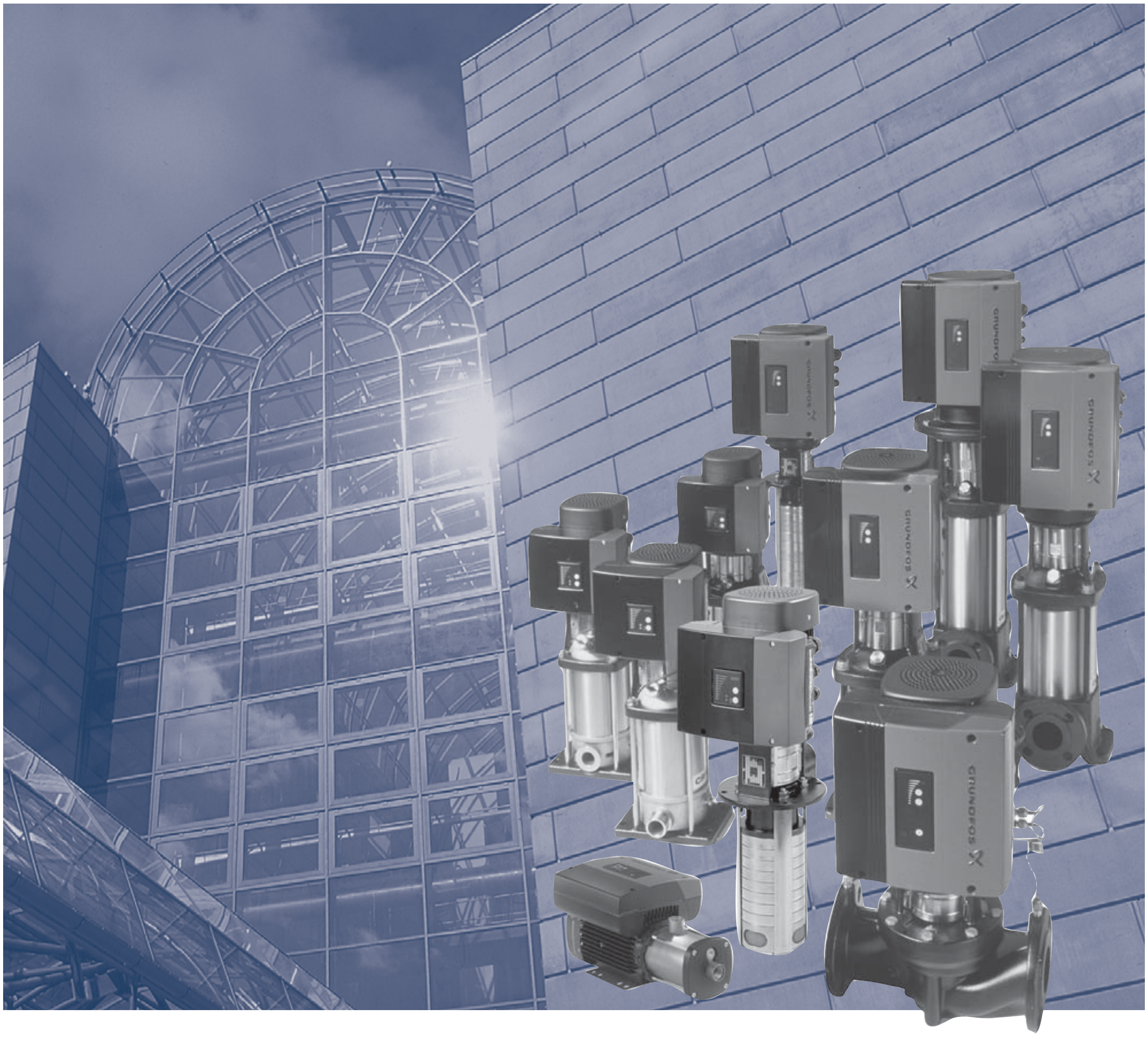
GRUNDFOS **PRODUCT GUIDE**

Grundfos E-pumps

Pumps with integrated variable frequency drive



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1. Introduction to E-pumps

General introduction

This product guide deals with Grundfos pumps fitted with Grundfos MLE motors, 1/2 to 30 Hp (0.37 - 22 kW). These motors are standard asynchronous motors with integrated variable frequency drive (VFD) 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 VFDs, 30 to 300 Hp (22-250 kW).

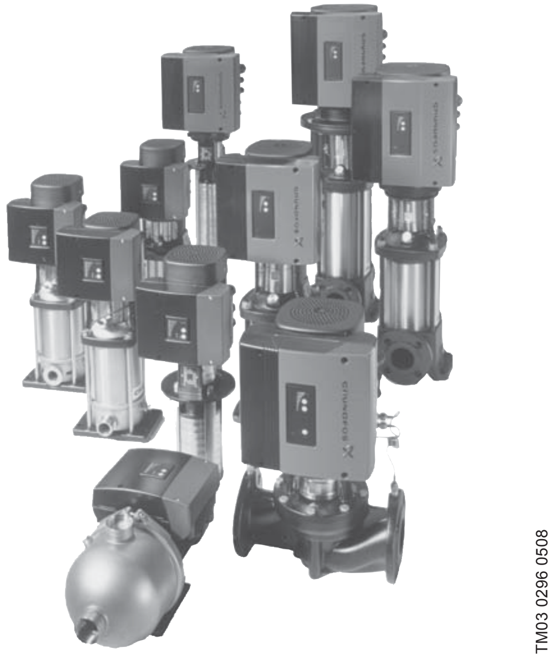

Fig. 1 Grundfos E-pumps

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. All that is required, is the power supply 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 the 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 integrated variable frequency drive has a built-in motor protection function which protects both motor and electronics against overload. This means that E-pump installations do not require a motor starter, but only a normal short-circuit protection for the cable.

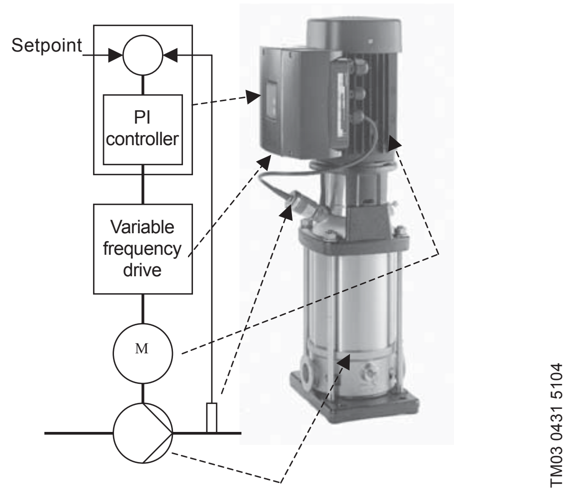

Fig. 2 Components of a Grundfos E-pump

2. Product overview

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 Series 1000 pumps without sensor.
- Single-stage TPE Series 2000 pumps with integrated differential-pressure sensor.

As standard, TPE 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 on the discharge side of 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:

- Pressure control
- flow control
- level control of liquid in a tank
- temperature control
- differential pressure control
- differential temperature control.

* E-pumps without sensor are also used when a remote analog signal is connected to the setpoint input terminal.

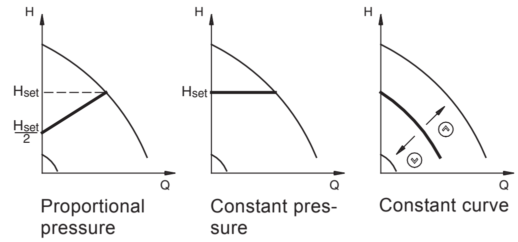

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Fig. 3 TPE Series 2000 with differential-pressure sensor

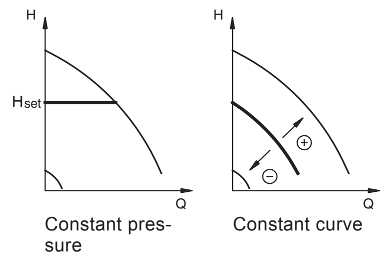

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Fig. 4 CRE, CRIE, CRNE with sensor

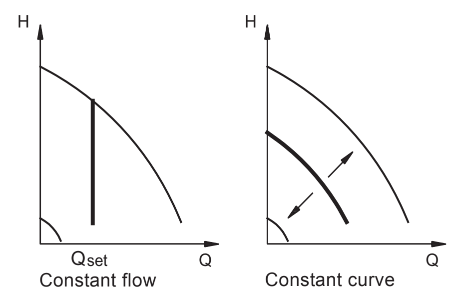

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Fig. 5 E-pumps without sensor

Product range, CRE

Range	CRE 1s	CRE 1	CRE 3	CRE 5	CRE 10	CRE 15	CRE 20
Nominal flow rate [US gpm (m^3h)]	4.5 (1.0)	8.5 (1.9)	15 (3.4)	30 (6.8)	55 (12.5)	95 (21.6)	110 (25.0)
Temperature range [°F (°C)]	–4 to +250 (–20 to +121)						
Temperature range [°F (°C)] – on request	–40 to +356 (–40 to +180)						
Max. working pressure [psi (bar)]	362 (25)						
Max. pump efficiency [%]	35	49	59	67	70	72	72
Flow range [US gpm (m^3h)]	0 - 5.7 (0 - 1.3)	0 - 12.8 (0 - 2.9)	0 - 23.8 (0 - 5.4)	0 - 45 (0 - 10.2)	0 - 70 (0 - 15.9)	0 - 125 (0 - 28.4)	0-155 (35.2)
Max. pump pressure (H [ft (m)])	760 (230)	790 (240)	790 (240)	780 (237)	865 (263)	800 (243)	700 (213)
Motor power [Hp]	0.33 - 2	.33 - 3	.33 - 5	.75 - 7.5	.75 - 15	2 - 25	3 - 25
Version							
CRE: Cast iron and stainless steel AISI 304	●	●	●	●	●	●	●
CRIE: Stainless steel AISI 304	●	●	●	●	●	●	●
CRNE: Stainless steel AISI 316	●	●	●	●	●	●	●
CRTE: Titanium	-	-	(CRTE 2)	(CRTE 4)	(CRTE 8)	(CRTE 16)	-

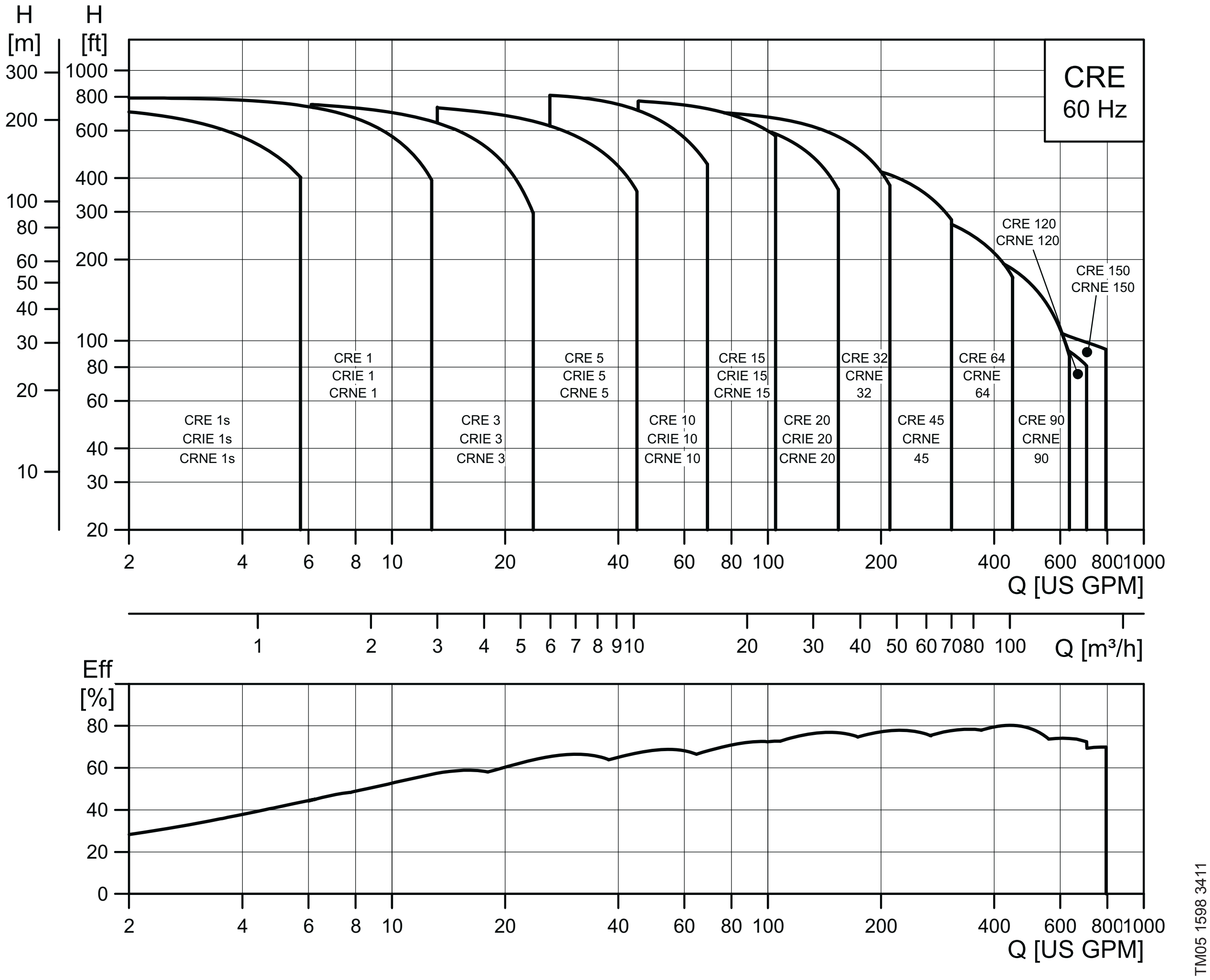
Range	CRE 32	CRE 45	CRE 64	CRE 90	CRE 120	CRE 150
Nominal flow rate [US gpm (m^3h)]	140 (32)	220 (50)	340 (77)	440 (100)	610 (139)	750 (170)
Temperature range [°F (°C)]	–22 to +250 (–30 to +121) 1)				–22 to +250 (–30 to +121) 1) & 2)	
Temperature range [°F (°C)] – on request	–40 to +356 (–40 to +180)				-	-
Max. working pressure [psi (bar)]	435 (30)					
Max. pump efficiency [%]	76	78	79	80	75	73
Flow range [US gpm]	14 - 210 (3.2 - 47.7)	22 - 310 (5.0 - 70.0)	34 - 450 (7.7 - 102.2)	44 - 630 (10.0 - 143.1)	61 - 700 (13.9 - 159.0)	75 - 790 (17.0 - 179.4)
Max. pump pressure (H [ft (m)])	720 (220)	490 (149)	330 (101)	230 (70)	140 (43)	150 (15)
Motor power [Hp]	5 - 30	7.5 - 30	10 - 30	15 - 30	20 - 25	25 - 30
Version						
CRE: Cast iron and stainless steel AISI 304	●	●	●	●	●	●
CRIE: Stainless steel AISI 304	-	-	-	-	-	-
CRNE: Stainless steel AISI 316	●	●	●	●	●	●
CRTE: Titanium	-	-	-	-	-	-

● Available

1) CRN 32 to CRN 90 with HQQE shaft seal: –4 to +250 °F (–20 to +121 °C)

2) CR, CRN 120 and 150 with 75 or 100 Hp motors with HBQE shaft seal: 0 °F to +250 °F (–17 to +121 °C)

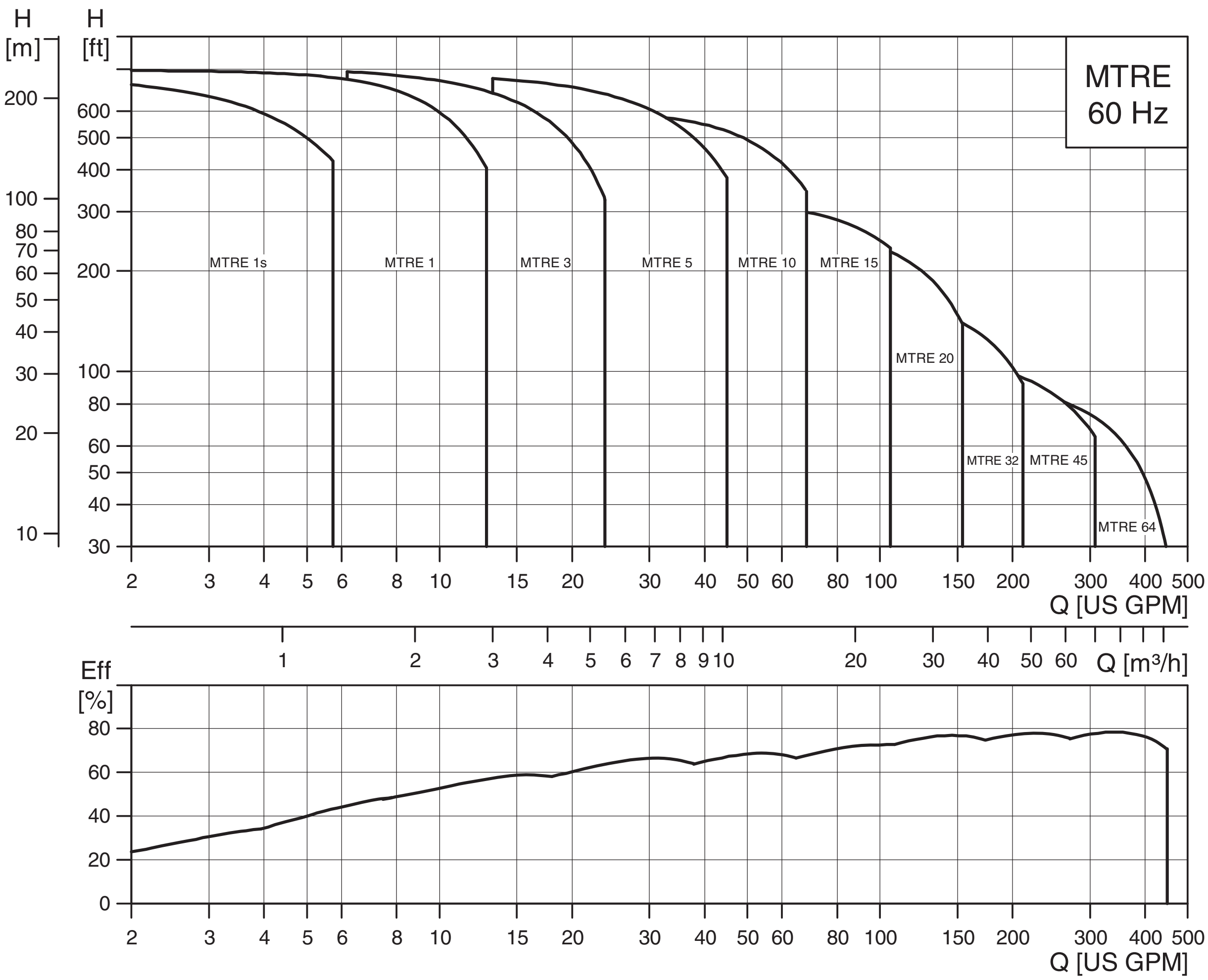
Performance range, CRE, CRIE, CRNE



Product range, MTRE

Range	MTRE 1s	MTRE 1	MTRE 3	MTRE 5	MTRE 10	MTRE 15	MTRE 20	MTRE 32	MTRE 45	MTRE 64
Nominal flow rate [US gpm (m^3h)]	4.4 (1.0)	8.5 (1.9)	15 (3.4)	30 (6.8)	55 (12.5)	95 (21.6)	110 (25.0)	140 (31.8)	220 (50.0)	340 (77.2)
Temperature range [°F (°C)]	+14 to +194 °F (–10 to +90)									
Max. pump efficiency [%]	35	49	59	67	70	72	72	76	78	79
Flow range [US gpm (m^3h)]	0 - 7 (0 - 1.6)	0 - 12.8 (0 - 2.9)	0 - 23.8 (0 - 5.4)	0 - 45 (0 - 10.2)	0 - 68 (0 - 15.4)	0 - 125 (0 - 28.4)	0 - 155 (0 - 35.2)	0 - 210 (0 - 47.7)	0 - 310 (0 - 70.4)	0 - 450 (0 - 102.2)
Maximum head (H [ft (m)]	760 (231)	795 (242)	820 (250)	780 (238)	835 (255)	800 (244)	700 (213)	630 (192)	470 (143)	320 (98)
Motor power [Hp]	0.33 - 2	0.33 - 3	0.5 - 5	0.75 - 7.5	1 - 15	2 - 25	3 - 25	5 - 30	7.5 - 30	10 - 30

Performance range, MTRE



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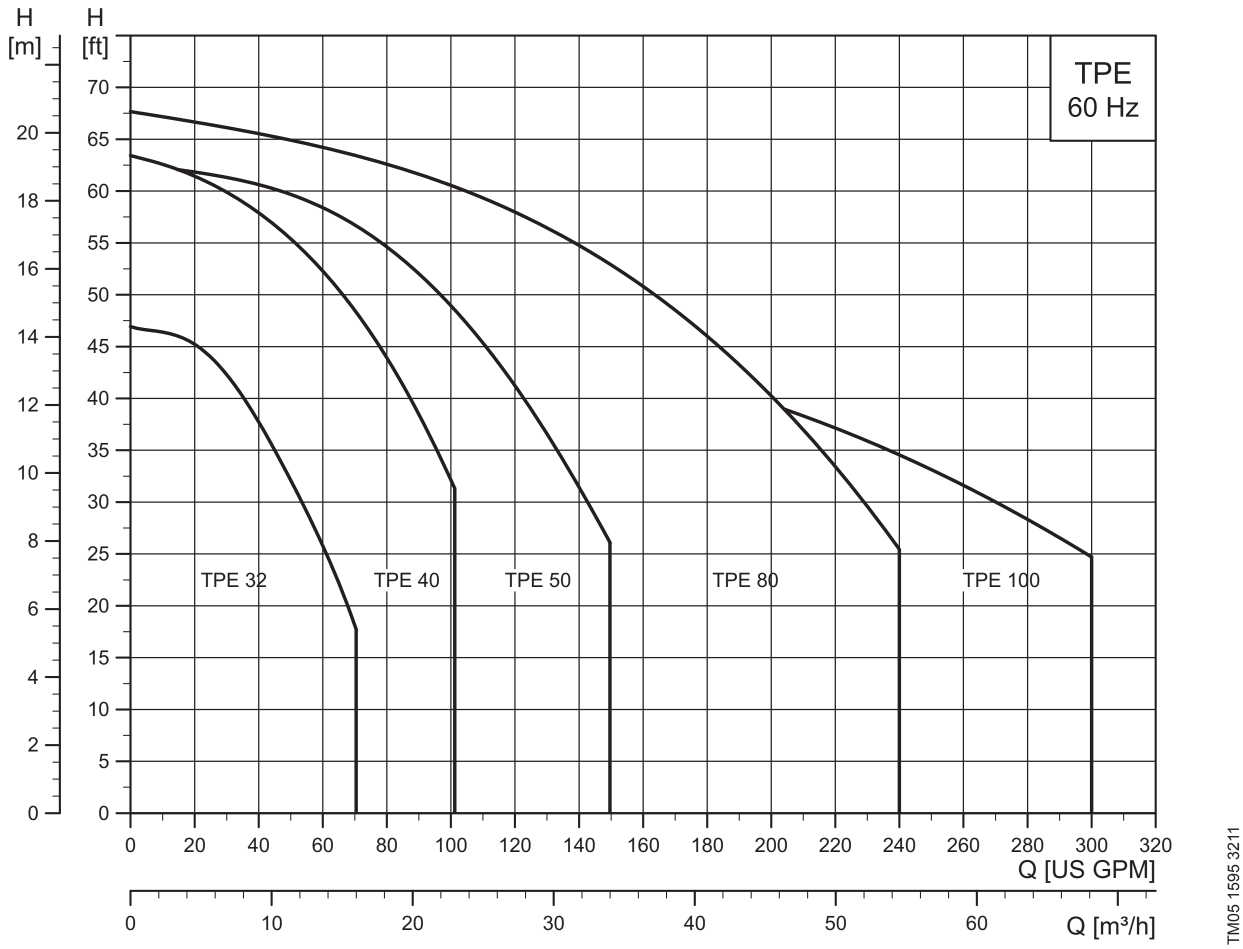
Product range, TPE

Range	TPE 32	TPE 40	TPE 50	TPE 80	TPE 100
Nominal flow rate [US gpm (m^{3}h)]	31 - 39 (7.0 - 8.9)	45 - 64 (10.2 - 14.5)	70 - 100 (15.9 - 22.7)	120 - 154 (27.3 - 35.0)	178 - 242 (40.4 - 55.0)
Temperature range [°F (°C)]	+32 to +284 °F (0 to +140)				
Max. pump efficiency [%]	68	71	74	78	80
Flow range [US gpm (m^{3}h)]	0 - 70 (0 - 15.9)	0 - 100 (0 - 22.7)	0 - 150 (0 - 34.1)	0 - 240 (0 - 54.5)	0 - 300 (0 - 68.1)
Maximum pressure (H [ft (m)]	47 (14.3)	63 (19.2)	63 (19.2)	67.5 (20.6)	49 (14.9)
Motor power [Hp]	0.33 - .75	0.33 - 1.5	0.33 - 2	0.5 - 3	1 - 3

Performance range, TPE



Functions

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

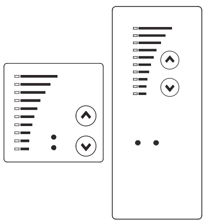
The difference in functions is seen in the settings offered via the R100 remote control. As described later, the menu structure of the R100 depends on the E-pump type in question.

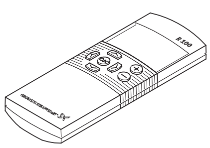
The tables on the following pages show which functions are available for the different E-pump types. CRE, CRIE, CRNE with sensor and all multistage pumps without sensor have the same menu structure in the R100.

All single-stage pumps, such as the TPE Series 1000 and the TPE Series 2000, have a different menu structure.

The result is two totally different menu structures for the complete E-pumps range.

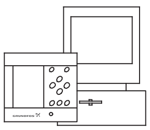
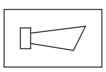
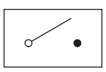
Overview of functions





E-pump functions		CRE, CRIE, CRNE with sensor		CRE, CRIE, CRNE, SPKE, CRKE, MTRE, CME without sensor		TPE Series 1000 without sensor		TPE Series 2000 with sensor	
		Single-phase	**Three-phase**	**Single-phase**	**Three-phase**	**Single-phase**	**Three-phase**	**Single-phase**	**Three-phase**
	Motor sizes [Hp]	**.5 - 1.5**	**1 - 30**	**.5 - 1.5**	**1 - 30**	**.33 - 1.5**	**.75 - 30**	**.33 - 1.5**	**.75 - 30**
	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 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)		●		●		●		●

● Available
1) Sensor-fitted
2) Only 15 - 30 Hp
3) Lubricated only 15 - 30 Hp

E-pump functions		E-pump type							
		CRE, CRIE, CRNE with sensor		CRE, CRIE, CRNE, SPKE, CRKE, MTRE, CME without sensor		TPE Series 1000 without sensor		TPE Series 2000 with sensor	
		Single-phase	Three-phase	Single-phase	Three-phase	Single-phase	Three-phase	Single-phase	Three-phase
	Motor sizes [Hp]	**.5 - 1.5**	**1 - 30**	**.5 - 1.5**	**1 - 30**	**.33 - 1.5**	**.75 - 30**	**.33 - 1.5**	**.75 - 30**
	**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	●	●	●	●	●	●	●	●
	**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 15 - 30 Hp
3) Lubricated only 15 - 30 Hp

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 variable frequency drive (VFD) 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 VFD.

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 feet

Q = flow rate in gpm

P = input power in Hp

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 VFD 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.

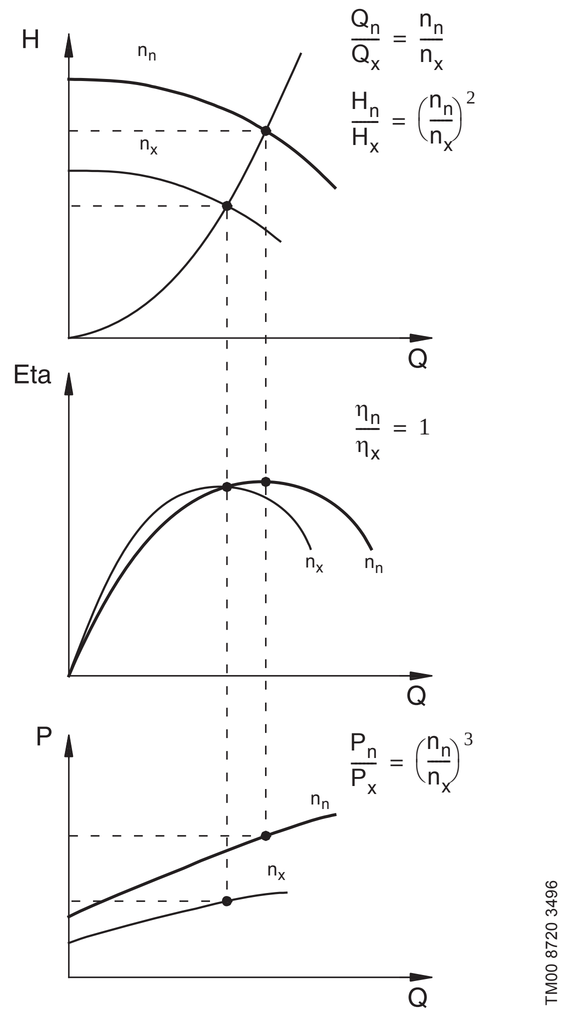


Fig. 6 Affinity equations

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 40 % 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 power supply). NPSH for the pump at maximum speed is shown in the same diagram.

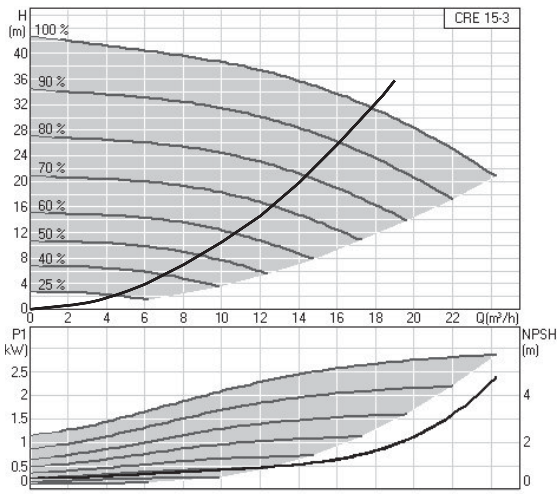


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Fig. 7 Performance curve of a CRE 15-3

Efficiency

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

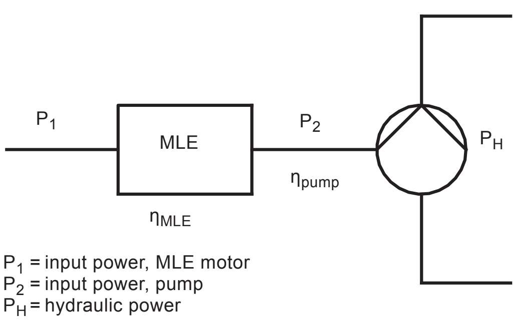

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Fig. 8 Efficiency of an E-pump

The efficiency of the MLE 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.

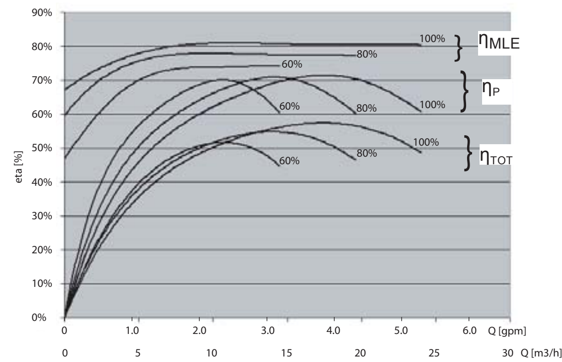

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Fig. 9 Efficiency curves for MLE, pump and complete E-pump at 100 %, 80 % and 60 % speed

Figure 9 shows the efficiency of the MLE and the pump part and finally the resulting efficiency of a CRE 15-3 with a 4 Hp (3 kW) MLE 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 = 76.6 gpm (17.4 m^3/h) and H = 105 ft (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_{MLE}	η_{TOT}
	[gpm (m^3/h)]	[ft (m)]	[kW]	[kW]	[kW]	[%]	[%]	[%]
100	76.6 (17.4)	105 (32)	3.55 (2.65)	2.86 (2.13)	2.02 (1.51)	71.1	80.4	57.2
80	61.6 (14)	69 (21.1)	1.97 (1.47)	1.53 (1.14)	1.07 (0.8)	70.5	77.6	54.7
60	46.2 (10.5)	39 (12)	0.89 (0.66)	0.66 (0.49)	0.46 (0.34)	70.4	73.8	51.9

The pump efficiency η_P 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 MLE 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 3.55 Hp to 0.89 Hp (2.65 kW to 0.66 kW) which is a 75 % 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).

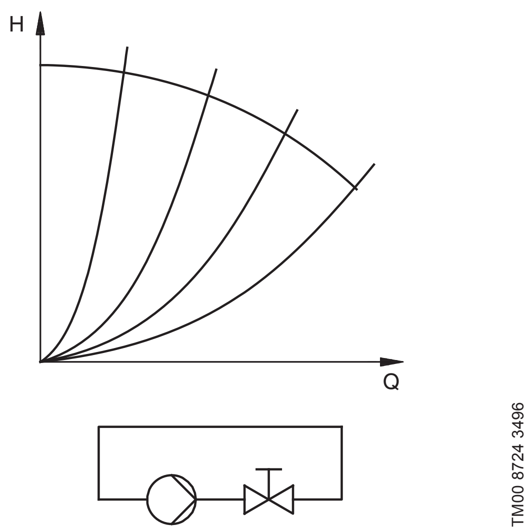


Fig. 10 System characteristics, closed system

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.).

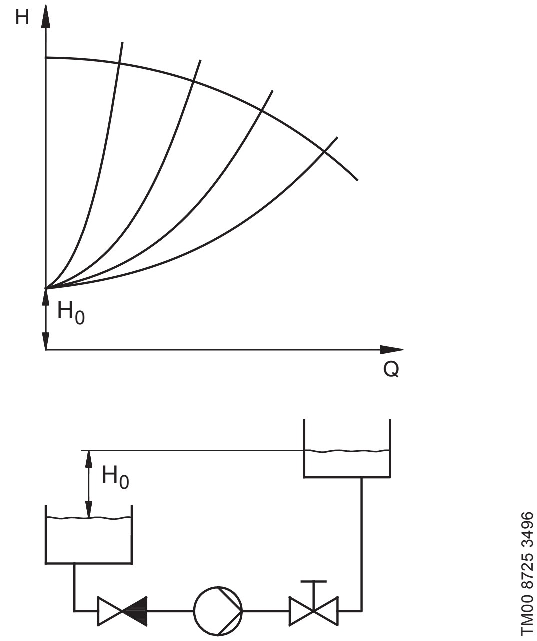


Fig. 11 System characteristic + static head, open system

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.

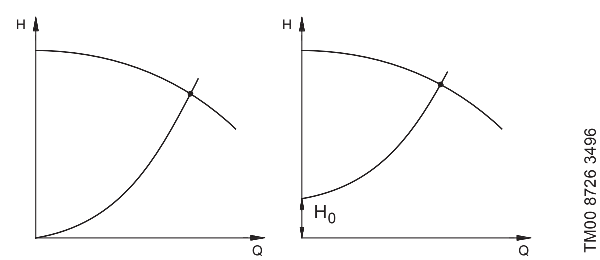


Fig. 12 Duty point of a closed and an open system, respectively

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 the pumping application. Compared to other control methods, frequency-controlled speed control is the method offering the highest efficiency and thus the most efficient utilization of the energy. Depending on the application and pump type, savings of up to 50 % or more are realistic.

Low operating costs

The efficient utilization 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 utilization 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 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 the control 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 17.

Systems	Applications	E-pump type			
		CRE, CRIE, CRNE with sensor	CRE, CRIE, CRNE, SPKE, CRKE, MTRE, CME without sensor	TPE Series 1000 without sensor	TPE Series 2000 with sensor
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 molding 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 supplies 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.

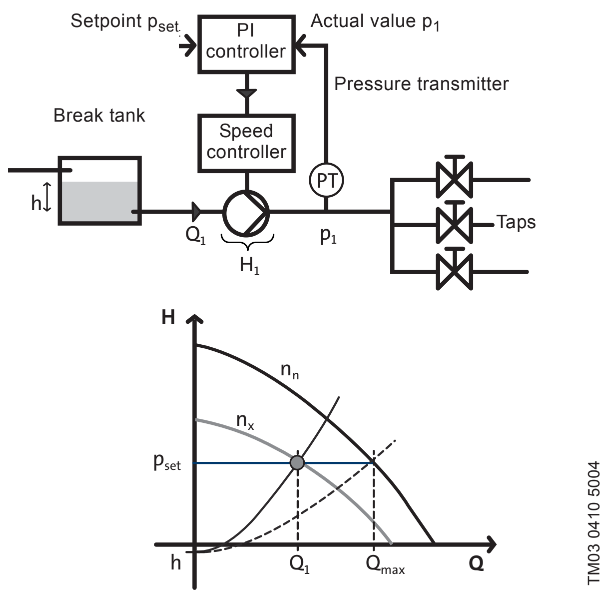


Fig. 13 Constant-pressure control

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 molding machine which must be water-cooled to ensure high quality production.

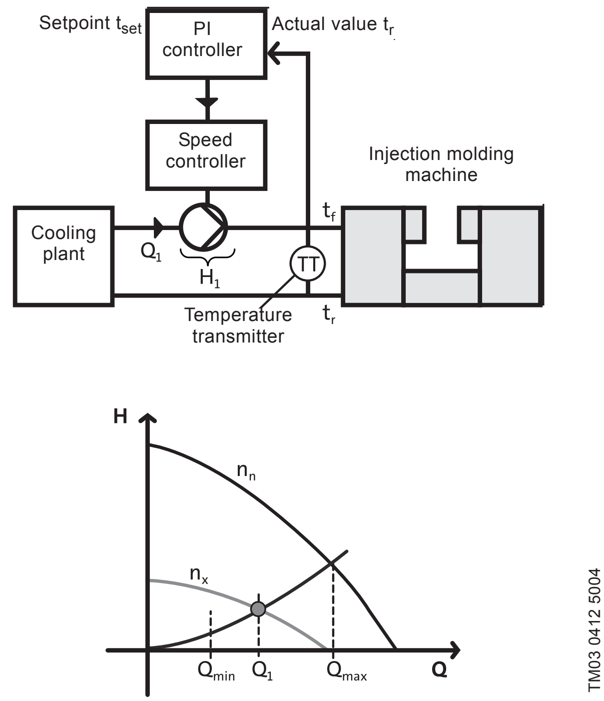


Fig. 14 Constant-temperature control

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 59 °F (15 °C) from a cooling plant. To ensure that the molding machine runs properly and is cooled sufficiently, the return-pipe temperature has to be kept at a constant level, t_r = 68 °F (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 68 °F (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.

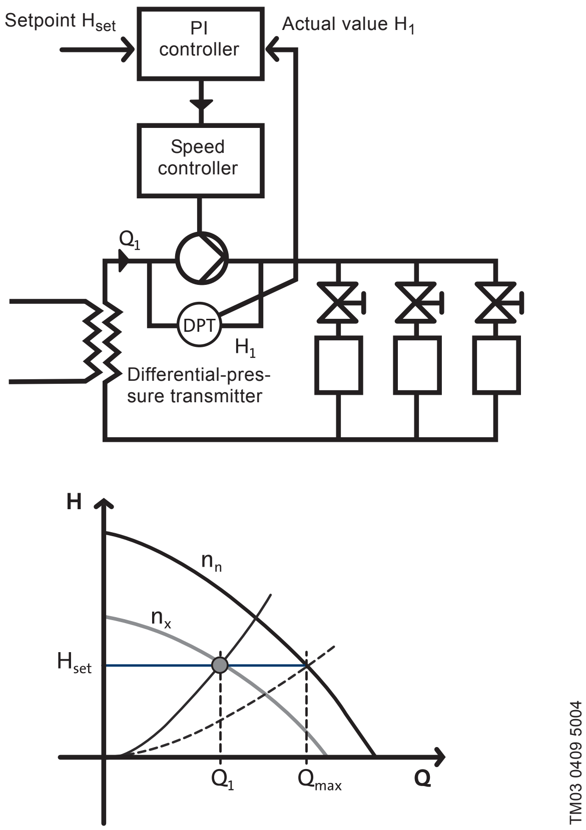


Fig. 15 Constant differential-pressure control

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.

Proportional 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.

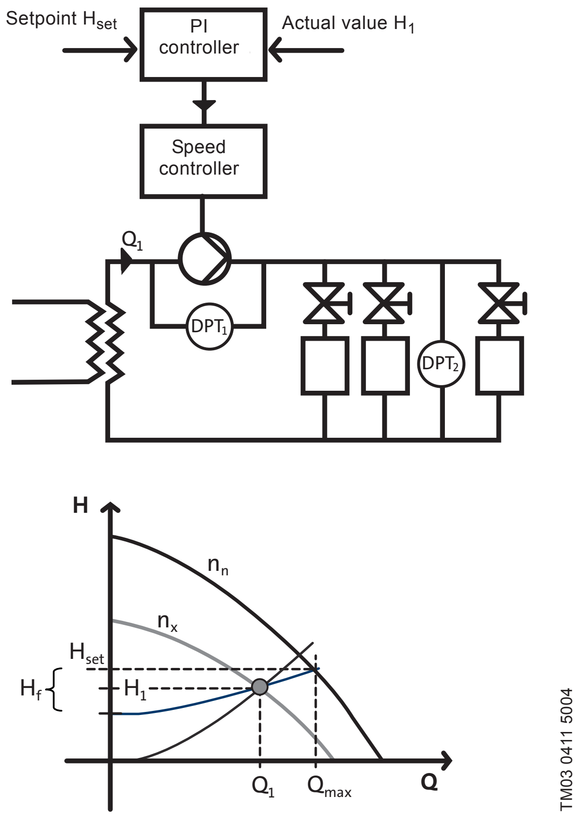


Fig. 16 Proportional differential-pressure control

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, 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 proportional differential-pressure control.
- The differential-pressure transmitter (DPT_2 in fig. 16) is placed close to the radiators, and the system is running with proportional 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. 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 the PI controller compensates automatically for the increase in required pressure in order to overcome the increase in pressure losses in the supply pipes, etc.

PI controller

The MLE has a built-in PI controller for speed control of pumps. The factory setting of gain (Kp) and integral time (Ti) can easily be changed. The controller can operate in both normal and inverse mode.

Normal mode

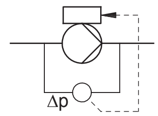
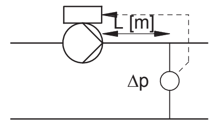
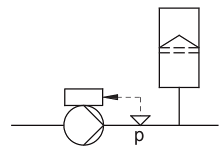
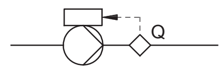
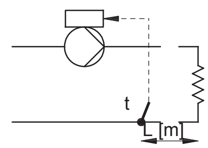
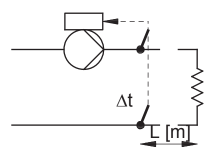
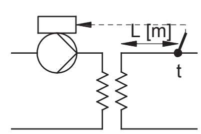
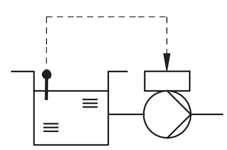
Normal mode is used in systems in which an increase in pump performance will result in a **rise** in the value measured at the feedback sensor. This will typically be the case in most MLE applications.

Normal mode is selected by setting the gain (Kp) to a positive value in the control panel.

Inverse mode

Inverse mode is used in systems in which an increase in pump performance will result in a **drop** in the value measured at the feedback sensor. This mode will typically be used for constant level operation (filling a tank) and for constant temperature operation in cooling systems.

Inverse mode is selected by setting the gain (Kp) to a negative value in the control panel.

System/application	K_p Heating systems ★	K_p Cooling system ★★	T_i
	0.5		0.5
	0.5		$L_{1)}$ < 16.4 ft: **0.5** L > 16.4 ft: 3 L > 32.8 ft: 5
	0.5		0.5
	0.5		0.5
	0.5	–0.5	10 + 1.52L
	0.5		10 + 1.52L
	0.5	–0.5	30 + 1.52L
	+2.5		100

★ Heating systems are systems in which an increase in pump performance will result in a **rise** in temperature at the sensor.

★★ Cooling systems are systems in which an increase in pump performance will result in a **drop** in temperature at the sensor.

L) Distance in [ft] between pump and sensor

3. E-pumps

Introduction

Grundfos E-pumps are fitted with a frequency-controlled standard Grundfos MLE motor with built-in PI controller for single-phase or three-phase power supplies.

Grundfos 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

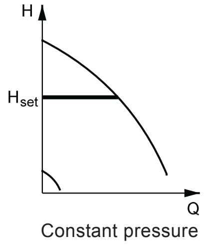
Fig. 17 CRE, CRIE and CRNE pumps

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.



TM03 9199 3507

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.

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 water utilities
- distribution from waterworks
- pressure boosting for industrial water supply.

Water treatment

- Ultra-filtration systems
- reverse osmosis systems
- softening, ionizing, demineralizing systems
- distillation systems
- separators.

Irrigation

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

MTRE, SPKE, CRKE pumps

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.

- The motor is a standard Grundfos MLE motor with integrated variable frequency drive. For further information on MLE motors, see page 46.
- The pump has optimized hydraulics as well as various types of connections, chambers, a motor stool, and various other parts.

MTRE, SPKE and CRKE pumps can be connected to an external sensor enabling the control of pressure, differential pressure, temperature, differential temperature, flow, or level control of liquid in a tank.

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 centers
- cooling units
- industrial washing machines
- filtering systems.

CME pumps

Fig. 20 CME pump

CME pumps are reliable, quiet and compact horizontal end-suction pumps. The modular pump design makes it easy to make customized 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.

- The motor is a standard Grundfos MLE motor with integrated variable frequency drive.
  For further information on MLE motors, see page 46.
- The pump is available in three material variants: cast iron, AISI 304 stainless steel, and AISI 316 stainless steel. It has optimized 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 pressure, differential pressure, temperature, differential temperature, flow, or level control of liquid in a tank.

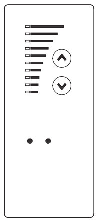
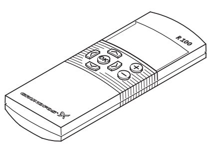
Applications of CME

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

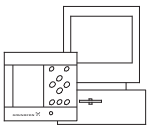
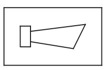
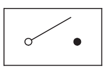
Below is a list representing some general examples of applications:

- 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 [Hp]	**0.5 - 1.5**	**1.0 - 30**	**0.5 - 1.5**	**1.0 - 30**
 	**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]		●[3]
	Standstill heating		●		●
	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 15-30 Hp.
[3] Lubricated, only 15-30 Hp.

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 [Hp]	**0.5 - 1.5**	**1.0 - 30**	**0.5 - 1.5**	**1.0 - 30**
	**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 15-30 Hp.
3) Lubricated, only 15-30 Hp.

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.

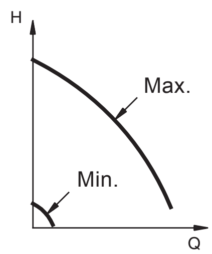


Fig. 21 Min. and max. curves

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 26.

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.

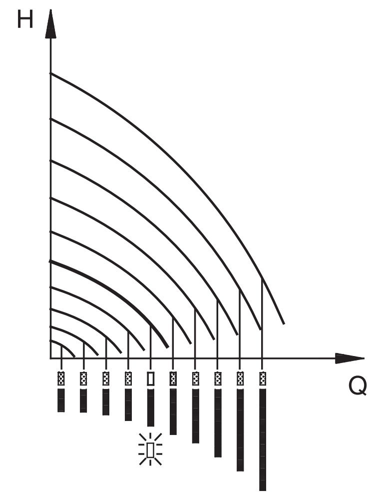


Fig. 22 Pump in control mode "Uncontrolled" (constant curve)

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.

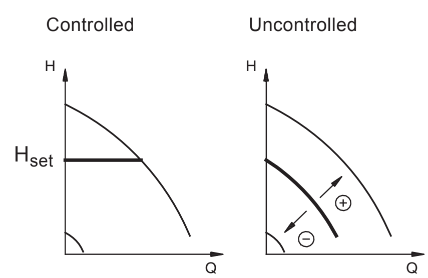


Fig. 23 Pump in control mode "Controlled" (constant pressure) or "Uncontrolled" (constant curve)

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 pump performance curve.

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).

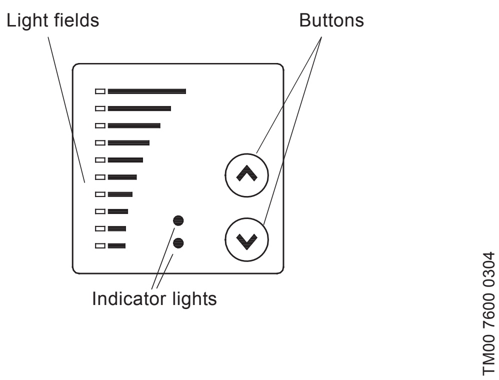


Fig. 24 Control panel, single-phase pumps, .5 Hp - 1.5 Hp (0.37 kW - 1.1 kW)

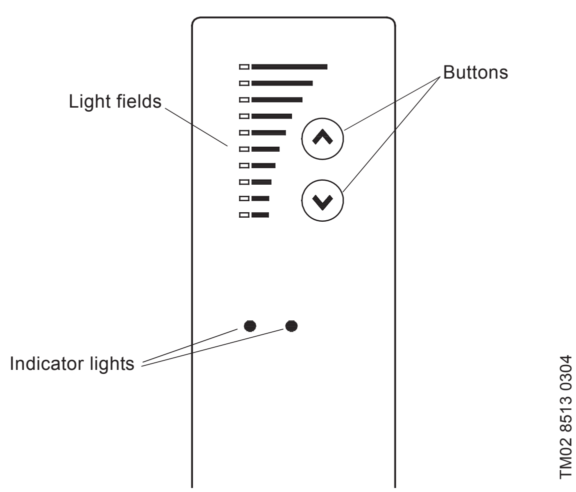


Fig. 25 Control panel, three-phase pumps, 1 Hp -30 Hp (0.75 - 22 kW)

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 yellow, indicating a desired setpoint of 3 bar (43.5 psi).
The setting range is equal to the sensor measuring range (see sensor nameplate).

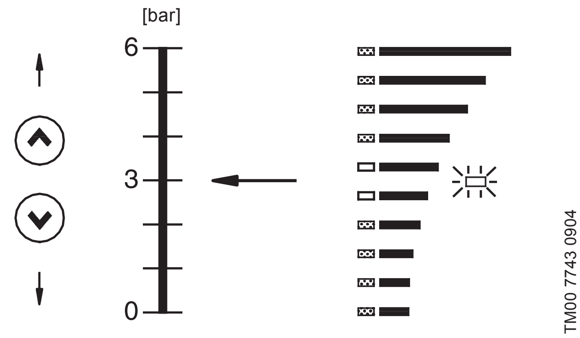


Fig. 26 Setpoint set to 3 bar (pressure control)

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.

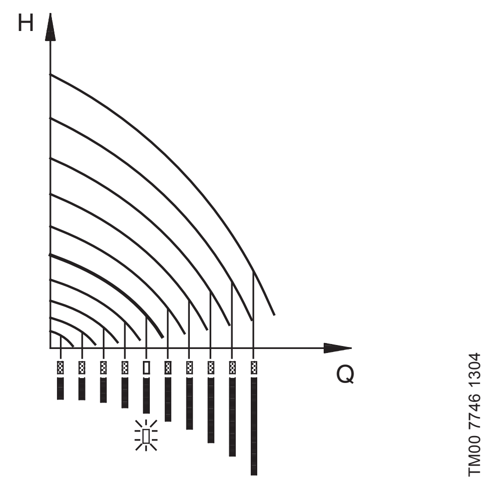


Fig. 27 Pump performance setting, control mode "Uncontrolled"

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.

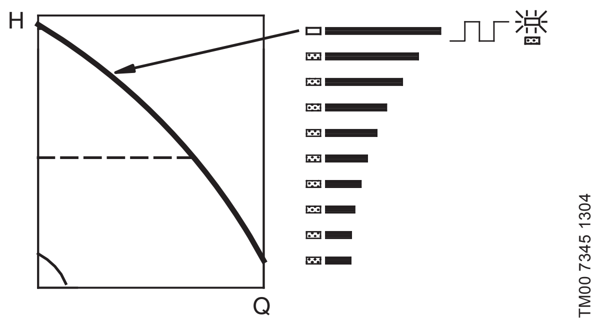


Fig. 28 Max. curve duty

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.

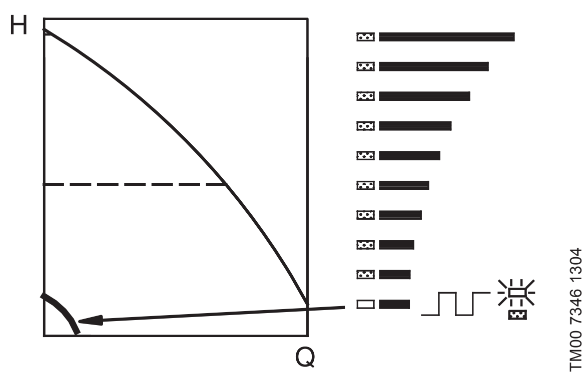


Fig. 29 Min. curve duty

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.

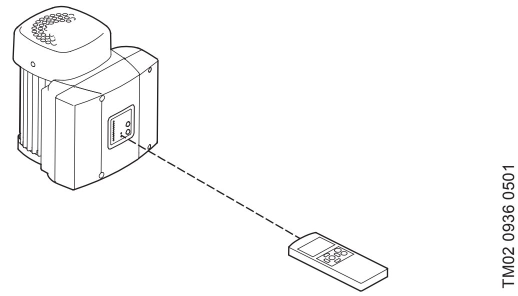


Fig. 30 R100 communicating with the pump via infrared light

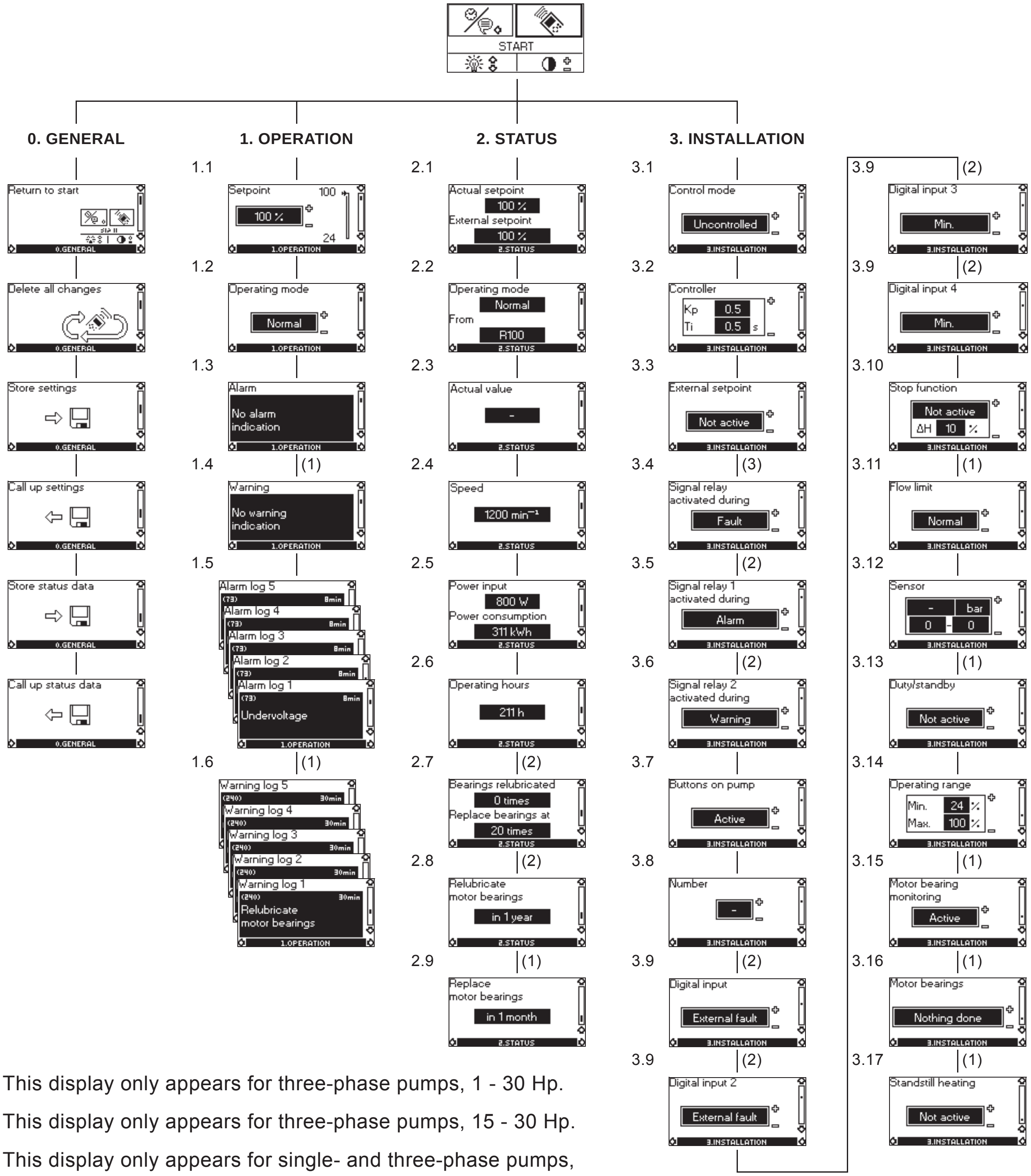
During communication, the R100 must be pointed at the control panel. When the R100 communicates with the pump, the red indicator light will flash rapidly. Keep pointing the R100 at the control panel until the red indicator light stops flashing.

The R100 offers setting and status displays for the pump.

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

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

Menu overview



(1) This display only appears for three-phase pumps, 1 - 30 Hp.

(2) This display only appears for three-phase pumps, 15 - 30 Hp.

(3) This display only appears for single- and three-phase pumps, 0.5 - 10 Hp.

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

Fig. 31 Menu overview

One display

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

Two displays

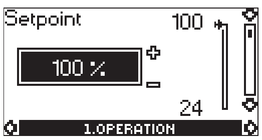
Pumps without or with factory-fitted pressure sensor have different functions and factory settings.

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 [psi].

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.

Note: 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.

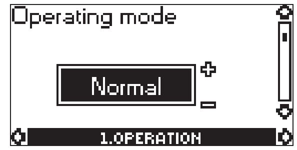
Setpoint and external signal

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 9 (see page 38).

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

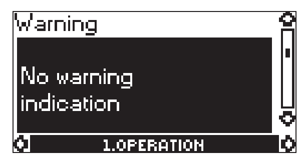
In E-pumps, faults may result in two types of indication: Alarm or Warning.

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/warning



In case of fault or malfunction of the MLE, the latest five warnings and latest five alarms can be found in the log menus.

Alarm

In case of an alarm, the MLE will stop the pump or change the operating mode depending on the alarm type.

Pump operation will be resumed when the cause of the alarm has been remedied and the alarm has been reset.

Warning

The MLE will continue the operation as long as the warning is active. The warning remains active until the cause no longer exists.

Resetting an alarm manually

- Press OK in the alarm display of the R100
- Press the ⊗ or ⊗ buttons on the MLE control panel
- Activate the digital input DI 1 (Start/stop).

Warning and alarm list

Fault code	Single phase MLE	Three phase MLE	Warning	Alarm
3	External fault	External fault		●
4	Too many restarts	Too many restarts		●
7	Too many restarts			●
30		Replace motor bearings	●	
31		Replace varistor*	●	
32	Overvoltage	Overvoltage		●
40	Undervoltage	Undervoltage		●
41		Undervoltage transient		●
45		Mains asymmetry		●
49	Overload	Overload		●
51		Blocked motor		●
55	Motor current protection	Motor current protection		●
56		Underload		●
57		Dry run		●
65	Motor temperature protection	Motor temperature protection		●
73	Hardware shutdown	Hardware shutdown		●
76	Internal communication error			●
77		Duty/Standby communication error	●	
85	Unrecoverable EEPROM fault	Unrecoverable EEPROM fault		●
88	Sensor fault	Sensor 1 fault	●	
91		Temperature sensor 1 fault	●	
93		Sensor 2 fault	●	
96	Reference input fault Common term: “External setpoint fault”	Reference input fault Common term: “External setpoint fault”	●[1)]	●[2)]
105	Electronic rectifier protection	Electronic rectifier protection		●
106	Electronic inverter protection	Electronic inverter protection		●
148		Drive-end bearing temperature	●	
149		Non drive-end bearing temperature	●	
155		Undervoltage		●
156		Internal communication error		●
175		Temperature sensor 2 fault	●	
190		Limit 1 exceeded	●	
191		Limit 2 exceeded	●	
240		Relubricate motor bearings	●	
255	Unknown			●

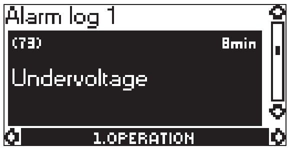
*The varistor protects the pump against power supply transients. If voltage transients occur, the varistor will be worn over time and need to be replaced. The more transients, the more quickly the varistor will be worn. A Grundfos technician is required for replacement of the varistor.

[1)] Single phase MLE
[2)] Three phase MLE

Fault log

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

Alarm log

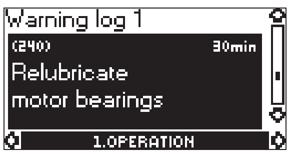


In case of "alarm" faults, the last five alarm indications will appear in the alarm log. "Alarm log 1" shows the latest fault.

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.

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

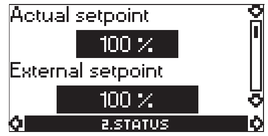
The displays appearing in this menu are status displays only. It is not possible to change or set values in the status menu.

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.

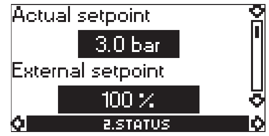
Actual setpoint

Without sensor (Uncontrolled)



Tolerance: ± 2 %

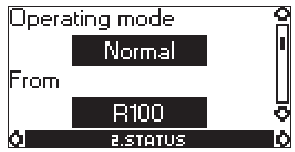
With pressure sensor (Controlled)



Tolerance: ± 2 %

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

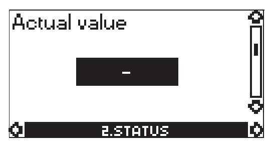
Operating mode



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.

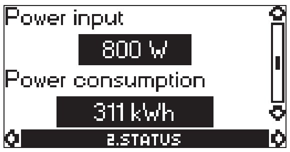
If a sensor is not connected to the pump, "-" will appear in the display.

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 power 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 %

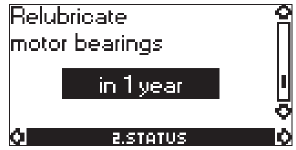
The value of operating hours is an accumulated value and cannot be reset.

Lubrication status of motor bearings (only 15-30 Hp)

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 37. When relubrication is confirmed, the figure in the above display will be increased by one.

Time until relubrication of motor bearings (only 15-30 Hp)



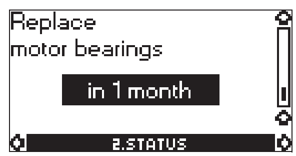
This display shows when to relubricate the motor bearings. The controller monitors the operating pattern of the pump and calculates the period between bearing relubrications. If the operating pattern changes, the calculated time until relubrication may change as well.

Displayable values:

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

Time until 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.

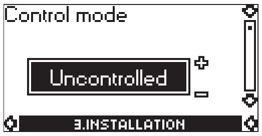
Displayable values:

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

Menu INSTALLATION

Control mode

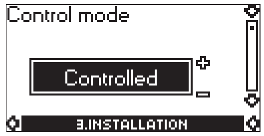
Without sensor (Uncontrolled)



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

- Controlled
- **Uncontrolled**.

With pressure sensor (Controlled)



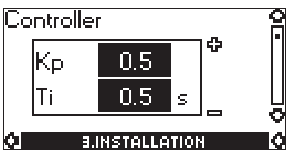
Select one of the following control modes (see fig. 23):

- **Controlled**
- Uncontrolled.

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

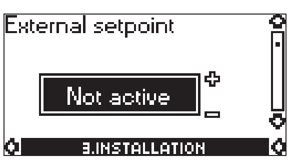
Controller

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 setpoint input terminal 4. See page 38.

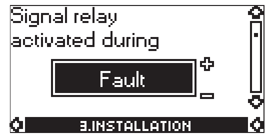
Signal relay

Pumps of 0.5 - 10 Hp have one signal relay.
The factory setting of the relay will be "Fault".

Pumps of 15 - 30 Hp have two signal relays. Signal relay 1 is factory-set to "Alarm" and signal relay 2 to "Warning".

Select how the signal relay should be activated.

Single-phase pumps 0.5 - 1.5 Hp



- Ready
- **Fault**
- Operation.

Three-phase pumps 1.0 - 30 Hp

- Ready
- **Alarm**
- Operation
- Pump running
- Warning
- Relubricate (15-30 Hp).

Three-phase pumps 15 - 30 kW

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

Ready

Pump is ready to run or running.

Warning

There is a warning

Alarm

There is an alarm.

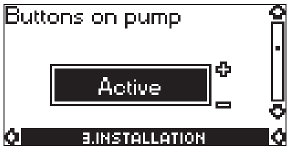
Operation

The pump is running or has been stopped by a stop function.

Relubricate

Lubrication time is exceeded.

Buttons on pump

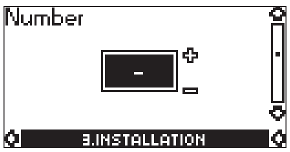


The operating buttons and on the control panel can be set to these values:

- **Active**
- Not active.

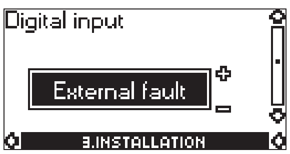
When set to "Not active" (locked), the buttons do not function. Set the buttons to "Not active" if the pump should be controlled via an external control system.

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. 39, page 38) 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 15-30 Hp).

The selected function is activated by closing the contact between either terminals 1 and 9, 9 and 10 or 9 and 11. See fig. 39, page 38.

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 and the control mode is set to "Controlled."

If the input is activated for more than 5 seconds, the stop function incorporated in the pump will take over. The pump will automatically restart when flow is restored and the flow switch detects flow.

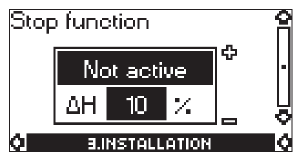
Dry running (only 15-30 Hp)

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 will automatically restart when the dry run input is not 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 heating of the pumped liquid which damages the pump
- to reduce wear of the shaft seals
- to reduce noise from operation.

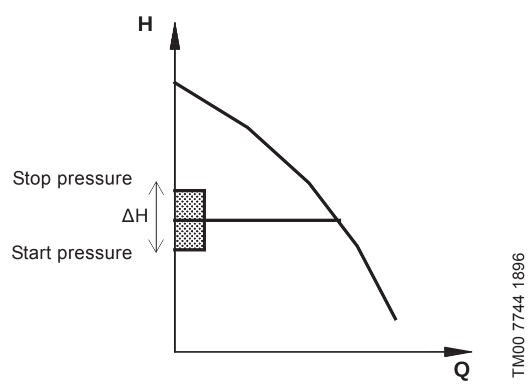


Fig. 32 Difference between start and stop pressures (ΔH)

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:

0.5 - 1.5 Hp, 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.

1.0 - 30 Hp, 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.

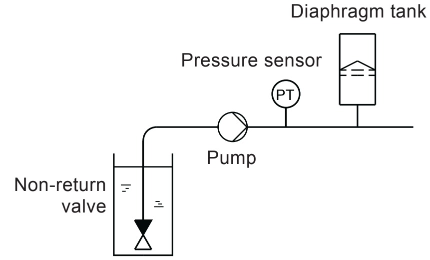
Flow switch

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

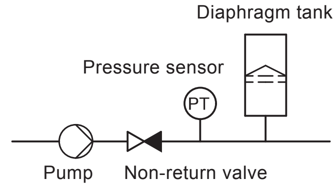
It is only possible to use the stop function if the system incorporates a pressure sensor, a non-return valve and a diaphragm tank.

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



TM03 8582 1907

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



TM03 8583 1907

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.

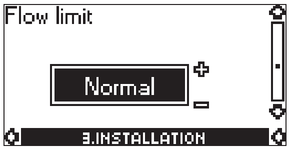
Recommended diaphragm tank size:

Rated flow of pump [gpm (m^3h)]	CRE pump	Typical diaphragm tank size [gal (liter)]
0 - 26 (0 - 5.9)	1s, 1, 3	2 (7.6)
27 - 105 (6.1 - 23.8)	5, 10, 15	4.4 (16.7)
106 - 176 (24.2 - 40)	20, 32	14 (53.0)
177 - 308 (40.2 - 70.0)	45	34 (128.7)
309 - 440 (70.2 - 99.9)	64, 90	62 (234.7)
441 - 750 (100 - 170)	120, 150	86 (325.5)

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:

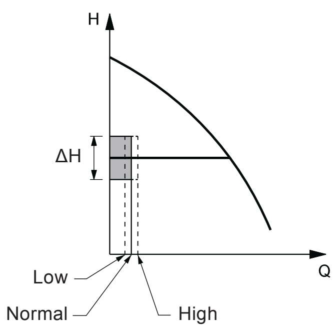
- Low
- **Normal**
- High
- Custom.

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 customized setup and optimizing to the process.

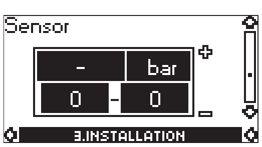


TM03 9060 3307

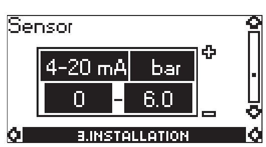
Fig. 35 Three pre-configured flow limits, "Low", "Normal" and "High"

Sensor

Without sensor (Uncontrolled)



With pressure sensor (Controlled)



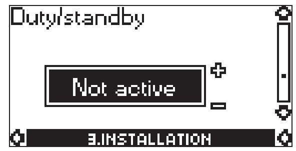
The setting of the sensor is only relevant in the case of controlled operation.

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. Install and prime the two pumps per the installation and operating instructions included with the pumps.
2. Verify the power supply is connected to the first pump per the installation and operating instructions.
3. Use the Grundfos R100 programmer to set the duty/standby to "not active" in the installation menu.
4. Use the Grundfos R100 programmer to set the "operating mode" to "stop" in the operation menu.
5. Use the Grundfos R100 programmer to set the other displays as required for the pump application (such as setpoint).
6. Disconnect the power supply to both pumps.
7. Installation of the "AYB" cable (91125604):
   a. Remove the plug from each MLE casing with a flat head screw driver (see fig. 36).
   b. Thread a new cable gland into each MLE casing with a crescent wrench (see fig. 36).
   c. Loosen the new cable gland caps and push the cable ends through the cable glands and into MLE motors.
   d. Remove the "AYB" connector plug from the first MLE motor (see fig. 37).
   e. Connect the black wire to the "A" terminal of the "AYB" connector plug.
   f. Connect the orange wire to the "Y" terminal of the "AYB" connector plug.
   g. Connect the red wire to the "B" terminal of the "AYB" connector plug.
   h. Reconnect the "AYB" connector plug to the first MLE motor.
   i. Tighten the new cable gland cap to secure the cable (see fig. 36).
   j. Repeat steps "d" through "i" for the second MLE motor.

8. Connect the power supply to the two pumps per the installation and operation instructions.
9. Use the Grundfos R100 programmer to verify the "operating mode" is set to "normal" in the operation menu of the second pump.
10. Use the Grundfos R100 programmer to set the other displays as required for the pump application (such as "setpoint").
11. Use the Grundfos R100 programmer to set the duty/standby to "active" in the installation menu of the second pump.
    Please note the second pump will search for the first pump and automatically set the duty/standby to "active" in the installation menu.
12. The second pump will operate for the first 24 hours. The two pumps will then alternate operation every 24 hours.

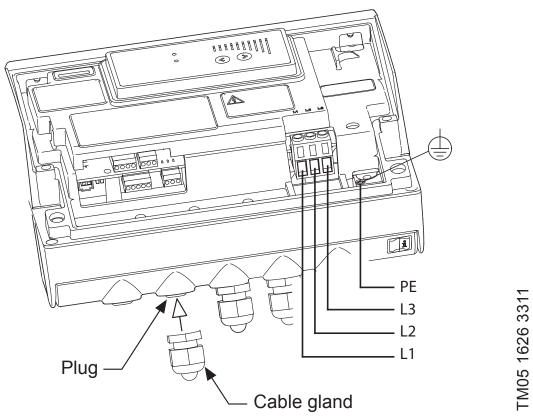


Fig. 36 Connecting cable gland to plug

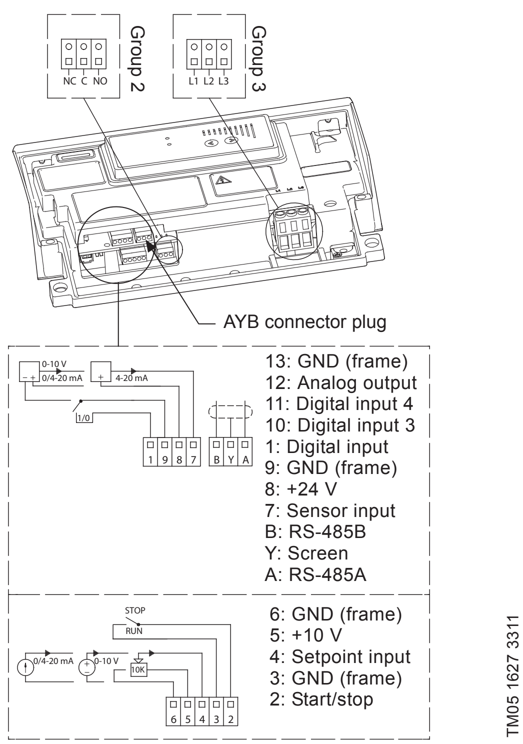
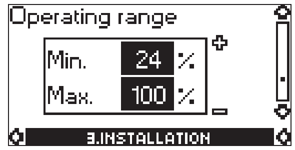


Fig. 37 AYB connector plug

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.

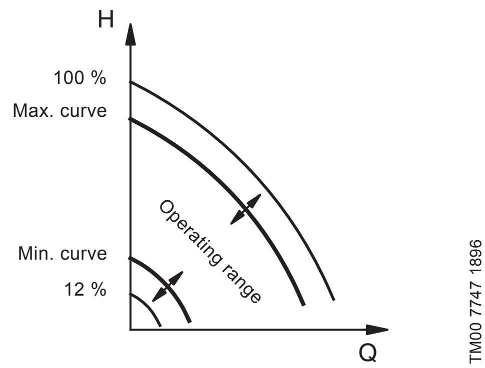


Fig. 38 Setting of the min. and max. curves in % of maximum performance

Motor bearing monitoring (only three-phase pumps)

The motor bearing monitoring function can be set to these values:

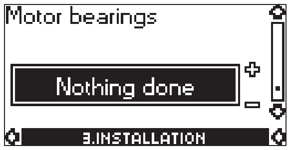
- **Active**
- Not active.

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 15-30 Hp)*, page 31.

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:

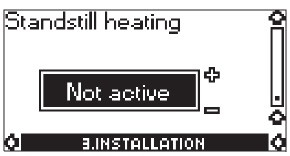
- Relubricated (15-30 Hp)
- Replaced
- **Nothing done**.

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 28.

When the motor bearings have been relubricated or replaced, select "Relubricated" or "Replaced" in the motor bearings screen. Then press "OK" to the screen "Relubrication/Replacement just done".

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

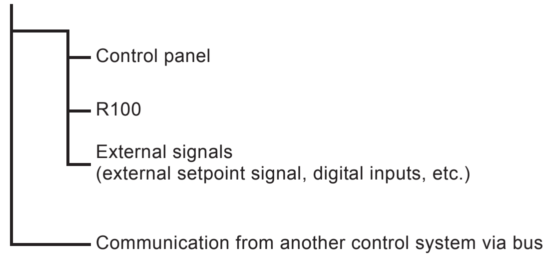
Special setup requirements differing from the settings available via the R100 require the use of the Grundfos PC Tool E-products. This again requires the assistance of a Grundfos service technician or engineer. Contact your local Grundfos company for more information.

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".

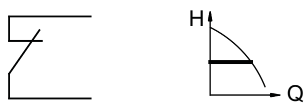
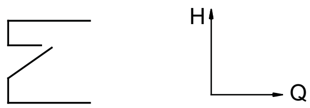
External forced-control signals

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

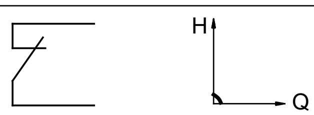
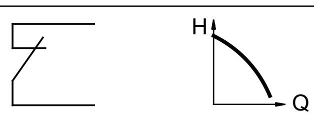
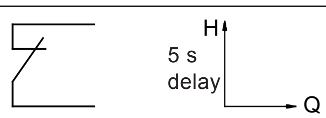
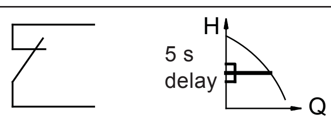
Start/stop (terminals 2 and 3)	
	**Normal duty**
	**Stop**

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) (terminals 9 and 10) (terminals 9 and 11)	
	**Normal duty**
	**Min. curve**
	**Max. curve**
	**External fault**
	**Flow switch**
	**Dry running**

Connection terminals

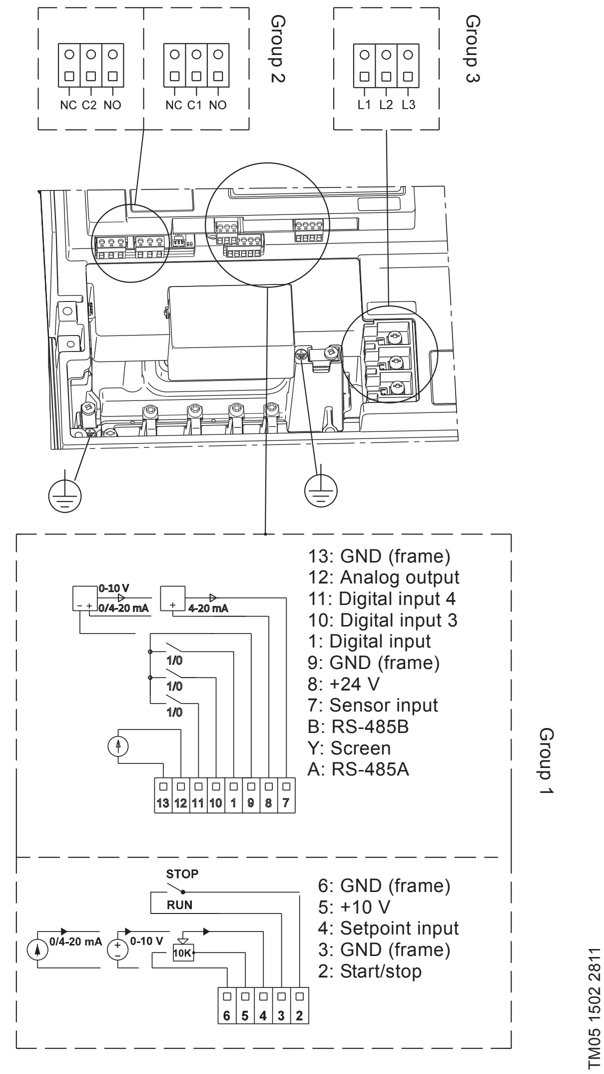


Fig. 39 Connection terminals

External setpoint signal

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

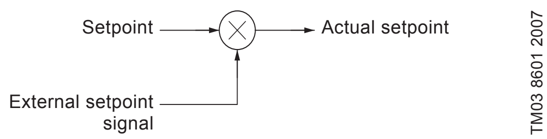


Fig. 40 Actual setpoint as a product (multiplied value) of setpoint and external setpoint signal

Select the actual external signal, 0-10 V, 0-20 mA, 4-20 mA, via the R100. See section *External setpoint*, page 32.

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.

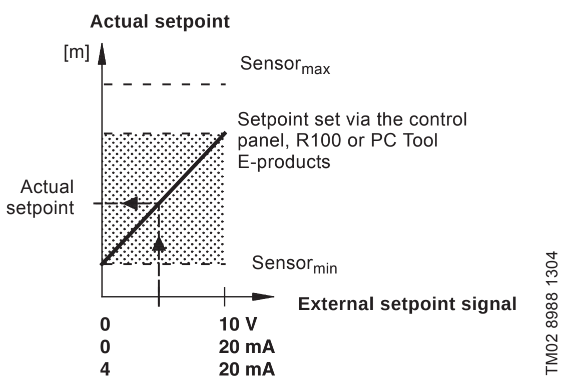


Fig. 41 Relation between the actual setpoint and the external setpoint signal in control mode "Controlled"

Example: At a sensor$_{min}$ value of 0 psi, a setpoint set of 50 psi and an external setpoint of 80 % (an 8V analog signal to Terminal 4 if using an analog signal of 0 - 10V), the actual setpoint will be as follows:

$$\text{Actual setpoint} = (\text{setpoint} - \text{sensor}_{min}) \times \%_{\text{external setpoint}} + \text{sensor}_{min}$$
$$= (50 - 0) \times 80\,\% + 0$$
$$= 40 \text{ psi}$$

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

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. To obtain full pump performance, adjust the setpoint on the MLE to 100 %.

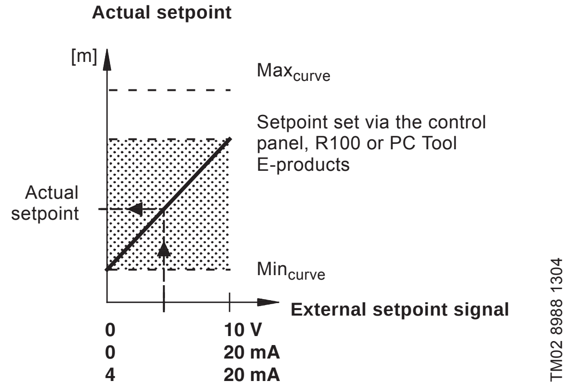


Fig. 42 Relation between the actual setpoint and the external setpoint signal in control mode "Uncontrolled"

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. 43, 44, and 43.

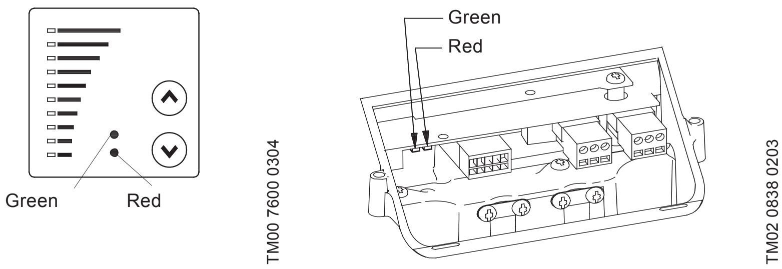


Fig. 43 Position of indicator lights on single-phase pumps

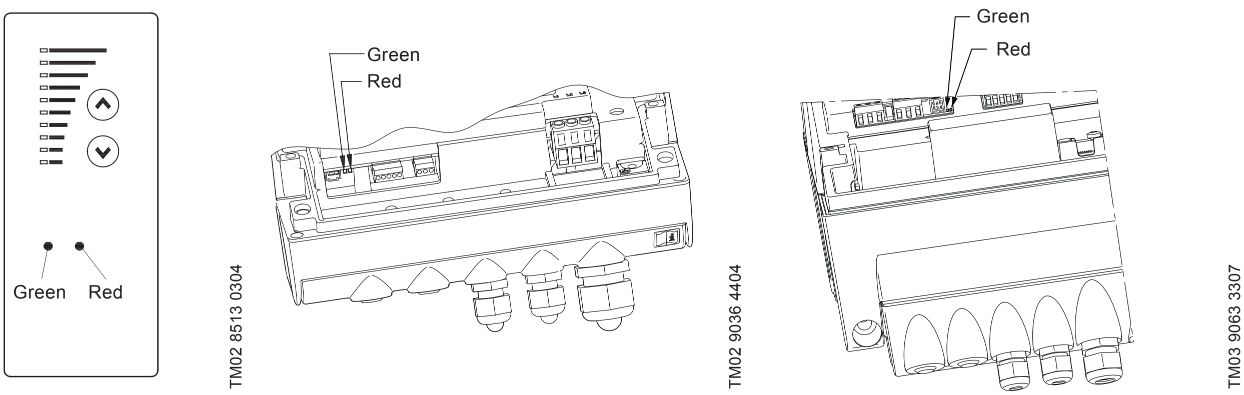


Fig. 44 Position of indicator lights on three-phase pumps

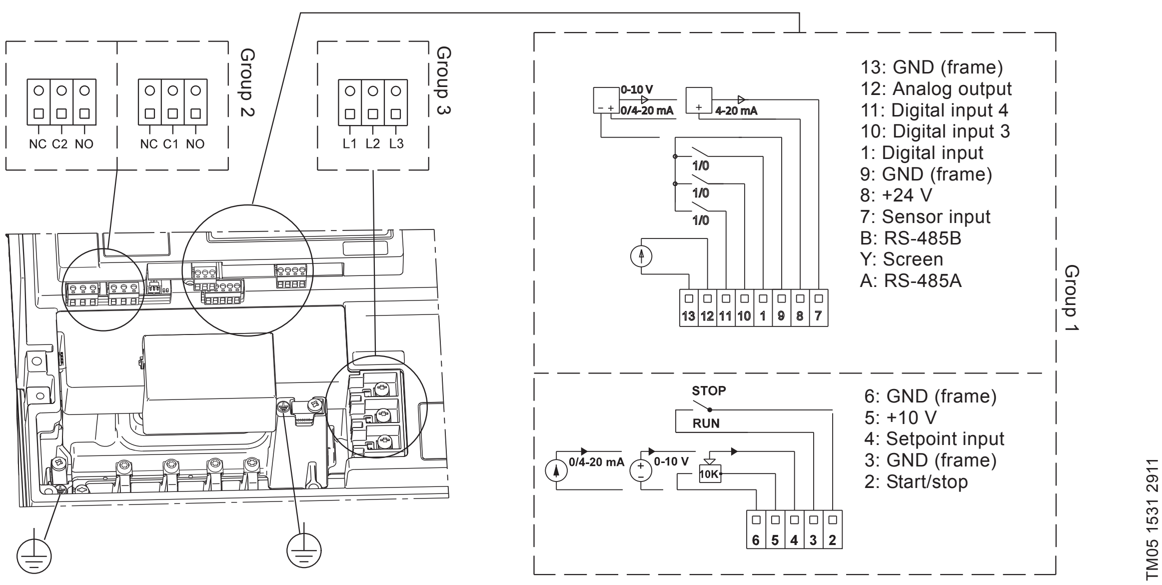


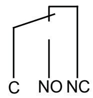
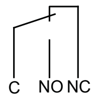
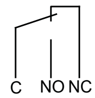
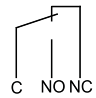
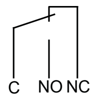
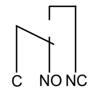
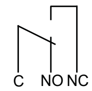
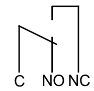
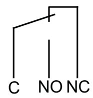
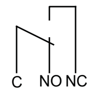
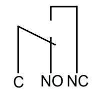
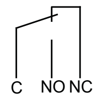
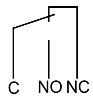
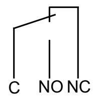
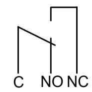
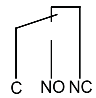
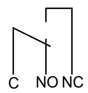
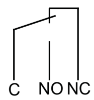
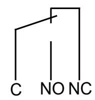
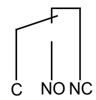
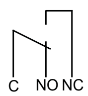
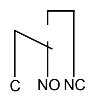
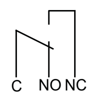
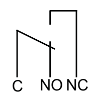
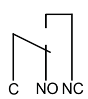
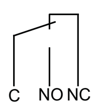
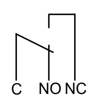
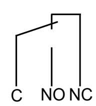
Fig. 45 Connection terminals

The pump incorporates an output for a potential-free signal via an internal relay.

For signal relay output values, see section *Signal relay*, page 32.

See signal relays in section *10. Advanced use of MLE motors* on page 65 for additional details.

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 70% 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 28.

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

Insulation resistance

0.5 to 10 Hp

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.

15 to 30 Hp

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 product guides are also available at www.grundfos.us/WebCAPS. For further information on WebCAPS, see section *Further product documentation* on p. 89.

4. Single-phase MLE motors

E-pumps with single-phase MLE motors

Grundfos single phase MLE motors offer these features:

- Single-phase power supply connection.
- Single-phase, asynchronous squirrel-cage induction motors designed to current IEC, DIN and VDE guidelines and standards. The motors incorporate a variable frequency drive and PI controller.
- Used for continuously variable speed control of Grundfos E-pumps.
- Available in power sizes 0.33 to 1.0 Hp, 4-pole, and 0.5 to 1.5 Hp, 2-pole.

TM02 1502 0101

Fig. 46 Single-phase MLE 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

See Grundfos Installation and Operating Instructions for this product.

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: 328 ft (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: 1640 ft (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: 1640 ft (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: 1640 ft (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: 1640 ft (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: 1640 ft (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: 1640 ft (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

Fulfill 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 MLE motors* on p. 43.

Enclosure class

Standard enclosure class: IP55 (TEFC).

Insulation class

F (IEC 85).

Ambient temperature

- During operation:
  -4 °F (-20 °C) to +104 °F (+40 °C).
- During storage/transport:
  -40 °F (-40 °C) to +140 °F (+60 °C).

Relative air humidity

Maximum 95 %.

Sound pressure level

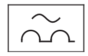
Motor [Hp]	Speed as stated on the nameplate [rpm]	Sound pressure level [dB(A)]
0.5	1400-1500	< 70
	1700-1800	
	2800-3000	
	3400-3600	
0.75	1400-1500	
	1700-1800	
	2800-3000	
	3400-3600	
1.0	1400-1500	
	1700-1800	
	2800-3000	
	3400-3600	
1.5	2800-3000	
	3400-3600	

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 power supply must not exceed 4 times per hour.

When the pump is switched on via the power supply, 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

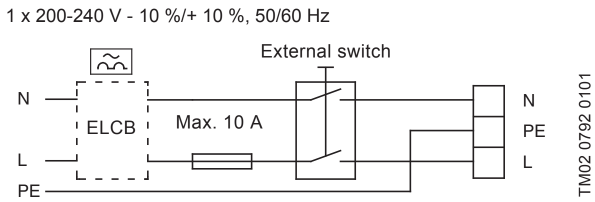


Fig. 47 Wiring diagram, single-phase MLE motors

Other connections

Figure 48 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 (terminals 2-3)
  - Digital input function (terminals 1-9, 9-10, 9-11)
  - Setpoint (terminals 4, 5, 6)
  - Sensor signals (terminals 7-8)
  - Bus connection (terminals B, Y, A).
    All inputs (group 1) are internally separated from the power supply-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 volts can be connected to the output as desired.
- **Group 3: Power supply** (terminals N, PE, L).
  A galvanically safe separation must fulfill the requirements for reinforced insulation including creepage distances and clearances specified in EN 60335.

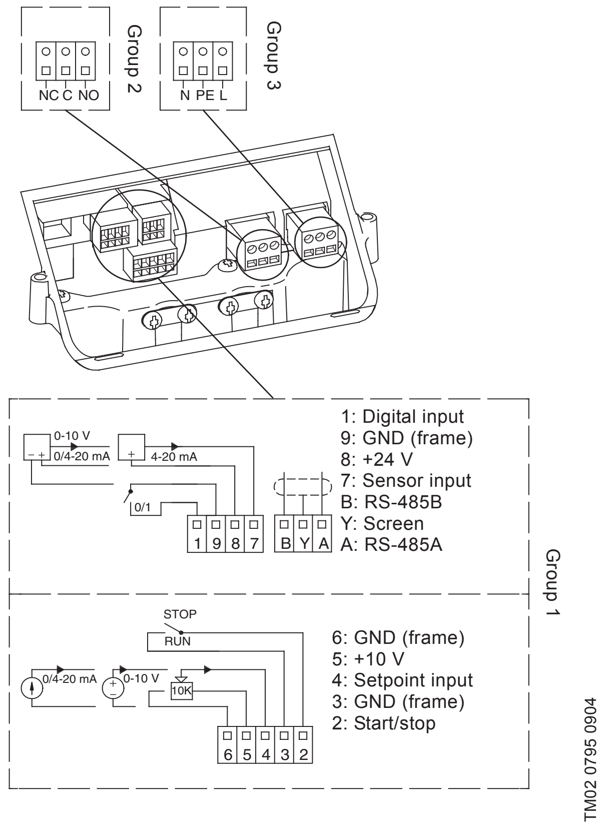


Fig. 48 Connection terminals

5. Three-phase MLE motors

E-pumps with three-phase MLE motors

Grundfos three-phase MLE motors offer these features:

- Three-phase power supply connection.
- Three-phase, asynchronous squirrel-cage induction motors designed to current IEC, DIN and VDE guidelines and standards. The motors incorporate a variable frequency drive and PI controller.
- Used for continuously variable speed control of Grundfos E-pumps.
- Available in power sizes 1 to 30 Hp, 2-pole.

GR8275

Fig. 49 Three-phase MLE motor

Supply voltage

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

Back-up fuse

See Installation and Operating Instructions.

Leakage current

Motor size [Hp]	Leakage current [mA]
1.0 - 3.0	< 3.5
5.0 - 7.5	< 5
10	< 10
15 - 30	>10

The leakage currents are measured in accordance with EN 60355-1 for 1.0 to 10 Hp and EN 61800-5-1 for 15 to 30 Hp 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: 328 ft (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: 1640 ft (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: 1640 ft (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: 1640 ft (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: 1640 ft (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: 1640 ft (500 m).

Bus input

- Grundfos GENIbus protocol, RS-485.
  Screened cable: 0.5 - 1.5 mm^2 / 28-16 AWG.
  Maximum cable length: 1640 ft (500 m).

EMC (electromagnetic compatibility to EN 61800-3)

Motor [Hp]	Emission/immunity
1.0 1.5 2.0 3.0 5.0 7.5 10	**Emission:** The motors may be installed in **residential areas** (first environment), unrestricted distribution, corresponding to CISPR11, group 1, class B. **Immunity:** The motors fulfill the requirements for both the first and second environment.
15 20 25 30	**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 fulfill the requirements for both the first and second environment.

For further information about EMC, see section *8. Bus communication* on page 56.

Enclosure class

Standard: IP55 (IEC34-5) (TEFC).

Insulation class

F (IEC 85).

Ambient temperature

During operation: -4 °F to +104 °F (-20 °C to +40 °C)

During storage/transport:

1.0 to 10 Hp:	-40°F to +140 °F (-40 °C to +60 °C)
15 to 30 Hp:	-13 °F to +158 °F (-25 °C to +70 °C)

Relative air humidity

Maximum 95 %.

Sound pressure level

Motor [Hp]	Speed stated on the nameplate [rpm]	Sound pressure level [dB(A)]
1.0	3400-3600	65
1.5		65
2.0		70
3.0		70
5.0		75
7.5		80
10		69
15		70
20		70
25		74
30		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).

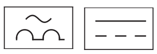
Additional protection

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


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 power supply voltage must not exceed 4 times per hour.

When the pump is switched on via the power supply, 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, 1.0 to 10 Hp

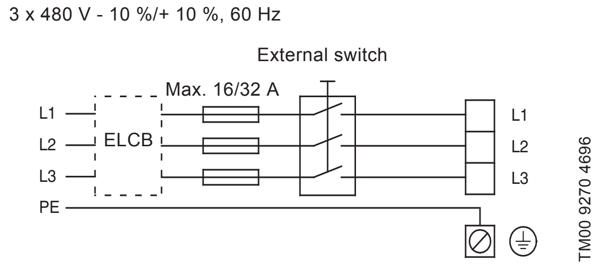


Fig. 50 Wiring diagram, three-phase MLE motors, 1.0 to 10 Hp

Other connections

Figure 51 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 (terminals 2-3)
  - Digital input function (terminals 1-9, 9-10, 9-11)
  - Setpoint (terminals 4, 5, 6)
  - Sensor signals (terminals 7-8)
  - Bus connection (terminals B, Y, A).
    All inputs (group 1) are internally separated from the power supply-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 and NC, C2, NO.)
    The output (group 2) is galvanically separated from other circuits. A maximum supply voltage of 250 volts can be connected to the output as desired.
- **Group 3: Power supply** (terminals L1, L2, L3, Ground).
  A galvanically safe separation must fulfill the requirements for reinforced insulation including creepage distances and clearances specified in EN 60335.

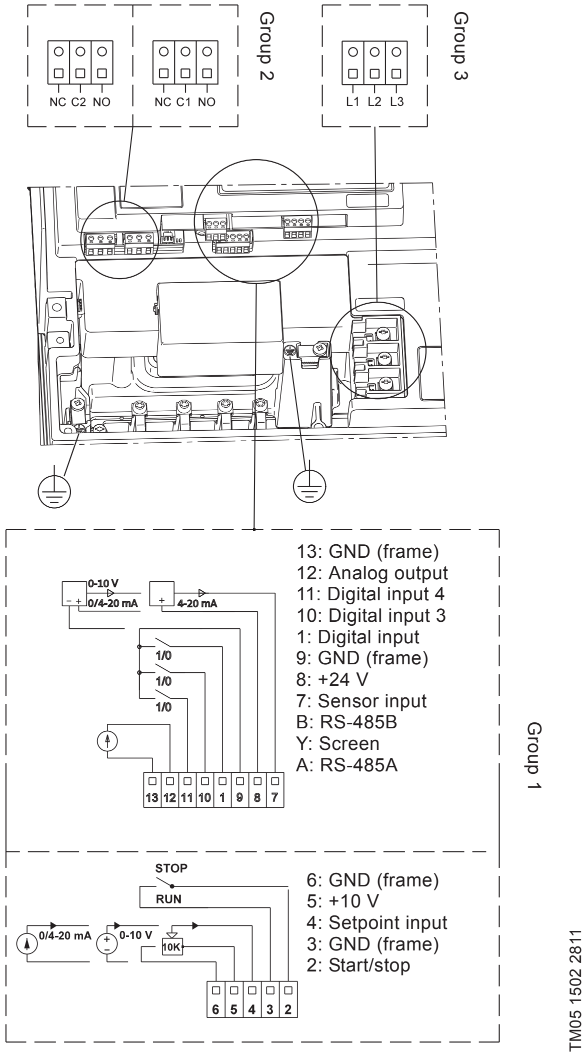


Fig. 51 Connection terminals

Wiring diagram, 15 - 30 Hp

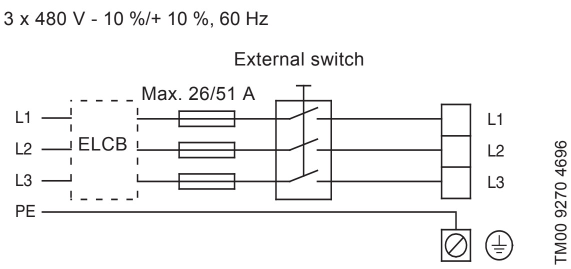


Fig. 52 Wiring diagram, three-phase MLE motors, 15 - 30 Hp

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, 9 and 10, 9 and 11
- 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, C1, NO, and NC, C2, 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: Power supply** (terminals L1, L2, L3). A galvanically safe separation must fulfill the requirements for reinforced insulation including creepage distances and clearances specified in EN 61800-5-1.

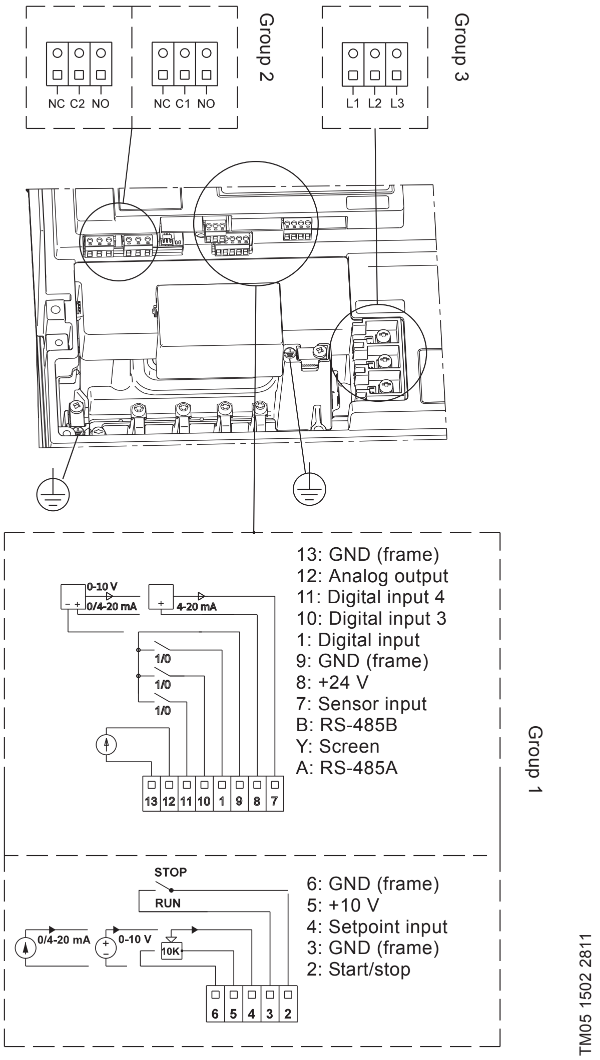


Fig. 53 Connection terminals

6. 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 fulfill 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 fulfill 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 power 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 power 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.

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.

EMC and C-tick

All E-pumps marked with the C-tick logo fulfill 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 MLE-motors are marked with C-tick.

The C-tick only covers emission.

Where can E-pumps be installed?

All E-pumps with MLE 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 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 power supply to MLE

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 power 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.

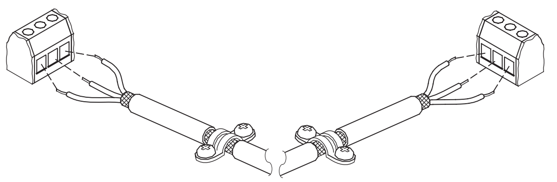
Connecting sensor and equipment on other low-voltage inputs

All connections to control inputs (terminals 1-9, 9-10, and 9-11) should be made with screened cables.

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

It is important that the screen is connected to ground/frame as direct as possible, i.e. by means of a metal cable bracket to encircle the screen completely. See fig. 54.

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



TM03 0266 5004

Fig. 54 Mounting of brackets on cable

An intertwined screen (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

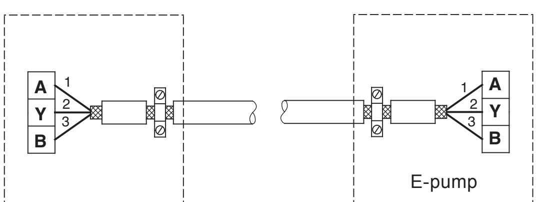
Connection to relay (terminals NC, C, NO) should be made by means of a screened cable.

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

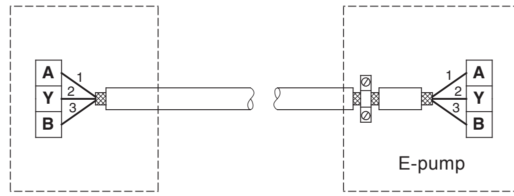
For the bus connection a screened 3-core cable must be used.



TM03 0265 5004

Fig. 55 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. 55.
- If the unit or panel has no cable clamp as shown in fig. 56, the screen is left unconnected at this end.

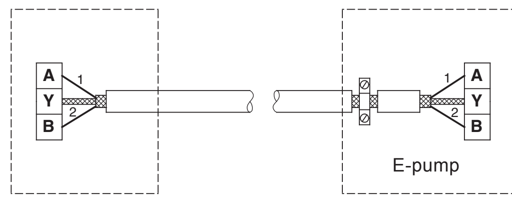


TM02 8841 0904

Fig. 56 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. 57. Make sure that the "pig's tail" is as short as possible.



TM02 8842 0904

Fig. 57 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 58.

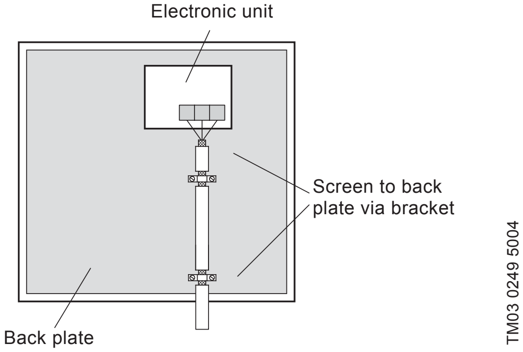


Fig. 58 Schematic drawing of connection of cable to back plate

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. 59, 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.

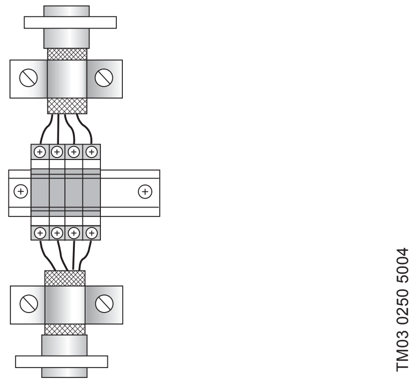


Fig. 59 Schematic drawing of extension of control cable

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 4 to 8 in. (10 to 20 cm) between the two groups should be observed.

7. E-pumps in parallel

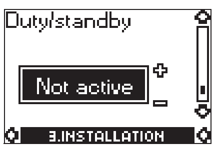
Control of E-pumps connected in parallel

E-pumps represent a complete system consisting of pump, variable frequency drive, 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, CKE, MTRE, CME without sensor
Built-in duty/standby function  	•	•
Hydro Multi-E 	•	-
BoosterpaQ Hydro MPC 	•	-

• Available.

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 35.

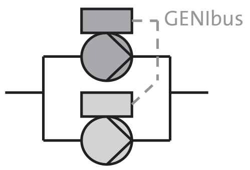


Fig. 60 Pumps connected via GENIbus interface

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

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-optimized software

The CU 351 incorporates application-optimized 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.

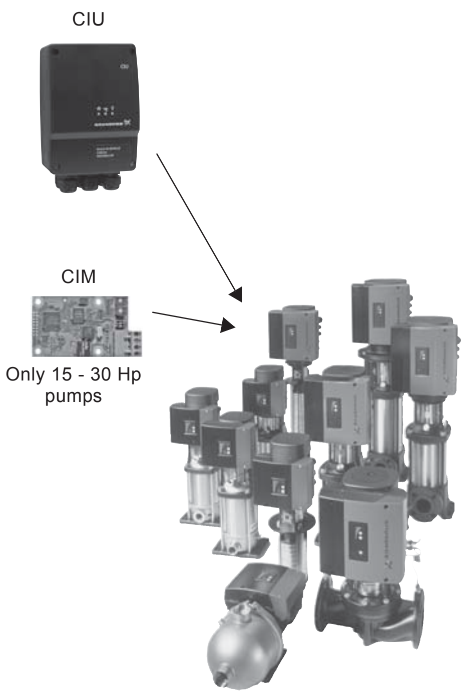
8. Bus communication

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 variable frequency drive and controller to the market.

Bus communication between E-pumps and other equipment like building management systems (SCADA) can take place with a Grundfos gateway and a standardized fieldbus, for instance Profibus.



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 MLE motors, 10 Hp and below. The CIM module can be fitted directly in the MLE motor terminal box (15 - 30 Hp only).

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	TP Series 1000 without sensor	TPE 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

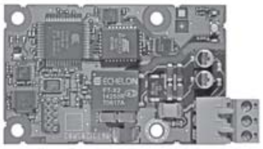


Fig. 61 CIM 100 LON module

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 15 - 30 Hp
From management system (SCADA) to E-pump	
Control mode	● 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)
Actual flow	
Actual power consumption	●
Operating hours	●
Energy consumption	●
Liquid temperature	● 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

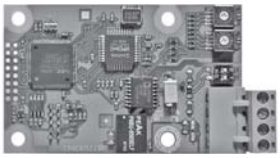


Fig. 62 CIM 150 Profibus module

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 15 - 30 Hp
From management system (SCADA) to E-pump	
Control mode	● 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)
Actual flow	
Actual power consumption	●
Operating hours	●
Energy consumption	●
Liquid temperature	● 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

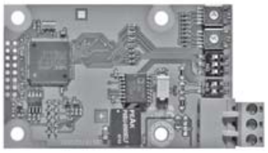


Fig. 63 CIM 200 Modbus module

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 15 - 30 Hp
From management system (SCADA) to E-pump	
Control mode	● 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)
Actual flow	
Actual power consumption	●
Operating hours	●
Energy consumption	●
Liquid temperature	● 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

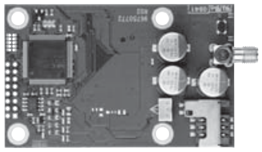


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Fig. 64 CIM 250 GSM/GPRS module

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 15 - 30 Hp
From management system (SCADA) to E-pump	
Control mode	● 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)
Actual flow	
Actual power consumption	●
Operating hours	●
Energy consumption	●
Liquid temperature	● 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

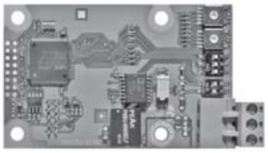

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Fig. 65 CIM 300 BACnet module

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 15 - 30 Hp
From management system (SCADA) to E-pump	
Control mode	● 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)
Actual flow	
Actual power consumption	●
Operating hours	●
Energy consumption	●
Liquid temperature	● 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].

9. Frequency-controlled operation

Variable frequency drive, function and design

Variable frequency drive (VFD)

Speed control of pumps involves a variable frequency drive. So it will be relevant to have a closer look at what a variable frequency drive is, how it operates and finally to discuss related precautions involved in using a variable frequency drive.

Basic function and characteristics

It is a well-known fact that the speed of an asynchronous motor depends primarily on the number of poles 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 magnetization, it is also necessary to change the amplitude of the voltage.

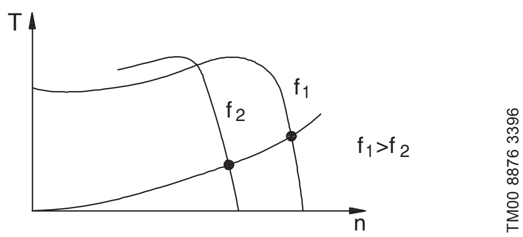


Fig. 66 Displacement of motor torque characteristic

A frequency/voltage control results in a displacement of the torque characteristic whereby the speed is changed. Figure 66 shows the motor torque characteristic (T) 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 variable frequency drive changes frequency and voltage, so therefore we can conclude that the basic task of a variable frequency drive is to change the fixed supply voltage/frequency, for instance 3 x 480 V, 60 Hz, into a variable voltage/frequency.

Components of the variable frequency drive

In principle, all variable frequency drives consist of the same functional blocks. As mentioned previously, the basic function is to convert the supply voltage into a new AC voltage with another frequency and amplitude.

First, variable frequency rectifies the incoming supply 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 variable frequency drive, the frequency of the supply 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 variable frequency drive 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 variable frequency drive is independent of the incoming frequency.
- The variable frequency drive can supply output frequencies which are higher than power supply frequency which makes oversynchronous operation possible.

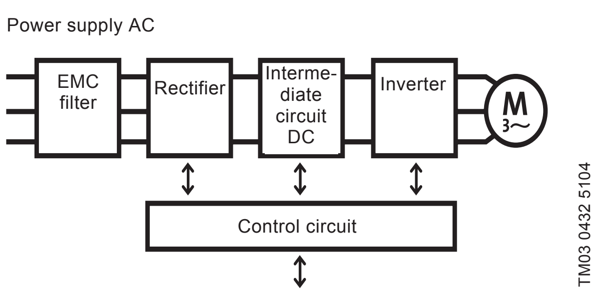


Fig. 67 The main blocks of a variable frequency drive

EMC filter

This block is not part of the primary function of the variable frequency drive 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 variable frequency drive does not send unacceptably high noise signals back to the power supply, thus disturbing other electronic equipment connected to the power supply. At the same time, the filter ensures that noise signals in the power supply generated by other equipment do not enter the electronic components of the variable frequency drive causing damage or disturbances.

Rectifier

Single-phase MLE 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 power supply 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 63.

In three-phase MLE motors, the rectifier is a conventional rectifier without any power factor correction. This will result in a non-sinusoidal current. This subject will be covered later.

Control circuit

The control circuit block has two functions: It controls the variable frequency drive 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 variable frequency drive is not sinusoidal as is the case for the supply voltage. The voltage supplied to the motor consists of a number of square wave pulses. See fig. 68.

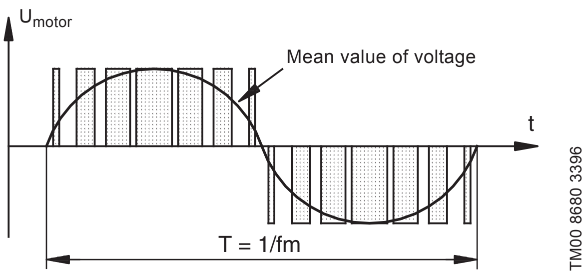
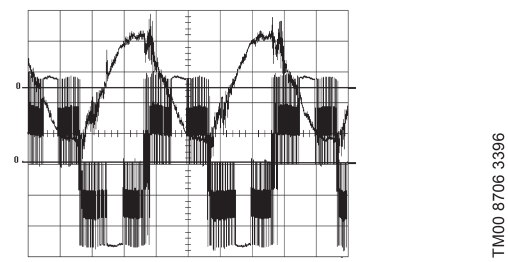


Fig. 68 The voltage supplied to the motor consists of a number of square wave pulses

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 variable frequency drive 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 variable frequency drives today. The motor current itself is almost sinusoidal. This is shown in fig. 69 (a) indicating motor current (top) and motor voltage. In fig. 69 (b) a section of the motor voltage is shown. This indicates how the pulse/pause ratio of the voltage changes.

a)



b)

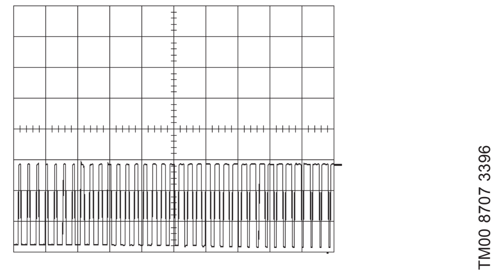


Fig. 69 a) indicates motor current (top) and motor voltage.
b) indicates a section of the motor voltage

Special conditions regarding variable frequency drives

When installing and using variable frequency drives, or pumps with integrated variable frequency drives, the installer and user must take account of the following. A variable frequency drive will behave differently on the power supply side than a standard asynchronous motor. This is described in detail below.

Non-sinusoidal power input, variable frequency drives supplied by three-phase supply

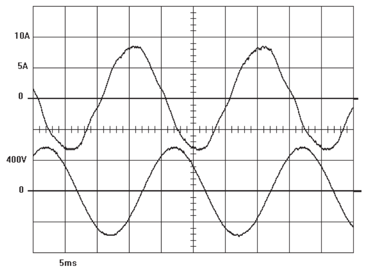
A variable frequency drive designed as the one described above will not receive sinusoidal current from the power supply. Among other things, this will influence the sizing of power supply cable, power switches, etc. Figure 70 shows how supply current and voltage appear for the following:

a) three-phase, two-pole standard asynchronous motor

b) three-phase, two-pole standard asynchronous motor with variable frequency drive.

In both cases, the motor supplies 4 Hp to the shaft.

a)



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b)

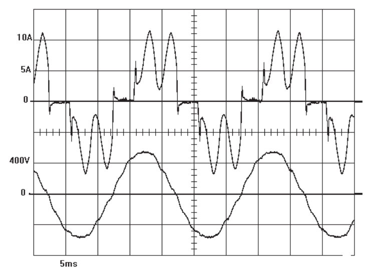

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Fig. 70 Supply current and voltage for a) a standard asynchronous motor and b) a three-phase MLE motor

A comparison of the current in the two cases shows the following differences. See fig. 70.

- The current for the system with variable frequency drive is not sinusoidal.
- The peak current is much higher (approx. 52 % higher) for the variable frequency drive solution.

	Standard motor	**Motor with variable frequency drive**
Supply voltage	400 V	400 V
Supply current, RMS	6.4 A	6.36 A
Supply current, peak	9.1 A	13.8 A
Power input, P1	4.93 Hp	4.94 Hp
Cos φ, power factor (PF)	Cos φ = 0.83	PF = 0.86

This is due to the design of the variable frequency drive connecting the power supply 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 power supply side of the motor. For a standard motor without a variable frequency drive, the relation between voltage (U), current (I) and power (P) is as follows:

$$P = \sqrt{3} \cdot U \cdot I \cdot \cos\varphi$$

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 = 4.78 Hp.

The same formula cannot be used for the calculation of the power input in connection with motors with variable frequency drives. 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 MLE motors the following values are provided as a guideline to the power factor depending on motor size:

Three-phase MLE motor 3600 rpm [Hp]	Power factor (PF)
1.0	0.73
1.5	0.83
2.0	0.87
3.0	0.91
5.0	0.92
7.5	0.94
10	0.93
15	0.89
20	0.89
25	0.88
30	0.88

When measuring the input current in connection with installation and service of a system with a variable frequency drive, it is necessary to use an instrument that is capable of measuring "non-sinusoidal" currents. In general, current measuring instruments for variable frequency drives must be of a type measuring "True RMS".

Power input, variable frequency drives supplied by single-phase supply

Single-phase MLE motors are fitted with the so-called PCF circuit, which generally speaking ensures sinusoidal power input. 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 MLE motor will be as low as possible.

Figure 71 shows the supply voltage and current for a 1.5 Hp MLE motor with PFC circuit. As appears, the supply current is more or less sinusoidal and in phase with the voltage.

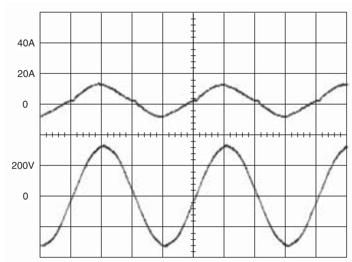

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Fig. 71 Supply voltage and current for a 1.5 Hp MLE motor with PFC circuit

Power factor and typical input supply current at rated load have the following values for the single-phase MLE motor range:

Motor P2 [Hp]	PF	Input current at rated voltage (230 V) and rated P2 at 3600 rpm [A]
0.5	0.96	2.5
0.75	0.97	3.5
1.0	0.97	4.7
1.5	0.97	6.8

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 harmonized standard under the EMC directive 2004/108/EC, and the purpose is to ensure that the power supply is not "contaminated" by non-sinusoidal loads which have a tendency to distort the waveform of the power supply voltage and furthermore cause unnecessarily high peak currents.

The requirements of EN 61000-3-2 can be summarized 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 power supply network with an input current up to 16 A.
  Note: Exempted from this are:
  – products with an input power lower than 0.10 Hp
  – products exclusively designed for professional use with an input power exceeding 1.5 Hp.

As appears, the standard does NOT apply to professional equipment with an input power from the power supply above 1.34 Hp. In principle, this means that the standard does not apply to Grundfos' 1.5 Hp (P2) MLE motors as their input power from the power supply exceeds 1.34 Hp. Nevertheless, due to the obvious advantages of the PFC circuit it has been decided that the entire range of single-phase E-pumps from 0.5 Hp up to and including 1.5 Hp 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:

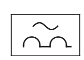
- The RMS value of the current is 40-50 % lower than for single-phase E-pumps without PFC circuit.
- Cables with a lower cross-section can be used.
- Smaller fuses are required in the installation.
- When connecting several pumps supplied by different phases in parallel, the current in the common neutral lead will be balanced so that the neutral lead current will never exceed the current in any one of the supply phases.
- The pump is less sensitive to variations in the supply voltage (the MLE motor can yield full power with the entire voltage supply range 200-240 V - 10 %/+ 10 % corresponding to 180-264 V).

Variable frequency drives and earth leakage circuit breakers (ELCB)

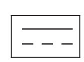
Earth leakage circuit breakers are used increasingly as extra protection in electrical installations. If a variable frequency drive is to be connected to such an installation, it must be ensured that the circuit breaker installed is of a type which will surely break, also if failure occurs on the DC side of the variable frequency drive.

The circuit breakers must be marked as follows in order to ensure correct functioning.

- For single-phase MLE motors, the circuit breaker must be marked with the following symbol:


ELCB

- For three-phase MLE 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.

10. Advanced use of MLE motors

Introduction

Grundfos MLE motors have many features for the advanced user.

Grundfos three-phase MLE 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 customize 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

Bearing monitoring is a built-in function indicating the time to relubricate or replace the bearings of the MLE motor. The relubrication feature is only available for three-phase pumps of 15-30 Hp.

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 [Hp]	**4-pole [Hp]**
0.50 - 1.5	**0.33 - 1.0**
-	-

Three-phase pumps	
2-pole [Hp]	
1.0 - 10	**15 - 30**
●	●

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 15 - 30 Hp basic controller and no special functional module is required.

Advanced level (only 15 - 30 Hp)

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 MLE motor as standard.
- Temperature sensors are fitted at the drive end and at the non-drive end of the motor.

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 MLE 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 MLE motor and terminal box.

The MLE motor has standstill heating included.
An external heater on the stator coil is not 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 [Hp]	4-pole [Hp]
0.50 - 1.5	0.33 - 1.0
-	-

Three-phase pumps	
2-pole [Hp]	
1.0 - 10	15 - 30
●	●

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 power supply. 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

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 is detected.

The stop function provides these benefits:

- The energy consumption is optimized and the system efficiency is improved.
- Unnecessary heating of the pumped liquid which damages pumps.
- 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 [Hp]	4-pole [Hp]
0.50 - 1.5	0.33 - 1.0
●	●

Three-phase pumps	
2-pole [Hp]	
1.0 - 10	15 - 30
●	●

Operating conditions for the stop function

A pressure sensor, a non-return valve, and a diaphragm tank are required for the stop function to operate properly.

Note: The non-return valve must always be installed before the pressure sensor. See fig. 72 and fig. 73.

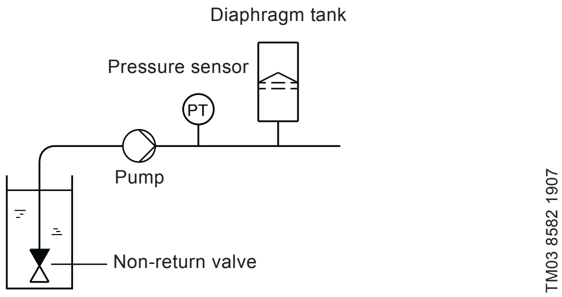


Fig. 72 Position of the non-return valve and pressure sensor in system with suction lift operation

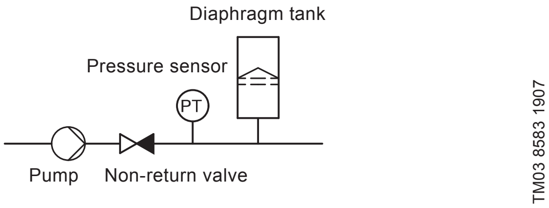


Fig. 73 Position of the non-return valve and pressure sensor in system with positive inlet pressure

When low flow is detected, the pump is in on/off operation. If there is flow, the pump will continue operating according to the setpoint. See fig. 74.

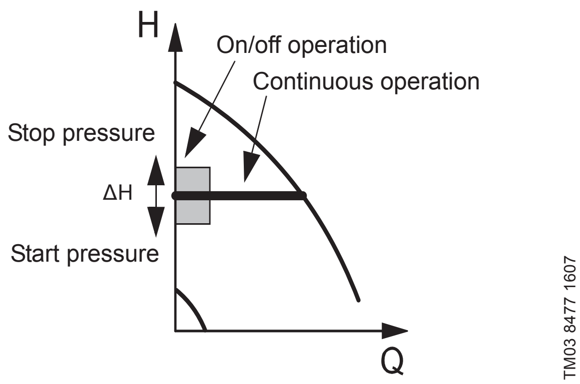


Fig. 74 Constant pressure with stop function. Differenc between start and stop pressures (ΔH)

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 air pressure must be 0.7 x setpoint.

Recommended diaphragm tank size:

Rated flow of pump [gpm (m^3h)]	CRE pump	Typical diaphragm tank size [gal (liter)]
0 - 26 (0 - 5.9)	1s, 1, 3	2 (7.6)
27 - 105 (6.1 - 23.8)	5, 10, 15	4.4 (16.7)
106 - 176 (24.2 - 40)	20, 32	14 (53.0)
177 - 308 (40.2 - 70.0)	45	34 (128.7)
309 - 440 (70.2 - 99.9)	64, 90	62 (234.7)
441 - 750 (100 - 170)	120, 150	86 (325.5)

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.

Low-flow detection function

- The low-flow detection function will check the flow regularly by reducing the speed for a short time. A small change in pressure or no change in pressure means that there is low flow.

Low-flow detection with flow switch

- When a flow switch detects low flow, the digital input will be activated.

Contact Grundfos for further information.

Dry-running protection

This function protects the pump against dry running. When lack of inlet pressure or water shortage is detected, the pump will be stopped before being damaged.

Lack of inlet pressure or water shortage can be detected with a switch connected to a digital input configured to dry-running protection.

The use of a digital input requires an accessory, such as:

- a Grundfos Liqtec® dry-running switch (for more information on LiqTec, see section *12. Accessories*)
- a pressure switch installed on the suction side of the pump
- a float switch installed on the suction side of the pump.

The pump cannot restart as long as the digital input is activated.

Temperature sensors 1 and 2

One or two Pt100 temperatures sensors may be connected to the input terminals 17, 18, 19, and 20.

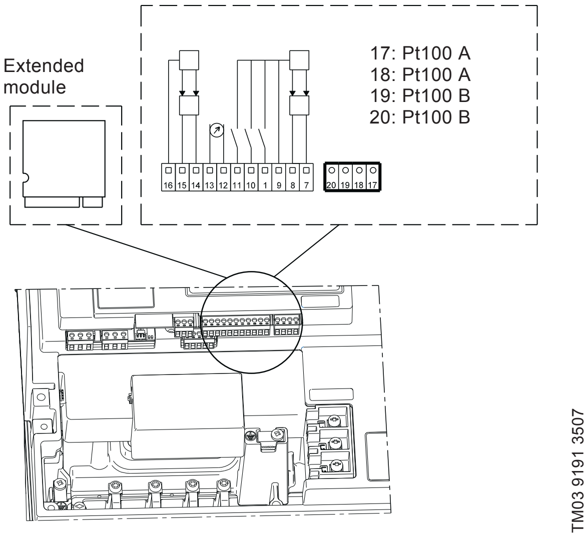


Fig. 75 Temperature sensor connections in the extended functional module

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 available on all MLE motors.

This function is available in these pump sizes:

Single-phase pumps	
2-pole [Hp]	**4-pole [Hp]**
0.50 - 1.5	**0.33 - 1.0**
-	-

Three-phase pumps	
2-pole [Hp]	
1.0 - 10	**15 - 30**
-	●

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

Signal relays are used to give an output indication of the current operational status of the MLE. The signal relay is a potential free contact (also called a dry contact). The output signals are typically 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 [Hp]	**4-pole [Hp]**
0.50 - 1.5	**0.33 - 1.0**
●	●
1 relay	1 relay

Three-phase pumps	
2-pole [Hp]	
1.0 - 10	**15 - 30**
●	●
1 relay	2 relays

Description

The signal relays can be set up with these three parameters:

- relay control
- relay setup
- relay delay.

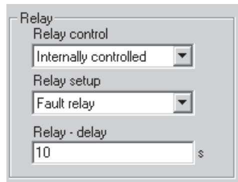


Fig. 76 Signal relay parameters for 0.5 - 10 Hp pumps

Fig. 77 Signal relay parameters for 15 - 30 Hp pumps

Relay control

See information in section *3. E-pumps* on page 32 for basic signal relay activation. The relay time is 0 seconds and the signal relay in internally controlled.

The advanced 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 variable frequency drive 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

The analog sensor inputs 1 and 2 are standardized 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.

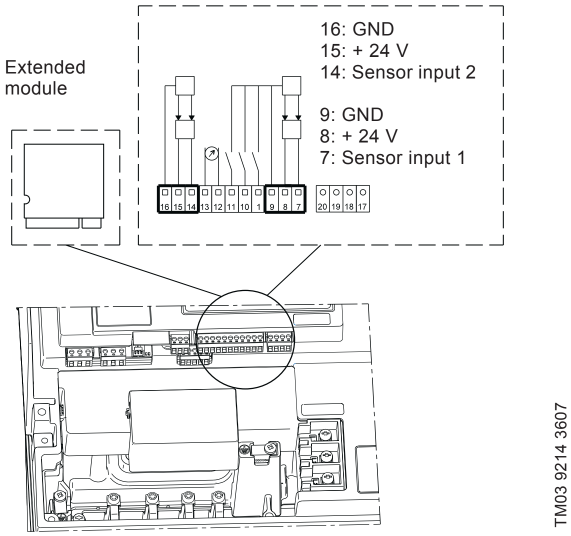


Fig. 78 Sensor inputs 1 and 2 connections

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 parameters.

This function is available in these pump sizes:

Single-phase pumps	
2-pole [Hp]	**4-pole [Hp]**
0.50 - 1.5	**0.33 - 1.0**
●	●
1 analog input	1 analog input

Three-phase pumps	
2-pole [Hp]	
1.0 - 10	**15 - 30**
●	●
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.

Analog output

Analog output

The analog output (0-10 mA) can be set via the PC Tool to one of these indications:

- feedback value
- speed
- frequency
- motor current
- external setpoint input
- limit exceeded.

The analog output is default set to not active.

Feedback value

The output signal is a function of the actual feedback sensor.

Speed

The output signal is a function of the actual pump speed.

Frequency

The output signal is a function of the actual frequency.

Motor current

The output signal is a function of the actual motor current.

External setpoint input

The output signal is a function of the external setpoint input.

Limit exceeded

The output signal indicates whether the limit is exceeded:

- Minimum output = limit is not exceeded.
- Maximum output = limit is exceeded.

Limit exceeded 1 and 2

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.

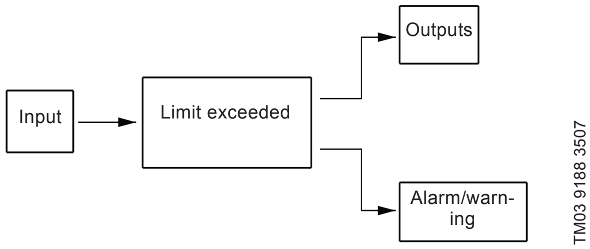


Fig. 79 Example of a "limit exceeded" sequence

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 cavitation or dry run.

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 [Hp]	**4-pole [Hp]**
0.50 - 1.5	**0.33 - 1.0**
-	-

Three-phase pumps	
2-pole [Hp]	
1.0 - 10	**15 - 30**
●	●

Description

The figures below show two examples of setpoint monitoring by means of the limit exceeded function.

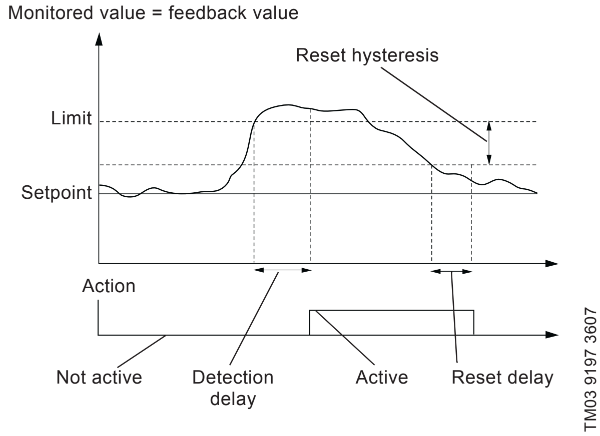


Fig. 80 Limit exceeded sequence with the limit type "max. limit", for example monitoring of bearing temperature

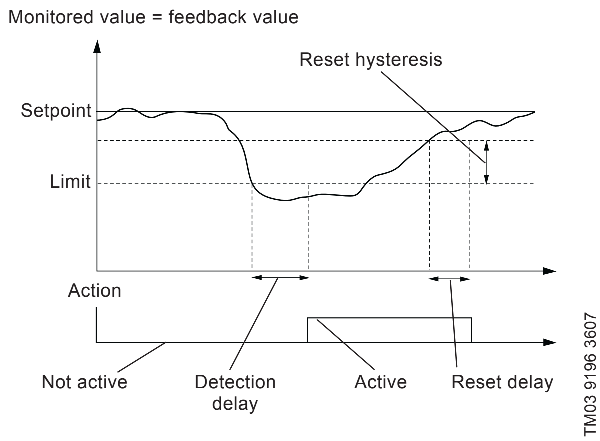


Fig. 81 Limit exceeded sequence with the limit type "min. limit"

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

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.

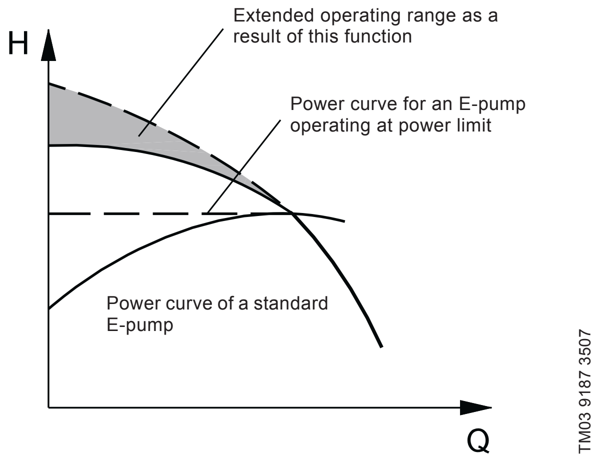


Fig. 82 Power curves of a standard pump and a pump operating at power limit

Purpose and benefits

This function utilizes the fact that often a standard E-pump does not load the MLE motor fully in the entire operating range. By controlling the MLE 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 MLE motor. See fig. 82.

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 [Hp]	**4-pole [Hp]**
0.50 - 1.5	**0.33 - 1.0**
-	-

Three-phase pumps	
2-pole [Hp]	
1.0 - 10	**15 - 30**
•	•

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 83 illustrates the operating range of a standard 60 Hz E-pump with increased pressure range achieved by using the "pump operating at power limit" function.

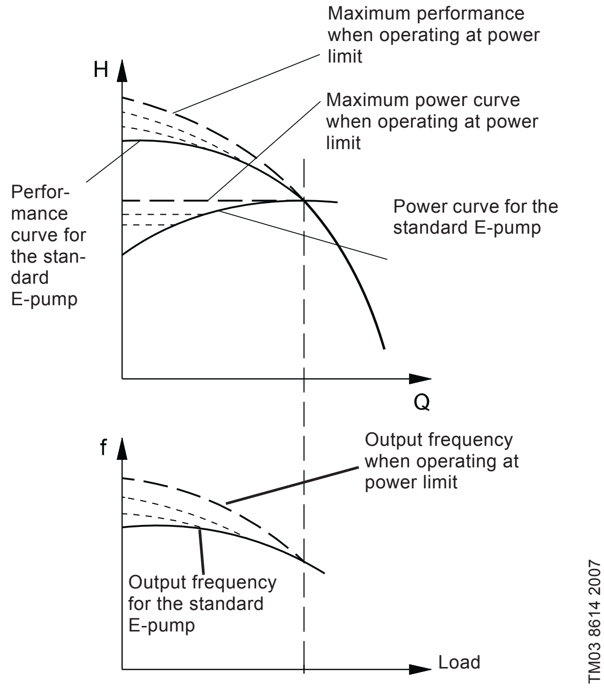


Fig. 83 Standard performance curve vs a performance curve with the "pump operating at power limit" function

The MLE 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 level.

Reduced motor size

Figure 84 shows the operating range of a standard 60 Hz pump where the "pump operating at power limit" function is used to optimize 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.

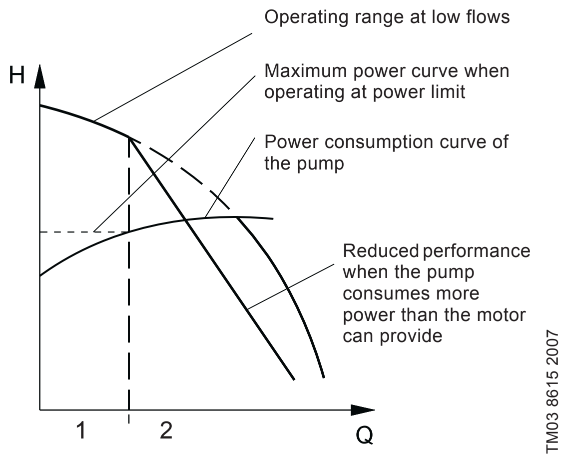


Fig. 84 Standard performance curve vs a curve operated at reduced power limit

Size of pump and MLE motor

No special considerations need to be taken when sizing pump and motor. If the pump is oversized for the motor, the MLE motor will just reduce its speed and thus the pump performance according to the illustration in fig. 84.

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.

Special conditions

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

High altitude

Motors installed up to 3280 ft above sea level can be loaded 100%. At higher altitudes, the cooling capability of air is reduced.

At altitudes above 3,280 ft (1000 m), the full load amps should be derated in accordance with the diagram in fig. 85.

At an altitude of 7380 ft (2250 m); the full load amps (12A) of the MLE must be derated to 95% according to fig. 85. The MLE full load amps at 7380 ft (2250 m) is 11.4 amps.

High ambient temperature

If the ambient temperature is above 104 °F (40 C), the motor full load amps must be reduced per fig. 85.

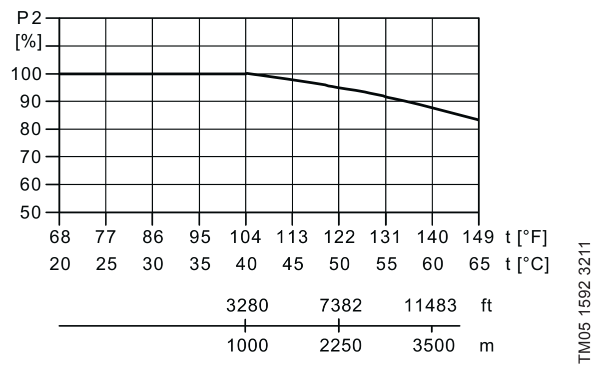


Fig. 85 Derating curve shows performance reduction at increased ambient temperature and installation altitude

11. MLE technical data

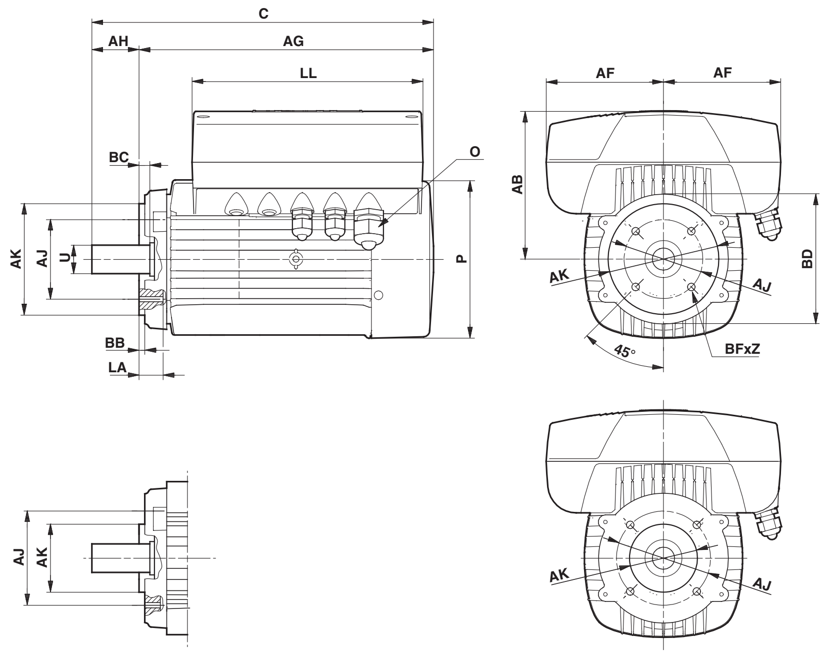
Grundfos MLE motors are equipped with NEMA standard C-face flanges.

Grundfos MLE 10 Hp and smaller motors are recognized under the Component Recognition Program of Underwriters Laboratories Inc. for the United States and Canada. Grundfos MLE motors 15 to 30 Hp are UL Listed for the U.S.A.

MLE motors are equipped with a reinforced bearing system with locked bearings at the drive end, either a deep-groove ball bearing or an angular-contact bearing depending on the motor model.

This ensures an even uptake of the load in order to maximize the lifetime of the bearings, which are guaranteed for a minimum of 18,0000 hours service life. At the non-drive end, the motors are fitted with bearings with axial clearance in order to meet production tolerances while allowing for thermal expansion during motor operation. This ensures trouble-free operation and long life.

Dimensional sketch, MLE single phase motors



TM03 1674 2705

Dimensional data, MLE single phase motors

2-pole

Power [Hp]	Short type designation	Stator housing [inches (mm)]							Shaft end [inches (mm)]	
		P	AB	AF	AF	C	AG	LL	U	AH
0.5 0.75	MLE71AB-2-56C-C MLE71BA-2-56C-C	5.55 (141)	5.51 (140)	4.13 (105)	4.13 (105)	8.70 (221)	7.52 (191)	6.65 (169)	0.62 (16)	2.06 (52)
1.0 1.5	MLE80AA-2-56C-C MLE80BA-2-56C-C	5.55 (141)	5.51 (140)	4.13 (105)	4.13 (105)	10.67 (271)	9.09 (231)	6.65 (169)	0.62 (16)	2.06 (52)

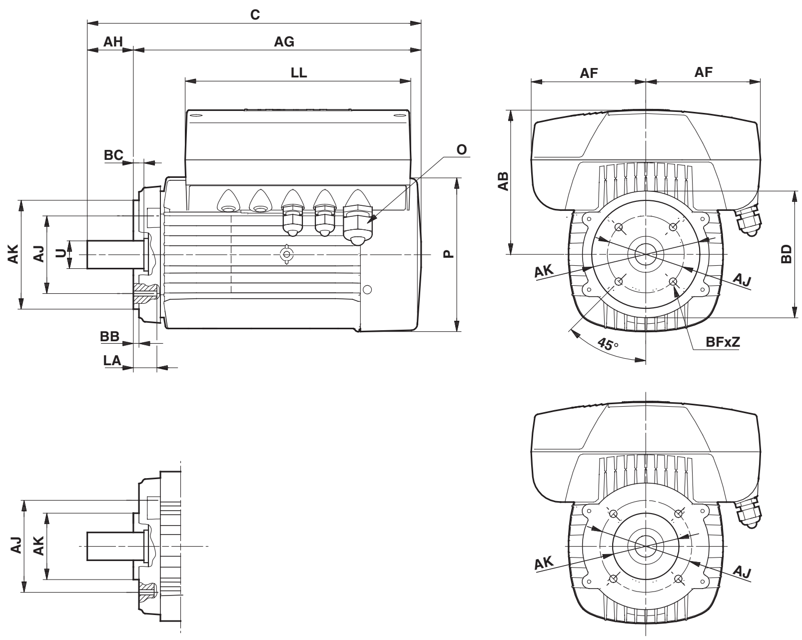
Power [Hp]	Short type designation	Flange [inches (mm)]						Cable entries [mm]
		LA	AJ	AK	BD	BF	BB	O
0.5 0.75	MLE71AB-2-56C-C MLE71BA-2-56C-C	0.47 (12)	3.35 (85)	2.76 (70)	4.13 (105)	M6 x 4 mm	0.10 (2.5)	2xM16 + 1xM20 + 1xknock out M16
1.0 1.5	MLE80AA-2-56C-C MLE80BA-2-56C-C	0.47 (12)	3.94 (100)	3.15 (80)	4.72 (120)	M6 x 4 mm	0.12 (3)	2xM16 + 1xM20 + 1xknock out M16

4-pole

Power [hp]	Short type designation	Stator housing [inches (mm)]							Shaft end [inches (mm)]	
		P	AB	AF	AF	C	AG	LL	U	AH
0.35 0.5	MLE71AB-4-56C-C MLE71BA-4-56C-C	5.55 (141)	5.51 (140)	4.13 (105)	4.13 (105)	8.70 (221)	7.52 (191)	6.65 (169)	0.62 (16)	2.06 (52)
0.75 1.0	MLE80AA-4-56C-C MLE80BA-4-56C-C	5.55 (141)	5.51 (140)	4.13 (105)	4.13 (105)	10.67 (271)	9.09 (231)	6.65 (169)	0.62 (16)	2.06 (52)

Power [hp]	Short type designation	Flange [inches (mm)]						Cable entries [mm]
		LA	AJ	AK	BD	BF	BB	O
0.35 0.5	MLE71AB-4-56C-C MLE71BA-4-56C-C	0.47 (12)	3.35 (85)	2.76 (70)	4.13 (105)	M6 x 4 mm	0.10 2.5)	2xM16 + 1xM20 + 1xknock out M16
0.75 1.0	MLE80AA-4-56C-C MLE80BA-4-56C-C	0.47 (12)	3.94 (100)	3.15 (80)	4.72 (120)	M6 x 4 mm	0.12 (3)	2xM16 + 1xM20 + 1xknock out M16

Dimensional sketch, MLE three phase motors 1 - 10 Hp



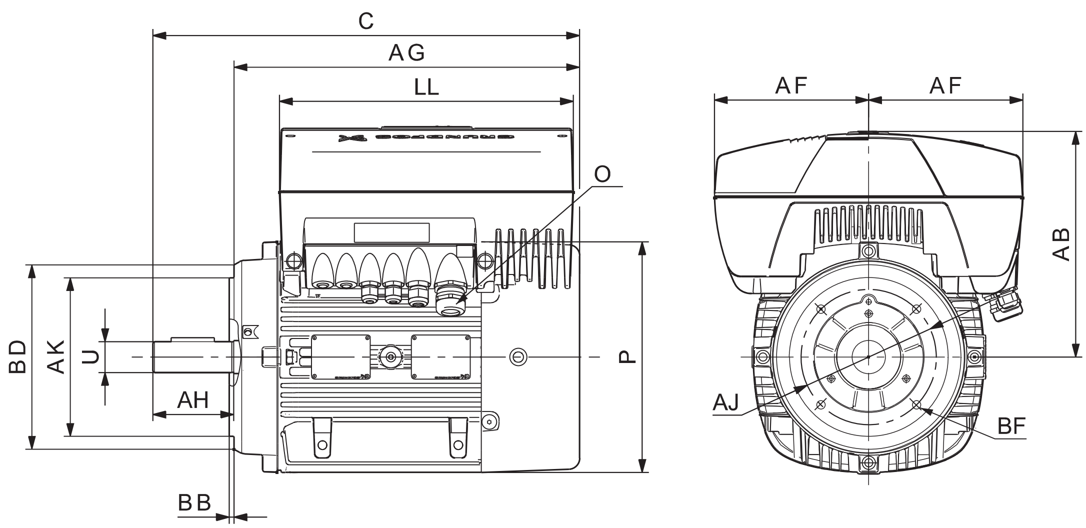
TM03 1674 2705

Dimensional data, MLE three phase motors 1 - 10 Hp

P2 [Hp]	Short type designation	Stator housing [inches (mm)]							Shaft end [inches (mm)]	
		P	AB	AF	AF	C	AG	LL	U	AH
1.00 1.50 2.00	MLE90CC-2-56C-G3 MLE90CC-2-56C-G3 MLE90CC-2-56C-G3	7.00 (178)	6.57 (167)	5.20 (132)	5.20 (132)	15.00 (381)	12.95 (329)	10.24 (260)	0.62 (16)	2.06 (52)
3.00	MLE90FA-2-182TC-G3	7.00 (178)	6.57 (167)	5.20 (132)	5.20 (132)	16.05 (408)	13.31 (338)	10.24 (260)	1.12 (28)	2.62 (67)
5.00	MLE112CA-2-184TC-G3	8.66 (220)	7.40 (188)	5.71 (145)	5.71 (145)	18.25 (464)	15.51 (394)	11.81 (300)	1.12 (28)	2.62 (67)
7.50	MLE132DA-2-215TC-G3	8.66 (220)	7.40 (188)	5.71 (145)	5.71 (145)	18.75 (476)	15.51 (394)	11.81 (300)	1.37 (35)	3.12 (79)
10.0	MLE132FA2-215-TC-G3	10.24 (260)	8.39 (213)	5.71 (145)	5.71 (145)	18.07 (459)	14.92 (379)	11.81 (300)	1.37 (35)	3.12 (79)

P2 [Hp]	Short type designation	Flange inches (mm)]							Cable entries [mm]
		LA	AJ	AK	BD	BF	BB	Z	O
1.00 1.50 2.00	MLE90CC-2-56C-G3 MLE90CC-2-56C-G3 MLE90CC-2-56C-G3	0.59 (15)	5.87 (149)	4.5 (114)	6.50 (165)	3/8 "-16	0.16 (4)	0.16 (4)	2xM16 + 1xM25 +2xknock out M16
3.00	MLE90FA-2-182TC-G3	0.75 (19)	7.24 (184)	8.50 (216)	8.50 (216)	1/2"-13	-	0.16 (4)	2xM16 + 1xM25 + 2xknock out M16
5.00	MLE112CA-2-184TC-G3	0.63 (16)	7.24 (184)	8.50 (216)	8.50 (216)	1/2"-13	-	0.16 (4)	2xM16 + 1xM25 + 2xknock out M16
7.50	MLE132DA-2-215TC-G3	0.63 (16)	7.24 (184)	8.50 (216)	8.50 (216)	1/2"-13	-	0.16 (4)	2xM16 +1xM25 + 2xknock out M16
10.0	MLE132FA2-215-TC-G3	0.63 (16)	7.24 (184)	8.50 (216)	8.50 (216)	1/2"-13	-	0.16 (4)	2xM16 + 1xM25 + 2xknock out M16

Dimensional sketch, MLE three phase motors 15 - 30 Hp



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Dimensional data, MLE three phase motors 15 - 30 Hp

P2 [Hp]	Short type designation	Stator housing [inches (mm)]							Shaft end [inches]	
		P	AB	AF	AF	C	AG	LL	U	AH
15	MLE160 254TC	13.39 (340)	12.13 (308)	8.27 (210)	8.27 (210)	22.56 (573)	18.78 (477)	15.75 (400)	1.62 (41)	3.75 (95)
20	MLE160 256TC	13.39 (340)	12.13 (308)	8.27 (210)	8.27 (210)	22.56 (573)	18.78 (477)	15.75 (400)	1.62 (41)	3.75 (95)
25	MLE160 284TSC	13.39 (340)	12.13 (308)	8.27 (210)	8.27 (210)	24.53 (623)	22.72 (577)	15.75 (400)	1.62 (41)	3.75 (95)
30	MLE180 286TSC	13.39 (340)	12.13 (308)	8.27 (210)	8.27 (210)	24.53 (623)	22.72 (577)	15.75 (400)	1.62 (41)	3.75 (95)

P2 [Hp]	Short type designation	Flange [inches (mm)]					Cable entries [mm]
		AJ	AK	BD	BF	BB	O
15	MLE160 254TC	7.25 (184)	8.50 (216)	9.88 (251)	½"	0.26 (7)	1xM40 + 1xM20 + 2xM16 + 2xknock out M16
20	MLE160 256TC	7.25 (184)	8.50 (216)	9.88 (251)	½"	0.26 (7)	1xM40 + 1xM20 + 2xM16 + 2xknock out M16
25	MLE160 284TSC	9.00 (229)	10.50 (267)	10.75 (273)	½"	0.32 (8)	1xM40 + 1xM20 + 2xM16 + 2xknock out M16
30	MLE180 286TSC	9.00 (229)	10.50 (267)	10.75 (273)	½"	0.32 (8)	1xM40 + 1xM20 + 2xM16 + 2xknock out M16

MLE technical data

2 pole

Hp	Short type designation	Voltage [V]	Ph	NEMA frame Size	Service Factor	Motor full load efficiency [%]	Full load current amps ** [A]	Service factor current amps [A]	Power factor	Full load speed [rpm]	Sound pressure level dB(A)
1/2	MLE71AB-2-56C-C	208-230	1	56C	1.0	71.0*	2.8 - 2.5	-	0.96	3400	63
3/4	MLE71BA-2-56C-C	208-230	1	56C	1.0	74.0*	3.9 - 3.5	-	0.97	3400	63
1	MLE80AA-2-56C-C	208-230	1	56C	1.0	76.0*	5.2 - 4.7	-	0.97	3400	62
1	MLE90CC-2-56C-G	460-480	3	56C	1.25	77.0	1.7	2.10	0.73	3500	65
1 1/2	MLE80BA-2-56C-C	208-230	1	56C	1.0	77.0*	7.5 - 6.8	-	0.97	3400	63
1 1/2	MLE90CC-2-56C-G	208-230	3	56C	1.0	82.5	4.35 - 4.05	-	0.94	3480	65
1 1/2	MLE90CC-2-56C-G	460-480	3	56C	1.15	84.0	2.2	2.50	0.83	3480	65
2	MLE90CC-2-56C-G	208-230	3	56C	1.0	84.0	5.75 - 5.25	-	0.95	3460	70
2	MLE90CC-2-56C-G	460-480	3	56C	1.15	85.5	2.7	3.10	0.87	3460	70
3	MLE90FA-2-182TC-G	208-230	3	182TC	1.0	85.5	8.3 - 7.6	-	0.95	3460	70
3	MLE90FA-2-182TC-G	460-480	3	182TC	1.15	86.5	3.7	4.30	0.91	3460	70
5	MLE112CA-2-184TC-G	208-230	3	184TC	1.0	87.5	13.8 - 13.3	-	0.94	3470	75
5	MLE112CA-2-184TC-G	460-480	3	184TC	1.15	88.5	6.1	7.00	0.92	3470	75
7 1/2	MLE132DA-2-215TC-G	208-230	3	215TC	1.0	88.5	20.0 - 18.5	-	0.94	3450	80
7 1/2	MLE132DA-2-215TC-G	460-480	3	215TC	1.15	88.5	8.9	10.3	0.94	3470	80
10	MLE132FA-2-215TC-G	460-480	3	215TC	1.15	89.5	11.6	13.4	0.93	3500	80
15	MLE160AA-2- 254TC-F	460-480	3	254TC	1.15	90.2	18.0	20.6	0.89	3500	68
20	MLE160AB-2- 256TC-F	460-480	3	256TC	1.15	90.2	24.0	27.5	0.89	3540	68
25	MLE160AC-2- 284TC-F	460-480	3	284TC	1.15	91.0	30.5	35.0	0.88	3540	70
30	MLE180AA-2- 286TC-F	460-480	3	286TC	1.15	91.0	36.5	42.0	0.88	3540	70

4 pole

Hp	Short type designation	Voltage [V]	Ph	NEMA frame Size	Service Factor	Motor full load efficiency [%]	Full load current amps ** [A]	Service factor current amps [A]	Power factor	Full load speed [rpm]	Sound pressure level dB(A)
1/3	MLE71AB-4-56C-C	208-230	1	56C	1.0	67.0*	2.0 - 1.9	-	0.94	1690	44
1/2	MLE71BA-4-56C-C	208-230	1	56C	1.0	70.0*	2.8 - 2.5	-	0.96	1690	45
3/4	MLE80AA-4-56C-C	208-230	1	56C	1.0	72.0*	4.0 - 3.7	-	0.96	1690	46
1	MLE80BA-4-56C-C	208-230	1	56C	1.0	73.0*	5.4 - 4.9	-	0.97	1690	49

* This is the combined efficiency of the motor and variable frequency drive.
** At 460 volts for 460-480 volt motors.

PC Tool E-products

Fig. 86 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.

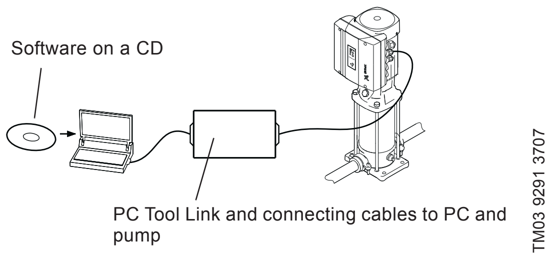


Fig. 87 Complete PC Tool E-products consisting of software and hardware

Purpose and benefits

Connection of the Grundfos PC Tool E-products offers a number of advantages during commissioning,
7
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 [Hp]	**4-pole [Hp]**
0.50 - 1.5	**0.33 - 1.0**
●	●

Three-phase pumps	
2-pole [Hp]	
1.0 - 10	**15 - 30**
●	●

Description

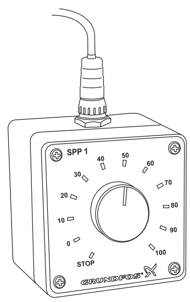
The Grundfos PC Tool E-products can be used by the customer for setting up, commissioning and servicing the E-pump.

12. Accessories

Overview of accessories

R100 remote control

Potentiometer

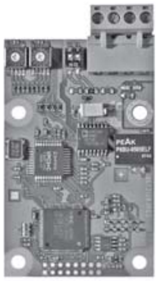


Pressure sensor

DPI sensor

CIU unit

CIM module



LiqTec

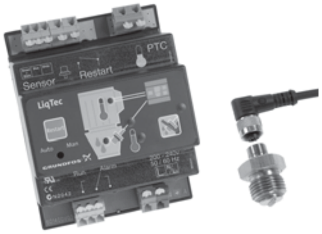
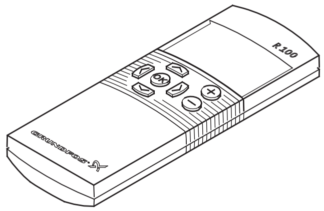


Fig. 88 Examples of accessories

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. 89 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.

An infrared light (IR) transmitter/receiver is located within the unit.

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.

Display

The display is a 1.8 in. x 1.2 in. (46 x 30 mm) graphic (dot matrix) LCD display with 100 x 65 dots.

The graphics appear in blue color on a grey background. The display has yellow back light to facilitate reading.

A countersunk tempered-glass plate protects the display against knocks and scratches.

Product number

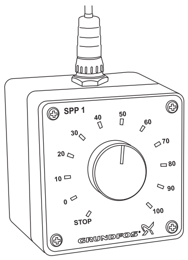
Product	Product number
R100	96615297

Potentiometer

Potentiometer for setpoint setting and start/stop of the pump.

Product number

Product	Product number
External potentiometer with cabinet for wall mounting	415929



TM05 1512 2811

Fig. 90 SPP 1 potentiometer

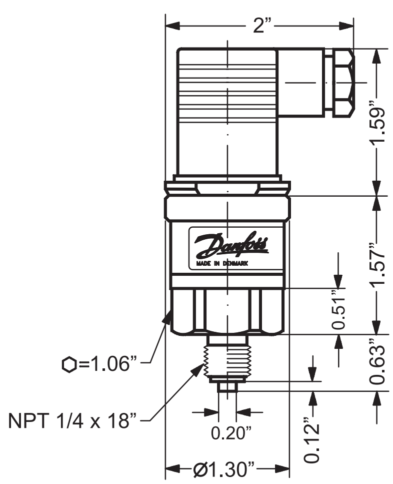
Pressure sensor

Accessory	Type	Supplier	Pressure range [psi (bar)]	Product number
Pressure sensors Pressure Transmitter with 6 ft screened cable Connection: 1/4" - 18 NPT	Danfoss	MBS3000	0 - 87 (0 - 6)	91136169
			0 - 145 (0 - 10)	91136170
			0 - 232 (0 - 16)	91136171
			0 - 362 (0 - 25)	91136172
			0 - 580 (0 - 40)	91136173
			0 - 870 (0 - 60)	91136174

Technical data

Pressure sensor						
Product number	91136169	91136170	91136171	91136172	91136173	91136174
Pressure range [psi (bar)]	0 - 87 (0 - 6)	0 - 145 (0 - 10)	0 - 232 (0 - 16)	0 - 362 (0 - 25)	0 - 580 (0 - 40)	0 - 870 (0 - 60)
Max. operating pressure [psi (bar)]	300 (20.1)	300 (20.1)	750 (51.7)	1450 (100)	2900 (200)	2900 (200)
Supply voltage	9 - 32 VDC					
Output signal [mA]	4 - 20					
Insulation resistance	> 100 MΩ at 100 V					
Accuracy, typical +/- FS [%]	0.5 %					
Response time, max. [ms]	4 ms					
Medium temperature range [°F (°C)]	-40 to +185 °F (-40 °C to +85 °C)					
Ambient temperature range [°F (°C)]	-40 to +185 °F (-40 °C to +85 °C)					
Wetted parts, material	AISI 316L					
Housing material	AISI 316L					
Enclosure rating	IP65					
Weight [lb (kg)]	0.3 (0.14)					
EMC - Emission	EN 61000-6-3					
EMC Immunity	EN 61000-6-2					
Pressure connection	NPT 1/4-18					
CE-marked	EMC protected in accordance with EU EMC Directive					

Dimensions



TM05 1532 2911

Fig. 91 Dimensional sketch

Grundfos differential-pressure sensor, DPI

<table>
<tr><th>Grundfos differential-pressure sensor, DPI</th><th>Pressure range [psi (bar)]</th><th>Product number</th></tr>
<tr><td rowspan="7">• 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 3 Hp and smaller
• 1 M8 screw (self-cutting) for mounting on 5 Hp - 10 Hp
• 1 M10 screw (self-cutting) for mounting on 15 - 25 Hp
• 1 M12 screw (self-cutting) for mounting on 30 Hp
• 3 capillary tubes (short/long)
• 2 fittings (1/4" - 7/16")
• 5 cable clips (black)
• Installation and operating instructions</td><td>0 - 8.7 (0 - 0.6)</td><td>96611522</td></tr>
<tr><td>0 - 14.5 (0 - 1.0)</td><td>96611523</td></tr>
<tr><td>0 - 23 (0 - 1.6)</td><td>96611524</td></tr>
<tr><td>0 - 36 (0 - 2.5)</td><td>96611525</td></tr>
<tr><td>0 - 58 (0 - 4.0)</td><td>96611526</td></tr>
<tr><td>0 - 87 (0 - 6.0)</td><td>96611527</td></tr>
<tr><td>0 - 145 (0 - 10)</td><td>96611550</td></tr>
</table>

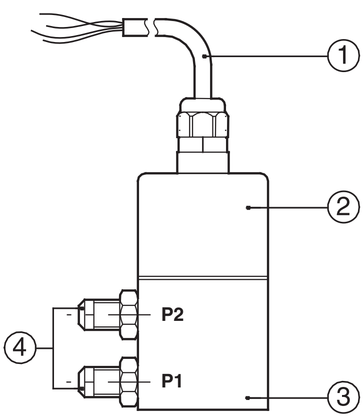
Select the differential-pressure sensor so that the maximum pressure of the sensor is higher than the maximum differential pressure of the pump.

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.

A specially coated silicon chip is used for greater accuracy.



TM03 2057 3505

Fig. 92 DPI sensor

Technical data

Grundfos differential-pressure sensor, DPI							
Product number	96611522	96611523	96611524	96611525	96611526	96611527	96611550
Pressure ranges, differential pressure [psi (bar)]	0 - 8.7 (0 - 0.6)	0 - 14.5 (0 - 1.0)	0 - 23 (0 - 1.6)	0 - 36 (0 - 2.5)	0 - 58 (0 - 4.0)	0 - 87 (0 - 6.0)	0 - 145 (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 [psi (bar)]	232 (16)						
Rupture pressure [bar]	1.5 x system pressure						
Measuring accuracy	2.5 % BFSL						
Response time	< 0.5 seconds						
Liquid temperature range	+14 °F to +158 °F (-10 °C to +70 °C)						
Storage temperature range	-40 °F to +176 °F (-40 °C to +80 °C)						
Electrical connection	26 GA, 3 ft 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 [lb]	1.2						
EMC (electromagnetic compatibility)	According to EN 60335-1						
Emission/immunity	According to EN 61800-3						
Connections	7/16"-UNF						
Sealing material	FKM						

Dimensions

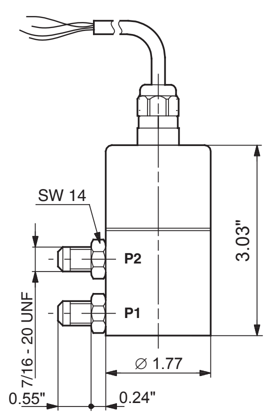


Fig. 93 Dimensional sketch

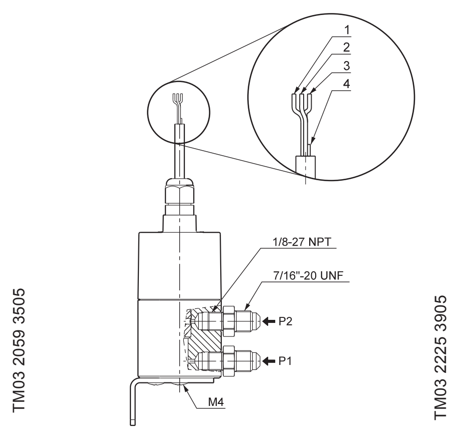


Fig. 94 Wiring

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

CIU communication interface units

TM04 2594 1008

Fig. 95 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.

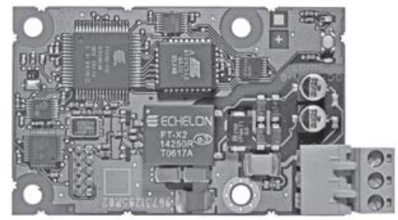
CIU 300

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. 96 Grundfos CIM module

The CIM modules enable communication of operating data, such as measured values and setpoints, between E-pumps of 15 - 30 Hp and a building management system.

The CIM modules are add-on communication modules which are fitted in the MLE terminal box.

Note: CIM modules must be fitted by authorized 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 (+266 °F ±9 °F (130 °C ± 5 °C)).
- Has a fail-safe design. If the sensor, sensor cable, electronic unit or power supply fails, the pump stops immediately.
- The LiqTec is **not** to be used with the MGFlex motor.

Mounting the LiqTec sensor

The LiqTec can be fitted to a DIN rail to be incorporated in a control cabinet.

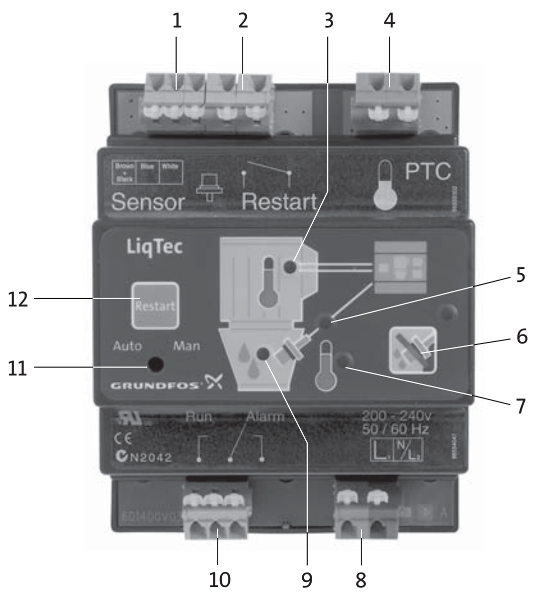
Electrical connection

Example of electrical connection, see page 88.

Calibration of sensor and controller

Follow the procedure on the next page.

Functions



TM03 0111 4004

Fig. 97 LiqTec functions

1. **Connection for dry-running sensor**
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 variable frequency drive 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 (+266 °F ±9 °F (130 °C ± 5 °C)).
   The alarm relay is activated.
8. **Supply voltage**
   200-240 VAC, 50/60 Hz and 80-130 VAC 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	Connect the sensor to pos. 1 on Controller and connect the power supply to pos. 8 on the Controller. See page 88.	
2	Submerge the sensor into the pumped liquid. The pumped liquid and the air temperature are to be +70 °F. **Note:** It is important that the pumped liquid is stagnant as the calibration will be misleading if the sensor is cooled by flowing water.	
3	Press the buttons at pos. 6 and pos. 12 on the Controller for approximately 20 seconds.	All red indicator lights (except pos. 7) start flashing.
4	When the green indicator lights at pos. 3 and pos. 9 on the Controller are constantly on, release the buttons at pos. 6 and pos. 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: 580 psi (40 bar).

Maximum liquid temperature: (+266 °F ±9 °F (130 °C ± 5 °C)).

Maximum ambient temperature: +131 °F (+55 °C).

Power consumption: 5 Watt.

Enclosure class: IPX0.

Maximum cable length: 65.6 ft (20 meters).

Standard cable: 16.4 ft (5 meters).

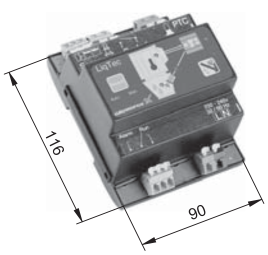
Extension cable: 49.2 ft (15 meters).

Note:

The LiqTec is not be connected to the PTC sensor. Assemble a jumper wire between the two terminals at pos. 4 on the Controller.

The MLE motor software provides protection against high motor temperature.

The LiqTec is designed for DIN rail mounting in a control cabinet.

Dry-running protection	Single phase power supply	LiqTec	Sensor 1/2"	Cable 16.4 ft (5 m)	Extension cable 49.2 ft (15 m)	Product number
	200-240 VAC	●	●	●	-	96556429
	80-130 VAC	●	●	●	-	96556430
	-	-	-	-	●	96443676
	-	-	●	●	-	96556427

TM02 1731 2001

Connection of E-pump to LiqTec

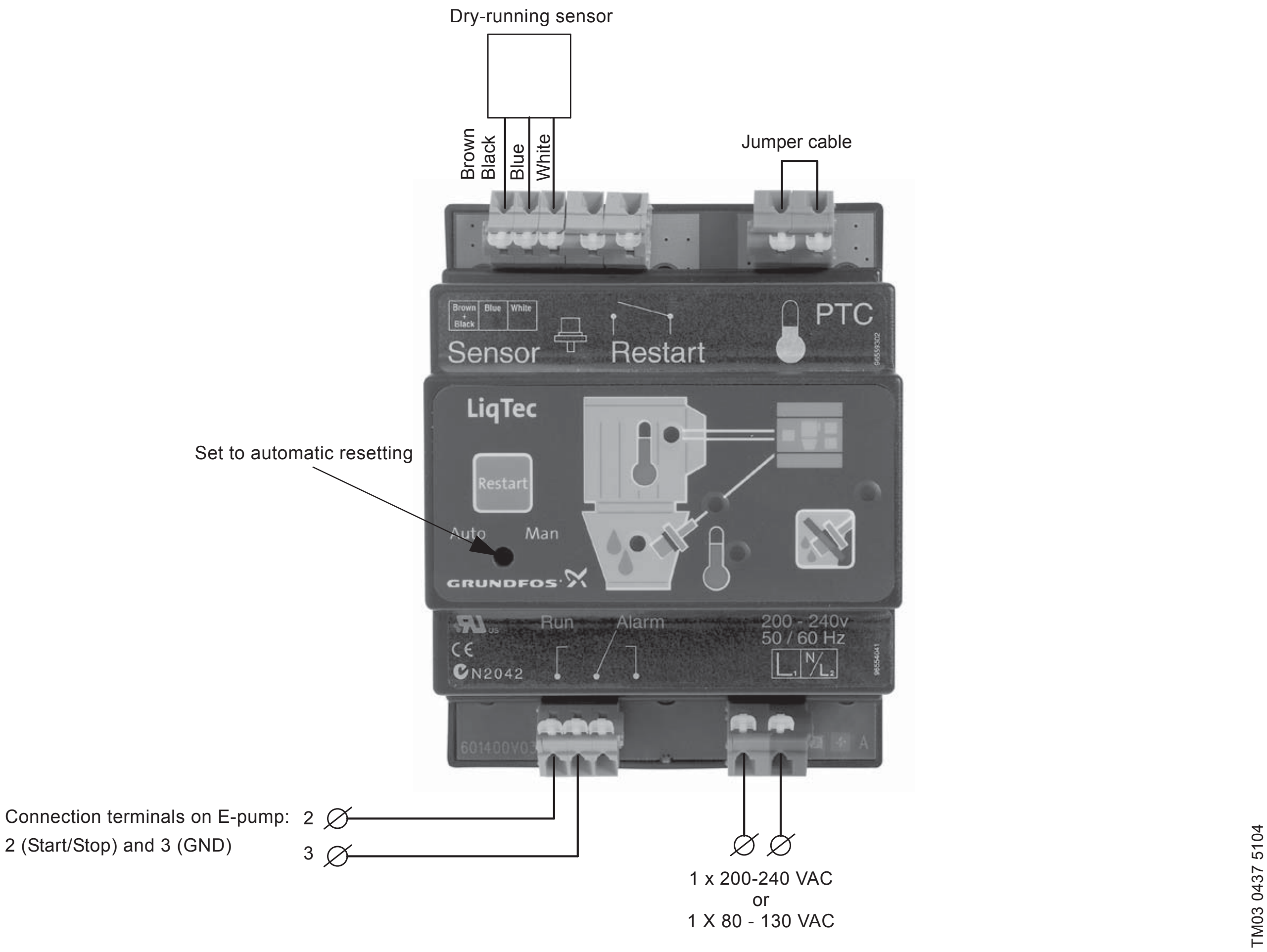
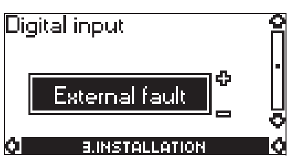


Fig. 98 Connection of E-pump to LiqTec

Setting the digital input

The digital input must be set to "External fault" via the R100.



Note: After dry-running fault, the E-pump must be restarted manually.

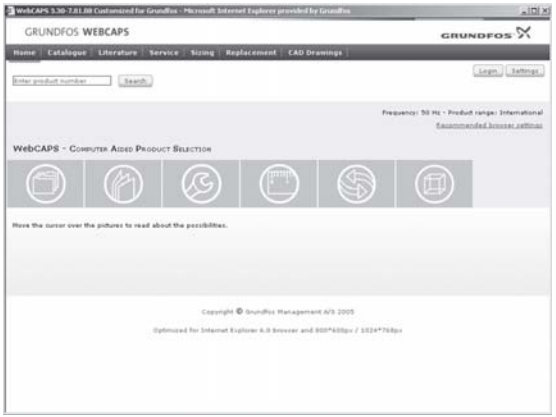
Disposal

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

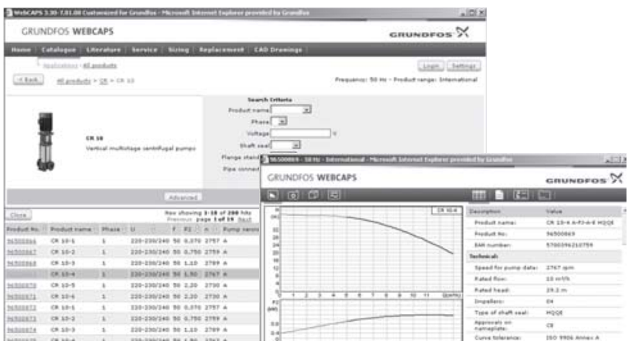


WebCAPS is a **Web**-based **C**omputer **A**ided **P**roduct **S**election program available on www.grundfos.com.

WebCAPS contains detailed information on more than 185,000 Grundfos products in more than 20 languages.

In WebCAPS, all information is divided into 6 sections:

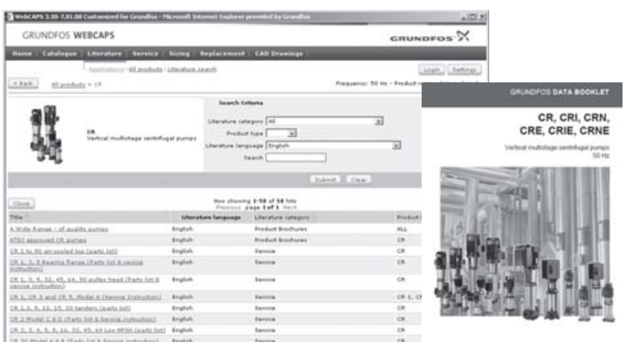
- Catalog
- Literature
- Service
- Sizing
- Replacement
- CAD drawings.



Catalog

This section is based on fields of application and pump types, and contains

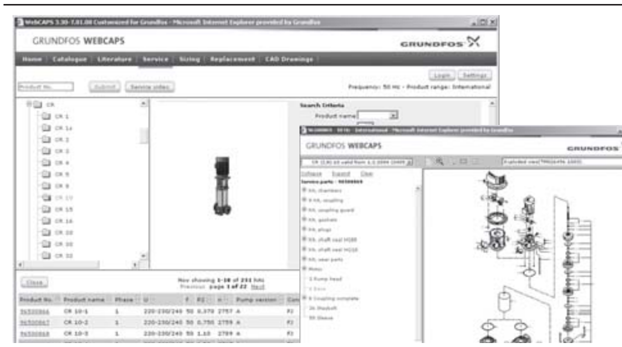
- technical data
- curves (QH, Eta, P1, P2, etc) which can be adapted to the density and viscosity of the pumped liquid and show the number of pumps in operation
- product photos
- dimensional drawings
- wiring diagrams
- quotation texts, etc.



Literature

In this section you can access all the latest documents of a given pump, such as

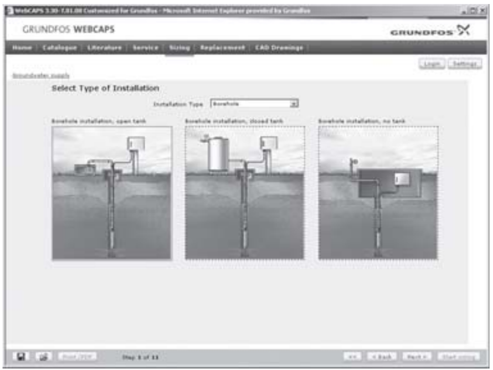
- product guides
- installation and operating instructions
- service documentation, such as Service kit catalog and Service kit instructions
- quick guides
- product brochures, etc.



Service

This section contains an easy-to-use interactive service catalog. Here you can find and identify service parts of both existing and discontinued Grundfos pumps.

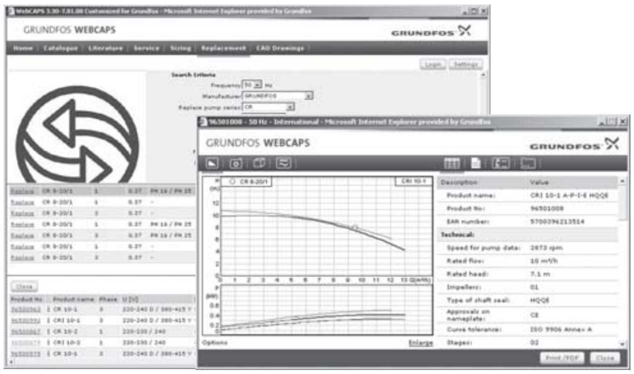
Furthermore, this section contains service videos showing you how to replace service parts.



Sizing

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

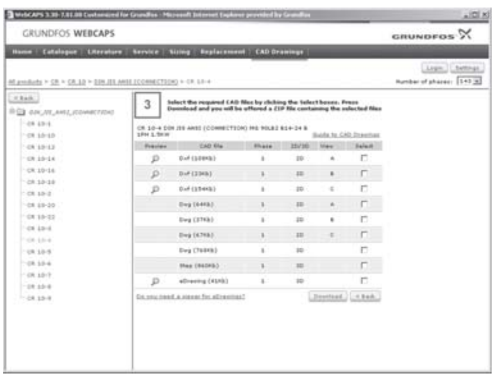
- select the most suitable and efficient pump for your installation
- carry out advanced calculations based on energy consumption, payback periods, load profiles, life cycle costs, etc.
- analyse your selected pump via the built-in life cycle cost tool
- determine the flow velocity in wastewater applications,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

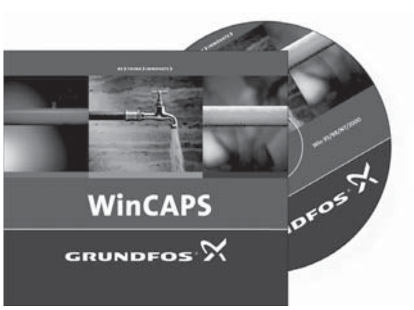
In this section it is possible to download 2-dimensional (2D) and 3-dimensional (3D) CAD drawings of most Grundfos pumps.

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



WinCAPS CD-ROM

WinCAPS is a **Win**dows-based **C**omputer **A**ided **P**roduct **S**election program containing detailed information on more than 185,000 Grundfos products in more than 20 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.

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BE > THINK > INNOVATE >

Being responsible is our foundation
Thinking ahead makes it possible
Innovation is the essence

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