
	Flow (m³/h)		Head (m)		
	For vibration velocity measurement positions, see figure.				

Remarks	

Pump arrangement	Pump type	Maximum values of r.m.s. vibration velocity (mm/s)	
Pump with rigid support	Horizontal pumps	5.5	6.3
Pump with flexible support	Horizontal pumps	4.5	7.1

Result of measurement:

Pos	RMS vibration velocity (mm/s)
X	
Y	
Z	

GRUNDFOS
Date: 25-Nov-14

Signature:
Name:
Dept.:

Part no 98443849/ECM1110596

98443849

Vibration report - ISO 10186

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GRUNDFOS

Vibration report

According to ISO 10816

Customer name	
Customer order no.	
Customer TAG no.	
GRUNDFOS order no.	
GRUNDFOS DUT id.	

Measured object			
Pump type		Part number	
P2 (kW)		Frequency (Hz)	
Number of poles		Serial no.	

Test conditions					
The pump is floor-mounted on vibration absorbers.	Voltage (V)		Frequency: (Hz)		
	Flow (m³/h)		Head (m)		
	For vibration velocity measurement positions, see figure.				

Remarks	

Result of measurement:

Pos	RMS vibration velocity (mm/s)
X	
Y	
Z	

Typical zone boundary limits

RMS vibration velocity (mm/s)	Class I	Class II
0.28	A	A
0.45		
0.71		
1.12	B	B
1.8		
2.8	C	C
4.5		
7.1	D	D
11.2		
18		
28		
45		

The machine classifications are as follows:
Class I: Individual parts of engines and machines, integrally connected to the complete machine in its normal operating condition. (Production electrical motors of up to 15 kW are typical examples of machines in this category.)

Class II: Medium-sized machines (typically electrical motors with 15 kW to 75 kW output) without special foundations, rigidly mounted engines or machines (up to 300 kW) on special foundations.

GRUNDFOS
Date: 27-Nov-14

Signature:
Name:
Dept.:

Part no 96 50 79 32/PMI/000/1135258

96507932

Impeller balancing report Grade 6.3

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GRUNDFOS

Certificate

Static Impeller Balancing
According to ISO 1940 Grade 6.3

General info	
Customer name	
Customer order no.	
Customer Tag no.	
GRUNDFOS order no.	
Product type	
GRUNDFOS DUT id.	
Part number	

We the undersigned hereby guarantee and certify that the impeller of the pump has been statically balanced and accepted according to ISO 1940 Grade 6.3.

Impeller Balancing	Machinery (examples)	Balance quality grade G	Magnitude [$^{\prime}$per $\cdot\Omega$ mm/s]
 The balancing is carried out on the backside of the impeller.	Crankshaft drives, inherently unbalanced, rigidly mounted	G 250	250
	Complete reciprocating engines for cars, trucks and locomotives	G 100	100
	Cars: wheels, wheel rims, wheel sets, drive shafts Crankshaft drives, inherently balanced, elastically mounted	G 40	40
	Agricultural machinery Crankshaft drives, inherently balanced, rigidly mounted Crushing machines	G 16	16
	Aircraft gas turbines Centrifuges (separators, decanters) Electric motors of shaft heights smaller than 80 mm Fans Machinery, general Machine-tools Process plant machines **Pumps** Turbo-chargers Water turbines	G 6.3	6,3
	Compressors Computer drives Gas turbines and steam turbines Machine-tool drives Textile machines	G 2.5	2,5
	Audio and video drives	G 1	1
	Gyroscopes	G 0.4	0,4

GRUNDFOS
Date:

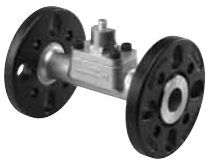
Signature:
Name:
Dept.:

Part No.: 99508316/PMI/000/1242402

99508316

13. Accessories

Grundfos sensors

Grundfos vortex flow sensor, VFI[1]	Type	Flow range [m³/h]	Pipe connection	O-ring		Connection type		Product number
				EPDM	FKM	Cast iron flange	Stainless steel flange	
	VFI 1.3-25 DN32 020 E	1.3 - 25	DN 32	•		•		97686141
	VFI 1.3-25 DN32 020 F				•	•		97686142
	VFI 1.3-25 DN32 020 E			•			•	97688297
	VFI 1.3-25 DN32 020 F				•		•	97688298
	VFI 2-40 DN40 020 E	2-40	DN 40	•		•		97686143
	VFI 2-40 DN40 020 F				•	•		97686144
	VFI 2-40 DN40 020 E			•			•	97688299
	VFI 2-40 DN40 020 F				•		•	97688300
	VFI 3.2-64 DN50 020 E	2-64	DN 50	•		•		97686145
	VFI 3.2-64 DN50 020 F				•	•		97686146
	VFI 3.2-64 DN50 020 E			•			•	97688301
• Sensor tube with sensor Sensor tube of 1.4408 and sensor of 1.4404 • 2 flanges • 5 m cable with M12 connection in one end • Quick guide	VFI 3.2-64 DN50 020 F				•		•	97688302
	VFI 5.2-104 DN65 020 E	5.2 - 104	DN 65	•		•		97686147
	VFI 5.2-104 DN65 020 F				•	•		97686148
	VFI 5.2-104 DN65 020 E			•			•	97688303
	VFI 5.2-104 DN65 020 F				•		•	97688304
	VFI 8-160 DN80 020 E	8-160	DN 80	•		•		97686149
	VFI 8-160 DN80 020 F				•	•		97686150
	VFI 8-160 DN80 020 E			•			•	97688305
	VFI 8-160 DN80 020 F				•		•	97688306
	VFI 12-240 DN100 020 E	12-240	DN 100	•		•		97686151
	VFI 12-240 DN100 020 F				•	•		97686152
	VFI 12-240 DN100 020 E			•			•	97688308
	VFI 12-240 DN100 020 F				•		•	97688309

1) For more information about the VFI sensor, see the "Grundfos direct sensors" data booklet, product number 97790189.

Grundfos differential pressure sensor, DPI	Content of sensor kit	Data sheet product number[2]	Pressure range [bar]	Product number
	• 1 sensor (7/16" connections), incl. 0.9 m screened cable • 1 original DPI bracket (for wall mounting) • 1 Grundfos bracket (for mounting on motor) • screws for mounting of sensor on bracket and motor • 3 capillary tubes (short/long) • 2 fittings (1/4" - 7/16") • 5 cable clips (black) • installation and operating instructions • service kit instruction	96985439	0 - 0.6	96611522
		96985440	0 - 1.0	96611523
		96985441	0 - 1.6	96611524
		96985463	0 - 2.5	96611525
		96985464	0 - 4.0	96611526
		96985465	0 - 6.0	96611527
		96985466	0-10	96611550

2) Enter the product number of the data sheet into Grundfos Product Center to view data for the sensor.
Note: Select the differential pressure sensor so that the maximum pressure of the sensor is higher than the maximum differential pressure of the pump.

Sensor	Type	Supplier	Measuring range [bar]	Transmitter output [mA]	Power supply [VDC]	Process connection	Product number
Pressure transmitter	RPI	Grundfos	0 - 0.6	4-20	12-30	G 1/2	97748907
			0 - 1.0				97748908
			0 - 1.6				97748909
			0 - 2.5				97748910
			0 - 4.0				97748921
			0 - 6.0				97748922
			0-12				97748923
			0-16				97748924

Sensor interface, SI 001 PSU[3]	Description	Product number
	Grundfos Direct Sensors™, type SI 001 PSU, is an external power supply for the VFI, DPI and other transmitters with 24 VDC supply voltage. It is used when the cable between transmitter and controller is more than 30 metres long.	96915820

3) For more information about the PSU sensor interface, see the Installation and operating instructions "SI 001 PSU - sensor interface", product number 96944355, or Quick guide, product number 96944356.

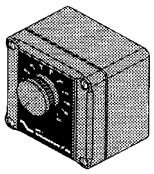
Sourced sensors

Danfoss pressure sensor kit	Pressure range [bar]	Product number
• Connection: G 1/2 A (DIN 16288 - B6kt) • Electrical connection: Plug (DIN 43650)	0 - 2.5	96478188
	0-4	91072075
	0-6	91072076
	0-10	91072077
	0-16	91072078
• Pressure sensor, type MBS 3000, with 2 m screened cable Connection: G 1/4 A (DIN 16288 - B6kt) • 5 cable clips (black) • Fitting instructions PT (00400212)	0 - 2.5	405159
	0-4	405160
	0-6	405161
	0-10	405162
	0-16	405163

	Type	Supplier	Measuring range	Product number
Flowmeter	SITRANS F M MAGFLO MAG 5100 W	Siemens	1-5 m^3/h (DN 25)	ID8285
Flowmeter	SITRANS F M MAGFLO MAG 5100 W	Siemens	3-10 m^3/h (DN 40)	ID8286
Flowmeter	SITRANS F M MAGFLO MAG 5100 W	Siemens	6-30 m^3/h (DN 65)	ID8287
Flowmeter	SITRANS F M MAGFLO MAG 5100 W	Siemens	20-75 m^3/h (DN 100)	ID8288
Temperature sensor	TTA (0) 25	Carlo Gavazzi	0-25 °C	96432591
Temperature sensor	TTA (-25) 25	Carlo Gavazzi	-25 to +25 °C	96430194
Temperature sensor	TTA (50) 100	Carlo Gavazzi	50-100 °C	96432592
Temperature sensor	TTA (0) 150	Carlo Gavazzi	0-150 °C	96430195
Accessory for temperature sensor. All with 1/2 RG connection.	Protecting tube ∅9 x 50 mm	Carlo Gavazzi		96430201
	Protecting tube ∅9 x 100 mm	Carlo Gavazzi		96430202
	Cutting ring bush	Carlo Gavazzi		96430203
Temperature sensor, ambient temperature	WR 52	tmg (DK: Plesner)	-50 to +50 °C	ID8295
Differential temperature sensor	ETSD	Honsberg	0-20 °C	96409362
Differential temperature sensor	ETSD	Honsberg	0-50 °C	96409363

Note: All sensors have 4-20 mA output signal.

Potentiometer



Potentiometer for setpoint setting and start/stop of the pump.

Product	Product number
External potentiometer with cabinet for wall mounting	625468

Grundfos GO

Grundfos GO is used for wireless infrared or radio communication with the pumps.

MI 301

MI 301 is a module with built-in infrared and radio communication. Use MI 301 in conjunction with an Android or iOS-based smartphone with a Bluetooth connection. MI 301 has a rechargeable Li-ion battery and you must charge it separately.

TM05 3890 1712

Fig. 158MI 301

Supplied with the product:

- Grundfos MI 301
- battery charger
- Quick guide.

Product numbers

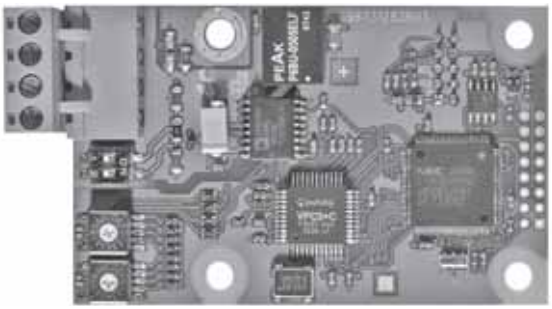
Grundfos GO variant	Product number
Grundfos MI 301	98046408

Supported units

Make	Model	Operating system	MI 301
Apple	iPod touch 4G	iOS 5.0 or later	•
	iPhone 4, 4S		•
	iPod touch 5G	iOS 6.0 or later	•
	iPhone 5		•
HTC	Desire S	Android 2.3.3 or later	•
	Sensation	Android 2.3.4 or later	•
Samsung	Galaxy S II		•
	Galaxy Nexus	Android 4.0 or later	•
LG	Google Nexus 4	Android 4.2 or later	•

Note: Similar Android and iOS-based devices may work as well, but are not supported by Grundfos.

CIM communication interface modules



GrA6121

Fig. 159 Grundfos CIM communication interface module

The CIM modules enable communication of operating data, such as measured values and setpoints, between E-pumps of 11-22 kW and a building management system. The CIM modules are add-on communication modules which are installed in the terminal box.

Note: CIM modules must be installed by authorised persons.

We offer the following CIM modules:

Description	Fieldbus protocol	Product number
CIM 100	LONWorks for pumps	96824797
CIM 110	LONWorks for multipump	96824798
CIM 150	PROFIBUS DP	96824793
CIM 200	Modbus RTU	96824796
CIM 250*	GSM	96824795
CIM 260-EU*	3G/4G cellular	99439302
CIM 260-US*	3G/4G cellular	99439306
CIM 270*	GRM	96898815
CIM 280-EU*	GiC/GRM 3G/4G	99439724
CIM 280-US*	GiC/GRM 3G/4G	99439725
CIM 300	BACnet MS/TP	96893770
CIM 500	Ethernet, BACnet IP	98301408
CIM 500	Ethernet, Modbus TCP	
CIM 500	Ethernet, PROFINET IO	
CIM 500	Ethernet, GRM IP	
CIM 500	Ethernet, EtherNet/IP	

* Antenna not included. See *Antennas and battery*.

Antennas and battery

Description	Product number
Antenna for roof for CIM/CIU 250/270	97631956
Antenna for desk for CIM/CIU 250/270	97631957
Antenna (rod) 3G/4G for CIM 260/280	99043061
Antenna (puc) 3G/4G for CIM 260/280	99518079
CIM 250 battery	99499908

For further information about data communication via CIM modules and fieldbus protocols, see the CIM documentation available in Grundfos Product Center.

EMC filter

EMC, electromagnetic compatibility to EN 61800-3

Motor [kW]		Emission/immunity
2-pole	4-pole	
0.37	0.37	Emission Motors may be installed in residential areas (first environment), unrestricted distribution, corresponding to CISPR11, group 1, class B. Immunity Motors fulfil the requirements for both the first and second environment.
0.55	0.55	
0.75	0.75	
1.1	1.1	
1.5	1.5	
2.2	2.2	
3.0	3.0	
4.0	4.0	
5.5	-	
-	5.5	Emission The motors are category C3, corresponding to CISPR11, group 2, class A, and may be installed in industrial areas (second environment). If equipped with an external Grundfos EMC filter, the motors are category C2, corresponding to CISPR11, group 1, class A, and may be installed in residential areas (first environment).
7.5	7.5	
11	11	
15	15	
18.5	18.5	
22	-	

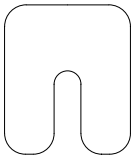
TM02 9198 1203

Fig. 160 EMC filter

The EMC filter for residential areas is available as a complete kit ready for installation.

Product	Product number
EMC filter, E-pumps 5.5 kW 4-pole and 7.5 kW	96041047
EMC filter, E-pumps 11-22 kW	96478309

Shims



TM04 3264 0908

Fig. 161 Shim

Shims to adjust motor height when aligning pump and motor.

Product	Product number
Small case (180 pcs)	96659156
Large case (360 pcs)	96659157

Each case contains three types of shims:

Type 1: 55 x 50 mm, 15 mm slot.

Type 2: 75 x 70 mm, 23 mm slot.

Type 3: 90 x 80 mm, 32 mm slot.

Each type has ten of each of three sizes: 0.05; 0.1; 0.2; 0.5; 0.7; 1 mm.

A large case contains 20 of each of the above-mentioned shims. Refills can be found via service.

MP 204 - advanced motor protection

The MP 204 is an electronic motor protection for pumps. One unit covers all electrical motors from 3 to 999 A, as well as voltages from 100 to 480 VAC.

Installation of the MP 204 is by means of screws onto a wall or back plate, or on a mounting rail.

Component	Description	Functions
MP 204  TM03 0150 4204	The MP 204 is an electronic motor protector and data collecting unit. Apart from protecting the motor, it can also send information to a CIU unit via GENIbus, like for instance: • trip • warning • energy consumption • input power • motor temperature. The MP 204 protects the motor primarily by measuring the motor current by means of a true RMS measurement. The pump is protected secondarily by measuring the temperature with a Tempcon sensor, a Pt100/Pt1000 sensor and a PTC sensor/thermal switch. The MP 204 is designed for single- and three-phase motors.	**Features** • Phase-sequence monitoring • indication of current or temperature • input for PTC sensor/thermal switch • indication of temperature in °C or °F • 4-digit, 7-segment display • setting and status reading with Grundfos GO remote control • setting and status reading via the Grundfos GENIbus fieldbus. **Tripping conditions** • Overload • underload (dry running) • temperature • missing phase • phase sequence • overvoltage • undervoltage • power factor (cos φ) • current unbalance. **Warnings** • Overload • underload • temperature • overvoltage • undervoltage • power factor (cos φ) • run capacitor (single-phase operation) • starting capacitor (single-phase operation) • loss of communication in network • harmonic distortion. **Learning function** • Phase sequence (three-phase operation) • run capacitor (single-phase operation) • starting capacitor (single-phase operation) • identification and measurement of Pt100/Pt1000 sensor circuit.

Control MP 204

The Control MP 204 is supplied as a plug-and-play control cabinet solution. The main switch and LED panel showing power consumption are all you see on the front. Inside you find the MP 204 unit and optional communication interface units.

Cabinet type	Description	Functions
Control MP 204  TM04 9512 4410	The Control MP 204 control cabinets are supplied with all necessary components. Three types of control cabinets are available, depending on functions and starting method. The control cabinets are designed for installation in a control cabinet for outdoor use. The Control MP 204 control cabinets have a built-in main switch and a thermal magnetic circuit breaker.	**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.

For more information about the MP 204 and Control MP 204, see the data booklet "Control MP 204", publication number 97770915.

14. Key application data

Dear customer, please fill in the following questionnaire in cooperation with a Grundfos representative. This will help to ensure that Grundfos supplies you with a pump solution adapted to meet exactly your needs in terms of pump type, pump materials, shaft seal arrangement, shaft seal type, elastomers and accessories.

Customer information:

Company name:	Project title:
Customer number:	Reference number:
Phone number:	Customer contact:
Fax number:	
E-mail address:	

Quotation made by:

Company name:	Prepared by:
Phone number:	Date:
Fax number:	Quotation number:
E-mail address:	

Operating conditions

Pumped liquid		
Type of liquid:		
Chemical composition (if available):		
Distilled or demineralised water?	Distilled	Demineralised
Conductivity of distilled/demineralised water:		[µS/cm]
Minimum liquid temperature:		[°C]
Maximum liquid temperature:		[°C]
Vapour pressure of liquid:		[bar]
Liquid concentration:		%
Liquid pH value:		
Liquid viscosity (dynamic):		[cP] = [mPa·s]
Liquid viscosity (kinematic):		[cSt] = [mm^2/s]
Liquid density:		[kg/m^3]
Specific heat capacity of liquid:		[kJ/(kg·K)]
Content of air/gas in liquid:		[vol-%]
Particle size:		[mm]
Contents of solids in liquid (if available):		% of mass
Additives in liquid?	Yes ❑	No ❑
Does the liquid crystallise?	Yes ❑	No ❑
When does crystallisation happen?		
Does the liquid get sticky when volatiles evaporate from the pumped liquid?	Yes ❑	No ❑
Description of "sticky" circumstances:		
Is the liquid hazardous, poisonous or harmful to the environment?	Yes ❑	No ❑
Special measures to be taken into account when dealing with this hazardous/poisonous liquid:		
Special measures for handling this liquid:		

CIP liquid (cleaning in place)	
Type of liquid:	
Chemical composition (if available):	
Liquid temperature during operation:	[°C]
Maximum liquid temperature:	[°C]
Vapour pressure of liquid:	[bar]
Liquid concentration:	%
Liquid pH value:	

Pump sizing				
Main duty point:	Q:	[m^3/h]	H:	[m]
Max. duty point:	Q:	[m^3/h]	H:	[m]
Min. duty point:	Q:	[m^3/h]	H:	[m]

Ambient operating conditions	
Ambient temperature:	[°C]
Altitude above sea level:	[m]

Pressure	
Minimum inlet pressure:	[bar]
Maximum inlet pressure:	[bar]
Outlet pressure (inlet pressure + head):	[bar]

ATEX

Required marking of the pump			
Customer's equipment group (e.g.: II):			
Customer's equipment category (e.g.: 2.3):			
Gas (G) and/or dust (D):	Gas (G) ❑	Dust (D) ❑	Gas and dust (G/D) ❑

Required marking of the motor	
Protection type (e.g.: d, de, e, nA):	
Maximum experimental safe gap (e.g.: B, C):	
Temperature class - gas (e.g.: T3, T4, T5):	
Temperature class - dust (e.g.: 125 °C):	[°C]

Description/sketch	
Detailed description of ATEX application: (attach a drawing if possible)	

ATEX certification required	Yes ❑	No ❑

Frequency converter			
Frequency converter option wanted?	Yes ❑	No ❑	
Control parameter:	Pressure:		[bar]
	Temperature:		[°C]
	Flow:		[m^3/h]
	Other:		
Detailed description of requirement: (attach a drawing if possible)			

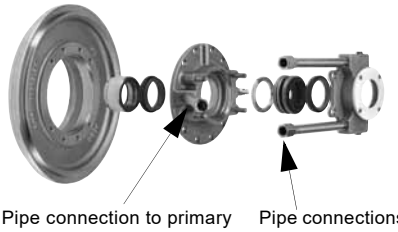
System information

Please provide us with some information about your system and maybe a simple sketch. This will give us hints as to whether you need accessories or monitoring equipment, or whether you already have a suitable system which makes it unnecessary to attach any further equipment.

Double shaft seal solutions

If you chose a tandem or a back-to-back shaft seal solution, you must connect either a flushing system or a pressurizing system for barrier liquid to the connection pipes.

Tandem shaft seals

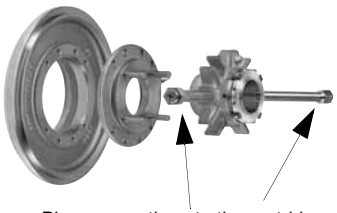


Pipe connection to primary shaft seal. The liquid is directed to the seal faces of the shaft seal. The primary seal is placed on the pumped liquid side.

Pipe connections to secondary shaft seal. The liquid is directed to the seal faces of the secondary shaft seal. The secondary seal is placed in the seal chamber.

GrA8480

Fig. 162 Flushing connections of tandem shaft seal arrangement with standard seals



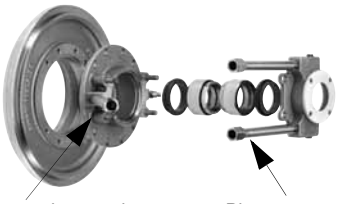
Pipe connections to the cartridge seal. The direction of the flushing flow depends on the direction of rotation of the shaft

GrA8610

Fig. 163 Flushing connections of tandem shaft seal arrangement with a cartridge seal

Is a flushing liquid available in the application? (See description of tandem shaft seals on Data booklet)	Yes ❑	No ❑
Description of the flushing liquid:		
Chemical composition (if available):		
Pressure of the flushing liquid:		[bar]
Does the application require flushing/cooling of the primary shaft seal?	Yes ❑	No ❑
Comments on flushing/cooling for the primary shaft seal:		
More comments/info about your system:		

Back-to-back seals



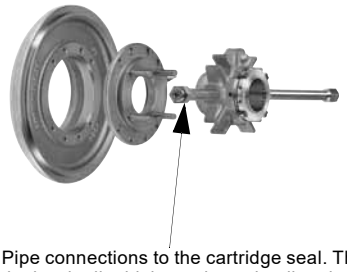
Pipe connection to primary shaft seal.

Pipe connections to secondary shaft seal.

The barrier liquid is directed to the seal faces of the shaft seals. Both primary and secondary seals are placed in the seal chamber

GrA8479

Fig. 164 Connections for barrier liquid of back-to-back seal arrangement with standard seals



Pipe connections to the cartridge seal. The direction of the barrier liquid depends on the direction of rotation of the shaft.

GrA8610

Fig. 165 Connections for barrier liquid of back-to-back seal arrangement with a cartridge seal

Is a barrier liquid available in the application? (See description of tandem shaft seals on Data booklet)	Yes ❑	No ❑	
Description of the barrier liquid:			
Chemical composition (if available):			
Pressure of the barrier liquid:		[bar]	
System requirements for the barrier liquid:			
Does the application require circulation of the barrier liquid?	Yes ❑	No ❑	(dead-end arrangement)
Comments on circulation for the primary shaft seal:			
Comments on dead-end arrangement:			
More comments/info about your system:			

Date: Date:

Grundfos representative Customer representative

Note: Visit Grundfos Product Center on http://product-selection.grundfos.com. Find the interactive Key Application Data Sheet by searching for 98150787. The sheet can be printed.

15. Grundfos Product Center

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

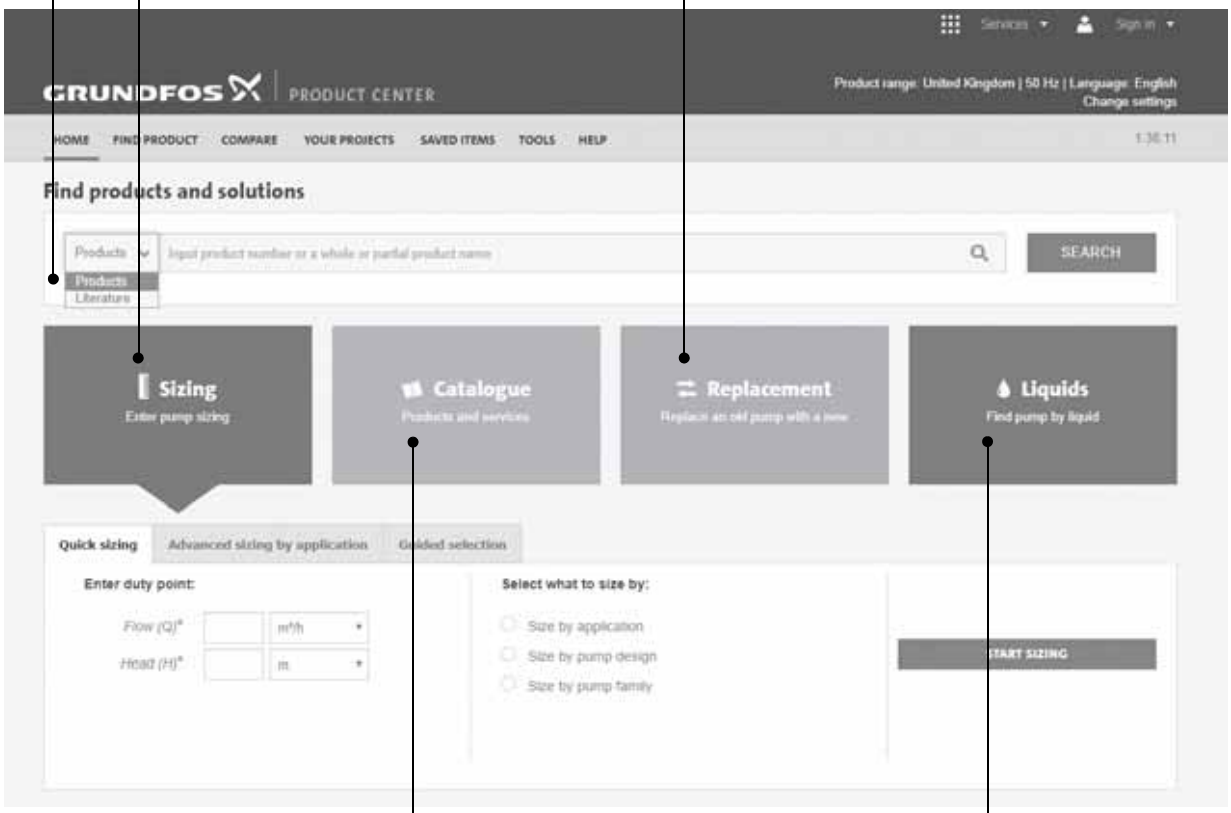
http://product-selection.grundfos.com

Select between "Products" and "Literature" when searching for the document.

"SIZING" enables you to size a pump based on entered data and selection choices.

"REPLACEMENT" enables you to find a replacement product. Search results will include information on the following:

- the lowest purchase price
- the lowest energy consumption
- the lowest total life cycle cost.



"CATALOGUE" gives you access to the Grundfos product catalogue.

"LIQUIDS" enables you to find pumps designed for aggressive, flammable or other special liquids.

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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