

SQFlex

Renewable-energy based
water supply systems
50/60 Hz



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1. Product data

Introduction

The SQFlex system is a reliable water supply system based on renewable energy sources, such as solar and wind energy. The SQFlex system incorporates an SQF submersible pump.

Very flexible as to its energy supply and performance, the SQFlex system can be combined and adapted to any need according to the conditions on the installation site.

The system components are

- SQF submersible pump
- CU 200 SQFlex control unit
- IO 50 SQFlex switch box
- IO 101 SQFlex switch box
- IO 102 SQFlex breaker box
- charge controller
- energy supply:
 - solar panels
 - wind turbine
 - generator
 - batteries.

SQF submersible pump

The SQF pump range comprises two pump technologies:

- the helical rotor pump (3") for high heads and small flows.
- the centrifugal pump (4") for low heads and large flows.

The performance curves in fig. 1 illustrates the pump performance for the two pump models.

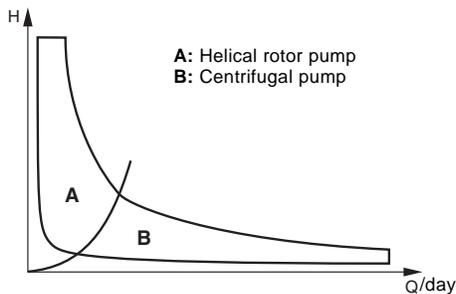
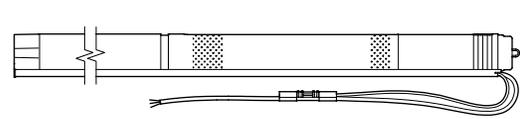


Fig. 1 Performance ranges for helical rotor and centrifugal pumps

The SQF pump is available as a complete unit only.

The SQF pump complete comprises:

- motor
- 6 ft (1.8 m) cable with water level electrode and socket
- cable guard.



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Fig. 2 SQF pump

Pump type	Pump size	Product number
3 SQF 2	3"	95027332
3 SQF 3	3"	95027333
6 SQF 2	3"	95027334
6 SFQ 3	3"	96834840
11 SQF 2	3"	95027335
16 SQF 10	4"	95027350
25 SQF 3	4"	95027351
25 SQF 7	4"	95027353
40 SQF 3	4"	95027354
40 SQF 5	4"	95027355
60 SQF 3	4"	95027443

Currently the complete range consists of six centrifugal pumps and five helical rotor pumps. The centrifugal pumps are adapted from Grundfos' present 4" SP range (16S, 25S, 40S, and 60S). These pumps are used when lower heads and higher flow rates are required.

The positive displacement helical pump ends are 3" in diameter and available in five models ranging from 3 to 11 gpm (0.68 to 2.50 m³/h). These are designed for higher head and lower flow requirements. The pump rotor is a single-twisted helix (spiral) made of hard-chromium plated stainless steel. During operation, the rotor rotates eccentrically in a double helical elastic stator.

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Motor

The motor has been developed specifically for the SQFlex system and is designed according to the permanent-magnet principle with built-in electronic unit and is available in only two sizes.

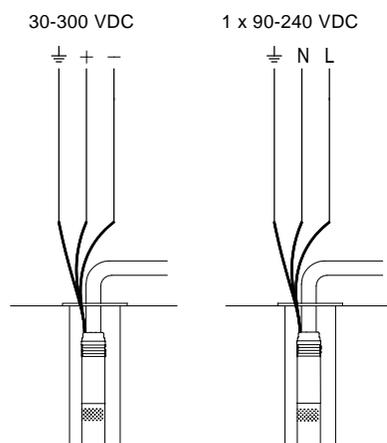
The motor speed range is 500-3600 rpm, depending on power input and load.

The motor is constructed in 304 stainless steel.

Max. ratings are as follows:

- Maximum power input (P_1) of 1400 W
- maximum current of 8.4 A
- maximum speed of 3600 rpm

The pump delivers its maximum performance when one of the above parameters is reached.



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Fig. 3 Wiring diagram

The motor is to be connected to the power supply as shown in fig. 3.

As the integrated electronic unit enables the motor to handle both DC and AC supply voltages, it makes no difference how the wires "+" and "-" or "N" and "L" are connected.

Supply voltage

Flexible as regards power supply and power range, the motor can be supplied with either DC or AC voltage:

- 30-300 VDC, PE
- 1 x 90-240 V -10% / $+6\%$, 50/60 Hz, PE.

CU 200 SQFlex control unit

The CU 200 is a combined status and control unit for the SQFlex pump system. Moreover, the CU 200 enables connection of a level switch placed in a water reservoir or tank.

IO 50 SQFlex switch box

The IO 50 is an on/off switch box designed for opening and closing the system power supply.

IO 101 SQFlex switch box

The IO 101 is an on/off switch box designed for opening and closing the system power supply and is used in solar-powered SQFlex systems with a back-up generator.

IO 102 SQFlex breaker box

The IO 102 is an on/off breaker box designed for opening and closing the system power supply and is used in wind-powered SQFlex systems or wind- and solar-powered SQFlex systems.

The IO 102 makes it possible to slow down or stop the wind turbine.

Charge controller

The charge controller is used when a battery backup system is installed with an SQFlex pumping system.

Solar modules

Grundfos' solar modules have been developed specifically for the SQFlex system. The solar modules are equipped with plugs and sockets enabling easy connection in series or parallel.

For further information on solar modules, please contact your local Grundfos company.

Generator

In case the power supply from its primary source of energy is temporarily insufficient or unavailable, the SQFlex system can be powered by a generator.

Batteries

The SQFlex system can be powered by batteries with a voltage supply of 30-300 VDC, maximum current 8.4 A.

Applications

Being designed for continuous as well as intermittent operation, the SQFlex system is especially suitable for water supply applications in remote locations, such as

- villages, schools, hospitals, single-family houses, etc.
- farms
 - watering of cattle
 - irrigation of fields and greenhouses
- game parks and game farms
 - watering applications
- conservation areas
 - surface water pumping
 - floating pump installations for pumping of water from ponds and lakes.

Pumped liquids

SQF pumps are applicable in thin, clean, non-aggressive, non-explosive liquids, not containing solid or long-fibered particles larger than sand grains.

pH value: 5 to 9.

Liquid temperature: +32 °F to +104 °F (0 °C to +40 °C)

The pump can run at free convection (~ 0 ft/s) at maximum 104 °F (+40 °C).

Sand content

Maximum sand content: 50 ppm.

A higher sand content will reduce the pump life considerably due to wear.

Salt content (chloride ions Cl⁻)

The table below shows the resistance of stainless steel to Cl⁻. The figures in the table are based on a pumped liquid with a pH value of 5 to 9.

Stainless steel AISI	Cl ⁻ content [ppm]	Liquid temperature [°F (°C)]
304	0-300	< 104 (40)
	300-500	< 86 (30)

Features and benefits

Dry-running protection

The SQF pump is protected against dry running in order to prevent damage to the pump. The dry-running protection is activated by a water level electrode placed on the motor cable 12-24 in. (.3 to .6 m) above the pump, depending on pump type.

The water level electrode measures the contact resistance to the motor sleeve through the water. When the water level falls below the water level electrode, the pump will be cut out. The pump will automatically cut in again 5 minutes after the water level is above the water level electrode.

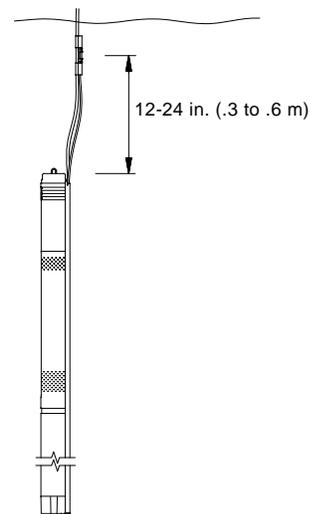


Fig. 4 Vertical installation

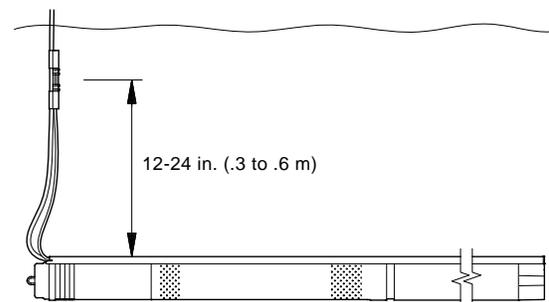


Fig. 5 Horizontal installation

High efficiency

The MSF 3 motor is a permanent-magnet motor (PM motor) featuring a higher efficiency within the power range compared to a conventional asynchronous motor.

In addition to this, the segmented motor stator contributes considerably to the high efficiency.

The MSF 3 motor is furthermore characterized by a high locked-rotor torque even at low power supply.

Overvoltage and undervoltage protection

Overvoltage and undervoltage may occur in case of unstable power supply or a faulty installation.

The pump will be cut out if the voltage falls outside the permissible voltage range. The motor is automatically cut in when the voltage is again within the permissible voltage range. Therefore no extra protection relay is needed.

Note: The MSF 3 motor is protected against transients from the power supply according to IEC 60664-1 "overvoltage category III" (4 kV). In areas with high lightning intensity, external lightning protection is recommended.

Overload protection

In case the upper load limit is exceeded, the motor will automatically compensate for this by reducing the speed. If the speed falls below 500 rpm, the motor will be cut out automatically.

The motor will remain cut out for 10 seconds after which period the pump will automatically attempt to restart.

The overload protection prevents burnout of the motor. Consequently, no extra motor protection is required.

Overtemperature protection

A permanent-magnet motor gives off very little heat to its surroundings. In combination with an efficient internal circulation system leading the heat away from the rotor, stator and bearings, this fact ensures optimum operating conditions for the motor.

As an extra protection, the electronic unit has a built-in temperature sensor. When the temperature rises above 185 °F (85°C), the motor is automatically cut out. When the temperature has dropped to 165 °F (73 °C), the motor is automatically cut in again.

Maximum Power Point Tracking (MPPT)

The built-in electronic unit gives the SQFlex system a number of advantages compared to conventional products. One of these advantages is the built-in microprocessor with MPPT (MPPT = **Maximum Power Point Tracking**).

Thanks to the MPPT-function, the pump duty point is continuously optimized according to the input power available. MPPT is only available for pumps connected to DC supply.

Wide voltage range

The wide voltage range enables the motor to operate at any voltage from 30-300 VDC or 90-240 VAC. This makes installation and sizing especially easy.

Built-in sand shield

The built-in sand shield prevents sand damage to the pump and motor by slinging it out through the oval slots located at the base of the pump end.

Reliability

The MSF 3 motor has been developed with a view to high reliability achieved through the following features:

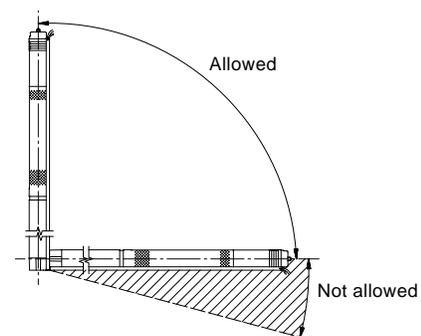
- carbon/ceramic bearings
- excellent starting capabilities
- various protection facilities.

Simple installation

The following features ensure simple installation of the SQF pump:

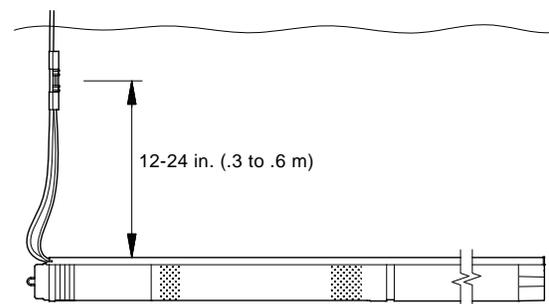
- low weight ensuring user-friendly handling
- installation in 3", 4" or larger boreholes
- only an on/off switch is needed, which means that no extra motor starter / starter box is necessary.

Note: Horizontal installation requires the water level electrode to be placed above the pump to ensure the dry-running protection.



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Fig. 6 Installation of SQF pumps



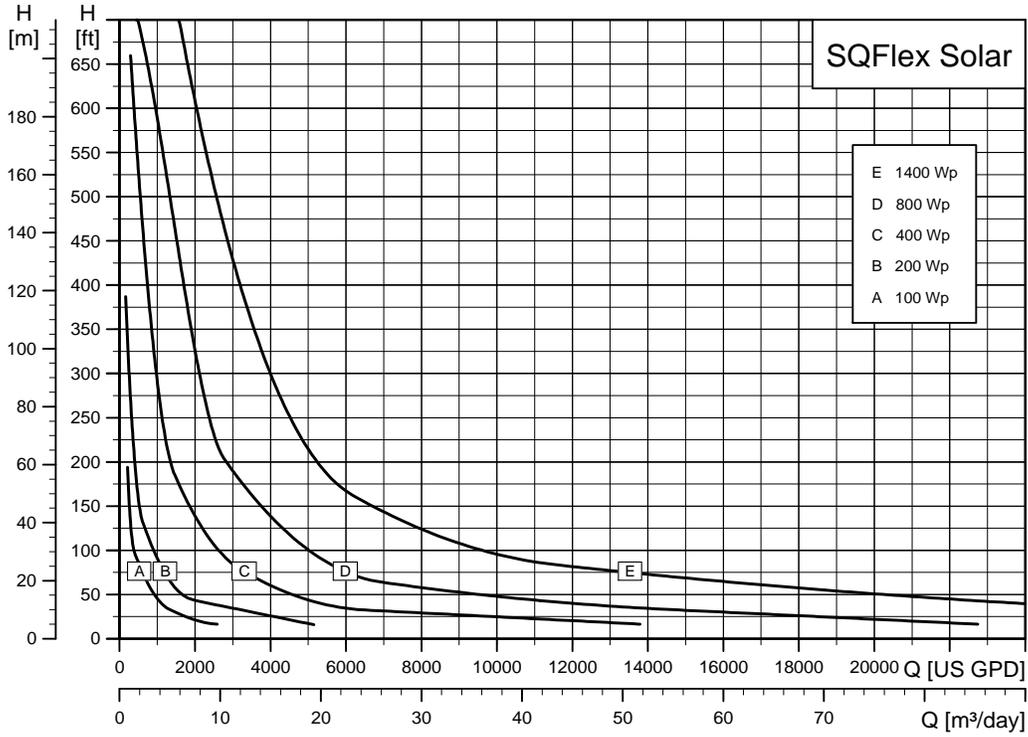
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Fig. 7 Horizontal installation

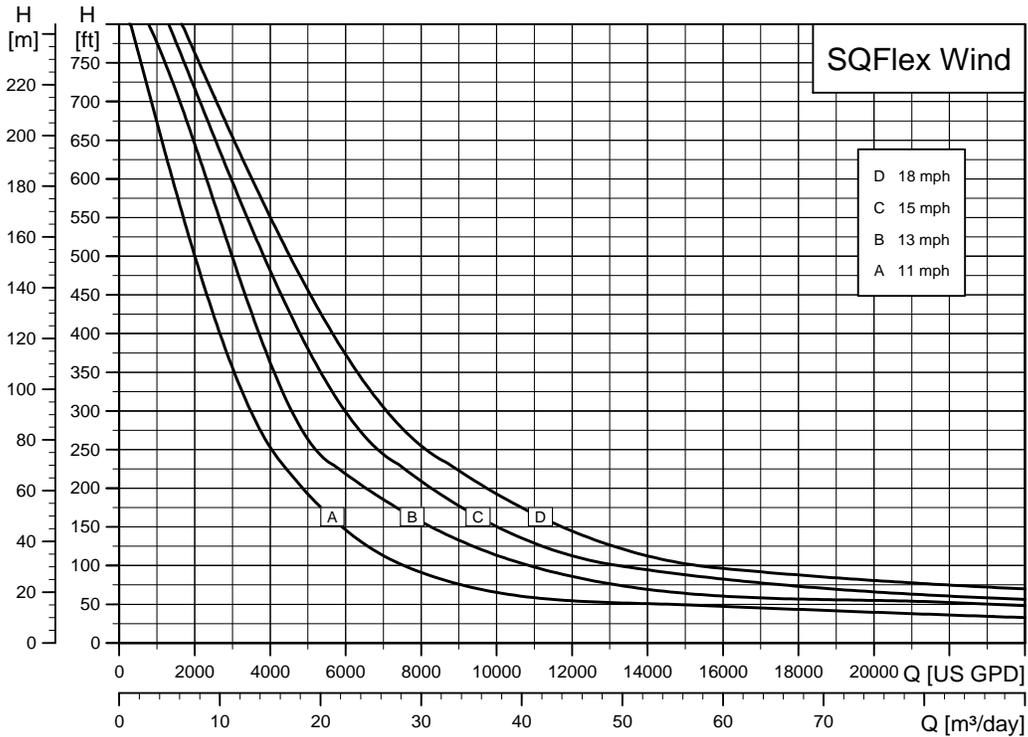
Ease of service

The modular pump and motor design facilitates installation and service. The cable and the end cover with socket are fitted to the pump with screws which enable replacement.

Performance range



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Note: The curves must not be used as guarantee curves.

System overview

The SQFlex system can be used in a number of combinations as shown in the table below.

System	consists of the following components							
	Pump	Solar panels ★	Wind turbine	Generator/ battery/ power supply	Charge controller	Switch box or breaker box	Control unit	Additional extras
SQFlex Solar See page 14.								
SQFlex Solar - with CU 200 and level switch See page 15.								 (★★)
SQFlex Solar - with back-up generator See page 16.								
SQFlex Solar - with back-up batteries See page 17.						 IO 50 or IO 101 (★★)		 Pressure tank  Pressure switch
SQFlex Wind See page 18.								
SQFlex Wind - with CU 200 and level switch See page 19.								 (★★)
SQFlex Combo - combination of solar and wind energy See page 20.								
SQFlex Combo - with CU 200 and level switch See page 21.								 (★★)
SQFlex system - with generator as power supply See page 22.								

★ For number of solar modules required, please consult the sizing tool in Grundfos WinCAPS/WebCAPS.

★★ Optional.

Identification

Type key for helical rotor pumps

Example	6 SQF -2
Rated flow at 3000 rpm [gpm]	
Type range	
Number of stages	

Type key for centrifugal pumps

Example	25 SQF -3
Rated flow of corresponding SP pump [gpm]	
Type range	
Number of stages	

2. Construction

Material specification, helical rotor pump

Pos.	Component	Material	SQF	
				AISI
1	Valve casing	Polyamide		
1a	Discharge chamber	Stainless steel	304	
1d	O-ring	NBR		
2	Valve cup	Polyamide		
3	Valve seat	NBR		
6	Flange, upper	Stainless steel	304	
7a	Circlip	Stainless spring steel	310	
9	Pump stator	Stainless steel/EPDM	304	
13	Pump rotor	Stainless steel	304	
16	Torsion shaft	Stainless steel	316	
39	Valve spring	Stainless spring steel	316 LN	
55	Outer sleeve	Stainless steel	304	
70	Valve guide	Polyamide		
159c	Sand shield	Polyamide		
	Cable guard	Stainless steel	304	
	Screws for cable guard	Stainless steel	316	

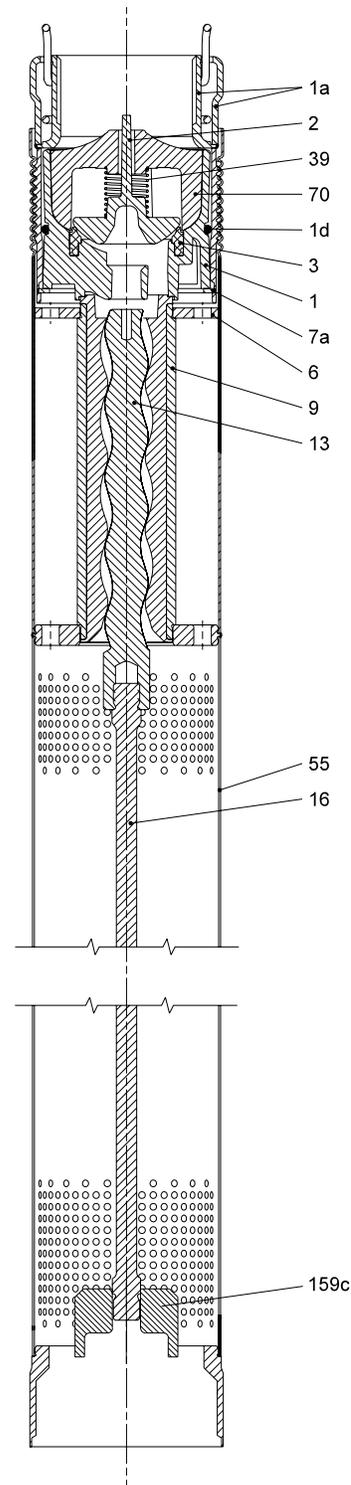


Fig. 8 Example: 6 SQF-2

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Material specification, centrifugal pump

Pos.	Component	Material	SQF	
				AISI
1	Valve casing	Stainless steel	304	
4	Chamber, top	Stainless steel	304	
6	Top bearing	NBR		
7	Neck ring	NBR/PPS		
8	Bearing	NBR		
9	Chamber, complete	Stainless steel	304	
11	Nut for split cone	Stainless steel	304	
12	Split cone	Stainless steel	304	
13	Impeller	Stainless steel	304	
14	Inlet part	Stainless steel	304	
14a	Connecting piece, complete (MSF 3 adapter)	Stainless steel	304	
15	Strainer	Stainless steel	304	
16	Shaft, cylindrical	Stainless steel	431	
17	Strap	Stainless steel	304	
18	Cable guard, pump	Stainless steel	304	
18c	Cable guard, motor	Stainless steel	304	
19	Nut for strap	Stainless steel	304	
19a	Nut	Stainless steel	316	
24	Coupling with nut	Stainless steel	329	
24a	Supporting ring	Stainless steel	316	
24b	Spline protector	NBR		
25	Retainer for neck ring, complete	Stainless steel	304	
85	Stop ring (only 25 SQF and 60 SQF)	Carbon/graphite PTFE		
	Screws for cable guard	Stainless steel	316	

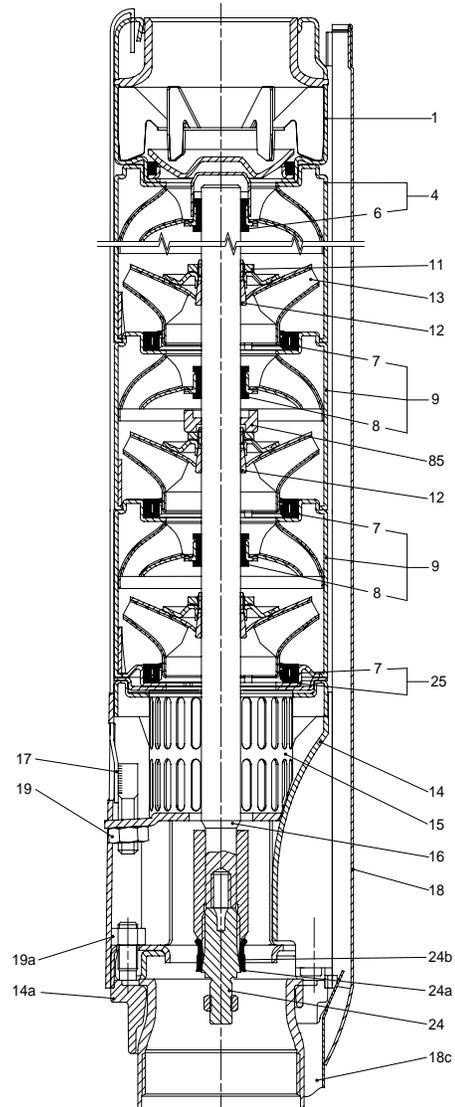


Fig. 9 Example: 60 SQF-3

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Material specification, motor

Pos.	Component	Material	MSF 3	
				AISI
201	Stator with sleeve, complete	Stainless steel		304
202	Rotor	Stainless steel		304
202a	Stop ring	PP		
202c	Shaft end	Stainless steel		316
203	Thrust bearing, stationary	Stainless steel/carbon		316
205	Bearing plate with radial bearing	Silicon carbide		304
206	Thrust bearing, rotating	Stainless steel/aluminium oxide Al_2O_3		316
220	Motor cable with plug			
222a	Filling plug	NBR		
223	Electronic unit			
224	O-ring	NBR		
225	Top cover	NBR		
232	Shaft seal	NBR		
243	Thrust-bearing housing	Stainless steel		316
	Four screws (M4)	Stainless steel		316

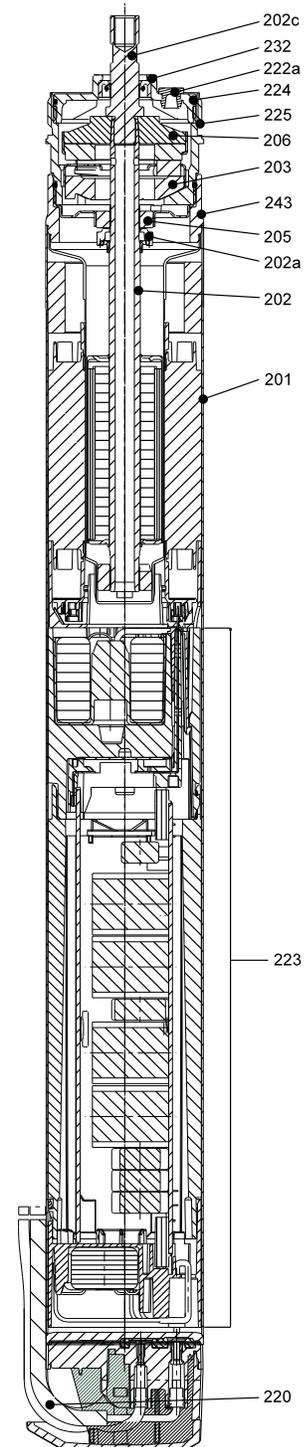


Fig. 10 MSF 3

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3. Selection

Sizing of SQFlex system

Grundfos has developed a PC-based sizing tool enabling the sizing of SQFlex systems.

The sizing tool is integrated in Grundfos WinCAPS and covers both solar- and wind-powered systems. Visit Grundfos.com to use WebCAPS, our online version of WinCAPS.

The following three parameters must be known for the sizing of the optimum SQFlex system:

- installation location
- maximum head required
- quantity of water required.

With a view to the sizing of a correct solar-powered SQFlex system, the world has been divided into six regions:

- North America
- South America
- Australia/New Zealand
- Asia/Pacific
- Southern Africa
- Europe/Middle East/Northern Africa.

Each region is divided into a number of zones according to the solar radiation in kWh/m² per day.

Voltage effect on pump efficiency

The pump efficiency can vary quite a bit depending on input voltage. This chart shows the dropoff in efficiency as the voltage gets lower. For example, if you have two systems with the exact same wattage rating, but System A is running at 120V and System B is running at 35V, System A will produce 20 % more water than System B.

SQ Flex optimal efficiency	
Panel output voltage	(% loss in gallons/day)
120V - 300V	- 0 %
90V	- 5 %
60V	- 10 %
35V	- 20 %

Application examples

SQFlex Solar

The SQFlex Solar system is the simplest of the range of SQFlex systems.

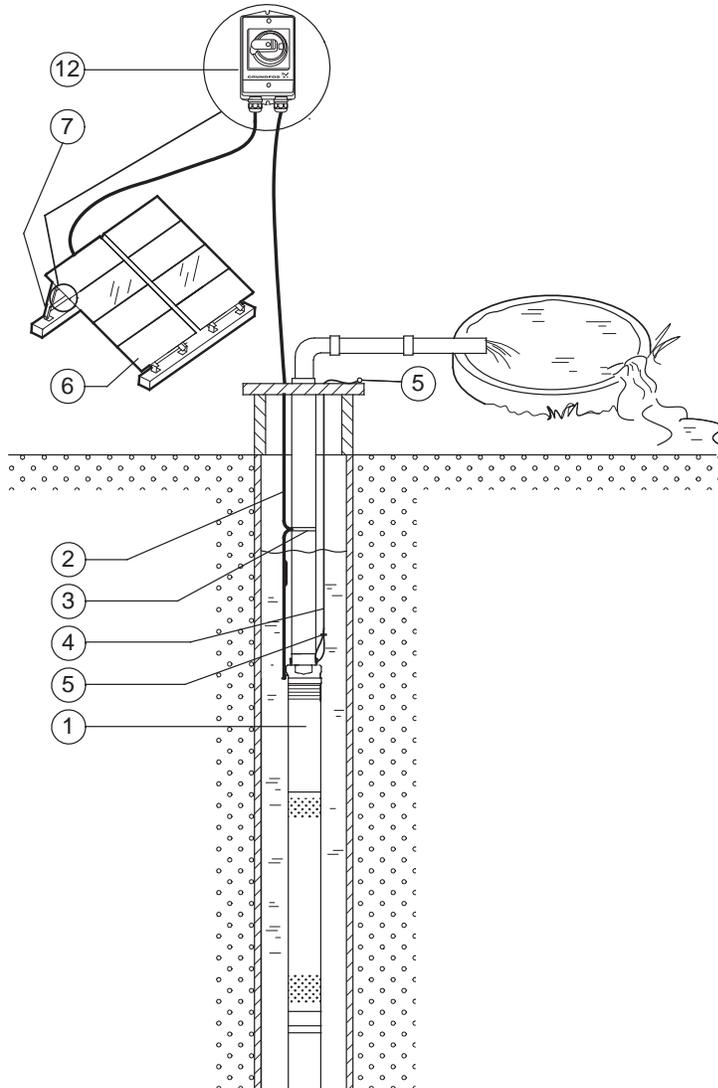
Benefits

- Easy to install
- Maintenance confined to periodic cleaning of the solar panels
- Few and simple components.

The protective circuit incorporated in the motor electronic unit cuts out the pump in case of dry running or similar situations.

By using the IO 50, the power supply to the pump can be closed manually, for example when

- there is no need for water supply
- the system requires service.



- 1 SQF pump
- 2 Submersible drop cable
- 3 Cable clips
- 4 Straining wire
- 5 Wire clamp
- 6 Solar panels
- 7 Support structure
- 12 IO 50 SQFlex switch box

Note: For the number of solar modules required, please consult the sizing tool in Grundfos WinCAPS.

Fig. 11 SQFlex Solar

SQFlex Solar

- with CU 200 and level switch

The SQFlex Solar system allows solar energy to be stored as water in a reservoir.

SQFlex Solar water supply systems with a water reservoir are used where

- there is a need for water supply at night
- for short periods, the solar energy is insufficient to run the pump
- there is a need for a back-up water source.

Benefits

Combined with the CU 200, the level switch acts as a pump cut-out function when the water reservoir is full.

The CU 200 offers indication of

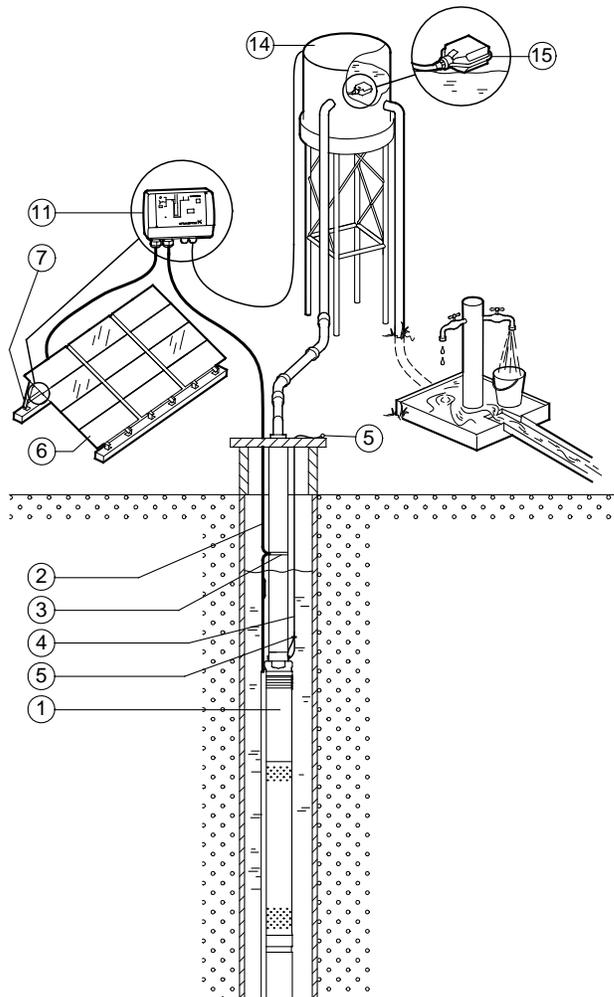
- full water reservoir (level switch activated)
- pump operation
- input power.

The CU 200 indicates operational stoppage in case of

- dry running
- service (see page 35)
- insufficient energy supply.

In addition, the system features

- easy installation
- maintenance confined to periodic cleaning of the solar panels.



- 1 SQF pump
- 2 Submersible drop cable
- 3 Cable clips
- 4 Straining wire
- 5 Wire clamp
- 6 Solar panels
- 7 Support structure
- 11 CU 200 SQFlex control unit
- 14 Water reservoir
- 15 Level switch

Note: For the number of solar modules required, please consult the sizing tool in Grundfos WinCAPS.

Fig. 12 SQFlex Solar with CU 200 and level switch

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SQFlex Solar

- with back-up generator

During periods of limited solar energy, the SQFlex Solar water supply system provides reliable water supply. The system is connected to an external back-up generator via the IO 101.

The system switches automatically to operation

- via generator when
 - the energy supply from the solar panels is insufficient
- via solar panels when
 - the generator is stopped manually or
 - the generator runs out of fuel.

Benefits

The system offers water supply during the night or during periods of insufficient solar energy.

Other benefits of the system include

- easy to install
- maintenance confined to periodic cleaning of the solar panels
- few and simple components
- flexible in terms of energy supply.

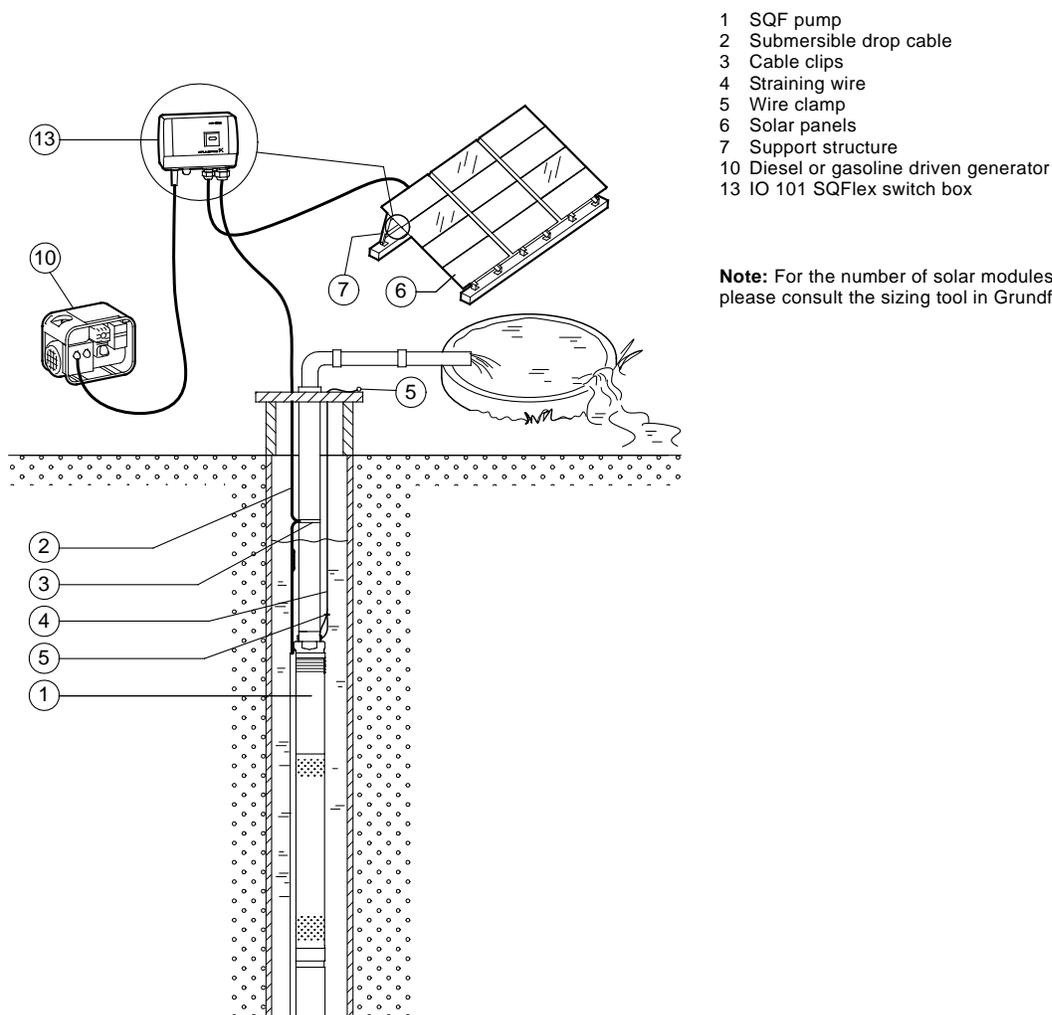


Fig. 13 SQFlex Solar with back-up generator

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SQFlex Solar

- with back-up batteries

During periods of limited solar energy, the SQFlex Solar system provides reliable water supply.

The supply of water is ensured by back-up batteries connected to the system via the charge controller.

The system is connected as shown in fig. 14.

- Power will be provided by the solar panels wired to produce 48-110 VDC (rated).
- Power from the solar panels will feed into a 48 VDC charge controller, which will regulate the current fed to the batteries.
- From the charge controller, power passes into the battery bank, which consists of the number of appropriately sized batteries, wired in series to achieve 48 VDC (rated) output.

- Power is drawn from the battery bank and routed through a CU 200.

Option: An IO 50 or IO 101 is to be installed to enable disconnection of the DC voltage.

If an IO 101 is installed, it is possible to add a generator to the system.

- Power is run from the CU 200 to the SQFlex pump.

Benefits

The system offers water supply during the night or during periods of insufficient solar energy.

Other benefits of the system include

- easy installation
- a minimum of maintenance
- few and simple components
- flexibility in terms of energy supply.

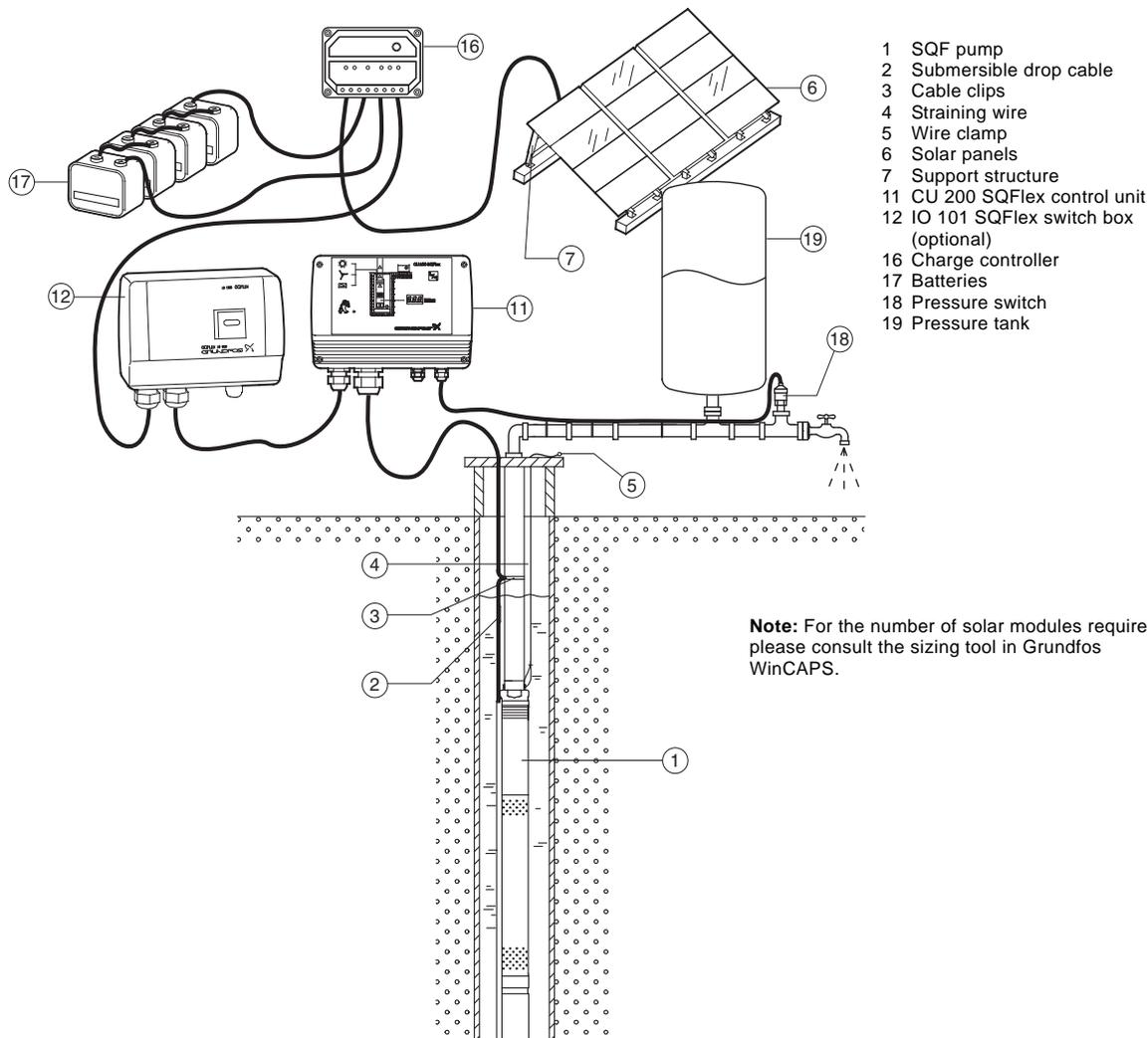


Fig. 14 SQFlex Solar with back-up batteries

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SQFlex Wind

The SQFlex Wind system is based on wind energy as the only energy source for pump operation.

The system is suitable for installation in areas where the wind is almost constant seen over a period of time.

As the turbine noise level increases with the wind speed, installation of the wind turbine near a residence is not recommended.

The IO 102 makes it possible to slow down the wind turbine when

- there is no need for water supply
- the system requires service.

Benefits

- Easy to install
- A minimum of maintenance
- Few and simple components

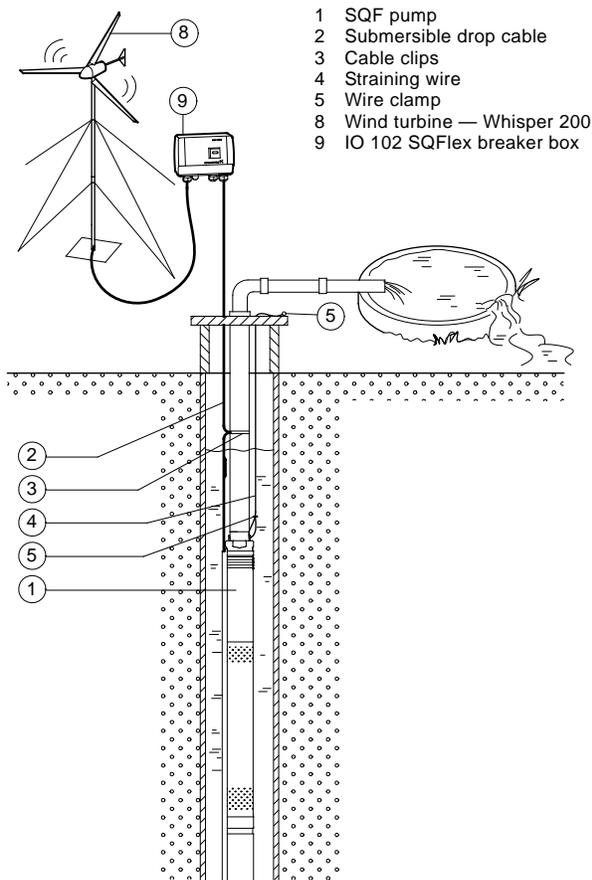


Fig. 15 SQ FlexWind

Proper siting for wind turbines

For proper wind siting you must locate your Whisper wind turbine 20 ft (6 m) above any surrounding object within a 250 ft (76 m) (radius as shown in fig. 16).

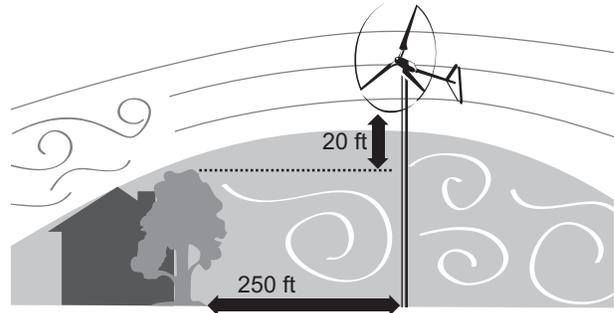
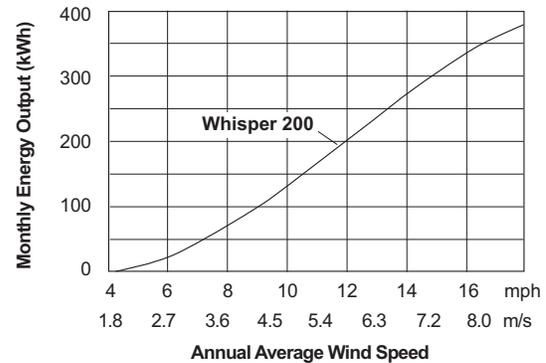
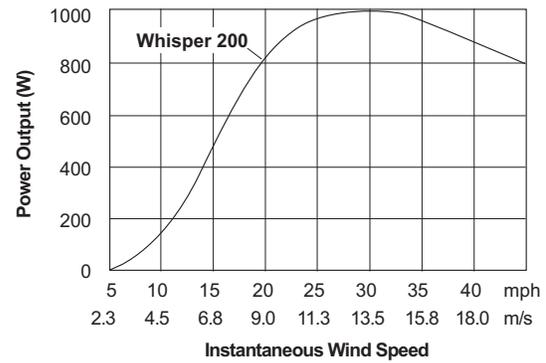


Fig. 16 Proper wind turbine siting

Wind turbine performance curves



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SQFlex Wind

- with CU 200 and level switch

The SQFlex Wind system allows wind energy to be stored as water in a reservoir.

SQFlex Wind water supply systems with a water reservoir are used where

- for short periods, the wind energy is insufficient to run the pump
- there is a need for a back-up water source.

As the turbine noise level increases with the wind speed, installation of the wind turbine near a residence is not recommended.

Benefits

Combined with the CU 200, the level switch acts as a pump cut-out function when the water reservoir is full.

The CU 200 offers indication of

- full water reservoir (level switch activated)
- pump operation
- input power.

The CU 200 indicates operational stoppage in case of

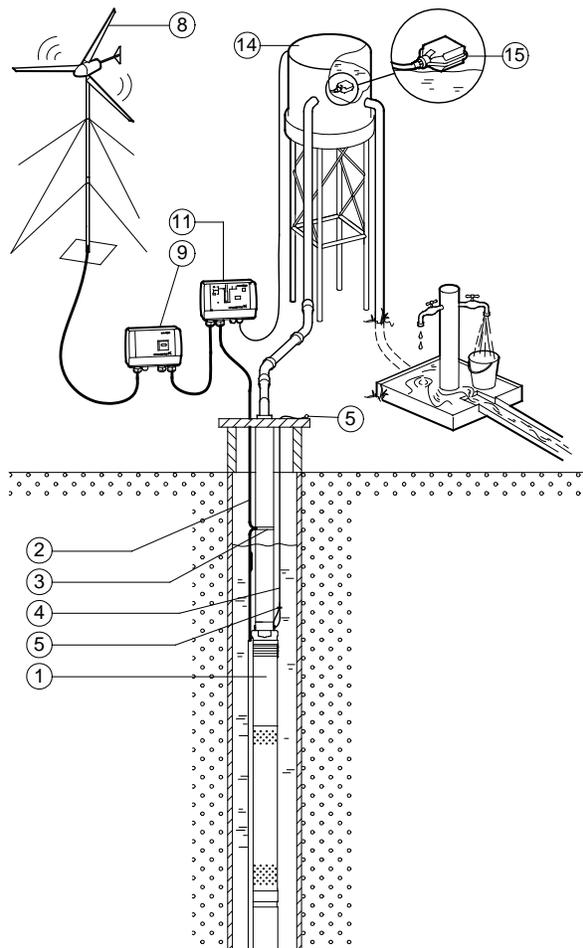
- dry running
- service (see page 35)
- insufficient energy supply.

The IO 102 makes it possible to switch off the power supply in the system and to slow down or stop the wind turbine when

- there is no need for water supply
- the system requires service.

Other benefits of the system include

- easy installation
- a minimum of maintenance.



- 1 SQF pump
- 2 Submersible drop cable
- 3 Cable clips
- 4 Straining wire
- 5 Wire clamp
- 8 Wind turbine
- 9 IO 102 SQFlex breaker box
- 11 CU 200 SQFlex control unit
- 14 Water reservoir
- 15 Level switch

Fig. 17 SQFlex Wind with CU 200 and level switch

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SQFlex Combo

- combination of solar and wind energy

The SQFlex Combo water supply system is ideal in areas where the solar and/or wind energy is sufficient to run the pump.

The energy supply to the pump is a combination of solar and wind energy.

As the turbine noise level increases with the wind speed, installation of the wind turbine near a residence is not recommended.

Benefits

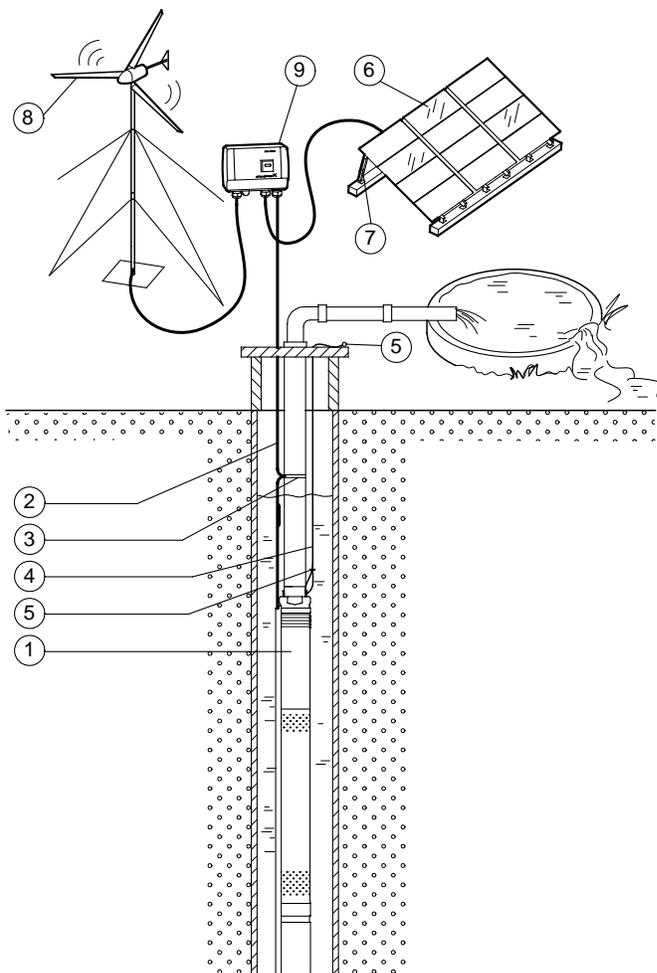
The system offers water supply during the night or during periods of insufficient solar energy.

Other benefits of the system include

- easy to install
- maintenance confined to periodic cleaning of the solar panels
- few and simple components.

The IO 102 makes it possible to switch off the power supply in the system and to slow down or stop the wind turbine when

- there is no need for water supply
- the system requires service.



- 1 SQF pump
- 2 Submersible drop cable
- 3 Cable clips
- 4 Straining wire
- 5 Wire clamp
- 6 Solar panels
- 7 Support structure
- 8 Wind turbine
- 9 IO 102 SQFlex breaker box

Note: For the number of solar modules required, please consult the sizing tool in Grundfos WinCAPS.

Fig. 18 SQFlex Combo – combination of solar and wind energy

TM02 2307 4101

SQFlex Combo

- with CU 200 and level switch

The SQFlex Combo system allows solar and wind energy to be stored as water in a reservoir.

SQFlex Combo water supply systems with a water reservoir are used where

- for short periods, the solar or wind energy is insufficient to run the pump
- there is a need for a back-up water source.

As the turbine noise level increases with the wind speed, installation of the wind turbine near a residence is not recommended.

Benefits

Combined with the CU 200, the level switch acts as a pump cut-out function when the water reservoir is full.

The CU 200 offers indication of

- full water reservoir (level switch activated)
- pump operation
- input power.

The CU 200 indicates operational stoppage in case of

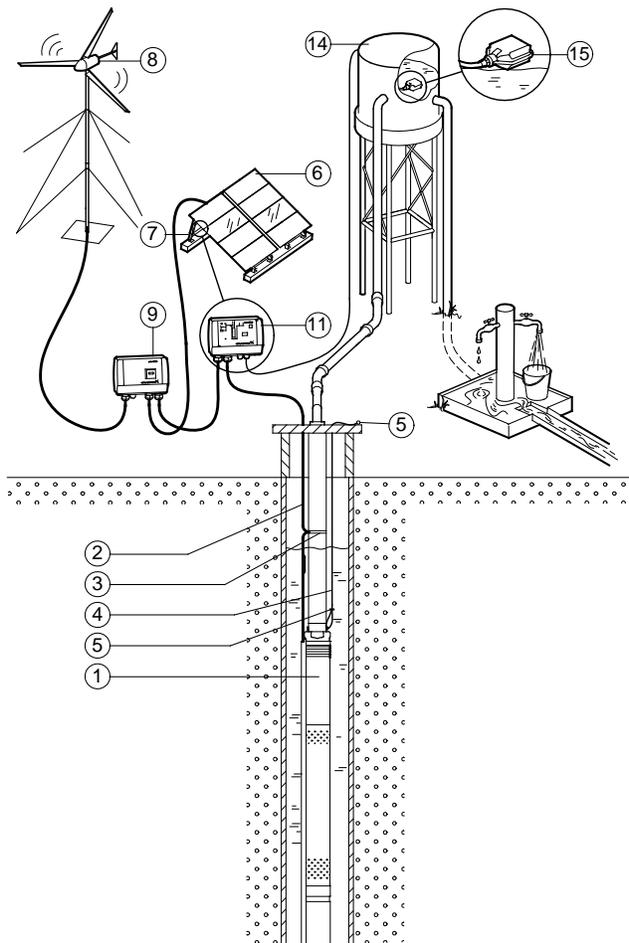
- dry running
- service (see page 35)
- insufficient energy supply.

The IO 102 makes it possible to switch off the power supply in the system and to slow down or stop the wind turbine when

- there is no need for water supply
- the system requires service.

Other benefits of the system include

- easy installation
- a minimum of maintenance.



Note: For the number of solar modules required, please consult the sizing tool in Grundfos WinCAPS.

Fig. 19 SQFlex Combi with CU 200 and level switch

TM02 2310 4101

SQFlex system

- with generator as power supply

The SQFlex water supply system is connected to a diesel or gasoline driven generator.

The generator must be running steadily before the pump is cut in.

Benefits

The system offers water supply 24 hours a day, independently of the weather.

Other benefits of the system include

- easy installation
- a minimum of maintenance required
- few and simple components.

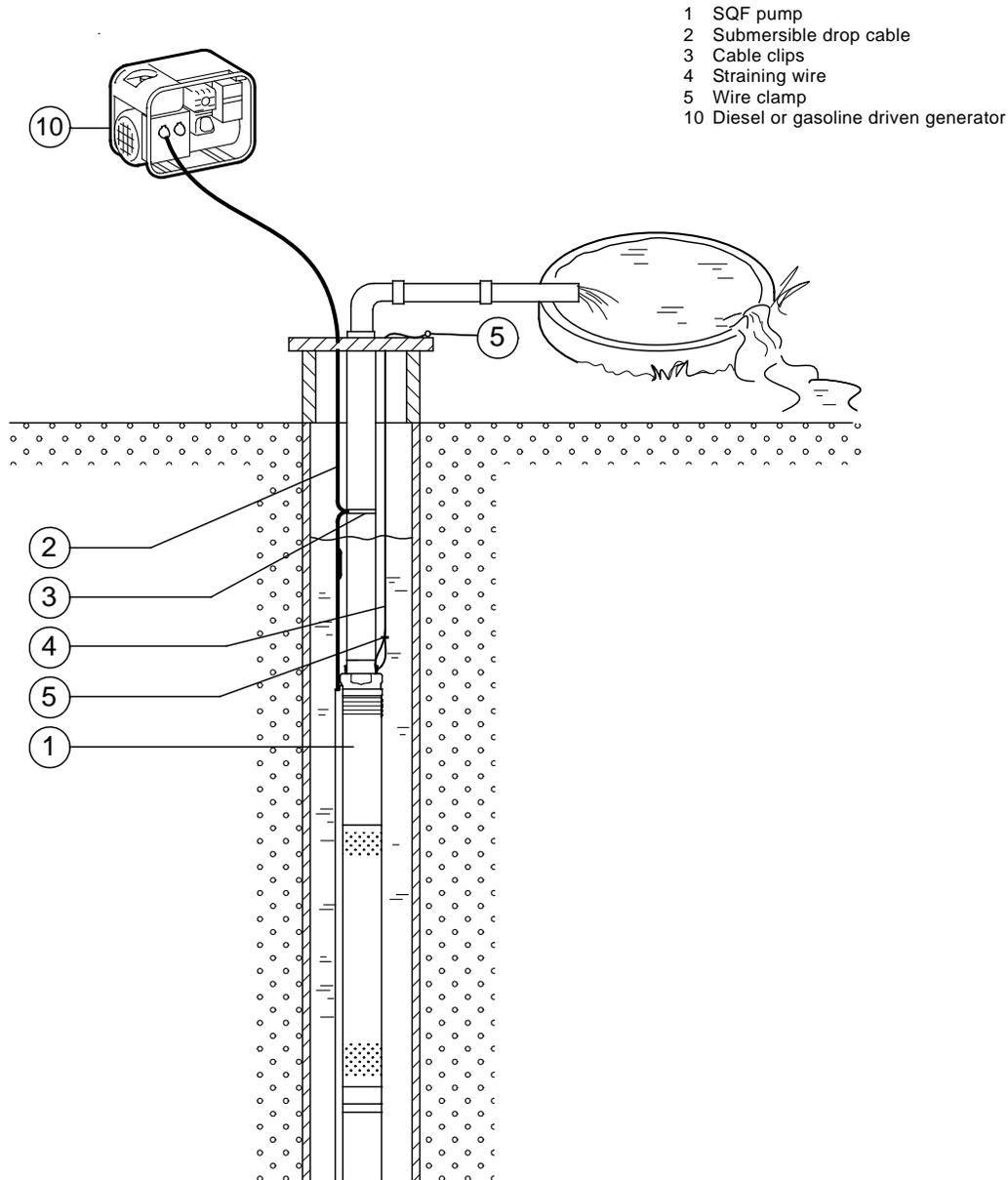


Fig. 20 SQFlex system with generator as power supply.

TM02 2311 4101

4. Solar panel wiring

Methods of solar panel wiring

Solar panels can be connected in one of three methods:

1. Series wiring
2. Parallel wiring
3. Series/parallel wiring (a combination of the two)

The Grundfos SQFlex pump is most efficient at voltages of 120V and above, up to a max of 300V. To maximize pump performance connect panels to obtain at least 120V.

Series wiring

All solar panels have a negative (-) and a positive (+) terminal.

When wiring panels in series, voltages add and amperage stays the same.

To wire panels in series connect the positive terminal of one panel to the negative terminal of the next panel.

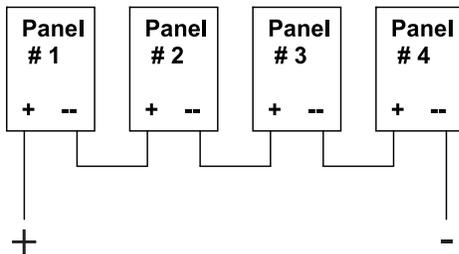


Fig. 21 Solar panel wiring in series

Panel voltages add in series, so if the panels in fig. 21 are rated at 70V (GF100), then the total voltage will be:

$$70 + 70 + 70 + 70 = 280V$$

Panel amperage remains the same, so if each panel produces 1.43 amps, then the total current will be 1.43 amps.

Panel wattage always adds, so if each panel is rated at 100W the total wattage (Watts = Volts x Amps) output will be:

$$100 + 100 + 100 + 100 = 400W$$

Parallel wiring

When wiring panels in parallel, results are the opposite of series wiring, that is, amperages add and voltage stays the same.

To wire panels in parallel, connect the positive terminal of each panel to the positive terminal of the other panels and negative terminal of each panel to the negative terminal of the other panels.

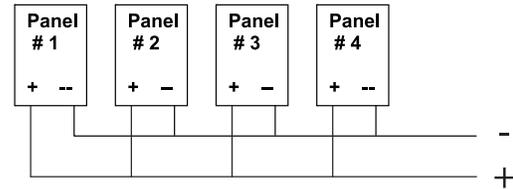


Fig. 22 Solar panel wiring in parallel

Panel voltage remains the same, so if the panels in fig. 22 produce 70V each, then the total output will be 70V.

Panel amperage adds in parallel, so if the panels in fig. 22 are rated at 1.43A, then the total current will be:

$$1.43 + 1.43 + 1.43 + 1.43 = 5.72A$$

Panel wattage always adds, so if each panel is rated at 100W the total wattage (Watts = Volts x Amps) output will be:

$$100 + 100 + 100 + 100 = 400W$$

Series/parallel circuits

A series/parallel circuit is simply two or more series circuits that are wired together in parallel.

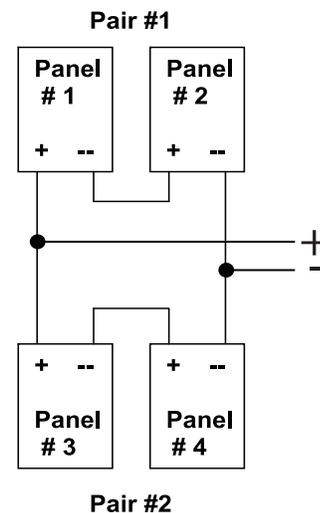


Fig. 23 Solar panel wiring in series/parallel circuit

In fig. 23 two separate pairs of panels have been wired in series and each of these series pairs have been wired together in parallel.

To determine the total voltage and amp output of this array, consider first each pair of panels wired in series. Think of each pair as a single panel. Each panel has a rating of 70V, 1.43A and 100W. Remember that in series, voltage adds, while amperage remains the same. Pair #1 provides $70 + 70 = 140V$ and 1.43A. Pair #2 provides the same (continued on next page).

Now add the two pairs in parallel. Remember in parallel, voltage remains the same and amperage adds. Each pair produces 140V, so total voltage = 140V. Each pair produces 1.43A, so total amperage is $1.43 + 1.43 = 2.86A$. Watts always add, so $100W \times 4 = 400W$.

Cable sizing chart

Since the SQFlex motor operates at peak efficiency with 120V or greater applied, we strongly recommend configuring panels to achieve 120V or greater.

Lower voltages result in greater losses in the drop cable, and it is important to the customer to make efficient use of every watt generated. Additionally, significant savings in drop cable costs can be realized by configuring for higher voltages.

Panels	Power (Wp)	Voltage (Vmp)	14 AWG	12 AWG	10 AWG	Amps [Imp]	Series	Parallel
1	100	70	290	461	733	1.4	1	
2	200	140	580	922	1466	1.4	2	
3	300	210	871	1383	2199	1.4	3	
4	400	280	1161	1844	2932	1.4	4	
6	600	210	435	692	1099	2.9	3	2
6	600	140	193	307	489	4.3	2	3
8	800	280	580	922	1466	2.9	4	2
8	800	140	145	231	366	5.7	2	4
9	900	210	290	461	733	4.3	3	3
10	1000	140	116	184	293	7.1	2	5
12	1200	280	387	615	977	4.3	4	3
15	1500	210	174	277	440	7.1	3	5
16	1600	280	290	461	733	5.7	4	4
18	1800	210	145	231	366	8.6	3	6
20	2000	140	58	92	147	14.3	2	10

Notes:

Max. cable length in ft; uses a max. 3 % voltage drop.

Based on the Grundfos GF100 panel.

Max. cable length between CU200 and SQFlex = 650 ft (198 m).

5. Performance curves

Curve conditions

Performance range, SQFlex Solar

The SQFlex Solar performance range shown on page 7 is based on

- solar radiation on a tilted surface (tilt angle of 20°)
- $H_T = 6 \text{ kWh/m}^2$ per day
- ambient temperature: +85 °F (+29 °C)
- 20° northern latitude.

Performance range, SQFlex Wind

The SQFlex Wind performance range shown on page 7 is based on

- average wind speed, measured over one month
- calculations according to Weibull's factor $k = 2$
- continuous operation over 24 hours.

Specific performance charts

The specific performance charts in the Performance Curves section of this booklet are based on the following guidelines:

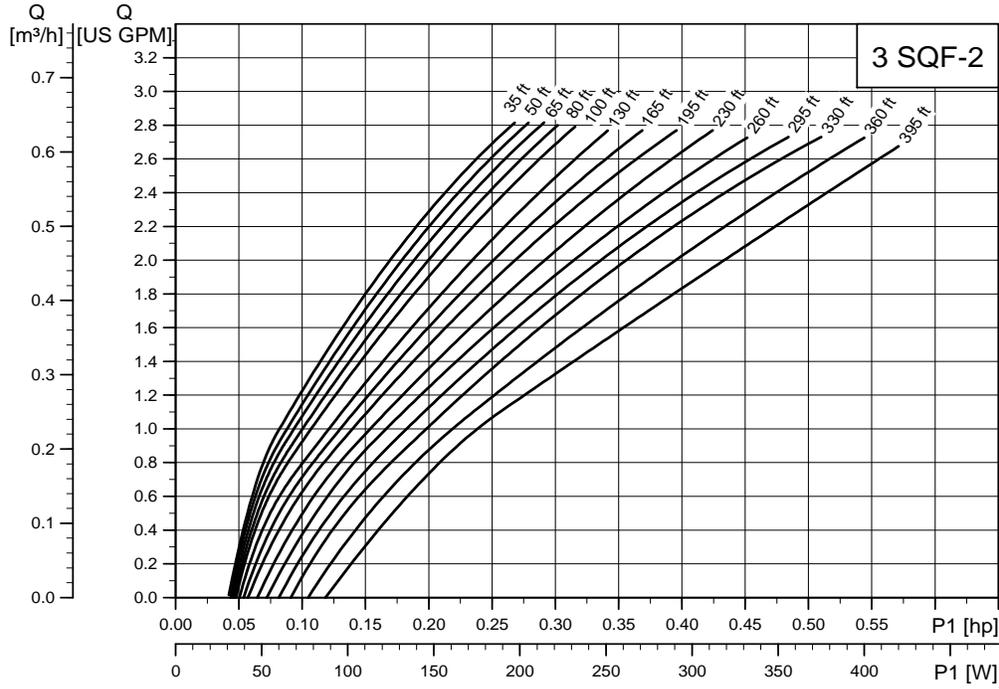
- All curves show mean values.
- The curves must not be used as guarantee curves.
- Typical deviation: $\pm 15 \%$.
- The measurements have been made at a water temperature of +68 °F (+20 °C).
- The curves apply to a kinematic viscosity of $1 \text{ mm}^2/\text{s}$ (1 cSt). If the pump is used for liquids with a viscosity higher than that of water, this will reduce the head and increase the power consumption.

Pressure loss

The QH curves are inclusive of inlet and valve losses at actual speed.

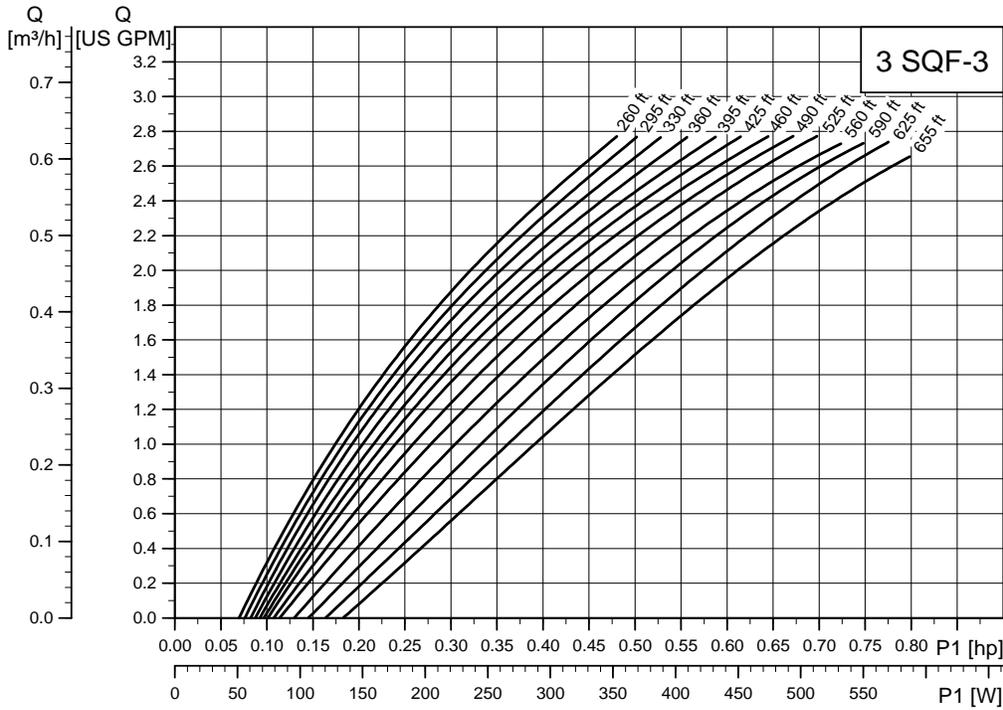
Curve charts

3 SQF-2



TM02 2426 4311

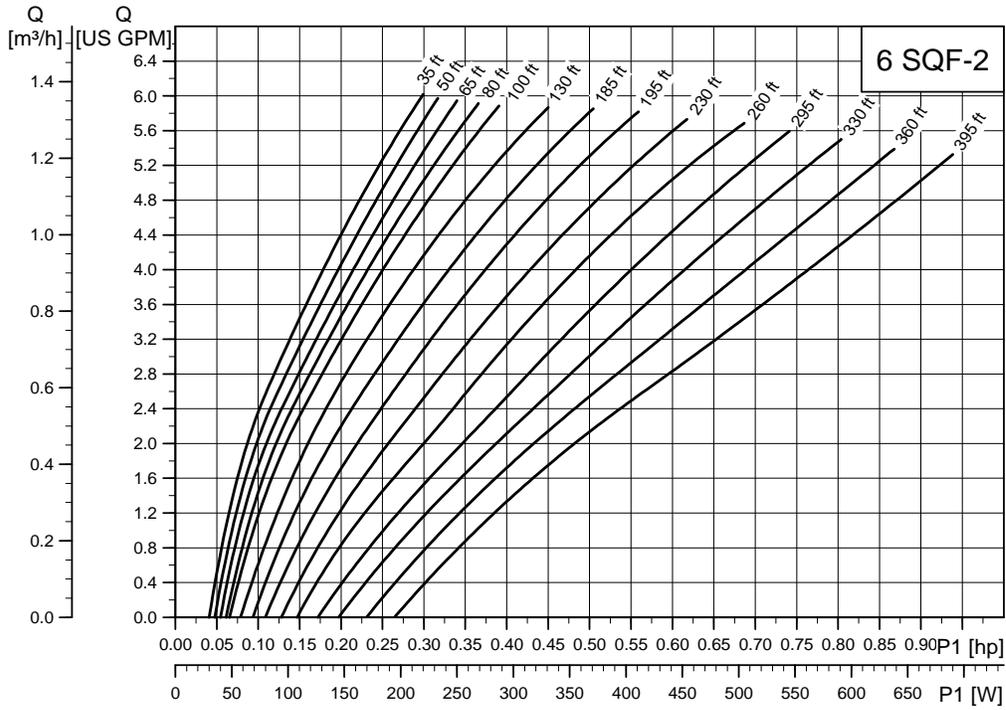
3 SQF-3



TM03 3930 4311

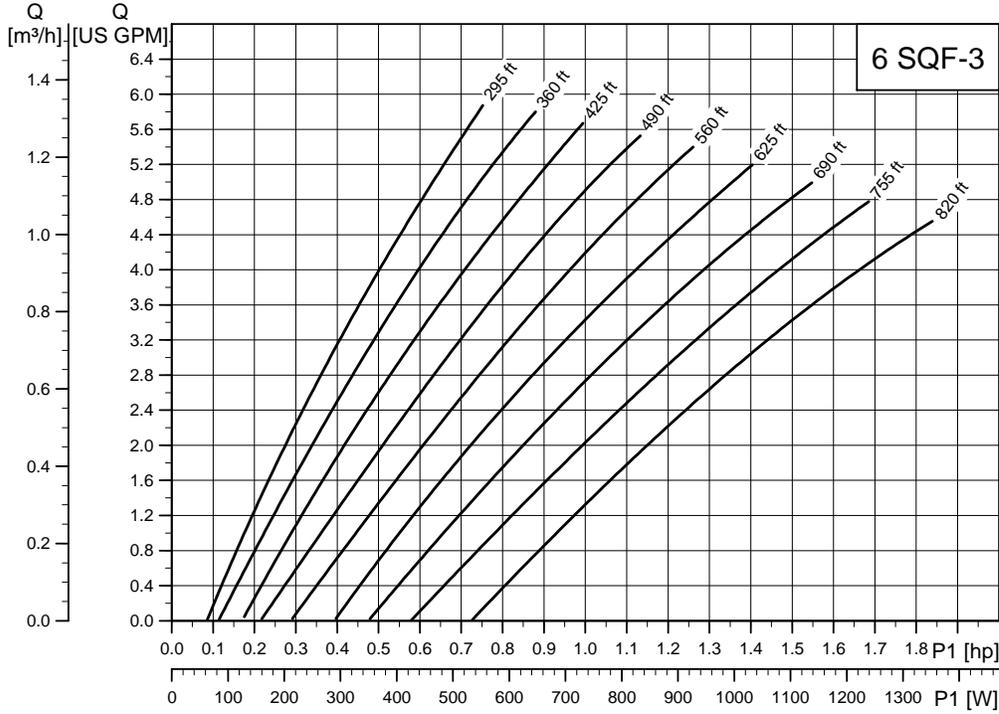
Note: Max. P1 (W) shown on curve represents max. motor RPM.

6 SQF-2



TM02 2427 4311

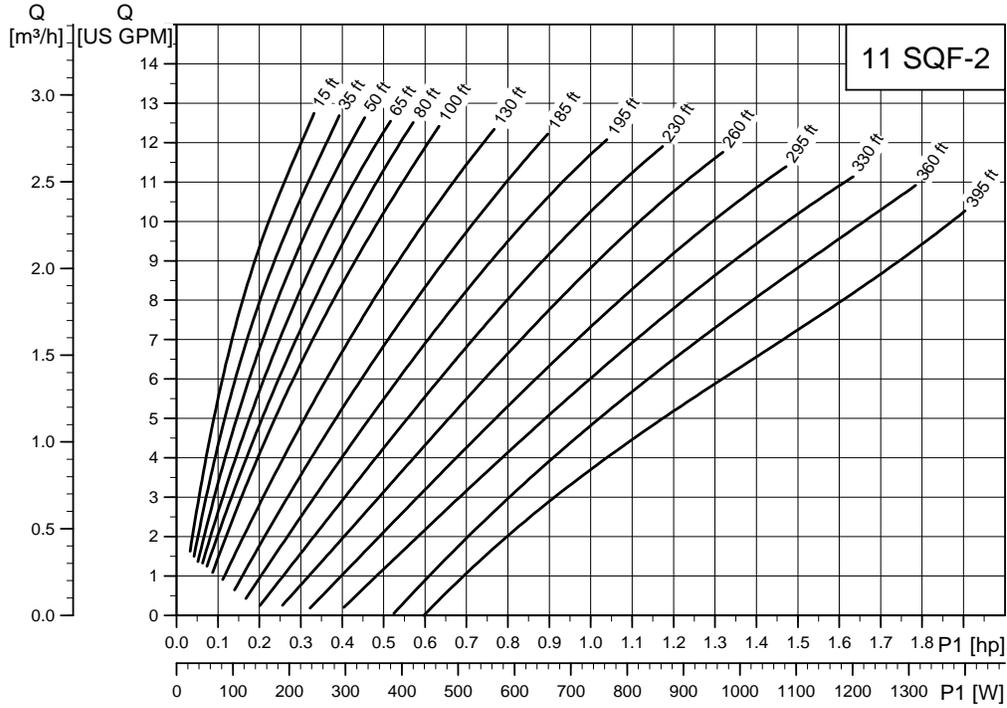
6 SQF-3



TM02 4648 4711

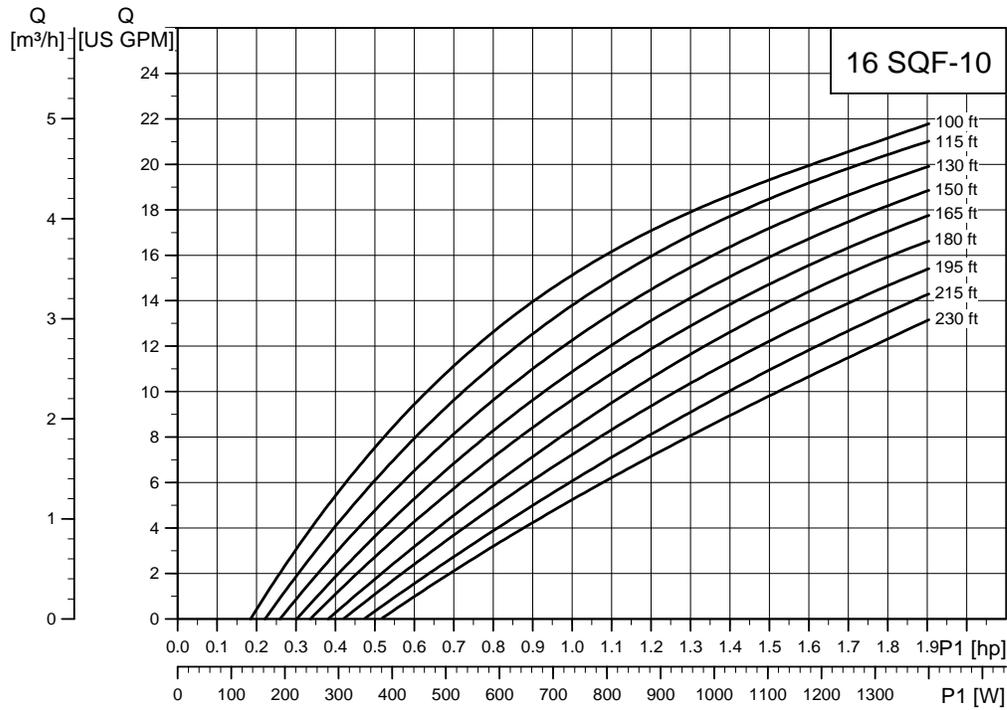
Note: Max. P1 (W) shown on curve represents max. motor RPM.

11 SQF-2



TM02 2428 4311

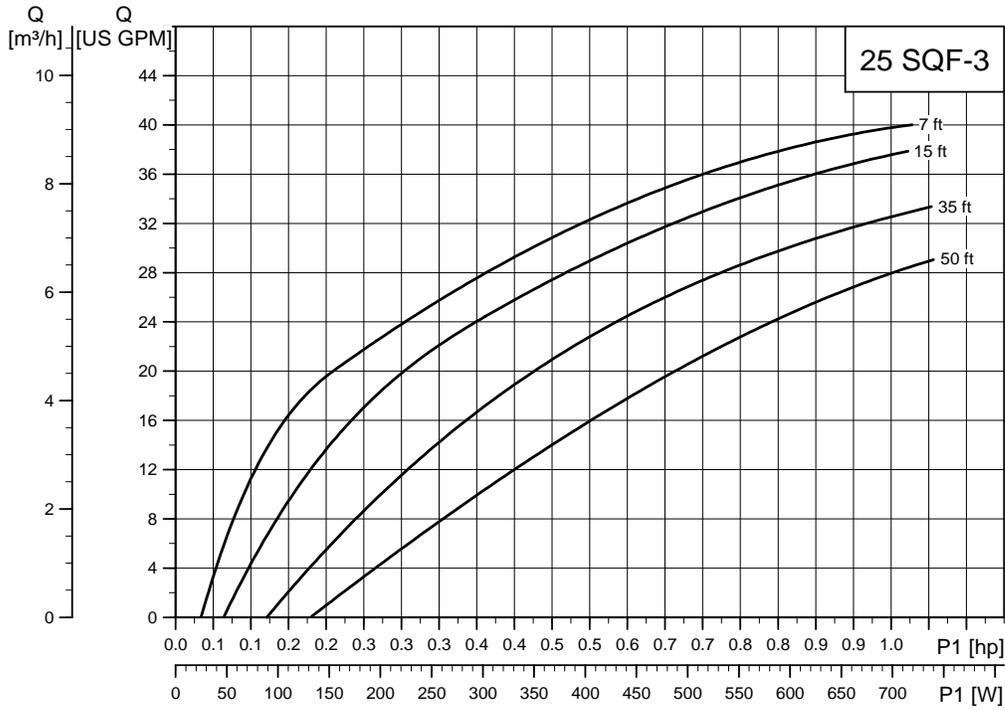
16 SQF-10



TM03 3931 4311

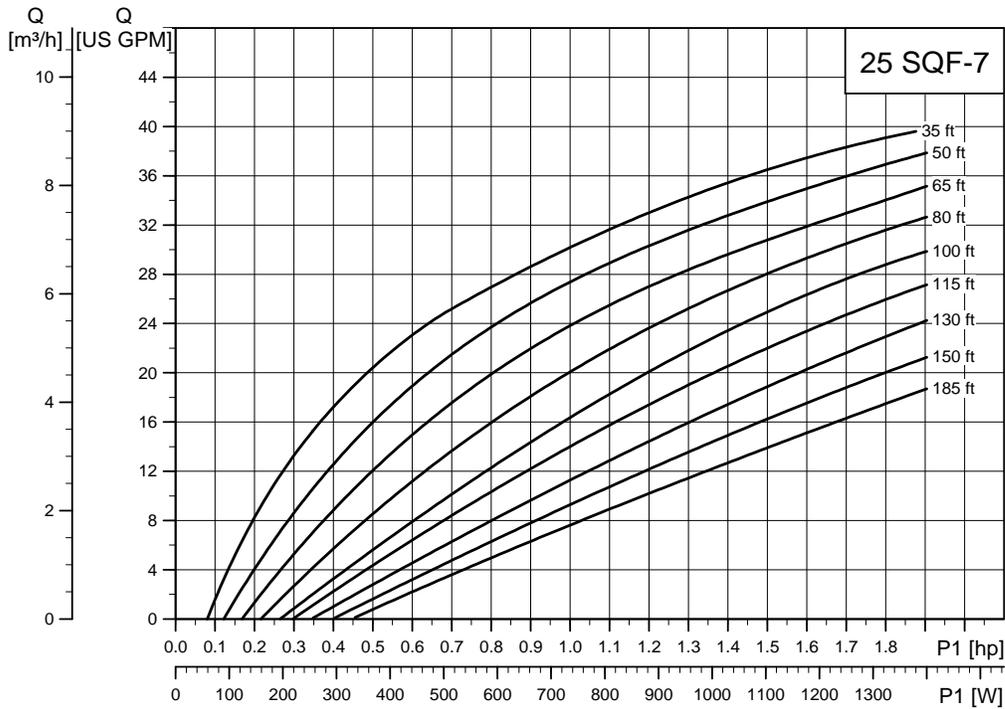
Note: Max. P1 (W) shown on curve represents max. motor RPM.

25 SQF-3



TM02 2429 4311

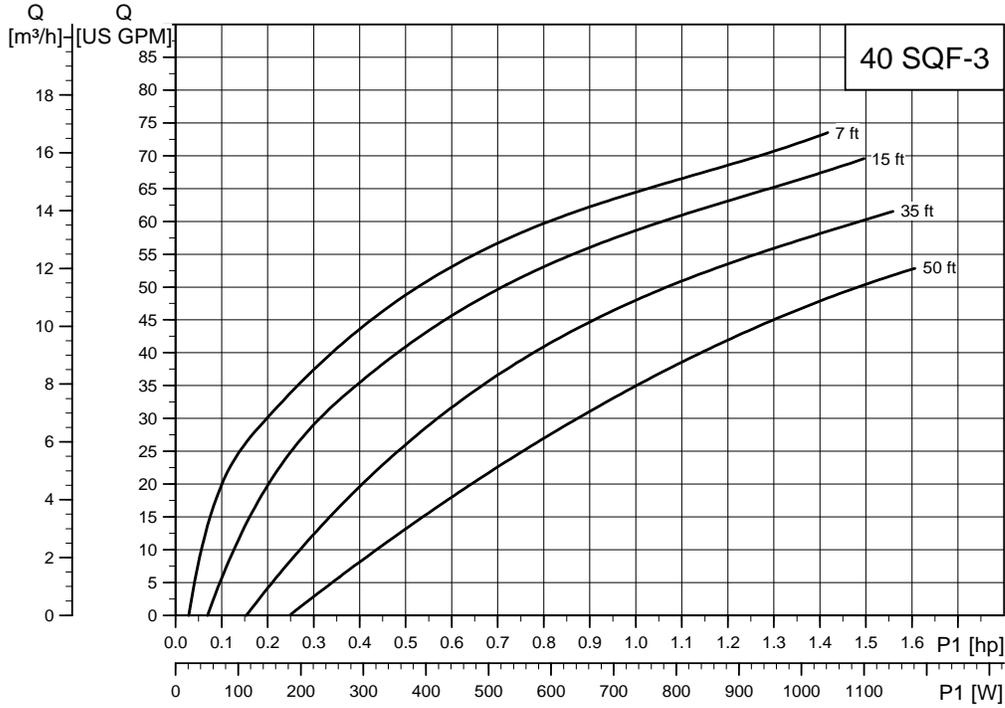
25 SQF-7



TM02 2430 4311

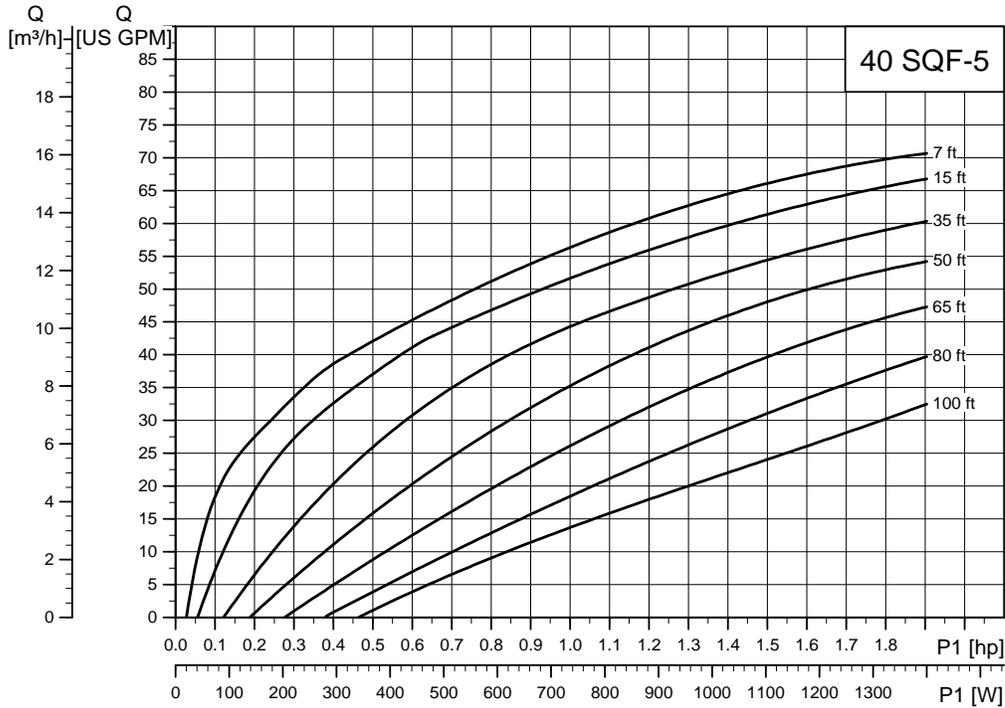
Note: Max. P1 (W) shown on curve represents max. motor RPM.

40 SQF-3



TM02 2431 4311

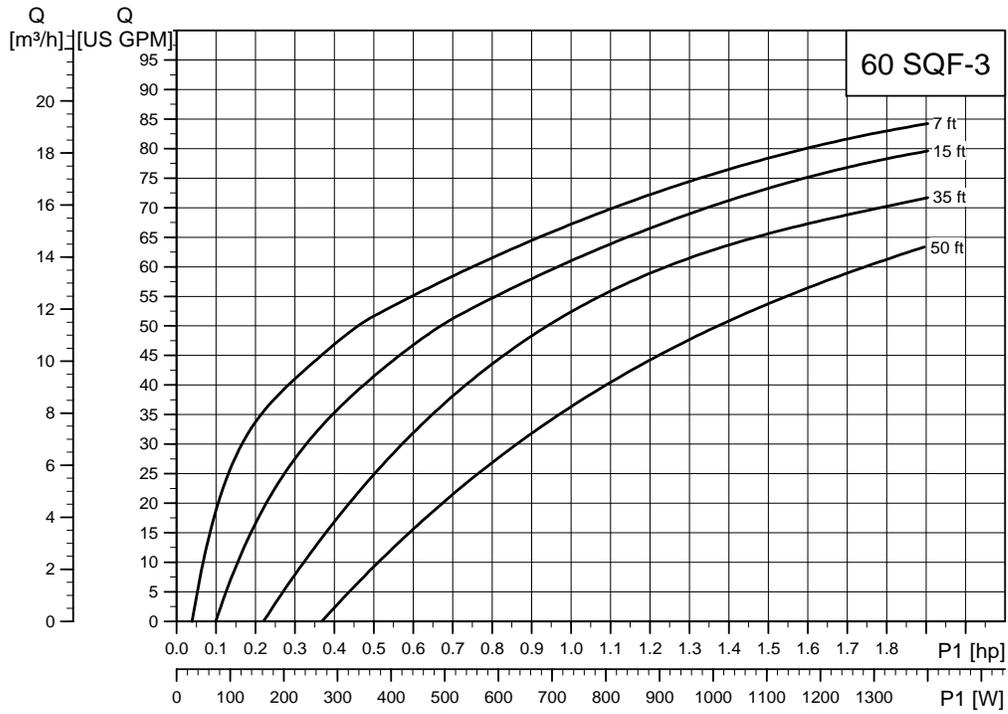
40 SQF-5



TM03 3932 4311

Note: Max. P1 (W) shown on curve represents max. motor RPM.

60 SQF-3

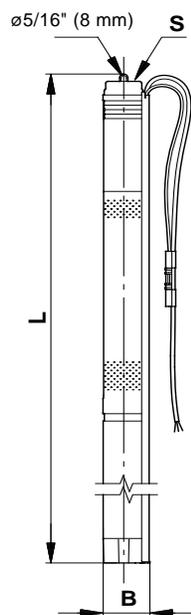


Note: Max. P1 (W) shown on curve represents max. motor RPM.

TM03 3933 4311

6. Technical data

Dimensions and weights



TM02 2209 3901

Pump type	Dimensions [in (mm)] ★			Net weight [lb]★	Gross weight [lb]★	Shipping volume [ft ³]★
	L	B	S			
3 SQF-2	47 (1194)	2.9 (74)	1" NPT	17	21	0.85
3 SQF-3	49 (1247)	2.9 (74)	1" NPT	17.5	21	0.85
6 SQF-2	48 (1219)	2.9 (74)	1" NPT	17.5	21	0.85
6 SQF-3	51 (1296)	2.9 (74)	1" NPT	1.8	2.2	0.85
11 SQF-2	49 (1247)	2.9 (74)	1 1/4" NPT	18	22	0.85
16 SQF-10	38 (965)	3.9 (100)	1 1/4" NPT	21	24	1.00
25 SQF-3	32 (813)	3.9 (100)	1 1/2" NPT	18	21	1.00
25 SQF-7	35 (889)	3.9 (100)	1 1/2" NPT	19.5	23	1.00
40 SQF-3	36 (915)	3.9 (100)	2" NPT	21	24	1.00
40 SQF-5	40 (1016)	3.9 (100)	2" NPT	23	26.5	1.00
60 SQF-3	39 (991)	3.9 (100)	2" NPT	24	27	1.00

★ Pump complete

SQF pump

Power supply to pump	30-300 VDC, PE. 1 x 90-240 V -10 % / +6 %, 50/60 Hz, PE.
Run-up time	Depends on the energy source.
Start/stop	No limitation to the number of starts/stops per hour.
Enclosure class	IP 68.
Motor protection	Built into the pump. Protection against <ul style="list-style-type: none"> • dry running by means of a water level electrode • overvoltage and undervoltage • overload • overtemperature.
Conductivity	≥ 70 µs/cm (micro siemens).
Sound pressure level	The sound pressure level of the pump is lower than the limiting values stated in the EC Machinery Directive.
Radio noise	The SQF complies with the EMC Directive 89/336/EEC. Approved according to the standards EN 61000-6-2 and EN 61000-6-3.
Reset function	The SQF can be reset via the CU 200 or by disconnecting the power supply for 1 minute.
Power factor	PF = 1.
Operation via generator	Voltage: 115-230 VAC -10 % / +6 %. The generator output must be <ul style="list-style-type: none"> • minimum 1000 W (helical rotor pumps) • minimum 1500 W (centrifugal pumps).
Earth-leakage circuit breaker	If the pump is connected to an electric installation where an earth-leakage circuit breaker (ELCB) is used as an additional protection, this circuit breaker must trip out when earth fault currents with DC content (pulsating DC) occur.
Borehole diameter	3 SQF, 6 SQF, 11 SQF: Minimum: 3 in. 16 SQF, 25 SQF, 40 SQF, 60 SQF: Minimum: 4 in.
Installation depth	Minimum: The pump must be completely submerged in the pumped liquid. Maximum: 500 ft below the static water table (220 psi).
Suction strainer	Holes of the suction strainer: 3 SQF, 6 SQF, 11 SQF: ø0.090 in. 16 SQF, 25 SQF: ø0.10 in. 40 SQF, 60 SQF: 0.16 in x 0.80 in.
Pumped liquids	pH 5 to 9. Sand content up to 50 ppm.
Marking	CE.

Motor

Electrical data

30-300 VDC or 1 x 90-240 VAC, 50/60 Hz

Pump type	Motor type	Max. power input P ₁ [W]	Max. current [A]
3 SQF-2	MSF 3	1400	8.4
3 SQF-3	MSF 3	1400	8.4
6 SQF-2	MSF 3	1400	8.4
6 SQF-3	MSF 3	1400	8.4
11 SQF-2	MSF 3	1400	8.4
16 SQF-10	MSF 3	1400	8.4
25 SQF-3	MSF 3	1400	8.4
25 SQF-7	MSF 3	1400	8.4
40 SQF-3	MSF 3	1400	8.4
40 SQF-5	MSF 3	1400	8.4
60 SQF-3	MSF 3	1400	8.4

CU 200 SQFlex control unit

Voltage	30-300 VDC, 8.4 A. 90-240 VAC, 8.4 A.
Power consumption	5 W.
Current consumption	Maximum 130 mA.
Pump cable	Maximum length between the CU 200 and the pump: 650 ft. Maximum length between the CU 200 and the level switch: 2000 ft.
Back-up fuse	Maximum 10 A.
Radio noise	The CU 200 complies with the EMC Directive 89/336/EEC. Approved according to the standards EN 55014 and 55014-2.
Relative air humidity	95 %.
Enclosure class	IP 55.
Ambient temperature	During operation: -22 °F to +122 °F (-30 °C to +50 °C). During storage: -22 °F to +140 °F (-30 °C to 60 °C).
Marking	CE.
Weight	4.5 lb.

IO 50 SQFlex switch box

Voltage	Maximum 300 VDC, 8.4 A. Maximum 265 VAC, 8.4 A.
Enclosure class	IP 66.
Ambient temperature	During operation: -22 °F to +122 °F (-30 °C to 50 °C). During storage: -22 °F to +140 °F (-30 °C to 60 °C).
Marking	CE.

IO 101 SQFlex switch box

Voltage	**115 VAC -15 % / +10 %, 50/60 Hz (internal relay). Maximum 225 VDC, 8.4 A. Maximum 115 VAC, 8.4 A. ** 230 VAC -15 % / +10 %, 50/60 Hz (internal relay). Maximum 225 VDC, 7 A. Maximum 265 VAC, 7 A.
Enclosure class	IP 55.
Ambient temperature	During operation: -22 °F to +122 °F (-30 °C to 50 °C). During storage: -22 °F to +140 °F (-30 °C to 60 °C).
Marking	CE.

IO 102 SQFlex breaker box

Voltage	Maximum 225 VDC, 8.4 A. Maximum 265 VAC, 8.4 A.
Enclosure class	IP 55.
Ambient temperature	During operation: -22 °F to +122 °F (-30 °C to 50 °C). During storage: -22 °F to +140 °F (-30 °C to 60 °C).
Marking	CE.

Charge controller

Voltage (solar input)	Maximum 110 VDC.
Current (solar input)	Maximum 15 A.
Output current (load)	Maximum 15 A.
Ambient temperature	-40 °F to +140 °F (-40 °C to +60 °C).
Weight	0.75 lb.

7. Accessories

CU 200 SQFlex control unit

Product	Product number
CU 200 SQFlex	96625360

The CU 200 is a combined status, control and communication unit especially developed for the SQFlex system. The CU 200 also enables connection of a level switch.

The CU 200 incorporates cable entries for

- power supply connection (pos. 6)
- pump connection (pos. 7)
- earth connection (pos. 8)
- level switch connection (pos. 9).

(The position numbers in brackets refer to fig. 24.)

Communication between the CU 200 and the pump takes place via the pump power supply cable. This is called mains borne signalling (or Power Line Communication), and this principle means that no extra cables between the CU 200 and the pump are required.

It is possible to start, stop and reset the pump with the on/off button (pos. 1). The CU 200 offers

- system monitoring
- alarm indication.

The following indications allow the operation of the pump to be monitored:

- water reservoir is full (level switch) (pos. 2)
- pump is running (pos. 3)
- input power (pos. 11).

The CU 200 offers the following alarm indications:

- Dry running (pos. 10)
- Service needed (pos. 5) in case of
 - no contact to pump
 - overvoltage
 - overtemperature
 - overload.

In addition, the CU 200 shows the symbols of the energy supply options (pos. 4).

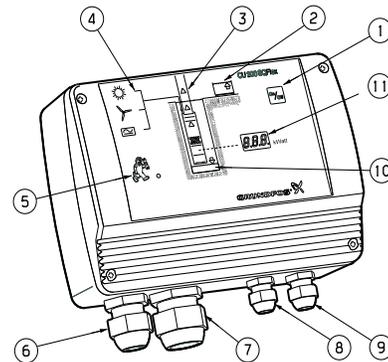


Fig. 24 CU 200 elements

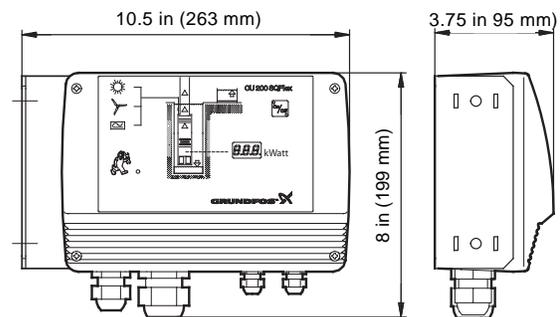


Fig. 25 CU 200, dimensional sketch

TM02 2325 1206

TM02 2323 1206

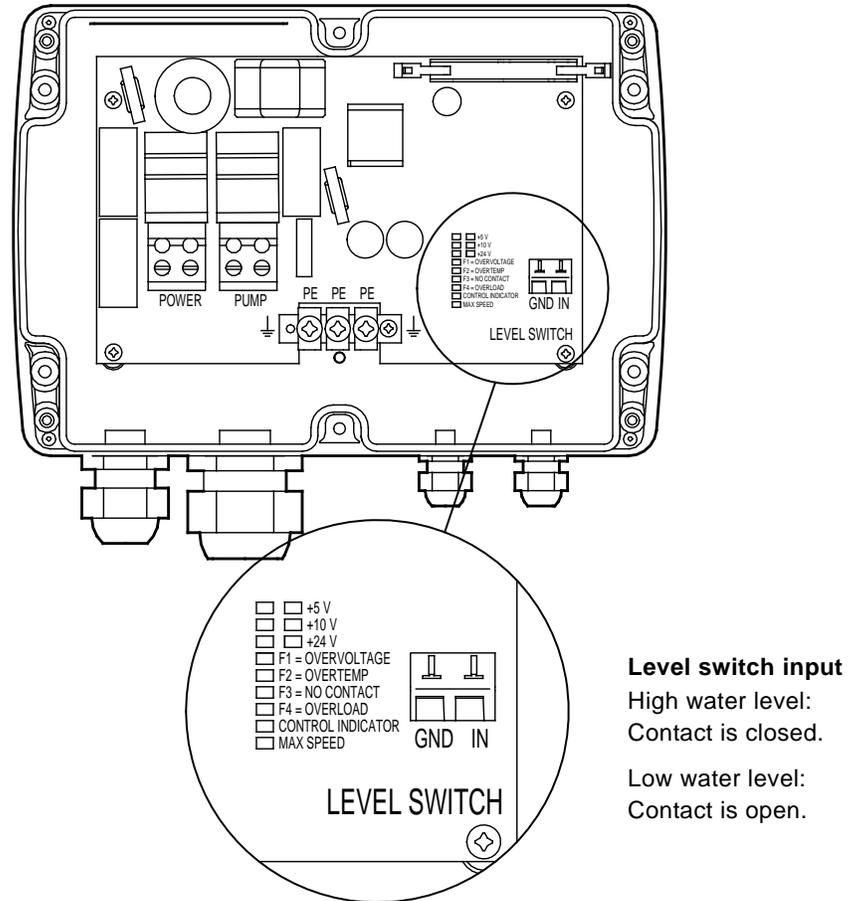


Fig. 26 Electrical connections, CU 200

TM02 2515 4401

IO 50 SQFlex switch box

Product	Product number
IO 50 SQFlex	96959028

The IO 50 is designed specifically for solar-powered SQFlex systems.

The IO 50 enables manual starting and stopping of the pump in an SQFlex Solar system and functions as a connection box joining all necessary cables.

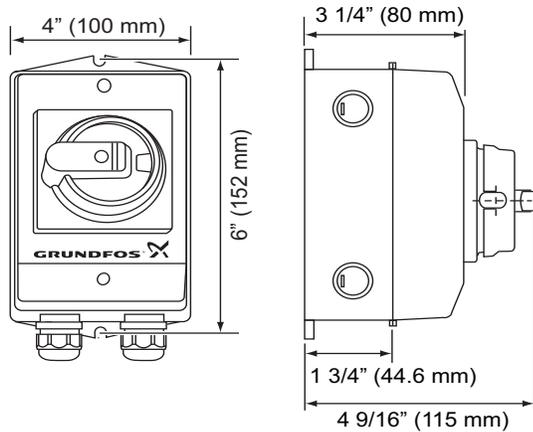


Fig. 27 IO 50, dimensional sketch

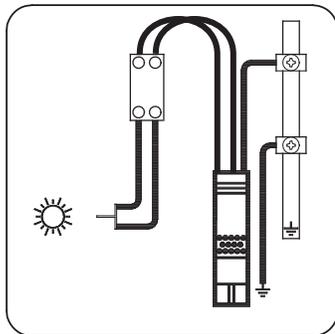


Fig. 28 Wiring diagram

IO 101 SQFlex switch box

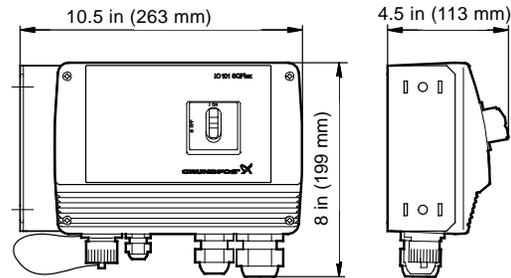
Product	Product number
IO 101 115 VAC SQFlex	96481502
IO 101 230 VAC SQFlex	96475074

The IO 101 is designed specifically for solar-powered SQFlex systems.

The IO 101 enables the connection of a back-up generator in case of insufficient solar energy. The switching between solar power and generator must be made manually.

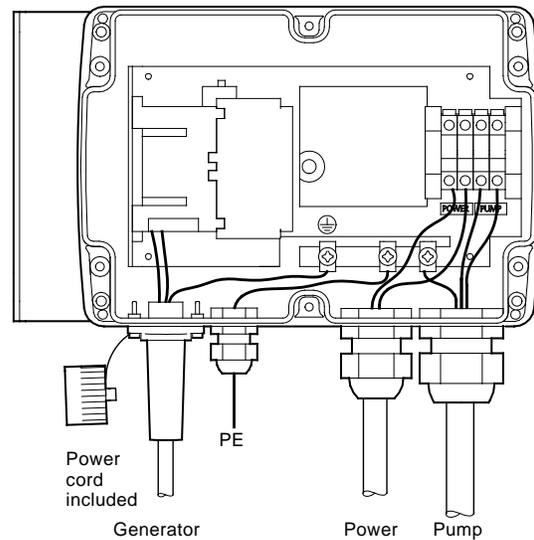
In case the generator is stopped manually or runs out of fuel, the IO 101 will automatically change over to the solar panels.

The IO 101 functions as a connection box joining all necessary cables.



TM02 2546 4003

Fig. 29 IO 101, dimensional sketch



TM02 4162 5001

Fig. 30 Electrical connections

IO 102 SQFlex breaker box

Product	Product number
IO 102 SQFlex for wind turbine	96475065

The IO 102 is designed specifically for wind-powered SQFlex systems.

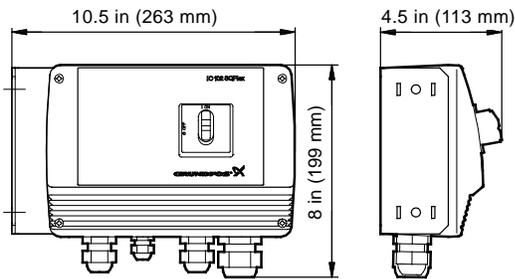
The IO 102 enables manual starting and stopping of the pump in an SQFlex Wind system or an SQFlex Combo system.

The on/off switch has a built-in "electrical brake" for the turbine. When the switch is in "off" position, the turbine stops or slows down.

The IO 102 rectifies the three-phase AC voltage from the wind turbine into DC voltage.

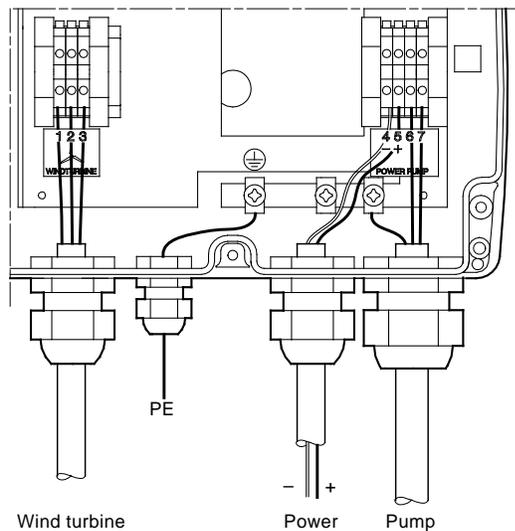
Furthermore, the IO 102 enables the combination of wind energy from the wind turbine and solar energy from the solar panels.

The IO 102 functions as a connection box joining all necessary cables.



TM02 4232 4003

Fig. 31 IO 102, dimensional sketch



TM02 4312 0502

Fig. 32 Electrical connections

Charge controller

Product	Product number
Charge controller	96023194

The charge controller is used when a battery backup system is installed with an SQFlex pumping system. These systems are typically used in applications where the pump is not running during most of the peak sun hours of the day, or where it is impossible or impractical to store large volumes of water. Examples include remote homes or cabins, automatic livestock waterers and very low-yielding wells.

The charge controller is a fully automatic battery charger and the only setting required is the selection of battery type.

There are three battery types to choose from:

- gel battery
- sealed battery
- flooded battery.

The charge controller enables manual disconnection of the pump, the solar modules or both at the same time.

Submersible drop cables

The submersible drop cables for SQF pumps are approved for use with potable water (KTW-approved). The cables are made of EPR (ethylene-propylene rubber).

Sizing of cable

Use the following formula:

$$L = \frac{\Delta P \times q \times V_{mp}^2}{W_p \times 0.00162} [\text{ft}]$$

where

L = Length of cable [ft]

ΔP = Power loss [%]

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

V_{mp} = Maximum power voltage [V]

W_p = Watt peak [Wp]

The sizing tool in Grundfos WinCAPS makes it possible to calculate the exact losses.

Whisper 200 wind turbine

Note: The IO 102 functions as a breaker box and must be included in wind-powered SQFlex systems. The IO 102 must be ordered separately.



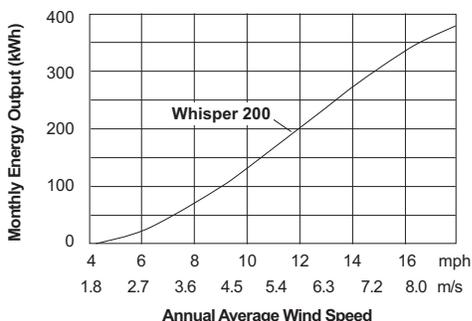
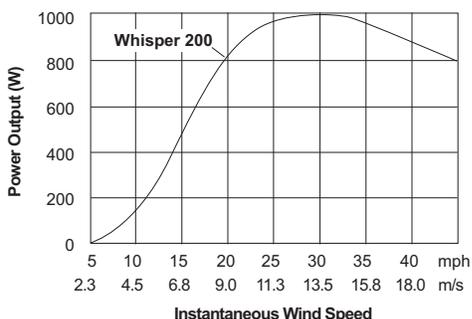
TM02 7886 4403

Description	Product number
Whisper 200 wind turbine	96472120

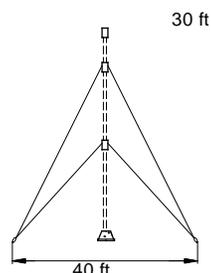
Specifications

Rotor diameter:	9 ft (2.75 m)
Weight:	65 lb.
Mount:	2.5" Schedule 40.
Start-up wind speed:	7 mph.

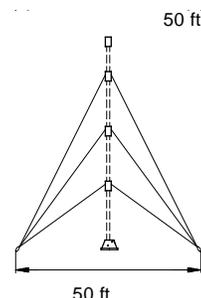
Wind turbine selection



Tower kit for Whisper 200



TM02 5582 3502



TM02 5582 3502

Description	Height [ft (m)]	Product number
Tower kit for Whisper 200	30 (9.2 m)	96475066
	50 (15.3)	96475067

Note: The pipes are not included.
For tower pipe selection, see below.

Tower installation kit

Description	Product number
Tower installation kit	96475069

Note: The gin pole is not included.

Tower pipe selection

The tower kit is designed to use a 2½" outside diameter pipe.

The following table shows the recommended wall thickness of the pipes, depending on the maximum speed of the wind at the location:

Maximum wind speed [mph]	Recommended wall thickness [in (mm)]
80	0.090 (2.29)
90	0.120 (3.05)
110	0.140 (3.56)

The wall thickness of the gin pole must be minimum 0.062 in.

Pipe pieces needed

Tower kit, 30 ft

- One 13 ft (3.9 m) length of pipe for tower.
- One 17 ft (5.2 m) length of pipe for tower.
- One 15 ft (4.5 m) length of pipe for gin pole.

Tower kit, 50 ft

- Two 15 ft (4.5 m) lengths of pipe for tower.
- One 20 ft (6.1 m) length of pipe for tower.
- One 19 ft (5.8 m) length of pipe for gin pole.

Auger/anchor



TM02 2571 4501

Description	Length [ft]	Product number
Auger/anchor (4 pcs.)	4 (1.2 m)	96475068

Grease

Description	Product number
Grease for lubrication of motor shaft	96037562

Level switch



TM02 2407 4201

Description	Product number
Level switch	010748

High water level: Contact is closed.
Low water level: Contact is open.

GF100 solar panel



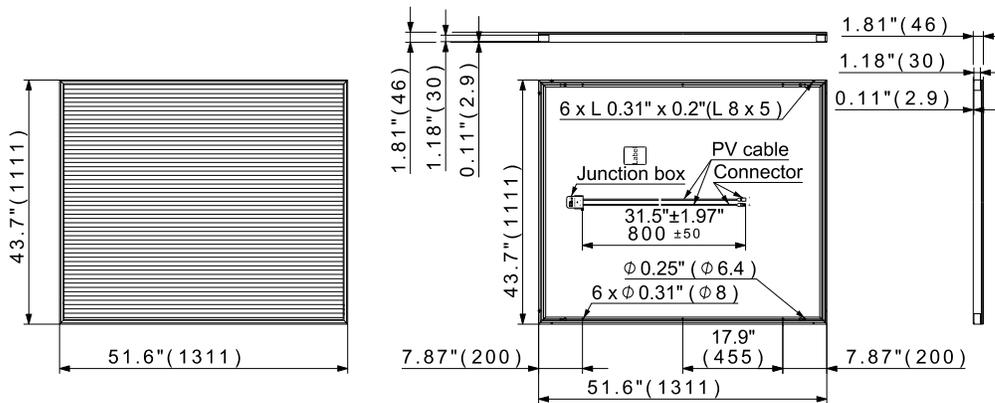
Fig. 33 GF100 solar panel

TM05 0052 0611

GF100 solar panel	
Peak power (P_{max})	100 [W]
Voltage (V_{mp})	70 [V]
Current (I_{mp})	1.43 [A]
Open circuit voltage (V_{oc})	96 [V]
Short circuit current (I_{sc})	1.7 [A]
Reference cell temperature (T_{cref})	77 °F (25 °C)
Solar irradiation at reference cell temperature (I_{tref})	1000 [W/m ²]
Net weight	43.7 [lbs] / 19.8 [kg]
Shipping volume	2.8 [ft ³] / 0.08 [m ³]

Description	Product number
GF100 solar panel (2 panels per package)	97790619
2-panel pole mount support 3" NPT	98042616
Inter-array wire kit	91126023
Array to controller wire kit	91126024

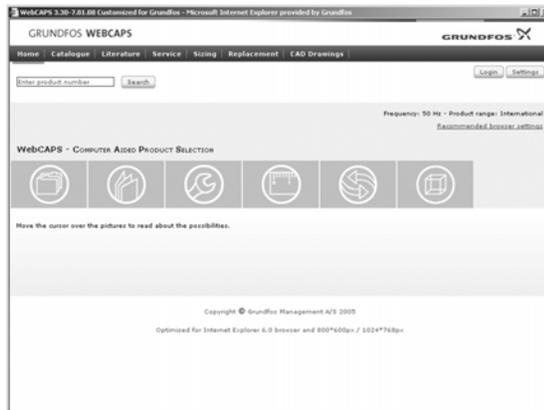
GF100 solar panel - dimensional sketch



TM05 0053 0611

8. Further product documentation

WebCAPS

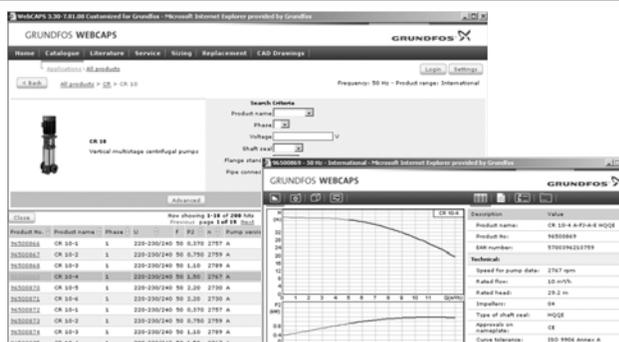


WebCAPS is a **Web-based Computer Aided Product Selection** program available on www.grundfos.com.

WebCAPS contains detailed information on more than 185,000 Grundfos products in more than 22 languages.

In WebCAPS, all information is divided into 6 sections:

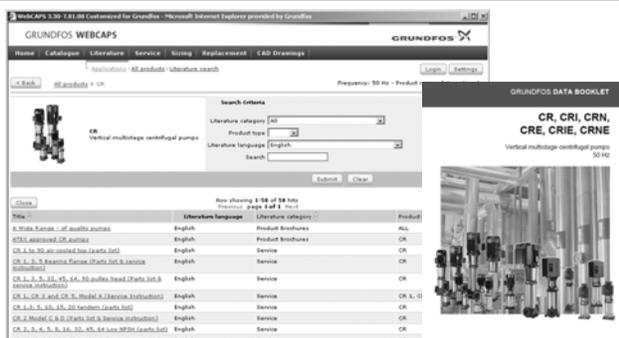
- Catalog
- Literature
- Service
- Sizing
- Replacement
- CAD drawings.



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

- data booklets
- 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 on 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.
- analyze 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 it with a more efficient Grundfos pump. The section contains replacement data on a wide range of pumps produced by other manufacturers than Grundfos.

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



CAD drawings

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

These formats are available in WebCAPS:

2-dimensional drawings:

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

3-dimensional drawings:

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

WinCAPS



Fig. 34 WinCAPS CD-ROM

WinCAPS is a **Windows-based Computer Aided Product Selection** program containing detailed information on more than 185,000 Grundfos products in more than 22 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.

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Repl. Rev. 0809

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