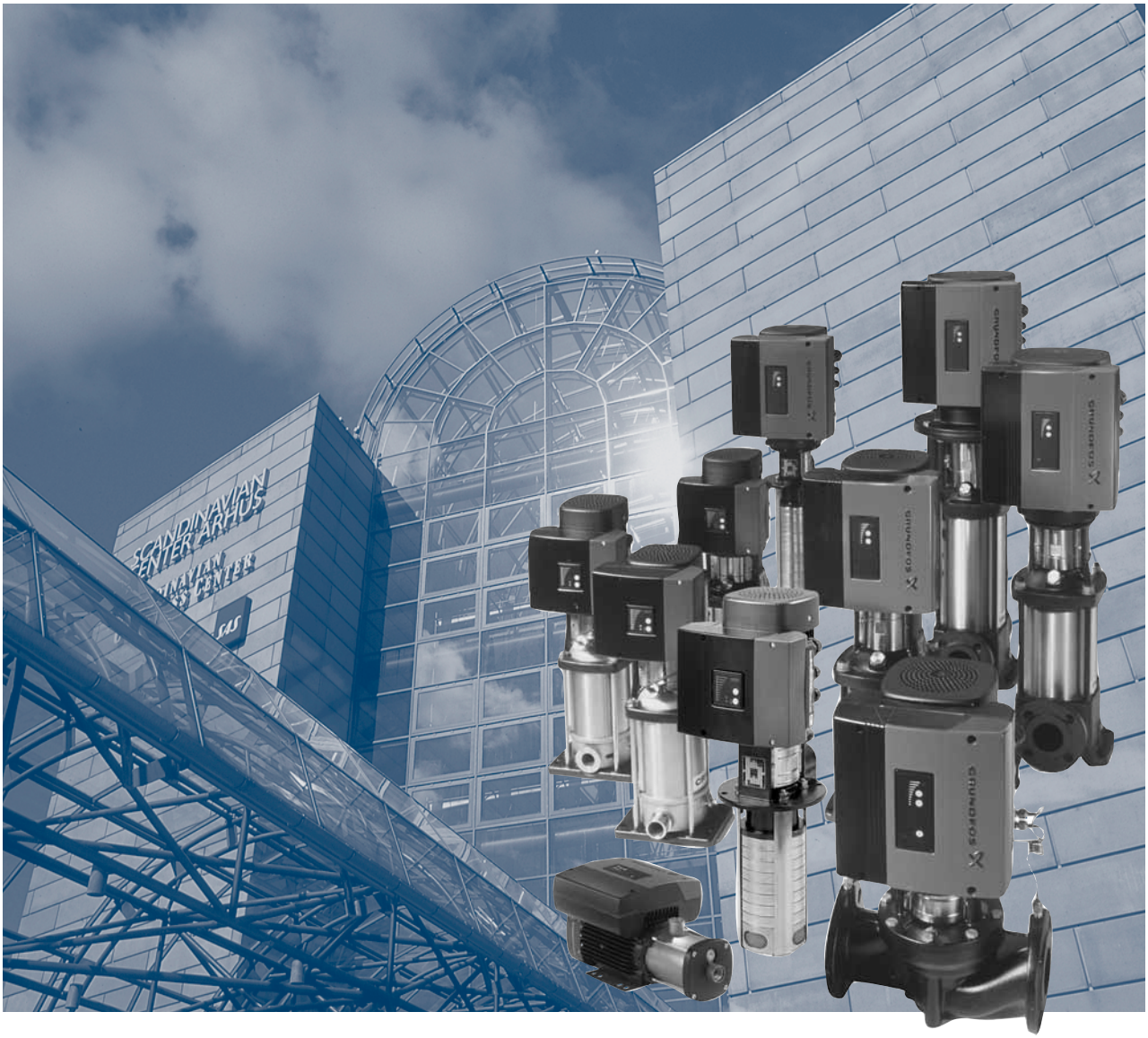
Grundfos E-pumps

Pumps with built-in frequency converter

50/60 Hz



Contents

1. Introduction to E-pumps

General introduction

This data booklet deals with Grundfos pumps fitted with Grundfos MGE motors, 0.37 - 22 kW. These motors are standard asynchronous motors with integrated frequency converter and controller. In some cases, the pumps have a factory-fitted sensor.

These pumps are referred to as E-pumps.

For information about E-pumps with a higher shaft power output, see our CUE range of frequency converters, 22-250 kW.

TM03 0296 0508

Fig. 1 Grundfos E-pumps

An E-pump is not just a pump, but a system which is able to solve application problems or save energy in a variety of pump installations. E-pumps are ideal as they can be installed instead of a non-controlled standard pump at no extra cost. All that is required, is the mains connection and the fitting of the E-pump in the pipe system, and the pump is ready for operation.

The pump has been tested and pre-configured from factory. The operator only has to specify the desired setpoint (pressure) and the system is operational.

In new installations, the E-pumps provide a number of advantages. The frequency converter integrated in the pumps has a built-in motor protection function which protects both motor and electronics against overload. This means that E-pump installations do not require motor protection, but only a normal short-circuit protection for the cable.

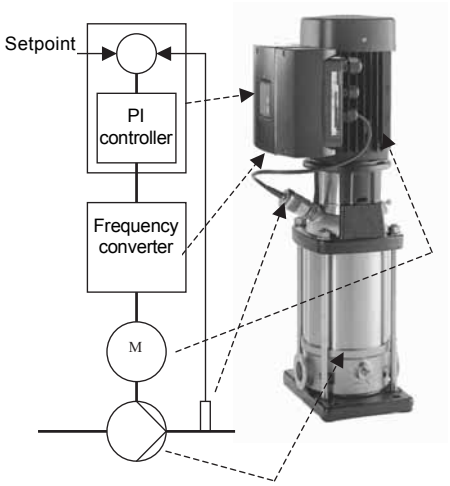


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Fig. 2 Components of a Grundfos E-pump

Grundfos E-pumps range

Grundfos E-pumps are available in three different functional groups:

- Multistage CRE, CRIE, CRNE pumps with pressure sensor.
  Multistage CRE, CRIE, CRNE, MTRE, SPKE, CRKE, CME pumps without sensor.
- Single-stage TPE, TPED Series 1000, NKE, NBE pumps without sensor.
- Single-stage TPE, TPED Series 2000 pumps with integrated differential-pressure sensor.

As standard, TPE, TPED Series 2000 pumps are supplied with a differential-pressure sensor enabling the control of the differential pressure across the pump.

CRE, CRIE, CRNE pumps are available with a pressure sensor enabling the control of the pressure after the pump.

The purpose of supplying the E-pumps with a differential-pressure sensor or pressure sensor is to make the installation and commissioning simple and quick. All other E-pumps are supplied without sensor.

E-pumps without sensor are used when uncontrolled operation (open loop) is required or when there is a wish to fit a sensor at a later stage in order to enable control on the basis of flow, temperature, differential temperature, pressure or differential pressure at some arbitrary point in the system.

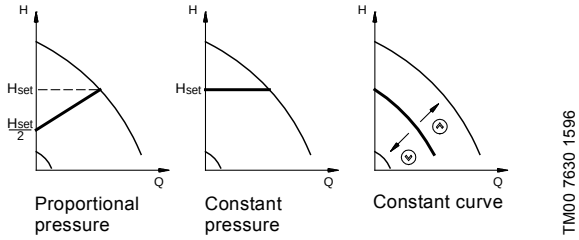


Fig. 3 TPE, TPED Series 2000 with differential-pressure sensor

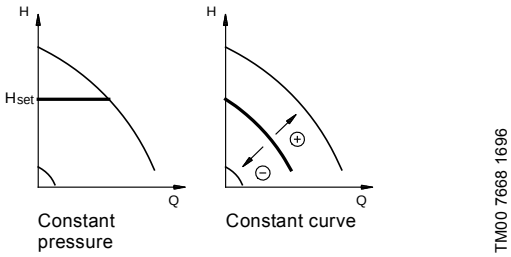


Fig. 4 CRE, CRIE, CRNE with sensor

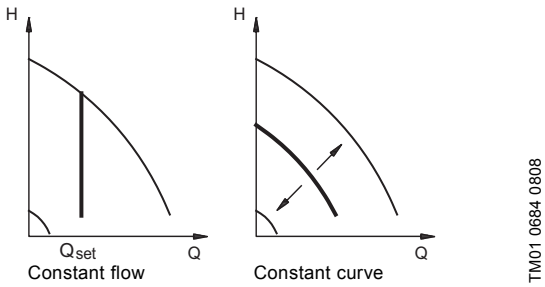


Fig. 5 E-pumps without sensor

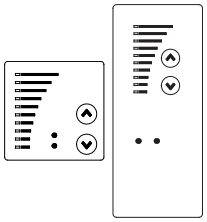
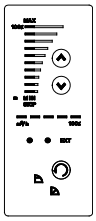
Functions

The functions of the E-pumps depend on pump type and whether the pump is supplied with or without sensor.

The difference in functions is seen in the settings offered via the R100 remote control. As described later, the menu structure of the R100 depends on the E-pump type in question.

The tables on the following pages show which functions are available for the different E-pump types. CRE, CRIE, CRNE with sensor and all multistage pumps without sensor have the same menu structure in the R100.
All single-stage pumps without sensor, such as NBE, NKE and TPE, TPED Series 1000, have a different menu structure.
Finally, TPE, TPED Series 2000 have their own menu structure.
The result is three totally different menu structures for the complete E-pumps range.

Overview of functions

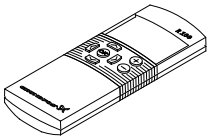
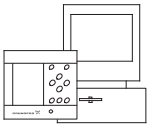
E-pump functions		E-pump type							
		CRE, CRIE, CRNE with sensor		CRE, CRIE, CRNE, SPKE, CRKE, MTRE, CME without sensor		TPE, TPED Series 1000 NBE, NKE without sensor		TPE, TPED Series 2000 with three-phase MGE	
		Single-phase	Three-phase	Single-phase	Three-phase	Single-phase	Three-phase	Single-phase	Three-phase
	Motor sizes [kW]	**0.37 - 1.1**	**0.75 - 22**	**0.37 - 1.1**	**0.75 - 22**	**0.25 - 1.1**	**0.55 - 22**	**0.25 - 1.1**	**0.55 - 22**
	**Setting via control panel**								
	Setpoint	•	•	•	•	•	•	•	
	Start/stop	•	•	•	•	•	•	•	
	Max. curve	•	•	•	•	•	•	•	
	Min. curve	•	•	•	•	•	•	•	
	Alarm reset	•	•	•	•	•	•	•	
	Constant or proportional pressure							•	
	Reading via control panel								
	Setpoint	•	•	•	•	•	•	•	
	Operating indication	•	•	•	•	•	•	•	
	Fault indication	•	•	•	•	•	•	•	
	**Setting via control panel**								
	Setpoint								•
	Start/stop								•
	Max. curve								•
	Min. curve								•
	Alarm reset								•
	Constant or proportional pressure								•
	Reading via control panel								
	Setpoint								•
	Operating indication								•
	Fault indication								•
	Operating mode: MIN, MAX, STOP								•
	Flow in %								•
	External control								•

• Available.

1) Sensor fitted.

2) Only 11-22 kW.

3) Lubricated, only 11-22 kW.

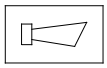
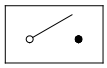
E-pump functions		E-pump type							
		CRE, CRIE, CRNE with sensor		CRE, CRIE, CRNE, SPKE, CRKE, MTRE, CME without sensor		TPE, TPED Series 1000 NBE, NKE without sensor		TPE, TPED Series 2000 with three-phase MGE	
		Single-phase	Three-phase	Single-phase	Three-phase	Single-phase	Three-phase	Single-phase	Three-phase
	Motor sizes [kW]	**0.37 - 1.1**	**0.75 - 22**	**0.37 - 1.1**	**0.75 - 22**	**0.25 - 1.1**	**0.55 - 22**	**0.25 - 1.1**	**0.55 - 22**
	**Setting via the R100**								
	Setpoint	•	•	•	•	•	•	•	•
	Start/stop	•	•	•	•	•	•	•	•
	Max. curve	•	•	•	•	•	•	•	•
	Min. curve	•	•	•	•	•	•	•	•
	Alarm reset	•	•	•	•	•	•	•	•
	Warning reset		•		•		•		•
	Controlled or uncontrolled	•	•	•	•	•	•		
	Constant pressure, proportional pressure or constant curve							•	•
	Controller constants, K_p, T_i	•	•	•	•	•			
	External setpoint signal	•	•	•	•	•	•	•	•
	Signal relay 1	•	•	•	•	•	•	•	•
	Signal relay 2		• [2]		• [2]		• [2]		• [2]
	Buttons on pump	•	•	•	•	•	•	•	•
	Pump number (for bus communication)	•	•	•	•	•	•	•	•
	Digital input	•	•	•	•	•	•	•	•
	Stop function	•	•	•	•				
	Flow limit		•		•				
	Sensor range and signal	• [1]	• [1]	•	•	•	•		
	Duty/standby	•	•	•	•				
	Operating range (min./max. speed)	•	•	•	•	•	•		
	Motor bearing monitoring		•		•		•		•
	Motor bearings changed or lubricated		• [3]		• [3]		• [3]		• [3]
	Standstill heating		•		•		•		•
	Reading via the R100								
	Setpoint	•	•	•	•	•	•	•	•
	Operating mode	•	•	•	•	•	•	•	•
	Actual sensor value	•	•	•	•	•	•	•	•
	Pump speed	•	•	•	•	•	•	•	•
	Power input	•	•	•	•	•	•	•	•
	Power consumption	•	•	•	•	•	•	•	•
	Operating hours	•	•	•	•	•	•	•	•
	Lubrication status (bearings)		• [2]		• [2]		• [2]		• [2]
	Replacement status (bearings)		•		•		•		•
	**Setting via GENIbus**								
	Setpoint	•	•	•	•	•	•	•	•
	Start/stop	•	•	•	•	•	•	•	•
	Max. curve	•	•	•	•	•	•	•	•
	Min. curve	•	•	•	•	•	•	•	•
	Controlled or uncontrolled	•	•	•	•	•	•		
	Constant pressure, proportional pressure or constant curve							•	•
	Reading via GENIbus								
	Setpoint	•	•	•	•	•	•	•	•
	Operating indication	•	•	•	•	•	•	•	•
	Pump status	•	•	•	•	•	•	•	•

• Available.

[1] Sensor fitted.

[2] Only 11-22 kW.

[3] Lubricated, only 11-22 kW.

E-pump functions		E-pump type							
		CRE, CRIE, CRNE with sensor		CRE, CRIE, CRNE, SPKE, CRKE, MTRE, CME without sensor		TPE, TPED Series 1000 NBE, NKE without sensor		TPE, TPED Series 2000 with three-phase MGE	
		Single-phase	Three-phase	Single-phase	Three-phase	Single-phase	Three-phase	Single-phase	Three-phase
	Motor sizes [kW]	**0.37 - 1.1**	**0.75 - 22**	**0.37 - 1.1**	**0.75 - 22**	**0.25 - 1.1**	**0.55 - 22**	**0.25 - 1.1**	**0.55 - 22**
	Setting via external signal								
	Setpoint	•	•	•	•	•	•	•	•
	Start/stop	•	•	•	•	•	•	•	•
	Min./max. curve via digital input					•	•	•	•
	Min./max. curve, external fault, flow switch via digital input	•	•	•	•				
	**Reading via external signal**								
	Fault signal (relay)							•	
	Fault, Operation or Ready signal (relay)	•		•		•			
	Fault, Operation, Ready, Pump running, Bearing lubrication, Warning, Limit exceeded 1 and 2		•		•		•		•
	Twin-pump function							•	•

• Available.

1) Sensor fitted.

2) Only 11-22 kW.

3) Lubricated, only 11-22 kW.

Speed control of E-pumps

Adjustment of pump performance is a must in many applications today. No doubt the best performance adjustment is achieved by means of a frequency converter as this gives the following advantages:

- large energy savings
- enhanced comfort
- longer life for systems as well as for individual components
- no appreciable loss of efficiency
- reduced water hammer
- fewer starts/stops.

A Grundfos E-pump is a good choice when performance adjustment is required.

This section describes what happens to the performance and energy consumption of an E-pump when its speed is controlled by means of a frequency converter.

The description includes the following:

- presentation of affinity equations
- presentation of the performance curves of speed-controlled pumps
- presentation of the system characteristics of closed as well as open systems.

Affinity equations

The following affinity equations apply with close approximation to the change of speed of centrifugal pumps:

$$\frac{Q_n}{Q_x} = \frac{n_n}{n_x} \qquad \frac{H_n}{H_x} = \left(\frac{n_n}{n_x}\right)^2 \qquad \frac{P_n}{P_x} = \left(\frac{n_n}{n_x}\right)^3$$

H = head in m

Q = flow rate in m^3/h

P = input power in kW

n = speed.

Q_x, H_x and P_x are the appropriate variables for the speed n_x. The approximated formulas apply on condition that the system characteristic remains unchanged for n_n and n_x and that it is based on this formula

$H = k \times Q^2$

k = a constant, i.e. a parabola through 0.0 as appears from fig. 6.

The power equation furthermore implies that the pump efficiency is unchanged at the two speeds. In practice, this is not quite correct. Finally, it is worth noting that the efficiencies of the frequency converter and the motor must also be taken into account if a precise calculation of the power saving resulting from a reduction of the pump speed is desired.

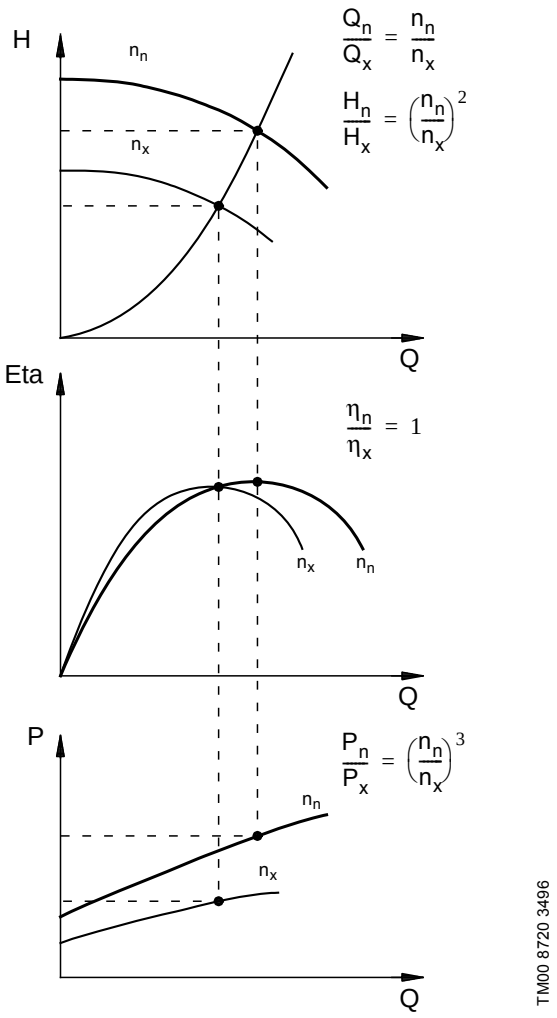


Fig. 6 Affinity equations

From the formulas it appears that the pump flow (Q) is proportional to the pump speed (n). The head (H) is proportional to the square of the speed (n) whereas the power (P) is proportional to the third power of the speed.

In practice, a reduction of the speed will result in a slight fall in efficiency. But this does not change the fact that there are often large power savings involved in controlling pump speed.

The formula for the calculation of the efficiency (η) is:

$$\eta_x = 1 - (1 - \eta_n) \times \left(\frac{n_n}{n_x}\right)^{0.1}$$

When used, the formula gives good approximation for speeds down to 40 % of maximum speed.

Performance curves of speed-controlled pumps

Performance curves

The curve chart below shows a CRE 15-3. The top part of the chart shows the QH performance curves at different speeds. Curves for speeds between 100 % and 50 % are included at 10 % intervals. Finally, a minimum curve at 25 % is shown.

The bottom part of the chart shows P1 (input power from the mains). NPSH for the pump at maximum speed is shown in the same diagram.

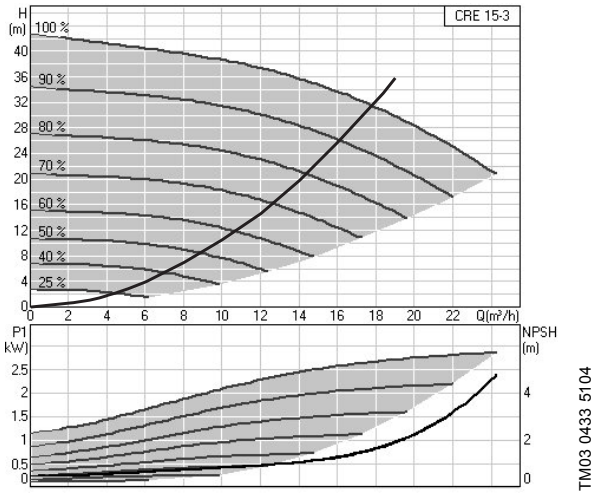
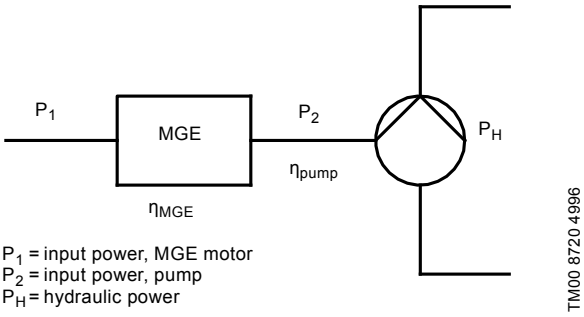


Fig. 7 Performance curve of a CRE 15-3

Efficiency

The total efficiency of the E-pump h_{total} is calculated by multiplying the efficiency of the MGE with the pump efficiency.



P_1 = input power, MGE motor
P_2 = input power, pump
P_H = hydraulic power

Fig. 8 Efficiency of an E-pump

The efficiency of the MGE motor depends on the size of the motor, the speed and the load of the shaft.

Firstly, the efficiency of the pump depends on the flow Q, and secondly the speed of the pump.

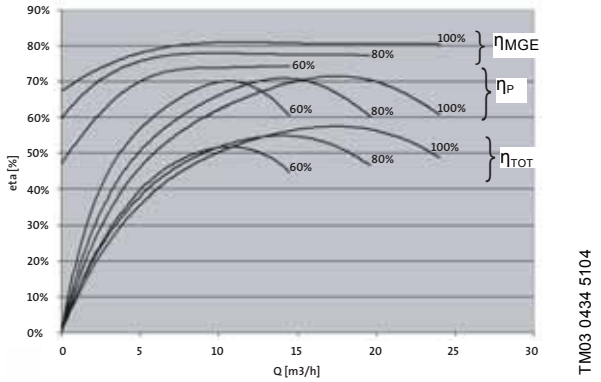


Fig. 9 Efficiency curves for MGE, pump and complete E-pump at 100 %, 80 % and 60 % speed

Figure 9 shows the efficiency of the MGE and the pump part and finally the resulting efficiency of a CRE 15-3 with a 3 kW MGE motor. The curves are drawn as a function of flow Q and for three different speed values: 100 %, 80 % and 60 %.

Assuming the situation shown in fig. 9, with a duty point at 100 % speed equal to Q = 17.4 m^3/h and H = 32 m, the change in efficiency at 80 and 60 % speed is shown in the following table:

Speed [%]	Q	H	P_1	P_2	P_H	η_P	η_{MGE}	η_{TOT}
	[m^3/h]	[m]	[kW]	[kW]	[kW]	[%]	[%]	[%]
100	17.4	32	2.65	2.13	1.51	71.1	80.4	57.2
80	14	21.1	1.47	1.14	0.8	70.5	77.6	54.7
60	10.5	12	0.66	0.49	0.34	70.4	73.8	51.9

The pump efficiency h_{MGE} is reduced from 71.1 % to 70.4 %, meaning less than one % point drop in efficiency.

Due to the big drop in speed and shaft load, the efficiency of the MGE is reduced in the range of 7 % points resulting in an overall reduction of E-pump efficiency equal to 5.3 % points.

Efficiency is important, but what counts is the power consumption as it directly influences the energy costs.

As appears from the table above, the power consumption P_1 drops from 2.65 kW to 0.66 kW which is a 75 % reduction. Assuming unchanged overall efficiency h_{TOT}, the drop in P_1 would have been from 2.65 kW down to 0.6 kW resulting in a 77 % reduction.

The conclusion is that the speed reduction is the most important factor with regard to energy saving, and that the drop in efficiency will only have minor influence on the possible savings achieved through speed control.

System characteristics

The characteristic of a system indicates the head required of a pump to circulate a given quantity of water through the system. In the following, distinction is made between closed and open systems.

Closed systems (circulation systems)

In a closed system, the liquid is flowing round in a closed circuit such as a radiator system. On condition that the system is fully vented and closed, the pump in a closed system does not have to overcome any static pressure.

Head = friction loss in the entire closed system.
In a closed system, the system characteristic will be a parabola through the Q/H-point 0.0. The curve shows that the friction loss in the system increases squarely with the circulated quantity of water.

$$H = k \times Q^2$$

The variable "k" is a constant. The higher "k" is, the steeper the parabola will be, and vice versa. The lower "k" is, the flatter the parabola will be. "k" is determined by valve position and friction loss.

Figure 10 shows system characteristics in a closed system (circulation system).

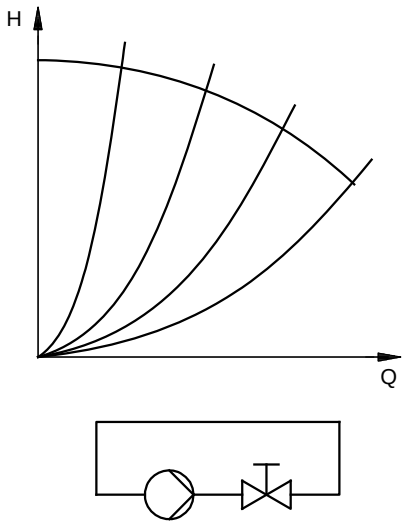


Fig. 10 System characteristics, closed system

Open systems (booster systems)

In many pumping jobs in open systems, there is a static head (H_0) to overcome. This is the case in fig. 11 where the pump is to pump from an open vessel up to a tank. H_0 is the level difference between the vessel the pump is pumping from and the tank into which the pump is to deliver the water.

Head = level difference + friction loss in the system.

The system characteristic will normally start in a point on the H-axis corresponding to the level difference. When this point has been reached, the characteristic will follow the line of a quadratic parabola:

$$H = H_0 + k \times Q^2$$

"k" represents the resistance in the system (pipes, fittings, valves, etc.).

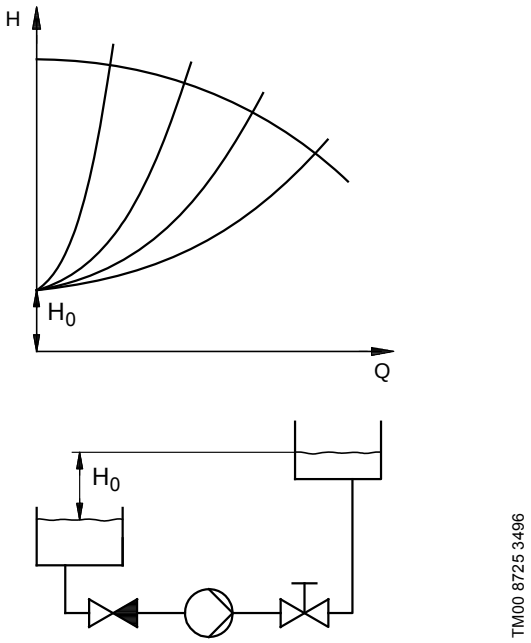


Fig. 11 System characteristic + static head, open system

Duty point

The duty point in a pumping system is always the point of intersection between the system characteristic and the performance curve of the pump.

Figure 12 shows the performance curve and the system characteristic of a closed and an open system, respectively.

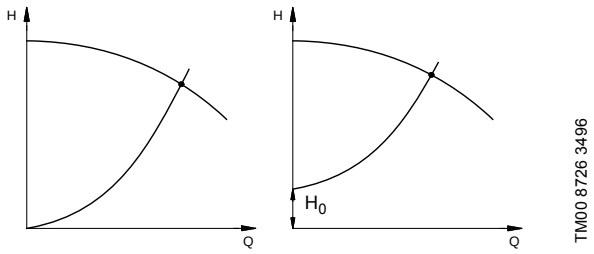


Fig. 12 Duty point of a closed and an open system, respectively

Advantages of speed control

Adaptation of performance through frequency-controlled speed control offers some obvious advantages:

Energy conservation

An E-pump uses only the energy required for a given pumping job. Compared to other control methods, frequency-controlled speed control is the method offering the highest efficiency and thus the most efficient utilisation of the energy. Depending on the application and pump type, savings of up to 50 % or more are realistic.

Low operating costs

The efficient utilisation of the energy offers the customer an attractive reduction of his/her operating costs. This is seen in the form of lower daily energy costs, but also in the form of lower wear on pumps and system components which again reduces the need for replacements.

Protection of the environment

The efficient utilisation of energy offers some environmental advantages in the form of less pollution. Pumps using less energy demand less power from the power stations.

Increased comfort

For the customer, controlled operation of the pumping system means increased comfort due to the automatic control and a lower noise level from pumps and pipework, etc.

Applications

Overview of applications

E-pumps can be used with advantage in many applications falling into one or more of the following three groups:

- E-pumps will generally be very beneficial in all pump applications with a varying demand for pump performance. Using E-pumps will result in energy saving and/or improved comfort or process quality, depending on the application.
- In some applications, E-pumps will reduce the need for control valves or other pressure-losing and costly components. In many cases, E-pumps can reduce the total system investment.
- E-pumps can also be a very good choice in applications where communication between the different units in the system, such as pumps, valves, etc. and an overall controller/computer system is required.

The table below shows the most common E-pump applications and which E-pump types can be used for which applications. The use of E-pumps in a number of applications is described on page 14.

Systems	Applications	E-pump type				
		CRE, CRIE, CRNE with sensor	CRE, CRIE, CRNE, SPKE, CRKE, MTRE, CME without sensor	TPE, TPED Series 1000 without sensor	NBE, NKE without sensor	TPE, TPED Series 2000
Heating system	Main circulator pump			●	●	● [1]
	Floor heating					● [1]
	Mixing loops					● [1]
	Boiler shunt			●	●	
	Pressure-holding system	● [2]	● [2]			
	Exhaust gas exchanger			●		
	Flow filter			●		
	Domestic hot-water production			●		
	Domestic hot-water recirculation			●		
	Heat surface			●		
	Heat recovery			●		
District heating system	Circulator pump in substation			●		● [1]
	Temperature shunt			●		
	Booster pump			●	●	
Boiler feeding	Feed pump		●			
Air-conditioning	Primary circulator pump			●	●	
	Secondary circulator pump			●	●	● [1]
	Zone circulator pump			●		● [1]
	Pressure-holding system		● [2]			
	Dry-cooler circulator pump			●	●	
	Wet-cooling tower pump		●	●	●	
	Wet-cooling tower internal circulator			●	●	
	Heat recovery pump			●	●	
Pressure boosting	Boost-up from break tank	●	● [2]			
	Boost-down from roof tank	●	● [2]			
	Boost direct from mains	●	● [2]			
	Pumping out system (waterworks)	●	● [2]			
	Booster pump in mains	●	● [2]			
Water treatment	Inlet booster pump	●	●			
	Treated-water supply pump	●	●			
	Reverse osmosis booster pump	●	●			
Swimming pools	Circulator pump			●	●	
	Filter pump			●	●	
Fountains	Dry-pit pump	●	●	●	●	
Commercial/industrial cooling	Brine primary circulator pump		●	●	●	
	Brine secondary circulator pump		●	●	●	●
	Brine zone circulator pump		●	●		●
	Cooling surface pump		●	●		●
	Pressure-holding system		● [2]			
	Dry-cooler circulator pump			●	●	
	Wet-cooling tower pump		●	●	●	
	Wet-cooling tower internal circulator			●	●	
	Heat recovery pump			●	●	
Cleaning and washdown	Pressure boosting	●	● [2]			
	CIP system	●	● [2]			
Machine tooling	Coolant pump		●			
Temperature control units	Cooling of tooling or injection mould machines	●	●	●		

● Available.

[1] Grundfos MAGNA pumps can also be used.

[2] Hydro MPC or Hydro Multi-E systems are preferred.

Application examples

As discussed earlier, speed control of pumps is an efficient way of adjusting pump performance to the system.

In this section, we will discuss the possibilities of combining speed-controlled pumps with PI controllers and sensors measuring system parameters, such as pressure, differential pressure and temperature.
On the following pages, the different options will be presented through examples.

Constant-pressure control

A pump has to supply tap water from a break tank to various taps in a building.

The demand for tap water varies, and so does the system characteristic, according to the required flow. To achieve comfort and energy savings, a constant supply pressure is recommended.

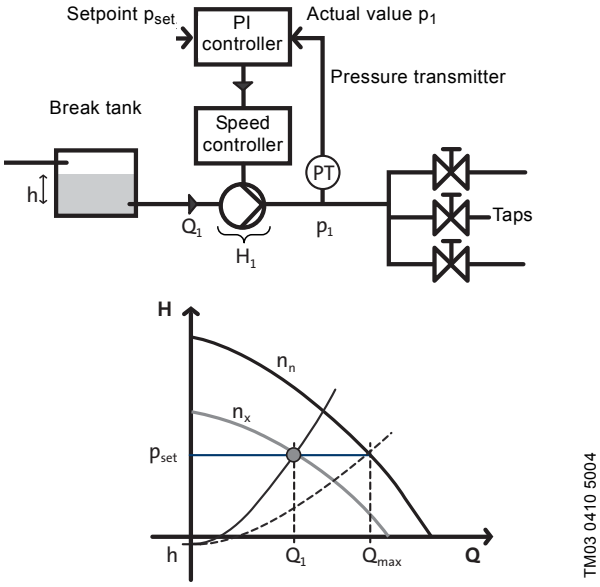


Fig. 13 Constant-pressure control

As appears from fig. 13, the solution is a speed-controlled pump with a PI controller. The PI controller compares the required pressure, p_{set}, with the actual supply pressure, p_1, measured by a pressure transmitter PT.

If the actual pressure is higher than the setpoint, the PI controller reduces the speed and consequently the performance of the pump until $p_1 = p_{set}$. Figure 13 shows what happens when the flow is reduced from $Q_{max.}$ to Q_1.

The controller reduces the speed of the pump from n_n to n_x in order to ensure that the required discharge pressure is $p_1 = p_{set}$. The pump ensures that the supply pressure is constant in the flow range of 0 to $Q_{max.}$. The supply pressure is independent of the level (h) in the break tank. If h changes, the PI controller adjusts the speed of the pump so that p_1 always corresponds to the setpoint.

Constant-temperature control

Performance adjustment by means of speed control is suitable for a number of industrial applications. Figure 14 shows a system with an injection moulding machine which must be water-cooled to ensure high quality production.

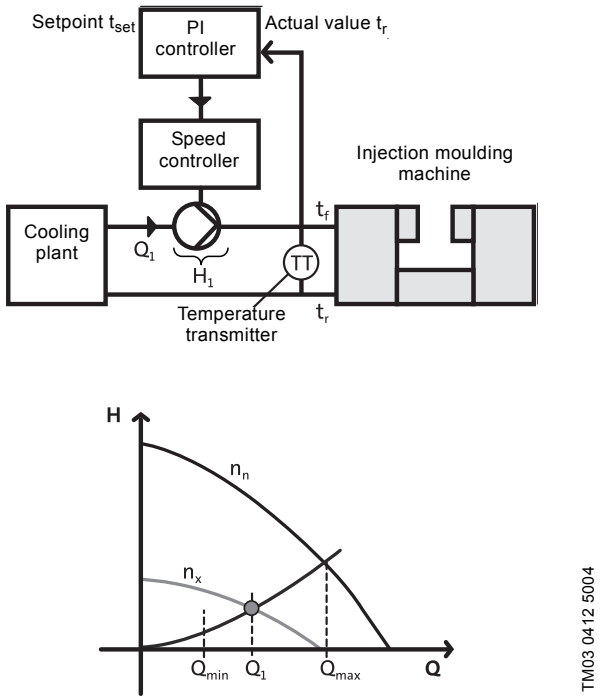


Fig. 14 Constant-temperature control

The pump will be operating at a fixed system characteristic. The controller will ensure that the actual flow, Q_1, is sufficient to ensure that $t_r = t_{set}$.

The machine is cooled with water at 15 °C from a cooling plant. To ensure that the moulding machine runs properly and is cooled sufficiently, the return-pipe temperature has to be kept at a constant level, t_r = 20 °C. The solution is a speed-controlled pump, controlled by a PI controller. The PI controller compares the required temperature, t_{set}, with the actual return-pipe temperature, t_r, which is measured by a temperature transmitter TT. This system has a fixed system characteristic, and therefore the duty point of the pump is located on the curve between Q_{min} and Q_{max}. The higher the heat loss in the machine, the higher the flow of cooling water needed to ensure that the return-pipe temperature is kept at a constant level of 20 °C.

Constant differential pressure in a circulation system

Circulation systems (closed systems) are well-suited for speed-controlled pump solutions.

It is an advantage that circulation systems with variable system characteristic are fitted with a differential-pressure-controlled circulator pump. See fig. 15.

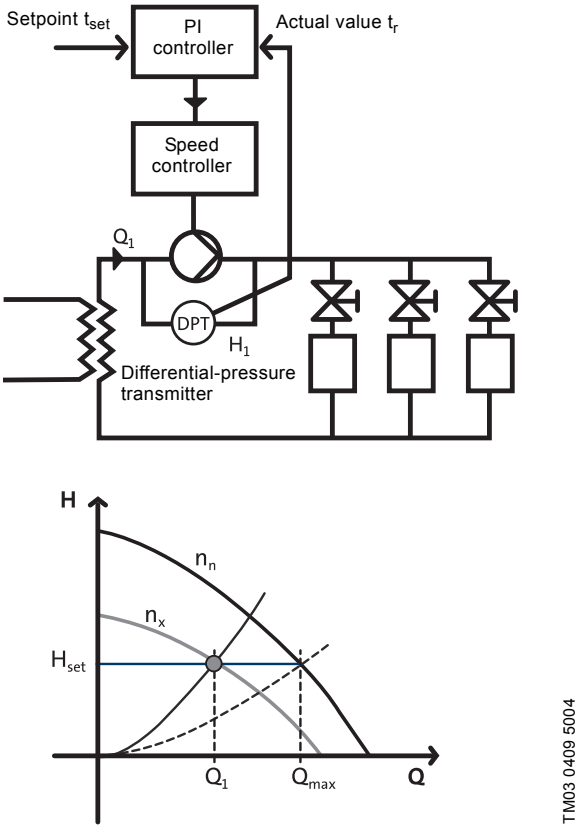


Fig. 15 Constant differential-pressure control

Figure 15 shows a heating system consisting of a heat exchanger where the circulated water is heated and delivered to three radiators by a speed-controlled pump. A control valve is connected in series at each radiator to control the flow according to the heat requirement.

The pump is controlled according to a constant differential pressure measured across the pump. This means that the pump system offers constant differential pressure in the Q range of 0 to Q_{max}, represented by the horizontal line in fig. 15.

Flow-compensated differential-pressure control

The main function of the pumping system in fig. 16 is to maintain a constant differential pressure across the control valves at the radiators. In order to do so, the pump must be able to overcome friction losses in pipes, heat exchangers, fittings, etc.

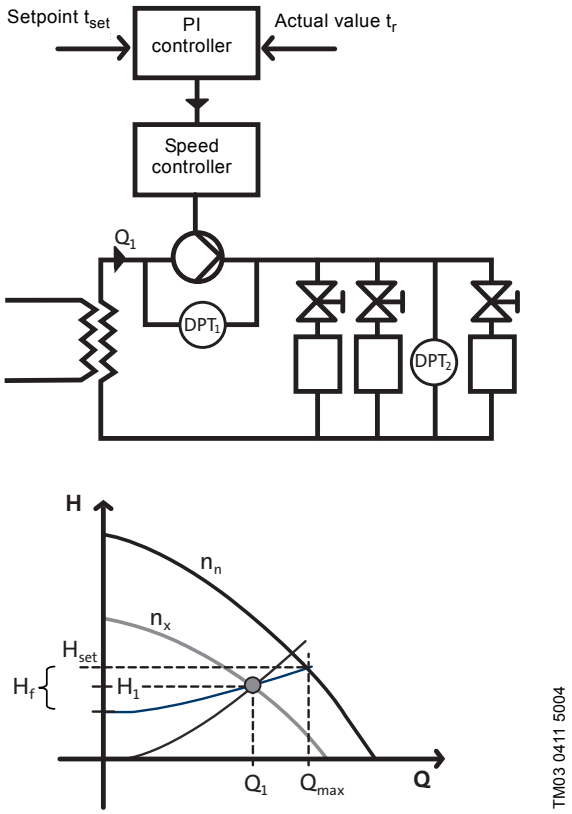


Fig. 16 Flow-compensated differential-pressure control

The circulator pump is controlled in a way that ensures that the pump head is increased in case of increased flow.

As mentioned earlier, the pressure loss in a system is proportional to the square of the flow. The best way to control a circulator pump in a system like the one shown in fig. 16, is to allow the pump to deliver a pressure which increases when the flow increases.

When the flow demand is low, the pressure losses in the pipes, heat exchangers, fittings, etc. are low as well, and the pump only supplies a pressure equivalent to what the control valve requires, H_{set} to H_f. When the flow demand increases, the pressure losses increase in second power, and therefore the pump has to increase the delivered pressure as shown in fig. 16.

Such a pumping system can be designed in two ways:

- The differential-pressure transmitter (DPT_1 in fig. 16) is placed across the pump, and the system is running with flow-compensated differential-pressure control.
- The differential-pressure transmitter (DPT_2 in fig. 16) is placed close to the radiators, and the system is running with differential-pressure control.

The advantage of the first solution, which is equal to a TPE Series 2000 pump solution, is that the pump, PI controller, speed control and transmitter are placed close to one another, making the installation easy.

This solution makes it possible to get the entire system as one single unit: a TPE Series 2000 pump. In order to get the system up and running, pump curve data must be stored in the controller. These data are used to calculate the flow and likewise to calculate how much the setpoint, H_{set}, has to be reduced at a given flow to ensure that the pump performance meets the requirements.

The second solution involves higher installation costs as the transmitter has to be fitted near the radiators and extra cabling is required. The performance of this system is more or less similar to the first system. The transmitter measures the differential pressure at the radiator and compensates automatically for the increase in required pressure in order to overcome the increase in pressure losses in the supply pipes, etc.

2. Multistage E-pumps

Introduction

Grundfos multistage E-pumps are fitted with a frequency-controlled standard Grundfos MGE motor with built-in PI controller for single-phase or three-phase mains connection.

Grundfos multistage E-pumps include the following pump types:

- CRE, CRIE and CRNE pumps with integrated pressure sensor
- CRE, CRIE and CRNE pumps without sensor
- MTRE pumps
- SPKE pumps
- CRKE pumps
- CME pumps.

CRE, CRIE, CRNE pumps

TM05 0300 0911

Fig. 17 CRE, CRIE and CRNE pumps

Grundfos CRE, CRIE and CRNE pumps are available in two variants:

- with pressure sensor
- without sensor.

Pumps with pressure sensor

CRE, CRIE and CRNE pumps with pressure sensor are used in closed-loop control (constant pressure or controlled operation). The pumps are factory-fitted with a pressure sensor and are pre-configured for constant discharge pressure control. E-pumps with pressure sensor are quick and easy to install and commission.

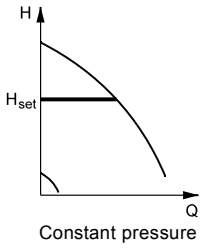


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Fig. 18 CRE, CRIE and CRNE with pressure sensor

Pumps without sensor

CRE, CRIE and CRNE pumps without sensor are not factory-fitted with a sensor, but require setup on installation.

- They can be set up for any type of sensor and be operated in closed-loop operation, controlling a process or a sub-process.
- They can be set up for open-loop operation on a specific curve or be controlled by an external control circuit.

Controlled by an advanced external control, the E-pump will function as actuator in the process.

Applications of CRE, CRIE, CRNE

CRE, CRIE and CRNE pumps are used in a wide variety of pumping systems where the performance and materials of the pump are required to meet specific demands.

Below is a list of general fields of application:

Industry

- Pressure boosting in process water systems
- washing and cleaning systems
- cooling and air-conditioning systems (refrigerants)
- boiler feed and condensate systems
- machine tools
- aquafarming
- transfer of oils, alcohols, acids, alkalis, glycol and coolants.

Water supply

- Filtration and transfer at waterworks
- distribution from waterworks
- pressure boosting in mains
- pressure boosting for industrial water supply.

Water treatment

- Ultra-filtration systems
- reverse osmosis systems
- softening, ionising, demineralising systems
- distillation systems
- separators.

Irrigation

- Field irrigation (flooding)
- sprinkler irrigation
- drip-feed irrigation.

MTRE, SPKE, CRKE pumps

TM02 8537 0508

Fig. 19 MTRE pumps

MTRE, SPKE and CRKE pumps are vertical multistage centrifugal pumps designed to be mounted on top of tanks with the chamber stack immersed in the pumped liquid.

The pumps are available in various sizes and with various numbers of stages to provide the flow and the pressure required.

The pumps consist of two main components:
The motor and the pump unit.

- The motor is a standard Grundfos MGE motor with built-in frequency converter designed to EN standards.
  For further information on MGE motors, see page 79.
- The pump unit has optimised hydraulics as well as various types of connection, chambers, a top and various other parts.

MTRE, SPKE and CRKE pumps can be connected to an external sensor enabling the control of for instance pressure, differential pressure, temperature, differential temperature or flow.

Applications of MTRE, SPKE, CRKE

The pumps are used in a wide variety of pumping systems where the performance and materials of the pump are required to meet specific demands.

Below is a list representing some general examples of applications:

- spark machine tools
- grinding machines
- machining centres
- cooling units
- industrial washing machines
- filtering systems.

CME pumps

GrA8697

Fig. 20 CME pump

CME pumps are reliable, quiet and compact horizontal end-suction pumps. The modular pump design makes it easy to make customised solutions. The CME pumps are available in cast iron and stainless steel.

The pumps are available in a large number of sizes and stages to provide the flow and pressure required.

The pumps consist of two main components:
The motor and the pump unit.

- The motor is a standard Grundfos MGE motor with built-in frequency converter designed to EN standards.
  For further information on MGE motors, see page 76.
- The pump unit is available in three material variants, i.e. cast iron and stainless steel, 1.4301 and 1.4401. It has optimised hydraulics and is available with various connections, for example DIN/JIS/ANSI flanges.

CME pumps can be connected to an external sensor enabling the control of for instance pressure, differential pressure, temperature, differential temperature or flow.

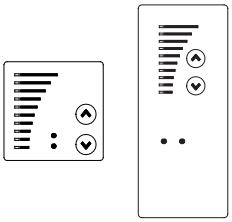
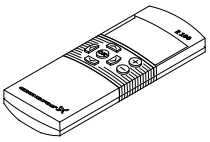
Applications of CME

The pumps are used in a wide variety of pumping systems where the performance of the pump is required to meet specific demands.

Below is a list representing some general examples of applications:

- pressure boosting
- water supply
- water treatment
- industrial washing and cleaning
- heating and cooling in industrial processes
- fertilizer systems
- dosing systems.

Overview of functions

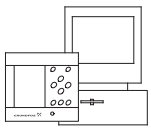
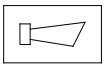
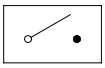
E-pump function		E-pump type			
		CRE, CRIE, CRNE with sensor		CRE, CRIE, CRNE, SPKE, CRKE, MTRE, CME without sensor	
		Single-phase	Three-phase	Single-phase	Three-phase
	Motor sizes [kW]	**0.37 - 1.1**	**0.75 - 22**	**0.37 - 1.1**	**0.75 - 22**
	**Setting via control panel**				
	Setpoint	•	•	•	•
	Start/stop	•	•	•	•
	Max. curve	•	•	•	•
	Min. curve	•	•	•	•
	Alarm reset	•	•	•	•
	Reading via control panel				
	Setpoint	•	•	•	•
	Operating indication	•	•	•	•
	Fault indication	•	•	•	•
	**Setting via the R100**				
	Setpoint	•	•	•	•
	Start/stop	•	•	•	•
	Max. curve	•	•	•	•
	Min. curve	•	•	•	•
	Alarm reset	•	•	•	•
	Warning reset		•		•
	Digital input	•	•	•	•
	Motor bearing monitoring		•		•
	Motor bearings changed or lubricated		•		•
	Standstill heating		• [3]		• [3]
	Controlled or uncontrolled	•	•	•	•
	Controller constants, K_p, T_i	•	•	•	•
	External setpoint signal	•	•	•	•
	Signal relay 1	•	•	•	•
	Signal relay 2		• [2]		• [2]
	Buttons on pump	•	•	•	•
	Pump number (for bus communication)	•	•	•	•
	Stop function	•	•	•	•
	Flow limit		•		•
	Sensor range and signal	• [1]	• [1]	•	•
	Duty/standby	•	•	•	•
	Operating range (min./max. speed)	•	•	•	•
	Reading via the R100				
	Setpoint	•	•	•	•
	Operating mode	•	•	•	•
	Actual sensor value	•	•	•	•
	Pump speed	•	•	•	•
	Power input	•	•	•	•
	Power consumption	•	•	•	•
	Operating hours	•	•	•	•
	Lubrication status (bearings)		• [2]		• [2]
	Replacement status (bearings)		•		•

• Available.

[1] Sensor fitted.

[2] Only 11-22 kW.

[3] Lubricated, only 11-22 kW.

E-pump function		E-pump type			
		CRE, CRIE, CRNE with sensor		CRE, CRIE, CRNE, SPKE, CRKE, MTRE, CME without sensor	
		Single-phase	Three-phase	Single-phase	Three-phase
	Motor sizes [kW]	**0.37 - 1.1**	**0.75 - 22**	**0.37 - 1.1**	**0.75 - 22**
	**Setting via GENIbus**				
	Setpoint	●	●	●	●
	Start/stop	●	●	●	●
	Max. curve	●	●	●	●
	Min. curve	●	●	●	●
	Controlled or uncontrolled	●	●	●	●
	Reading via GENIbus				
	Setpoint	●	●	●	●
	Operating indication	●	●	●	●
	Pump status	●	●	●	●
	Setting via external signal				
	Setpoint	●	●	●	●
	Start/stop	●	●	●	●
	Min./max. curve, external fault, flow switch via digital input	●	●	●	●
	Reading via external signal				
	Fault, Operation or Ready signal (relay)	●	●	●	●
	Fault, Operation, Ready, Pump running, Bearing lubrication, Warning, Limit exceeded 1 and 2		●		●

● Available.

1) Sensor fitted.

2) Only 11-22 kW.

3) Lubricated, only 11-22 kW.

Modes

Grundfos E-pumps are set and controlled according to operating and control modes.

Overview of modes

Operating modes	Normal	—	Stop	— Min. —	Max.
Control modes	Uncontrolled	—	Controlled		
	Constant curve		Constant pressure[1)]		

1) In this example, the pump is fitted with a pressure sensor. The pump may also be fitted with a temperature sensor in which case the description would be constant temperature in control mode "Controlled".

Operating mode

When the operating mode is set to "Normal", the control mode can be set to "Controlled" or "Uncontrolled".

The other operating modes that can be selected are "Stop", "Min." or "Max.".

- Stop: The pump has been stopped.
- Min.: The pump is operating at its minimum speed.
- Max.: The pump is operating at its maximum speed.

Figure 21 is a schematic illustration of min. and max. curves.

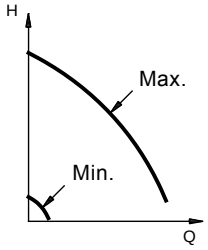


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Fig. 21 Min. and max. curves

The max. curve can for instance be used in connection with the venting procedure during installation.
The min. curve can be used in periods in which a minimum flow is required.

If the power supply to the pump is disconnected, the mode setting will be stored.

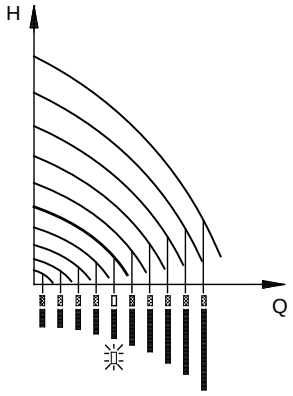
The R100 remote control offers additional settings and status displays. See section *Setting via the R100*, page 23.

Control modes

Pumps without factory-fitted sensor

The pumps are factory-set to control mode "Uncontrolled".

In control mode "Uncontrolled", the pump will operate according to the constant curve set. See fig. 22.



TM00 7746 1304

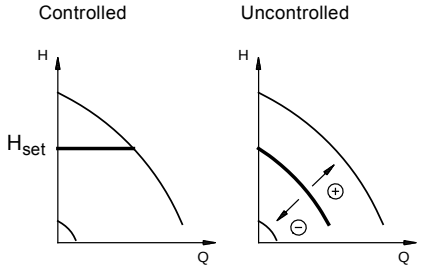
Fig. 22 Pump in control mode "Uncontrolled" (constant curve)

Pumps with pressure sensor

The pump can be set to one of two control modes, i.e. "Controlled" and "Uncontrolled". See fig. 23.

In control mode "Controlled", the pump will adjust its performance, i.e. pump discharge pressure, to the desired setpoint for the control parameter.

In control mode "Uncontrolled", the pump will operate according to the constant curve set.



TM00 7668 0404

Fig. 23 Pump in control mode "Controlled" (constant pressure) or "Uncontrolled" (constant curve)

Setting up the pump

Factory setting

Pumps without factory-fitted sensor

The pumps have been factory-set to control mode "Uncontrolled".

The setpoint value corresponds to 100 % of the maximum pump performance. See data sheet for the pump.

Pumps with pressure sensor

The pumps have been factory-set to control mode "Controlled". The setpoint value corresponds to 50 % of the sensor measuring range (see sensor nameplate).

Setting via the control panel

The pump control panel (fig. 24 or 25) incorporates the following buttons and indicator lights:

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

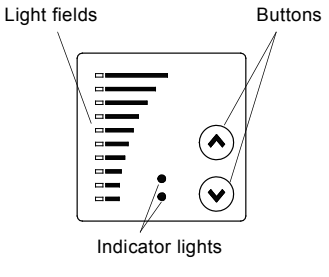


Fig. 24 Control panel, single-phase pumps, 0.37 - 1.1 kW

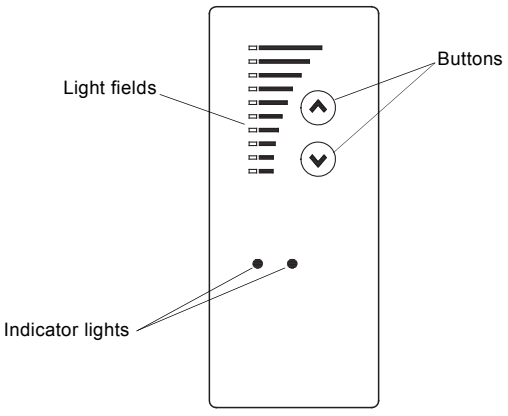


Fig. 25 Control panel, three-phase pumps, 0.75 - 22 kW

Setpoint setting

Set the desired setpoint by pressing ⊛ or ⊛.

The light fields on the control panel will indicate the setpoint set.

Pump in control mode "Controlled" (pressure control)

Example

Figure 26 shows that the light fields 5 and 6 are activated, indicating a desired setpoint of 3 bar. The setting range is equal to the sensor measuring range (see sensor nameplate).

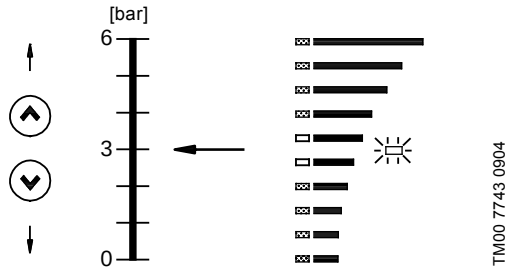


Fig. 26 Setpoint set to 3 bar (pressure control)

Pump in control mode "Uncontrolled"

Example

In control mode "Uncontrolled", the pump performance is set within the range from min. to max. curve. See fig. 27.

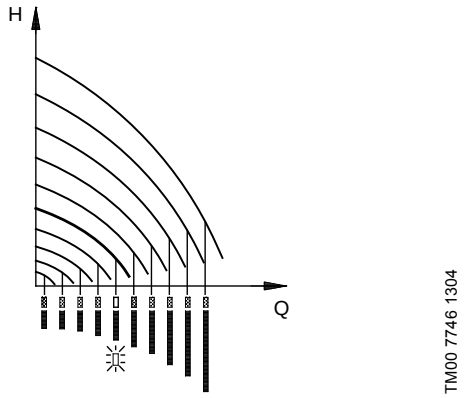


Fig. 27 Pump performance setting, control mode "Uncontrolled"

Setting to max. curve duty

Press ⊙ continuously to change to the max. curve of the pump (top light field flashes). See fig. 28. When the top light field is on, press ⊙ for 3 seconds until the light field starts flashing.

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

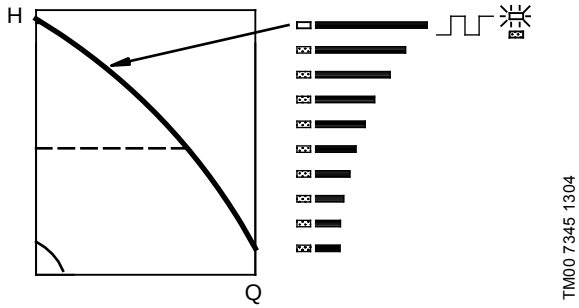


Fig. 28 Max. curve duty

Setting to min. curve duty

Press ⊙ continuously to change to the min. curve of the pump (bottom light field flashes). See fig. 29. When the bottom light field is on, press ⊙ for 3 seconds until the light field starts flashing.

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

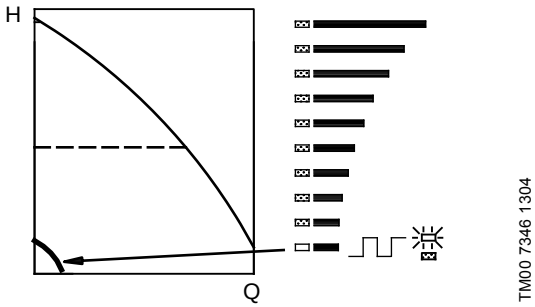


Fig. 29 Min. curve duty

Start/stop of pump

Start the pump by continuously pressing ⊙ until the desired setpoint is indicated. This is operating mode "Normal".

Stop the pump by continuously pressing ⊙ until none of the light fields are activated and the green indicator light flashes.

Setting via the R100

The pump is designed for wireless communication with the Grundfos R100 remote control.

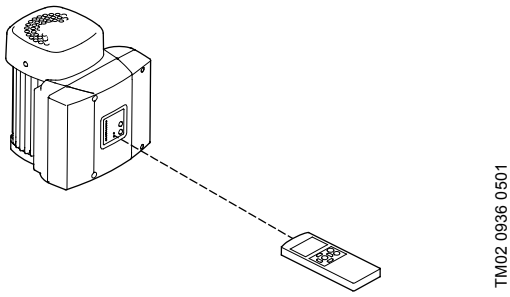


Fig. 30 R100 communicating with the pump via infrared light

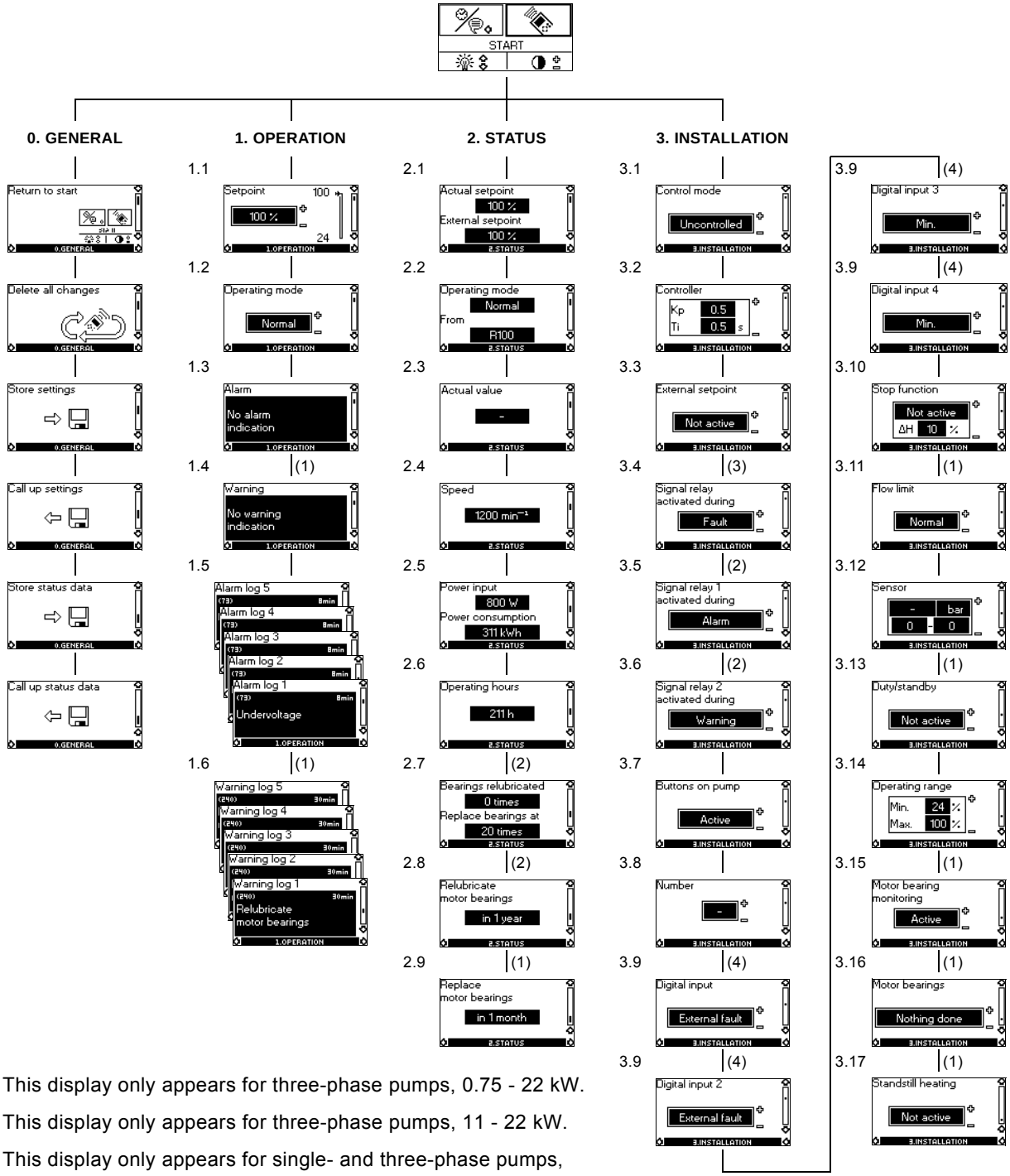
During communication, the R100 must be pointed at the control panel. When the R100 communicates with the pump, the red indicator light will flash rapidly. Keep pointing the R100 at the control panel until the red indicator light stops flashing.

The R100 offers setting and status displays for the pump.

The displays are divided into four parallel menus, fig. 31:

0. GENERAL (see operating instructions for the R100)
1. OPERATION
2. STATUS
3. INSTALLATION

The figure above each individual display in fig. 31 refers to the section in which the display is described.



(1) This display only appears for three-phase pumps, 0.75 - 22 kW.

(2) This display only appears for three-phase pumps, 11 - 22 kW.

(3) This display only appears for single- and three-phase pumps, 0.37 - 7.5 kW.

(4) This display only appears if an advanced I/O module is installed.

Fig. 31 Menu overview

Displays in general

In the following explanation of the functions, one or two displays are shown.

One display

Pumps without or with factory-fitted sensor have the same function.

Two displays

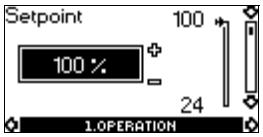
Pumps without or with factory-fitted pressure sensor have different functions and factory settings.

Menu OPERATION

This is the first display in this menu:

Setpoint

Without sensor (Uncontrolled)



- Setpoint set
- Actual setpoint
- Actual value

Set the setpoint in [%].

With pressure sensor (Controlled)

- Setpoint set
- Actual setpoint
- Actual value

Set the desired pressure in [bar].

In control mode "Uncontrolled", the setpoint is set in % of the maximum performance. The setting range will lie between the min. and max. curves.

In control mode "Controlled", the setting range is equal to the sensor measuring range.

If the pump is connected to an external setpoint signal, the value in this display will be the maximum value of the external setpoint signal.

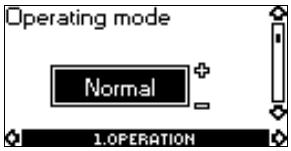
Setpoint and external signal

The setpoint cannot be set if the pump is controlled via external signals (Stop, Min. or Max). The R100 will give this warning: External control!
Check if the pump is stopped via terminals 2 and 3 (open circuit) or set to min. or max. via terminals 1 and 3 (closed circuit).

Setpoint and bus communication

The setpoint cannot be set if the pump is controlled from an external control system or via bus communication. The R100 will give this warning: Bus control!
To override bus communication, disconnect the bus connection.

Operating mode



Select one of the following operating modes:

- Stop
- Min.
- **Normal** (duty)
- Max.

The operating modes can be selected without changing the setpoint setting.

Fault indications

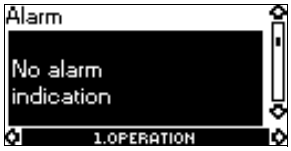
In E-pumps, faults may result in two types of indication: Alarm or Warning.

An "alarm" fault will activate an alarm indication in the R100 and cause the pump to change operating mode, typically to stop. However, for some faults resulting in alarm, the pump is set to continue operating even if there is an alarm.

A "warning" fault will activate a warning indication in the R100, but the pump will not change operating or control mode.

Note: The indication "Warning" only applies to three-phase pumps.

Alarm



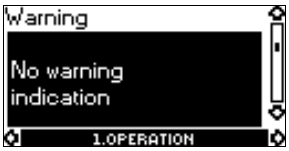
In case of alarm, the cause will appear in this display.

Possible causes:

- No alarm indication
- Too high motor temperature
- Undervoltage
- Mains voltage asymmetry (11-22 kW)
- Overvoltage
- Too many restarts (after faults)
- Overload
- Underload (11-22 kW)
- Sensor signal outside signal range
- Setpoint signal outside signal range
- External fault
- Duty/standby, Communication fault
- Dry running (11-22 kW)
- Other fault.

If the pump has been set up to manual restart, an alarm indication can be reset in this display if the cause of the fault has disappeared.

Warning (only three-phase pumps)



In case of warning, the cause will appear in this display.

Possible causes:

- No warning indication
- Sensor signal outside signal range
- Relubricate motor bearings (11-22 kW)
- Replace motor bearings
- Replace varistor (11-22 kW).*)

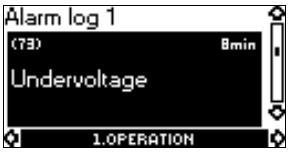
A warning indication will disappear automatically once the fault has been remedied.

*) The varistor protects the pump against mains voltage transients. If voltage transients occur, the varistor will be worn over time and need to be replaced. The more transients, the more quickly the varistor will be worn. A Grundfos technician is required for replacement of the varistor.

Fault log

For both fault types, alarm and warning, the R100 has a log function.

Alarm log

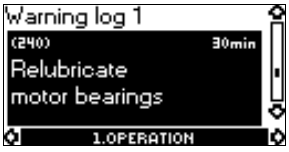


In case of "alarm" faults, the last five alarm indications will appear in the alarm log. "Alarm log 1" shows the latest fault, "Alarm log 2" shows the latest fault but one, etc.

The example above gives this information:

- The alarm indication "Undervoltage".
- The fault code (73).
- The number of minutes the pump has been connected to the power supply after the fault occurred, 8 min.

Warning log (only three-phase pumps)



In case of "warning" faults, the last five warning indications will appear in the warning log. "Warning log 1" shows the latest fault, "Warning log 2" shows the latest fault but one, etc.

The example above gives this information:

- The warning indication "Relubricate motor bearings".
- The fault code (240).
- The number of minutes the pump has been connected to the power supply since the fault occurred, 30 min.

Menu STATUS

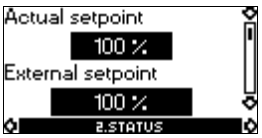
The displays appearing in this menu are status displays only. It is not possible to change or set values.

The displayed values are the values that applied when the last communication between the pump and the R100 took place. If a status value is to be updated, point the R100 at the control panel, and press [OK]. If a parameter, e.g. speed, should be called up continuously, press [OK] constantly during the period in which the parameter in question should be monitored.

The tolerance of the displayed value is stated under each display. The tolerances are stated as a guide in % of the maximum values of the parameters.

Actual setpoint

Without sensor (Uncontrolled)



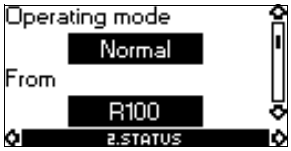
Tolerance: ± 2 %

With pressure sensor (Controlled)

Tolerance: ± 2 %

This display shows the actual setpoint and the external setpoint in % of the range from minimum value to the setpoint set.

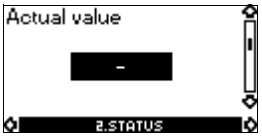
Operating mode



This display shows the actual operating mode (Stop, Min., Normal (duty) or Max.). Furthermore, it shows where this operating mode was selected (R100, Pump, Bus, External or Stop func.).

Actual value

Without sensor (Uncontrolled)



With pressure sensor (Controlled)

This display shows the value actually measured by a connected sensor.

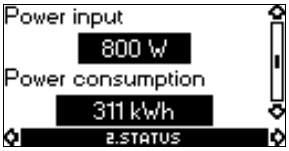
If no sensor is connected to the pump, "-" will appear in the display.

Speed

Tolerance: ± 5 %

The actual pump speed will appear in this display.

Power input and power consumption



Tolerance: ± 10 %

This display shows the actual pump input power from the mains supply. The power is displayed in W or kW.

The pump power consumption can also be read from this display. The value of power consumption is an accumulated value calculated from the pump's birth and it cannot be reset.

Operating hours

Tolerance: ± 2 %

The value of operating hours is an accumulated value and cannot be reset.

Lubrication status of motor bearings (only 11-22 kW)

This display shows how many times the motor bearings have been relubricated and when to replace the motor bearings.

When the motor bearings have been relubricated, confirm this action in the INSTALLATION menu. See *Confirming relubrication/replacement of motor bearings (only three-phase pumps)*, page 32. When relubrication is confirmed, the figure in the above display will be increased by one.

Time till relubrication of motor bearings (only 11-22 kW)

This display shows when to relubricate the motor bearings. The controller monitors the operating pattern of the pump and calculates the period between bearing relubrications. If the operating pattern changes, the calculated time till relubrication may change as well.

Displayable values:

- in 2 years
- in 1 year
- in 6 months
- in 3 months
- in 1 month
- in 1 week
- Now!

Time till replacement of motor bearings (only three-phase pumps)

When the motor bearings have been relubricated a prescribed number of times stored in the controller, the display in the previous section will be replaced by the display below.

This display shows when to replace the motor bearings. The controller monitors the operating pattern of the pump and calculates the period between bearing replacements.

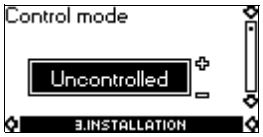
Displayable values:

- in 2 years
- in 1 year
- in 6 months
- in 3 months
- in 1 month
- in 1 week
- Now!

Menu INSTALLATION

Control mode

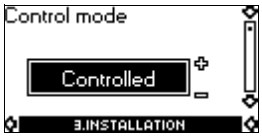
Without sensor (Uncontrolled)



Select one of the following control modes (see fig. 23):

- Controlled
- **Uncontrolled**.

With pressure sensor (Controlled)



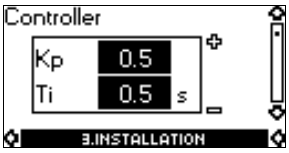
Select one of the following control modes (see fig. 23):

- **Controlled**
- Uncontrolled.

Note: If the pump is connected to a bus, the control mode cannot be selected via the R100.

Controller

E-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, the gain and the integral time can be changed in the display below.



- The gain (K_p) can be set within the range from 0.1 to 20.
- The integral time (T_i) can be set within the range from 0.1 to 3600 s. If "3600 s" is selected, the controller will function as a P controller.
- Furthermore, it is possible to set the controller to inverse control, meaning that if the setpoint is increased, the speed will be reduced. In the case of inverse control, the gain (K_p) must be set within the range from -0.1 to -20.

External setpoint

The input for external setpoint signal can be set to different signal types.

Select one of the following types:

- 0-10 V
- 0-20 mA
- 4-20 mA
- **Not active**.

If "Not active" is selected, the setpoint set via the R100 or on the control panel will apply.

If one of the signal types is selected, the actual setpoint is influenced by the signal connected to the external setpoint input.

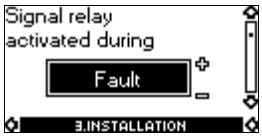
Signal relay

Pumps of 0.37 - 7.5 kW have one signal relay. The factory setting of the relay will be "Fault".

Pumps of 11 - 22 kW have two signal relays. Signal relay 1 is factory-set to "Alarm" and signal relay 2 to "Warning".

In one of the displays below, select in which one of three or six operating situations the signal relay should be activated.

Single-phase pumps 0.37 - 1.1 kW



- Ready
- **Fault**
- Operation.

Three-phase pumps 0.75 - 22 kW

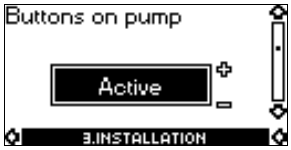
- Ready
- **Alarm**
- Operation
- Pump running
- Warning
- Relubricate (11-22 kW).

Three-phase pumps 11 - 22 kW

- Ready
- Alarm
- Operation
- Pump running
- **Warning**
- Relubricate.

Note: "Fault" and "Alarm" cover faults resulting in "Alarm".
"Warning" covers faults resulting in "Warning".
"Relubricate" covers only that one individual event.
For distinction between alarm and warning, see section *Fault indications*, page 25.

Buttons on pump

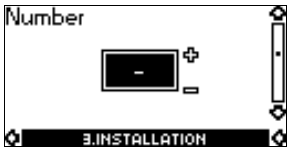


The operating buttons ⊙ and ⊙ on the control panel can be set to these values:

- **Active**
- Not active.

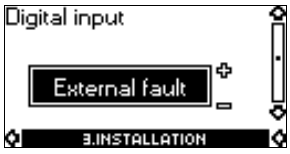
When set to "Not active" (locked), the buttons do not function. Set the buttons to "Not active" if the pump should be controlled via an external control system.

Pump number



A number between 1 and 64 can be allocated to the pump. In the case of bus communication, a number must be allocated to each pump.

Digital inputs



The digital inputs of the pump (terminal 1, fig. 37, page 33) can be set to various functions.

Select one of the following functions:

- Min. (min. curve)
- Max. (max. curve)
- External fault
- Flow switch
- Dry running (from external sensor) (only 11-22 kW).

The selected function is activated by closing the contact between either terminals 1 and 9, 1 and 10 or 1 and 11. See fig. 37, page 33.

Min.:

When the input is activated, the pump will operate according to the min. curve.

Max.:

When the input is activated, the pump will operate according to the max. curve.

External fault

When the input is activated, a timer will be started.
If the input is activated for more than 5 seconds, the pump will be stopped and a fault will be indicated.
If the input is deactivated for more than 5 seconds, the fault condition will cease and the pump can only be restarted manually by resetting the fault indication.

Flow switch

When this function is selected, the pump will be stopped when a connected flow switch detects low flow.
It is only possible to use this function if the pump is connected to a pressure sensor.

If the input is activated for more than 5 seconds, the stop function incorporated in the pump will take over.

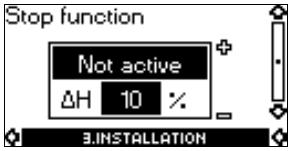
Dry running (only 11-22 kW)

When this function is selected, lack of inlet pressure or water shortage can be detected. This requires the use of an accessory, such as

- a Grundfos Liqtec® dry-running sensor
- a pressure switch installed on the suction side of a pump
- a float switch installed on the suction side of a pump.

When lack of inlet pressure or water shortage (Dry running) is detected, the pump will be stopped. The pump cannot restart as long as the input is activated.

Stop function



The stop function can be set to these values:

- Active
- **Not active**.

When the stop function is active, the pump will be stopped at very low flows.

Purpose of the stop function:

- to avoid unnecessary heating of the pumped liquid
- to reduce wear of the shaft seals
- to reduce noise from operation.

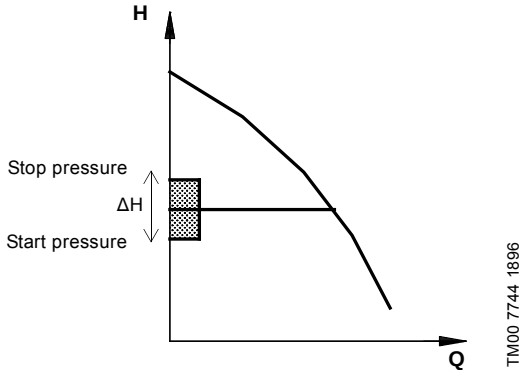


Fig. 32 Difference between start and stop pressures (ΔH)

ΔH is factory-set to **10 % of actual setpoint**.
ΔH can be set within the range from 5 % to 30 % of actual setpoint.

Low flow can be detected in two ways:

- a built-in "low-flow detection function" which functions if the digital input is not set up for flow switch
- a flow switch connected to the digital input.

Low-flow detection function

The pump will check the flow regularly by reducing the speed for a short time. If there is no or only a small change in pressure, this means that there is low flow. The speed will be increased until the stop pressure (actual setpoint + 0.5 x ΔH) is reached and the pump will stop. When the pressure has fallen to the start pressure (actual setpoint - 0.5 x ΔH), the pump will restart.

When restarting, the pumps will react differently according to pump type:

0.37 - 1.1 kW, single-phase pumps

The pump will return to continuous operation at constant pressure and continue checking the flow regularly by reducing the speed for a short time.

0.75 - 22 kW, three-phase pumps

1. If the flow is higher than the low-flow limit, the pump will return to continuous operation at constant pressure.
2. If the flow is still lower than the low-flow limit, the pump will continue in start/stop operation until the flow is higher than the low-flow limit. When the flow is higher than the low-flow limit, the pump will return to continuous operation.

Flow switch

When the digital input is activated for more than 5 seconds because there is low flow, the speed will be increased until the stop pressure (actual setpoint + 0.5 x ΔH) is reached, and the pump will stop. When the pressure has fallen to the start pressure, the pump will start again. If there is still no flow, the pump will quickly reach the stop pressure and stop. If there is flow, the pump will continue operating according to the setpoint.

Operating conditions for the stop function

It is only possible to use the stop function if the system incorporates a pressure sensor, a non-return valve and a diaphragm tank.

Note: The non-return valve must always be installed before the pressure sensor. See figs 33 and 34.

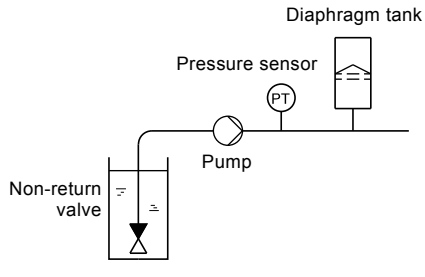


Fig. 33 Position of the non-return valve and pressure sensor in system with suction lift operation

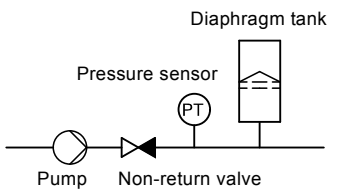


Fig. 34 Position of the non-return valve and pressure sensor in system with positive inlet pressure

Diaphragm tank

The stop function requires a diaphragm tank of a certain minimum size. The tank must be installed immediately after the pump, and the precharge pressure must be 0.7 x actual setpoint.

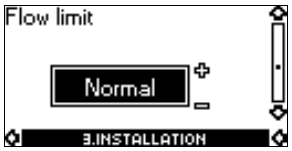
Recommended diaphragm tank size:

Rated flow of pump [m^3/h]	CRE pump	Typical diaphragm tank size [litres]
0-6	1s, 1, 3, 5	8
7-24	10, 15, 20	18
25-40	32	50
41-70	45, 64	120
71-100	90	180

If a diaphragm tank of the above size is installed in the system, the factory setting of ΔH is the correct setting. If the tank installed is too small, the pump will start and stop too often. This can be remedied by increasing ΔH.

Flow limit for the stop function (only three-phase pumps)

Note: Flow limit for the stop function only works if the system is not set up for flow switch.



In order to set at which flow rate the system is to go from continuous operation at constant pressure to start/stop operation, select among these four values of which three are pre-configured flow limits:

- Low
- **Normal**
- High
- Custom.

The default setting of the pump is "Normal", representing approx. 10 % of the pump rated flow.

If a lower flow limit than "Normal" is desired or the tank size is smaller than recommended, select "Low".

If a higher flow than "Normal" is desired or a large tank is used, select "High".

The value "Custom" can be seen in the R100, but it can only be set via the PC Tool E-products. "Custom" is for customised setup and optimising to the process.

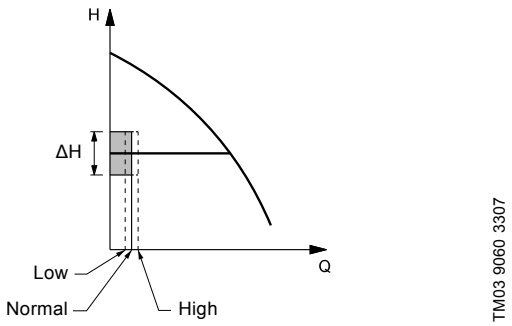
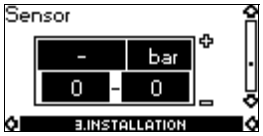


Fig. 35 Three pre-configured flow limits, "Low", "Normal" and "High"

Sensor

Without sensor (Uncontrolled)



With pressure sensor (Controlled)

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.

Duty/standby (only three-phase pumps)

The duty/standby function applies to two pumps connected in parallel and controlled via GENIbus.

The duty/standby function can be set to these values:

- Active
- **Not active**.

When the function is set to "Active", the following applies:

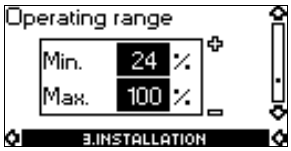
- Only one pump is running at a time.
- The stopped pump (standby) will automatically be cut in if the running pump (duty) has a fault. A fault will be indicated.
- Changeover between the duty pump and the standby pump will take place every 24 hours.

Activate the duty/standby function as follows:

1. Connect one of the pumps to the mains supply. Set the duty/standby function to "Not active". Using the R100, make the necessary settings in menu OPERATION and INSTALLATION.
2. Set the operating mode to "Stop" in menu OPERATION.
3. Connect the other pump to the mains supply. Using the R100, make the necessary settings in menu OPERATION and INSTALLATION. Set the duty/standby function to "Active".

The running pump will search for the other pump and automatically set the duty/standby function of this pump to "Active". If it cannot find the other pump, a fault will be indicated.

Operating range



How to set the operating range:

- Set the min. curve within the range from max. curve to 12 % of maximum performance. The pump has been factory-set to 24 % of maximum performance.
- Set the max. curve within the range from maximum performance (100 %) to min. curve.

The area between the min. and max. curves is the operating range.

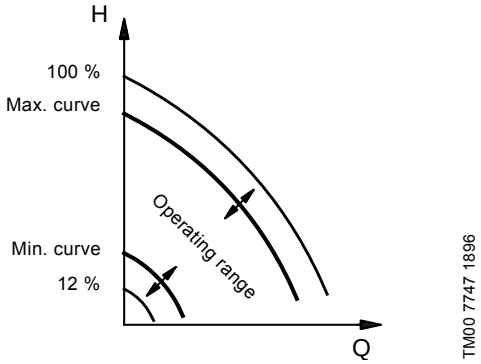


Fig. 36 Setting of the min. and max. curves in % of maximum performance

Motor bearing monitoring (only three-phase pumps)

The motor bearing monitoring function can be set 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. See section *Lubrication status of motor bearings (only 11-22 kW)*, page 27.

Note: The counter will continue counting even if the function is switched to "Not active", but a warning will not be given when it is time for relubrication.

When the function is switched to "Active" again, the accumulated mileage will again be used to calculate the relubrication time.

Confirming relubrication/replacement of motor bearings (only three-phase pumps)

This function can be set to these values:

- Relubricated (11-22 kW)
- Replaced
- **Nothing done**.

When the bearing monitoring function is "Active", the controller will give a warning indication when the motor bearings are due to be relubricated or replaced.
See section *Fault indications*, page 25.

When the motor bearings have been relubricated or replaced, confirm this action in the above display by pressing [OK].

Note: "Relubricated" cannot be selected for a period of time after confirming relubrication.

Standstill heating (only three-phase pumps)

The standstill heating function can be set to these values:

- Active
- **Not active**.

When the function is set to "Active", an AC voltage will be applied to the motor windings. The applied AC voltage will ensure that sufficient heat is generated to avoid condensation in the motor.

Setting via the PC Tool E-products

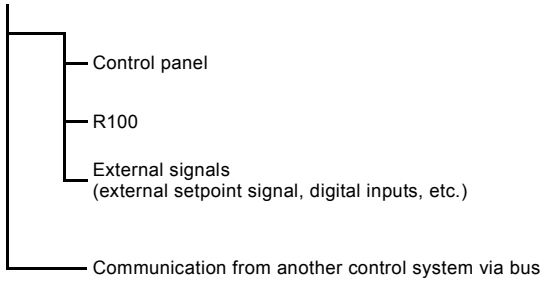
Special setup requirements differing from the settings available via the R100 require the use of the Grundfos PC Tool E-products. This again requires the assistance of a Grundfos service technician or engineer. Contact your local Grundfos company for more information.

Priority of settings

The priority of settings depends on two factors:

1. control source
2. settings.

1. Control source



2. Settings

- Operating mode "Stop"
- operating mode "Max." (max. curve)
- operating mode "Min." (min. curve)
- setpoint setting.

An E-pump can be controlled by different control sources at the same time, and each of these sources can be set differently. **Consequently, it is necessary to set an order of priority of the control sources and the settings.**

Note: If two or more settings are activated at the same time, the pump will operate according to the function with the highest priority.

Priority of settings without bus communication

Priority	Control panel or R100	External signals
1	Stop	
2	Max.	
3		Stop
4		Max.
5	Min.	Min.
6	Setpoint setting	Setpoint setting

Example: If the E-pump has been set to operating mode "Max." (max. frequency) via an external signal, such as digital input, the control panel or the R100 can only set the E-pump to operating mode "Stop".

Priority of settings with bus communication

Priority	Control panel or R100	External signals	Bus communication
1	Stop		
2	Max.		
3		Stop	Stop
4			Max.
5			Min.
6			Setpoint setting

Example: If the E-pump is operating according to a setpoint set via bus communication, the control panel or the R100 can set the E-pump to operating mode "Stop" or "Max.", and the external signal can only set the E-pump to operating mode "Stop".

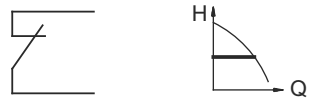
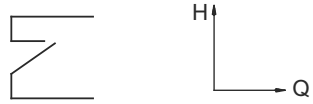
External forced-control signals

The pump has inputs for external signals for these forced-control functions:

- start/stop of pump
- digital input.

Start/stop input

Functional diagram: Start/stop input

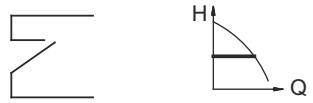
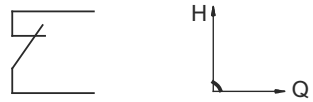
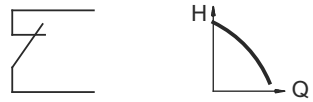
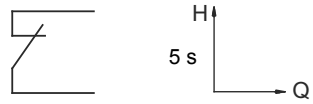
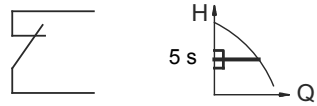
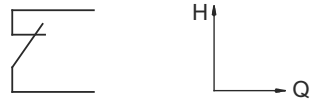
Start/stop (terminals 2 and 3)	
	**Normal duty**
	**Stop**

Digital inputs

Via the R100, one of the following functions can be selected for the digital input:

- Normal (duty)
- Min. (curve)
- Max. (curve)
- External fault
- Flow switch
- Dry running.

Functional diagram: Input for digital function

Digital function (terminals 1 and 9)	
	**Normal duty**
	**Min. curve**
	**Max. curve**
	**External fault**
	**Flow switch**
	**Dry running**

Connection terminals

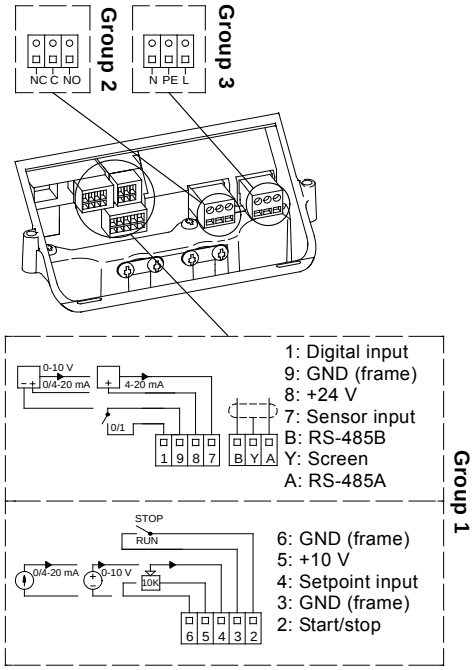


Fig. 37 Connection terminals

External setpoint signal

The setpoint can be remote-set by connecting an analog signal transmitter to the input for the setpoint signal (terminal 4).

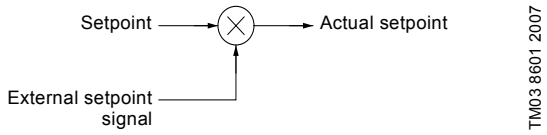


Fig. 38 Actual setpoint as a product (multiplied value) of setpoint and external setpoint signal

Select the actual external signal, 0-10 V, 0-20 mA, 4-20 mA, via the R100. See section *External setpoint*, page 28.

If control mode "Uncontrolled" is selected via the R100, the pump can be controlled by any controller.

In control mode "Controlled", the setpoint can be set externally within the range from $sensor_{min}$ to the setpoint set on the pump or via the R100.

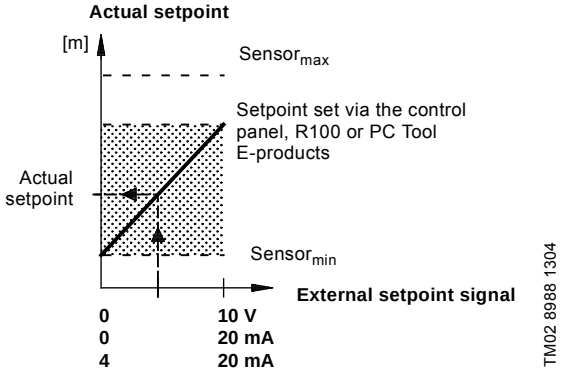


Fig. 39 Relation between the actual setpoint and the external setpoint signal in control mode "Controlled"

Example: At a $sensor_{min}$ value of 0 bar, a setpoint set of 3 bar and an external setpoint of 80 %, the actual setpoint will be as follows:

$$\text{Actual setpoint} = (\text{setpoint} - \text{sensor}_{min}) \times \%_{\text{external setpoint}} + \text{sensor}_{min}$$
$$= (3 - 0) \times 80\ \% + 0$$
$$= 2.4 \text{ bar}$$

In control mode "Uncontrolled", the setpoint can be set externally within the range from the min. curve to the setpoint set on the pump or via the R100.

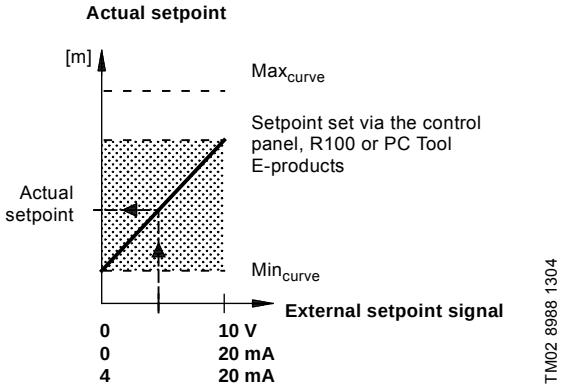


Fig. 40 Relation between the actual setpoint and the external setpoint signal in control mode "Uncontrolled"

Bus signal

The pump supports serial communication via an RS-485 input. The communication is carried out according to the Grundfos bus protocol, GENIbus, and enables connection to a building management system or another external control system.

Operating parameters, such as setpoint, operating mode, etc. can be remote-set via the bus signal. At the same time, the pump can provide status information about important parameters, such as actual value of control parameter, input power, fault indications, etc.

Contact Grundfos for further details.

Note: If a bus signal is used, the number of settings available via the R100 will be reduced.

Other bus standards

Grundfos offers various bus solutions with communication according to other standards.

Contact Grundfos for further details

Indicator lights and signal relay

The operating condition of the pump is indicated by the green and red indicator lights on the pump control panel and inside the terminal box. See figs 41 and 42.

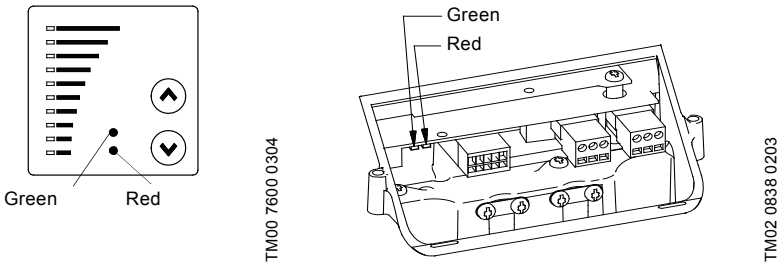


Fig. 41 Position of indicator lights on single-phase pumps

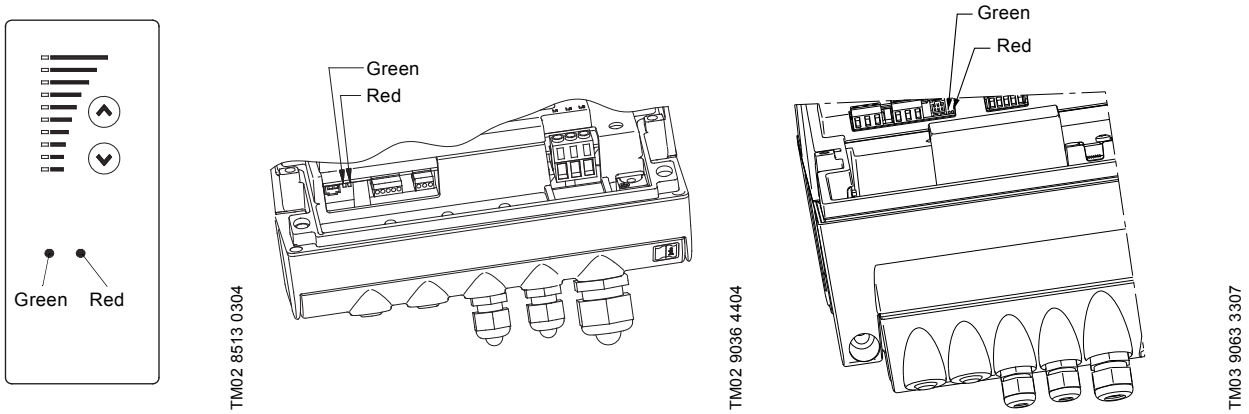
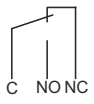
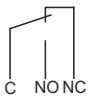
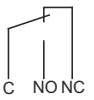
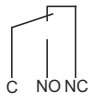
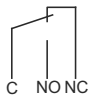
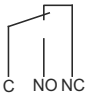
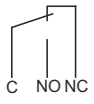
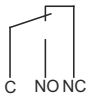
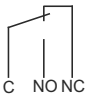
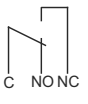
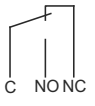
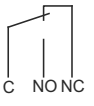
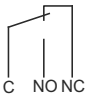
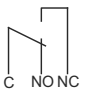
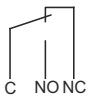
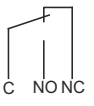


Fig. 42 Position of indicator lights on three-phase pumps

Besides, the pump incorporates an output for a potential-free signal via an internal relay.

For signal relay output values, see section *Signal relay*, page 28.

The functions of the two indicator lights and the signal relay are as shown in the following table:

Indicator lights		Signal relay activated during:				Description
Fault (red)	Operation (green)	Fault/Alarm, Warning and Relubricate	Operating	Ready	Pump running	
Off	Off					The power supply has been switched off.
Off	Permanently on					The pump is operating.
Off	Permanently on					The pump has been stopped by the stop function.
Off	Flashing					The pump has been set to stop.
Permanently on	Off					The pump has stopped because of a "Fault"/"Alarm" or is running 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). If the cause is "External fault", the pump must be restarted manually by resetting the "Fault" indication.
Permanently on	Permanently on					The pump is operating, but it has or has had a "Fault"/"Alarm" allowing the pump to continue operation or it is operating with a "Warning" or "Relubricate" indication. If the cause is "Sensor signal outside signal range", the pump will continue operating according to the max. curve and the fault indication cannot be reset until the signal is inside the signal range. If the cause is "Setpoint signal outside signal range", the pump will continue operating according to the min. curve and the fault indication cannot be reset 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

A fault indication can be reset 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 the R100. See section *Fault indications*, page 25.

When the R100 communicates with the pump, the red indicator light will flash rapidly.

Insulation resistance

0.37 - 7.5 kW

Do not measure the insulation resistance of motor windings or an installation incorporating E-pumps using high-voltage megging equipment, as this may damage the built-in electronics.

11 - 22 kW

Do not measure the insulation resistance of an installation incorporating E-pumps using high-voltage megging equipment, as this may damage the built-in electronics.

The motor conductors can be disconnected separately and the insulation resistance of the motor windings can be tested.

Further product documentation

Specific data booklets are also available on www.grundfos.com > International website > WebCAPS. For further information on WebCAPS, see page 123.

3. TPE, TPED, NKE, NBE

Introduction

The Grundfos single-stage E-pumps described in this section include the following pump types:

- TPE, TPED Series 1000
- NKE
- NBE.

Note: TPE, TPED is also available as a TPE, TPED Series 2000 E-pump, including a differential-pressure sensor. See page 56.

TPE, TPED, NKE and NBE pumps consist of two main components: The motor and the pump unit.

- The motor is a Grundfos MGE motor (0.25 - 22 kW) with built-in frequency converter designed to EN standards.
- The pump unit has optimised hydraulics, union or flanged connections and various other parts.

TPE, TPED, NKE and NBE pumps can be connected to an external sensor and require setup during installation.

- The pumps can be set up for any type of sensor and be operated in closed-loop operation, controlling a process or a sub-process.
- The pumps can be set up for open-loop operation according to a specific curve or be controlled by an external control circuit.

Controlled by an advanced external control, the E-pump will function as actuator in the process.

TPE, TPED Series 1000

TM02 1502 0101 - GR8275

Fig. 43 TPE pumps without sensor

TPE, TPED Series 1000 are vertical single-stage centrifugal pumps.

Due to the in-line design, the pump can be installed in a horizontal or vertical one-pipe system where the suction and discharge ports are in the same plane and have the same pipe dimensions. This design provides a more compact pump design and pipework.

The pumps are available in various sizes to provide the flow and the pressure required.

Applications of TPE, TPED Series 1000

TPE, TPED Series 1000 are used in a wide variety of pumping systems where the performance and materials of the pump are required to meet specific demands.

Below is a list of some general examples of application:

- district heating systems
- heating systems
- air-conditioning systems
- district cooling systems
- water supply
- industrial processes
- industrial cooling.

NKE and NBE pumps

GrA2524

Fig. 44 NKE and NBE pumps

NKE and NBE pumps are horizontal single-stage volute pumps with axial suction port and radial discharge port.

NKE pumps are of the long-coupled pump type and NBE pumps are of the close-coupled pump type.

Applications of NKE and NBE

The NKE and NBE series are multi-purpose E-pump ranges suitable for a variety of different applications demanding reliable and cost-efficient supply.

Below is a list of three general fields of application:

Water supply

- Filtration and transfer at waterworks
- pressure boosting
- public water supply.

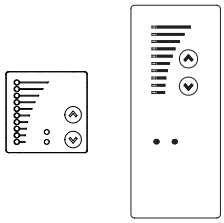
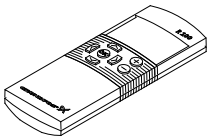
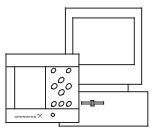
Building utility

- District heating plants
- cooling and air-conditioning systems (refrigerants)
- washing and cleaning systems
- fire protection systems
- boiler feed and condensate systems.

Irrigation

- Field irrigation (flooding)
- sprinkler irrigation
- drip-feed irrigation.

Overview of functions

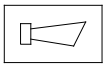
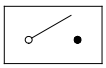
E-pump functions		E-pump type	
		TPE, TPED Series 1000, NBE, NKE without sensor	TPE, TPED Series 1000, NBE, NKE without sensor
		Single-phase	Three-phase
	Motor sizes [kW]	**0.25 - 1.1**	**0.55 - 22**
	**Setting via control panel**		
	Setpoint	•	•
	Start/stop	•	•
	Max. curve	•	•
	Min. curve	•	•
	Alarm reset	•	•
	Reading via control panel		
	Setpoint	•	•
	Operating indication	•	•
	Fault indication	•	•
	**Setting via the R100**		
	Setpoint	•	•
	Start/stop	•	•
	Max. curve	•	•
	Min. curve	•	•
	Alarm reset	•	•
	Warning reset		•
	Digital input	•	•
	Motor bearing monitoring		•
	Motor bearings changed or lubricated		• [3]
	Standstill heating		•
	Controlled or uncontrolled	•	•
	Controller constants, K_p, T_i	•	•
	External setpoint signal	•	•
	Signal relay 1	•	•
	Signal relay 2		• [2]
	Buttons on pump	•	•
	Pump number (for bus communication)		•
	Sensor range and signal	•	•
	Operating range (min./max. speed)	•	•
	Reading via the R100		
	Setpoint	•	•
	Operating mode	•	•
	Actual sensor value	•	•
	Pump speed	•	•
	Power input	•	•
	Power consumption	•	•
	Operating hours	•	•
	Lubrication status (bearings)		• [2]
	Replacement status (bearings)		•
	**Setting via GENIbus**		
	Setpoint	•	•
	Start/stop	•	•
	Max. curve	•	•
	Min. curve	•	•
	Controlled or uncontrolled	•	•
	Reading via GENIbus		
	Setpoint	•	•
	Operating indication	•	•
	Pump status	•	•

• Available.

[1] Only TPED.

[2] Only 11-22 kW.

[3] Lubricated, only 11-22 kW.

E-pump functions		E-pump type	
		TPE, TPED Series 1000, NBE, NKE without sensor	TPE, TPED Series 1000, NBE, NKE without sensor
		Single-phase	Three-phase
	Motor sizes [kW]	**0.25 - 1.1**	**0.55 - 22**
 	**Setting via external signal**		
	Setpoint	•	•
	Start/stop	•	•
	Min./max. curve via digital input	•	•
	Reading via external signal		
	Fault, Operation or Ready signal (relay)	•	
	Fault, Operation, Ready, Pump running, Bearing lubrication, Warning, Limit exceeded 1 and 2		•
Additional functions	**Additional functions**		
	Twin-head pump function	• 1)	• 1)

• Available.
1) Only TPED.
2) Only 11-22 kW.
3) Lubricated, only 11-22 kW.

Modes

Grundfos E-pumps are set and controlled according to operating and control modes.

Overview of modes

Operating modes	Normal	—	Stop — Min. — Max.		
Control modes	Uncontrolled	—	Controlled		
	Constant curve		Constant pressure[1)]		

1) In this example the pump is fitted with a differential-pressure sensor. The pump may also be fitted with a temperature sensor in which case the description would be constant temperature in control mode "Controlled".

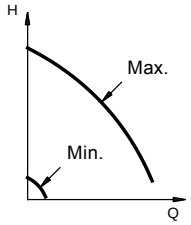
Operating mode

When the operating mode is set to "Normal", the control mode can be set to "Controlled" or "Uncontrolled".

The other operating modes that can be selected are "Stop", "Min." or "Max.".

- Stop: The pump has been stopped.
- Min.: The pump is operating at its minimum speed.
- Max.: The pump is operating at its maximum speed.

Figure 45 is a schematic illustration of min. and max. curves.



TM00 5547 0995

Fig. 45 Min. and max. curves

The max. curve can for instance be used in connection with the venting procedure during installation.
The min. curve can be used in periods in which a minimum flow is required.

If the power supply to the pump is disconnected, the mode setting will be stored.

The R100 remote control offers additional settings and status displays. See section *Setting via the R100*, page 43.

Additional operating modes, TPED pumps

The TPED pumps offer the following additional operating modes:

- **Alternating operation.**
  Pump operation alternates every 24 hours. If the duty pump stops due to a fault, the other pump will start.
- **Standby operation.**
  One pump is operating continuously. In order to prevent seizing-up, the other pump is started for 10 sec. every 24 hours. If the duty pump stops due to a fault, the other pump will start.

Select the operating mode by means of the selector switch in the terminal box.

The selector switch enables changeover between the operating modes "alternating operation" (left position) and "standby operation" (right position).

The switches in the two terminal boxes must be set to the same position. If the switches are positioned differently, the pump will be in "standby operation".

Twin-head pumps can be set and operated in the same way as single-head pumps. The duty pump uses its setpoint setting, whether it is set via the control panel, the R100 or via bus.

Note: Both pumps should be set to the same setpoint and control mode. Different settings will result in different operation when changing between the two pumps.

If the power supply to the pump is disconnected, the pump setting will be stored.

The R100 remote control offers additional settings and status displays.

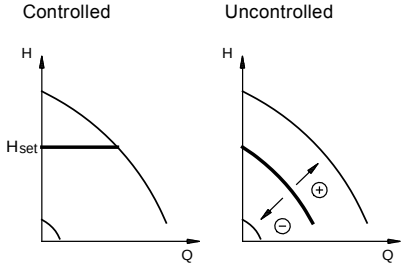
Control modes

The pump can be set to two control modes:

- Controlled
- Uncontrolled.

In control mode "Controlled", the pump will adjust its performance to the desired setpoint for the control parameter (pressure, differential pressure, temperature, differential temperature or flow).

In control mode "Uncontrolled", the pump will operate according to the constant curve set.



TM00 7668 0404

Fig. 46 Pump in control mode "Controlled" (differential-pressure control) and in control mode "Uncontrolled"

The pumps have been factory-set to control mode "Uncontrolled".

Setting up the pump

Factory setting

TPE, NKE, NKGE and NBE, NBGE pumps

The pumps have been factory-set to uncontrolled operation.

The setpoint value corresponds to 100 % of the maximum pump performance. See data sheet for the pump.

In sections *Menu OPERATION* (page 45) and *Menu INSTALLATION* (page 48), the factory setting is marked with **bold**-faced type under each individual display.

TPED pumps

The pumps have been factory-set to uncontrolled operation and the additional operating mode "alternating operation".

The setpoint value corresponds to 100 % of the maximum pump performance. See data sheet for the pump.

In sections *Menu OPERATION* (page 45) and *Menu INSTALLATION* (page 48), the factory setting is marked with **bold**-faced type under each individual display.

Setting via the control panel

The pump control panel (fig. 47 or 48) incorporates the following buttons and indicator lights:

- buttons, ⊛ and ⊛, for setpoint setting
- light fields, yellow, for indication of setpoint
- Indicator lights, green (operation) and red (fault).

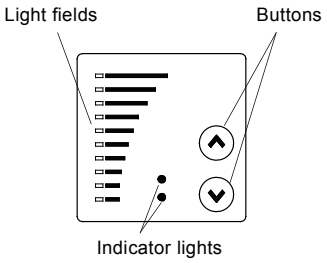


Fig. 47 Control panel, single-phase pumps, 0.37 - 1.1 kW

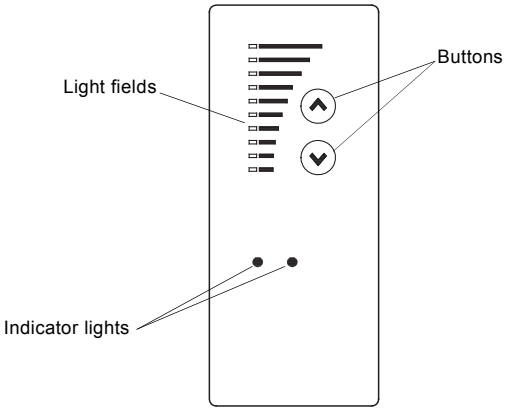


Fig. 48 Control panel, three-phase pumps, 0.55 - 22 kW

Setpoint setting

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

Set the desired setpoint by pressing ⊛ or ⊛.

The light fields on the control panel will indicate the setpoint set.

Pump in control mode "Controlled" (differential-pressure control)

Example

Figure 49 shows that the 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 sensor nameplate).

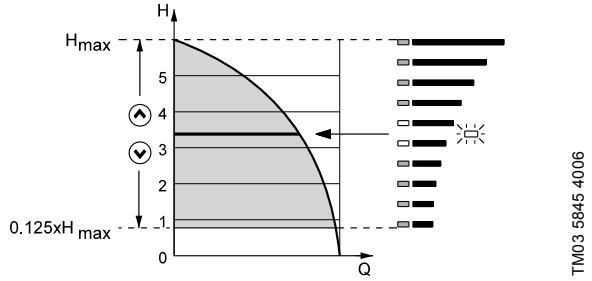


Fig. 49 Setpoint set to 3.4 m (differential-pressure control)

Pump in control mode "Uncontrolled"

Example

In control mode "Uncontrolled", the pump performance is set within the range from min. to max. curve. See fig. 50.

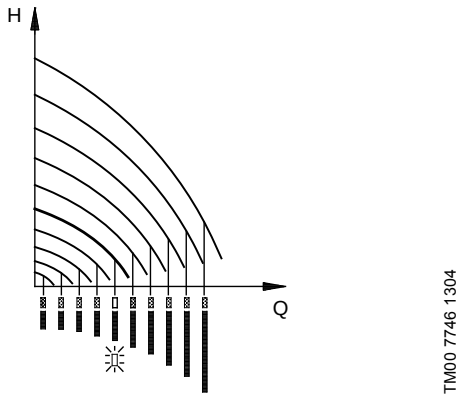


Fig. 50 Pump performance setting, control mode "Uncontrolled"

Setting to max. curve duty

Press ⊛ continuously to change to the max. curve of the pump (top light field flashes). See fig. 51.

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

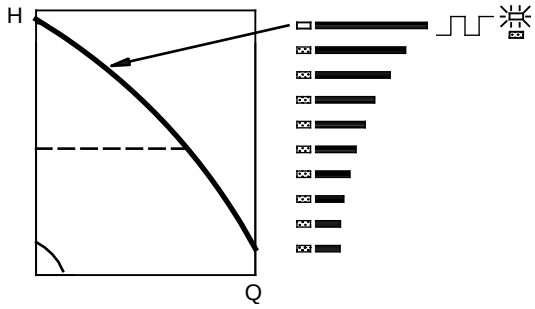


Fig. 51 Max. curve duty

Setting to min. curve duty

Press ⊛ continuously to change to the min. curve of the pump (bottom light field flashes). See fig. 52.

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

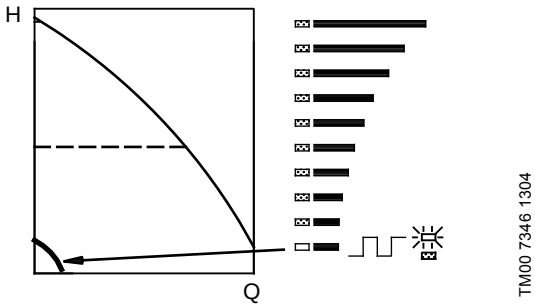


Fig. 52 Min. curve duty

Start/stop of pump

Start the pump by continuously pressing ⊛ until the desired setpoint is indicated.

Stop the pump by continuously pressing ⊛ until none of the light fields are activated and the green indicator light flashes.

Setting via the R100

The pump is designed for wireless communication with the Grundfos R100 remote control.

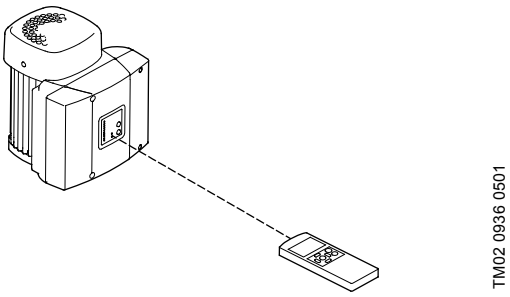


Fig. 53 R100 communicating with the pump via infrared light

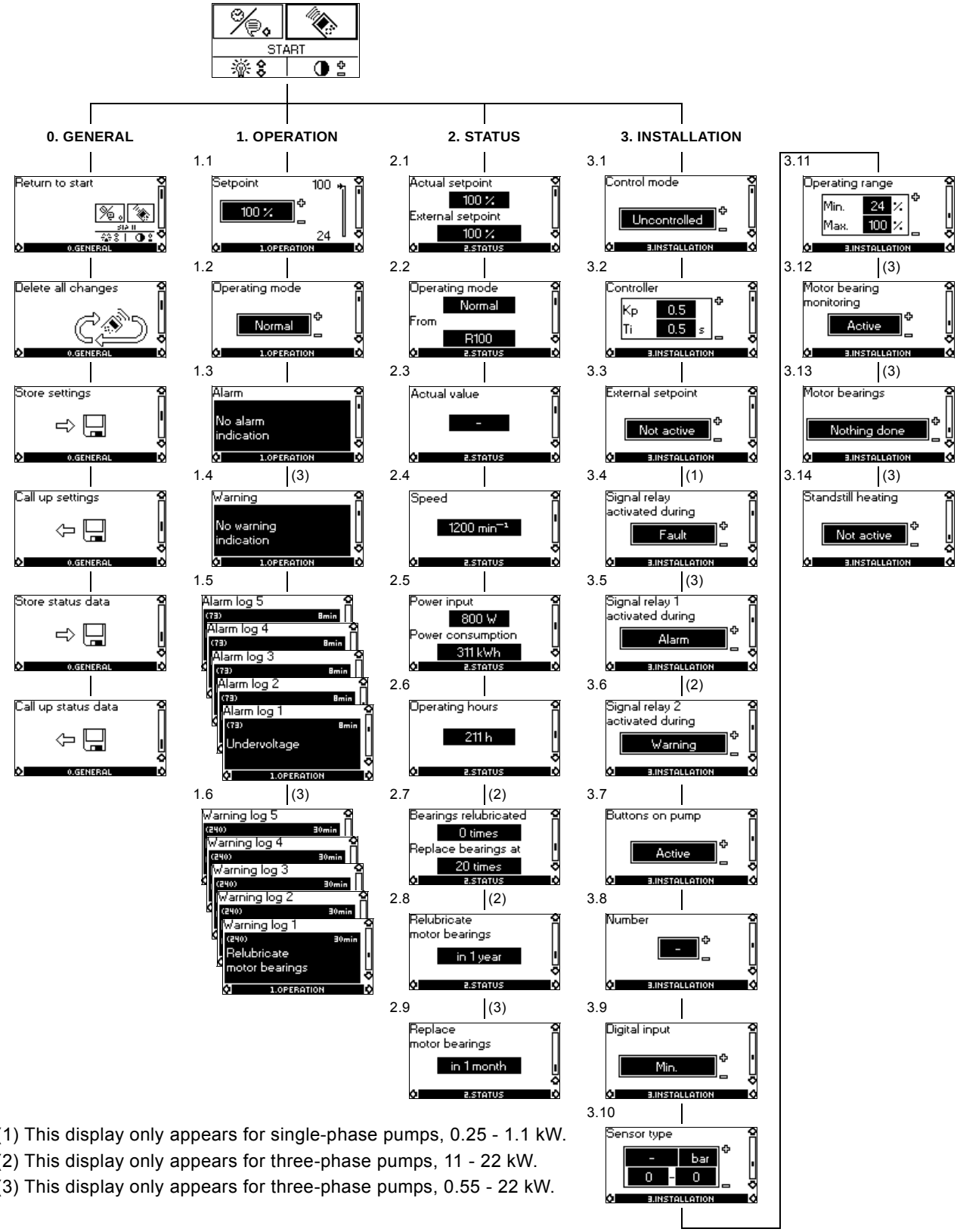
During communication, the R100 must be pointed at the control panel. When the R100 communicates with the pump, the red indicator light will flash rapidly. Keep pointing the R100 at the control panel until the red indicator light stops flashing.

The R100 offers setting and status displays for the pump.

The displays are divided into four parallel menus, fig. 54:

0. GENERAL (see operating instructions for the R100)
1. OPERATION
2. STATUS
3. INSTALLATION

The figure above each individual display in fig. 54 refers to the section in which the display is described.



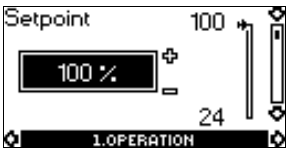
(1) This display only appears for single-phase pumps, 0.25 - 1.1 kW.
(2) This display only appears for three-phase pumps, 11 - 22 kW.
(3) This display only appears for three-phase pumps, 0.55 - 22 kW.

Fig. 54 Menu overview

Menu OPERATION

This is the first display in this menu:

Setpoint



- Setpoint set
- Actual setpoint
- Actual value

Set the desired setpoint in this display.

In control mode "Controlled", the setting range is equal to the sensor measuring range, e.g. 0 to 25 m.

In control mode "Uncontrolled", the setpoint is set in % of the maximum performance. The setting range will lie between the min. and max. curves.

If the pump is connected to an external setpoint signal, the value in this display will be the maximum value of the external setpoint signal.

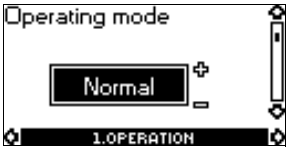
Setpoint and external signal

The setpoint cannot be set if the pump is controlled via external signals (Stop, Min.or Max.). The R100 will give this warning: External control!
Check if the pump is stopped via terminals 2 and 3 (open circuit) or set to min. or max. via terminals 1 and 3 (closed circuit).

Setpoint and bus communication

The setpoint cannot be set if the pump is controlled from an external control system or via bus communication. The R100 will give this warning: Bus control!
To override bus communication, disconnect the bus connection.

Operating mode



Select one of the following operating modes:

- Stop
- Min.
- **Normal** (duty)
- Max.

The operating modes can be selected without changing the setpoint setting.

Fault indications

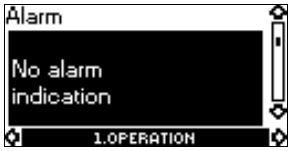
In E-pumps, faults may result in two types of indication: Alarm or Warning.

An "alarm" fault will activate an alarm indication in the R100 and cause the pump to change operating mode, typically to stop. However, for some faults resulting in alarm, the pump is set to continue operating even if there is an alarm.

A "warning" fault will activate a warning indication in the R100, but the pump will not change operating or control mode.

Note: The indication "Warning" only applies to pumps of 11 kW and up.

Alarm



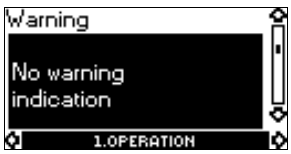
In case of alarm, the cause will appear in this display.

Possible causes:

- No alarm indication
- Too high motor temperature
- Undervoltage
- Mains voltage asymmetry (11-22 kW)
- Overvoltage
- Too many restarts (after faults)
- Overload
- Underload (11-22 kW)
- Sensor signal outside signal range
- Setpoint signal outside signal range
- External fault
- Other fault.

If the pump has been set up to manual restart, an alarm indication can be reset in this display if the cause of the fault has disappeared.

Warning (only three-phase pumps)



In case of warning, the cause will appear in this display.

Possible causes:

- No warning indication
- Sensor signal outside signal range
- Relubricate motor bearings (11-22 kW)
- Replace motor bearings
- Replace varistor(11-22 kW)[*)]

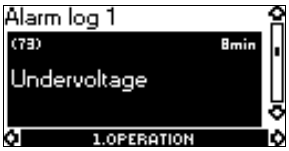
A warning indication will disappear automatically once the fault has been remedied.

[*)] The varistor protects the pump against mains voltage transients. If voltage transients occur, the varistor will be worn over time and need to be replaced. The more transients, the more quickly the varistor will be worn. A Grundfos technician is required for replacement of the varistor.

Fault log

For both fault types, alarm and warning, the R100 has a log function.

Alarm log

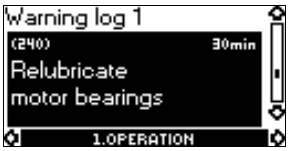


In case of "alarm" faults, the last five alarm indications will appear in the alarm log. "Alarm log 1" shows the latest fault, "Alarm log 2" shows the latest fault but one, etc.

The example above gives this information:

- The alarm indication "Undervoltage".
- The fault code (73).
- The number of minutes the pump has been connected to the power supply after the fault occurred, 8 min.

Warning log (only three-phase pumps)



In case of "warning" faults, the last five warning indications will appear in the warning log. "Warning log 1" shows the latest fault, "Warning log 2" shows the latest fault but one, etc.

The example above gives this information:

- The warning indication "Relubricate motor bearings".
- The fault code (240).
- The number of minutes the pump has been connected to the power supply since the fault occurred, 30 min.

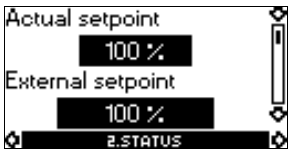
Menu STATUS

The displays appearing in this menu are status displays only. It is not possible to change or set values.

The displayed values are the values that applied when the last communication between the pump and the R100 took place. If a status value is to be updated, point the R100 at the control panel, and press [OK]. If a parameter, e.g. speed, should be called up continuously, press [OK] constantly during the period in which the parameter in question should be monitored.

The tolerance of the displayed value is stated under each display. The tolerances are stated as a guide in % of the maximum values of the parameters.

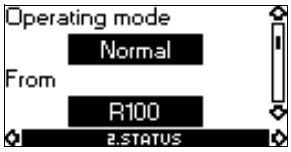
Actual setpoint



Tolerance: ± 2 %

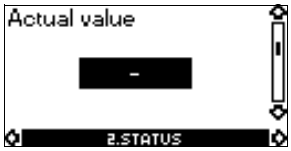
This display shows the actual setpoint and the external setpoint in % of the range from minimum value to the setpoint set.

Operating mode



This display shows the actual operating mode (Stop, Min., Normal (duty) or Max.). Furthermore, it shows where this operating mode was selected (R100, Pump, Bus or External).

Actual value



This display shows the value actually measured by a connected sensor.

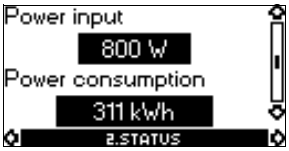
If no sensor is connected to the pump, "-" will appear in the display.

Speed

Tolerance: ± 5 %

The actual pump speed will appear in this display.

Power input and power consumption



Tolerance: ± 10 %

This display shows the actual pump input power from the mains supply. The power is displayed in W or kW.

The pump power consumption can also be read from this display. The value of power consumption is an accumulated value calculated from the pump's birth and it cannot be reset.

Operating hours

Tolerance: ± 2 %

The value of operating hours is an accumulated value and cannot be reset.

Lubrication status of motor bearings (only 11-22 kW)

This display shows how many times the motor bearings have been relubricated and when to replace the motor bearings.

When the motor bearings have been relubricated, confirm this action in the INSTALLATION menu. See *Confirming relubrication/replacement of motor bearings (only three-phase pumps)*, page 50. When relubrication is confirmed, the figure in the above display will be increased by one.

Time till relubrication of motor bearings (only 11-22 kW)

This display shows when to relubricate the motor bearings. The controller monitors the operating pattern of the pump and calculates the period between bearing relubrications. If the operating pattern changes, the calculated time till relubrication may change as well.

Displayable values:

- in 2 years
- in 1 year
- in 6 months
- in 3 months
- in 1 month
- in 1 week
- Now!

Time till replacement of motor bearings (only three-phase pumps)

When the motor bearings have been relubricated, a prescribed number of times stored in the controller, the display in the previous section will be replaced by the display below.

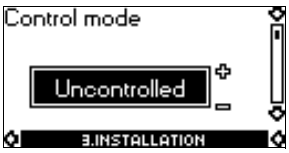
This display shows when to replace the motor bearings. The controller monitors the operating pattern of the pump and calculates the period between bearing replacements.

Displayable values:

- in 2 years
- in 1 year
- in 6 months
- in 3 months
- in 1 month
- in 1 week
- Now!

Menu INSTALLATION

Control mode



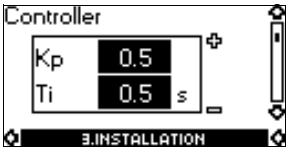
Select one of the following control modes (see fig. 46):

- Controlled
- **Uncontrolled**.

Note: If the pump is connected to a bus, the control mode cannot be selected via the R100.

Controller

E-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, the gain and the integral time can be changed in the display below.



- The gain (K_p) can be set within the range from 0.1 to 20.
- The integral time (T_i) can be set within the range from 0.1 to 3600 s. If "3600 s" is selected, the controller will function as a P controller.
- Furthermore, it is possible to set the controller to inverse control, meaning that if the setpoint is increased, the speed will be reduced. In the case of inverse control, the gain (K_p) must be set within the range from -0.1 to -20.

External setpoint

The input for external setpoint signal can be set to different signal types.

Select one of the following types:

- 0-10 V
- 0-20 mA
- 4-20 mA
- **Not active**.

If "Not active" is selected, the setpoint set via the R100 or on the control panel will apply.

If one of the signal types is selected, the actual setpoint is influenced by the signal connected to the external setpoint input.

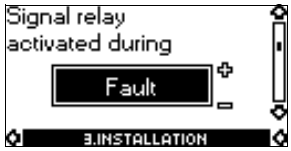
Signal relay

Pumps of 0.25 - 7.5 kW have one signal relay. The factory setting of the relay will be "Fault".

Pumps of 11 - 22 kW have two signal relays. Signal relay 1 is factory-set to "Alarm" and signal relay 2 to "Warning".

In one of the displays below, select in which one of three or six operating situations the signal relay should be activated.

Single-phase pumps
0.25 - 1.1 kW



- Ready
- **Fault**
- Operation.

Three-phase pumps
0.55 - 22 kW

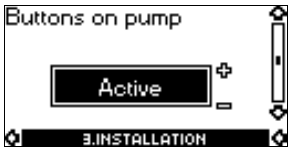
- Ready
- **Alarm**
- Operation
- Pump running
- Warning
- Relubricate.

Three-phase pumps
11 - 22 kW

- Ready
- Alarm
- Operation
- Pump running
- **Warning**
- Relubricate.

Note: "Fault" and "Alarm" cover faults resulting in "Alarm".
"Warning" covers faults resulting in "Warning".
"Relubricate" covers only that one individual event.
For distinction between alarm and warning, see section *Fault indications*, page 45.

Buttons on pump

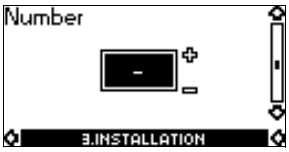


The operating buttons ⊙ and ⊙ on the control panel can be set to these values:

- **Active**
- Not active.

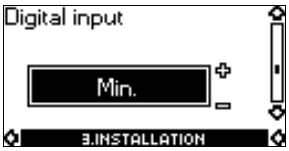
When set to "Not active" (locked), the buttons do not function. Set the buttons to "Not active" if the pump should be controlled via an external control system.

Pump number



A number between 1 and 64 can be allocated to the pump. In the case of bus communication, a number must be allocated to each pump.

Digital input



The digital input of the pump (terminal 1, fig. 56, page 51) can be set to different functions.

Select one of the following functions:

- **Min.** (min. curve)
- Max. (max. curve).

The selected function is activated by closing the contact between terminals 1 and 9. See fig. 56, page 51.

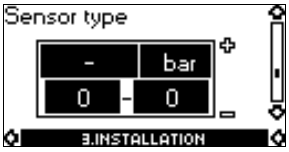
Min.:

When the input is activated, the pump will operate according to the min. curve.

Max.:

When the input is activated, the pump will operate according to the max. curve.

Sensor

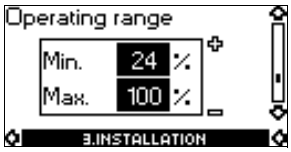


The setting of the sensor is only relevant in the case of controlled operation.

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.

Operating range



How to set the operating range:

- Set the min. curve within the range from max. curve to 12 % of maximum performance. The pump has been factory-set to 24 % of maximum performance.
- Set the max. curve within the range from maximum performance (100 %) to min. curve.

The area between the min. and max. curves is the operating range.

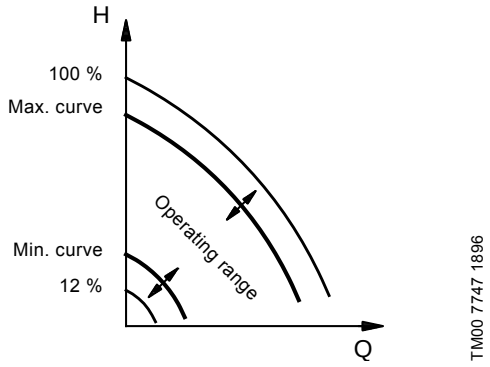


Fig. 55 Setting of the min. and max. curves in % of maximum performance

Motor bearing monitoring (only three-phase pumps)

The motor bearing monitoring function can be set 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. See section *Lubrication status of motor bearings (only 11-22 kW)*, page 47.

Note: The counter will continue counting even if the function is switched to "Not active", but a warning will not be given when it is time for relubrication.

When the function is switched to "Active" again, the accumulated mileage will again be used to calculate the relubrication time.

Confirming relubrication/replacement of motor bearings (only three-phase pumps)

This function can be set to these values:

- Relubricated
- Replaced
- **Nothing done**.

When the bearing monitoring function is "Active", the controller will give a warning indication when the motor bearings are due to be relubricated or replaced. See section *Fault indications*, page 45.

When the motor bearings have been relubricated or replaced, confirm this action in the above display by pressing [OK].

Note: "Relubricated" cannot be selected for a period of time after confirming relubrication.

Standstill heating (only three-phase pumps)

The standstill heating function can be set to these values:

- Active
- **Not active**.

When the function is set to "Active", an AC voltage will be applied to the motor windings when the pump is not operating. The applied AC voltage will ensure that sufficient heat is generated to avoid condensation in the motor.

Setting via the PC Tool E-products

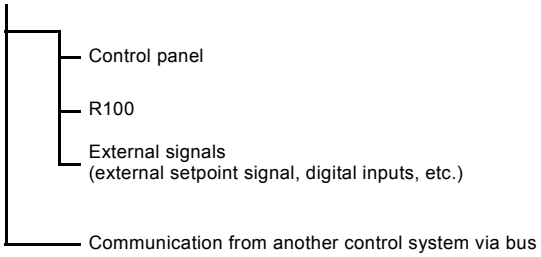
Special setup requirements differing from the settings available via the R100 require the use of the Grundfos PC Tool E-products. This again requires the assistance of a Grundfos service technician or engineer. Contact your local Grundfos company for more information.

Priority of settings

The priority of settings depends on two factors:

1. control source
2. settings.

1. Control source



2. Settings

- Operating mode "Stop"
- operating mode "Max." (max.curve)
- operating mode "Min." (min. curve)
- setpoint setting.

An E-pump can be controlled by different control sources at the same time, and each of these sources can be set differently. **Consequently, it is necessary to set an order of priority of the control sources and the settings.**

Note: If two or more settings are activated at the same time, the pump will operate according to the function with the highest priority.

Priority of settings without bus communication

Priority	Control panel or R100	External signals
1	Stop	
2	Max.	
3		Stop
4		Max.
5	Min.	Min.
6	Setpoint setting	Setpoint setting

Example: If the E-pump has been set to operating mode "Max." (max. frequency) via an external signal, such as digital input, the control panel or the R100 can only set the E-pump to operating mode "Stop".

Priority of settings with bus communication

Priority	Control panel or R100	External signals	Bus communication
1	Stop		
2	Max.		
3		Stop	Stop
4			Max.
5			Min.
6			Setpoint setting

Example: If the E-pump is operating according to a setpoint set via bus communication, the control panel or the R100 can set the E-pump to operating mode "Stop" or "Max.", and the external signal can only set the E-pump to operating mode "Stop".

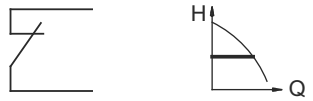
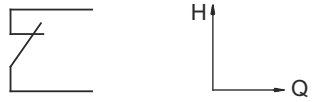
External forced-control signals

The pump has inputs for external signals for these forced-control functions:

- start/stop of pump
- digital function.

Start/stop input

Functional diagram: Start/stop input

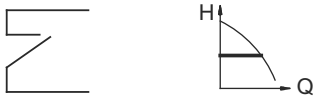
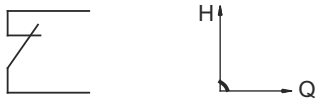
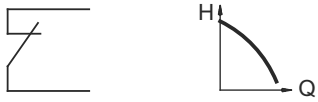
Start/stop (terminals 2 and 3)	
	Normal duty
	Stop

Digital input

Via the R100, one of the following functions can be selected for the digital input:

- Normal (duty)
- Min. (curve)
- Max. (curve).

Functional diagram: Input for digital function

Digital function (terminals 1 and 9)	
	Normal duty
	Min. curve
	Max. curve

Connection terminals

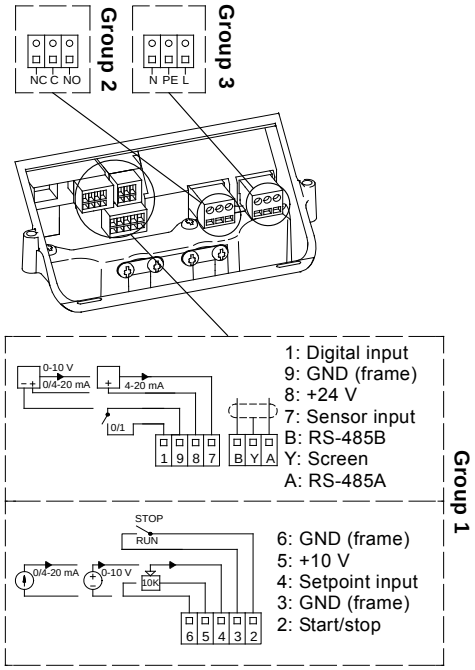


Fig. 56 Connection terminals, TPE, NKE and NBE

External setpoint signal

The setpoint can be remote-set by connecting an analog signal transmitter to the input for the setpoint signal (terminal 4).

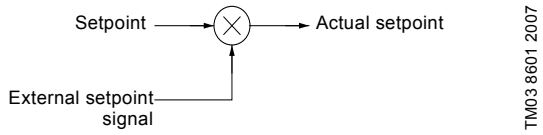


Fig. 57 Actual setpoint as a product (multiplied value) of setpoint and external setpoint signal

Select the actual external signal, 0-10 V, 0-20 mA, 4-20 mA, via the R100. See section *External setpoint*, page 48.

If control mode "Uncontrolled" is selected via the R100, the pump can be controlled by any controller.

In control mode "Controlled", the setpoint can be set externally within the range from $sensor_{min}$ to the setpoint set on the pump or via the R100.

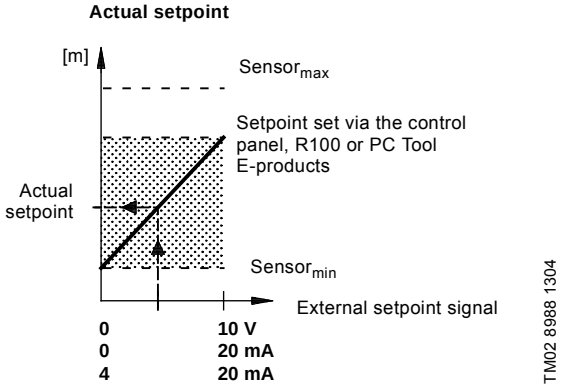


Fig. 58 Relation between the actual setpoint and the external setpoint signal in control mode "Controlled"

Example: At a $sensor_{min}$ value of 0 m, a setpoint set of 20 m and an external setpoint of 80 %, the actual setpoint will be as follows:

$$H_{actual} = (H_{set} - H_{min}) \times \%_{external\ setpoint} + H_{min}$$
$$= (20 - 0) \times 80\ \% + 0$$
$$= 16\ m$$

In control mode "Uncontrolled", the setpoint can be set externally within the range from the min. curve to the setpoint set on the pump or via the R100.

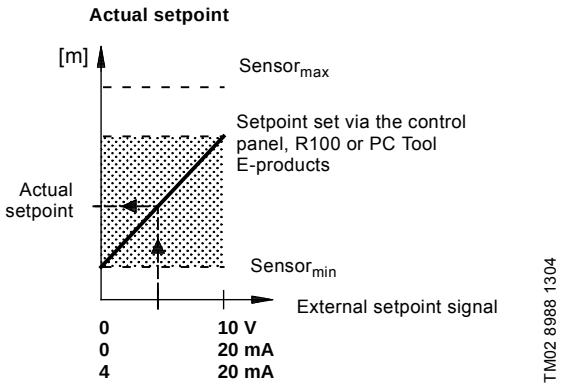


Fig. 59 Relation between the actual setpoint and the external setpoint signal in control mode open loop

Bus signal

The pump supports serial communication via an RS-485 input. The communication is carried out according to the Grundfos bus protocol, GENIbus, and enables connection to a building management system or another external control system.

Operating parameters, such as setpoint, operating mode, etc. can be remote-set via the bus signal. At the same time, the pump can provide status information about important parameters, such as actual value of control parameter, input power, fault indications, etc.

Contact Grundfos for further details.

Note: If a bus signal is used, the number of settings available via the R100 will be reduced.

Other bus standards

Grundfos offers various bus solutions with communication according to other standards.

Contact Grundfos for further details.

Indicator lights and signal relay

The operating condition of the pump is indicated by the green and red indicator lights on the pump control panel and inside the terminal box. See figs 60 and 61.

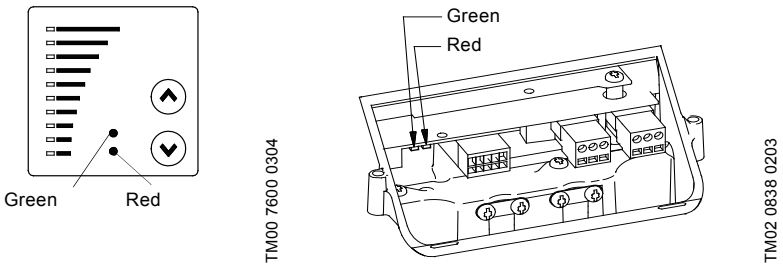


Fig. 60 Position of indicator lights on single-phase pumps

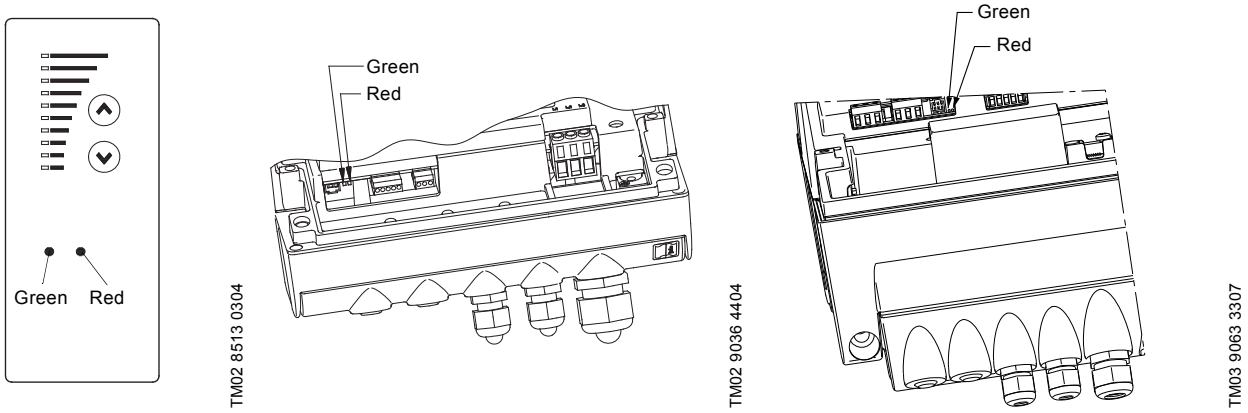
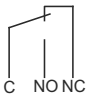
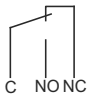
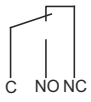


Fig. 61 Position of indicator lights on three-phase pumps

Besides, the pump incorporates an output for a potential-free signal via an internal relay.

For signal relay output values, see section *Signal relay*, page 48.

The functions of the two indicator lights and the signal relay are as shown in the following table:

Indicator lights		Signal relay activated during:				Description
Fault (red)	Operation (green)	Fault/Alarm, Warning and Relubricate	Operating	Ready	Pump running	
Off	Off					The power supply has been switched off.
Off	Permanently on					The pump is operating.
Off	Flashing					The pump has been set to stop.
Permanently on	Off					The pump has stopped because of a "Fault"/ "Alarm" or is running 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 is operating, but it has or has had a "Fault"/"Alarm" allowing the pump to continue operation or it is operating with a "Warning" or "Relubricate" indication. If the cause is "Sensor signal outside signal range", the pump will continue operating according to the max. curve and the fault indication cannot be reset until the signal is inside the signal range. If the cause is "Setpoint signal outside signal range", the pump will continue operating according to the min. curve and the fault indication cannot be reset 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

A fault indication can be reset 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 the R100. See section *Fault indications*, page 45.

When the R100 communicates with the pump, the red indicator light will flash rapidly.

Insulation resistance

0.25 - 7.5 kW

Do not measure the insulation resistance of motor windings or an installation incorporating E-pumps using high-voltage megging equipment, as this may damage the built-in electronics.

11 - 22 kW

Do not measure the insulation resistance of an installation incorporating E-pumps using high-voltage megging equipment, as this may damage the built-in electronics.

The motor conductors can be disconnected separately and the insulation resistance of the motor windings can be tested.

Further product documentation

Specific data booklets are also available on www.grundfos.com > International website > WebCAPS. For further information on WebCAPS, see page 123.

4. TPE, TPED Series 2000

Introduction

Grundfos TPE, TPED Series 2000 pumps are fitted with a frequency-controlled MGE motor. The pumps have built-in PI controller and are fitted with a differential-pressure sensor.

TPE, TPED Series 2000 pumps

Fig. 62 TPE Series 2000 pumps

TPE, TPED Series 2000 pumps with differential-pressure sensor are vertical single-stage centrifugal pumps.

Due to the in-line design, the pump can be installed in a horizontal or vertical one-pipe system where the suction and discharge ports are in the same plane and have the same pipe dimensions. This design provides a more compact pump design and pipework.

The pumps are available in various sizes to provide the flow and pressure required. The twin-head pump version, TPED series 2000, is only available with the three-phase MGE motor (0.75 - 22 kW).

TPE, TPED Series 2000 pumps consist of two main components: The motor and the pump unit.

- The motor is a Grundfos MGE motor (0.75 - 22 kW) with built-in frequency converter designed to EN standards.
- The pump unit has optimised hydraulics, union or flanged connections, a top and various other parts.

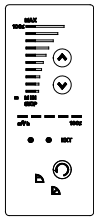
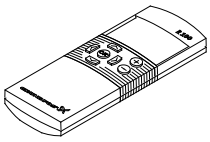
Applications of TPE, TPED Series 2000

TPE, TPED Series 2000 pumps are used in a wide variety of pumping systems where the performance and materials of the pump are required to meet specific demands.

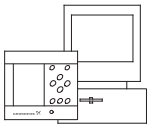
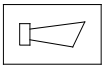
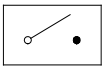
Below is a list of some general examples of application:

- heating systems
- refrigeration systems
- building cooling systems
- mixing loops.

Overview of functions

E-pump functions		E-pump type	
		TPE, TPED Series 2000 with single-phase MGE	TPE, TPED Series 2000 with three-phase MGE
	Motor sizes [kW]	**0.25 - 1.1**	**0.75 - 22**
	**Setting via control panel**		
	Setpoint	•	
	Start/stop	•	
	Max. curve	•	
	Min. curve	•	
	Alarm reset	•	
	Constant or proportional pressure	•	
	Reading via control panel		
	Setpoint	•	
	Operating indication	•	
	Fault indication	•	
	**Setting via control panel**		
	Setpoint		•
	Start/stop		•
	Max. curve		•
	Min. curve		•
	Alarm reset		•
	Constant or proportional pressure		•
	Reading via control panel		
	Setpoint		•
	Operating indication		•
	Fault indication		•
	Operation mode: MIN, MAX, STOP		•
	Flow in %		•
	External control		•
	**Setting via the R100**		
	Setpoint	•	•
	Start/stop	•	•
	Max. curve	•	•
	Min. curve	•	•
	Alarm reset	•	•
	Warning reset		•
	Digital input	•	•
	Motor bearing monitoring		•
	Motor bearings changed or lubricated		• [2]
	Standstill heating		•
	Constant pressure, proportional pressure or constant curve	•	•
	External setpoint signal	•	•
	Signal relay 1	•	•
	Signal relay 2		• [1]
	Buttons on pump	•	•
	Pump number (for bus communication)	•	•
	Reading via the R100		
	Setpoint	•	•
	Operating mode	•	•
	Actual sensor value	•	•
	Pump speed	•	•
	Power input	•	•
	Power consumption	•	•
	Operating hours	•	•
	Lubrication status (bearings)		• [1]
	Replacement status (bearings)		•

• Available.
[1] Only 11-22 kW.
[2] Lubricated, only 11-22 kW.

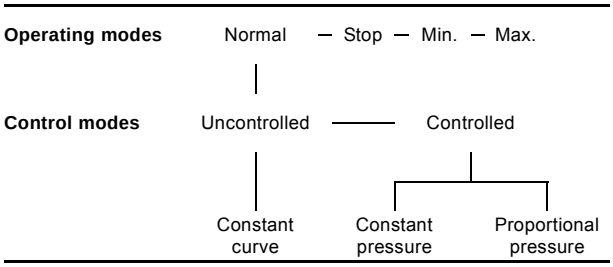
E-pump functions		E-pump type	
		TPE, TPED Series 2000 with single-phase MGE	TPE, TPED Series 2000 with three-phase MGE
	Motor sizes [kW]	**0.25 - 1.1**	**0.75 - 22**
	**Setting via GENIbus**		
	Setpoint	•	•
	Start/stop	•	•
	Max. curve	•	•
	Min. curve	•	•
	Constant pressure, proportional pressure or constant curve	•	•
	Reading via GENIbus		
	Setpoint	•	•
	Operating indication	•	•
	Pump status	•	•
	Setting via external signal		
	Setpoint	•	•
	Start/stop	•	•
	Min./max. curve via digital input	•	•
	**Reading via external signal**		
	Fault signal (relay)	•	
	Fault, Operation, Ready, Pump running, Bearing lubrication, Warning, Limit exceeded 1 and 2		•
Additional functions	**Additional functions**		
	Twin-head pump function	•	•

• Available.
1) Only 11-22 kW.
2) Lubricated, only 11-22 kW.

Modes

Grundfos E-pumps are set and controlled according to operating and control modes.

Overview of modes



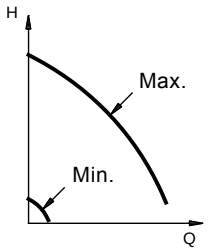
Operating mode

When the operating mode is set to "Normal", the control mode can be set to "Constant curve", "Constant pressure" or "Proportional pressure".

The other operating modes that can be selected are "Stop", "Min." or "Max.".

- Stop: The pump has been stopped.
- Min.: The pump is operating at its minimum speed.
- Max.: The pump is operating at its maximum speed.

Figure 63 is a schematic illustration of min. and max. curves.



TM00 5547 0995

Fig. 63 Min. and max. curves

The max. curve can for instance be used in connection with the venting procedure during installation.
The min. curve can be used in periods in which a minimum flow is required.

If the power supply to the pump is disconnected, the mode setting will be stored.

The R100 remote control offers additional settings and status displays. See section *Setting via the R100*, page 63.

Additional operating modes, TPED pumps

The TPED pumps offer the following additional operating modes:

- **Alternating operation.**
  Pump operation alternates every 24 hours. If the duty pump stops due to a fault, the other pump will start.
- **Standby operation.**
  One pump is operating continuously. In order to prevent seizing-up, the other pump is started for 10 sec. every 24 hours. If the duty pump stops due to a fault, the other pump will start.

Select the operating mode by means of the selector switch in the terminal box.

The selector switch enables changeover between the operating modes "alternating operation" (left position) and "standby operation" (right position).

The switches in the two terminal boxes must be set to the same position. If the switches are positioned differently, the pump will be in "standby operation".

Twin-head pumps can be set and operated in the same way as single-head pumps. The duty pump uses its setpoint setting, whether it is set via the control panel, the R100 or via bus.

Note: Both pumps should be set to the same setpoint and control mode. Different settings will result in different operation when changing between the two pumps.

If the power supply to the pump is disconnected, the pump setting will be stored.

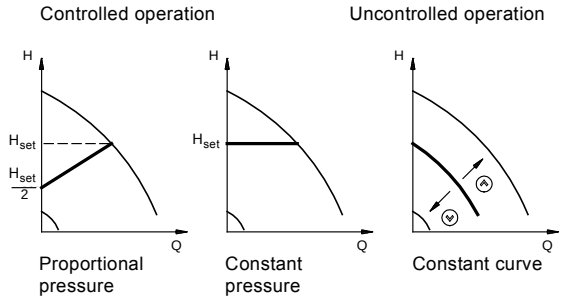
The R100 remote control offers additional settings and status displays.

Control modes

The pump can be set to two primary control modes:

- Proportinal pressure
- Constant pressure.

Furthermore, the pump can be set to constant curve.



TM00 7630 3604

Fig. 64 Controlled and uncontrolled operation

Proportional-pressure control

The pump head is reduced at falling water demand and increased at rising water demand. See fig. 64.

Constant-pressure control

The pump maintains a constant pressure, irrespective of water demand. See fig. 64.

Constant-curve mode

The pump is not controlled. The curve can be set within the range from min. curve to max. curve. See fig. 64.

The pumps have been factory-set to proportional pressure. See section *Setting up the pump*, page 61. In most cases, this is the optimum control mode, and at the same time it consumes the least energy.

Guide to the selection of control mode based on system type

System type	System description		Select this control mode
Relatively big pressure losses in the boiler, chiller or heat exchanger circuit and the pipes.	1. Two-pipe heating systems with thermostatic valves	• with a dimensioned pump head higher than 4 metres • very long distribution pipes • strongly throttled pipe balancing valves • differential-pressure regulators • big pressure losses in those parts of the system through which the total quantity of water flows (e.g. boiler, chiller, heat exchanger and pipes up to the first branching).	Proportional pressure 
	2. Primary circuit pumps in systems with big pressure losses in the primary circuit.		
Relatively small pressure losses in the boiler, chiller or heat exchanger circuit and the pipes.	1. Two-pipe heating or cooling systems with thermostatic valves	• with a dimensioned pump head lower than 2 metres • sized for natural circulation • with small head losses in those parts of the system through which the total quantity of water flows (e.g. boiler, chiller, heat exchanger and pipes up to the first branching) • modified to a high differential temperature between flow pipe and return pipe (e.g. district heating).	Constant pressure 
	2. Floor heating systems with thermostatic valves.		
	3. One-pipe heating systems with thermostatic valves or pipe balancing valves.		
	4. Primary circuit pumps in systems with small pressure losses in the primary circuit.		

Setting up the pump

Factory setting

TPE pumps

The pumps have been factory-set to proportional pressure.

The head corresponds to 50 % of the maximum pump head. See data sheet for the pump.

Many systems will operate satisfactorily with the factory setting, but most systems can be optimised by changing this setting.

In sections *Menu OPERATION* (page 65) and *Menu INSTALLATION* (page 68), the factory setting is marked with **bold**-faced type under each individual display.

TPED pumps

The pumps have been factory-set to proportional pressure and the additional operating mode "alternating operation".

The head corresponds to 50 % of the maximum pump head. See data sheet for the pump.

Many systems will operate satisfactorily with the factory setting, but most systems can be optimised by changing this setting.

In sections *Menu OPERATION* (page 65) and *Menu INSTALLATION* (page 68), the factory setting is marked with **bold**-faced type under each individual display.

Setting via the control panel, single-phase pumps

The pump control panel (fig. 65) incorporates the following buttons and indicator lights:

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

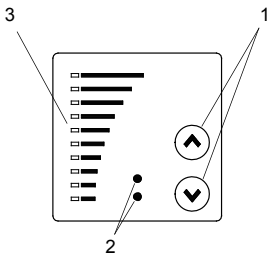


Fig. 65 Control panel, single-phase pumps, 0.37 - 1.1 kW

Pos.	Description
1	Buttons for setting
2	Indicator lights for indication of operation and fault
3	Light fields for indication of head and performance

Setting of control mode

Description of function, see section *Control modes*, page 59.

Change the control mode by pressing the two setting buttons simultaneously for 5 seconds. The control mode will change from constant pressure ⌓, to proportional pressure ◺ or vice versa.

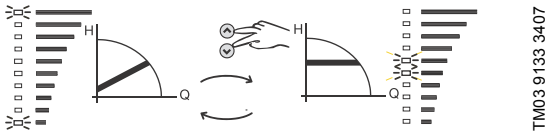


Fig. 66 Setting the control mode

Setting of pump head

Set the pump head by pressing ⌃ or ⌄.

The light fields on the control panel will indicate the head set (setpoint). See the following examples.

Proportional pressure

Figure 67 shows that the light fields 5 and 6 are activated, indicating a desired head of 3.4 metres at maximum flow. The setting range lies between 25 % to 90 % of maximum head.

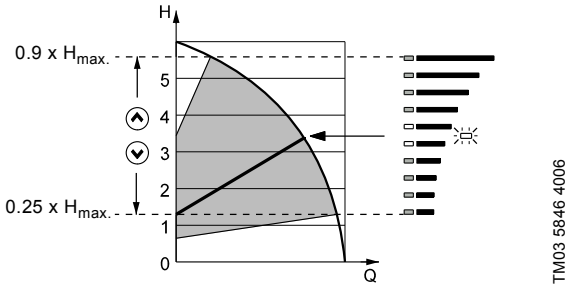


Fig. 67 Pump in control mode "Proportional pressure"

Constant pressure

Figure 68 shows that the light fields 5 and 6 are activated, indicating a desired head of 3.4 metres. The setting range lies between 1/8 (12.5 %) of maximum head and maximum head.

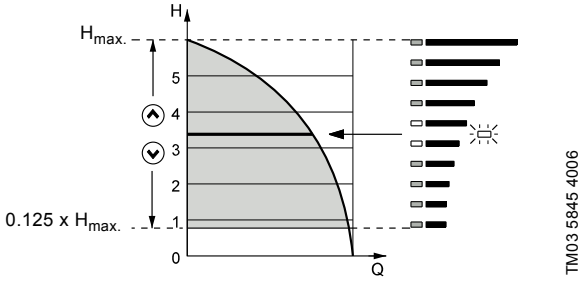
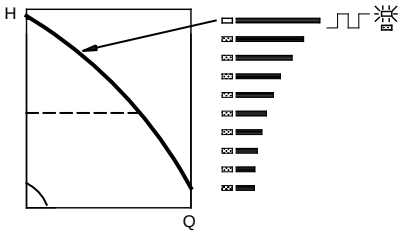


Fig. 68 Pump in control mode "Constant pressure"

Setting to max. curve duty

Press ⊛ continuously to change to the max. curve of the pump (top light field flashes). See fig. 69.

To change back, press ⊛ continuously until the desired head is indicated.



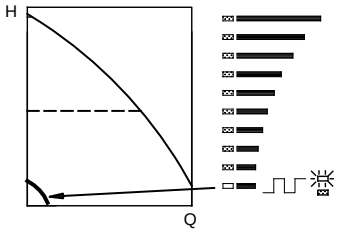
TM00 7345 1196

Fig. 69 Max. curve duty

Setting to min. curve duty

Press ⊛ continuously to change to the min. curve of the pump (bottom light field flashes). See fig. 70.

To change back, press ⊛ continuously until the desired head is indicated.



TM00 7346 1196

Fig. 70 Min. curve duty

Start/stop of pump

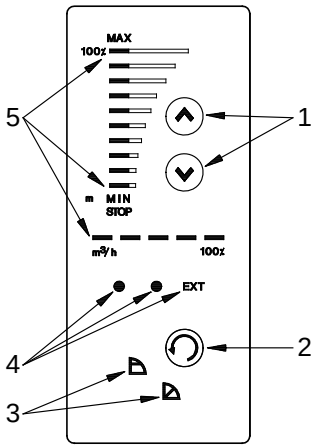
Start the pump by continuously pressing ⊛ until the desired head is indicated.

Stop the pump by continuously pressing ⊛ until none of the light fields are activated and the green indicator light flashes.

Setting via the control panel, three-phase pumps

The pump control panel (fig. 71) incorporates the following buttons and indicator lights:

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



TM03 0177 4304

Fig. 71 Control panel, three-phase pumps, 0.55 - 22 kW

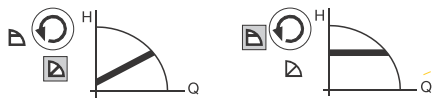
Pos.	Description
1 and 2	Buttons for setting
3 and 5	Light fields for indication of • control mode (pos. 3) • head, performance and operating mode (pos. 5)
4	Indicator lights for indication of • operation and fault • external control (EXT)

Setting of control mode

Description of function, see section *Control modes*, page 59.

Change the control mode by pressing ⊛ (pos. 2) according to the following cycle:

- constant pressure, ⊛
- proportional pressure, ⊛.



TM03 9061 3307

Fig. 72 Setting the control mode

Setting of pump head

Set the pump head by pressing ⊙ or ⊙.

The light fields on the control panel will indicate the head set (setpoint). See the following examples.

Proportional pressure

Figure 73 shows that the light fields 5 and 6 are activated, indicating a desired head of 3.4 metres at maximum flow. The setting range lies between 25 % to 90 % of maximum head.

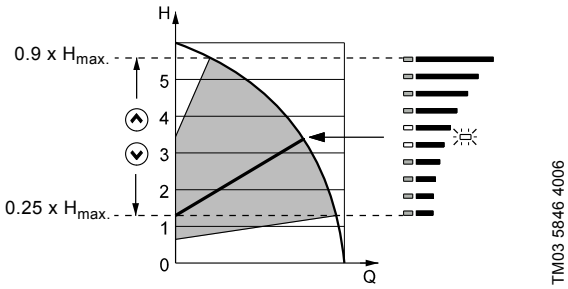


Fig. 73 Pump in control mode "Proportional pressure"

Constant pressure

Figure 74 shows that the light fields 5 and 6 are activated, indicating a desired head of 3.4 metres. The setting range lies between 1/8 (12.5 %) of maximum head and maximum head.

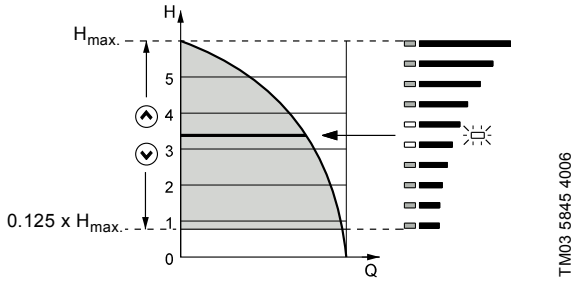


Fig. 74 Pump in control mode "Constant pressure"

Setting to max. curve duty

Press ⊙ continuously to change to the max. curve of the pump (MAX illuminates). See fig. 75.

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

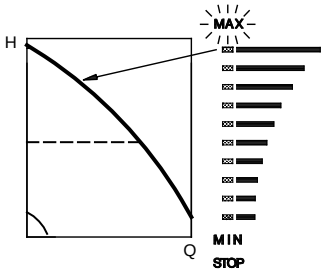


Fig. 75 Max. curve duty

Setting to min. curve duty

Press ⊙ continuously to change to the min. curve of the pump (MIN illuminates). See fig. 76.

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

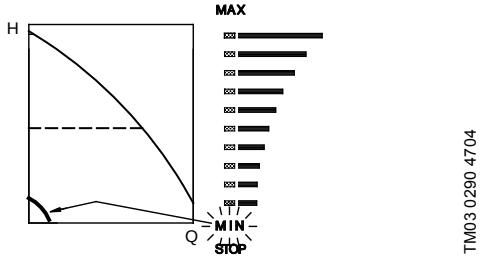


Fig. 76 Min. curve duty

Start/stop of pump

Start the pump by continuously pressing ⊙ until the desired head is indicated.

Stop the pump by continuously pressing ⊙ until STOP illuminates and the green indicator light flashes.

Setting via the R100

The pump is designed for wireless communication with the Grundfos R100 remote control.

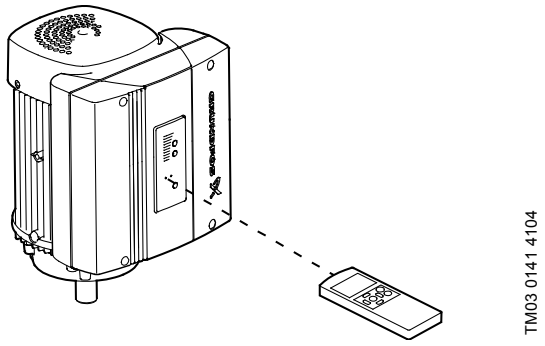


Fig. 77 R100 communicating with the pump via infrared light

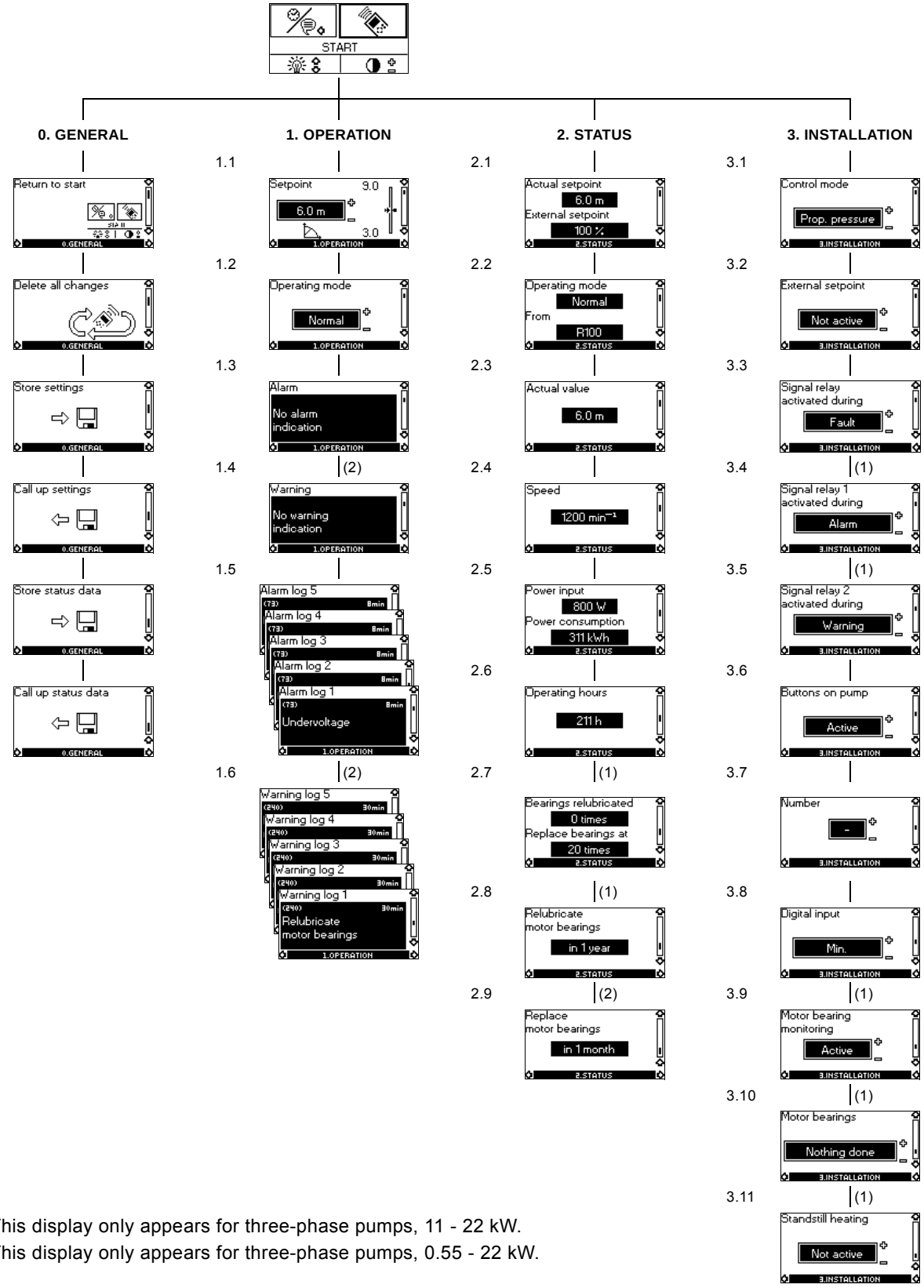
During communication, the R100 must be pointed at the control panel. When the R100 communicates with the pump, the red indicator light will flash rapidly. Keep pointing the R100 at the control panel until the red indicator light stops flashing.

The R100 offers setting and status displays for the pump.

The displays are divided into four parallel menus, fig. 78:

0. GENERAL (see operating instructions for the R100)
1. OPERATION
2. STATUS
3. INSTALLATION

The figure above each individual display in fig. 78 refers to the section in which the display is described.



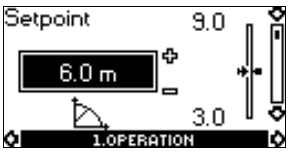
(1) This display only appears for three-phase pumps, 11 - 22 kW.
(2) This display only appears for three-phase pumps, 0.55 - 22 kW.

Fig. 78 Menu overview

Menu OPERATION

This is the first display in this menu:

Setpoint



- Setpoint set
- Actual setpoint
- Actual head

Set the desired setpoint in [m] in this display.

In control mode "Prop. pressure", the setting range is from 1/4 to 3/4 of maximum head.

In control mode "Const. pressure", the setting range is from 1/8 of maximum head to maximum head.

In control mode "Const. curve", the setpoint is set in % of the maximum curve. The curve can be set within the range from min. curve to max. curve.

Select one of the following operating modes:

- Stop
- Min. (min. curve)
- Max. (max. curve).

If the pump is connected to an external setpoint signal, the value in this display will be the maximum value of the external setpoint signal.

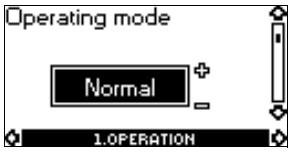
Setpoint and external signal

The setpoint cannot be set if the pump is controlled via external signals (Stop, Min. or Max.). The R100 will give this warning: External control!
Check if the pump is stopped via terminals 2 and 3 (open circuit) or set to min. or max. via terminals 1 and 3 (closed circuit).

Setpoint and bus communication

The setpoint cannot be set if the pump is controlled from an external control system or via bus communication. The R100 will give this warning: Bus control!
To override bus communication, disconnect the bus connection.

Operating mode



Select one of the following operating modes:

- Stop
- Min.
- **Normal** (duty)
- Max.

The operating modes can be selected without changing the setpoint setting.

Fault indications

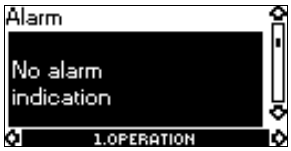
In E-pumps, faults may result in two types of indication: Alarm or Warning.

An "alarm" fault will activate an alarm indication in the R100 and cause the pump to change operating mode, typically to stop. However, for some faults resulting in alarm, the pump is set to continue operating even if there is an alarm.

A "warning" fault will activate a warning indication in the R100, but the pump will not change operating or control mode.

Note: The indication "Warning" only applies to three-phase pumps.

Alarm



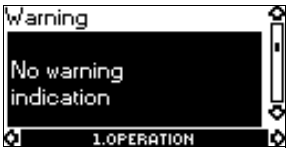
In case of alarm, the cause will appear in this display.

Possible causes:

- No alarm indication
- Too high motor temperature
- Undervoltage
- Mains voltage asymmetry (11-22 kW)
- Overvoltage
- Too many restarts (after faults)
- Overload
- Underload (11-22 kW)
- Sensor signal outside signal range
- Setpoint signal outside signal range
- External fault
- Other fault.

If the pump has been set up to manual restart, an alarm indication can be reset in this display if the cause of the fault has disappeared.

Warning (only three-phase pumps)



In case of warning, the cause will appear in this display.

Possible causes:

- No warning indication
- Sensor signal outside signal range
- Relubricate motor bearings (11-22 kW)
- Replace motor bearings
- Replace varistor (11-22 kW)*)

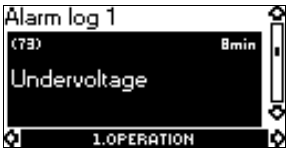
A warning indication will disappear automatically once the fault has been remedied.

*) The varistor protects the pump against mains voltage transients. If voltage transients occur, the varistor will be worn over time and need to be replaced. The more transients, the more quickly the varistor will be worn. A Grundfos technician is required for replacement of the varistor.

Fault log

For both fault types, alarm and warning, the R100 has a log function.

Alarm log

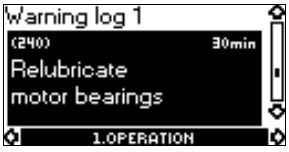


In case of "alarm" faults, the last five alarm indications will appear in the alarm log. "Alarm log 1" shows the latest fault, "Alarm log 2" shows the latest fault but one, etc.

The example above gives this information:

- The alarm indication "Undervoltage".
- The fault code (73).
- The number of minutes the pump has been connected to the power supply after the fault occurred, 8 min.

Warning log (only three-phase pumps)



In case of "warning" faults, the last five warning indications will appear in the warning log. "Warning log 1" shows the latest fault, "Warning log 2" shows the latest fault but one.

The example above gives this information:

- The warning indication "Relubricate motor bearings"
- The fault code (240)
- The number of minutes the pump has been connected to the power supply since the fault occurred, 30 min.

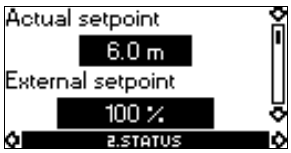
Menu STATUS

The displays appearing in this menu are status displays only. It is not possible to change or set values.

The displayed values are the values that applied when the last communication between the pump and the R100 took place. If a status value is to be updated, point the R100 at the control panel, and press [OK]. If a parameter, e.g. speed, should be called up continuously, press [OK] constantly during the period in which the parameter in question should be monitored.

The tolerance of the displayed value is stated under each display. The tolerances are stated as a guide in % of the maximum values of the parameters.

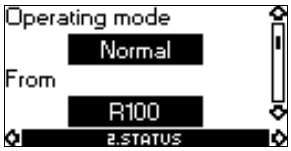
Actual setpoint



Tolerance: ± 2 %

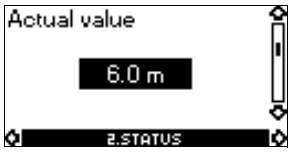
This display shows the actual setpoint and the external setpoint in % of the range from minimum value to the setpoint set.

Operating mode



This display shows the actual operating mode (Stop, Min., Normal (duty) or Max.). Furthermore, it shows where this operating mode was selected (R100, Pump, Bus or External).

Actual value



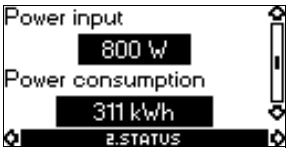
This display shows the value actually measured by a connected sensor.

Speed

Tolerance: ± 5 %

The actual pump speed will appear in this display.

Power input and power consumption



Tolerance: ± 10 %

This display shows the actual pump input power from the mains supply. The power is displayed in W or kW.

The pump power consumption can also be read from this display. The value of power consumption is an accumulated value calculated from the pump's birth and it cannot be reset.

Operating hours

Tolerance: ± 2 %

The value of operating hours is an accumulated value and cannot be reset.

Lubrication status of motor bearings (only 11-22 kW)

This display shows how many times the motor bearings have been relubricated and when to replace the motor bearings.

When the motor bearings have been relubricated, confirm this action in the INSTALLATION menu. See section *Confirming relubrication/replacement of motor bearings (only three-phase pumps)*. When relubrication is confirmed, the figure in the above display will be increased by one.

Time till relubrication of motor bearings (only 11-22 kW)

This display shows when to relubricate the motor bearings. The controller monitors the operating pattern of the pump and calculates the period between bearing relubrications. If the operating pattern changes, the calculated time till relubrication may change as well.

Displayable values:

- in 2 years
- in 1 year
- in 6 months
- in 3 months
- in 1 month
- in 1 week
- Now!

Time till replacement of motor bearings (only three-phase pumps)

When the motor bearings have been relubricated, a prescribed number of times stored in the controller, the display in the previous section will be replaced by the display below.

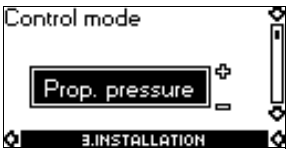
This display shows when to replace the motor bearings. The controller monitors the operating pattern of the pump and calculates the period between bearing replacements.

Displayable values:

- in 2 years
- in 1 year
- in 6 months
- in 3 months
- in 1 month
- in 1 week
- Now!

Menu INSTALLATION

Control mode



Select one of the following control modes (see fig. 64):

- **Prop. pressure** (proportional pressure)
- Const. pressure (constant pressure)
- Const. curve (constant curve).

Note: If the pump is connected to a bus, the control mode cannot be selected via the R100.

External setpoint

The input for external setpoint signal can be set to different signal types.

Select one of the following types:

- 0-10 V
- 0-20 mA
- 4-20 mA
- **Not active**.

If "Not active" is selected, the setpoint set via the R100 or on the control panel will apply.

If one of the signal types is selected, the actual setpoint is influenced by the signal connected to the external setpoint input.

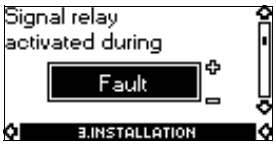
Signal relay

Pumps of 0.37 - 7.5 kW have one signal relay.
The factory setting of the relay will be "Fault".

Pumps of 11 - 22 kW have two signal relays. Signal relay 1 is factory-set to "Alarm" and signal relay 2 to "Warning".

In one of the displays below, select in which one of three or six operating situations the signal relay should be activated.

Single-phase pumps
0.25 - 1.1 kW



- Ready
- **Fault**
- Operation.

Three-phase pumps
0.55 - 22 kW

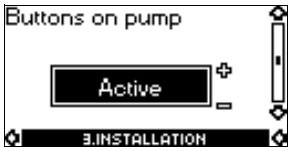
- Ready
- **Alarm**
- Operation
- Pump running
- Warning
- Relubricate (11-22 kW).

Three-phase pumps
11 - 22 kW

- Ready
- Alarm
- Operation
- Pump running
- **Warning**
- Relubricate.

Note: "Fault" and "Alarm" cover faults resulting in "Alarm".
"Warning" covers faults resulting in "Warning".
"Relubricate" covers only that one individual event.
For distinction between alarm and warning, see section *Fault indications*, page 65.

Buttons on pump



The operating buttons ⊙ and ⊙ on the control panel can be set to these values:

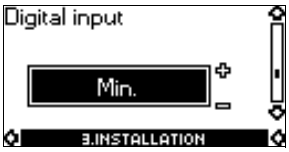
- **Active**
- Not active.

When set to "Not active" (locked), the buttons do not function. Set the buttons to "Not active" if the pump should be controlled via an external control system.

Pump number

A number between 1 and 64 can be allocated to the pump. In the case of bus communication, a number must be allocated to each pump.

Digital input



The digital input of the pump (terminal 1, fig. 79, page 71) can be set to different functions.

Select one of the following functions:

- **Min.** (min. curve)
- Max. (max. curve).

The selected function is activated by closing the contact between terminals 1 and 9. See fig. 79, page 71.

Min.:

When the input is activated, the pump is operating according to the min. curve.

Max.:

When the input is activated, the pump is operating according to the max. curve.

Motor bearing monitoring (only three-phase pumps)

The motor bearing monitoring function can be set 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. See section *Lubrication status of motor bearings (only 11-22 kW)*, page 67.

Note: The counter will continue counting even if the function is switched to "Not active", but a warning will not be given when it is time for relubrication.

When the function is switched to "Active" again, the accumulated mileage will again be used to calculate the relubrication time.

Confirming relubrication/replacement of motor bearings (only three-phase pumps)

This function can be set to these values:

- Relubricated (11-22 kW)
- Replaced
- **Nothing done**.

When the bearing monitoring function is "Active", the controller will give a warning indication when the motor bearings are due to be relubricated or replaced.
See section *Fault indications*, page 65.

When the motor bearings have been relubricated or replaced, confirm this action in the above display by pressing [OK].

Note: "Relubricated" cannot be selected for a period of time after confirming relubrication.

Standstill heating (only three-phase pumps)

The standstill heating function can be set to these values:

- Active
- **Not active**.

When the function is set to "Active", a DC voltage will be applied to the motor windings. The applied DC voltage will ensure that sufficient heat is generated to avoid condensation in the motor.

Setting via the PC Tool E-products

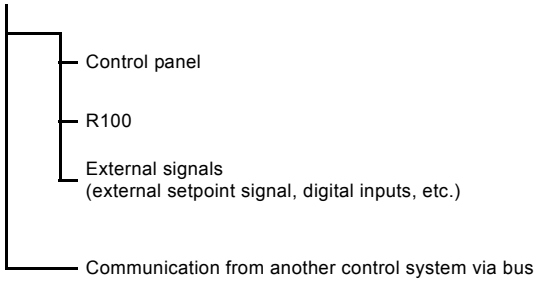
Special setup requirements differing from the settings available via the R100 require the use of Grundfos PC Tool E-products. This again requires the assistance of a Grundfos service technician or engineer. Contact your local Grundfos company for more information.

Priority of settings

The priority of settings depends on two factors:

1. control source
2. settings.

1. Control source



2. Settings

- Operating mode "Stop"
- operating mode "Max." (max.curve)
- operating mode "Min." (min. curve)
- setpoint setting.

An E-pump can be controlled by different control sources at the same time, and each of these sources can be set differently. **Consequently, it is necessary to set an order of priority of the control sources and the settings.**

Note: If two or more settings are activated at the same time, the pump will operate according to the function with the highest priority.

Priority of settings without bus communication

Priority	Control panel or R100	External signals
1	Stop	
2	Max.	
3		Stop
4		Max.
5	Min.	Min.
6	Setpoint setting	Setpoint setting

Example: If the E-pump has been set to operating mode "Max." (max. frequency) via an external signal, such as digital input, the control panel or the R100 can only set the E-pump to operating mode "Stop".

Priority of settings with bus communication

Priority	Control panel or R100	External signals	Bus communication
1	Stop		
2	Max.		
3		Stop	Stop
4			Max.
5			Min.
6			Setpoint setting

Example: If the E-pump is operating according to a setpoint set via bus communication, the control panel or the R100 can set the E-pump to operating mode "Stop" or "Max.", and the external signal can only set the E-pump to operating mode "Stop".

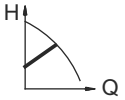
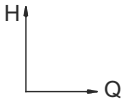
External forced-control signals

The pump has inputs for external signals for these forced-control functions:

- start/stop of pump
- digital function.

Start/stop input

Functional diagram: Start/stop input

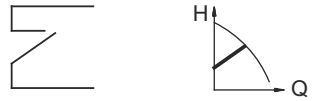
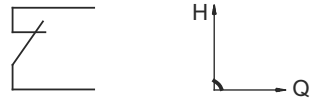
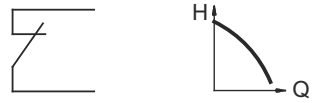
Start/stop (terminals 2 and 3)		
		**Normal duty**
		**Stop**

Digital input

Via the R100, one of the following functions can be selected for the digital input:

- Normal (duty)
- Min. (curve)
- Max. (curve).

Functional diagram: Input for digital function

Digital function (terminals 1 and 9)	
	**Normal duty**
	**Min. curve**
	**Max. curve**

Connection terminals

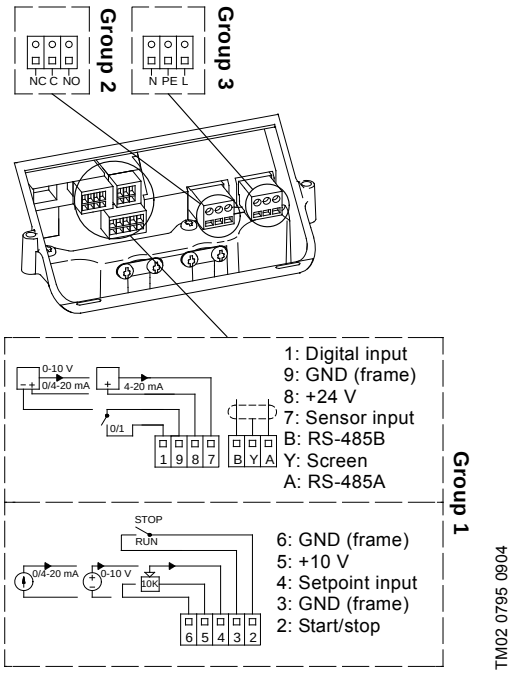


Fig. 79 Connection terminals, TPE Series 2000

External setpoint signal

The setpoint can be remote-set by connecting an analog signal transmitter to the input for the setpoint signal (terminal 4).

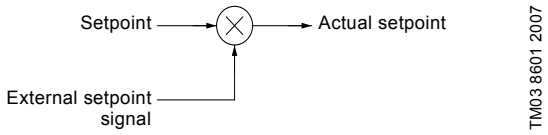


Fig. 80 Actual setpoint as a product (multiplied value) of setpoint and external setpoint signal

Select the actual external signal, 0-10 V, 0-20 mA, 4-20 mA, via the R100.

Control mode "Controlled"

If control mode "Controlled" is selected via the R100, the pump can be controlled to the following:

- proportional pressure
- constant pressure.

In control mode "Prop. pressure", the setpoint can be set externally within the range from 25 % of maximum head to the setpoint set on the pump or with the R100. See fig. 81.

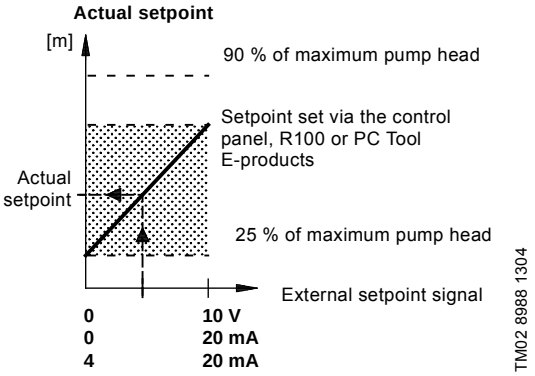


Fig. 81 Relation between the actual setpoint and the external setpoint signal in control mode "Prop. pressure"

Example: At a maximum head of 12 metres, a setpoint of 6 metres and an external setpoint of 40 %, the actual setpoint will be as follows:

H_{actual} = $(H_{set} - 1/4\ H_{max}) \times \%_{external\ setpoint} + 1/4\ H_{max}$

= (6 - 12/4) x 40 % + 12/4

= 4.2 m

In control mode "Const. pressure", the setpoint can be set externally within the range from 12.5 % of maximum head to the setpoint set on the pump or with the R100. See fig. 82.

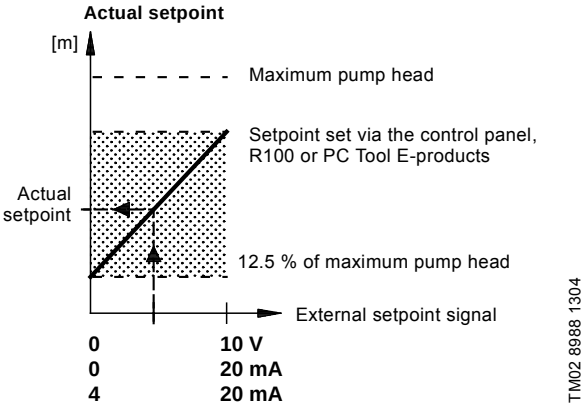


Fig. 82 Relation between the actual setpoint and the external setpoint signal in control mode "Constant pressure"

Example: At a maximum head of 12 metres, a setpoint of 6 metres and an external setpoint of 80 %, the actual setpoint will be as follows:

$$H_{actual} = (H_{set} - 1/8\ H_{max}) \times \%_{external\ setpoint} + 1/8\ H_{max}$$
$$= (6 - 12/8) \times 80\ \% + 12/8$$
$$= 5.1\ m$$

Control mode "Uncontrolled"

If control mode "Uncontrolled", see control hierarchy in section *Overview of modes*, page 59, is selected via the R100, the pump is controlled to a constant curve and can be controlled by any (external) controller.

In control mode "Const. curve", the setpoint can be set externally within the range from the min. curve to the setpoint set on the pump or with the R100. See fig. 83.

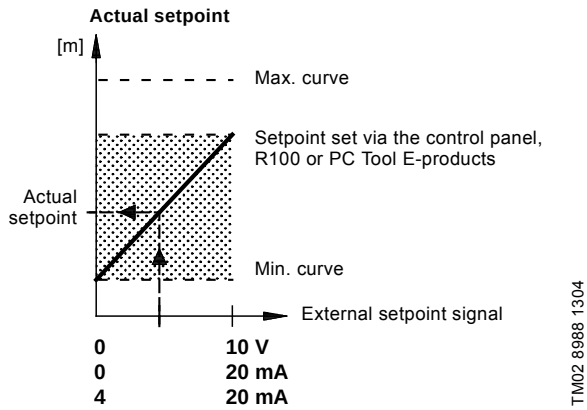


Fig. 83 Relation between the actual setpoint and the external setpoint signal in control mode "Constant curve"

Bus signal

The pump supports serial communication via an RS-485 input. The communication is carried out according to the Grundfos bus protocol, GENIbus, and enables connection to a building management system or another external control system.

Operating parameters, such as setpoint, operating mode, etc. can be remote-set via the bus signal. At the same time, the pump can provide status information about important parameters, such as actual value of control parameter, input power, fault indications, etc.

Contact Grundfos for further details.

Note: If a bus signal is used, the number of settings available via the R100 will be reduced.

Other bus standards

Grundfos offers various bus solutions with communication according to other standards.

Contact Grundfos for further details.

Indicator lights and signal relay

The operating condition of the pump is indicated by the green and red indicator lights on the pump control panel and inside the terminal box. See figs 84 and 85.

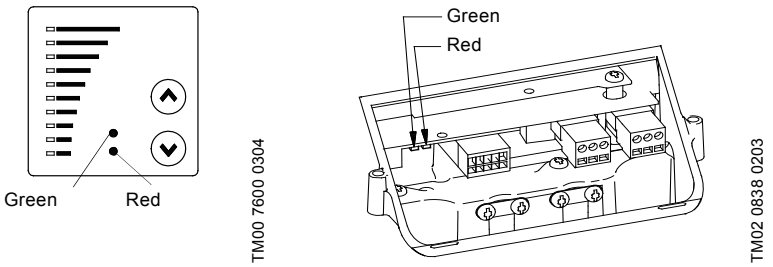


Fig. 84 Position of indicator lights on single-phase pumps

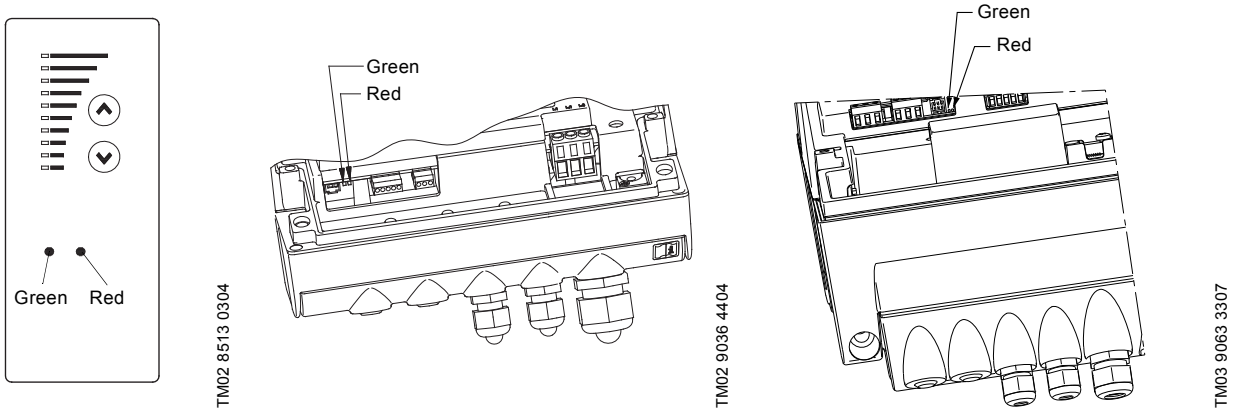
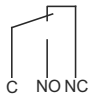
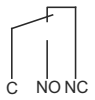
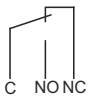
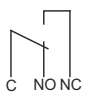
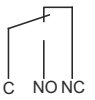
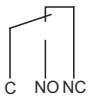
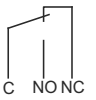
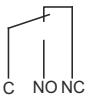
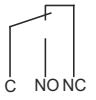
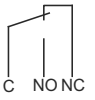


Fig. 85 Position of indicator lights on threee-phase pumps

Besides, the pump incorporates an output for a potential-free signal via an internal relay.

For signal relay output values, see section *Signal relay*, page 68.

The functions of the two indicator lights and the signal relay are as shown in the following table:

Indicator lights		Signal relay activated during:				Description
Fault (red)	Operation (green)	Fault/Alarm, Warning and Relubricate	Operating	Ready	Pump running	
Off	Off					The power supply has been switched off.
Off	Permanently on					The pump is operating.
Off	Flashing					The pump has been set to stop.
Permanently on	Off					The pump has stopped because of a "Fault"/"Alarm" or is running 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 is operating, but it has or has had a "Fault"/"Alarm" allowing the pump to continue operation or it is operating with a "Warning" or "Relubricate" indication. If the cause is "Sensor signal outside signal range", the pump will continue operating according to the max. curve and the fault indication cannot be reset until the signal is inside the signal range. If the cause is "Setpoint signal outside signal range", the pump will continue operating according to the min. curve and the fault indication cannot be reset 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

A fault indication can be reset 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 the R100. See section *Fault indications*, page 65.

When the R100 communicates with the pump, the red indicator light will flash rapidly.

Insulation resistance

0.25 - 7.5 kW

Do not measure the insulation resistance of motor windings or an installation incorporating E-pumps using high-voltage megging equipment, as this may damage the built-in electronics.

11 - 22 kW

Do not measure the insulation resistance of an installation incorporating E-pumps using high-voltage megging equipment, as this may damage the built-in electronics.

The motor conductors can be disconnected separately and the insulation resistance of the motor windings can be tested.

Further product documentation

Specific data booklets are also available on www.grundfos.com > International website > WebCAPS. For further information on WebCAPS, see page 123.

5. Single-phase MGE motors

E-pumps with single-phase MGE motors

Grundfos MGE 71 and MGE 80 motors offer these features:

- Single-phase mains connection.
- Single-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 0.25 to 0.75 kW, 4-pole, and 0.37 to 1.1 kW, 2-pole.

TM02 1502 0101

Fig. 86 Single-phase MGE motor

Supply voltage

1 x 200-240 V - 10 %/+ 10 %, 50/60 Hz, PE.

1 x 208-230 V - 10 %/+ 10 %, 50/60 Hz, PE.

Back-up fuse

Motor sizes from 0.25 to 1.1 kW: Max. 10 A.

Standard as well as quick-blow or slow-blow fuses may be used.

Leakage current

Earth leakage current: < 3.5 mA.

The leakage currents are measured in accordance with EN 60355-1.

Input/output

Start/stop

- External potential-free switch.
  Voltage: 5 VDC.
  Current: < 5 mA.
  Screened cable: 0.5 - 1.5 mm^2 / 28-16 AWG.

Digital input

- External potential-free switch.
  Voltage: 5 VDC.
  Current: < 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 > 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 = 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 > 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 = 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, max. 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 2-core cable: 0.5 - 1.5 mm^2 / 28-16 AWG.
  Maximum cable length: 500 m.

EMC (electromagnetic compatibility)

Emission

Comply with the limits in EN 61800-3 for the first environment (residential areas), unrestricted distribution, corresponding to CISPR11, group 1, class B.

Immunity

Fulfil the requirements for both the first and the second environment according to EN 61800-3.

For further information about EMC, see section *E-pumps with single-phase MGE motors*, page 84.

Enclosure class

Standard enclosure class: IP55.

Insulation class

F (IEC 85).

Ambient temperature

During operation: -20 °C to +40 °C.

During storage/transport: -40 °C to +60 °C.

Relative air humidity

Maximum 95 %.

Sound pressure level

Motor [kW]	Speed as stated on the nameplate [min^{-1}]	Sound pressure level [dB(A)]
0.37	1400-1500	< 70
	1700-1800	
	2800-3000	
	3400-3600	
0.55	1400-1500	
	1700-1800	
	2800-3000	
	3400-3600	
0.75	1400-1500	
	1700-1800	
	2800-3000	
	3400-3600	
1.1	2800-3000	
	3400-3600	

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

If the motor is connected to an electric installation where an earth leakage circuit breaker is used as additional protection, this circuit breaker must be marked with the following symbol:


ELCB

Note: When an earth leakage circuit breaker is selected, the total leakage current of all the electrical equipment in the installation must be taken into account.

Start/stop of pump

The number of starts and stops via the mains voltage must not exceed 4 times per hour.

When the pump is switched on via the mains, it will start after approx. 5 seconds.

If a higher number of starts and stops is desired, the input for external start/stop must be used when starting/stopping the pump.
When the pump is started/stopped via an external on/off switch, it will start immediately.

Wiring diagram

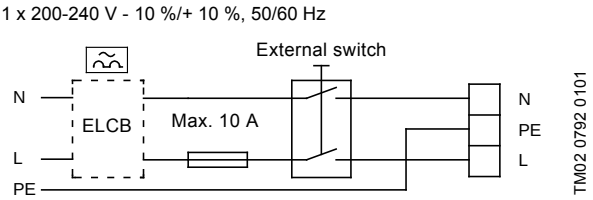


Fig. 87 Wiring diagram, single-phase MGE motors

Other connections

Figure 88 shows the connection terminals of external potential-free contacts for start/stop and digital function, external setpoint signal, sensor signal, GENIbus and relay signal.

Note: If no external on/off switch is connected, short-circuit terminals 2 and 3 using a short wire.

Note: As a precaution, the wires to be connected to the following connection groups must be separated from each other by reinforced insulation in their entire lengths:

- **Group 1: Inputs** (external start/stop, digital function, setpoint and sensor signals, terminals 1-9, and bus connection, terminals B, Y, 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 N, PE, L).
  A galvanically safe separation must fulfil the requirements for reinforced insulation including creepage distances and clearances specified in EN 60335.
- **Group 4: Communication cable** (8-pin male socket)**, only TPED**
  The communication cable is connected to the socket in group 4. The cable ensures communication between the two pumps, whether one or two pressure sensors are connected.
  The selector switch in group 4 enables changeover between the operating modes "alternating operation" and "standby operation".

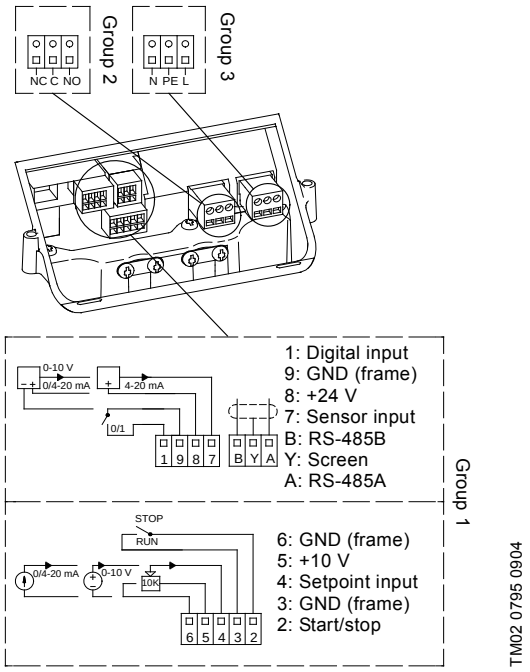


Fig. 88 Connection terminals

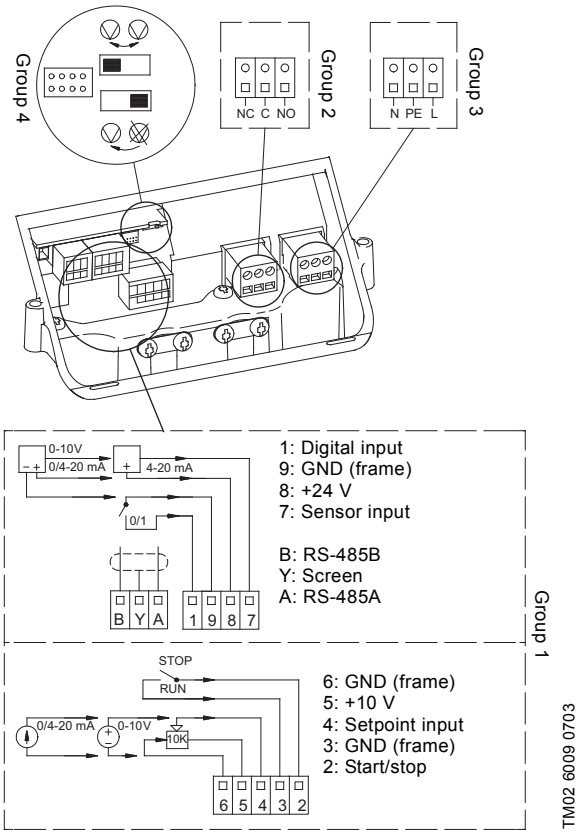


Fig. 89 Connection terminals, TPED Series 2000

6. Three-phase MGE motors

E-pumps with three-phase MGE motors

Grundfos MGE 90, MGE 100, MGE 112, MGE 132, MGE160 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 0.55 to 18.5 kW, 4-pole, and 0.75 to 22 kW, 2-pole.

GR8275

Fig. 90 Three-phase MGE motor

Supply voltage

3 x 380-480 V - 10 %/+ 10 %, 50/60 Hz, PE.

Back-up fuse

Motor size [kW]	Max. fuse [A]
0.55 - 5.5	16
7.5	32
11	26
15	36
18.5	43
22	51

Standard as well as quick-blow or slow-blow fuses may be used.

Leakage current

Motor size [kW]	Leakage current [mA]
0.55 - 3.0	< 3.5
4.0 - 5.5	< 5
5.5, 1400-1800 min^{-1}	< 10
7.5	
11 - 22	>10

The leakage currents are measured in accordance with EN 60355-1 for 0.55 to 7.5 kW and EN 61800-5-1 for 11 to 22 kW motors.

Input/output

Start/stop

- External potential-free switch.
  Voltage: 5 VDC.
  Current: < 5 mA.
  Screened cable: 0.5 - 1.5 mm^2 / 28-16 AWG.

Digital input

- External potential-free switch.
  Voltage: 5 VDC.
  Current: < 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 > 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 = 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 > 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 = 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, max. 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
0.55 0.75 1.1 1.5 2.2 3.0 4.0 5.5 7.5	**Emission:** The motors may be installed in **residential areas** (first environment), unrestricted distribution, corresponding to CISPR11, group 1, class B. **Immunity:** The motors fulfil the requirements for both the first and second environment.
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 *E-pumps with single-phase MGE motors*, page 76.

Enclosure class

Standard: IP55 (IEC34-5).

Insulation class

F (IEC 85).

Ambient temperature

During operation: -20 °C to +40 °C

During storage/transport:

0.25 to 7.5 kW: -40 °C to 60 °C

11 to 22 kW: -25 °C to 70 °C.

Relative air humidity

Maximum 95 %.

Sound pressure level

Motor [kW]	Speed stated on the nameplate [min^{-1}]	Sound pressure level [dB(A)]
0.55	1400-1500	47
	1700-1800	52
	2800-3000	60
	3400-3600	65
0.75	1400-1500	47
	1700-1800	52
	2800-3000	60
	3400-3600	65
1.1	1400-1500	49
	1700-1800	53
	2800-3000	60
	3400-3600	65
1.5	1400-1500	53
	1700-1800	57
	2800-3000	65
	3400-3600	70
2.2	1400-1500	50
	1700-1800	52
	2800-3000	65
	3400-3600	70
3.0	1400-1500	55
	1700-1800	60
	2800-3000	65
	3400-3600	70
4.0	1400-1500	58
	1700-1800	63
	2800-3000	70
	3400-3600	75
5.5	1400-1500	52
	1700-1800	56
	2800-3000	75
	3400-3600	80
7.5	1400-1500	54
	1700-1800	58
	2800-3000	65
	3400-3600	69
11	1400-1500	54
	1700-1800	59
	2800-3000	65
	3400-3600	70
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).

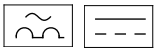
Additional protection

If the motor is connected to an electric installation where an earth leakage circuit breaker is used as additional protection, this circuit breaker must fulfil the following:

- It is suitable for handling leakage currents and cutting-in in case of short pulse-shaped leakage.
- It trips out when alternating fault currents and fault currents with DC content, i.e. pulsating DC and smooth DC fault currents, occur.

For these pumps an earth leakage circuit breaker **type B** must be used.

This circuit breaker must be marked with the following symbols:



Note: When an earth leakage circuit breaker is selected, the total leakage current of all the electrical equipment in the installation must be taken into account.

Start/stop of pump

The number of starts and stops via the mains voltage must not exceed 4 times per hour.

When the pump is switched on via the mains, it will start after approx. 5 seconds.

If a higher number of starts and stops is desired, the input for external start/stop must be used when starting/stopping the pump.
When the pump is started/stopped via an external on/off switch, it will start immediately.

Wiring diagram, 0.55 - 7.5 kW

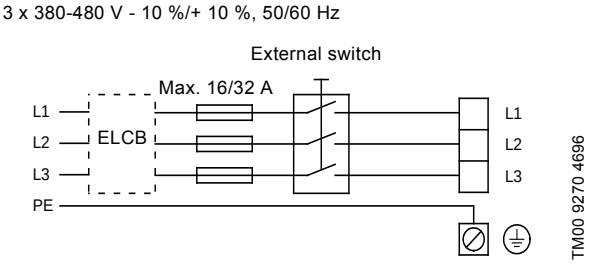


Fig. 91 Wiring diagram, three-phase MGE motors, 0.75 - 7.5 kW

Other connections

Figure 92 shows the connection terminals of external potential-free contacts for start/stop and digital function, external setpoint signal, sensor signal, GENIbus and relay signal.

Note: If no external on/off switch is connected, short-circuit terminals 2 and 3 using a short wire.

Note: As a precaution, the wires to be connected to the following connection groups must be separated from each other by reinforced insulation in their entire lengths:

- **Group 1: Inputs** (external start/stop, digital function, setpoint and sensor signals, terminals 1-9, and bus connection, terminals B, Y, 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. A maximum supply voltage of 250 V or protective extra-low voltage can be connected to the output as desired.
- **Group 3: Mains supply** (terminals L1, L2, L3, PE).
  A galvanically safe separation must fulfil the requirements for reinforced insulation including creepage distances and clearances specified in EN 60335.
- **Group 4: Communication cable** (8-pin male socket)**, only TPED**
  The communication cable is connected to the socket in group 4. The cable ensures communication between the two pumps, whether one or two pressure sensors are connected.
  The selector switch in group 4 enables changeover between the operating modes "alternating operation" and "standby operation".

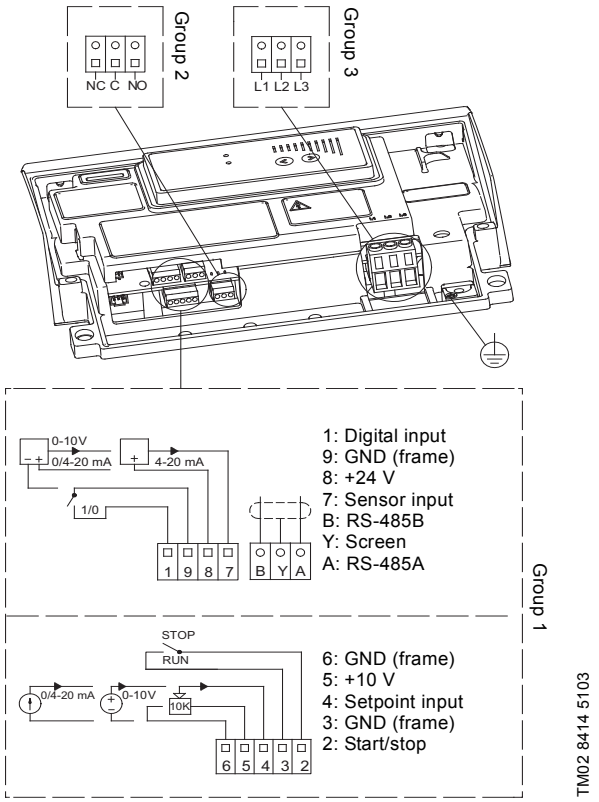


Fig. 92 Connection terminals

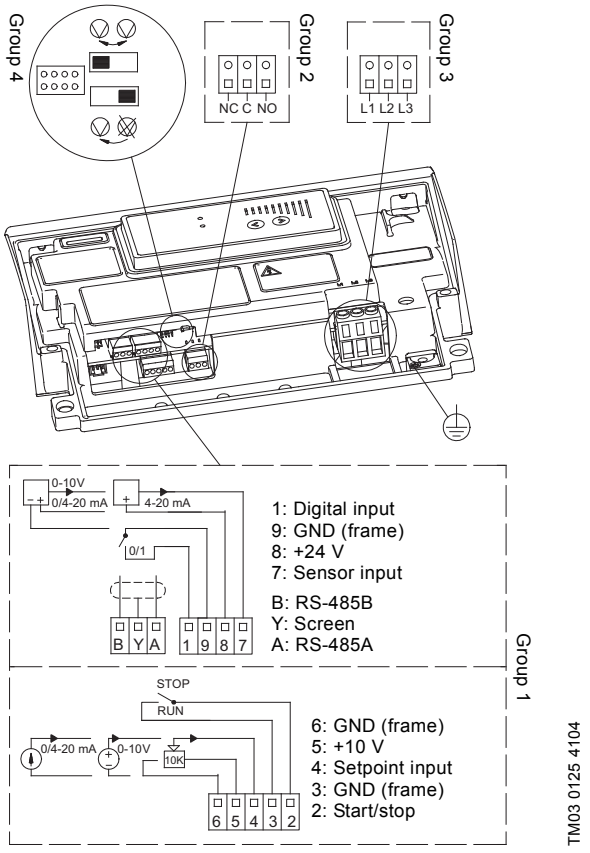


Fig. 93 Connection terminals, TPED Series 2000

Wiring diagram, 11 - 22 kW

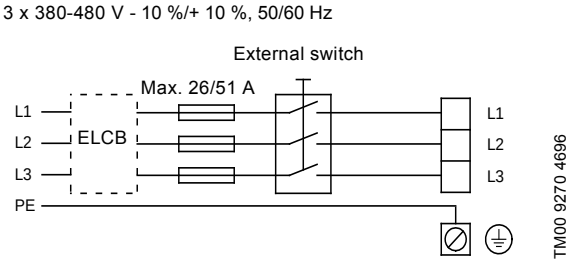


Fig. 94 Wiring diagram, three-phase MGE motors, 11 - 22 kW

Other connections

Note: As a precaution, the wires to be connected to the following connection groups 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.
- **Group 4: Communication cable** (8-pin male socket)**, only TPED**
  The communication cable is connected to the socket in group 4. The cable ensures communication between the two pumps, whether one or two pressure sensors are connected.
  The selector switch in group 4 enables changeover between the operating modes "alternating operation" and "standby operation".

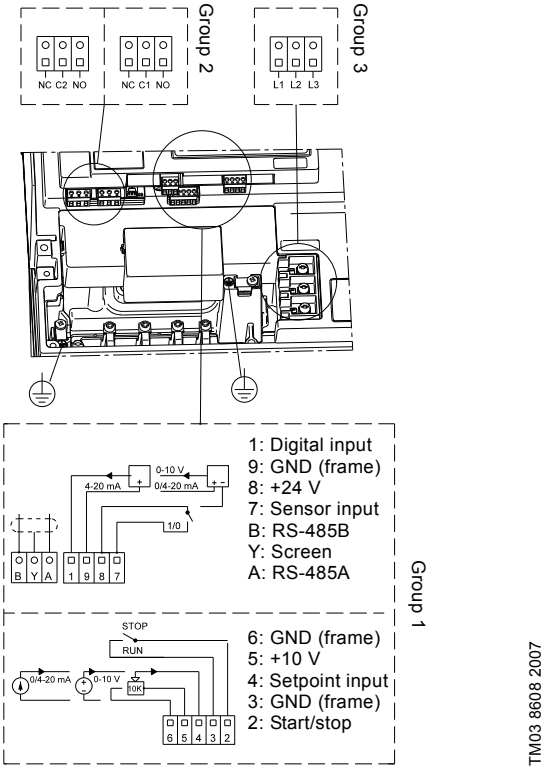


Fig. 95 Connection terminals

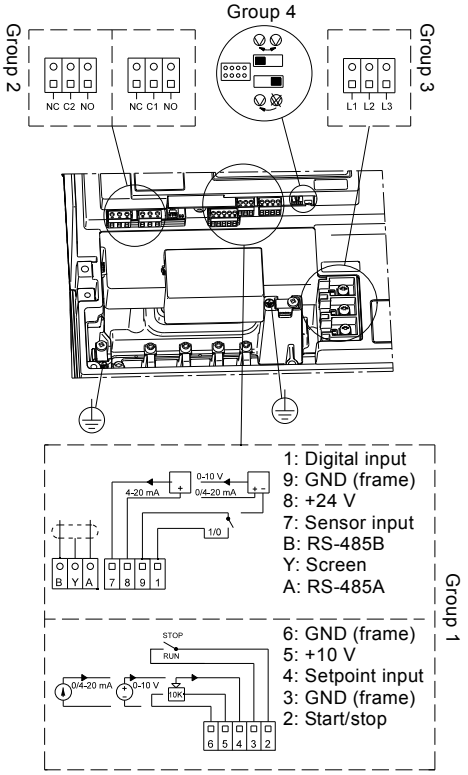


Fig. 96 Connection terminals, TPED Series 2000

7. EMC

EMC and proper installation

General information

The growing use of electric/electronic controls and electronic equipment including PLCs and computers within all business areas require these products to fulfil the existing standards within EMC (ElectoMagnetic Compatibility). The equipment must be mounted properly.

This section deals with these issues.

What is EMC?

ElectoMagnetic Compatibility is an electric or electronic device's ability to function in a given electromagnetic environment without disturbing the surroundings and without being disturbed by other devices in the surroundings. EMC 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/TV.

Immunity

Immunity deals with a device's ability 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, mobile phones, etc.

E-pumps and EMC

All Grundfos E-pumps are CE- and C-tick-marked indicating that the product is designed to meet the EMC requirements defined by the EU (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 will limit the amount of electrical noise which the E-pump emits to the mains supply network (emission). All remaining inputs included in the electronic unit will also be 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 can E-pumps be installed?

All E-pumps with MGE motors can be used 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) include establishments which are **not** connected to a low-voltage network that supplies domestic buildings. The level of electromagnetic disturbance can be expected to 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.

EMC 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 big cable loops are often made inside the terminal box to get some 'spare cable'. Of course, this can be useful, However, with regard to EMC it is a poor solution as these cable loops will function as antennas inside the terminal box.

To avoid EMC problems, the mains supply cable and its individual conductors in the terminal box of the E-pump must be as short as possible. If required, spare cable can be established outside the E-pump.

Connecting sensor and equipment on other low-voltage inputs

All connections to control inputs (terminals 1-9) should be made with screened cables.

To obtain an efficient EMC protection, the screen must be connected to earth/frame in both ends and be unbroken between the two connection points.

It is important that the screen is connected to earth/frame as direct as possible, i.e. by means of a metal cable bracket to encircle the screen completely. See fig. 97.

To ensure a good connection between the cable bracket and earth/frame, any painting and surface treatment on the metal surfaces must be removed.

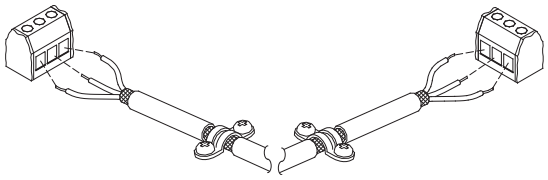


Fig. 97 Mounting of brackets on cable

An intertwined screen at a length of a couple of cm (also called a pig's tail) is a very bad closing as the pig's tail can destroy the whole screen effect.

Connection to signal relay in E-pumps

Connection to relay (terminals NC, C, NO) should be made by means of a screened cable.

Provided the voltage used is low-voltage, the connection can be used together with the other control signals. Otherwise, a separate cable must be used.

Connection to GENIbus, A, Y, B

a) New installations

For the bus connection a screened 3-core cable must be used.

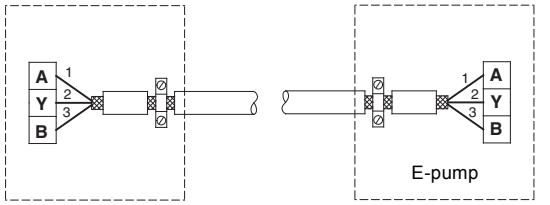


Fig. 98 Connection with screened 3-core cable and metal cable bracket at both ends

- If the E-pump is connected to an electronic unit, control panel, etc. with a cable clamp identical to the one on the E-pump, the screen must be connected to this cable clamp. See fig. 98.
- If the unit or panel has no cable clamp as shown in fig. 99, the screen is left unconnected at this end.

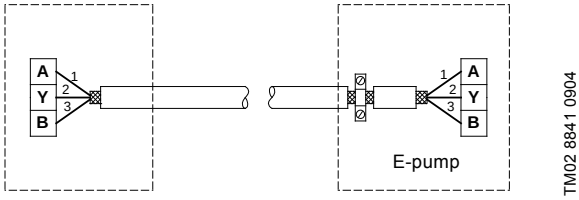


Fig. 99 Connection with screened 3-core cable and metal cable bracket at only the E-pump end

b) Replacing an existing pump

- If a screened 2-core cable is used in the existing installation, it must be connected as shown in fig. 100. Make sure that the "pig's tail" is as short as possible.

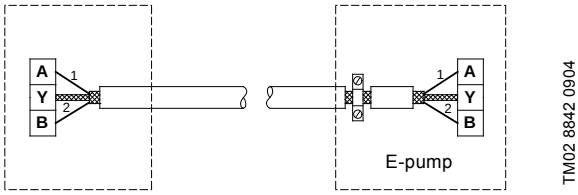


Fig. 100 Connection with screened 2-core cable

- If a screened 3-core cable is used in the existing installation, follow the instructions above for a) New installations.

Connection in control panel

Control panels often contain contactors, relays, solenoid valves for pneumatics and other electromechanical components. These components and cables to and from these can be considered potential sources of noise and therefore, if possible, should be placed separately from any electronic equipment in the same panel. This means that a distance as long as possible should be kept to these, and the components should be screened against their influence.

Cable ducts should be divided so that cables to electronics and cables to contactors should be carried separately.

Back plate

Control panels are often made of metal and/or have a metal back plate. This back plate can therefore be used as reference for all screening, i.e. all screens are connected to this back plate via cable brackets.

When installing the cable brackets, make sure that they have a good electrical connection to the metal back plate. Therefore, any painting and surface treatment must be removed.

Control signal from E-pumps to control panel

a) Unbroken control cable

An unbroken connection from the E-pump to the connection in the control panel is always preferable. Immediately after entry of the cable into the panel, remove a piece of insulation, and connect the screen to the back plate via a cable bracket. See page 101.

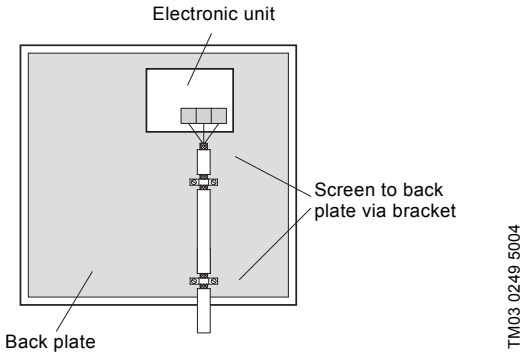


Fig. 101 Schematic drawing of connection of cable to back plate

Connect the cable to the back plate of the control panel close to the final connection. The unscreened cable ends must be as short as possible.

b) Extension of control cable

If an extension of the screened control cable is required, it must be made properly.

As shown in fig. 102, both cable ends must be closed by a cable bracket to the common back plate and the unscreened cable ends must be as short as possible.

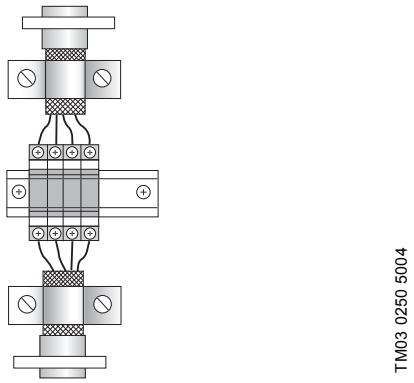


Fig. 102 Schematic drawing of extension of control cable

Keep as long a distance as possible to contactors and power current installation.

Other conditions of importance

Unscreened cable sections must be twisted-pair cables and as short as possible.

Non-conductive panels

Control panels not made of metal and with metal back plate are generally a bad solution with regard to EMC.

In such cases, it is of great importance to be careful with the placing of the different types of unit and to keep distance between the noisy and sensitive units.

Cabling

Do not place the control signal cables in the same bunch as the power cables. A distance of 10 to 20 cm between the two groups should be observed.

8. E-pumps in parallel

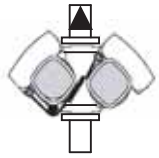
Control of E-pumps connected in parallel

As already described, E-pumps represent a complete system consisting of pump, frequency converter, PI controller and in some cases a sensor. E-pumps offer a closed-loop control solution resulting in for instance constant pressure in the system.

In some applications, parallel pump operation is required for one or more of the following reasons:

- One pump cannot achieve the required performance (flow).
- Standby capacity is required to ensure reliability of supply.
- Overall efficiency needs to be improved in case of big variations in the flow demand.

The table below shows the possibilities of controlling E-pumps connected in parallel.

Parallel operation Control possibilities	CRE, CRIE, CRNE with sensor	CRE, CRIE, CRNE, SPKE, CRKE, MTRE, CME without sensor	TPE, TPED Series 1000, NBE, NKE without sensor	TPE Series 2000	TPED Series 2000
Built-in duty/standby function 	•	•	-	-	-
Built-in alternating/standby function 	-	-	• [1]	-	•
Control MPC 	•	•	•	•	•
Control MPC Series 2000 	-	-	-	•	•

• Available.
1) Applies to TPED pumps only.

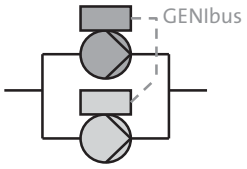
Duty/standby function for three-phase CRE pumps

The "Duty/standby" function enables duty/standby operation of two CRE pumps connected in parallel and controlled via GENIbus.

This means the following:

- Only one pump is operating at a time.
- If a fault occurs in the operating pump, the idle pump (in standby) automatically starts up and a fault indication appears in the pump which was in operation.
- The two pumps run alternately for 24 operating hours.
- As the two pumps never operate at the same time, both pump type, pump size and operating mode may differ.

The two pumps are connected by means of the GENIbus interface. The function must be enabled with the R100. See page 31.



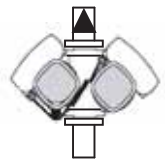
TM03 0414 5004

Fig. 103 Pumps connected via GENIbus interface

CRE pumps running duty/standby in this way cannot use the GENIbus interface for remote communication.

Alternating/standby function for TPED Series 2000

All TPED Series 2000 pumps have built-in alternating/standby function. The pumps are supplied with a special cable for the communication between the two power heads. The function is activated from factory and "alternating" mode is selected as default. See pages 41 and 59.



TM03 0413 5004

Fig. 104 TPED Series 2000

E-pumps controlled by external controllers

E-pumps can be connected to control systems in the following two ways:

E-pumps connected to Control MPC

E-pumps can be connected directly to the Grundfos Control MPC.

Control MPC incorporates among other things a CU 351 controller that can control up to six pumps.

The CU 351 incorporates features such as:

Start-up wizard

Correct installation and commissioning is a prerequisite for attaining optimum performance of the system and trouble-free operation year in and year out.

During commissioning of the system, a start-up wizard is shown on the display of the CU 351. The wizard will guide the operator through the various steps via a series of dialogue boxes to ensure that all settings are done in the correct sequence.

Application-optimised software

The CU 351 incorporates application-optimised software which helps you set up your system to the application in question.

Furthermore, navigating through the menus of the controller is done in a user-friendly way. You do not need any training to be able to set and monitor the system.

Ethernet connection

The CU 351 incorporates an Ethernet connection which makes it possible to get full and unlimited access to the setting and monitoring of the system via a remote PC.

Service port (GENI TTL)

The service port of the CU 351 enables easy access to updating software and data logging in service situations.

External communication

Control MPC enables communication with other fieldbus protocols. In order to communicate with other fieldbus protocols, a GENIbus module and a gateway are required.

Control MPC can communicate with Profibus, Interbus-S, radio/modem/PLC via G100 gateway and LON bus via G10 LON gateway.

TPE Series 2000 pumps connected to Control MPC Series 2000

TPE Series 2000 pumps can be connected directly to the Grundfos Control MPC Series 2000.

Control MPC Series 2000 incorporates among other things a CU 351 controller that can control up to six pumps.

Control MPC Series 2000 is a pump controller designed for control and monitoring of up to six Grundfos MAGNA, UPE or TPE Series 2000 pumps. All pumps must be of the same type and size.

Control MPC Series 2000 is used for controlling circulator pumps in heating and air-conditioning applications.

Control MPC Series 2000 ensures optimum adaptation of the performance to the demand by closed-loop control of the following:

- proportional differential pressure
- constant differential pressure.

By means of an external sensor the Control MPC Series 2000 can also ensure optimum adaptation of the performance to the demand by closed-loop control of the following:

- differential pressure (remote)
- flow
- temperature
- temperature difference.

Note: For further information about Control MPC and Control MPC Series 2000, see the data booklet titled Control MPC. The data booklet is available on www.grundfos.com > International website > WebCAPS. For further information on WebCAPS, see page 123.

9. Bus communication

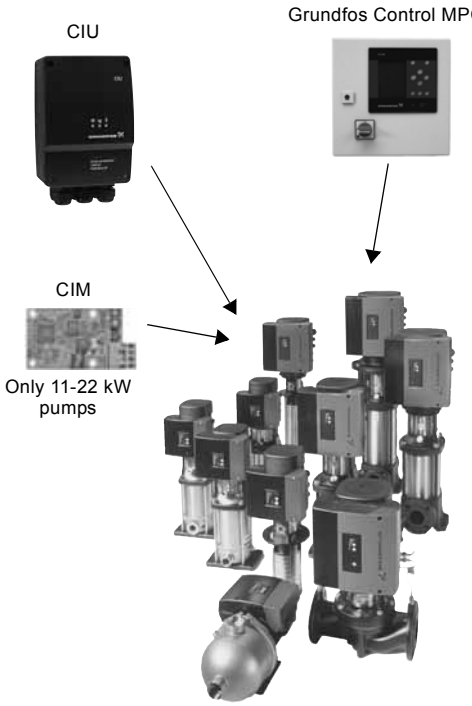
Bus communication with E-pumps

All Grundfos E-pumps are fitted with a fieldbus interface based on the RS-485 hardware platform.

The bus is named GENIbus (Grundfos Electronics Network Intercommunication) and is a Grundfos-developed bus with its own protocol. The GENIbus was first introduced in 1991 when Grundfos introduced the first pumps with integrated frequency converter and controller to the market.

Bus communication with E-pumps can take place in three different ways:

- communication directly to the Control MPC.
- communication to other equipment like building management systems (SCADA) via a Grundfos gateway and a standardised fieldbus, for instance Profibus.
- communication to third-party equipment via embedded Grundfos protocol software.



Communication directly to the Grundfos Control MPC

As described above, E-pumps can be connected directly to the Control MPC for multi-pump control and communication to management systems (SCADA).

Communication to other equipment via a Grundfos gateway

E-pumps can communicate with building management systems (SCADA) via a CIU unit which converts from the GENIbus to another fieldbus, such as LON, Profibus, Modbus, etc.

CIU unit

The Grundfos CIU unit (Communication Interface Unit) is used as a gateway for communication between E-pumps and other buses than GENIbus.

The CIU unit is to be mounted on the wall or in a cabinet. It contains a CIM module (Communication Interface Module) for a specific bus.

The CIU unit has no functionality in itself, but must have a CIM module fitted to be able to communicate.

The CIU unit must be used for MGE motors, models C and D. For Model F, the CIM module can be fitted directly in the pump terminal box.

Communication

The CIU unit can communicate the following data points between the E-pumps and the management system:

Data points	CIU unit		
	Multistage E-pumps with or without sensor	TPE, TPED Series 1000, NBE, NKE without sensor	TPE, TPED Series 2000
From management system (SCADA) to E-pump			
Control mode	• [1]	• [1]	• [2]
Setpoint, 0-100 %	•	•	•
Start/stop	•	•	•
Max.	•	•	•
Min.	•	•	•
From E-pump to management system (SCADA)			
Fault indication	•	•	•
Operating indication	•	•	•
Actual control mode	•	•	•
Actual head	• [3]	• [3]	•
Actual power consumption	•	•	•
Operating hours	•	•	•
Energy consumption	•	•	•
Liquid temperature	•	•	•
Speed [rpm]	•	•	•

• Available.
[1] Control modes: Controlled or uncontrolled.
[2] Control modes: Proportional pressure, constant pressure or constant curve.
[3] Actual controlled value, depending on sensor type.

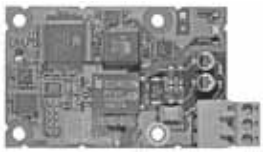
Buses

The following CIU units are available:

- CIU 100, LON
- CIU 150, Profibus DP
- CIU 200, Modbus RTU.
- CIU 250, Modbus/SMS messaging
- CIU 300, BACnet MS/TP

Technical details for these buses can be found in the following sections.

CIM 100 LON module



GrA6119

Fig. 105 CIM 100 LON module

The CIM 100 LON module (CIM = Communication Interface Module) enables data transmission between a LON network and a Grundfos E-pump.

The CIM 100 is fitted in the E-pump to be communicated with or in a CIU unit.

The CIM 100 can communicate the following data points between the E-pump and a management system.

Data points	CIM 100		
	Multistage E-pumps with or without sensor	TPE, TPED Series 1000, NBE, NKE without sensor	TPE, TPED Series 2000
From management system (SCADA) to E-pump			
Control mode	• [2]	• [2]	• [1]
Setpoint, 0-100 %	•	•	•
Start/stop	•	•	•
Max.	•	•	•
Min.	•	•	•
From E-pump to management system (SCADA)			
Fault indication	•	•	•
Operating indication	•	•	•
Actual control mode	•	•	•
Actual head	• [3]	• [3]	•
Actual flow			•
Actual power consumption	•	•	•
Operating hours	•	•	•
Energy consumption	•	•	•
Liquid temperature	• [3]	• [3]	
Speed [rpm]	•	•	•

• Available.
[1] Control modes: Proportional pressure, constant pressure or constant curve.
[2] Control modes: Constant pressure, constant flow or constant curve, depending on connected sensor type.
[3] Depending on connected sensor type:
If a differential-pressure sensor is connected, head is indicated in [kPa].
If a flow sensor is connected, flow is indicated in [m^3/h].
If a temperature sensor is connected, liquid temperature is indicated in [°C].

CIM 150 Profibus module

GrA6121

Fig. 106 CIM 150 Profibus module

The CIM 150 Profibus module (CIM = Communication Interface Module), which is a Profibus slave, enables data transmission between a Profibus-DP network and a Grundfos E-pump.

The CIM 150 is fitted in the E-pump to be communicated with or in a CIU unit.

The CIM 150 can communicate the following data points between the E-pump and a management system.

Data points	CIM 150		
	Multistage E-pumps with or without sensor	TPE, TPED Series 1000, NBE, NKE without sensor	TPE, TPED Series 2000
From management system (SCADA) to E-pump			
Control mode	• [2]	• [2]	• [1]
Setpoint, 0-100 %	•	•	•
Start/stop	•	•	•
Max.	•	•	•
Min.	•	•	•
From E-pump to management system (SCADA)			
Fault indication	•	•	•
Operating indication	•	•	•
Actual control mode	•	•	•
Actual head	• [3]	• [3]	•
Actual flow			•
Actual power consumption	•	•	•
Operating hours	•	•	•
Energy consumption	•	•	•
Liquid temperature	• [3]	• [3]	
Speed [rpm]	•	•	•

• Available.
1) Control modes: Proportional pressure, constant pressure or constant curve.
2) Control modes: Constant pressure, constant flow, constant curve, depending on connected sensor type.
3) Depending on connected sensor type:
If a differential-pressure sensor is connected, head is indicated in [kPa].
If a flow sensor is connected, flow is indicated in [m^3/h].
If a temperature sensor is connected, liquid temperature is indicated in [°C].

CIM 200 Modbus module

GrA6120

Fig. 107 CIM 200 Modbus module

The CIM 200 Modbus module (CIM = Communication Interface Module), which is a Modbus slave, enables data transmission between a Modbus RTU network and a Grundfos E-pump.

The CIM 200 is fitted in the E-pump to be communicated with or in a CIU unit.

The CIM 200 can communicate the following data points between the E-pump and a management system.

Data points	CIM 200		
	Multistage E-pumps with or without sensor	TPE, TPED Series 1000, NBE, NKE without sensor	TPE, TPED Series 2000
From management system (SCADA) to E-pump			
Control mode	• [2]	• [2]	• [1]
Setpoint, 0-100 %	•	•	•
Start/stop	•	•	•
Max.	•	•	•
Min.	•	•	•
From E-pump to management system (SCADA)			
Fault indication	•	•	•
Operating indication	•	•	•
Actual control mode	•	•	•
Actual head	• [3]	• [3]	•
Actual flow			•
Actual power consumption	•	•	•
Operating hours	•	•	•
Energy consumption	•	•	•
Liquid temperature	• [3]	• [3]	
Speed [rpm]	•	•	•

• Available.
[1] Control modes: Proportional pressure, constant pressure or constant curve.
[2] Control modes: Constant pressure, constant flow or constant curve, depending on connected sensor type.
[3] Depending on connected sensor type:
If a differential-pressure sensor is connected, head is indicated in [kPa].
If a flow sensor is connected, flow is indicated in [m^3/h].
If a temperature sensor is connected, liquid temperature is indicated in [°C].

CIM 250 GSM/GPRS module

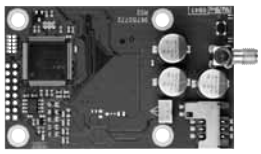


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Fig. 108 CIM 250 GSM/GPRS module

The CIM 250 GSM/GPRS module (CIM = Communication Interface Module) enables data transmission between a GSM/GPRS network and a Grundfos E-pump.

The CIM 250 is fitted in the E-pump to be communicated with or in a CIU unit.

The CIM 250 can communicate the following data points between the E-pump and a management system.

Data points	CIM 250		
	Multistage E-pumps with or without sensor	TPE, TPED Series 1000, NBE, NKE without sensor	TPE, TPED Series 2000
From management system (SCADA) to E-pump			
Control mode	• [2]	• [2]	• [1]
Setpoint, 0-100 %	•	•	•
Start/stop	•	•	•
Max.	•	•	•
Min.	•	•	•
From E-pump to management system (SCADA)			
Fault indication	•	•	•
Operating indication	•	•	•
Actual control mode	•	•	•
Actual head	• [3]	• [3]	•
Actual flow			•
Actual power consumption	•	•	•
Operating hours	•	•	•
Energy consumption	•	•	•
Liquid temperature	• [3]	• [3]	
Speed [rpm]	•	•	•

• Available.
1) Control modes: Proportional pressure, constant pressure or constant curve.
2) Control modes: Constant pressure, constant flow or constant curve, depending on connected sensor type.
3) Depending on connected sensor type:
If a differential-pressure sensor is connected, head is indicated in [kPa].
If a flow sensor is connected, flow is indicated in [m^3/h].
If a temperature sensor is connected, liquid temperature is indicated in [°C].

CIM 300 BACnet module

GrA6120

Fig. 109 CIM 300 BACnet module

The CIM 300 BACnet module (CIM = Communication Interface Module), which is a BACnet master, enables data transmission between a BACnet MS/TP (Master-Slave/Token Passing) network and a Grundfos E-pump.

The CIM 300 is fitted in the E-pump to be communicated with or in a CIU unit.

The CIM 300 can communicate the following data points between the E-pump and a management system.

Data points	CIM 300		
	Multistage E-pumps with or without sensor	TPE, TPED Series 1000, NBE, NKE without sensor	TPE, TPED Series 2000
From management system (SCADA) to E-pump			
Control mode	• [2]	• [2]	• [1]
Setpoint, 0-100 %	•	•	•
Start/stop	•	•	•
Max.	•	•	•
Min.	•	•	•
From E-pump to management system (SCADA)			
Fault indication	•	•	•
Operating indication	•	•	•
Actual control mode	•	•	•
Actual head	• [3]	• [3]	•
Actual flow			•
Actual power consumption	•	•	•
Operating hours	•	•	•
Energy consumption	•	•	•
Liquid temperature	• [3]	• [3]	
Speed [rpm]	•	•	•

• Available.
[1] Control modes: Proportional pressure, constant pressure or constant curve.
[2] Control modes: Constant pressure, constant flow or constant curve, depending on connected sensor type.
[3] Depending on connected sensor type:
If a differential-pressure sensor is connected, head is indicated in [kPa].
If a flow sensor is connected, flow is indicated in [m^3/h].
If a temperature sensor is connected, liquid temperature is indicated in [°C].

10. Frequency-controlled operation

Frequency converter, function and design

Frequency converter

As mentioned earlier, speed control of pumps involves a frequency converter. So it will be relevant to have a closer look at what a frequency converter is, how it ope-rates and finally to discuss related precautions involved in using a frequency converter.

Basic function and characteristics

It is a well-known fact that the speed of an asynchronous motor depends primarily on the pole number and the frequency of the supply voltage. The amplitude of the voltage supplied and the load on the motor shaft also influence the motor speed, however, not to the same degree. Consequently, changing the frequency of the supply voltage is an ideal method for asynchronous motor speed control. In order to ensure a correct motor magnetisation, it is also necessary to change the amplitude of the voltage.

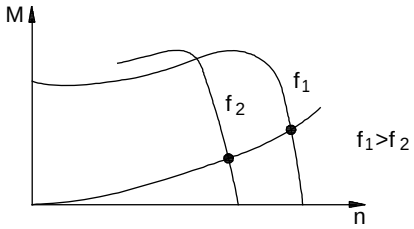


Fig. 110 Displacement of motor torque characteristic

A frequency/voltage control results in a displacement of the torque characteristic whereby the speed is changed. Figure 110 shows the motor torque characteristic (M) as a function of the speed (n) at two different frequencies/voltages. In the same diagram is also drawn the load characteristic of the pump. As it appears from the figure, the speed is changed by changing the frequency/voltage of the motor. The frequency converter changes frequency and voltage, so therefore we can conclude that the basic task of a frequency converter is to change the fixed supply voltage/frequency, for instance 3 x 400 V, 50 Hz, into a variable voltage/frequency.

Components of the frequency converter

In principle, all frequency converters consist of the same functional blocks. As mentioned previously, the basic function is to convert the mains voltage supply into a new AC voltage with another frequency and amplitude.

First of all the frequency converter rectifies the incoming mains voltage and stores the energy in an intermediate circuit consisting of a capacitor. The resulting DC voltage is then converted to a new AC voltage with another frequency and amplitude.

Because of the intermediate circuit in the frequency converter, the frequency of the mains voltage has no direct influence on the output frequency and thus on the motor speed. It does not matter whether the frequency is 50 or 60 Hz as the rectifier can handle both. Additionally, the incoming frequency will not influence the output frequency, as this is defined by the voltage/frequency pattern which is defined in the inverter. Keeping the above mentioned facts in mind, using a frequency converter in connection with asynchronous motors provides the following benefits:

- The system can be used in both 50 and 60 Hz areas without any modifications.
- The output frequency of the frequency converter is independent of the incoming frequency.
- The frequency converter can supply output frequencies which are higher than mains supply frequency which makes oversynchronous operation possible.

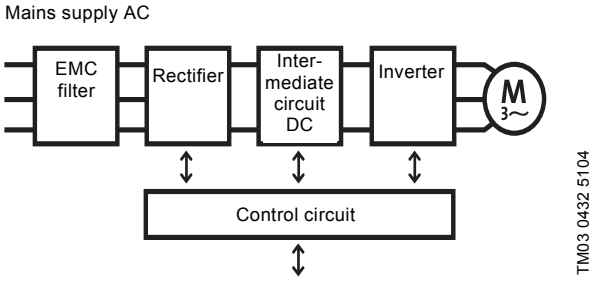


Fig. 111 The main blocks of a frequency converter

EMC filter

This block is not part of the primary function of the frequency converter and therefore, in principle, could be left out. However, in order to meet the requirements of the EMC directive of the European Union or other local requirements, the filter is necessary. The EMC filter ensures that the frequency converter does not send unacceptably high noise signals back to the mains, thus disturbing other electronic equipment connected to the mains. At the same time, the filter ensures that noise signals in the mains generated by other equipment do not enter the electronic components of the frequency converter causing damage or disturbances.

Rectifier

Single-phase MGE motors are fitted with a rectifier followed by a so-called PFC circuit (PFC = Power Factor Correction). The purpose of this circuit is to ensure that the current input from the mains is sinusoidal and that the power factor is very close to 1.

The PFC circuit is necessary in order to comply with the EMC directive, standard EN 61000-3-2 stipulating the limits for harmonic current emissions. For a detailed description of the PFC circuit and its influence on its surroundings, see page 99.

In three-phase MGE motors, the rectifier is a conventional rectifier without any power factor correction. This will result in a non-sinusoidal mains current. This subject will be covered later.

Control circuit

The control circuit block has two functions: It controls the frequency converter and at the same time it takes care of the entire communication between the product and the surroundings.

The inverter

The output voltage from a frequency converter is not sinusoidal as is the case for ordinary mains voltage. The voltage supplied to the motor consists of a number of square wave pulses. See fig. 112.

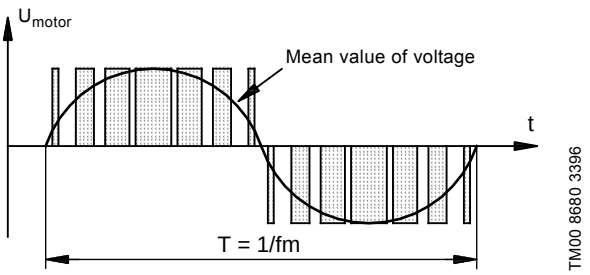


Fig. 112 The voltage supplied to the motor consists of a number of square wave pulses.

The mean value of these pulses forms a sinusoidal voltage of the desired frequency and amplitude. The switching frequency can be from a few kHz and up to 20 kHz, depending on the type and size of the inverter.

To avoid noise generation in the motor windings, a frequency converter with a switching frequency above the range of audibility (~16 kHz) is preferable. This principle of inverter operation is called PWM (Pulse Width Modulation) control, and it is the control principle which is most common in frequency converters today. The motor current itself is almost sinusoidal. This is shown in fig. 113 (a) indicating motor current (top) and motor voltage. In fig. 113 (b) a section of the motor voltage is shown. This indicates how the pulse/pause ratio of the voltage changes.

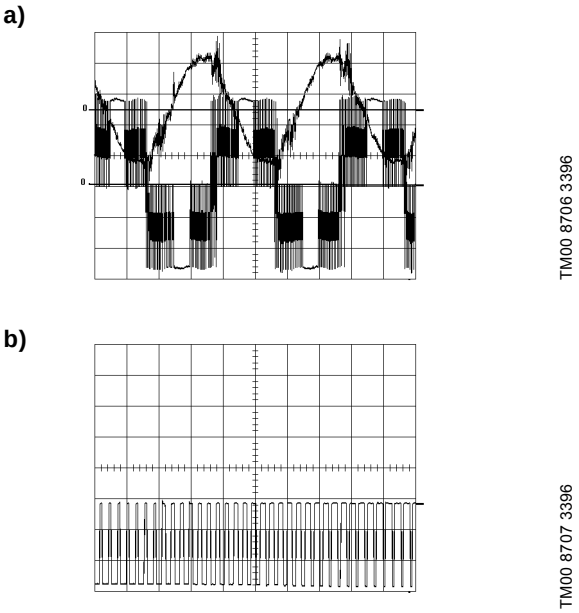


Fig. 113 a) indicates motor current (top) and motor voltage.
b) indicates a section of the motor voltage.

Special conditions regarding frequency converters

When installing and using frequency converters, or pumps with integrated frequency converter, the installer and user must take account of the following. A frequency converter will behave differently on the mains supply side than a standard asynchronous motor. This is described in detail below.

Non-sinusoidal power input, frequency converters supplied by three-phase supply

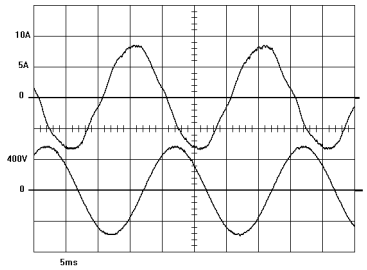
A frequency converter designed as the one described above will not receive sinusoidal current from the mains. Among other things, this will influence the sizing of mains supply cable, mains switch, etc. Figure 114 shows how mains current and voltage appear for the following:

a) three-phase, two-pole standard asynchronous motor

b) three-phase, two-pole standard asynchronous motor with frequency converter.

In both cases, the motor supplies 3 kW to the shaft.

a)



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b)

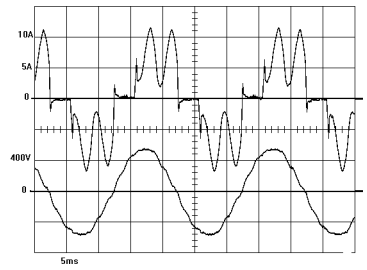

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Fig. 114 Mains current and voltage for a) a standard asynchronous motor and b) a three-phase MGE motor

A comparison of the current in the two cases shows the following differences. See fig. 114.

- The current for the system with frequency converter is not sinusoidal.
- The peak current is much higher (approx. 52 % higher) for the frequency converter solution.

	Standard motor	Motor with frequency converter
Mains voltage	400 V	400 V
Mains current, RMS	6.4 A	6.36 A
Mains current, peak	9.1 A	13.8 A
Power input, P1	3.68 kW	3.69 kW
Cos φ, power factor (PF)	Cos φ = 0.83	PF = 0.86

This is due to the design of the frequency converter connecting the mains to a rectifier followed by a capacitor. The charging of the capacitor happens during short time periods in which the rectified voltage is higher than the voltage in the capacitor at that moment. As mentioned above, the non-sinusoidal current results in other conditions at the mains supply side of the motor. For a standard motor without a frequency converter, the relation between voltage (U), current (I) and power (P) is as follows:

$$P = \sqrt{3} \cdot U \cdot I \cdot \text{Cos } \varphi$$

U is the voltage between two phases and (I) is the phase current, both effective values (RMS values), and φ is phase displacement between current and voltage. In the example the following applies:

U = 400 V, I = 6.2 A, Cos φ = 0.83.

The result is a power input of P = 3.57 kW.

The same formula cannot be used for the calculation of the power input in connection with motors with frequency converters. In fact, in this case, there is no safe way of calculating the power input, based on simple current and voltage measurements, as these are not sinusoidal. Instead, the power must be calculated by means of instruments and on the basis of instantaneous measurements of current and voltage.

If the power (P) is known as well as the RMS value of current and voltage, the so-called power factor (PF) can be calculated using this formula:

$$PF = \frac{P}{\sqrt{3} \cdot U \cdot I}$$

Unlike what is the case when current and voltage are sinusoidal, the power factor has no direct connection with the way in which current and voltage are displaced in time.

For MGE motors the following values are provided as a guideline to the power factor depending on motor size:

Three-phase MGE motor 3000 rpm [kW]	Power factor (PF)
0.75	0.67
1.1	0.72
1.5	0.74
2.2	0.78
3.0	0.84
4.0	0.85
5.5	0.85
7.5	0.86
11	0.91
15	0.89
18.5	0.88
22	0.91

When measuring the input current in connection with installation and service of a system with frequency converter, it is necessary to use an instrument that is capable of measuring "non-sinusoidal" currents. In general, current measuring instruments for frequency converters must be of a type measuring "True RMS".

Power input, frequency converters supplied by single-phase supply

Single-phase MGE motors are fitted with the so-called PCF circuit, which generally speaking ensures sinusoidal power input from the mains. The PFC circuit also ensures that the current is in phase with the voltage in order to achieve a power factor close to 1. When PF = 1, the input current to the MGE motor will be as low as possible.

Figure 115 shows the mains voltage and current for a 1.1 kW MGE motor with PFC circuit. As appears, the mains current is more or less sinusoidal and in phase with the voltage.

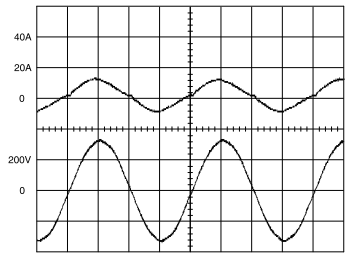

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Fig. 115 Mains voltage and current for a 1.1 kW MGE motor with PFC circuit

For comparison figure 116 shows current and voltage in Grundfos' first generation of MGE motors without PFC circuit. Note that the current has a very high peak value and runs over a very short time.

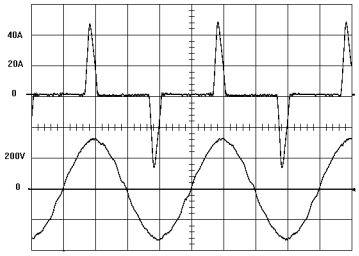

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Fig. 116 Current and voltage in Grundfos' first generation of MGE motors without PFC circuit

The following table illustrates the difference between a single-phase MGE motor without and with PFC circuit, respectively:

	MGE motor without PFC	MGE motor with PFC
Mains voltage	230 V	230 V
Power input, P1	1.57 kW	1.58 kW
Mains current, RMS	13.1 A	7.1 A
Mains current, peak	48.2 A	11.1 A
Crest factor	3.7	1.56
Cos φ, power factor (PF)	0.53	0.97

As appears from the table, power factor and mains current are substantially better for an MGE motor with PFC circuit.

Power factor and typical input mains current at rated load have the following values for the new single-phase MGE motor range:

Motor P2 [kW]	PF	Input current at rated voltage (230 V) and rated P2 at 2840 rpm [A]
0.37	0.95	2.6
0.55	0.96	3.8
0.75	0.96	5.0
1.1	0.97	7.1

As mentioned previously, the PFC circuit is a result of the requirements of EN 61000-3-2 concerning limits for harmonic current emissions. EN 61000-3-2 is a harmonised standard under the EMC directive 2004/108/EC, and the purpose is to ensure that the mains are not "contaminated" by non-sinusoidal loads which have a tendency to distort the waveform of the mains voltage and furthermore cause unnecessarily high peak currents in the mains.

The requirements of EN 61000-3-2 can be summarised as follows:

- Class A products must comply with the limits for harmonic current emissions laid down by the standard.
- The standard is applicable to all equipment connected to the public mains supply network with an input current up to 16 A.
  Note: Exempted from this are:
  – products with an input current lower than 75 W
  – products exclusively designed for professional use with an input current exceeding 1 kW.

As appears, the standard does NOT apply to professional equipment with an input current from the mains above 1 kW. In principle, this means that the standard does not apply to Grundfos' 0.75 and 1.1 kW (P2) MGE motors as their input power from the mains exceeds 1 kW. Nevertheless, due to the obvious advantages of the PFC circuit it has been decided that the entire range of single-phase E-pumps from 0.37 kW up to and including 1.1 kW must comply with the standard.

The PFC circuit features the following advantages for the customer:

- Compliance with EN 61000-3-2 concerning harmonic current emissions.
- The pump current input is more or less sinusoidal and the power factor (PF) is very close to 1 (0.95 - 0.97).

In practical terms, this means the following:

- The RMS value of the current is 40-50 % lower than for single-phase E-pumps without PFC circuit.
- Cables with a lower cross-section can be used.
- Smaller fuses are required in the installation.
- When connecting several pumps supplied by different phases in parallel, the current in the common neutral lead will be balanced so that the neutral lead current will never exceed the current in any one of the mains phases.
- The pump is less sensitive to variations in the mains voltage (the MGE motor can yield full power with the entire mains voltage supply range 200-240 V - 10 %/+ 10 % corresponding to 180-264 V).

Frequency converters and earth leakage circuit breakers (ELCB)

Earth leakage circuit breakers are used increasingly as extra protection in electrical installations. If a frequency converter is to be connected to such an installation, it must be ensured that the circuit breaker installed is of a type which will surely break, also if failure occurs on the DC side of the frequency converter.

The circuit breakers must be marked as follows in order to ensure correct functioning.

- For single-phase MGE motors, the circuit breaker must be marked with the following symbol:


ELCB

- For three-phase MGE motors, the circuit breaker must be marked with the following symbol:


ELCB

Both types of earth leakage circuit breaker are available in the market today.

11. Advanced use of MGE motors

Introduction

Grundfos MGE motors have many features for the advanced user.

Grundfos three-phase MGE motors have features such as bearing monitoring, standstill heating, stop function, signal relays, analog sensors and limit exceeded. These features give a unique opportunity to customise the E-pumps.

The PC Tool E-products gives access to most of the settings available in the products, as well as the possibility of logging and viewing data.

All of these features are described below.

Bearing monitoring

What is bearing monitoring?

Bearing monitoring is a built-in function indicating the time to relubricate or replace the bearings of the MGE motor. The relubrication feature is only available for three-phase pumps of 11-22 kW.

Purpose and benefits

The purpose of this function is to give an indication to the user when it is time to relubricate or replace the motor bearings. This is important information for maintenance planning.

Bearing monitoring provides these benefits:

- The bearing can be relubricated at the right time according to the manufacturer's recommendations.
- Maximum life of the motor bearings is obtained.
- Maintenance intervals are determined by the pump itself.
- No worn-down or damaged bearings, and consequently no costly down-time, due to overseen maintenance.

Applications

Bearing monitoring is application-independent and available in these pump sizes:

Single-phase pumps	
2-pole [kW]	4-pole [kW]
0.37 - 1.1	0.25 - 1.1
-	-

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

Description

When the bearing monitoring function determines that it is time to relubricate the bearings, the user will receive a warning via the R100, PC Tool E-products, bus or relay.

When the bearings have been relubricated, a certain number of times, the warning function will inform the user to replace the bearings.

The number of relubrications before bearing replacement is set up by Grundfos.

Technical description

The bearing monitoring function is available on two levels for calculating the relubrication interval, basic and advanced:

Bearing monitoring function

Basic level

Calculation of relubrication intervals based on motor revolutions.
The basic level is a standard feature of the 11-22 kW basic controller and no special functional module is required.

Advanced level (only 11-22 kW)

Calculation of relubrication intervals based on motor revolutions and bearing temperature.

Note: The advanced-level function requires the following:
- The extended functional module is fitted in the MGE motor.
- Temperature sensors are fitted at the drive end and at the non-drive end of the motor.

Standstill heating

What is standstill heating?

Standstill heating is a feature ensuring that even during standstill periods the motor windings have a certain minimum temperature.

Purpose and benefits

The purpose of this function is to make the MGE motor more suitable for outdoor installation. During standstill periods, there is a need to keep the motor temperature higher than the ambient temperature to avoid condensation in and on the motor.

Traditionally this issue has been solved by using an anti-condensation heater on the stator coil heads. Now Grundfos provides this feature by means of a special function within the MGE motor and terminal box.

The MGE motor has standstill heating included. No external heater on the stator coil is necessary.

Applications

This function is especially suitable in outdoor applications and at installation sites with fluctuating temperatures.

This function is available in these pump sizes:

Single-phase pumps	
2-pole [kW]	4-pole [kW]
0.37 - 1.1	0.25 - 1.1
-	-

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

Description

The working principle is that AC voltage is applied to the motor windings. The applied AC voltage will ensure that sufficient heat is generated to avoid condensation in the motor. The terminal box is kept warm and dry by the heat generated via the mains voltage connected. However, it is a condition that the terminal box is not exposed to open air. It must be provided with a suitable cover to protect it from rain.

Stop function

What is the stop function?

The stop function ensures that the pump is stopped at low or no flow. The function is also called low-flow stop function.

Purpose and benefits

The purpose of the stop function is to stop the pump when low flow or low consumption is detected.

The stop function provides these benefits:

- The energy consumption is limited and the system efficiency is improved.
- Unnecessary heating of the pumped liquid is avoided.
- Wear of the shaft seals is reduced.
- Noise from operation is reduced.

Applications

The stop function is used in systems with periodically low or no consumption thus preventing the pump from running against closed valve.

This function is available in these pump sizes:

Single-phase pumps	
2-pole [kW]	4-pole [kW]
0.37 - 1.1	0.25 - 1.1
•	•

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

Note: When the stop function is set up by means of a configuration file, the function is preset from factory. Default factory configuration files can be downloaded to the product at a later stage via the PC Tool E-products.

Operating conditions for the stop function

The stop function can be used in systems incorporating:

- a pressure sensor
- a non-return valve
- a diaphragm tank.

Note: The non-return valve must always be installed before the pressure sensor. See figs 117 and 118.

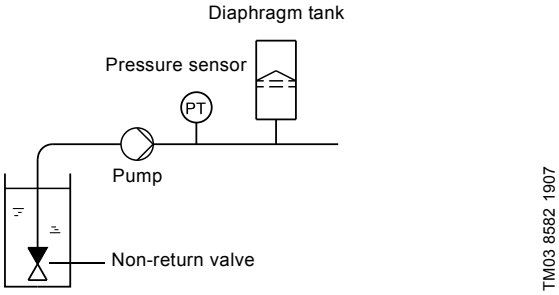


Fig. 117 Position of the non-return valve and pressure sensor in system with suction lift operation

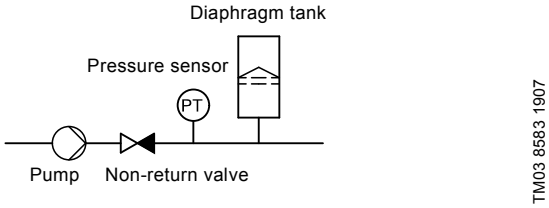


Fig. 118 Position of the non-return valve and pressure sensor in system with positive inlet pressure

Diaphragm tank

The stop function requires a diaphragm tank of a certain minimum size. The tank must be installed near the discharge of the pump, and the precharge pressure must be 0.7 x setpoint.

Recommended diaphragm tank size:

Rated flow of pump [m^3/h]	CRE pump	Typical diaphragm tank size [litres]
0-6	1s, 1, 3, 5	8
7-24	10, 15, 20	18
25-40	32	50
41-70	45, 64	120
71-100	90	180

If a diaphragm tank of the above size is installed in the system, no additional adjustment should be necessary. If the tank installed is too small, the pump will start and stop often. Tank size will influence at which flow the system will go into start/stop operation.

Description

The low-flow stop function can operate in two different ways:

- by means of an integrated "low-flow detection function"
- by means of an external flow switch connected to the digital input.

Contact Grundfos for further information.

Temperature sensors 1 and 2

What are temperature sensors 1 and 2?

Temperature sensors 1 and 2 are inputs from one or two temperature sensors. The inputs must be connected to the connections for two Pt100 sensors. See fig. 119.

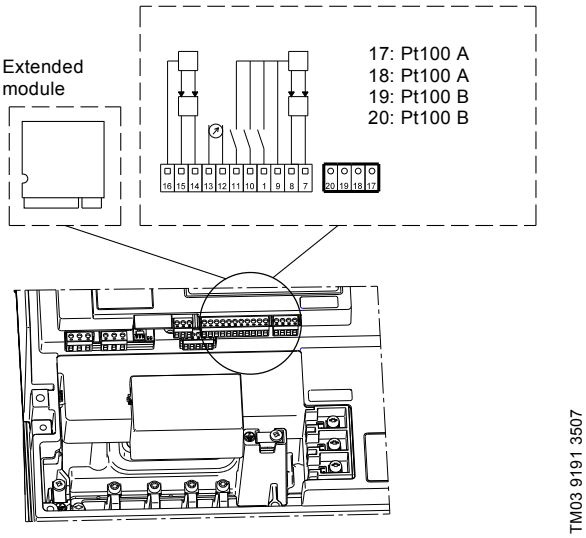


Fig. 119 Temperature sensor connections in the extended functional module

Purpose and benefits

The temperature sensor inputs 1 and 2 provide these benefits:

- The temperature sensor inputs can be used as input to the "limit exceeded" functions 1 and 2.
- In combination with the bearing monitoring function, the temperature sensors provide optimum monitoring of the motor bearings.
- A bearing warning or a bearing alarm can be indicated as the motor bearing temperature is measured.
- Status readings of the measured temperatures are available via the R100, PC Tool E-products and bus.
- The function has a built-in signal fault detection if the temperature sensors fail or a conductor is broken.

Applications

The temperature inputs can be used in all applications where temperatures in the system or in the motor need to be monitored.

Note: The temperature sensor inputs are only available when the extended functional module is fitted in the MGE motor.

This function is available in these pump sizes:

Single-phase pumps	
2-pole [kW]	4-pole [kW]
0.37 - 1.1	0.25 - 1.1
-	-

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

Temperature sensors 1 and 2 can be fitted from factory, or retrofitted as a service kit.

Description

The temperature sensor inputs enable several functions.

- The temperature sensor inputs 1 and 2 can be used as input to the "limit exceeded" functions 1 and 2. If a limit is exceeded, this will be indicated. The indication will be in the form of outputs (relay) or alarms/warnings set up/defined in the "limit exceeded" functions 1 and 2.
- The temperature sensor inputs 1 and 2 can be set up to measure bearing temperature. The measured values of temperature sensor 1 and 2 are used in the calculation of relubrication intervals. Additionally, the measured value can activate the indication of a bearing warning or a bearing alarm. In case of high bearing temperature, a warning or an alarm can be logged and force the pump to stop.

Signal relays

What are signal relays?

Signal relays are used to give an output indication of the current operational status. The output signals are potential-free and can be transmitted to external control systems.

Purpose and benefits

The signal relays offer these features:

- The signal relays can be remotely (via bus) or internally controlled.
- The signal relays can be set up to indicate several types of operational status.
- A relay delay can be defined to avoid activating the relay in case of periodic failures.

Applications

Signal relays can be used in all applications involving a need to read out the operational status to e.g. a control room or to a superior control system.

Grundfos E-pumps have one or two signal relays, depending on the size of the pump.

Single-phase pumps	
2-pole [kW]	**4-pole [kW]**
0.37 - 1.1	**0.25 - 1.1**
•	•
1 relay	1 relay

Three-phase pumps			
2-pole [kW]		**4-pole [kW]**	
0.75 - 7.5	**11 - 22**	**0.55 - 7.5**	**11 - 18.5**
•	•	•	•
1 relay	2 relays	1 relay	2 relays

Description

The signal relays can be set up with these three parameters:

- relay control
- relay setup
- relay delay.

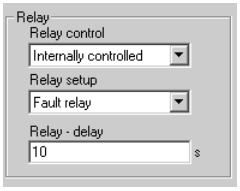


Fig. 120 Signal relay parameters for 0.37 - 7.5 kW pumps

Fig. 121 Signal relay parameters for 11 - 22 kW pumps

Relay control

The relay control can only be set via the PC Tool E-products.

Relay control has these two setting options:

- **Internally controlled**
  The relay is internally controlled by the frequency converter software according to the setup of the relay [Ready, Fault, Operation].
- **Remotely controlled**
  The relay is controlled via commands from the GENIbus.

Analog sensor inputs 1 and 2

What are analog sensor inputs 1 and 2?

The analog sensor inputs 1 and 2 are standardised inputs for measuring all types of analog parameters.

Sensor input 1 is the only sensor input set up for closed-loop operation. The input will be used as the sensor feedback input.

Sensor input 2 is referred to as the secondary sensor.

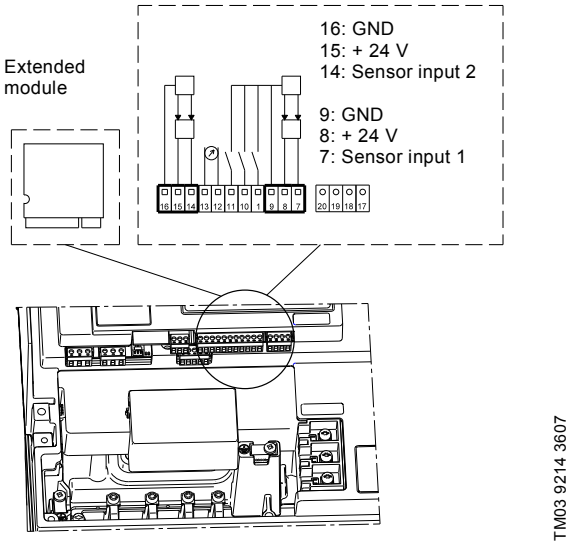


Fig. 122 Sensor inputs 1 and 2 connections in the extended functional module

Note: Sensor inputs 1 and 2 are only available when the extended functional module is fitted in the MGE motor.

Purpose and benefits

The analog sensor inputs 1 and 2 provide these benefits:

- Sensor input 1 can be feedback input for the built-in PI controller.
- It is possible to monitor secondary parameters in the process, e.g. flow or liquid temperature.
- The secondary sensor can be set up as a redundant sensor.
- The sensors can give input to the "limit exceeded" functions 1 and 2.
- Status readings of the inputs are available via the R100 and PC Tool E-products.

Applications

Analog sensor inputs 1 and 2 can be used in applications with a need for monitoring essential analog parameters.

This function is available in these pump sizes:

Single-phase pumps	
2-pole [kW]	**4-pole [kW]**
0.37 - 1.1	**0.25 - 1.1**
•	•
1 analog input	1 analog input

Three-phase pumps			
2-pole [kW]		**4-pole [kW]**	
0.75 - 7.5	**11 - 22**	**0.55 - 7.5**	**11 - 18.5**
•	•	•	•
1 analog input	2 analog inputs	1 analog input	2 analog inputs

Description

The analog sensors 1 and 2 enable several functions.

- When the secondary sensor is set up as an input to the "limit exceeded" functions 1 and 2, defined outputs or warnings or alarms can be given when system parameters are outside defined system limits.
- Connecting a flow sensor.
  When sensor input 2 is set up with a flow sensor, the measured value can be used as input to the proportional-pressure function. The flow displayed in the R100 will be the measured flow instead of the estimated flow.
  The flow measurement can also be used in the low-flow stop function to detect low flow instead of estimating the flow by lowering the speed of the pump.
- Sensor reading via the R100 and PC Tool E-products.
  When sensors are set up. the user can get a status reading via the R100 and PC Tool E-products.

Limit exceeded 1 and 2

What is limit exceeded?

Limit exceeded is a monitoring function monitoring one or two values/inputs. The function enables different **inputs** to activate various **outputs** and **alarms/ warnings** when the signal input has exceeded pre-determined limits.

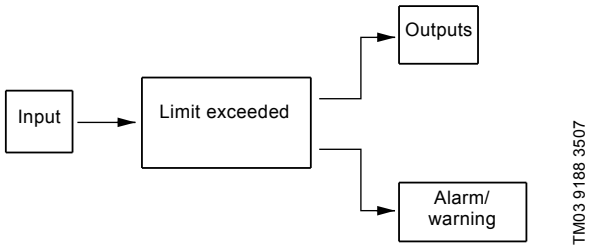


Fig. 123 Example of a "limit exceeded" sequence

Purpose and benefits

The purpose of this function is to monitor parameters which are central for the application. This will enable the controller to react to possible, abnormal operating conditions. This makes the E-pump a more important and integrated part of a system, and it can thus replace other existing monitoring units.

The liquid temperature can be monitored, and thus the E-pump can ensure that the system temperature does not exceed a maximum permissible level.

The minimum inlet pressure can be monitored, and thus the E-pump can prevent damage caused by a liquid-feeding system falling out.

Applications

The limit exceeded function is typically used for monitoring secondary parameters in the systems.

This function is available in these pump sizes:

Single-phase pumps	
2-pole [kW]	4-pole [kW]
0.37 - 1.1	0.25 - 1.1
-	-

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.

Description

The figures below show two examples of setpoint monitoring by means of the limit exceeded function.

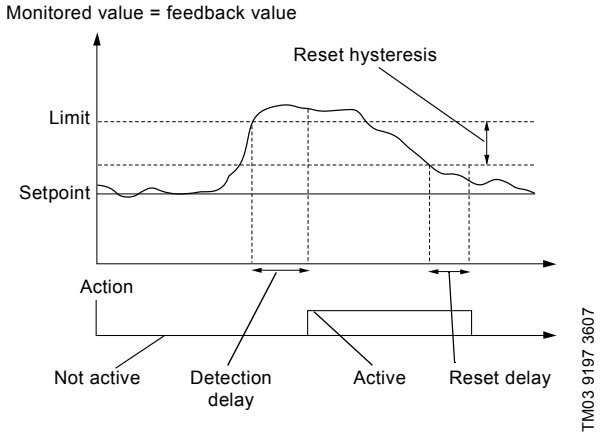


Fig. 124 Limit exceeded sequence with the limit type "max. limit", for example monitoring of bearing temperature

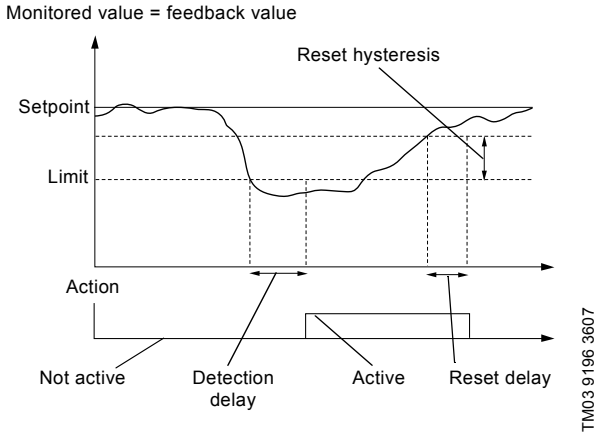


Fig. 125 Limit exceeded sequence with the limit type "min. limit"

When the limit is exceeded, the signal input crosses the limit as an increasing or decreasing value, and the function can be set to cover both situations.

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.

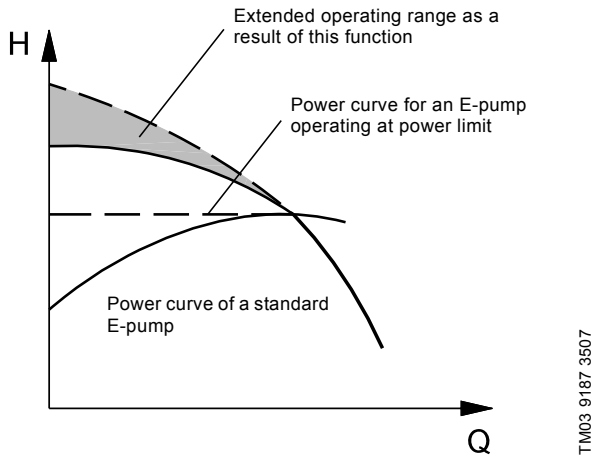


Fig. 126 Power curves of a standard pump and a pump operating at power limit

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. 126.

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:

Single-phase pumps	
2-pole [kW]	4-pole [kW]
0.37 - 1.1	0.25 - 1.1
-	-

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

As mentioned in section *Purpose and benefits*, there are two primary fields of application for this function:

Increased pressure

Figure 127 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.

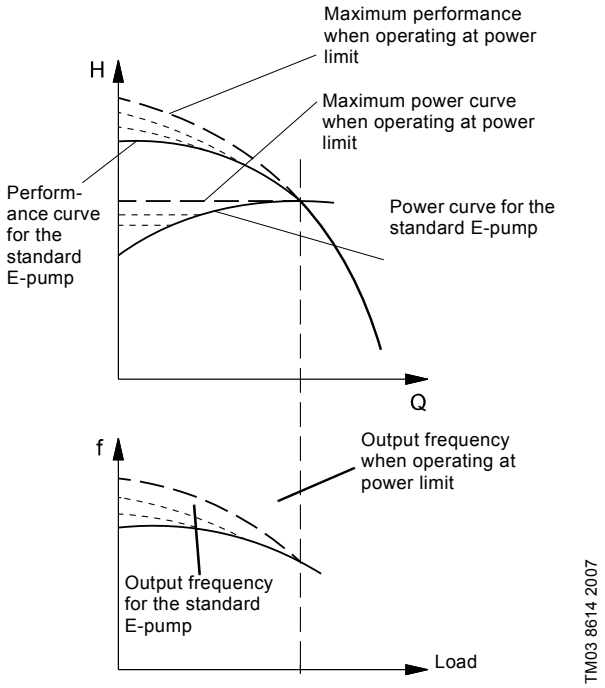


Fig. 127 Standard performance curve vs a performance curve with the "pump operating at power limit" function

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 128 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.

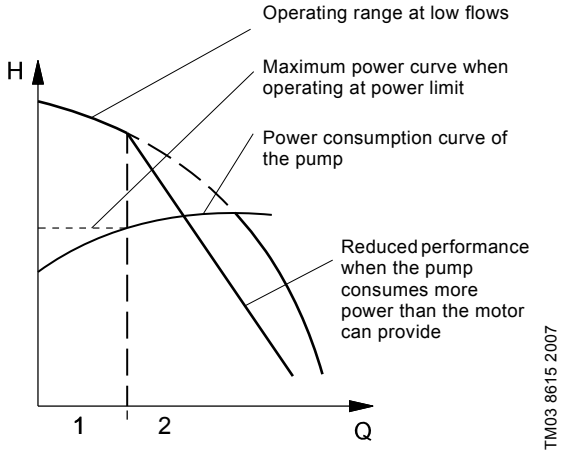


Fig. 128 Standard performance curve vs a curve operated at reduced power limit

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. 128.

Setup

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

PC Tool E-products

What is PC Tool E-products?

Fig. 129 Opening picture in PC Tool E-products

The Grundfos PC Tool E-products is the ultimate tool when working with Grundfos E-pumps.

With the PC Tool E-products you get access to most of the settings available in your E-pump, and data can be logged and viewed.

The PC tool is a combination of a software program supplied on a CD and hardware connecting your computer with your E-pump.

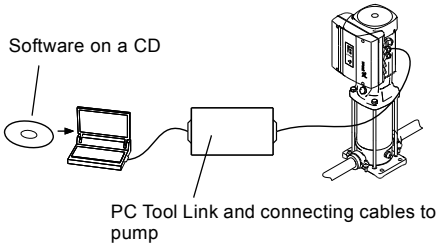


Fig. 130 Complete PC Tool E-products consisting of software and hardware

Purpose and benefits

Connection of the Grundfos PC Tool E-products offers a number of advantages during commissioning, operation and service of E-pumps.

PC Tool E-products enables the following:

- monitoring of the operational status of your E-pump
- standard configuration of E-pumps
- custom configuration of E-pumps
- saving logged data from E-pumps.

Application

The PC Tool E-products can be used for these pump sizes:

Single-phase pumps	
2-pole [kW]	4-pole [kW]
0.37 - 1.1	0.25 - 1.1
•	•

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

Description

The Grundfos PC Tool E-products is a common user platform/user interface used throughout the entire production process of an E-pump. Furthermore, PC Tool E-products can be used by the customer for setting up, commissioning and servicing the E-pump.

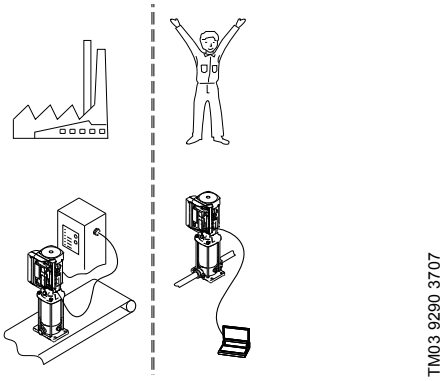


Fig. 131 PC Tool E-products used in production and on site by the customer

The Grundfos PC Tool E-products thus enables subsequent configuration or reconfiguration of your product to optimise it to exactly your application. And PC Tool E-products is indispensable for fault finding and service.

12. Accessories

Overview of accessories

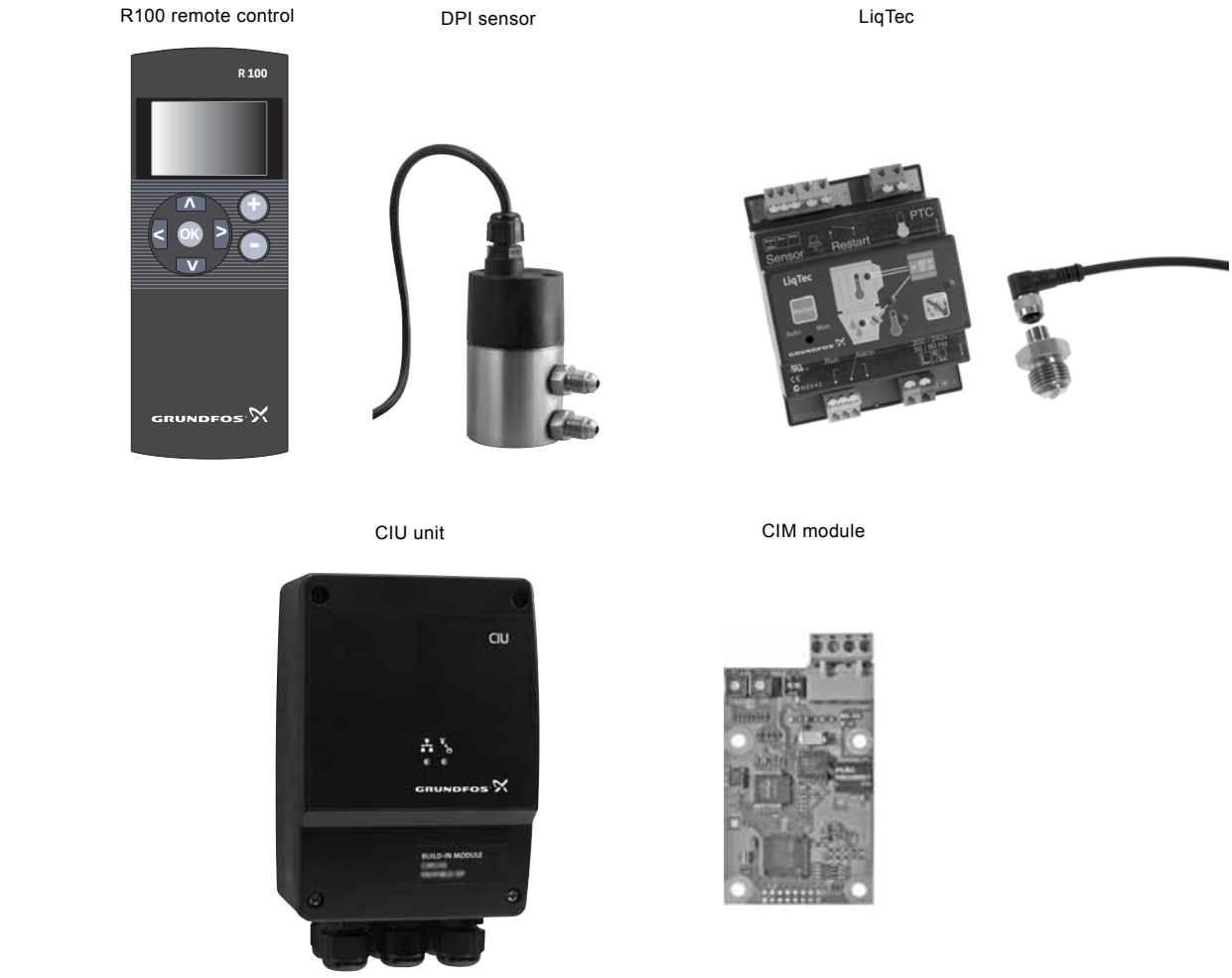
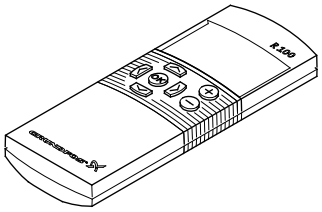


Fig. 132 Examples of accessories

Remote control, R100

The Grundfos R100 remote control is designed for wireless IR communication with Grundfos products. The R100 is supplied with a case, batteries, a detachable pocket clip and operating instructions.

The functions available depend on each individual product. See installation and operating instructions for the product.



TM00 4498 2802

Fig. 133 R100 remote control

Construction

The R100 is a robust mechanical construction made of impact-resistant polycarbonate (PC). The R100 has silicone rubber buttons.

The R100 is to be regarded as an ordinary service and measuring tool, and is therefore designed to withstand wear and stress from everyday use.

The quality of the polycarbonate allows infrared light to pass through. The IR transmitter/receiver is therefore located within the unit and protected against mechanical damage.

The design of the unit and the position of the buttons enable operation of the R100 with one hand only.

The R100 is completely maintenance-free. It can be cleaned with a damp cloth without cleaning material, etc.

Display

The display is a 46 x 30 mm graphic (dot matrix) LCD display with 100 x 65 dots.

The graphics appear in blue colour on a grey background. The display has yellow back light to facilitate reading in dim rooms.

The 68 Hz display refresh rate means that the picture is completely steady and flicker-free.

The contrast ratio is better than 3:1 which in combination with a reading angle of ± 30 ° in all directions offers a very readable display.

A countersunk tempered-glass plate protects the display against knocks and scratches.

Product number

Product	Product number
R100	96615297

Potentiometer

Potentiometer for setpoint setting and start/stop of the pump.

Product number

Product	Product number
External potentiometer with cabinet for wall mounting	625468

Sensors

Accessory	Type	Supplier	Measuring range	Product number
Pressure sensor • Connection: G 1/2 A (DIN 16288 - B6kt) • Electrical connection: plug (DIN 43650)	MBS 3000	Danfoss	0 - 2.5 bar	96478188
			0 - 4 bar	91072075
			0 - 6 bar	91072076
			0 - 10 bar	91072077
			0 - 16 bar	91072078
			0 - 25 bar	91072079
Flowmeter	MAGFLO MAG 3100/5000	Siemens	1 - 5 m^3 (DN 25)	ID8285
Flowmeter	MAGFLO MAG 3100/5000	Siemens	3 - 10 m^3 (DN 40)	ID8286
Flowmeter	MAGFLO MAG 3100/5000	Siemens	6 - 30 m^3 (DN 65)	ID8287
Flowmeter	MAGFLO MAG 3100/5000	Siemens	20 - 75 m^3 (DN 100)	ID8288
Temperature sensor	TTA (0) 25	Carlo Gavazzi	0 °C to +25 °C	96432591
Temperature sensor	TTA (-25) 25	Carlo Gavazzi	-25 °C to +25 °C	96430194
Temperature sensor	TTA (50) 100	Carlo Gavazzi	+50 °C to +100 °C	96432592
Temperature sensor	TTA (0) 150	Carlo Gavazzi	0 °C to +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 °C to +50 °C	ID8295
Differential-temperature sensor	ETSD	Honsberg	0 °C to +20 °C	96409362
Differential-temperature sensor	ETSD	Honsberg	0 °C to +50 °C	96409363

Danfoss pressure sensor kits consisting of	Pressure range [bar]	Product number
• Danfoss pressure transmitter, type MBS 3000, with 2 m screened cable Connection: G 1/2 A (DIN 16288 - B6kt) • 5 cable clips (black) • Instruction manual PT (400212)	0 - 4	96428014
	0 - 6	96428015
	0 - 10	96428016
	0 - 16	96428017
	0 - 25	96428018

Grundfos differential-pressure sensor, DPI	Pressure range [bar]	Product number
• 1 sensor incl. 0.9 m screened cable (7/16" connections) • 1 original DPI bracket (for wall mounting) • 1 Grundfos bracket (for mounting on motor) • 2 M4 screws for mounting of sensor on bracket • 1 M6 screw (self-cutting) for mounting on MGE 90/100 • 1 M8 screw (self-cutting) for mounting on MGE 112/132 • 1 M10 screw (self-cutting) for mounting on MGE 160 • 1 M12 screw (self-cutting) for mounting on MGE 180 • 3 capillary tubes (short/long) • 2 fittings (1/4" - 7/16") • 5 cable clips (black) • Installation and operating instructions	0 - 0.6	96611522
	0 - 1.0	96611523
	0 - 1.6	96611524
	0 - 2.5	96611525
	0 - 4.0	96611526
	0 - 6.0	96611527
	0 - 10	96611550

Select the differential-pressure sensor so that the maximum pressure of the sensor is higher than the maximum differential pressure of the pump.

Fitting kit	Product number
Fitting kit for TPED with two sensors	96491010

Grundfos differential-pressure sensor, DPI

Product description

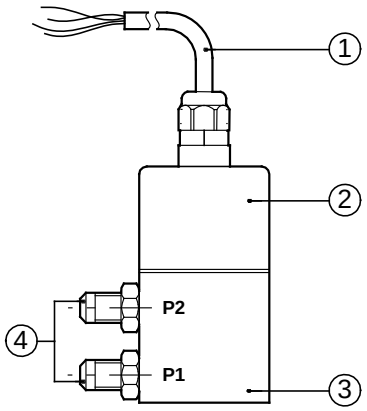
The sensor housing and parts in contact with the liquid are made of Inox DIN 1.4305 (pos. 3) with composite PA top (pos. 2). The connections (pos. 4) are DIN 1.4305, 7/16" UNF connection and gaskets are FKM.

A black and screened cable (pos. 1) goes through a screwed connection PG with M 12 x 1.5 connection.

The sensor is supplied with angular bracket for mounting on motor or bracket for wall mounting.

Kits with other cable lengths and various fitting connectors are available.

The measuring is carried out by a specially coated silicon chip.

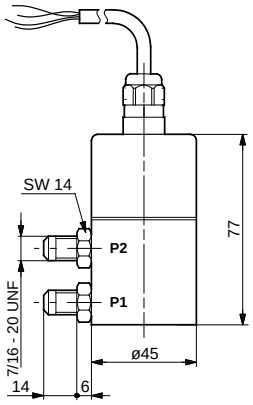


TM03 2057 3505

Fig. 134 DPI sensor

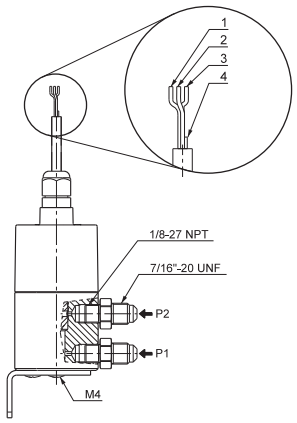
Technical data

Grundfos differential-pressure sensor, DPI							
Product number	96611522	96611523	96611524	96611525	96611526	96611527	96611550
Pressure ranges, differential pressure [bar]	0 - 0.6	0 - 1.0	0 - 1.6	0 - 2.5	0 - 4.0	0 - 6.0	0 - 10
Supply voltage	12 - 30 VDC						
Output signal	4 - 20 mA						
Load [Ω]	24 V: max. 500 [Ω], 16 V: max. 200 [Ω], 12 V: max. 100 [Ω]						
Max. system pressure, P1 and P2 simultaneously [bar]	16						
Rupture pressure [bar]	1.5 x system pressure						
Measuring accuracy	2.5 % BFSL						
Response time	< 0.5 seconds						
Liquid temperature range	-10 °C to +70 °C						
Storage temperature range	-40 °C to +80 °C						
Electrical connection	3-wire 0.13 mm^2, 0.9 m cable - M12 x 1.5 in sensor top						
Short-circuit-proof	Yes						
Protected against reverse polarity	Yes						
Over supply voltage	Yes						
Materials in contact with liquid	DIN 1.4305 FKM and PPS						
Enclosure class	IP55						
Weight [g]	550						
EMC (electromagnetic compatibility)	According to EN 60335-1						
Emission/immunity	According to EN 61800-3						
Connections	7/16"-UNF						
Sealing material	FKM						



TM03 2059 3505

Fig. 135 Dimensional sketch



TM03 2225 3905

Fig. 136 Wiring

1	12-30 V supply voltage	Brown
2	GND (earth lead)	Yellow
3	Signal lead	Green
4	Test lead (can be cut off during mounting). This lead must not be connected to the power supply.	White

Temperature sensor, TTA

Product description

Temperature sensor with Pt100 temperature sensor fitted in a ∅6 x 100 mm measuring tube made of stainless steel, DIN 1.4571 and a 4-20 mA sensor built into a type B head DIN 43.729.

The connecting head is made of painted pressure die-cast aluminium with Pg 16 screwed connection, stainless screws and neoprene rubber gasket.

The sensor is built into the system either by means of a cutting ring bush or by means of one of the two matching protecting tubes ∅9 x 100 mm or ∅9 x 50 mm, respectively.

The protecting tube has G 1/2 connection.

Cutting ring bush or protecting tube must be ordered separately.

Technical data

Type		TTA (-25) 25	TTA (0) 25	TTA (0) 150	TTA (50) 100
Product number		96430194	96432591	96430195	96432592
Measuring range		-25 °C to 25 °C	0 °C to 25 °C	0 °C to 150 °C	50 °C to 100 °C
Measuring accuracy		According to IEC 751, class B, 0.3 °C at 0 °C			
Response time, τ (0.9) in water 0.2 m/s	without protecting tube:	28 seconds			
	with oil-filled protecting tube:	75 seconds			
Enclosure class		IP55			
Output signal		4 - 20 mA			
Supply voltage		8.0 - 35.0 VDC			
EMC (electromagnetic compatibility)	Emission:	According to EN 50081			
	Immunity:	According to EN 50082			

Accessories

Type	Protecting tube Ø9 x 50 mm	Protecting tube Ø9 x 100 mm	Cutting ring bush
Product number	96430201	96430202	96430203
Description	Protecting tube of stainless steel SINOX SSH 2 for ∅6 mm measuring tube. Pipe connection G 1/2.		Cutting ring bush for ∅6 mm measuring tube. Pipe connection G 1/2.

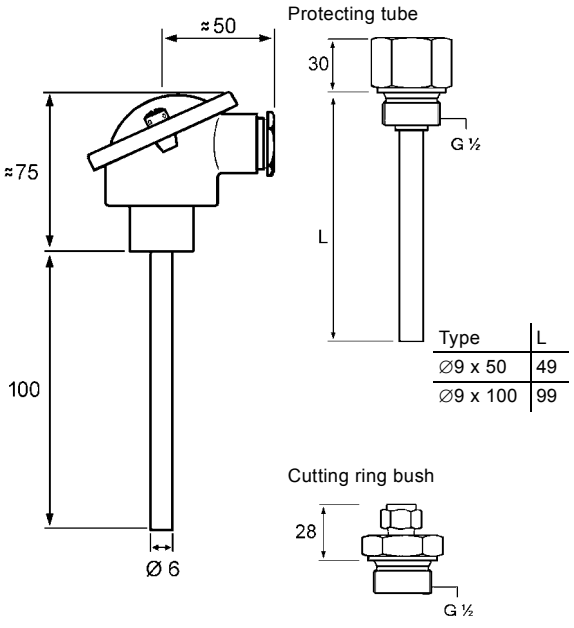


Fig. 137 Dimensional sketch

Connection of sensor

As far as E-pumps are concerned, the cable from the sensor is connected to pump terminals (7) and (8).

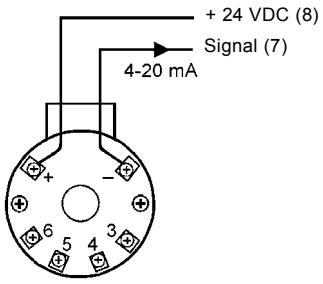


Fig. 138 Connection of sensor

Differential-temperature sensor, HONSBERG

Product description

The temperature sensors T1 and T2 measure the temperature in their respective location at the same time. Besides the temperature measurement, the T1 features an electronic unit calculating the temperature difference between T1 and T2 and transmitting the result as a 4-20 mA signal via a current amplifier.
As the measured signal transmitted from the T2 is also a current signal, a relatively large distance is allowed between T2 and T1.
As will appear from fig. 139, it has no effect on the output signal, I_{out}, which of the sensors that measures the highest temperature.
Thus, the current signal generated will always be positive between 4 and 20 mA.

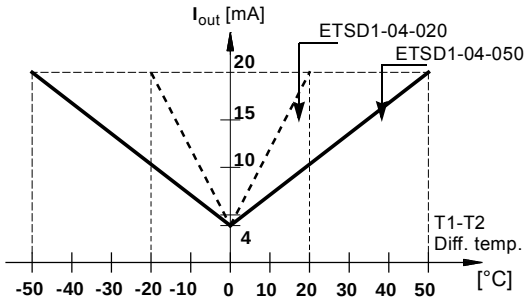


Fig. 139 Sensor characteristic

Technical data

Type	ETSD1-04-020K045 + ETSD2-K045	ETSD1-04-050K045 + ETSD2-K045
Product number	96409362	96409363
Measuring range: Temperature difference (T1-T2) or (T2-T1)	0 °C to 20 °C	0 °C to 50 °C
Supply voltage	15-30 VDC	
Output signal	4-20 mA	
Measuring accuracy	± 0.3 % FS	
Repeatability	± 1 % FS	
Response time, τ (0.9)	2 minutes	
Ambient temperature	-25 °C to 85 °C	
Operating temperature of T1 and T2	-25 °C to 105 °C	
Maximum distance between T1 and T2	300 m with screened cable	
Electrical connection	Between T1 and T2: M12 x 1 plug (incl. in kit), output signal with DIN 43650-A plug type	
Storage temperature	-45 °C to 125 °C	
Short-circuit-proof	Yes	
Protected against polarity reversal	Yes, up to 40 V	
Materials in contact with liquid	Stainless steel, DIN 1.4571	
Enclosure class	IP65	
EMC (electromagnetic compatibility)	Emission: According to EN 50081	
	Immunity: According to EN 50082	

ETSD1-	04-	020	K	045	Specification
ETSD1-					Reference temperature, T1.
	04-				0 °C corresponds to 4 mA.
		020			20 °C corresponds to 20 mA.
		050			50 °C corresponds to 20 mA.
			K		Material in contact with liquid: Stainless steel, DIN 1.4571.
				045	Length of sensing element: 45 mm.

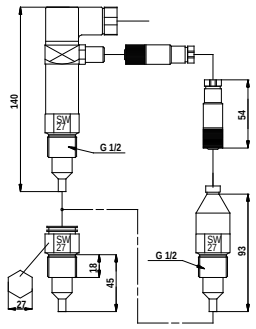
ETSD2-	K	045	Specification
ETSD2-			Reference temperature, T2.
	K		Material in contact with liquid: Stainless steel, DIN 1.4571.
		045	Length of sensing element: 45 mm.

Installation

The two sensors must be fitted in such a way that the sensing elements are located in the middle of the flow of the liquid to be measured.

For tightening, use only the hexagon nut.
The upper part of the sensors may be turned to any position suitable for the connection of cables.

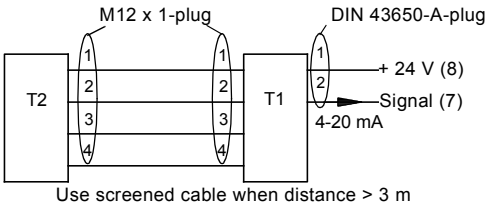
The sensors have G 1/2 thread. See fig. 140.



TM02 0705 5000

Fig. 140 Dimensional sketch

As far as E-pumps are concerned, the cable from sensor T1 is to be connected to pump terminals (7) and (8). See fig. 141.



TM02 0706 5000

Fig. 141 Wiring diagram

EMC filter

If E-pumps with MGE motor, 11-22 kW, are going to be used unrestricted in residential areas, an additional EMC filter must be installed between the power supply and the E-pump.

For information regarding EMC, see section *E-pumps with single-phase MGE motors*, page 76.

TM02 9198 1203

Fig. 142 EMC filter

Product number and contents of kit

Product number: 96478309.

The kit contains the following:

- filter in IP54 aluminium cabinet
- for connection to the motor terminal box:
  - 1 reducer from M40 x 1.5 to M32 x 1.5
  - 1 EMC nut M40 x 1.5
  - 1 EMC cable gland M32 x 1.5
- installation and operating instructions.

Technical data

Mains connection: 380-480 V, 50/60 Hz.

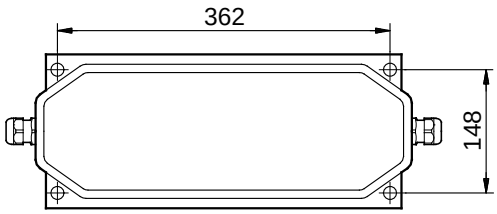
Maximum load: 50 A.

Enclosure class: IP54.

Weight: 12 kg.

Mounting of EMC filter

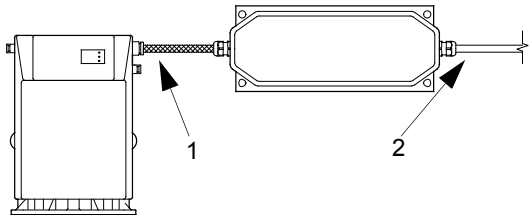
Mount the filter on an even surface. See fig. 143.



TM02 6623 1203

Fig. 143 Dimensional sketch

To meet CISPR 11, class B, group 1, the cable between filter and motor must be a screened cable. See fig. 144, pos. 1. The ends of the screened cable must be terminated with EMC cable glands to ensure correct functioning of the filter. The normal cable glands in the MGE motor have to be exchanged with special EMC cable gland supplied in this kit.



TM02 6624 1203

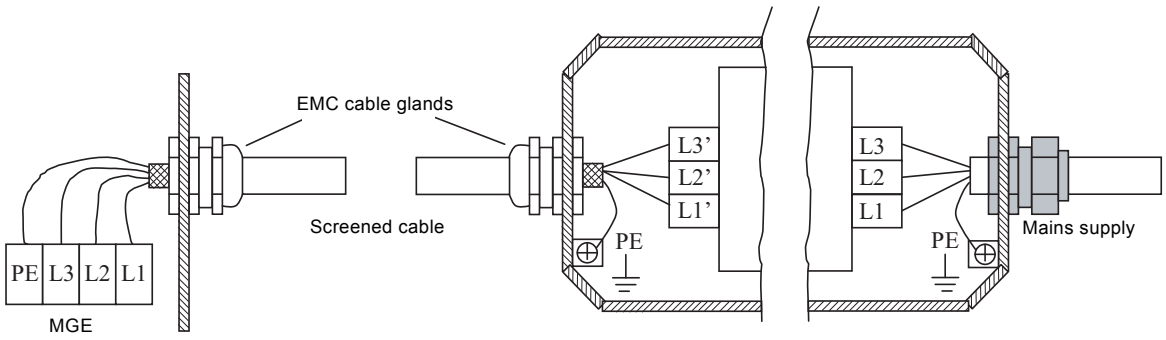
Fig. 144 Connection cables

Make sure that the screened cable has at least the same current value as the mains cable, pos. 2.

The screened cable is not included in the kit.

Product number

Product	Product number
EMC filter for MGE motors 11-22 kW	96478309



TM03 0417 5004

Fig. 145 Wiring diagram

CIU communication interface units

TM04 2594 1008

Fig. 146 Grundfos CIU unit

The CIU units enable communication of operating data, such as measured values and setpoints, between E-pumps and a building management system. The CIU unit incorporates a 24-240 VAC/VDC power supply module and a CIM module. It can either be fitted on a DIN rail or on a wall.

We offer the following CIU units:

CIU 100

For communication via LON.

CIU 150

For communication via Profibus DP.

CIU 200

For communication via Modbus RTU.

CIU 250

For wireless communication via GSM, GPRS or SMS.

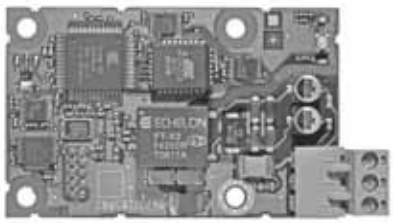
CIU 300

For communication via BACnet MS/TP.

Description	Fieldbus protocol	Product number
CIU 100	LON	96753735
CIU 150	Profibus DP	96753081
CIU 200	Modbus RTU	96753082
CIU 250	GSM/GPRS	96787106
CIU 300	BACnet MS/TP	96893769

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

CIM communication interface modules



TM04 2594 1008

Fig. 147 Grundfos CIM 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 fitted in the pump terminal box.

Note: CIM modules must be fitted by authorised personnel.

We offer the following CIM modules:

CIM 100

For communication via LON.

CIM 150

For communication via Profibus DP.

CIM 200

For communication via Modbus RTU.

CIU 250

For wireless communication via GSM, GPRS or SMS.

CIM 300

For communication via BACnet MS/TP.

Description	Fieldbus protocol	Product number
CIM 100	LON	96824797
CIM 150	Profibus DP	96824793
CIM 200	Modbus RTU	96824796
CIM 250	GSM/GPRS	96824795
CIM 300	BACnet MS/TP	96893770

For further information about data communication via CIM modules and fieldbus protocols, see the CIM documentation available www.grundfos.com > International website > WebCAPS.

LiqTec

Description

LiqTec features:

- Protects the pump against dry-running.
- Protects the pump against too high liquid temperature (130 °C ± 5 °C).
- Can monitor the motor temperature if the PTC sensor in the motor has been connected.
- Has a fail-safe design. If the sensor, sensor cable, electronic unit or power supply fails, the pump stops immediately.

Mounting the LiqTec sensor

The LiqTec can be fitted to a DIN rail to be incorporated in a control cabinet.

Electrical connection

Example of electrical connection, see page 122.

Calibration of sensor and controller

Follow the procedure on the next page.

Functions

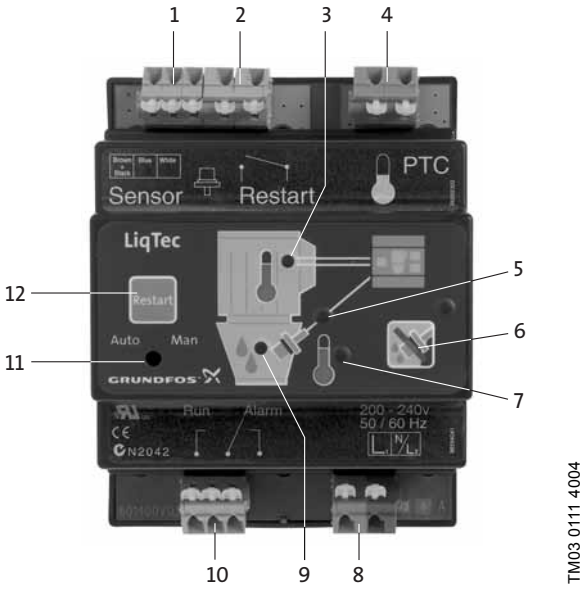


Fig. 148 LiqTec functions

1. **Connection for dry-running sensor**
   Part number of dry-running sensor: 96556427.
2. **Connection for external restarting**
3. **Motor PTC**
   Green light indicates OK or short-circuited terminals.
   Red light indicates too high motor temperature.
   The alarm relay is activated.
4. **Connection for PTC sensor**
   This input is not used in connection with E-pumps as the frequency converter protects the motor against overload.
5. **Sensor indicator light**
   Red light indicates defective sensor or cable.
   The alarm relay is activated.
6. **Deactivation of the dry-running monitoring function**
   Press the button to deactivate the dry-running monitoring function. Red flashing light. The PTC monitoring function is still active.
   Press [Restart] to reactivate the dry-running monitoring function.
7. **High liquid temperature indicator light**
   Red light indicates too high liquid temperature (130 °C ± 5 °C).
   The alarm relay is activated.
8. **Supply voltage**
   200-240 V, 50/60 Hz.
9. **Dry-running indicator light**
   Green light indicates OK (liquid in pump).
   Red light indicates dry running (no liquid in pump).
   The alarm relay is activated.
10. **Alarm/Run relay output**
    Potential-free changeover contact.
    Maximum contact load: 250 V, 1 A, AC (inductive load).
11. **Auto/Man**
    Changeover between automatic and manual restarting.
    The default setting is "Man".
    Changeover is carried out by means of a small screwdriver.
    When "Auto" has been selected, the alarm indication will automatically be reset 10 to 20 seconds after detection of liquid.
12. **Restart**
    Press [Restart] to restart the pump. The button has no influence on the PTC monitoring.

Calibration of sensor and controller

Step	Action	Result
1	Check that the sensor is correctly connected to the controller. See page 122.	
2	Before fitting the sensor in the pump, submerge the sensor into stagnant water. Any kind of container with water can be used. **Note:** It is important that the water is stagnant as the calibration will be misleading if the sensor is cooled by flowing water.	
3	Keep the buttons (pos. 6 and 12) pressed for approx. 20 seconds.	All red indicator lights (except pos. 7) start flashing.
4	When the green indicator lights (pos. 3 and 9) are constantly on, stop pressing the buttons (pos. 6 and 12).	The calibration is completed.

Further information

Information related to IEC 60730-1:

- Software class A
- Pollution degree 2
- Type 1.

The LiqTec has been cURus-approved according to UL 508.

Maximum pressure: 40 bar.

Maximum liquid temperature: +130 °C ± 5 °C.

Maximum ambient temperature: +55 °C.

Power consumption: 5 Watt.

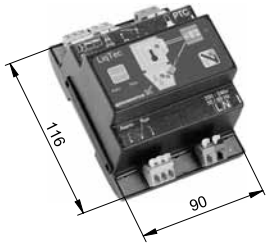
Enclosure class: IPX0.

Maximum cable length: 20 metres.

Standard cable: 5 metres.

Extension cable: 15 metres.

Note: For motor temperature monitoring of E-pumps, the LiqTec must not be connected to the PTC sensor of the pump as the motor software provides protection against too high motor temperature. Use the LiqTec mainly in connection with the CRE, CRIE, CRNE pump types. Fit the sensor in the pump head. The LiqTec is also suitable for other E-pump types. LiqTec is prepared for DIN rail mounting in control cabinet.

Dry-running protection	Pump type	Voltage [V]	LiqTec	Sensor 1/2"	Cable 5 m	Extension cable 15 m	Product number
 TM02 1731 2001	**CRE CRIE CRNE MTRE SPKE CRKE CME**	200-240	•	•	•	-	96443674
		80-130	•	•	•	-	96463912
		-	-	-	-	•	96443676

Connection of CRE pump to LiqTec

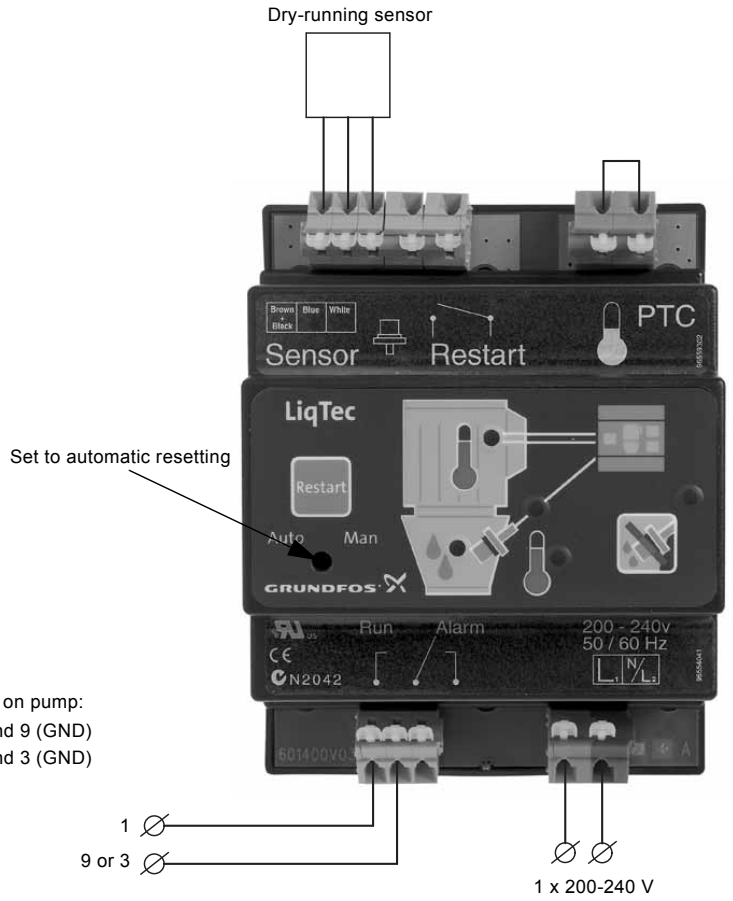
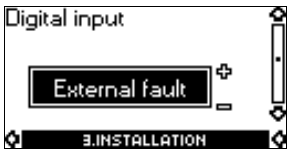


Fig. 149 Connection of CRE pump to LiqTec

Setting the digital input

The digital input must be set to "External fault" via the R100.



Note: After dry-running fault, the pump must be restarted manually.

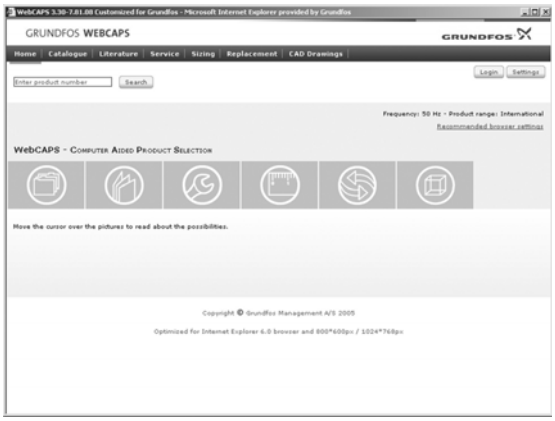
Disposal

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

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

13. Further product documentation

WebCAPS



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

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

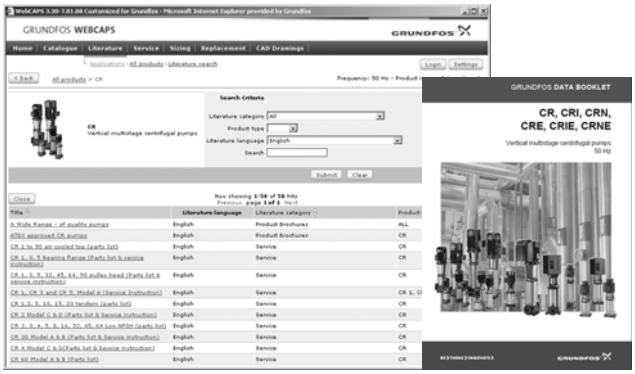
Information in WebCAPS is divided into six sections:

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

Catalogue

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

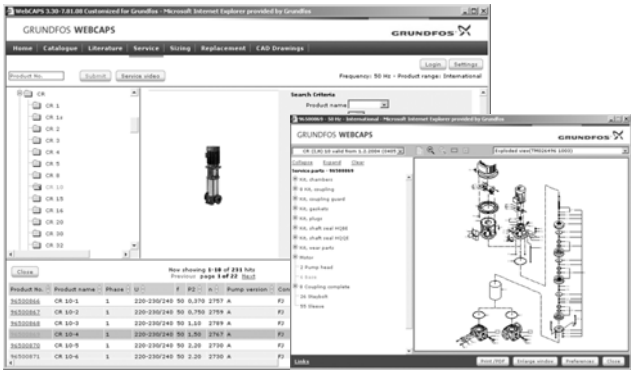
- technical data
- curves (QH, Eta, P1, P2, etc.) which can be adapted to the density and viscosity of the pumped liquid and show the number of pumps in operation
- product photos
- dimensional drawings
- wiring diagrams
- quotation texts, etc.



Literature

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

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



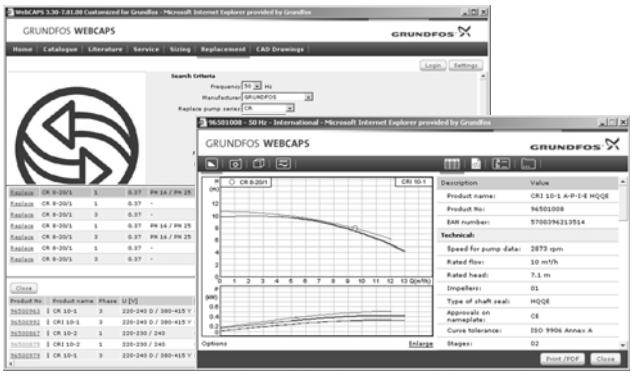
Service

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

Sizing

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

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



Replacement

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

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

CAD drawings

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

These formats are available in WebCAPS:

2-dimensional drawings:
- .dxf, wireframe drawings
- .dwg, wireframe drawings.

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

WinCAPS

Fig. 150 WinCAPS CD-ROM

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

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

WinCAPS is available on CD-ROM and updated once a year.

Subject to alterations.

BE > THINK > INNOVATE >

Being responsible is our foundation
Thinking ahead makes it possible
Innovation is the essence

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