ENGINEERING
TOMORROW

Operating guide

Energy Recovery Device
iSave 21 Plus
Installation, Operation and Maintenance Manual

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Installation, Operation and Maintenance Manual.
Original operating manual document.

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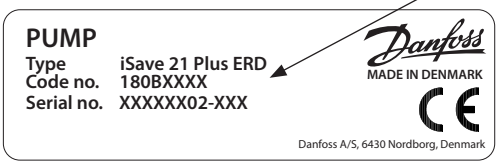
Validity
This manual is valid for iSave 21 Plus

Code no.	Serial no.
180F7015	XXXXXX02-XXX
180F7016	XXXXXX02-XXX
180F7017	XXXXXX02-XXX
180F7018	XXXXXX02-XXX



The serial number is referring to the Serial no. on the product label. The digits shown (02) indicate the version number of the pump.
This document is only valid for ERD version 2 and upwards.

Table of Contents

2. Introduction

2.1 General

iSave is manufactured by Danfoss A/S, and is sold and marketed by a net of authorised distributors world wide.

This manual contains the necessary instructions for the installation, operation and service of the iSave.

All personnel who are responsible for the operation and maintenance of the iSave unit must read and fully understand these instructions, especially the section “Safety” before:

- Transporting of the iSave unit.
- Lifting the unit.
- Installing the iSave unit on a frame.
- Connecting the iSave unit to the fluid system.
- Connecting the electrical motor and instrumentation.
- Commissioning the unit.
- Servicing the iSave unit, mechanics and electrics.
- Decommissioning the iSave unit.

Ensure that these instructions are always readily available to all personnel concerned.

2.2 Target group

This manual is intended for use by personnel with qualified training and experience in the operation and maintenance of a Sea Water Reverse Osmosis (SWRO) or Brackish Water Reverse Osmosis (BWRO) system.

2.3 Symbols

NB!	Indicates something to be noted by the reader.
	Indicates a situation which will or couldresult in damage to the iSave and its function.
	Indicates a situation which will or could result in personal injury and/or damage to the iSave.
	Electrical hazard. Indicates a high-voltage warning
	Safety glasses required
	Hearing protection required
	Safety shoes required
	Safety helmet required

2.4 Manufacturer and customer service address

Danfoss A/S
DK-6430 Nordborg,
Denmark
Telephone: +45 7488 2222
Email: highpressurepumpss@danfoss.com
Home page: hpp.danfoss.com

2.5 Country specific information

1.4.1 United Kingdom

UK importer:
Danfoss Ltd.
22 Wycombe End
HP9 1NB Beaconsfield
United Kingdom

2.6 Additional technical documents

Document name	Content
Datasheet	Description of the technical data and dimensions of the iSave
iSave parts list	Sectional drawings, parts list and spare part numbers.
Instruction: start and stop of the SWRO with iSave unit	Description of how to start and stop the iSave in the preferred RO system set-up.
Instruction: Membrane cleaning of RO system with iSave unit	Description of how to clean the membranes in the preferred RO system set-up.
Instruction: Hose assembly and installation	Guideline for Hose assembly and installation
Operating and maintenance instructions, electric motor	Operating and maintenance instructions for the standard electric motor, delivered from Danfoss.

See also appendix 10

3. Safety

3.1 General

The iSave must not be used for other purposes than those recommended and specified without first consulting your local iSave distributor.

This manual must be read and completely understood by the responsible specialist personnel prior to installation and commissioning.
Use of this manual does not relieve operation and maintenance personnel of the responsibility of applying normal good judgment in the operation and care of this product and its components.

This manual must be available to all personnel concerned at the site at all time.

An iSave must always be installed and used in accordance with existing national and local sanitary and safety regulations and laws. It is the responsibility of the safety officer or the chief operator to assure compliance with all local regulations that are not taken into account in this manual.

The iSave is a rotating machine that typically operates at high pressure.

Always wear suitable safety and lifting equipment when handling the iSave.

- Bolt the iSave properly to the base before start-up to avoid personal injury and/or damage to the iSave.
- The pipe connections to the iSave must be stress-free mounted, securely fastened to the iSave and well supported. Improper installation will or could result in personal injury and/or damage to the iSave.
- Proper installation and care of shutdown devices and over-pressure protection equipment is essential.

Electrical hazard

- All electrical installation work must be carried out by authorised personnel in accordance with EN60204-1 and/or local regulations.
- Install a lockable circuit breaker to avoid inadvertent starting. Protect th motor and other electrical equipment from overloads with suitable equipment.
- The electric motors must be supplied with adequate cooling ventilation.
- Improper installation can cause fatal injuries.
- The iSave must not operate outside the application range.
- During the initial start-up, slowly raise the pressure of the system and adjust the over-pressure protection equipment for proper limit settings.
- Make sure that the pressure is released from the iSave before the iSave is disconnected from any pipe or hose connections in the iSave.
- Make sure that the iSave can be drained without injuring anyone and without contaminating nearby equipment or the environment.
- Before intervening in the iSave/system, the power must be shut off and the starting device must be locked. When intervening in the iSave unit, follow the instructions for Service/Maintenance, chapter 8.
- A failure to follow the instructions can result in personal injury and/or damage to the iSave. It will also invalidate the warranty.

NB!

- The iSave must never run dry. Dry running produces heat and will cause damage to internal parts.
- If the iSave does not function satisfactorily, contact your local iSave distributor.

Use of this manual does not relieve operation and maintenance personnel of the responsibility of applying normal good judgment in the operation and care of this product.

If the recommendations in the manual are not followed, Danfoss reserves the right to void the warranty.

3.2 Intended use

The iSave is designed for use as energy recovery device in Sea Water Reverse Osmosis (SWRO) or Brackish Water Reverse Osmosis (BWRO) system.
The iSave must not be used for other purposes than recommended and quoted for without consulting your local iSave distributor.

3.3 Application range

For application range see data sheet 521B1464 available in appendix 10.3.

⚠ Applications not suitable for the iSave can cause damages to the iSave unit, with risk of personal injury.

3.4 Preferred system design

Danfoss recommends building systems with a high degree of safety. The P&ID in chapter 5.16 shows the Danfoss preferred system design.

⚠
- It is always the system builders' responsibility that the system design does not cause any form of hazard and are adapted to local regulations.
- Proper installation and care of shutdown devices and over-pressure protectio equipment is essential.

4. Arrival inspection, handling and storage

4.1 Arrival inspection

The iSave is packed in a wood container with plugs in the port connections to protect the unit from damage during transport.

Remove all packing materials immediately after delivery. Immediately check the shipment for damage on arrival and make sure that the name plate/type designation is in accordance with the packing slip and your order.

In case of damage and/or missing parts, a report should be drawn up and presented to the carrier at once.

The identification label on the iSave states the specific type, the serial number and the code number of the iSave; see fig. below. The last three digits of the Serial No. indicate the week and year of production.

4.2 Return to the supplier

Flush the iSave with clean water. Drain the iSave and plug the port connections with a cap/cover.

Pack the iSave into a suitable container and make sure that it is suitably fastened to the container.

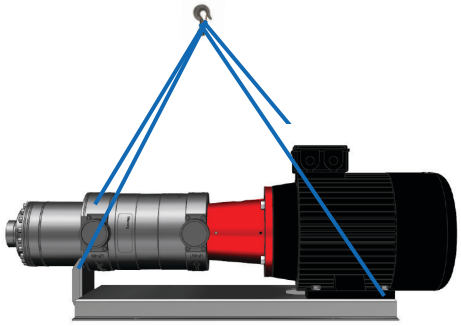
Please contact your local authorised distributor or:

Danfoss A/S
DK-6430 Nordborg,
Denmark
Telephone: +45 7488 2222
Fax: +45 7445 3831
Email: highpressurepumps@danfoss.com
Homepage: hpp.danfoss.com

4.3 Handling

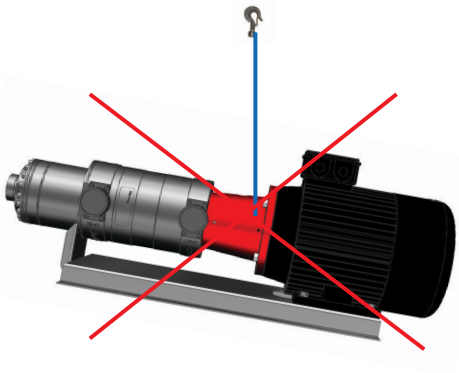
- Personnel involved in lifting and transportation of the equipment must be trained in proper handling and safety procedures.
- Observe the local regulations regarding lifting.
- Use suitable, permitted lifting equipment.
- The iSave (set) could slip the lifting arrangement.
- Be aware of individuals located in the operation area while lifting the component.

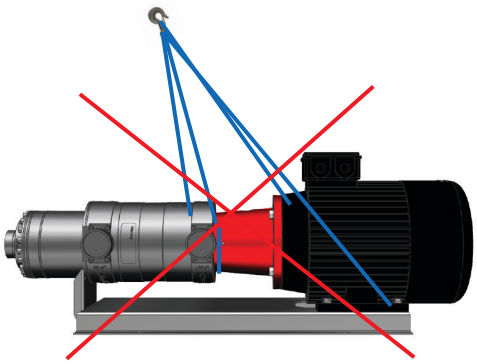
Check the mass (weight) of the iSave unit. All parts weighing more than 20 kg must be lifted using lifting slings and suitable lifting devices, e.g. an overhead crane or industrial truck. All iSave units weight more than 20 kg.



Once the lifting is done the lifting eye must be removed from the pump.

Secure lifting slings around the part of the iSave and the back of the electric motor. Make sure that the load is balanced before attempting the lift.

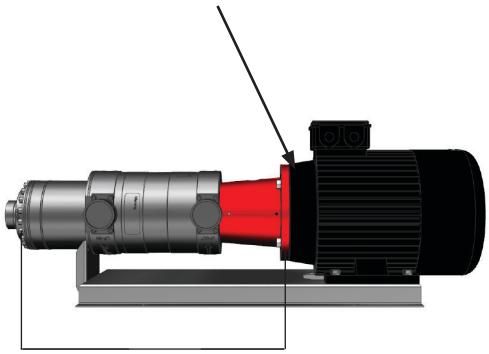




Never lift the iSave unit with only one fastening point.
Incorrect lifting can result in personally injury and/or damage to the unit.

Never lift the iSave in the bell housing.

Incorrect lifting can result in personally injury and/or damage to the unit.



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4.4 Storage

Each iSave is tested before shipment and therefore holds water.
Storage temperature: 1 °C to +70 °C (33 °F to 158 °F) – provided that the pump is drained of fluid and stored “plugged”.

Frost protection is required at temperatures below 1°C. Danfoss recommends using DOWFROST from DOW Chemical Company

or Chillsafe mono propylene glycol from Arco Chemical Company.

If the iSave is protected against frost, the storage temperature can be: -40 °C to +70 °C (-40 °F to 158 °F)

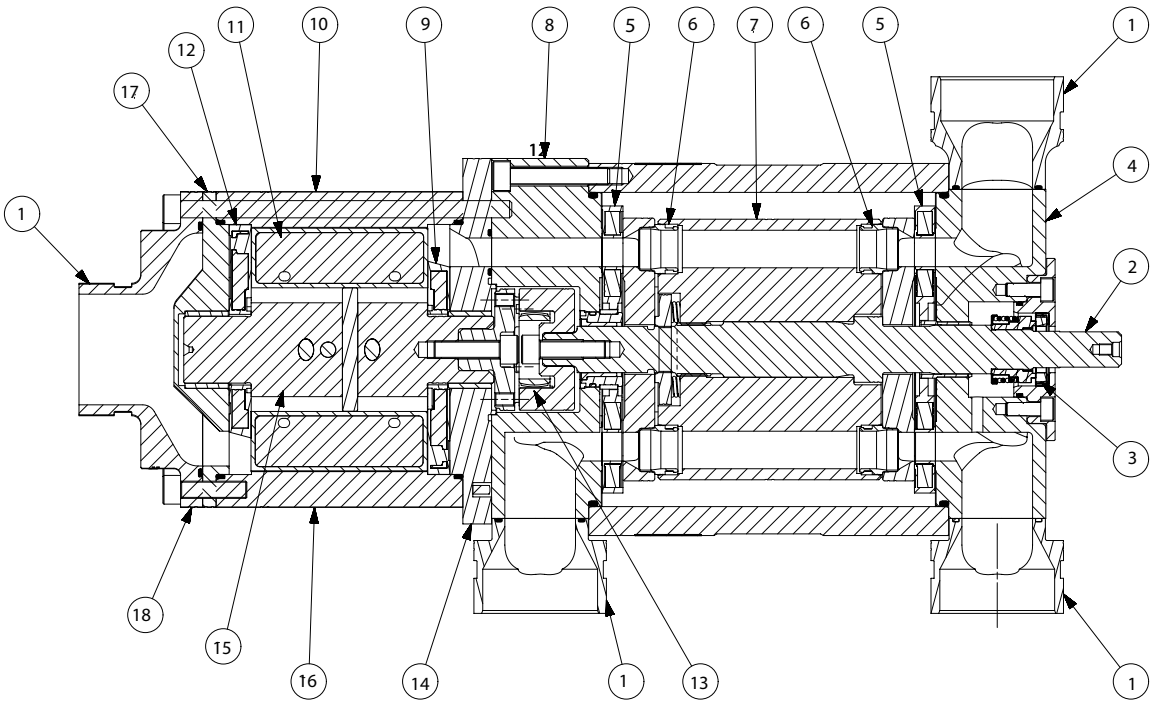
- The iSave is NOT delivered frost-protected from the factory.
- Only remove caps from the openings of the iSave at the time of installation.

4.5 Outdoor Storage

For outdoor storage cover the iSave (set) with waterproof material.

5. Technical data and design review

5.1 Design details



1: 2" Victaulic connections
2: Shaft
3: Low pressure shaft seal
4: Port flange
5: Port plate
6: Valve plate
7: Cylinder drum
8: Port flange
9: Port plate
10: Pins
11: Vanes
12: Port plate
13: Coupling
14: Adapter flange
15: Rotor
16: Stator
17: Port flange
18: Outlet flange

5.2 Sound level of the iSave

The noise level from the iSave including the electrical motor is 78 dB (A). Measurements according to EN ISO 20361. The test is made under following conditions:

1. iSave and electrical motor mounted on Danfoss base plate.
2. Baseplate is isolated from concrete ground by rubber vibration dampers.
3. Flexible hoses are used on high pressure and low pressure sides of the iSave.
4. Rotation speed 1,500 rpm
5. System pressure 60 barg and a booster pressure of 3 barg.

Influences

Since the iSave is mounted on a base plate and connected to the electromotor by a bell housing, the noise level can only be determined for the complete unit (system).

It is therefore important that the iSave unit is mounted correctly on a frame with dampers to minimise vibrations and noise.

It is also strongly recommended to use high-pressure flexible hoses between the hard piping in the RO plant and the iSave. See "hose assembly and installation" in appendix 10.6. Alternative use multiple flexible Victaulic® couplings on the hard piping.

The noise level is influenced by:

- The speed of the iSave. High speed creates more noise than low speed.
- Rigid mounting of the iSave baseplate generates more noise than flexible mounting
- Pipe mounting directly to the iSave increases the noise level compared to flexible hoses.

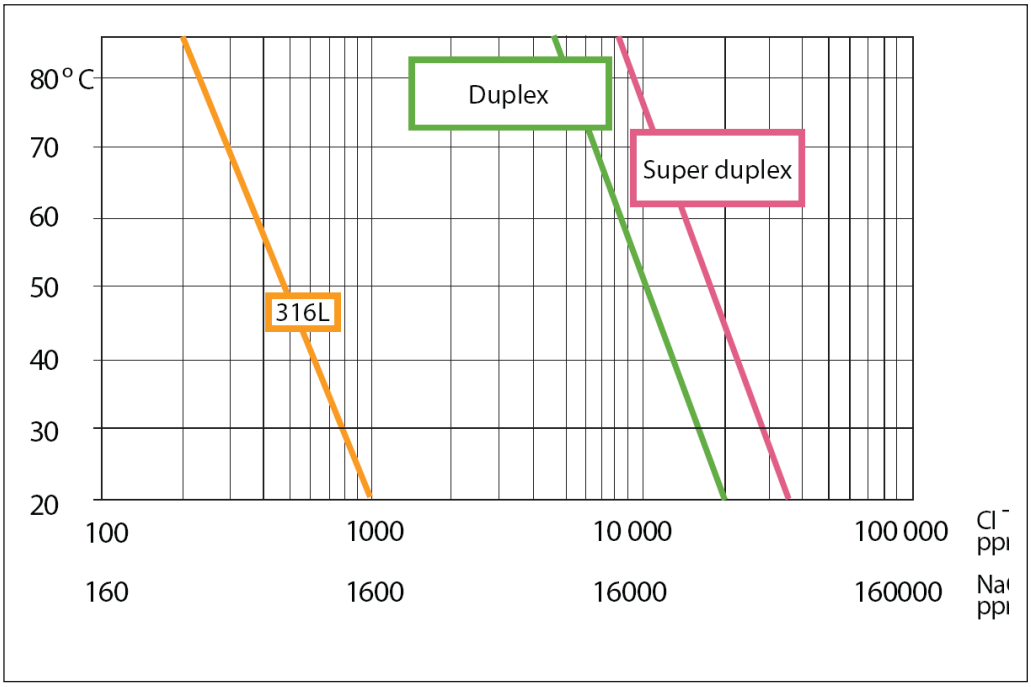
5.3 Materials

All critical parts of the iSave are made of super-duplex 1.4410/UN S32750 or the like. Non-critical parts that are not in contact with sea water are made of AISI 316.
The shaft to the electrical motor is sealed by a standardised mechanical seal.
For a detailed material/part overview see appendix

In order to minimise the risk of crevice corrosion, always flush the iSave according to the specified start/stop procedure.

5.4 Temperature and corrosion

The chart below illustrates the corrosive resistance of different types of stainless steel related to NaCl concentration and temperature.



Depending on the NaCl concentration, the fluid temperature must be between: +2 °C to +50 °C (+35.6 °F to 122 °F).

5.5 Dimensions and weights

For dimensions and weights please refer to the iSave datasheet. See appendix 10.3

5.6 Electrical motor data

See datasheet in appendix 10.3 and "Operating and Maintenance instructions, electric motor" in appendix 10.6

5.7 How does the iSave work?

Figure 5.1 shows a section view of the iSave

The iSave consists of a rotating isobargic pressure exchanger and a positive displacement pump, also called booster pump. The rotation speed of the pressure exchanger and the pump is exactly the same, as they are driven by the same electric motor.

5.7.1 Pressure exchanger function:

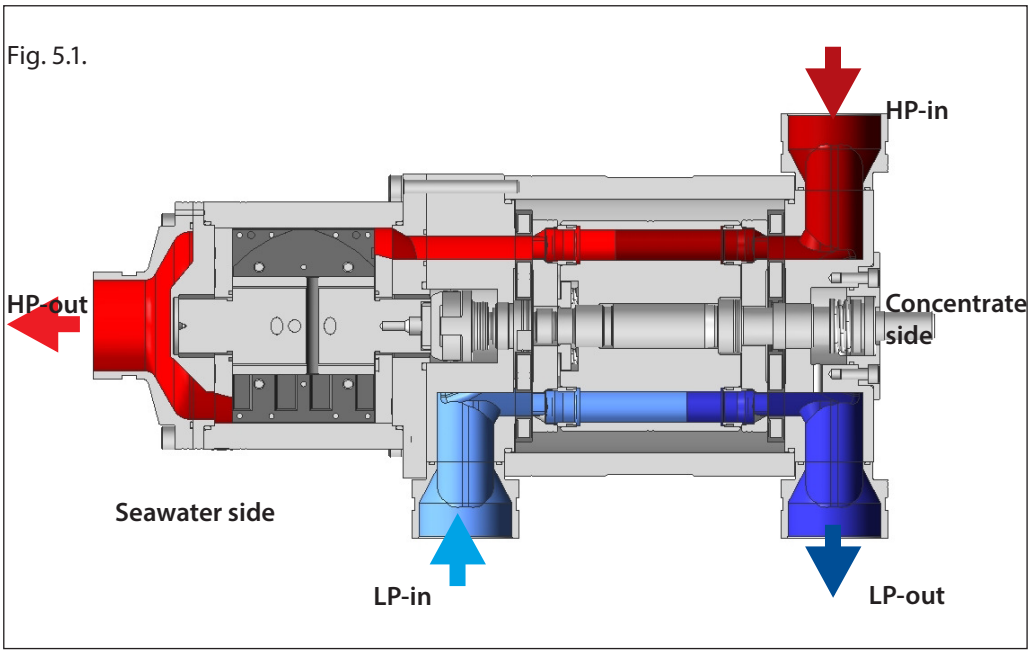
The pressure exchanger consists of two port plates, one at the concentrate side and one at the seawater side. In between there is a rotor with several ducts that connect the concentrate side with the seawater side.
The pressure exchanger transfers pressure from the high-pressure (HP) concentrate (HP in) to the low-pressure (LP) seawater coming from low-pressure feed pump (LP in).
To separate the HP side from the LP side there is a sealing zone on both port plates.
A single duct in the rotor is either on the HP side, or on the LP side or in the sealing zone.
A single duct is never in contact with more than one zone at the time. When the rotor rotates a duct will go from the LP zone over the first sealing zone into the HP zone, and hereafter from the HP zone over the second sealing zone and back to the LP zone.

The flow through the HP side of the iSave is forced and controlled by the booster pump.

When the high-pressure concentrate is flowing into the iSave it pressurizes the sea water in the duct coming from “LP in”. The pressurized seawater is then pumped out of “HP out”. Just before the HP concentrate in the duct comes to the seawater port plate, the duct goes into the sealing zone and the flow in the duct stops. When the duct goes into the LP zone the concentrate water is de-pressurized. The (LP) seawater coming from the LP feed pump (LP in) forces the LP concentrate out of “LP out”.
This pressure exchange process is repeated for each duct with every rotation of the rotor, and the ducts are thus continuously filling and discharging. The flow on the HP side and LP side of the iSave is nearly constant over time.

There is no physical barrier in the ducts between the concentrate and seawater. This means that there will be a small amount of mixing between the two liquids.

Fig. 5.1.



NB!

When the iSave is rotating the water always flows respectively from LP-in to HP-out, AND from HP-in to LP-out. However, if the feed flow into LP-in is higher than the flow into HP-in, some of the LP feed flow will flow directly to LP-out.
When the iSave is not rotating the seawater can only run directly from LP-in to LP-out.

5.7.2 Booster pump

The booster pump is a positive displacement pump, which means that the flow is controlled by the speed of the electric motor; e.g. if the rotation speed of the electric motor is raised by 10%, the flow will be 10% higher and vice versa. The required rpm can be calculated based on the "rated flow" of the particular iSave. See datasheet in appendix 10.3.

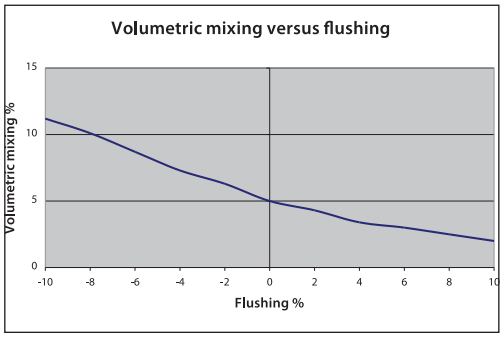
At low speeds you may hear some minor clicking sounds from the pump. This is normal and is caused by the pins in the vane pump.

5.7.3 Lubrication flow

To lubricate the moving parts in the pressure exchanger there is a well defined leak between the port plates and the rotor, as well as in the high pressure bearing between the pressure exchanger and the booster pump. This leak is typically called "lubricating flow". The leaks go from the high pressure side to the low pressure side of the pressure exchanger, and from the booster pump to the low pressure side of the pressure exchanger.

5.7.4 Mixing

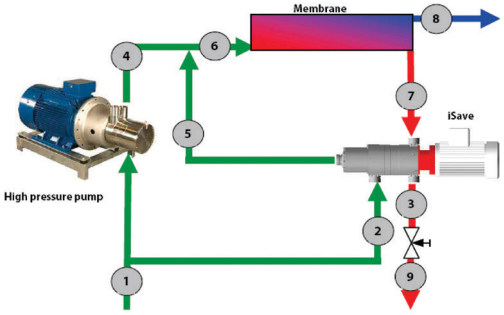
There is no physical barrier in the ducts between the concentrate and seawater. This means that there will be a small amount of mixing between the two liquids. Because the two liquids are in contact for a short amount of time, the mixing is relatively low. On the RO market the mixing rate is defined as "balanced flow" when HP-out is equal to LP-in. Experience from the market shows that the corresponding increase in membrane operating pressure is about 1 barg.



The customer can reduce mixing by over-flushing the LP feed with excess feed water. See figure below. Over-flushing means energy loss. Optimal over-flushing is obtained when the energy loss on LP feed is equal to or less than the energy loss caused by the excess pressure at the membrane.

5.7.5 How does the iSave work in an RO system?

The figure below illustrates a typical flow path of an SWRO or BWRO with an iSave.



The high-pressure (HP) concentrate (7) flows to the low-pressure (LP) concentrate outlet (3).
The LP sea water (2) flows to the HP sea water outlet (5).
The rotor, moving between the high-pressure and low-pressure streams, removes the high-pressure concentrate (7) and replaces it with feed water (2).
The flow rate on the HP sea water outlet (5) is controlled by the iSave alone.
The flow rate on the LP concentrate outlet (3) is controlled by the sea water feed pump (1) and the back pressure valve. This means that changing the LP feed flow (2) will not affect HP outlet flow (5) and, vice versa, that changing the HP outlet flow (5) will not affect the LP outlet flow (3).

As LP sea water (2) is flushing the LP concentrate to LP outlet (3), it is essential that the flow on the LP inlet (2) is equal to or slightly higher than the HP inlet (7). Otherwise there will be an "under-flush" and higher mixing will occur in the HP outlet (5). This higher mixing will result in a slightly higher pressure at the membrane.

The booster pump integrated in the iSave must only overcome the pressure drop from the high-pressure outlet (5) to the high-pressure inlet (7).

During the RO process operation, water is pumped into the HP-membrane feed (6) by the HP pump (4) and the iSave (5). Almost all water coming from the HP pump (4) penetrates the membranes (8). Only a slight amount of the water is used as lubrication flow in the iSave. The lubrication flow is measured as the difference between the HP pump flow rate (4) and the permeate flow rate (8). The resistance to permeate in the membrane pressurises the HP loop.

The isobaric pressure exchanger technology in an SWRO or BWRO change the HP concentrate into HP seawater that is feed into the HP membranes. The iSave energy recovery technology thus significantly reduces flow needed from the main HP pump (4).
Overall energy consumption of a SWRO or BWRO plant using the iSave depends on the recovery rate.

The operator can change the recovery rate to optimise the RO system performance. Changing the recovery rate in an RO system equipped with iSave is easy. Using the VFD, change the speed of the iSave and thereby the flow in the HP flow rate. Then change the LP feed (2) flow to the iSave to minimise mixing and optimise energy consumption. Make sure that flow and pressure are within the rated parameter of the iSave in question.

5.8 Seawater quality

5.8.1 Pre-filtration

It is important that the incoming water is filtered properly to assure optimum service life of the iSave. A true graded density melt-blown depth filter cartridge rated at 3 µm is therefore recommended. Poor pre-filtration of the feed water will result in reduced service life of the iSave.

The iSave may request a different pre-filter of the seawater than the HP pump and other components in the RO system.
As the various filters on the market differ greatly, Danfoss High Pressure Pumps recommends using cartridges with consistent, reliable performance and high efficiency, in which fibres are blown continuously onto a central support core.
Danfoss High Pressure Pumps does not recommend cartridges requiring any type of binders or resins.

It is important with selection of a proper filter housing to ensure good cartridge end sealing. If there is a high risk of water by-pass it is recommended to use a second stage filter solution.

NB!

Filters can be purchased from Danfoss High Pressure Pumps.

5.8.2 Air bubbles

Large bubbles in a pressurised RO system can result in damage to piping and equipment. All air must be bleed from both the LP and HP before the RO system is pressurised. Special consideration should also be given to air bubbles in feed flow, continuously fed into the HP pump and iSave.

5.8.3 Chemicals

The iSave should not be exposed to chemicals that will damage the RO membranes.

5.9 Initial start up and flushing

Prior to the initial start-up, all piping associated with the iSave unit should be thoroughly flushed to assure that no impurities enter the iSave. Inadequate pre-flushing will strongly affect the life of the iSave and may lead to its eventual breakdown.

It is recommended to disconnect all connections to the iSave and to thoroughly flush the piping before the iSave is connected to the inlet and outlet connections.

It is essential that the water used for the final pre-flush is pre-filtered to a level described in chapter 5.8

It is recommended to install temporary basket strainers at both inlets to the iSave during the initial start-up and commissioning.

Also see “Instruction for start and stop of the SWRO with iSave unit” in appendix 10.1.

5.10 Initial start-up and settings of safety equipment

The high-pressure pump feed water into the high pressure line may be able to generate a pressure higher than the maximum allowable pressure in the system. There is thus a risk of personal injury and/or damage to the iSave.

Depending of the type and size of the feed pump of the RO system, this pump may be able to generate a pressure higher than the maximum allowable pressure in the LP system. There is thus a risk that the iSave or the LP equipment could be damaged by over-pressurisation.

To prevent such over-pressurisation, appropriate relief valves should be used and procedures should be implemented to safeguard the HP and LP sides of the iSave and/or the RO system.

5.11 Flushing

RO membranes require periodic flushing to limit biological fouling.
There are two types of flushing: feed water (Seawater) flush and fresh water (Permeate) flush.
Regardless of the flush water used, the water must be pre-filtered to the level described in chapter 5.8. All parts of the iSave must be flushed, i.e. LP- and HP flow channels.

Feed water flushing is part of a normal shutdown sequence. After the HP pump has been stopped, the permeate and concentrate production will continue until the high-pressure drops below the osmotic

pressure. Both the iSave and the LP seawater feed pump must run until the conductivity measured at point (7) and (3) are satisfactory. See also P&ID in chapter 5.16.

Fresh water flushing is performed before every extended shutdown of the RO plant. Permeate is simultaneously fed into the iSave at LP in (2), and either to the HP pump inlet (1) or through some other injection point such as the CIP connections or full flow cleaning connection. See also P&ID in chapter 5.16. Permeate may be produced during this flushing process.

NB! Special attention should be given to the pressure in the HP line (7) as the iSave may start to cavitate when it runs at high speed and the pressure in the HP line (7) drops below 3 bargs. This can be avoided by reducing the speed of the iSave to about 750 rpm and keeping the pressure in the HP line at the minimum of 3 barg. At this low pressure the iSave may only run for a maximum of 10 minutes.

Failing to flush the iSave with fresh water before extended shutdowns may result in extensive biological growth and cause corrosion in the iSave and other equipment in the RO system.

5.12 CIP or membrane cleaning

The purpose of membrane cleaning is to reduce scaling and fouling in the membranes. For optimal performance specific chemicals are required, depending on the cause of the pollution. After chemical treatment the system must be flushed with fresh water.

The flush water coming out of the membranes may consist of a large amount of suspended inorganic particles. It is important to assure that these particles are not lead into the iSave.
It is essential that the water used for the final pre-flush is pre-filtered to a level described in chapter 5.8.
The iSave should not be exposed to chemicals that will damage the RO membranes

Also see instruction “Membrane cleaning of RO system with iSave unit” in appendix 10.2.

5.13 High pressure remains after shutdown

The HP line of the RO system equipped with an iSave can remain pressurised for a long time after shutdown. Pressure decreases as water slowly leaks through the iSave. If more rapid system depressurisation is required, the system should be bled through a suitable valve on the HP concentrate line.

Always check the pressure in the high-pressure lines before making service in the HP lines or pressurised equipment.

5.14 Over-pressurisation caused by low pressure isolation

If the low-pressure side of the iSave is blocked and the iSave is exposed to high-pressure, there is a risk that the iSave or the LP piping could be damaged by over-pressurisation.

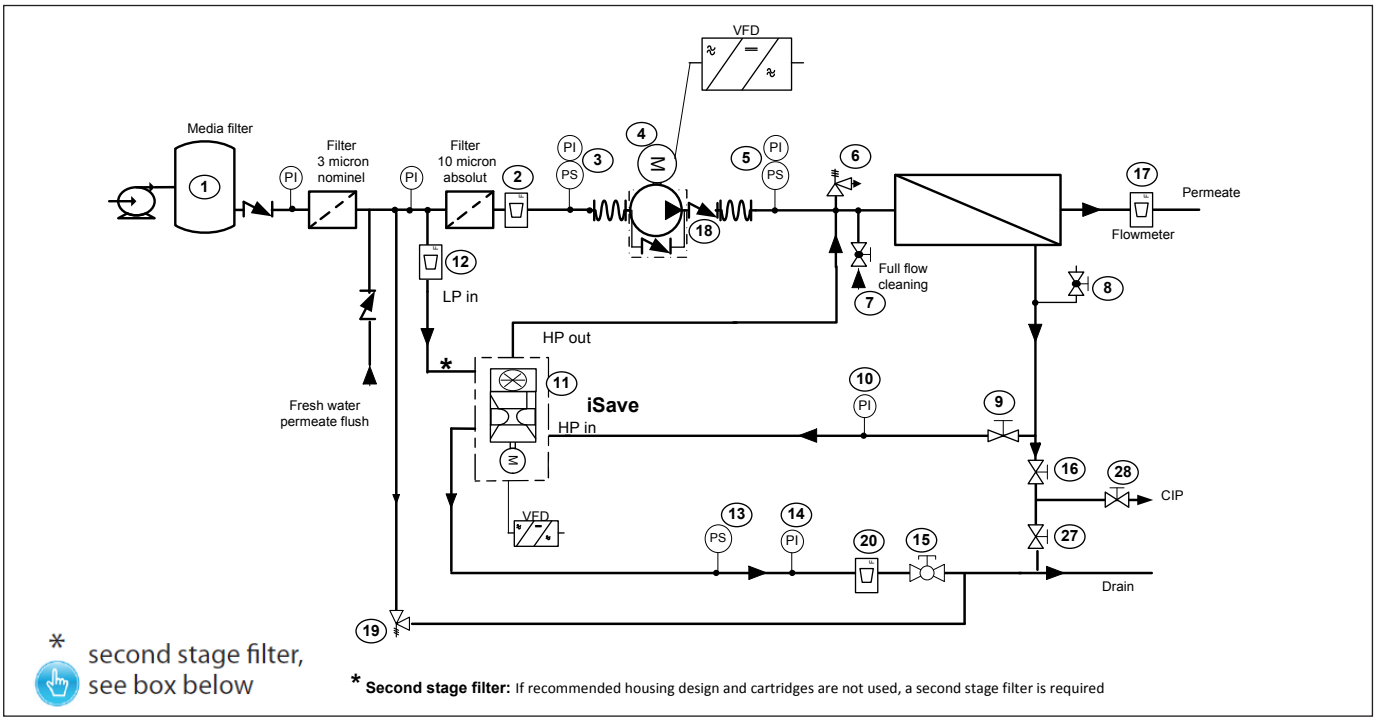
⚠ To prevent such over-pressurisation, appropriate relief valves should be used and procedures should be implemented to assure that the HP of the iSave is depressurised prior to the isolation of the LP side.

5.15 Over-pressurisation caused by the high pressure pump.

The HP pump may be able to generate a pressure higher than the maximum allowable pressure for the iSave or the system – particularly if the HP pump is a positive displacement pump, the pump will be able to generate extremely high levels of pressure.

⚠ To prevent such over-pressurisation, appropriate relief valves should be used and procedures should be implemented to assure that the HP of the iSave is protected against excess pressure.

5.16 Preferred system design and P&ID



Explanation of P&ID setup

- The pressure switch (3) must stop the iSave (11) and the high-pressure pump (4) at pressures lower than the minimum inlet pressure or higher than the allowable maximum pressure.
- The non-return valve (18) prevents the high pressure flow from the membrane to flow back through the HP pump and into the low pressure piping. This may occur when the high pressure pump stops.
- The pressure relief valve (6) protects the entire system against pressure overload and relieves the water if the pressure exceeds the maximum set pressure. If the high pressure pump is a positive displacement pump, the pump can build up a very high pressure that will exceed the mechanical strength of the membrane housing, pipes and other accessories.
- The valve (8) bleeds the air out of the system. The valve must be placed at the highest point in the system.
- The pressure relief valve (19) protects the low pressure pipes against pressure overload and relieves the water if the pressure exceeds the maximum allowable pressure.

- Inlet filters assure proper water quality. High quality water extends the service life of the whole system.
- It is important with selection of a proper filter housing to ensure good cartridge end sealing. If there is a high risk of water by-pass it is recommended to use a second stage filter solution.
- The pressure switch (13) must stop the iSave when the pressure is lower than the minimum inlet pressure or higher than the maximum pressure.

See “Start and stop” procedure, “Membrane cleaning” procedure instruction in appendices 10.1 and 10.2

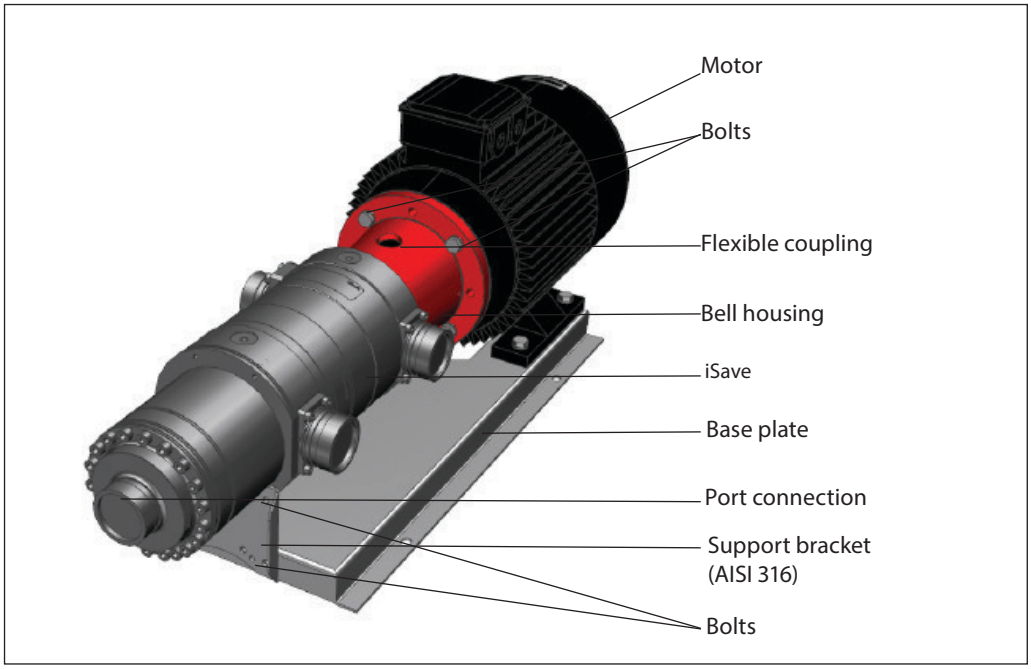
6. On-site installation

6.1 General

For safety instructions see chapter 3.1

6.2 Installation and alignment

The figure below illustrates the major iSave components.
Fig. 1



The iSave is connected to the electric motor by the bell housing and a coupling. The bell housing is not suitable for bearing the weight of either the iSave or the motor. Both the iSave and motor must be supported without applying stress/load to the bell housing.

Danfoss provides the iSave with a baseplate and support brackets. Although the baseplate is of a sturdy design, it can flex or bend when it is bolted to the foundation. The baseplate thus requires a solid foundation such as concrete or rigid steel frame. The baseplate itself must be aligned to avoid bending caused by bolting to an uneven foundation.

A rigid foundation for the iSave assembly is important, and the iSave assembly must be bolted to the foundation.

The bolts used must be of proper design and must be installed in accordance with the bolt manufacturer's recommendations.

To reduce noise it is recommended to use resilient mounts between the baseplate and the foundation. Make sure that the bolts are properly locked and will stay locked over time.

An unlocked bolt can result in personal injury and/or damage to the iSave.

Misalignment of the base plate may cause stress and/or damage to the bell housing.

6.3 Orientation

The iSave can be mounted horizontally and vertically.

When mounted vertically, the electric motor must be placed above the iSave.

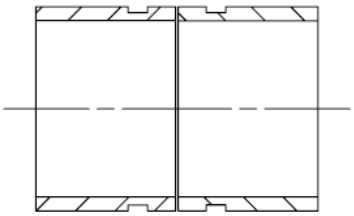
6.4 Piping and joints

Piping material and schedule is of high importance. The strength of the Victaulic® connections is influenced by the material used for both the Victaulic® clamps and the hard piping.
The hard piping and connections used must be of proper design and must be installed in accordance with the manufacturer's recommendations.

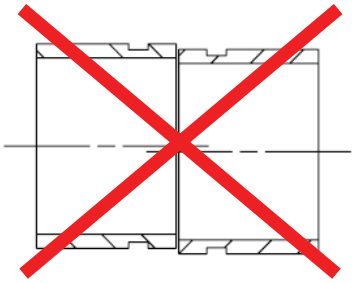
Hard piping to the iSave must be properly aligned to avoid stress on the iSave port connections. Pipe connections must be aligned as shown in the figures below. Don't use the iSave as a strain for hard piping.

Misalignment of the hard pipes may place stress on the iSave port connection and may damage the iSave

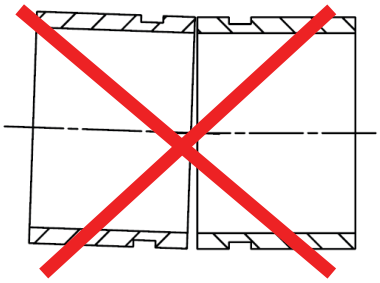
The hard piping and connections used must be of proper design and must be installed in accordance with the manufacturer's recommendations.
A failure to comply with this will or may result in personal injury and/or damage to the iSave.



Correct piping alignment



Incorrect piping alignment



Incorrect piping alignment

6.5 Flexible couplings and flexible hoses

The strength of the Victaulic® connections is influenced by the material used for both the Victaulic® clamps and hose couplings.
The flexible hose and connections used must be of proper design and must be installed in accordance with the manufacturer's recommendations.

See also "Hose assembly and installation" in appendix 10.5

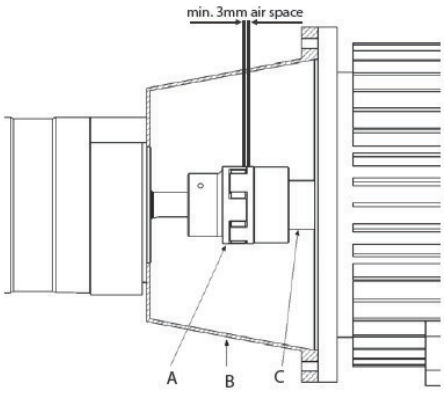
The flexible hose and connections used must be of proper design and must be installed in accordance with the manufacturer's recommendations. A failure to comply with this will or may result in personal injury and/or damage to the iSave.

6.6 Mounting of coupling

The figure below illustrates how to mount the flexible coupling between the iSave and to connect it to the electric motor.

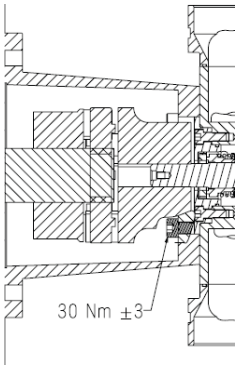
Any axial and radial load on the shaft must be avoided.

A: Flexible coupling
B: Bell housing
C: Motor shaft



6.7 Mounting of bell housing on iSave

The figure below illustrates how to mount the bell housing on the iSave.
Screw the 4 bolts through the bell housing and into the iSave and tighten them to 30 Nm.



6.8 Accessibility

With respect to the service and replacement of the complete iSave unit, it is recommended to maintain sufficient space around the unit.

The space must be sufficient enough to allow for safe lifting of the equipment, with no risk for personal injury and/or damage to the iSave.

6.9 Drives

6.9.1 Electric motor

The iSave must only be driven by an electric motor.

Using anything other than an electric motor can lead to an irreparable fracture of the iSave's internal parts.

6.9.2 Speed control

The rotation speed on the electric motor can be controlled by a VFD.
The direction of rotation is engraved with an arrow on the iSave.

Checking the direction of rotation can be made by:

1. Looking at the fan in the end of the electric motor.
2. Removing the plug in the bell housing and watch the rotation of coupling.
3. Before assembly the iSave on the electrical motor, check the rotation of the shaft on the electrical motor.

Special attention has to be on NON PROTECTED – FREE ROTATING shaft on the electrical motor. Ignorance will or could result in personal injury.

- Running the iSave in the wrong direction for more than a few minutes can cause un-intended wear on the iSave.
- If the electric motor is running at a lower speed, extra care must be taken to ensure that the electric motor is NOT overheated. External cooling may be necessary.

6.9.3 Starting torque on the iSave/ramping the electric motor

Because of the inertia of the iSave internal parts and the fact that the iSave includes a positive displacement pump, the torque will exceed the maximum allowable torque for the iSave when the speed is not ramped up from zero to maximum.

It is required to use a VFD or a soft starter.

A minimum of 10 seconds is required when ramping up the speed from zero to maximum. Otherwise, the torque on the iSave will exceed the maximum limit and may lead to an irreparable fracture of the iSave's internal parts.

6.9.4 Torque overloads protection on the iSave

The electric motor and iSave must always be protected against overload.
Both at start-up and at continues operation the maximum torque on the iSave must be monitored.

The electric motor must be shut of if the maximum torque of the iSave exceeds the defined limit. The response time of the power shutoff to the iSave must be of maximum 1 second.

If more electric motors are powered by the same soft starter or VFD, each electric motor must be equipped with "torque limit equipment" to protect the iSave against overload.

Below are examples of equipment which can measure the load on the electric motor or limit the torque on the iSave.

1. VFD with integrated current monitoring relays.
2. External current monitoring relays.
3. Torque limiter coupling.

See also examples of "iSave overload protection" equipment in appendix 10.5

The electric motor and iSave must always be protected against overload.
Otherwise, the torque will exceed the maximum limit and may lead to an irreparable fracture of the iSave's internal parts.

7. Commissioning, start-up and shutdown

7.1 Safety regulations

The operator ensures that all inspection and installation work is performed by authorised, qualified specialist personnel who are thoroughly familiar with the manual.

Before starting up the iSave and the high pressure pump, make sure that the following requirements are met:

- The iSave has been properly connected to the electric power supply and is equipped with all protection devices in accordance with EN60204-1.
- Check that all motor protections are properly set.
- All safety equipment, auxiliary equipment and connections required are proper connected and operational.
- Check all bolts in all connections and in the foundation of the iSave and the pumps.

7.2 Support

Danfoss A/S offers commissioning and service at system manufacturer's location. Rate quotes are offered upon request.

7.3 Commissioning

Before starting up the iSave and the high pressure pump make sure that the following requirements are met:

- All pipes are flushed, free from debris and full of water.
- The iSave has been bled and is full of water.
- At pressure lower than 10 bargs, check the system for leakage.

Slowly raise the pressure in the system and set all pressure switches to the correct limit and continually check all connections for leakage.

- Set pressure relief valve on both low and high pressure at the maximum system pressure.
- Check high pressure hoses for proper assembly and inspect for externa leakage for all connections.
- At low pressure, start the iSave and check direction of rotation.
- Start the system according to the "Start and stop procedure" instructions in appendix. 10.1

8. Service/ Maintenance

8.1 Safety regulations

The operator ensures that all maintenance, inspection and installation work is performed by authorised, qualified specialist personnel who are thoroughly familiar with the manual.

Before intervening in the iSave/system;
- The power must be shut off and the starting device be locked.
- The pressure in the High Pressure lines must be drained to the Low Pressure side.
- The Water in all connected pipes must be drained.

Always use suitable safety and lifting equipment when handling the iSave, and follow the instructions in chapter 4.3

- When saftey equipment has been adjusted make sure that proper re-adjustment has been made before start-up.
- When the system is re-started after service and maintenance follow the instructions in chapter 7 and in “Start and stop procedures” in appendix. 10.1

8.2 Support

Danfoss A/S offers commissioning and service at the system manufacturer’s location. Rate quotes are offered upon request.

8.3 Maintenance schedule

The schedule of preventive maintenance below will help ensure that the iSave provides years of trouble-free performance.

One day after commissioning:

1. Re-check bolts in the foundation and the baseplate of the iSave and tighten the bolts to specified torque if necessary.
2. Visually inspect all pipe connections / couplings for external leakage.
3. Re-check bolts in all pipe connections / couplings and tighten the bolts to specified torque if necessary.
4. Replace filters if necessary
5. Clean the filter housing and reinstall filters. Make sure no debris enters the system.

Three months after commissioning:

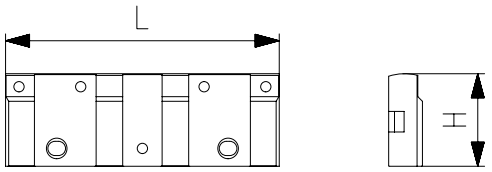
1. Re-check bolts in the foundation and the baseplate of the iSave and tighten the bolts to specified torque if necessary.
2. Re-check alignment of iSave baseplate and iSave.
3. Visually inspect all pipe connections / couplings for external leakage.
4. Re-check bolts in all pipe connections / couplings and tighten the bolts to specified torque if necessary.
5. Replace filters if necessary.
6. Clean the filter elements and install the new filters. Make sure no debris enters the system.
7. Audibly inspect the iSave assembly. If there is irregular sounds or vibrations inspect the internals parts of the iSave and replace if necessary.

8,000 hours of operation after commissioning:

1. Re-check bolts in the foundation and the baseplate of the iSave and tighten the bolts to specified torque if necessary.
2. Re-check alignment of iSave baseplate and iSave.
3. Visually inspect all pipe connections / couplings for external leakage.
4. Re-check bolts in all pipe connections / couplings and tighten the bolts to specified torque if necessary.
5. Replace filters if necessary.
6. Clean the filter elements and install the new filter. Make sure no debris enters the system.
7. Audibly inspect the iSave assembly. If there is irregular sounds or vibrations inspect the internals parts of the iSave and replace if necessary.
8. Visually inspect pump coupling and replace if necessary.
9. Audibly inspect the iSave assembly. If there is irregular sounds or vibrations inspect the internals parts of the iSave and replace if necessary.
10. Check power consumption and flow out of the iSave. If there is irregular performances inspect the internals parts of the iSave and replace if necessary.
11. Inspect and replace, if necessary, the vanes in the vane pump.

Dimensions of the vanes

iSave type	iSave 21 Plus
Original height (H)	27 mm
Change when H is less than	26 mm
Original length (L)	79.84 mm
Change when L is less than	79.64 mm



Annually:

1. See above section: **"8,000 hour of operation after commissioning".**
2. See **"Operating- and maintenance instruction, electric motor" in appendix 10.6**

Follow manufacturer's recommendations for electric motor service and maintenance.

9. Trouble-shooting

9.1 Safety regulations

The operator ensures that all inspection and installation work is performed by authorised, qualified personnel who are thoroughly familiar with the manual.

Before intervening in the iSave/system;

- The power must be shut off and the starting device be locked.
- The pressure in the high-pressure lines must be drained to low-pressure side.
- The water in all connected pipes must be drained.

The numbers in () correspond to the preferred system design and P&ID

Problem	Possible cause	Action
VFD can't start the iSave at initial start-up.	VFD is not designed for constant torque.	Choose a VFD that is designed for constant torque.
	Ramp-up settings in the VFD is not correct. VFD is tilting.	Set Ramp-up parameters correct.
	Valve (9) is closed	Open valve (9)
	Pressure in the HP line (5) is too high	Start the iSave only when the pressure in the HP line is low.
Torque on iSave too high during operation	Pressure difference from HP-out (5) to HP-in (10) is too high.	Clean or change membranes.
		Debris in the booster pump or iSave.
		Wear in the booster pump or iSave.
		Design of the basic plant doesn't fit the performance of the iSave.
Permeate production is too low (17).	Valves (6), (7), (8) or (16) are leaking.	Repair or change valve.
	Internal leakage in iSave	Repair iSave
	HP pump flow (2) is to small	Incorrect speed on the HP pump.
		Check the HP pump and repair if necessary.
Pressure on the membranes (5) is too high.	Fouling on the membranes	Clean the membranes
	Mixing in the iSave is too high.	Check flow on LP-in (12) and adjust flow.
	Flow out of the iSave is too low, causes a recovery rate that is too high.	Check speed on iSave and change if necessary.
		Booster pump in the iSave is worn out. Perform service on the VP.
Pressure on the membranes (5) is too low.	Valves (6), (7), (8) or (16) are leaking.	Repair or change valve (s).
	Internal leakage in iSave	Repair iSave
	HP pump flow (2) is too small	Incorrect speed on the HP pump.
		Check the HP pump and repair if necessary.

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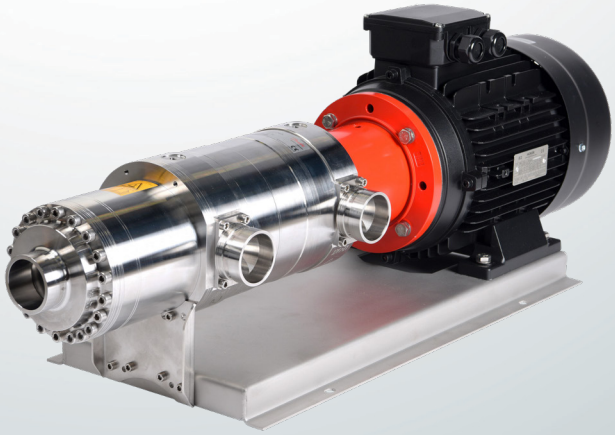
Appendices

Energy Recovery Device
iSave 21 Plus
Installation, Operation and Maintenance Manual



10. Appendix

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Design guide

iSave Energy Recovery Device

Start and stop of the SWRO with iSave

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Table of Contents

Below procedures are general guidelines for the start-up and shut-down functions of SWRO-systems with the Danfoss iSave Energy Recovery Device.
Procedure details may differ depending on the system design.
The numbers marked in () refer to the diagram on page 5.

iSave can be both a single iSave and multiple iSaves in parallel.

General SWRO system understanding with ISave

- Basically the permeate flow is the same as the flow from the high-pressure pump.
- The HP concentrate flow into iSave HP-in and HP seawater-out is determined by the rpm of the iSave.
- The iSave (s) HP flow determines the recovery rate (higher rpm on the iSave gives lower recovery rate and vice versa).
- Flow on the low-pressure side of the iSave is determined by feed pump and the pressure control valve LP-out (15) (not by the rpm of the iSave).
- The flow on the low-pressure side must be at least the same as on the high-pressure side of the iSave (LP in flow = HP in flow; this is called balanced flow).
- Continuously operation:
- To minimize mixing, the flow on the low-pressure side can be adjusted up to 10% higher than the high-pressure flow with the limitation that the flow rate at LP inlet may not exceed 70 m^3/h.

Prior to start-up

High quality water extends the service life of the whole system.
Both the APP pump and iSave are sensitive to hard particles.
Before connecting any APP pump or iSave to a piping system **ALL** pipes must be thorough flushed with high quality pre-filtered water or mechanical cleaned.

1. Install all filter cartridges in the system.
2. With the iSave(s) and APP pump(s) *disconnected* from the piping, the system must be flushed in order to remove possible impurities from the system (pipes, hoses, membranes etc.).
   Flushing must run until the system can be ensured clean.
3. Connect the iSave(s) and APP pump(s) to the pipework. The iSave(s) and APP pump(s) are now ready for start-up.

Starting up the system

1. Make sure that all valves are set in normal operating positions.
2. Start the seawater supply pump (A).
3. Make sure all pipework is flushed with water. Vent all air from the system through air valve (8) and iSave unit (11). After venting, close valve (8).
   At initial start-up also bleed the iSave(s) and APP pump(s).

4. Start the iSave(s).
   In general: Only start the iSaves when the pressure "HP in" (10) is below 20 barg/290 psig. Always start the iSave unit before the high-pressure pump is started.

   There are in principle two ways to start multi ple iSaves:
   - Slowly ramp up all the iSaves at the same time.
   - Slowly ramp up one by one.

   Starting sequence - one by one:
   a) Start iSave #1.
   b) After 5 sec. start iSave #2.
   c) In a sequence of 5 sec. start the remaining iSaves.
   Comments:
   - Ramp up time on iSaves is set between 10 –15 sec.

   Starting sequence - Start all iSaves at the same time.
   Comments:
   - Ramp up time on iSaves is set between 10 –15 sec.

   If the pressure (10) at "HP in" drops below 3 barg/43.5 psig, the sound will change of the iSave. This is due to cavitation. "HP in" pressure at 3 barg/43.5 psig is acceptable for less than 10 min. within a period of 6 hours.
   If possible run the iSave at its min allowable speed to reduce cavitation.

5. With a pressure control valve (15), adjust the back pressure of the "LP-out" to fulfill the minimum presure requested in the Data sheet. (May only be necessary at initial start up).

6. An "over flush" of the iSave can be done to bleed any remaining air from the system. Flush over a period of minimum 2 minutes.

7. Adjust the speed of the iSave unit to desired flow (rpm). The speed is controlled by a VFD.

8. Start the high-pressure pump(s) (4), and the system pressure (5) will rise until the permeate flow (17) almost equals the flow (2) from the high-pressure pump.

9. **For iSave 21 and iSave 40:**
   Check the low pressure flow rates (12), and if required, adjust flow with valve (15) to achieve balanced flow to the iSave(s).

   1. If the "LP-in" flow (12) is too low and the "LP-out" pressure (14) is higher than 1 barg/14.5 psig, increase flow and decrease pressure by opening the pressure control valve (15).
   2. If the "LP-in" flow (12) is too low and the "LP-out" pressure (14) is below 1 barg/ 14.5 psig, adjust the flow by raising the flow from the seawater supply pump (A).
   3. If the "LP-in" flow (12) is too high, reduce flow by closing the pressure control valve (15) or the flow from the seawater supply pump (A).

10. **For iSave 50 and iSave 70:**
    Check the low pressure flow rates (12), and if required, adjust flow with valve (15) to achieve balanced flow to the iSave(s).

    1. If the "LP-in" flow (12) is too low and the "LP-in" pressure (21) is higher than 2 barg/29 psig, increase flow and decrease pressure by opening the pressure control valve (15).
    2. If the "LP-in" flow (12) is too low and the "LP-in" pressure (21) is below 2 barg/ 29 psig, adjust the flow by raising the flow from the seawater supply pump (A).
    3. If the "LP-in" flow (12) is too high, reduce flow by closing the pressure control valve (15) or the flow from the seawater supply pump (A).

Daily system shutdown

1. The system is running in normal operation and producing permeate flow.

2. Stop the high-pressure pump (4).

3. Keep the iSave(s) (11) running until the TDS in the high-pressure line is equal to the TDS in the low-pressure line.
   NB! If the pressure (10) at "HP in" drops below 3 barg/43.5 psig, the sound will change of the iSave. This is due to cavitation. "HP in" pressure at 3 barg/43.5 psig is acceptable for less than 10 minutes within a period of 6 hours.
   If possible run the iSave at its minimum allowable speed to reduce cavitation.

4. Stop the iSave(s)(11).

5. Stop the seawater supply pump (A).

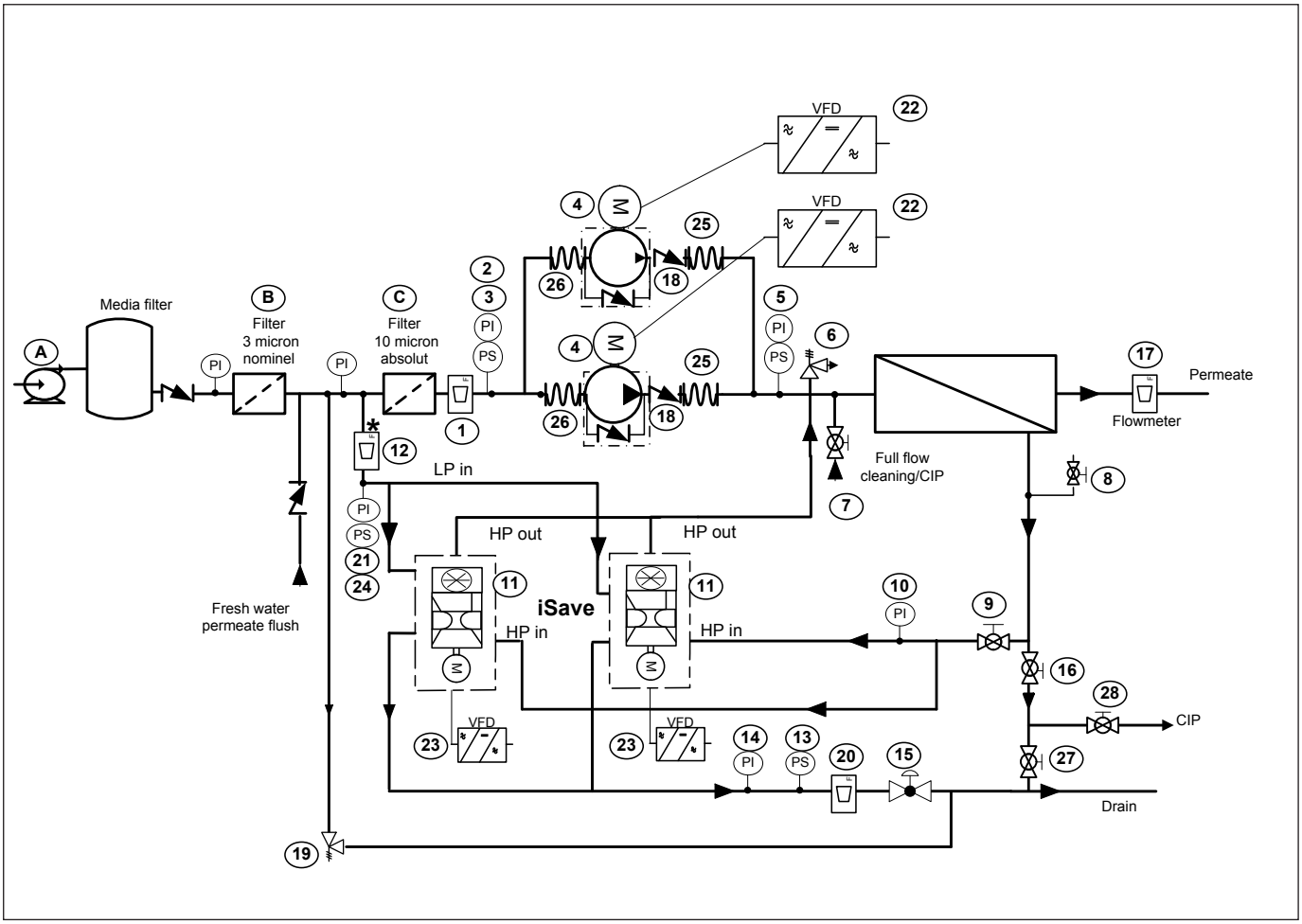
More than one day system shutdown

1. Run the "daily system shutdown" procedure.
2. Supply permeate water to the SWRO system by using fresh water/permeate flush connection..
3. When the pressure "HP in" (10) is below 20 barg/ 290 psig start the iSave(s).

   NB! If the pressure (10) in "HP in" drops below 3 barg/43.5 psig, the sound will change of the iSave. This is due to cavitation. "HP in" pressure at 3 barg/43.5 psig is acceptable for less than 10 minutes within a period of 6 hours.

   If possible run the iSave at its minimum allowable speed.

4. Start the APP pump(s) in a period of 5 sec. by using normal ramp-up settings.
5. Stop the APP pump(s) after 5 sec.
6. Run the iSave(s) until the TDS in the high-pressure line is equal to the TDS in the low-pressure line.
7. Stop iSave(s) and permeate water supply.



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Design guide

Energy Recovery Device
iSave
Membrane cleaning of RO-system

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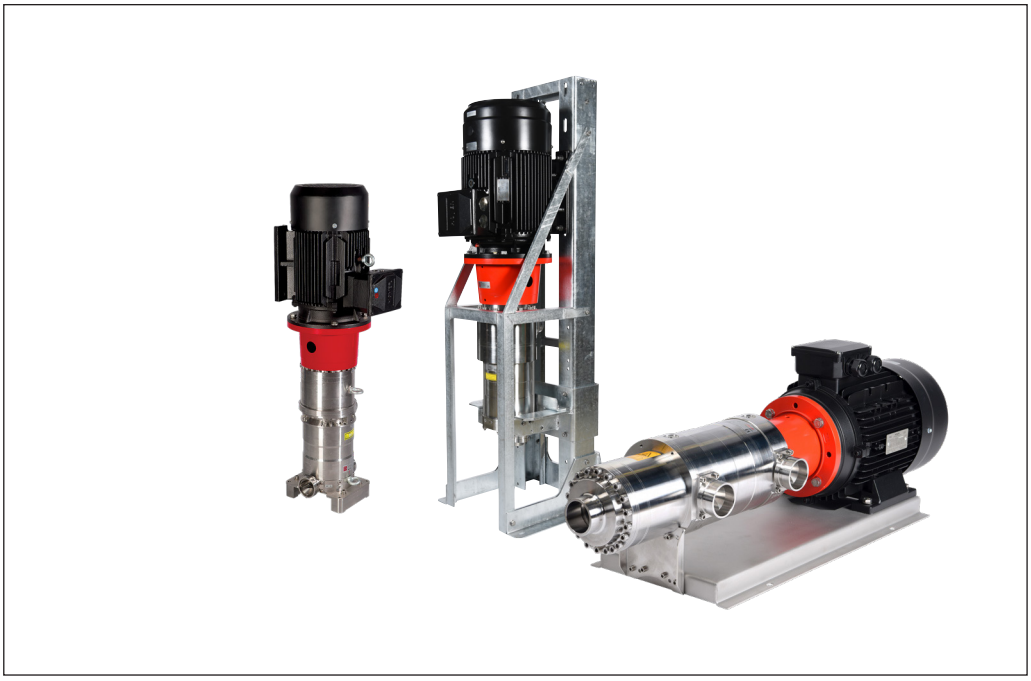


Below procedures are general guidelines for the membrane cleaning of SWRO-systems with the Danfoss iSave. Procedure details may differ depending on the system design.
The numbers marked in () refer to the diagram's below.

The purpose of membrane cleaning is to reduce scaling and fouling in the membranes. For optimal performance specific chemicals are required, depending on the cause of the contamination. After chemical treatment the system must be flushed with fresh water. The flushing water, coming out of the membranes, may consist of a large amount of suspended inorganic particles. It is important to assure that these particles are not fed into the iSave(s) or pump(s).

NB! It is recommended to disconnect the piping from the "HP in" of the iSave and flush the contaminated water from the membranes directly to drain. By disconnecting the pipes there will be no accumulation of contaminations in the HP-piping and HP-valves. See P&ID no 2.

Membrane cleaning

The procedures below are based on Dow's Cleaning and Sanitization: Cleaning steps described in Dow's Form No. 609-02090-1005. Other procedure may be used depending on the membranes used.

Below procedure is according P&ID no 1.

1. Stop the high-pressure pump(s) (4), and stop the iSave(s) (11).

2. Stop the seawater supply pump (A).

3. Close valve (9 and 27) and open valve (16 and 28), and feed cleaning solution through valve (7).

4. Pump mixed cleaning solutions to the vessel at conditions of low flow rate and low pressure to displace the process water. Use only enough pressure to compensate for the pressure drop from feed to concentrate. The pressure should be low enough that essentially no or little permeate is produced. A low pressure minimizes re-deposition of dirt on the membrane. Dump the brine/ concentrate to prevent dilution of the cleaning solution.

5. Recycle: After the process water is displaced, cleaning solution will be present in the concentrate/ brine stream. Recycle the cleaning solution from the piping to the cleaning solution tank.

6. Turn of the pump and allow the elements to soak.

7. Feed the cleaning solution at high flow into the "full flow cleaning" adapter (7). The high flow rate flushes out the foulants removed from the membrane surface by the cleaning.

8. Flush RO permeate or deionised water into the "full flow cleaning" adapter (7). Flush out the cleaning solution. It is essential that the water used for the final pre-flush is pre-filtered to a level described in the datasheet.

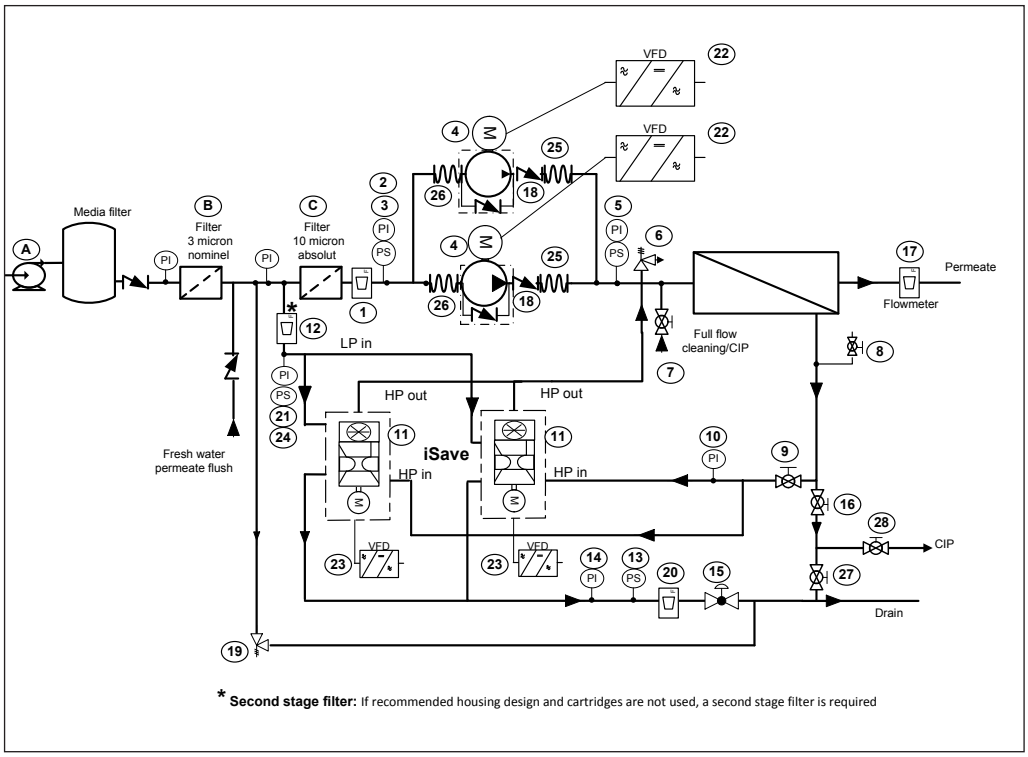
9. Open valve (9) and continue flushing. The iSave(s) may start to rotate backward – this is OK.

10. When flushing is finalised – assure that no foulants remain in the piping or valve (9).

11. Close the high pressure "full flow cleaning" valve (7) and close valve (16 and 28).

12. Open valve (27)

P&ID no. 1



Below procedure is according P&ID no 2.

1. Stop the high-pressure pump(s) (4), and stop the iSave (11).

2. Stop the seawater supply pump (A).

3. Disconnect pipe in joint (9) and connect the pipe to low pressure "Full flow cleaning" joint (16).

4. Plug pipe in joint (9).

5. Close valve (27) and open valve (28)

6. Pump mixed cleaning solutions through valve (7) to the vessel at conditions of low flow rate and low pressure to displace the process water. Use only enough pressure to compensate for the pressure drop from feed to concentrate. The pressure should be low enough that essentially no or little permeate is produced. A low pressure minimizes re-deposition of dirt on the membrane. Dump the brine/ concentrate to prevent dilution of the cleaning solution.

7. Recycle: After the process water is displaced, cleaning solution will be present in the concentrate stream. Recycle the cleaning solution from the piping to the cleaning solution tank.

8. Turn of the pump and allow the elements to soak.

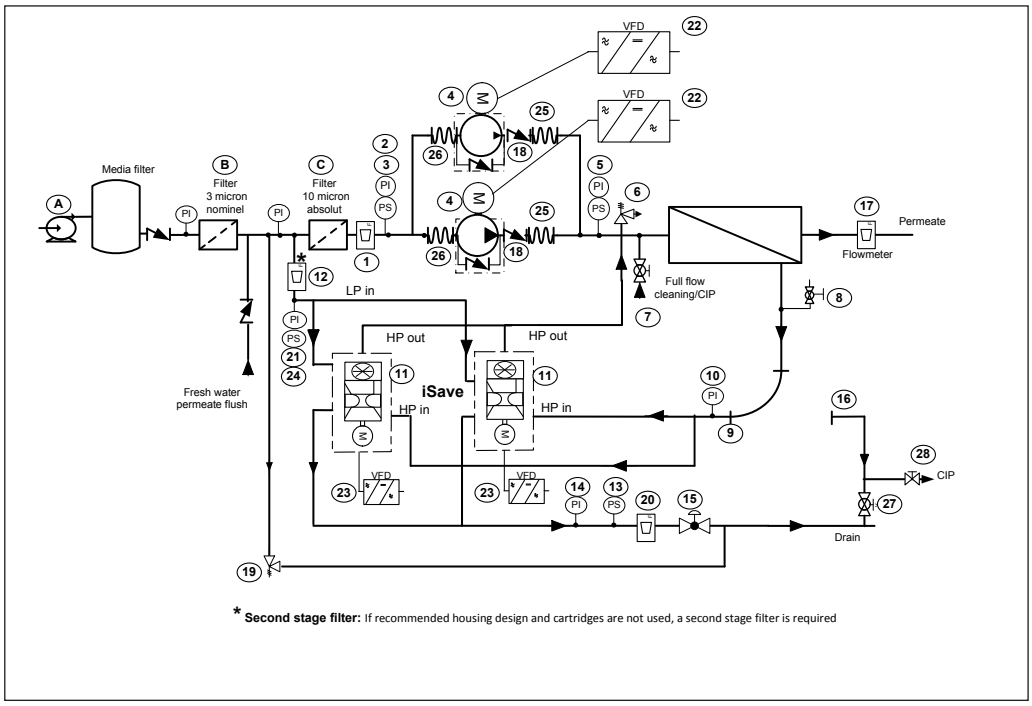
9. Feed the cleaning solution at high flow into the "full flow cleaning" adapter (7) on the feed side of the membrane. The high flow rate flushes out the foulants removed from the membrane surface by the cleaning.

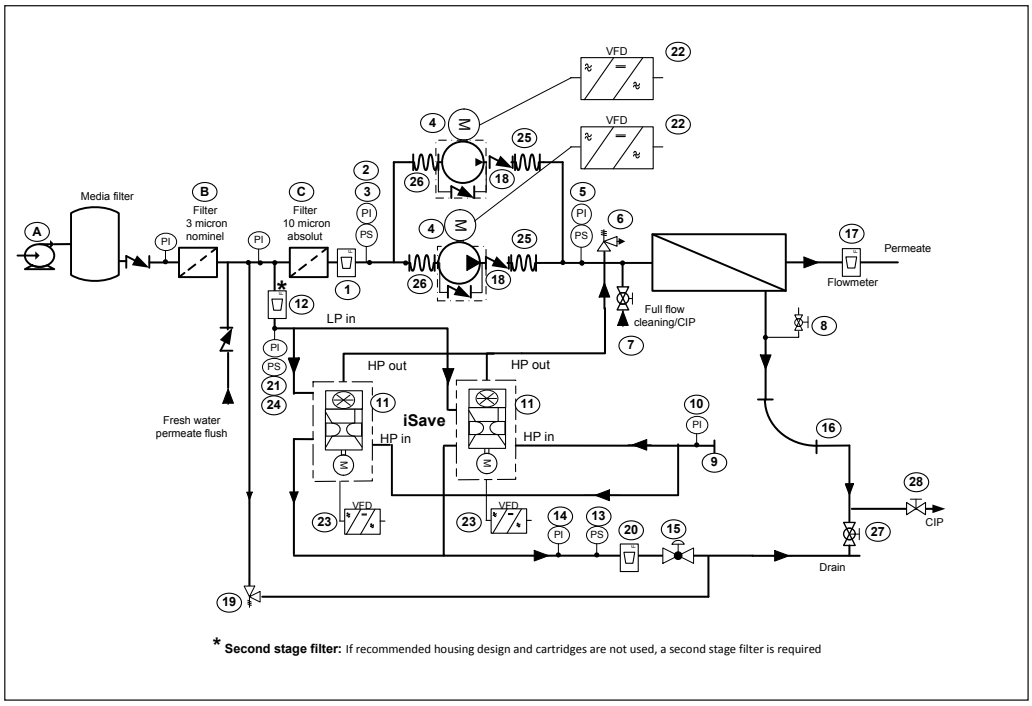
10. Flush RO permeate or deionised water into the "full flow cleaning" adapter (7) on the feed side of the membrane. Flush out the cleaning solution.
    It is essential that the water used for the final pre-flush is pre-filtered to a level described in the datasheet.

11. When flushing is finalised – Close the high pressure "full flow cleaning" valve (7) and close valve (28).

12. Connect the high pressure pipe to joint (9) again.

P&ID no. 2





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ENGINEERING
TOMORROW

Data sheet

Energy Recovery Device
iSave 21 Plus / iSave 40

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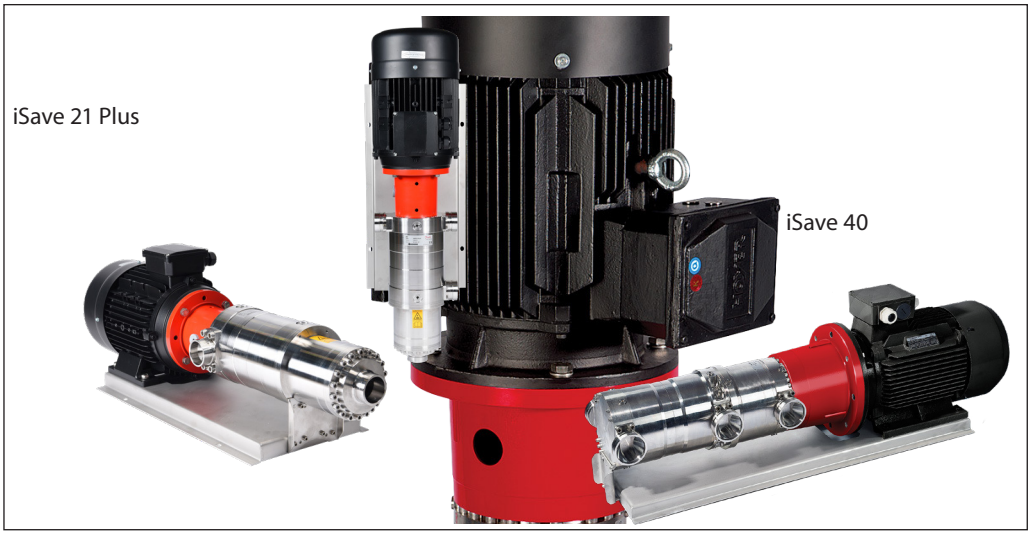
1. General information



The iSave 21 Plus and iSave 40 consists of an isobaric pressure exchanger, a high-pressure positive displacement booster pump and an electric motor.

The isobaric pressure exchangers are based on the technology used in the Danfoss APP pumps, and the high-pressure booster pumps are based on the vane pump principle enabling a very light and compact design. The design of iSave 21 Plus and iSave 40 ensures lubrication of the moving parts by the fluid itself.

All parts included in the iSave 21 Plus and iSave 40 are designed to provide long service life with a constant high efficiency and minimum service required.

The vane pumps are fixed displacement pumps in which the flow is proportional to the number of revolutions of the driving shaft – enabling flow control.

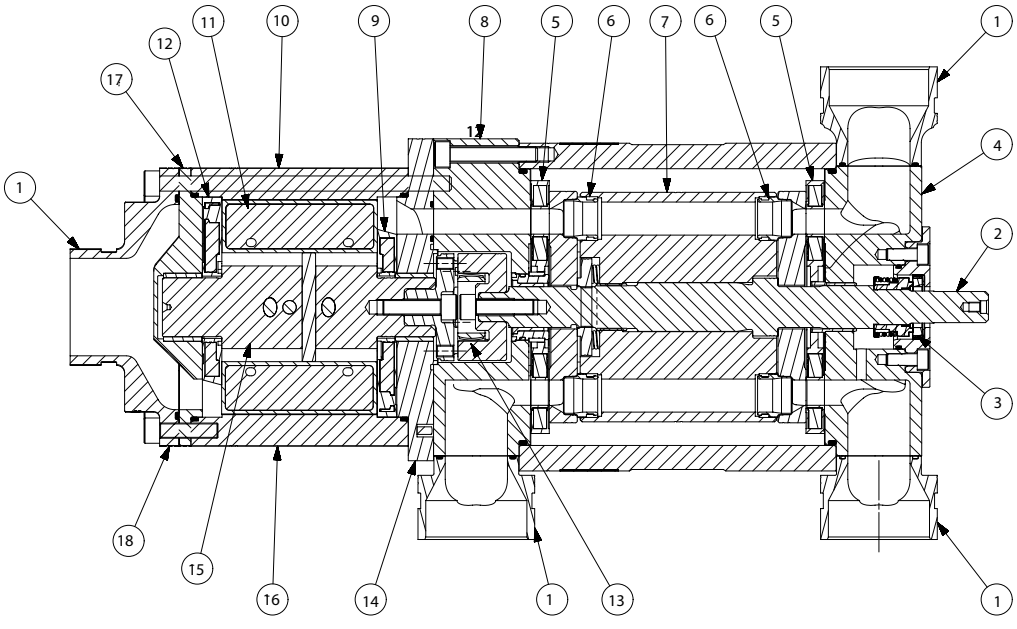
The electric motor provides speed control of both the pressure exchanger and the high-pressure booster pump on the same shaft – preventing overspin/overflushing.

The iSaves need a VFD that allows the motor to apply a constant torque from low speed to maximum speed.

The sectional drawings below illustrate the main components of the iSave 21 Plus and iSave 40, respectively

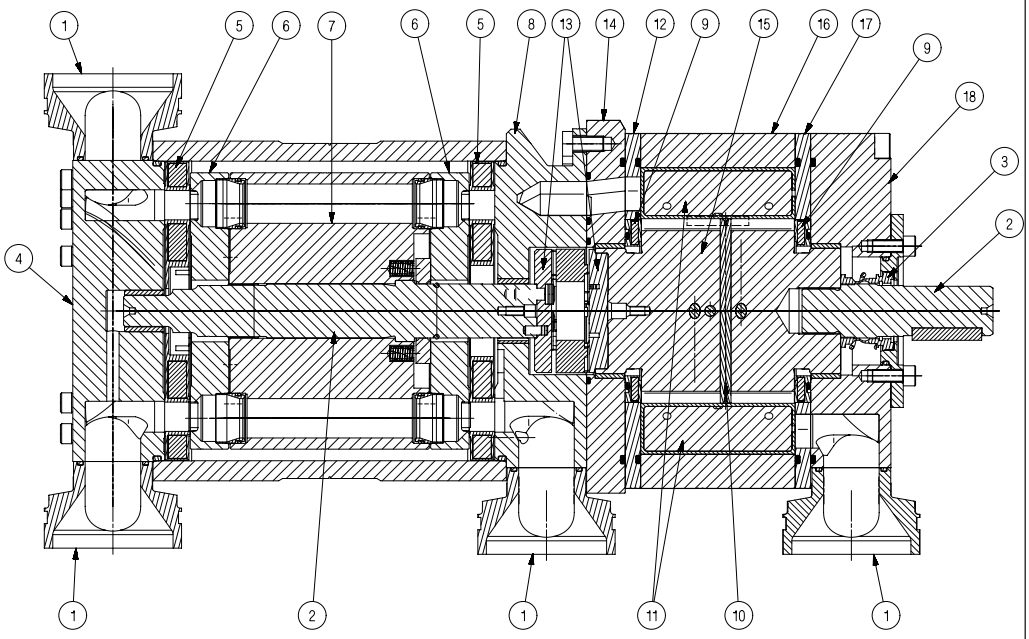
1.1 iSave 21 Plus

1. 2" Victaulic connections
2. Shaft
3. Low pressure shaft seal
4. Port flange
5. Port plate
6. Valve plate
7. Cylinder drum
8. Port flange
9. Port plate
10. Pins
11. Vanes
12. Port plate
13. Coupling
14. Adapter flange
15. Rotor
16. Stator
17. Port flange
18. Outlet flange



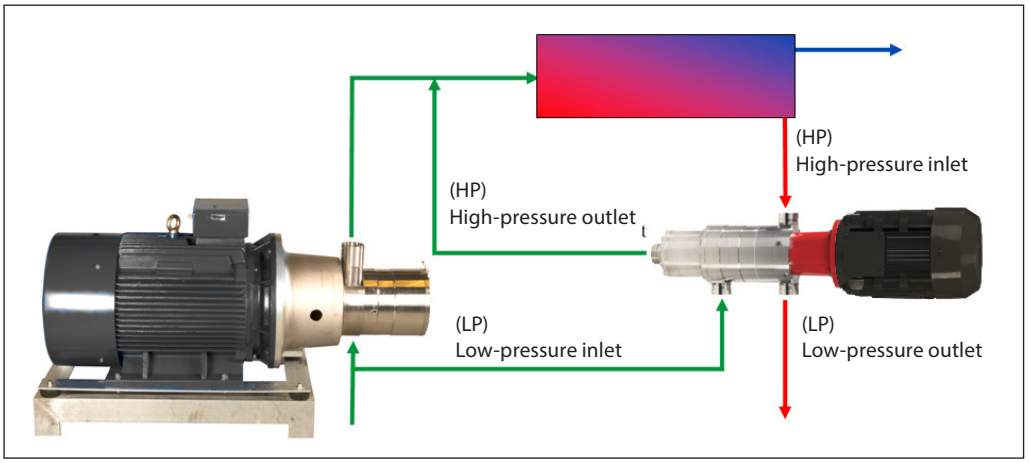
1.2 iSave 40

1. 3″ Victaulic connections
2. Shaft
3. Low pressure shaft seal
4. Port flange
5. Port plate
6. Valve plate
7. Cylinder barrel
8. Port flange
9. Sealing plate
10. Pins
11. Vanes
12.Port plate
13. Coupling
14. Adapter flange
15. Rotor
16. Stator
17. Port plate
18. Outlet flange



2. Benefits

- One of the smallest and lightest energy recovery devices on the market
- Few components
- High efficiency
- No need for high-pressure flow meters
- No expensive high-pressure mechanical seal
- No risk of over spin/over flushing
- Easy modular service
- All parts of the device are made of high corrosion-resistant materials e.g. Super Duplex



3. Technical data

3.1 iSave without motor

iSave size		iSave 21 Plus	iSave 40
Code number		180F7015	180F7011
Geometric displacement	cm^3/rev	273	626
	In^3/rev	16.7	38.2
Pressure			
Differential pressure HP in - HP out max. [1]	bar	5	5
	psi	72.5	72.5
HP max. outlet pressure	barg	83	83
	psig	1200	1200
HP min. inlet pressure	barg	15	20
	psig	217	290
HP max. inlet pressure	barg	83	83
	psig	1200	1200
HP inlet min. pressure, intermittent [2] [3]	barg	3	3
	psig	44	44
LP inlet max. pressure	barg	5	5
	psig	72	72
LP inlet max. pressure intermittent [3]	barg	10	10
	psig	145	145
LP outlet min. pressure	barg	1	1
	psig	14.5	14.5
LP differential LP in - out at HP max. flow	bar	0.9	1.2
	psi	13	17.5
Speed			
Min. speed	rpm	500	600
Max. speed	rpm	1500	1200
Typical flow			
HP outlet flow range [4] at max. differential pressure	m^3/h	6-22	21-41
	gpm	26-96	92-180.5
Lubrication flow at 60 barg (871 psig) max.	m^3/h	0.4	0.8
	gpm	1.8	3.5
LP inlet max. flow	m^3/h	33	67
	gpm	145	295
Torque			
Torque at max. differential pressure operation [1]	Nm	49	102
	lbf-ft	36	75
Max. starting torque (stick/slip)	Nm	50	150
	lbf-ft	37	110
Media temperature [5]	°C	2-40	2-40
	°F	36-122	36-122
Ambient temperature	°C	0-50	0-50
	°F	32-104	32-104
Filtration requirements (nominal) [6]		3 micron melt-blow	
Salinity increase at membrane at 40% recovery rate		2-3 %	
Weight	kg	47	123
	lb	103	271

1) Continuous torque above max. differential pressure will reduce the lifetime of the iSave.
2) Pressure can reach this pressure level at start-up and permeate flush.
3) Intermittent pressure is acceptable for less than 10 minutes within a period of 6 hours.
4) Typical average flow at 60 bar.
5) Dependent on NaCl concentation.
6) Please see section 7. filtration.

3.2 iSave with IEC motor

iSave		iSave 21 Plus A)	iSave 21 Plus	iSave 40	
Code number horizontal		180F7016	180F7017	180F7001	180F7004
Code number vertical		180F7016	180F7017	180F7003	180F7005
Motor size IEC version IEC 400 V, 50 Hz 1)	kW	5.5	7.5	11	15
	HP	7.5	10	15	20
Frame size	IEC	132 S	132 M	160 L	180 L
	pole	4	4	6	6
Motor data					
Nominal speed	rpm	1450	1450	970	970
Min. speed at 400 V	rpm	500	2) 500	600	600
Max. speed at 400 V	rpm	1500	1500	3) 1100	1200
Rated current at 400 V	A	11	15.2	22	30
Torque					
Motor torque at norminal speed 3) 4)	Nm	36	49	5) 108	146
	lbf-ft	26.5	36	80	107.7
Motor torque at min. speed 3)	Nm	27	36	95	129
	lbf-ft	20	27	70	95
Motor ambient temperature, max.	°C	40	40	40	40
	°F	122	122	122	122
Motor insulation	Class	B	B	B	B
Motor degrees of protection	IP	55	55	55	55
Sound pressure level max. 6)	dB(A)	78	79	84	84
Weight	kg	105	116	254	305
	lb	231	255	560	672
Footprint (horizontal/vertical)	m^2	0.31	0.32	0.5/0.16	0.54/0.17
	$foot^2$	3.34	3.45	5.38/1.72	5.81/1.83

A) Differential pressure HP in - HP out max. is limited to 3 bar [44 psi]

1) Three-phase-asynchronous-motor according to DIN-IEC and VDE 0530 standards.
- Voltage and frequency according to IEC 38
- The motors are fitted with a rating plate in multi-tension: 380-420 V / 660-720 V, 50 Hz or 440-480 V, 60 Hz
- Tolerance ± 5% according to VDE 0530
- Standard coating according to IEC 60721-2-1

2) If voltage is below 400 V we recommend to use another size of electric motor.
Please contact Danfoss High Pressure Pumps for further information.

3) Torque load for iSave and motor see diagram on page 23 and 25.

4) Due to inertia and stick-slip friction of the iSave, the torque may exceed the maximum allowable operation torque for the iSave when it is taken into use and/ or speed is ramped up from zero to maximum. A VFD or a soft starter must be used for ramp up.

5) The starting torque must not exceed the values stated under “Max. starting torque (stick/slip)”. The VFD must be able to deliver 140% start torque. The Danfoss VFD type FC 301 and FC 302 can be used. For advice on VFD settings, please consult our relevant guideline or contact Danfoss.

6) A-weighted sound pressure level at 1 meter from the pump unit surfaces (reference box) acc. to EN ISO 20361 section 6.2. The noise measurements are performed acc. to EN ISO 3744:2010 on ERD with motor (motor-pump unit) at max. pressure and speed.

3.3 iSave with NEMA motor (can only be ordered through Danfoss US)

iSave		iSave 21 Plus A)	iSave 21 Plus	iSave 40
Code number horizontal		180U0013	180U0052	180U0012
Code number vertical		180U0013	180U0052	180U0002
Motor size NEMA version 1) High efficiency 460 V, 60 Hz	kW	7.5	11	15
	HP	10	15	20
Frame size	NEMA	215TC	254	286TC
	pole	4	4	6
Motor data				
Nominal speed	rpm	2) 1760	1765	1175
Min. speed continuous at 400 V	rpm	500	500	600
Max. speed continuous at 400 V	rpm	1500	1500	1200
Motor rated current 460 V	A	12.4	18	24.2
Torque				
Motor torque at norminal speed 3) 4)	Nm	40	59.7	119
	(lbf-ft)	29.4	44	5) 88.2
Motor torque at min. speed 4)	Nm	20	31	95
	(lbf-ft)	14.7	23	70
Motor ambient temperature, max. 3,300 feet above sea level	°C	40	40	40
	(°F)	122	122	122
Motor degrees of protection	IP	55	55	55
Sound pressure level max. 6)	dB(A)	78	79*)	84
Weight	kg	152	206	324
	(lb)	335	454	715
Footprint (horizontal/vertical)	m^2	0.38	0.45/0.16	0.65/0.23
	$foot^2$	4.09	4.85/1.72	7.0/2.48

A) Differential pressure HP in - HP out max. is limited to 3 bar [44 psi]

*) Tested with IEC motor

1) Three-phase-asynchronous-motor according to NEMA MG-1 and UL 1004-1 standards.
- Insulation class F, service factor 1.25.
- Fan-cooled TEFC (IC411). Voltage and frequency according to NEMA MG-1 part 12.
- The motors are fitted with a rating plate 230 / 460 V, 60 Hz.
- Plus or minus 10% of rated voltage, with rated frequency. Standard coating according to motor supplier specifications.

2) Max. speed for iSave 21 is 1500 rpm.

3) Torque load for iSave and motor see diagramme on page 23 and 25.

4) Due to inertia and stick-slip friction of the iSave, the torque may exceed the maximum allowable operation torque for the iSave when it is taken into use and/ or speed is ramped up from zero to maximum. A VFD or a soft starter must be used for ramp up.

5) The starting torque must not exceed the values stated under "Max. starting torque (stick/slip)". The VFD must be able to deliver 140% start torque. The Danfoss VFD type FC 301 and FC 302 can be used. For advice on VFD settings, please consult our relevant guideline or contact Danfoss.

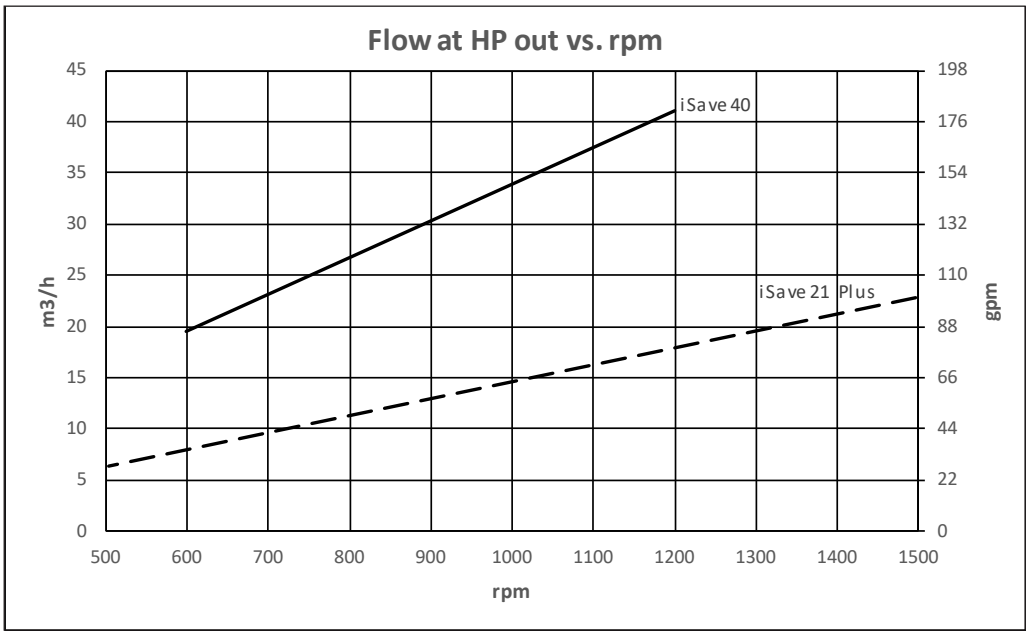
6) A-weighted sound pressure level at 1 meter from the pump unit surfaces (reference box) acc. to EN ISO 20361 section 6.2. The noise measurements are performed acc. to EN ISO 3744:2010 on ERD with motor (motor-pump unit) at max. pressure and speed.

4. Flow at different rpm

The diagram shows that the HP flow can be changed by changing the rotation speed of the iSave. The flow/rpm ratio is constant, the required flow is obtainable by changing the rotation speed to a required value.

For accurate data please use our selection tool which is available on our website: www.isave.danfoss.com

The iSave is delivered with a 3.1 performance certificate according to EN10204.

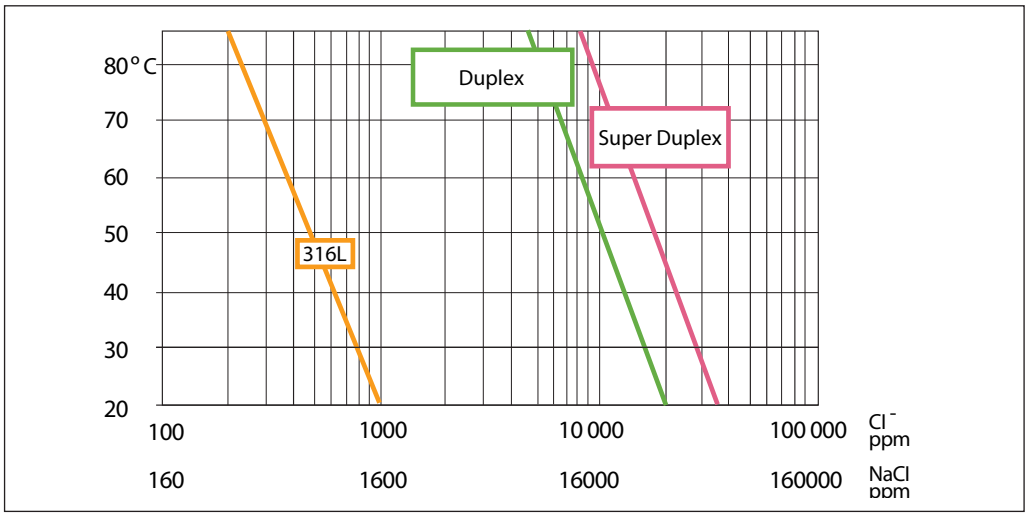


5. Corrosion

5.1 Operation

The chart below illustrates the corrosive resistance of different types of stainless steel related to NaCl concentration and temperature. All critical parts of the iSave is made of Super Duplex 1.4410/UNS 32 750 or Duplex 1.4462/UNS 32803.

Always flush the iSave with fresh water at operation stop in order to minimize the risk of crevice corrosion.



6. Noise level

The noise level for the iSaves is measured at max. speed, a pressure of 80 barg and a booster pressure of 5 bar. Since the iSave is mounted on a bell housing and electric motor, the noise level can only be determined for the complete unit (system).

It is therefore important that a horizontal iSave unit is mounted correctly on a frame with dampeners to minimize vibrations and noise. We recommend to mount a vertical iSave directly to the floor with bolts. It is also strongly recommended to use high-pressure flexible hoses between the hard piping in the RO-plant and the iSave or to use multiple connections with Victaulic clamps.

The noise level is influenced by:

Speed:

- High rpm makes more fluid/structure-borne pulsations/vibrations than low rpm due to higher frequency.

Pressure:

- High pressure makes more noise than low pressure.

Mounting:

- Rigid mounting makes more noise than flexible mounting due to structure-borne vibrations.

Connections to iSave:

- Pipes connected directly to the iSave make more noise than flexible hoses due to structure-borne vibrations.
- Variable frequency drives (VFD): Motors regulated by VFDs can increase noise level if the VFD does not have the right settings.

Noise level (dB(A) measured for the iSave 21 Plus and 40 at different speed and system pressure. Booster pressure 3 bar.

iSave 21 Plus

rpm \ barg/psig	20/290	60/870	80/1160
500	60	62	68
1000	69	72	74
1500	77	78	78

iSave 40

rpm \ barg/psig	30/435	60/870	80/1160
800	73	77	78
1000	76	79	81
1200	78	82	84

7. Filtration

It is important that the incoming water is filtered properly to ensure optimum service life. A true graded density, melt-blown depth filter cartridge rated at 3 µm is therefore recommended.

It is important with selection of a proper filter housing to ensure good cartridge end sealing. If there is a high risk of water by-pass it is recommended to use a second stage filter solution.

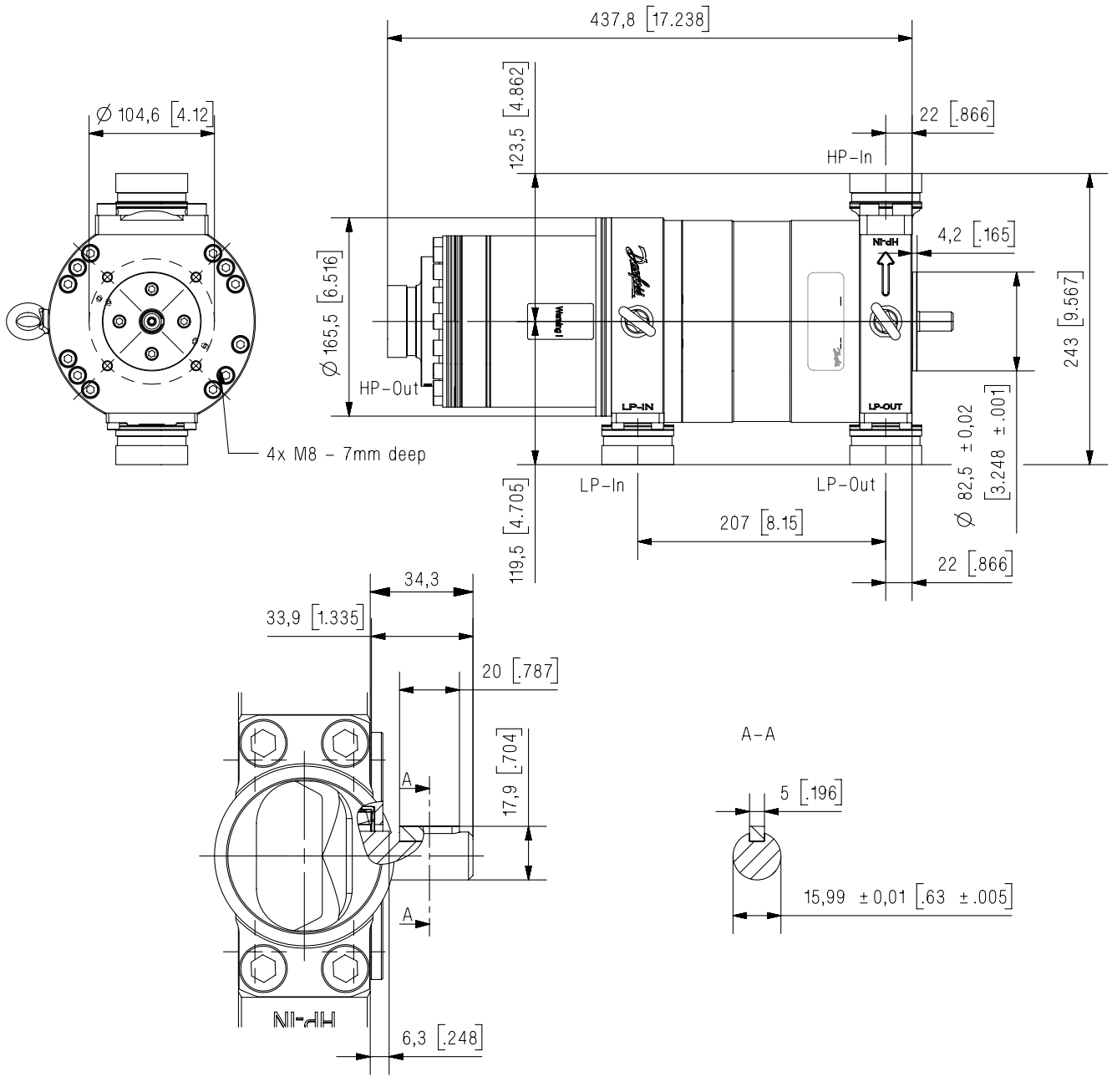
As the various filters on the market differ greatly, Danfoss High Pressure Pumps recommends using cartridges with consistent, reliable performance and high efficiency and where fibres are blown continuously onto a central support core. High Pressure Pumps does not recommend cartridges requiring any type of binders or resins.

Filters can be purchased from Danfoss High Pressure Pumps. Please see section 10.0, “RO systems with an iSave”, for installation of filter. For more information on the importance of proper filtration, please consult our publication “Filtration” (code number 521B1009), which also will provide you with an explanation of filtration definitions and a guidance on how to select the right filter.

8. iSave drawings

8.1 Assembled iSave 21 Plus and iSave 40 without electric motor

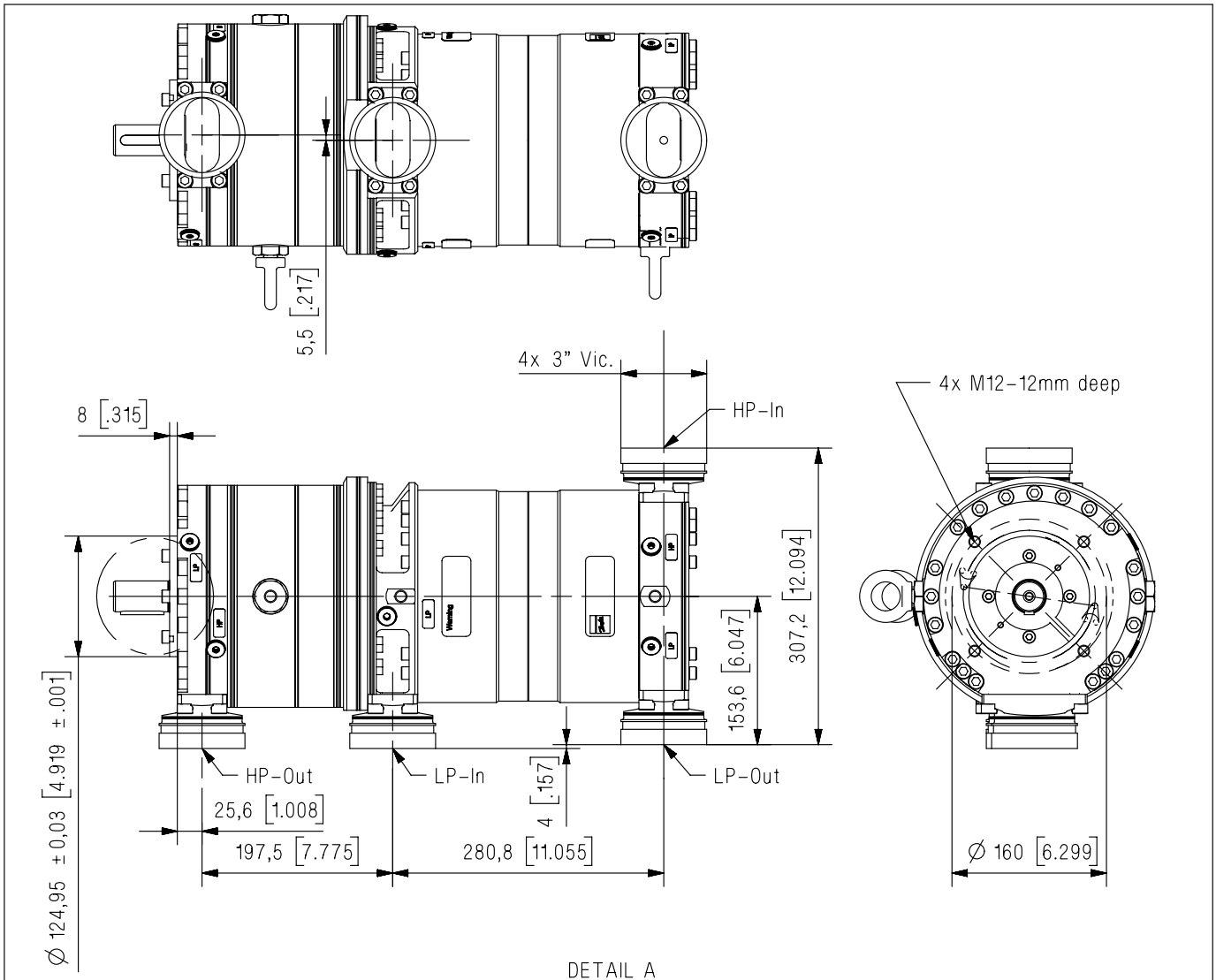
iSave 21 Plus



Discription	iSave 21 Plus
Parrallel key, DIN 6885	5 x 5 x 20 mm 0.20 x 0.20 x 0.78 inch
HP–connection	2" Victaulic
LP–connection	2" Victaulic

Dimensions without tolerances acc. To ISO 2768–1 designation C.

iSave 40

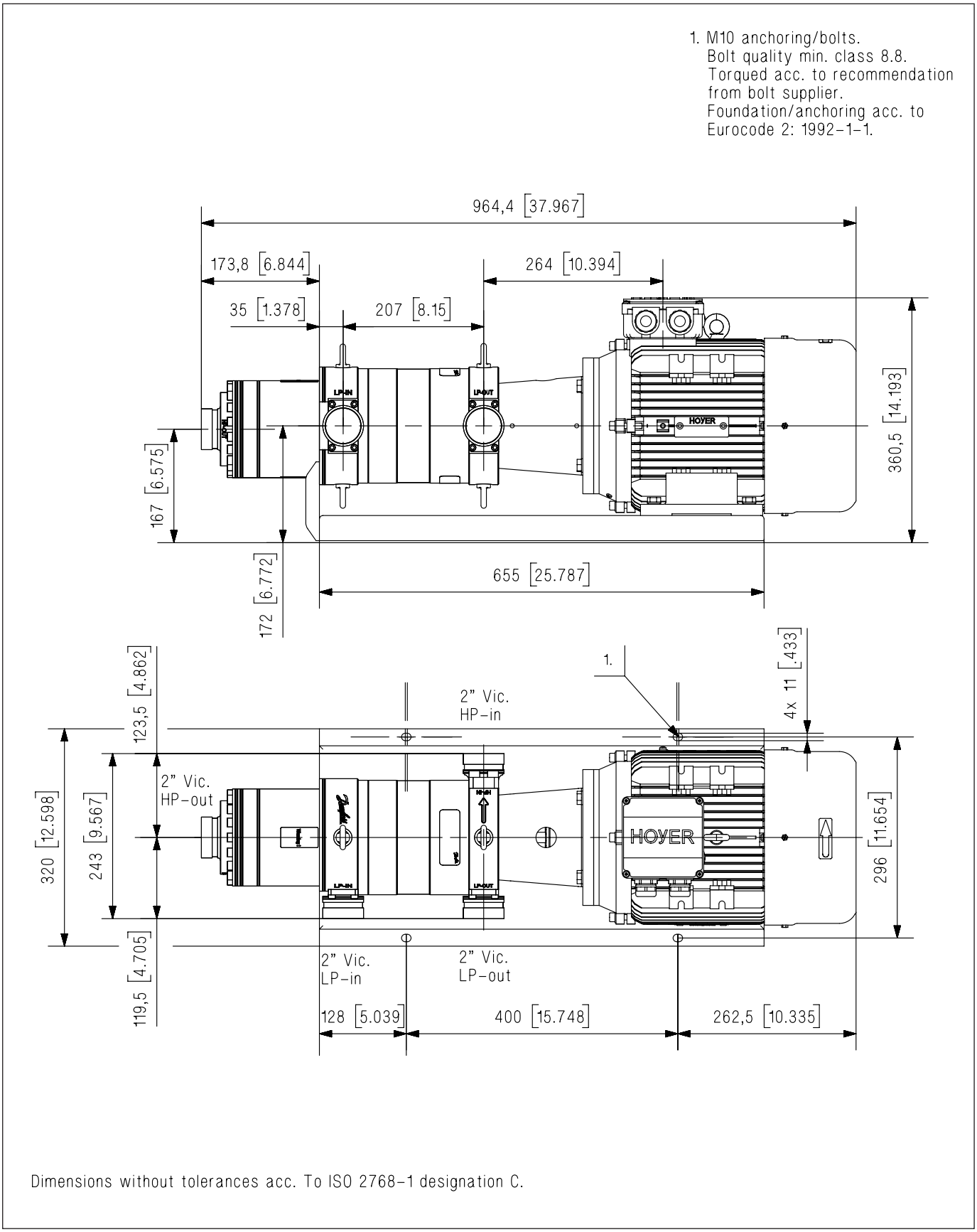


Discription	iSave 40
Parallel key, DIN 6885	10 x 8 x 35 mm 0.39 x 0.31 x 1.38 inch
HP-connections	3" Victaulic
LP-connections	3" Victaulic
Bleed	G 1/4"

Dimensions without tolerances acc. to ISO 2768-1 designation C.

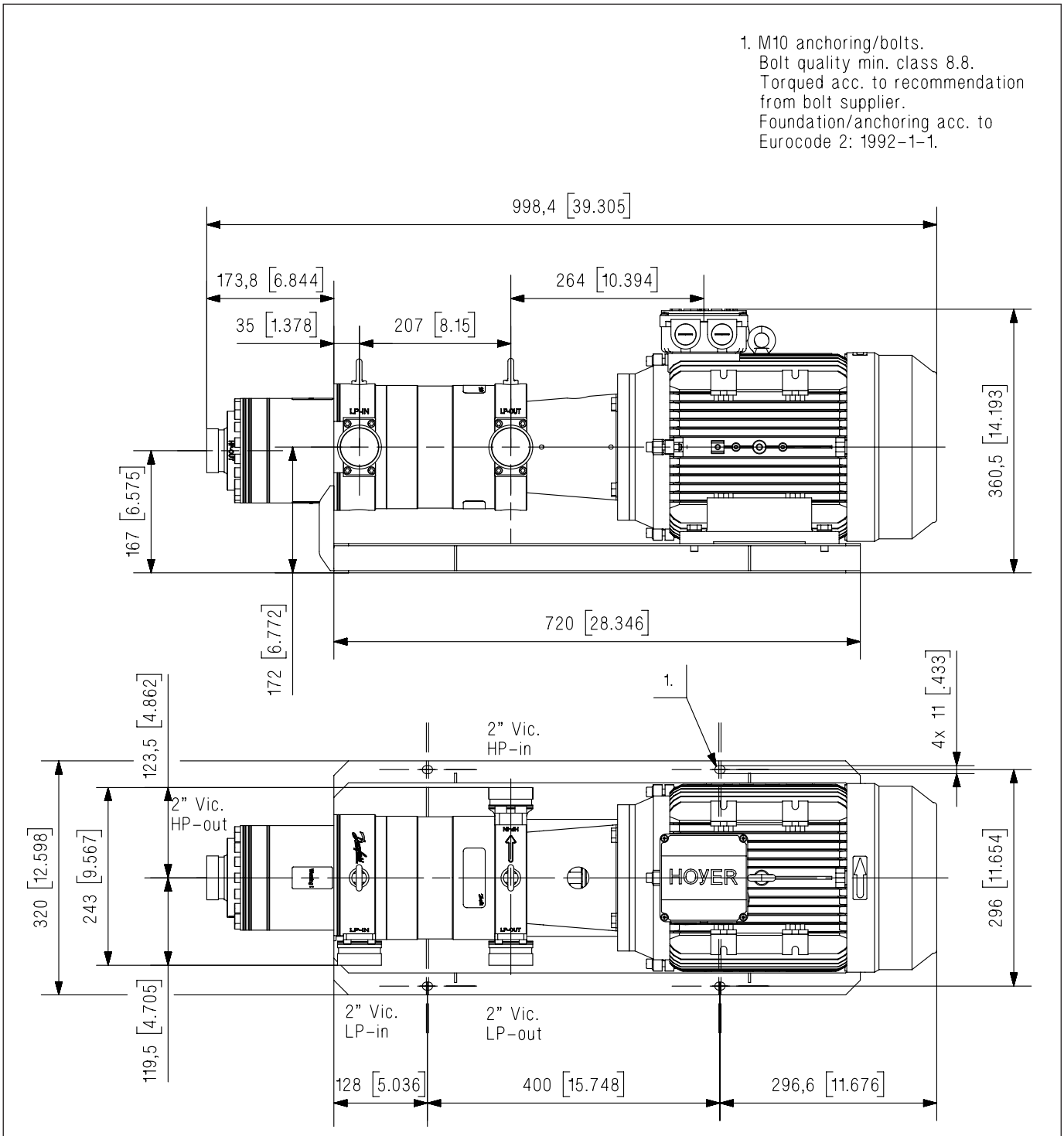
8.2 Assembled iSave 21 Plus and iSave 40 with IEC electric motor

iSave 21 Plus, 5.5 kW, 4 pole, IEC motor



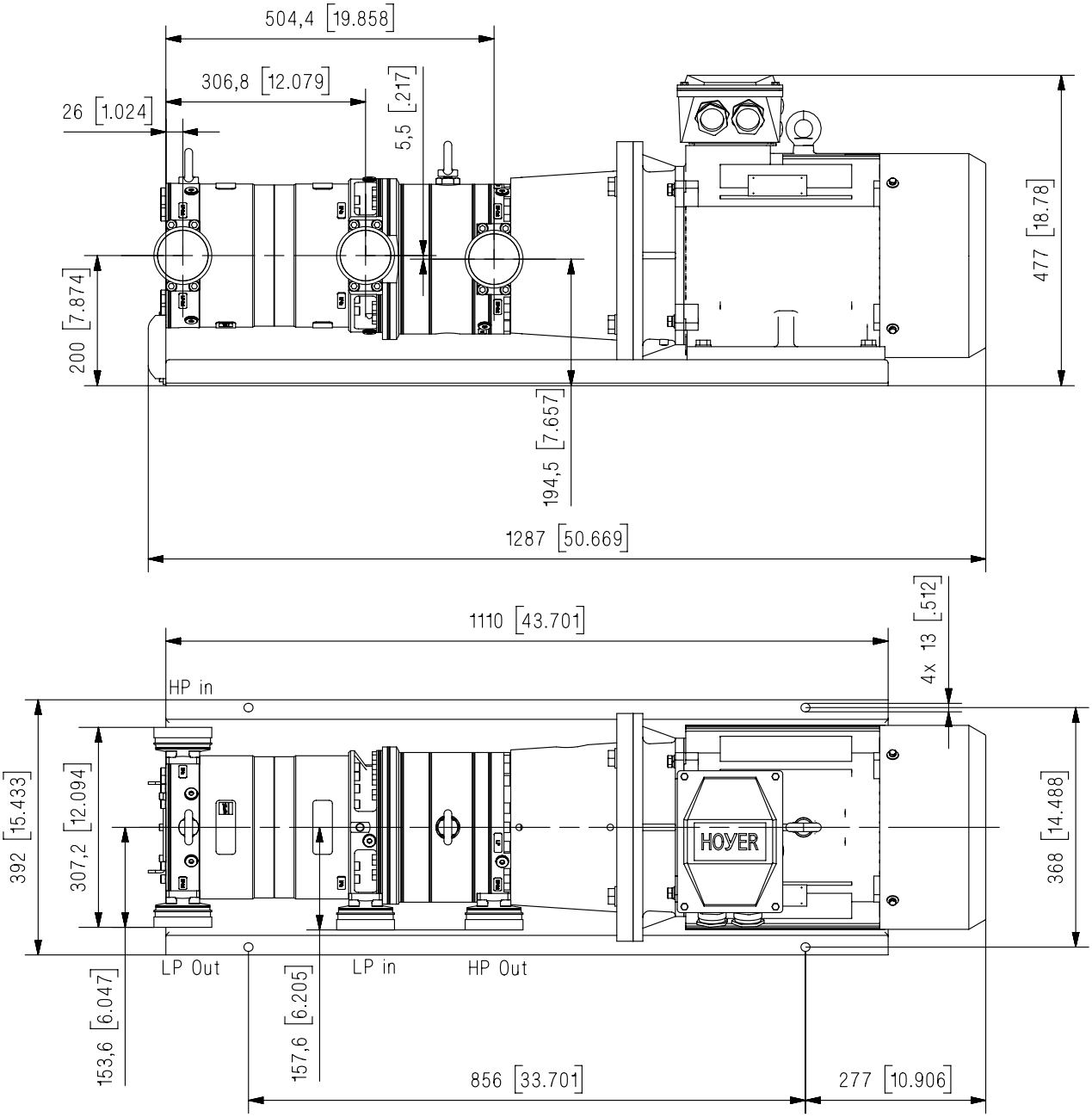
Dimensions without tolerances acc. To ISO 2768-1 designation C.

iSave 21 Plus, 7.5 kW, 4 pole, IEC motor



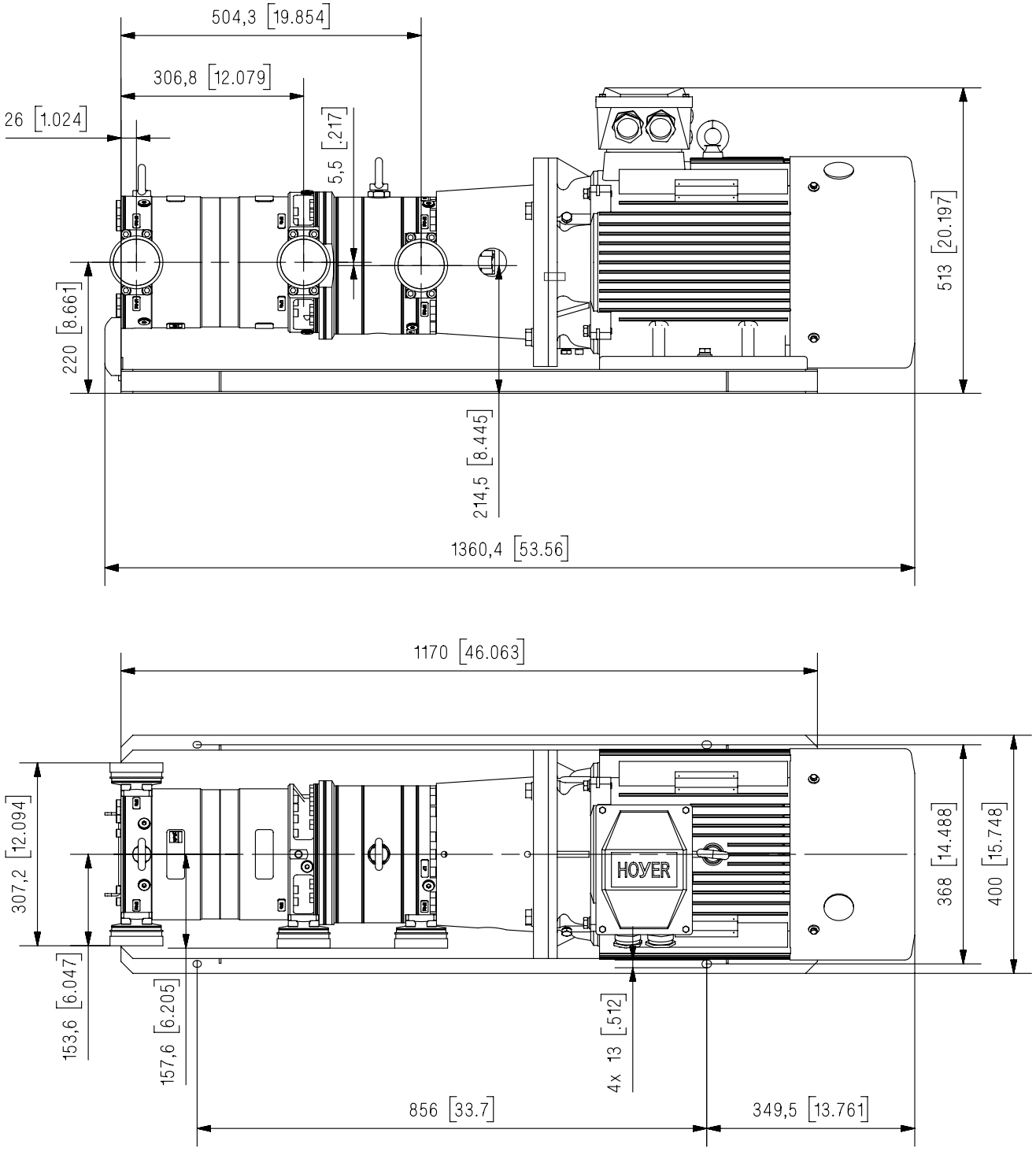
Dimensions without tolerances acc. To ISO 2768-1 designation C.

iSave 40 - horizontal, 11 kW, 6 pole, IEC motor



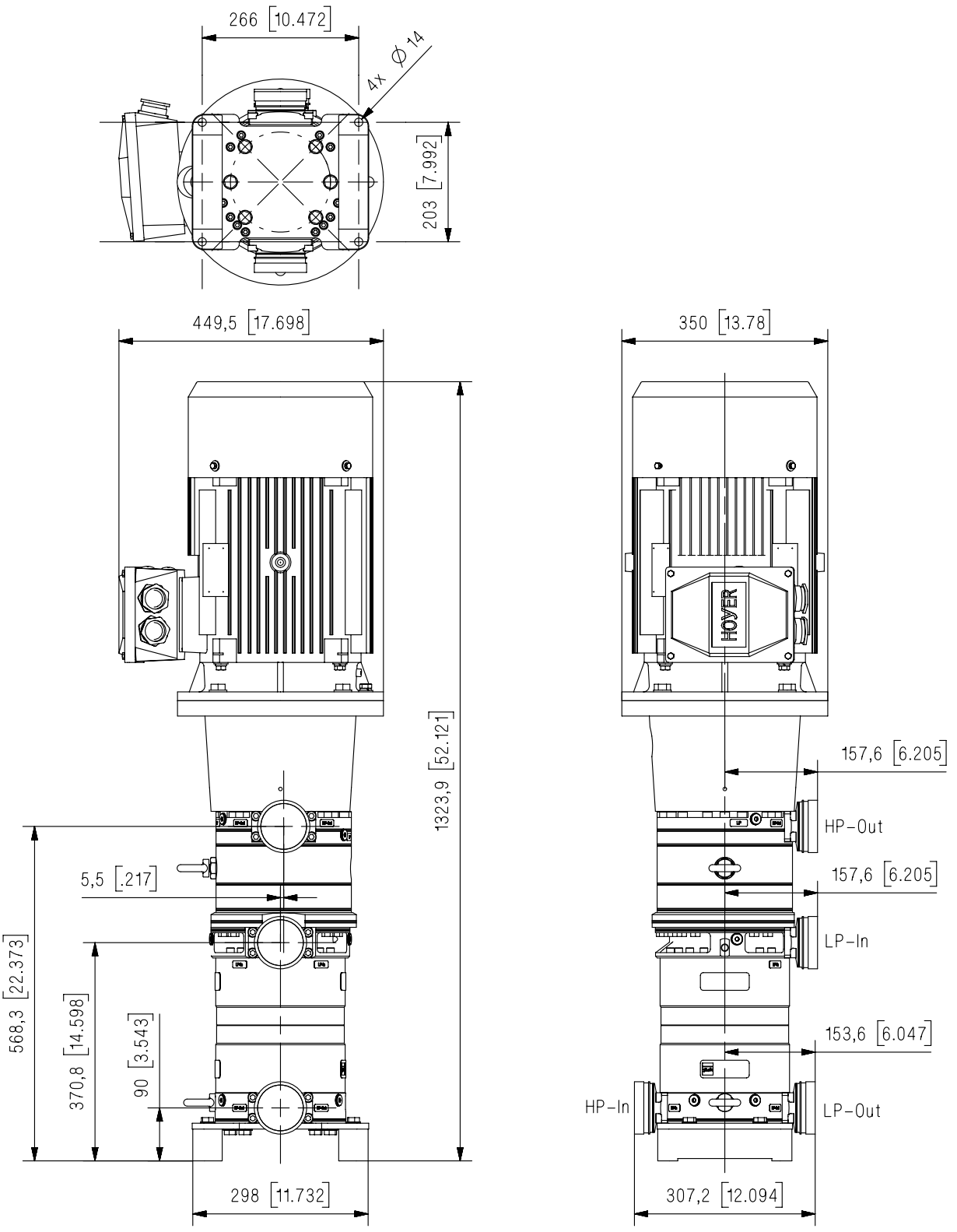
Dimensions without tolerances acc. To ISO 2768–1 designation C.

iSave 40 - horizontal, 15 kW, 6 pole, IEC motor



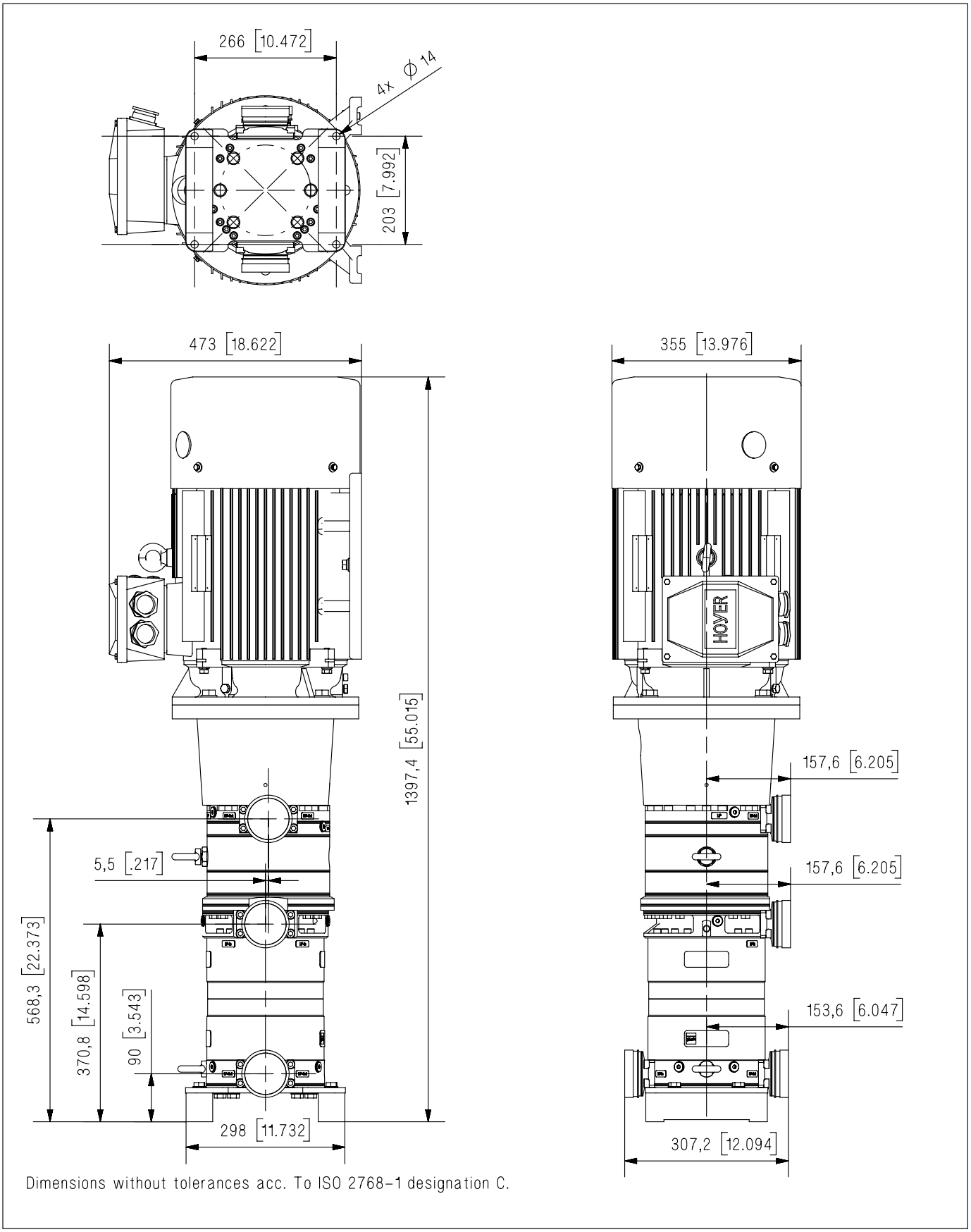
Dimensions without tolerances acc. To ISO 2768–1 designation C.

iSave 40 - vertical, 11 kW, 6 pole, IEC motor



Dimensions without tolerances acc. to ISO 2768-1 designation C.

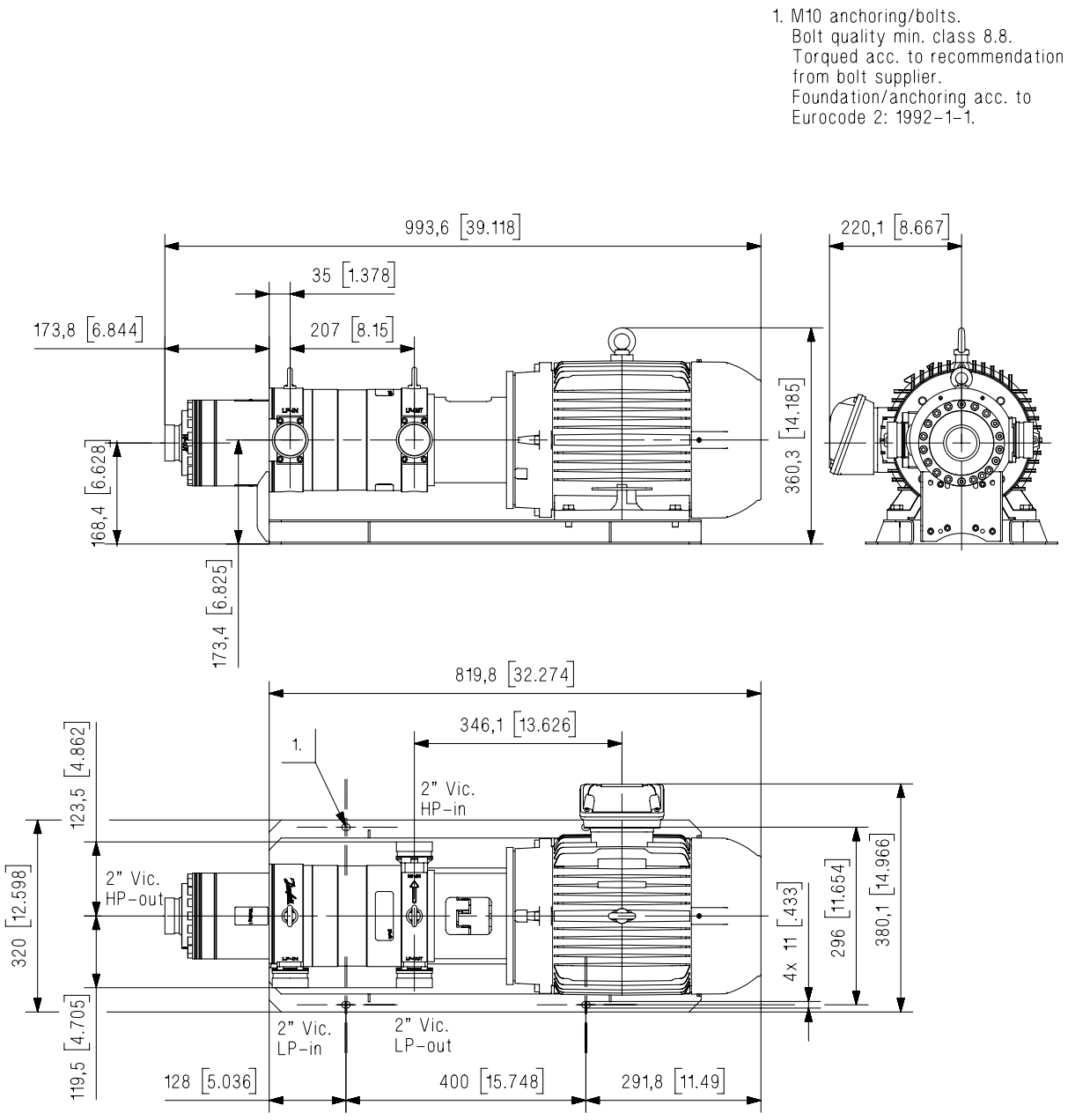
iSave 40 - vertical, 15 kW, 6 pole, IEC motor



Dimensions without tolerances acc. To ISO 2768–1 designation C.

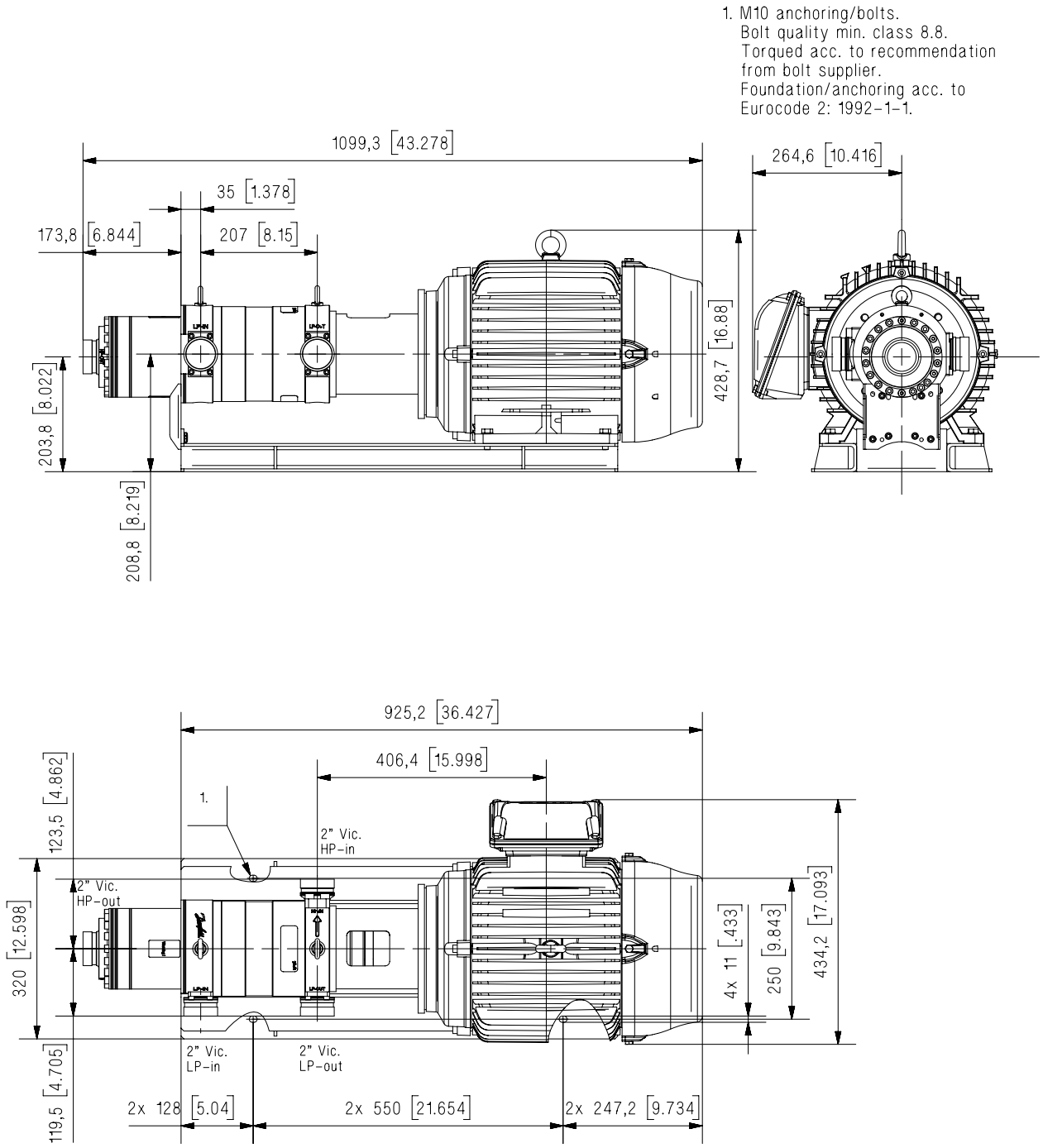
8.3 Assembled iSave 21 Plus and iSave 40 with NEMA motor

iSave 21 Plus, 10 HP, 4 pole, NEMA motor



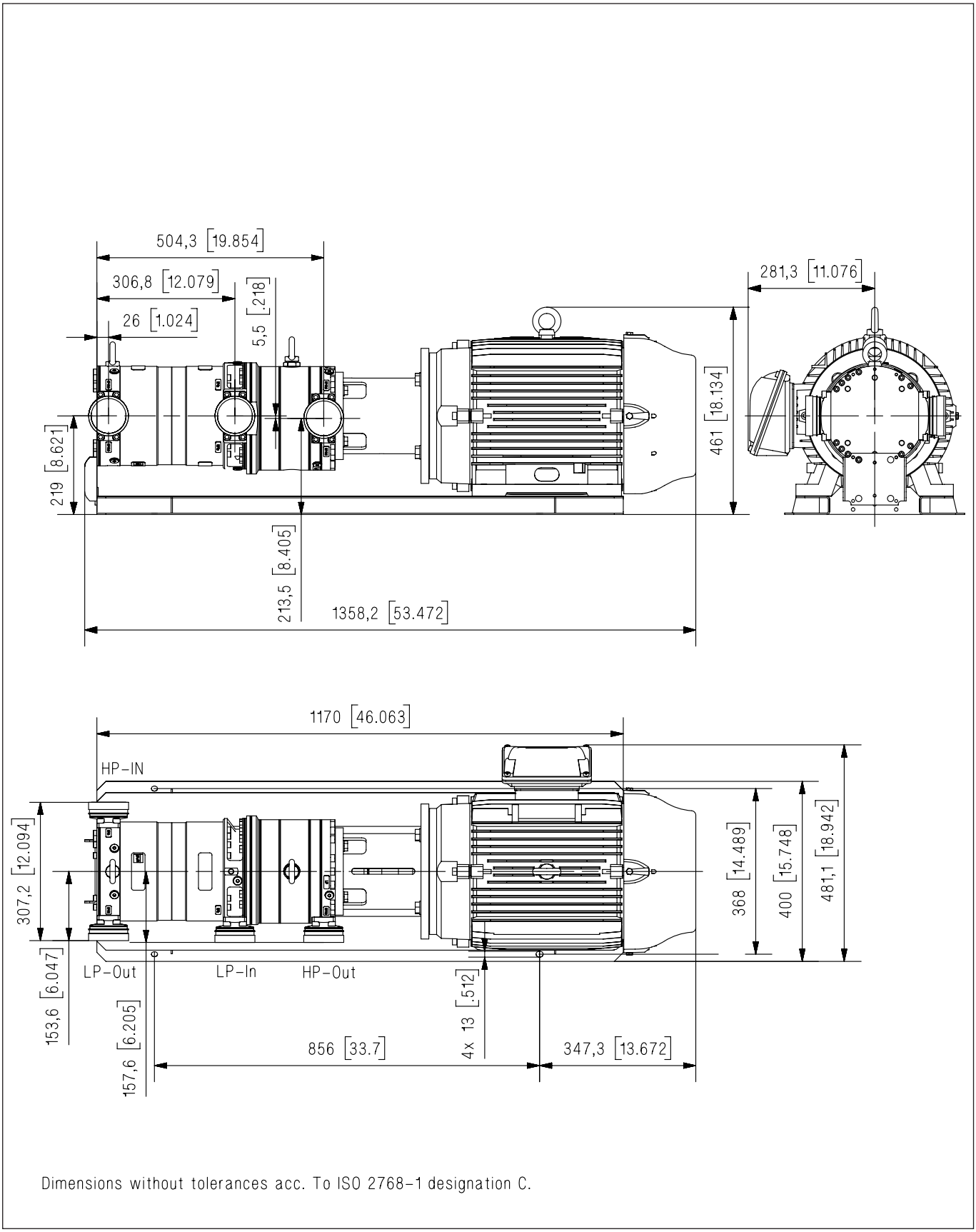
Dimensions without tolerances acc. To ISO 2768-1 designation C.

iSave 21 Plus, 15 HP, 4 pole, NEMA motor

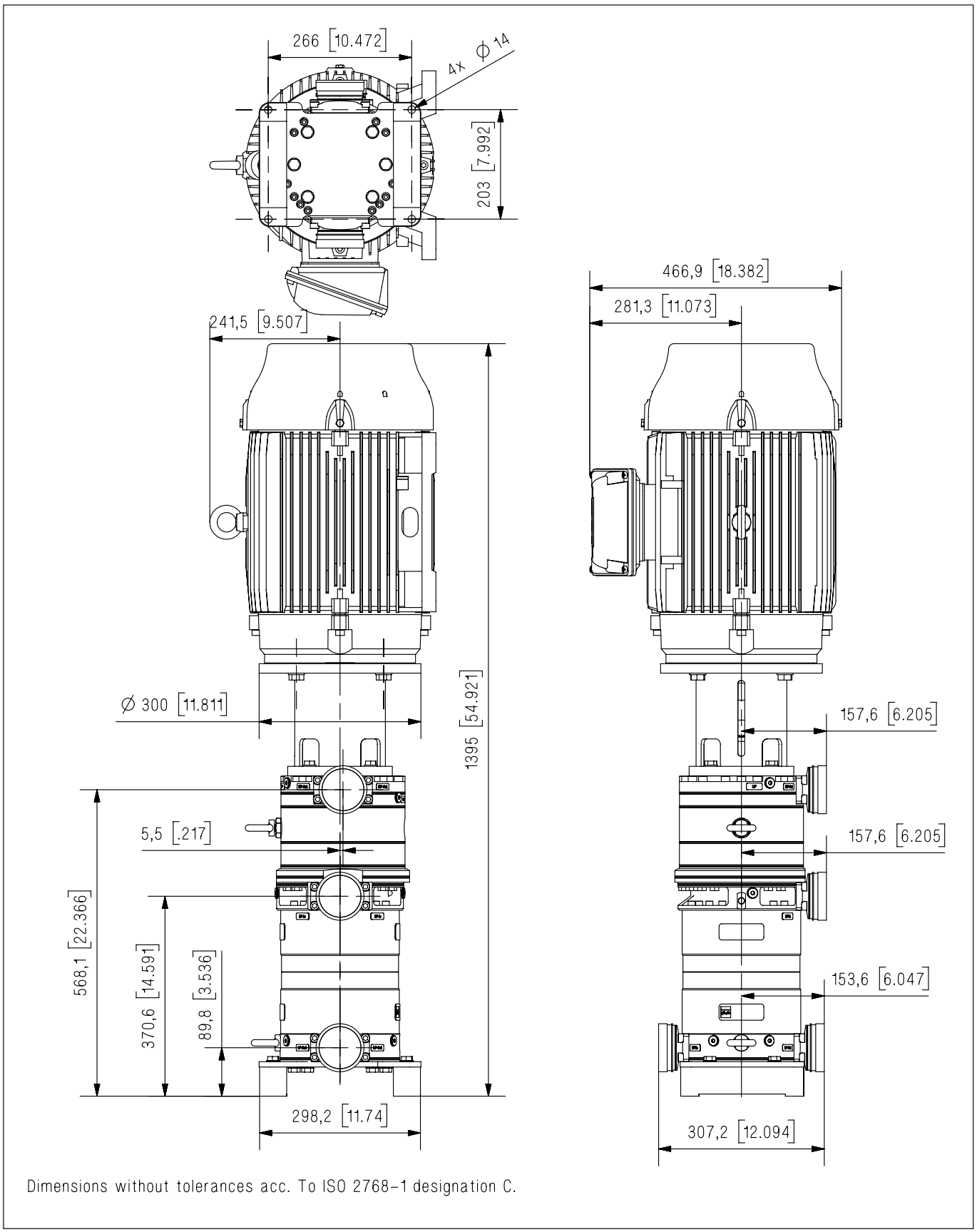


Dimensions without tolerances acc. To ISO 2768-1 designation C.

iSave 40 - horizontal, 20 HP, 6 pole, NEMA motor



iSave 40 - vertical, 20 HP, 6 pole, NEMA motor

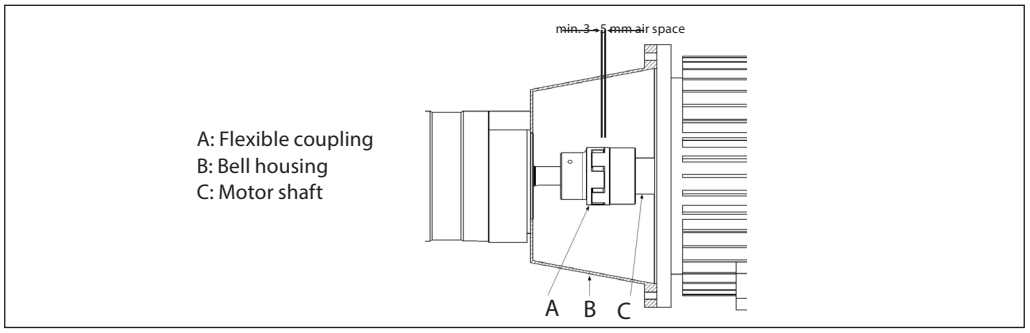


9. Installation

Orientation
iSave 21 Plus and iSave 40 can be mounted horizontal and vertical. iSave 40 can be mounted horizontally and vertically - when mounted vertically, the electric motor must be placed at the top of the iSave.
The iSave 21 Plus baseplate can be used for both horizontal and vertical installations.
The iSave 40 has a base when installed vertical.

Mounting
The figure below illustrates how to mount the iSave and connect it to the electric motor.

Note: Any axial and radial load on the shaft must be avoided.

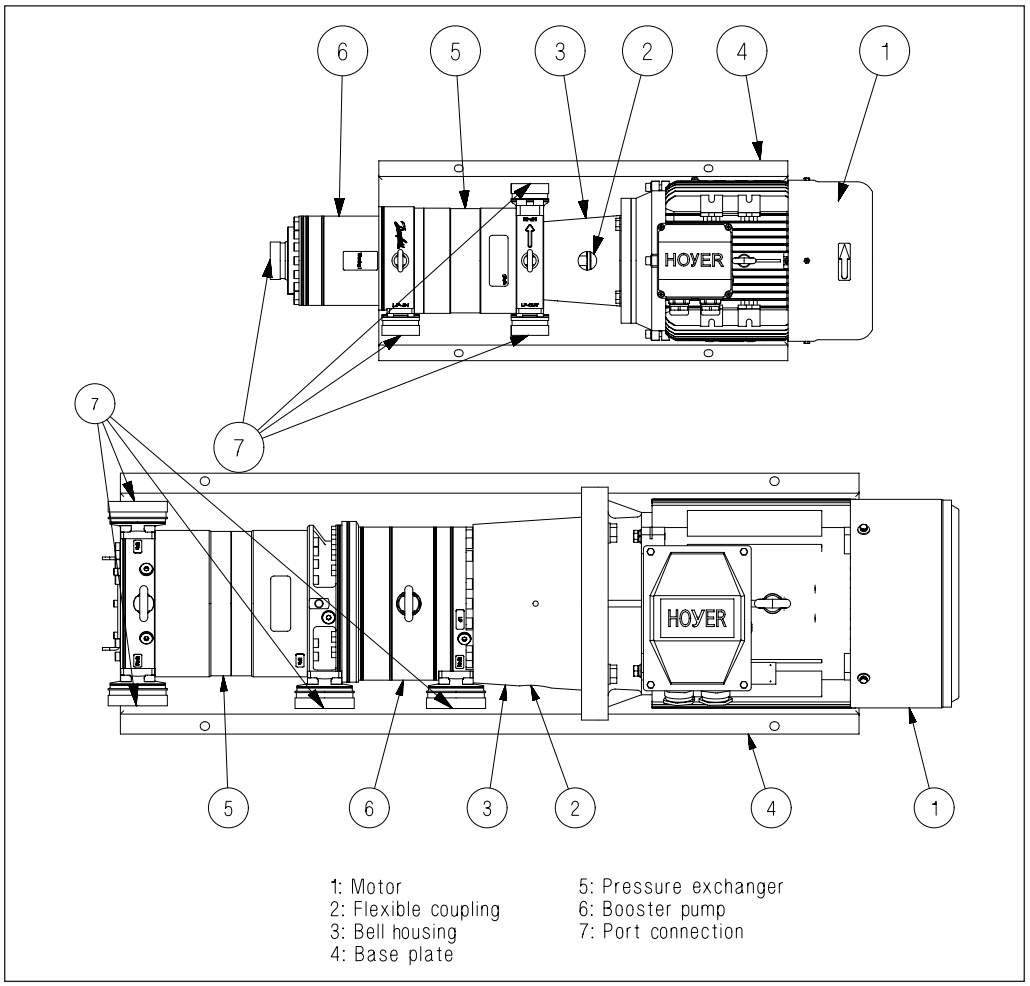


The iSave is connected to the electric motor by a bell housing and coupling.

If a horizontal iSave is delivered without base plate it is important to support the iSave and motor. The bell housing is not able to carry the weight of either the iSave or the motor when using horizontal mounting.

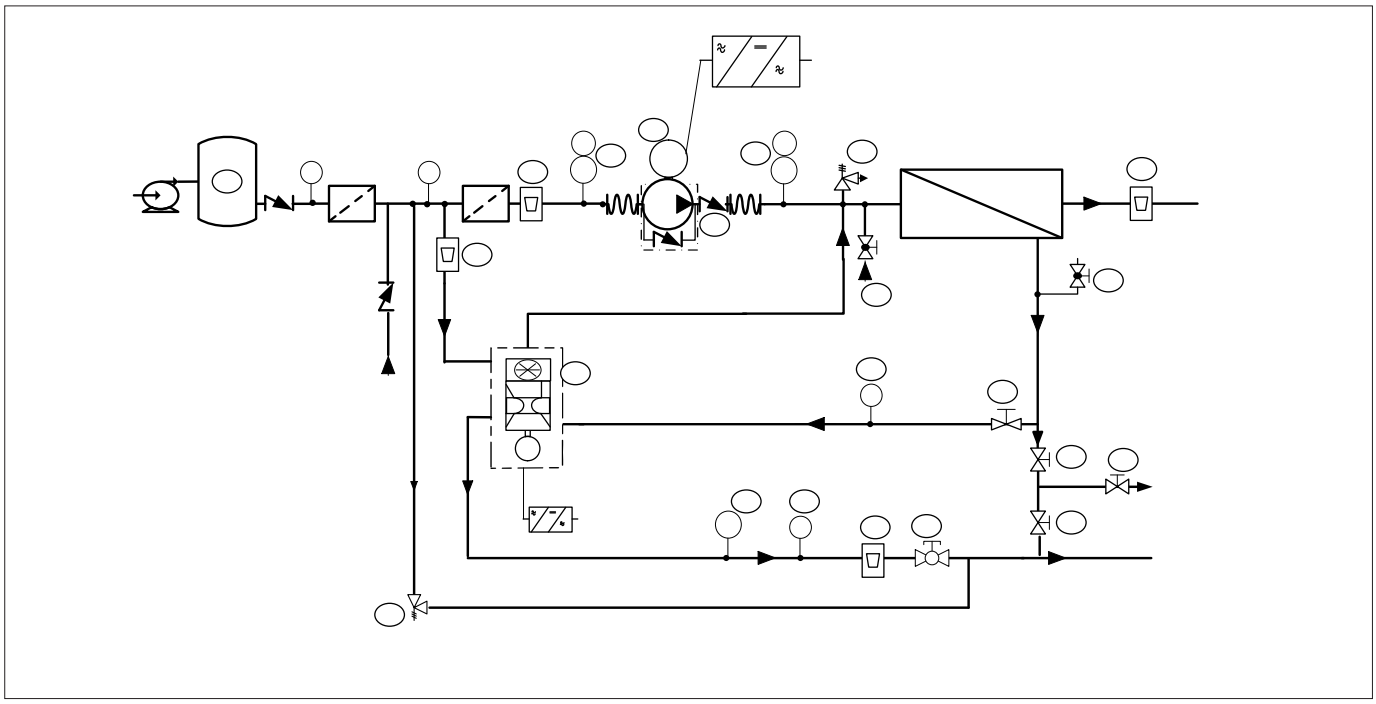
The iSave and motor must be supported without applying stress/overload to the bell housing.

If a horizontal iSave is delivered with a baseplate, a rigid mounting surface is required such as concrete foundation, optional base frame or a container with suitable steel substructure.



10. RO systems with an iSave

P&ID setup



Explanation of P&ID setup

A. Place inlet filters on LP string in front of the iSave (11). Inlet filters assure proper water quality. High quality water extends the service life of the whole system. It is impor tant with selection of a proper filter housing to ensure good cartridge end sealing. If there is a high risk of water by-pass it is recom mended to use a second stage filter solution. Please consult section 7, "Filtration" for guidance on how to select the right filter. Thoroughly clean pipes and flush system prior to start-up.

B. Place a monitoring pressure switch set (3) at minimum inlet pressure between filter and pump inlet. The monitoring switch must stop the iSave (11) and the high-pressure pump (4) at pressures lower than minimum inlet pressure.

C. Dimension the piping to obtain minimum pressure loss (large flow, minimum pipe length, minimum number of bends/connec- tions and fittings to prevent pressure loss and flow turbulence). Use flexible hoses to minimize vibrations and noise.

D. To balance the flow between high-pressure out and low-pressure in, place a variable area flow meter (12) on low-pressure inlet to the iSave.

E. In order to eliminate the risk of damage and cavitation, a positive pressure at the low-pressure outlet from the iSave is always to be maintained at minimum 1 barg (14.5 psig) and maximum 10 barg (145 psig). It is recommended to install monitoring pressure switch (13) in order to prevent high/low-pres sure.

F. Install a VFD to control the speed of the iSave.

G. Install a pressure and flow control valve (15) to control pressure in low-pressure out.

H. Although the iSave 21 Plus automatically will bleed itself, there should be an air bleed valve (8) installed on the highest point of the high-pressure piping to ensure proper bleeding of the RO system.

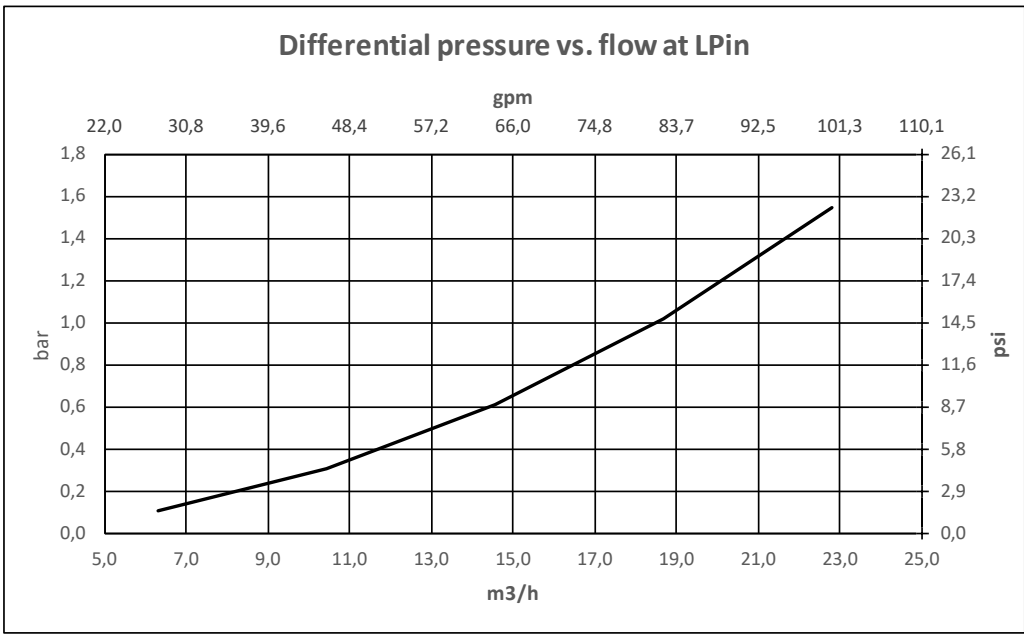
I. The pressure relief valve (6) protects the whole system against pressure overload and relieves the water if the pressure exceeds the maximum set pressure.
If the high-pressure pump is a positive displacement pump, the pump can built up a very high pressure that will exceed mechani- cal strength of the membrane housing, pipes and other accessories.

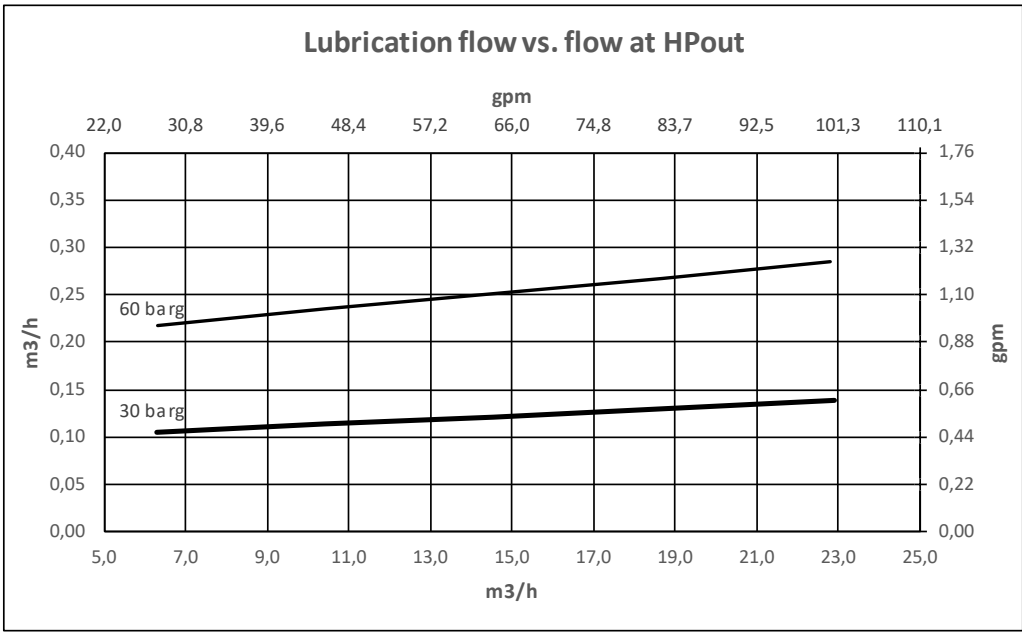
J. The pressure relief valve (19) protects the low-pressure pipes against pressure overload and relieves the water if the pressure exceeds the maximum allowable pressure.

For alternative P&ID setup, please contact Danfoss High Pressure Pumps sales organisation.

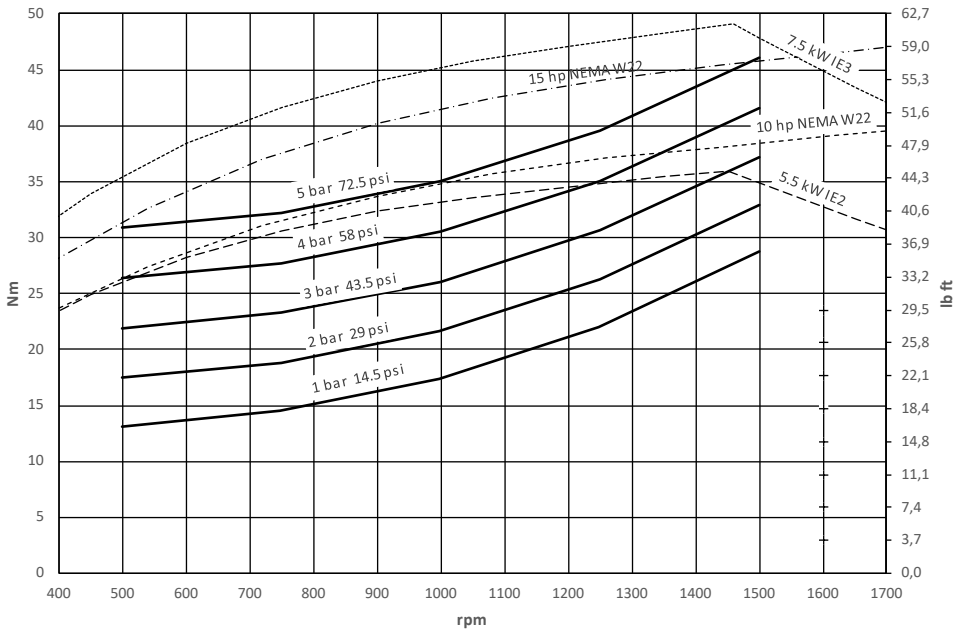
11. Performance curves

11.1 Performance and torque curves iSave 21 Plus

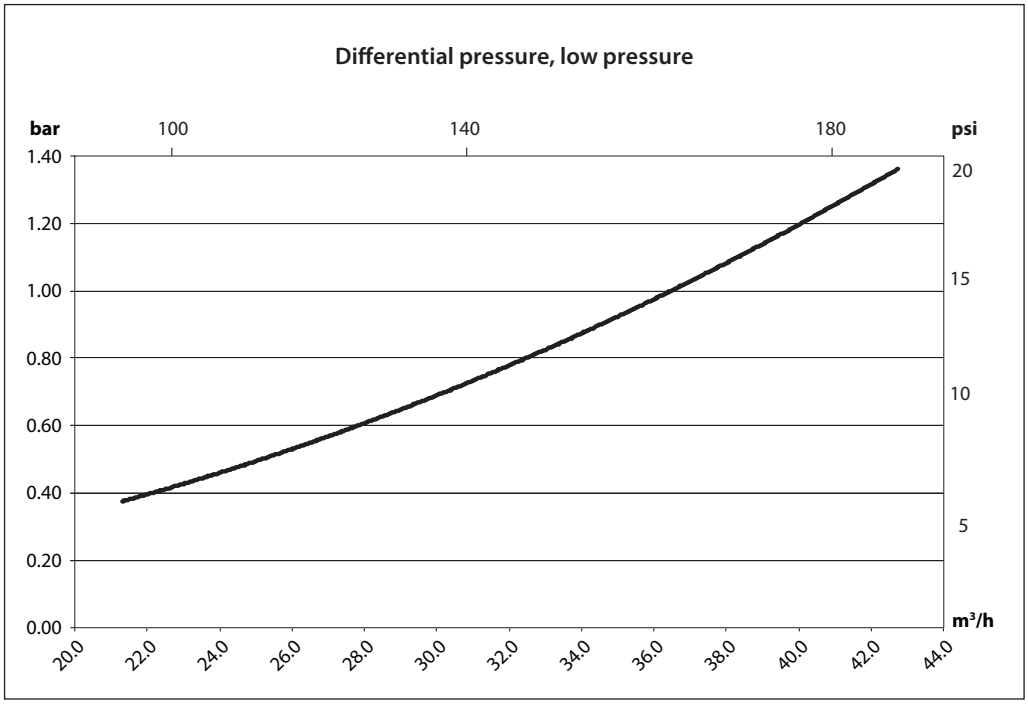


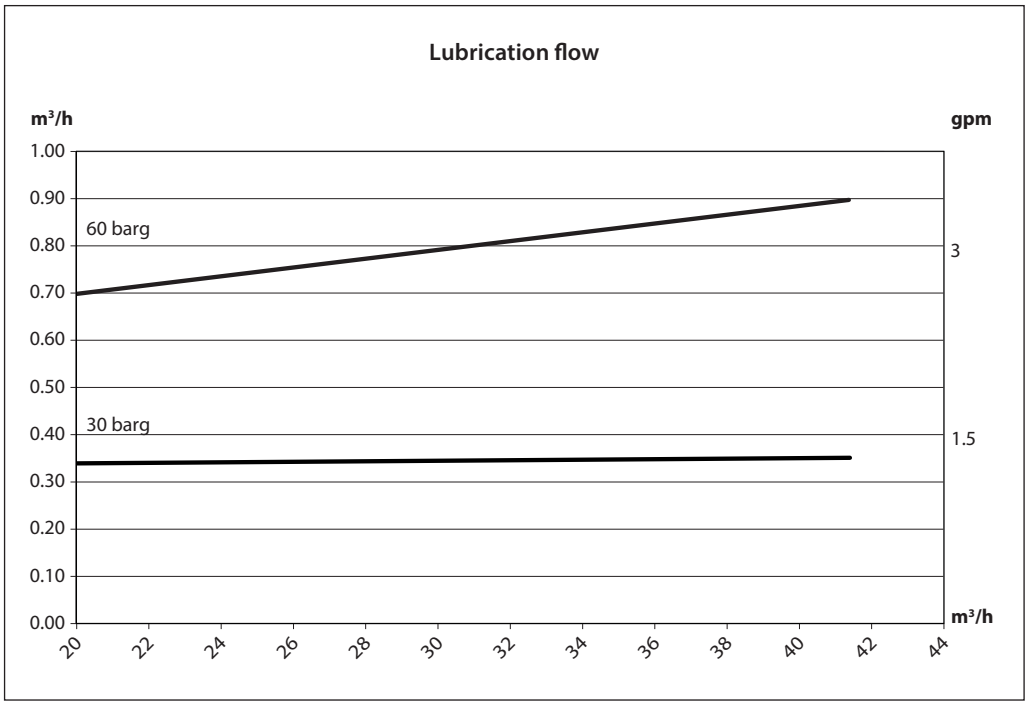


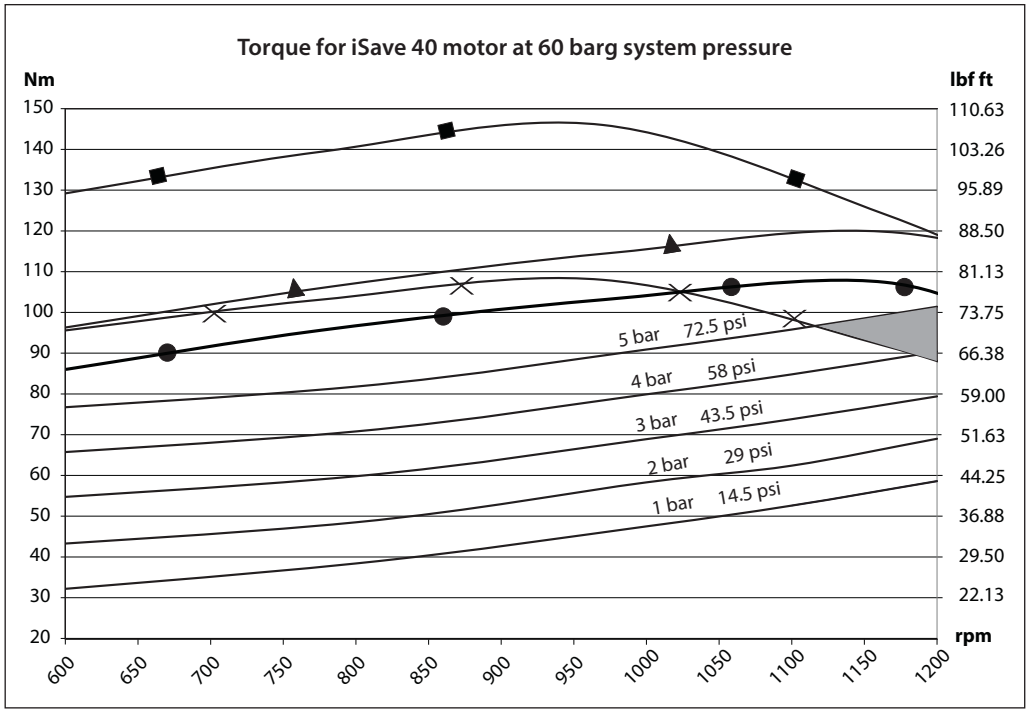
Torque for iSave 21 and motor at 60 barg system pressure



11.2 Performance and torque curves iSave 40







Important:
The marked area at 1100-1200 rpm shows the operation area which cannot be reached with a 11 kW motor at 400 voltage supply. A 15 kW is needed if max rpm (1100-1200) and max differential pressure (4 to 5 bar) is required.

Max motor torque for 15 kW, IEC180L-6, 50 Hz, 400 V

Max motor torque for 20 HP, NEMA286TC-6, 60 Hz, 460 V

Max motor torque for 11 kW, IEC160L-6, 50 Hz, 400 V

Max motor torque for 11 kW, IEC160L-6, 60 Hz, 480 V

The straight pressure lines (1 to 5 bar) show the needed shaft torque for the iSave at different pressures.

12. Service

12.1 Warranty

The Danfoss iSave is designed for long operation, low maintenance and reduced lifecycle costs.

Provided that the iSave has been running according to the Danfoss specifications, Danfoss guarantees 8,000 hours service-free operation, however, max. 18 months from date of production.

The life of an iSave may be greatly shortened if Danfoss recommendations concerning system design are not followed.

If the recommendations in the manual are not followed, Danfoss reserves the right to void the warranty.

Standstill

The iSave is made of Duplex or Super Duplex materials with excellent corrosion resistance. However, it is always required to flush the iSave when the system is shut down.

12.2 Maintenance

In our experience, poor filtration is the number one cause of iSave damage. Danfoss recommends an periodic inspection where worn parts, if any, must be replaced. This is done in order to to prevent a potential breakdown of the iSave.

12.3 Repair

In case of irregular function of the iSave, please contact Danfoss High Pressure Pumps.

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Parts list

Energy Recovery Device
iSave 21 Plus

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Table of Contents

iSave 21 Plus

This part list provides an overview of the content of various service sets for the iSave 21 Plus as well as exploded views of the iSave, pressure exchanger and booster pump.

Pressure exchanger

Note: The parts listed are not sold seperately, only in various kits

Exploded view, see following pages.

Pos.	Qnt.	Designation	Material	180F4101 Valve plate	180F4102 Port plate, brine	180F4155 Port plate, sea water	180F4156 HP bearing	180F4157 Sealing kit
101	1	PE Housing	Duplex					
102	1	Mounting flange	Super Duplex					
103	1	Intermediate flange	Super Duplex					
104	1	Port plate Sea water	«Super Duplex PEEK»			X		
105	1	Port plate Brinea	«Super Duplex PEEK»		X			
106	2	Int. Valve plate	Super Duplex	X				
107	1	Cylinder barrel	Super Duplex					
108	1	Shaft	Super Duplex					
109	1	Spring stop	Super Duplex					
110	2	Victaulic studs 2″	Super Duplex					
111	1	2″ victaulic studs	Super Duplex					
112	1	Cover	Super Duplex					
113	1	Ass. HP Bearing support	«Super Duplex PEEK»				X	
114	1	Clips iSave	PPS HPV				X	
115	2	Pin Ø6 x 10	PEEK		X	X		X
116	2	Pin Ø6 × 10	AISI 316					X
117	29	Screw M8 × 45,0, A4-80	AISI 316					X
118	12	Screw M6 × 16 CS RS A4	AISI 316					X
119	1	Shaft seal Ø18	AISI 316					X
120	3	Compression spring ø1,4 × ø9,5	Hastelloy C276					
121	4	Screw M10 × 30 A4-80	AISI 316					X
122	2	O-ring 135,00 × 3,00	NBR 70					X
123	3	O-ring 50,00 × 2,00	NBR 70					X
124	1	O-ring 40,00 × 2,00	NBR 70					X
125	1	O-ring Ø30,00 × 2,00	NBR 70				X	X
126	24	Backup ring	PTFE					X
127	24	O-ring 18,00 × 2,00	NBR 90					X
128	1	O-ring 17,00 × 3,00 NBR 70	NBR 70					X
129	1	Bush/Bearing	PEEK					
130	1	Key 5 × 5 × 20	AISI 316Ti					X
131	1	Lifting eye M8 (DIN 580E)	AISI 316					

Booster Pump (vane pump)

Note: The parts listed are not sold seperately, only in various kits

Exploded view, see following pages.

Pos.	Qnt..	Designation	Material	180F4157 Sealing kit	180F4162 Vane kit	180F4158 Side plate
1	1	Stator ring	«Super Duplex PEEK»			
2	1	Int. Flange	«Super Duplex PEEK»			
3	1	Connection flange	«Super Duplex PEEK»			
4	1	Port flange	«Super Duplex PMC TRIBO 180»			
5	1	Side plate OUT	«Super Duplex PEEK»			X
6	1	Rotor	Super Duplex			
7	8	Vane	«Super Duplex PEEK»		X	
8	4	Pin Ø6,9	PEEK			
9	1	Side plate IN	«Super Duplex PEEK»			X
10	2	Pin Ø4 × 9	PEEK	X		X
11	1	Pin Ø6 × 10	AISI 316	X		
12	12	Screw M8 × 30 A4-80	AISI 316	X		
13	1	Pin Ø6 × 16 A4	AISI 316	X		
14	3	O-ring 112,00 × 2,50	NBR 70	X		
15	13	Screw M8 × 150 A4-80	AISI 316	X		

iSave 21 Plus

Exploded view, see following pages.

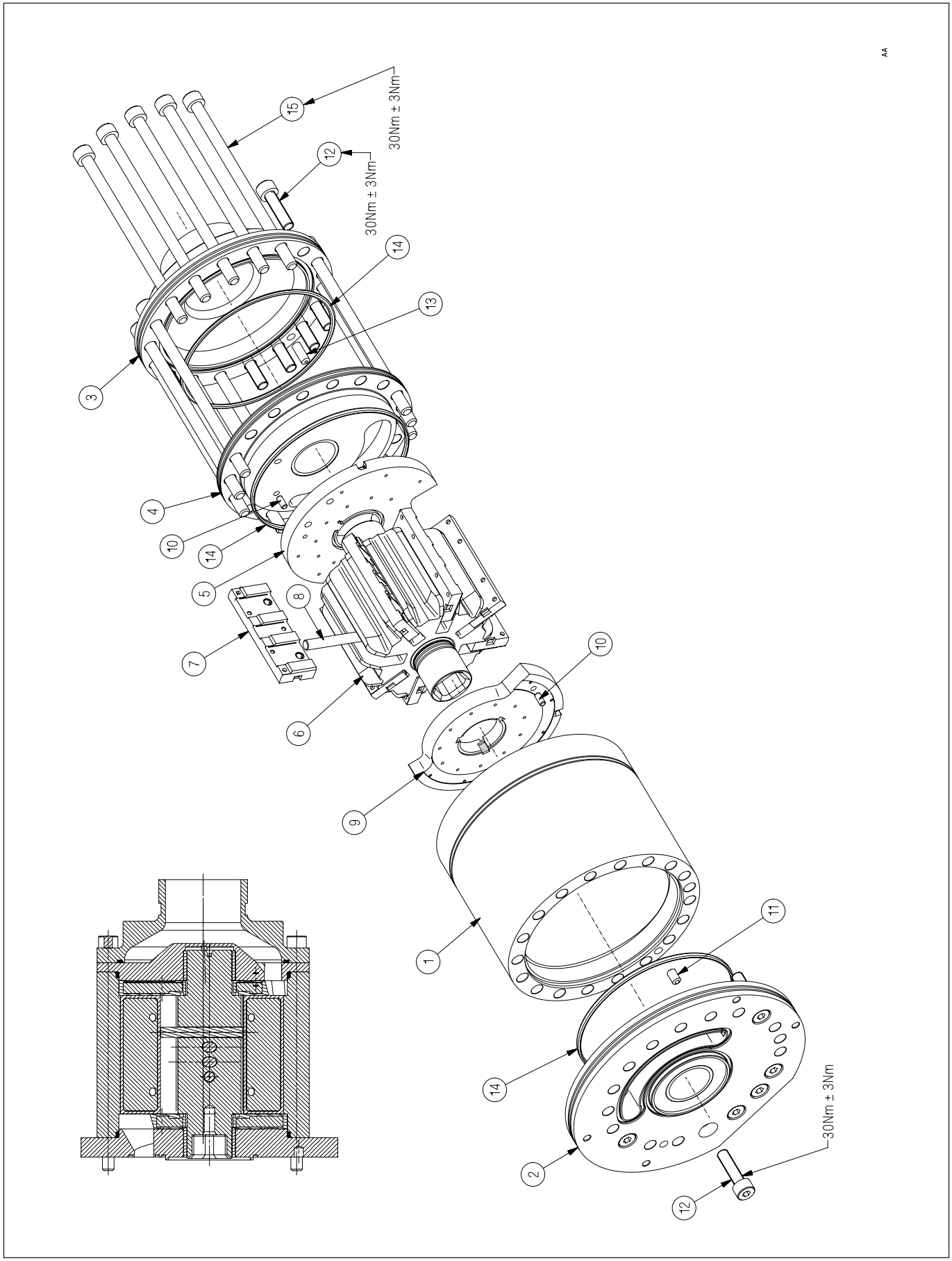
Pos.	Qnt.	Designation	Material	180F4157 Sealing kit	180F4159 Coupling kit
201	1	Booster pump			
202	1	Pressure exchanger			
203	1	PE Coupling	Super Duplex		X
204	1	Spider softex 24/30	Green Hytrel		X
205	1	VP Coupling	Super Duplex		X
206	2	Screw M8 × 30	Super Duplex	X	X
16	1	O-ring 60 × 2	NBR 70	X	X
17	1	O-ring 80 × 2	NBR 70	X	X
18	1	Pin Ø6 × 10	AISI 316	X	X

iSave 21 Plus on base plate

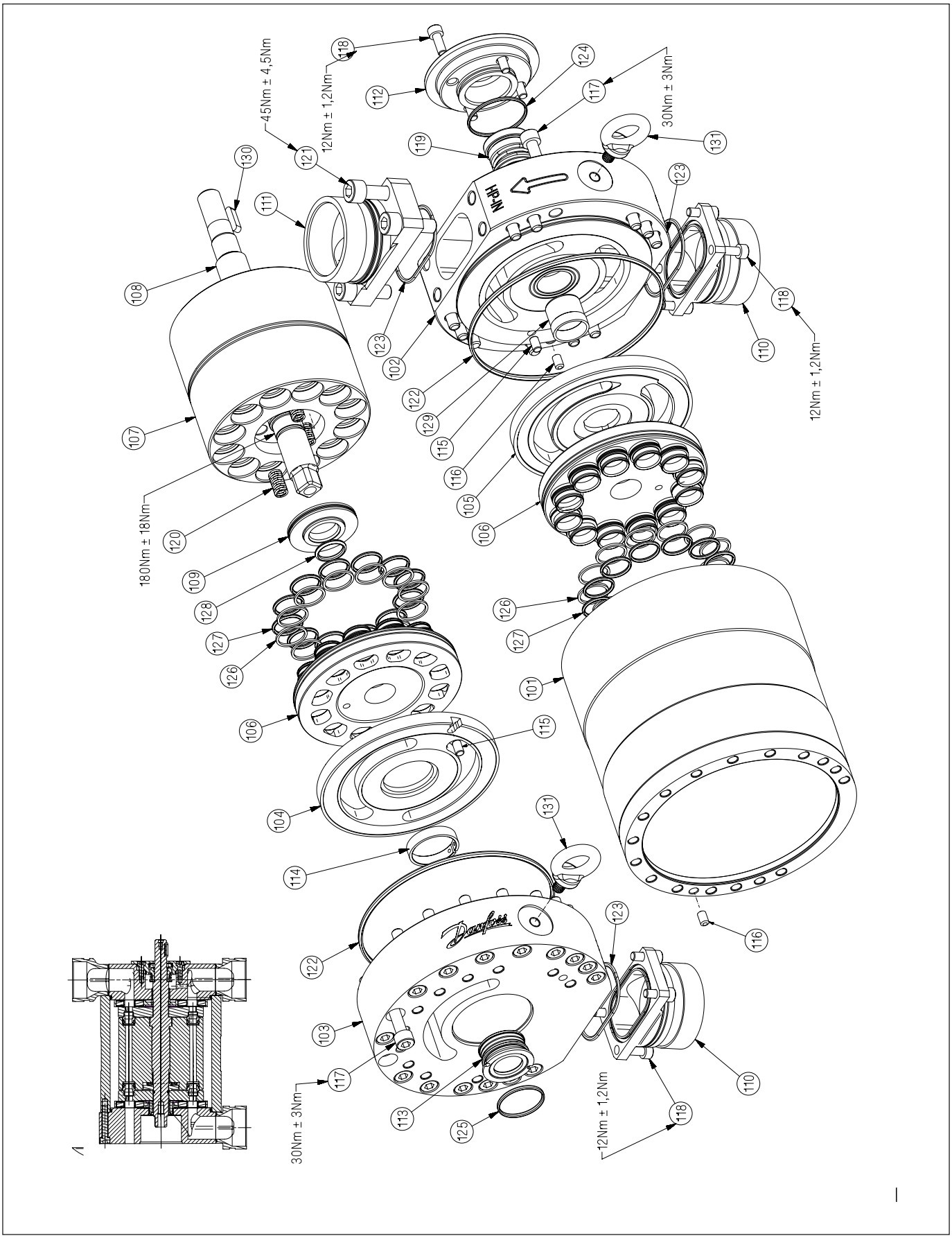
Exploded view, see following pages.

Pos.	Qnt.	Designation	Coupling 180Z0244
1	1	iSave 21	
2	1	Base plate	
3	1	Bell housing	
4	1	Electric motor	
5	1	Coupling	X
6	4	Bolt M10 × 30 A4	
7	4	Washer	
8	6	Bolt M6 × 16 A4	
9	1	Plug	
10	8	Washer	
11	4	Bolt M8 × 20 A4	
12	1	Rubber plate	
13	1	Support	

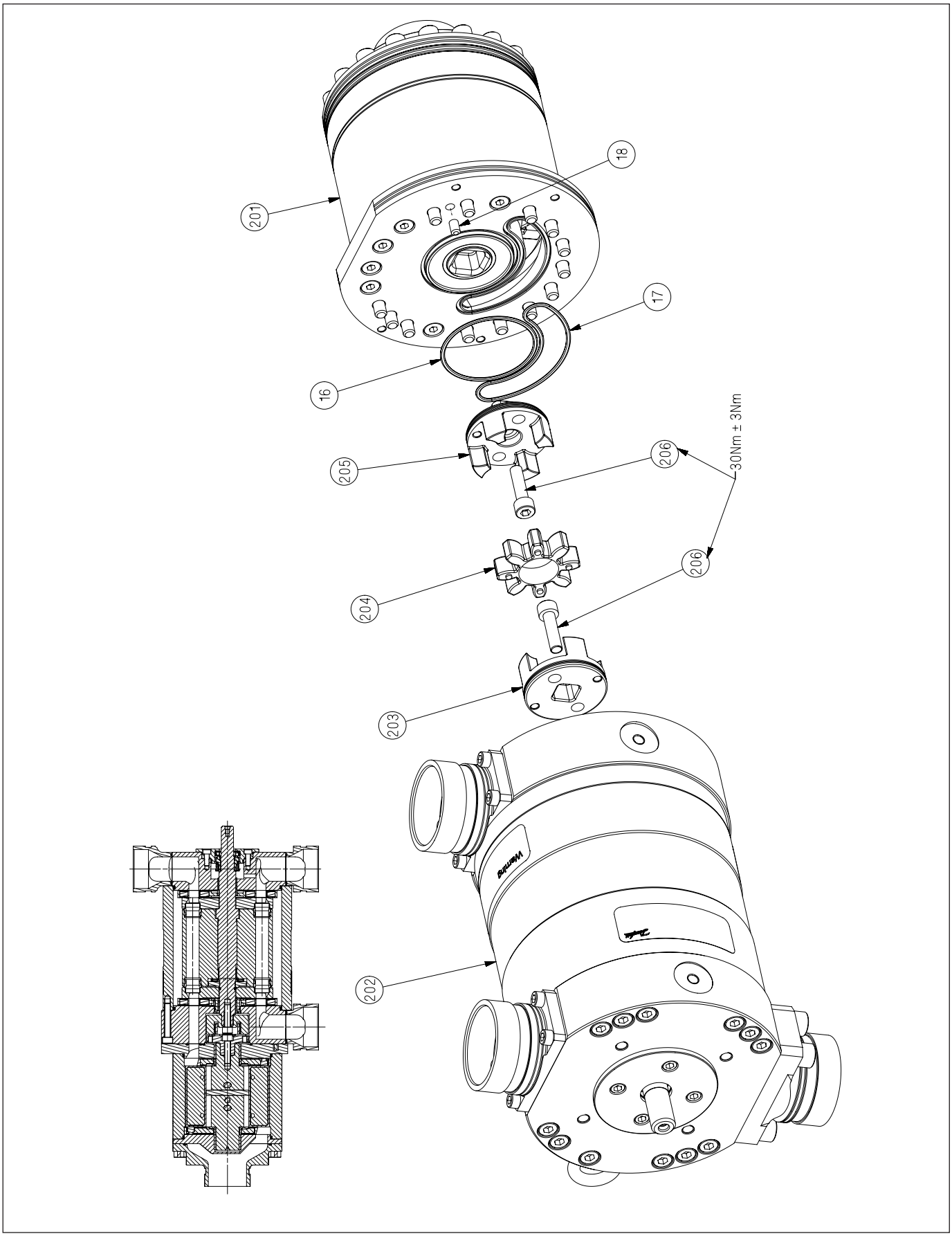
Exploded view
Vane pump



Exploded view
Pressure exchanger



Exploded view
iSave 21 Plus



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Instruction

Right and wrong
Hose assembly routing tips

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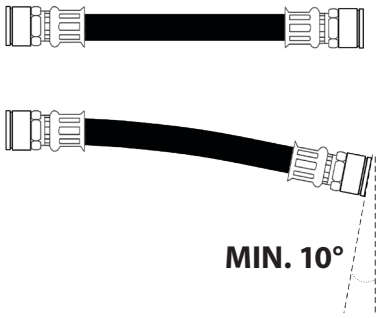
Correct hose installation is essential for safe and satisfactory performance. The size of the hoses impacts the installation recommendations. This manual has therefore been split in recommendation for hoses up to 2" and recommendation larger than 2".

Hose routing tips:
Danfoss recommends installing hose whip restraints whenever your pressurized hose assemblies are in proximity to personnel or crucial equipment.
Check with these examples when installing your hoses.

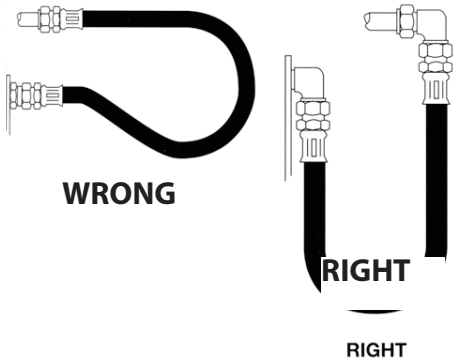
1. Hoses up to 2"

When installing hoses, avoid twisting the hose as the hose will try to straighten under pressure.

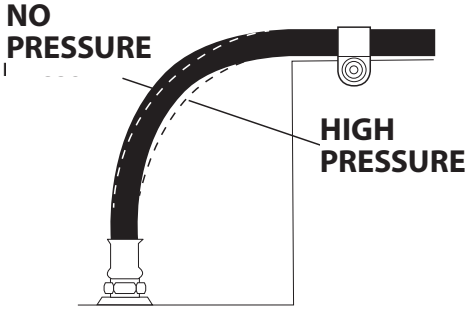
This can cause hose failure via hose blowout from the fitting and/or hose burst at the point of strain.



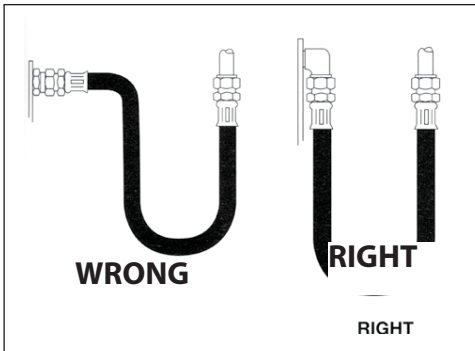
Always provide some angle on straight hose installations, this reduces forces and ensures that hose is only bending i one direction. The Hose must have some slack to compensate for hose length variations.



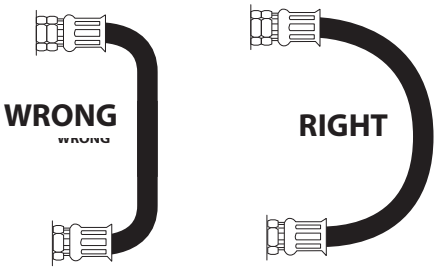
At radius below required minimum, angle adapters should be used to prevent sharp hose bends.



To allow the hose to expand when pressurized, clamps should not be used at bends. If possible, do not clamp high and low pressure lines together.



Use proper angle adapters to avoid sharp twist or bend of hose.

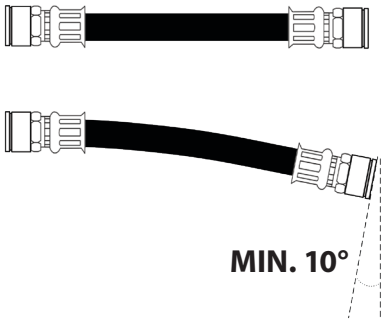


To prevent hose collapse and flow restriction, hose bend radii should be kept as large as possible. Tight bends can also compromise the hose reinforcement and cause premature hose failure. Refer to hose specification table on page 6 for minimum bend radii.

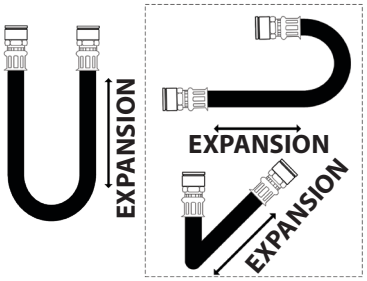
2. Hoses larger than 2”

Whenever possible, high pressure hoses should always be connected directly to Danfoss provided adapters and check valves. Elbows and distance pipes should be avoided to prevent excessive side loads.

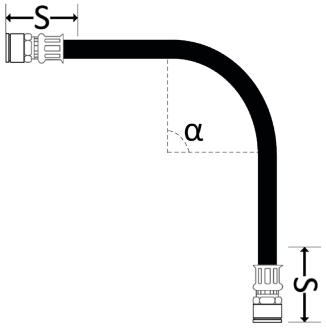
Danfoss 3” HP hoses are nylon reinforced; when using hoses that are not steel reinforced the connected items must be grounded to avoid electrical stray currents.



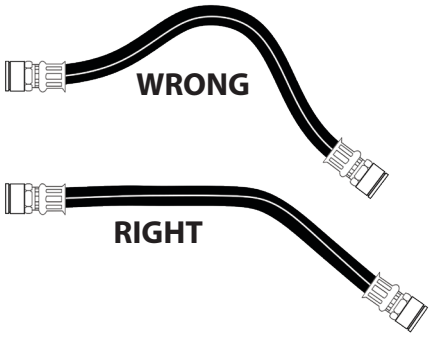
Always provide some slack on straight hose installations. This compensates for hose length variations with differences in internal fluid pressures. A small angle will reduce the forces from the hose and allow the hose to bend when pressurized.



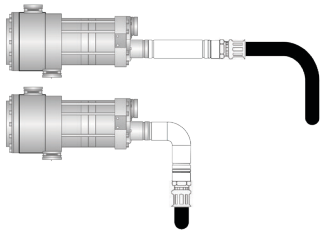
Flexing a metal hose in two separate planes of movement will torque the hose assembly. Always install the metal hose assembly so that flexing occurs in one plan only and this is the same plane in which bending occurs. If multiple planes of motion are required use a dog leg assembly.



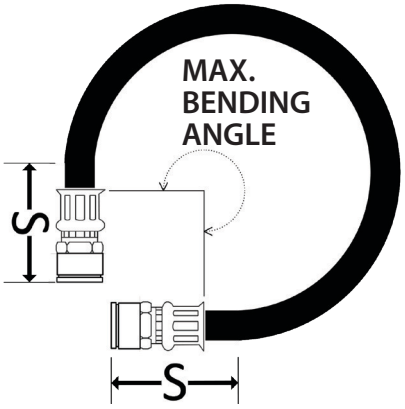
The installation should allow a straight distance S before bending the hose. Not doing so may compromise the hose reinforcement and cause hose failure. Max. bending angle and distance S can be found in table 1 on page 6.



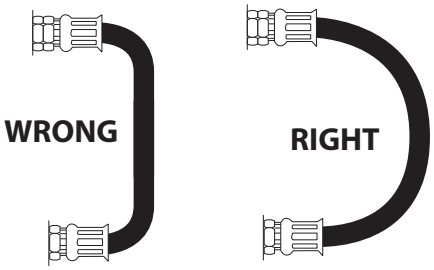
Hoses should not be twisted and should only have one bend.



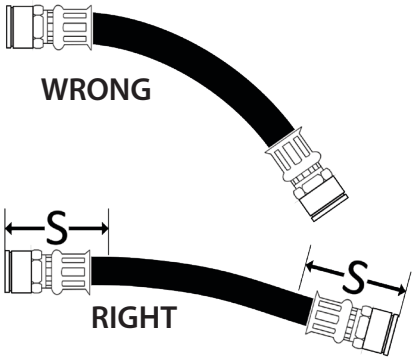
The use of pipe or fittings between pump and iSave connectors and hoses should be avoided. Such configurations can apply excessive loads on the connectors and can cause connector and/or connector bolt failure. If this cannot be avoided, the piping system must be protected by either hose whip restraints mounted directly to the frame or the hard piping must be fixed relative to any pump/iSave movements.



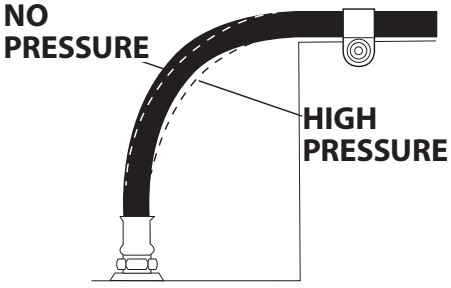
If hose is bent, ensure max. bending angle and distance S from each connector (see table 1 on page 6).



To prevent hose collapse and flow restriction, hose bend radii should be kept as large as possible. Tight bends can also compromise the hose reinforcement and cause premature hose failure. Refer to hose specification table on page 6 for minimum bend radii.



The hose must have a distance S before bending starts.

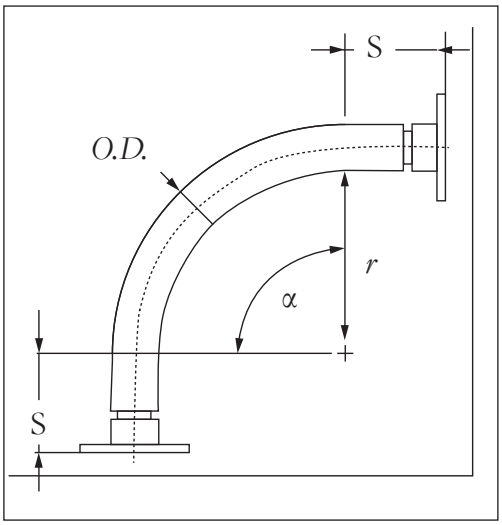


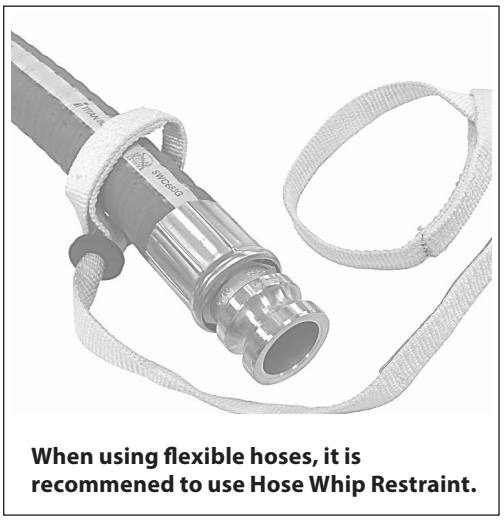
To allow the hose to expand when pressurized, clamps should not be used at bends. If possible, do not clamp high and low pressure lines together.

3. Hose specification table

High pressure hoses						
Code number	**Pipe connection[1] [A]**	**Pipe connection material**	**Hose size Inner diameter**	**Hose length ISO 1436 [B]**	**Bending radius**	**S**
180Z0228	1.5" Vic. OGS	Super duplex EN 1.4410	25.4 mm (1.0")	0.66 m (26")	152 mm (6.08"), max. 90°	79 mm (3.11″)
180Z0229	1.5" Vic. OGS	Super duplex EN 1.4410	25.4 mm (1.0")	1.16 m (45.7")	152 mm (6.08"), max. 180°	79 mm (3.11″)
180Z0167	1.5" Vic. OGS	Super duplex EN 1.4410	38.0 mm (1.5")	1.16 m (45.7")	250 mm (9.84"), max. 180°	85 mm (3.35″)
180Z0140	2.0" Vic. OGS	Super duplex EN 1.4410	50 mm (2.0")	1.25 m (49")	630 mm (24.8"), max. 90°	115 mm (4.53″)
180Z0263	2.5" Vic. OGS[1]	Super duplex EN 1.4410	50 mm (2.0")	1.78 m (70")	630 mm (24.8"), max. 180°	115 mm (4.53″)
180Z0280	2.5" Vic. OGS	Super duplex EN 1.4410	50 mm (2.0")	1.00 m (39.4")	630 mm (24.8"), max. 90°	115 mm (4.53″)
180Z0619	2.5" Vic. OGS	Super duplex EN 1.4410	65 mm (2.5")	1.78 m (70")	200 mm (7.87"), max. 270°	150 mm (5.90″)
180Z0618	2.5" Vic. OGS	Super duplex EN 1.4410	65 mm (2.5")	1.00 m (9.4")	200 mm (7.87"), max. 90°	150 mm (5.90″)
180Z0612	3.0" Vic. OGS	Super duplex EN 1.4410	76 mm (3.0")	1.79 m (70.5")	250 mm (9.84"), max. 270°	150 mm (5.90″)
180Z0611	3.0" Vic. OGS	Super duplex EN 1.4410	76 mm (3.0")	1.00 m (39.4")	250 mm (9.84"), max. 90°	150 mm (5.90″)
180Z1000	3.0" Vic. OGS	Super duplex EN 1.4410	76 mm (3.0")	1,25 m (49")	250 mm (9.84"), max. 180°	150 mm (5.90″)
180Z1001	3.0" Vic. OGS	Super duplex EN 1.4410	76 mm (3.0")	1,6 m (63")	250 mm (9.84"), max. 180°	150 mm (5.90″)
Low pressure hoses						
180Z0298	2.0″ Vic. OGS	Super duplex EN 1.4410		2.0 m (79″)		
180Z0144	3.0″ Vic. OGS	Super duplex EN 1.4410		2.0 m (79″)		

[1] The installation instuction for Style 77DX is located in the Victaulic document I-100 Field Installation Handbook (htpp://static.victaulic.com)





When using flexible hoses, it is recommened to use Hose Whip Restraint.

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Electric Motors

Motor Manual

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HOYER MOTORS

HOYER
MOTORS

Motor Manual

General

This manual concerns the following types of standard induction motors from Hoyer:
HMA3, HMC3, HMA2, HMC2, HMD, HMT, MS, Y2E1, Y2E2, YDT
These motors are manufactured in accordance with IEC/EN 60034-4 and IEC/EN 60072.
Motors are rated for the ambient temperature range -20°C to +40°C and site altitudes ≤1000 m above sea level.
Low-voltage motors are components for installation in machinery. They are CE marked according to the Low Voltage Directive 2014/35/EU.
Motors not fulfilling the IE3 efficiency level must be equipped with a variable speed drive when used in EU.

Transport and storage

Check the motor for external damage immediately upon receipt and, if found, inform the forwarding agent right away.
Check all rating plate data, and compare it with the requirement of the motor.
Turn the shaft by hand to check free rotation, remove transport locking if used.
Transport locking must be used again for internal transport also. It is also important that transport locking is used when motors are transported mounted on equipment.
All motors should be stored indoors, in dry, vibration- and dust-free conditions.

Lifting eyebolts must be tightened before use. Damaged eyebolts must not be used, check before use. Lifting eyes at motor must not be used to lift the motor when it is attached to other equipment.

Before commissioning, measure the insulation impedance. If values are ≤ 10MΩ at 25°C, the winding must be oven dried.
The insulation resistance reference is halved for each 20°C rise in motor temperature.
It is recommended that shafts are rotated periodically by hand to prevent grease migration.

Installation

The motor must be fixed on a stable, clear and flat foundation. It must be sufficiently rigid to withstand possible short circuit forces.
It is important to ensure that the mounting conditions do not cause resonance with the rotational frequency and the doubled supply frequency.
Only mount or remove drive components (pulley, coupling, etc.) using suitable tools, never hit the drive components with a hammer as this will cause damage to the bearing.
The motor are balancing with half key, ensure that the drive components are also the same.
Correct alignment is essential to avoid bearing, vibration and shaft failure.
Use appropriate methods for alignment.
Re-check the alignment after the final tightening of the bolts or studs.
Check that drain holes and plugs face downwards. We recommend opening the drain hole for motors placed outdoors and not running 24 hours / day, so that the motor can breathe, thus ensuring a dry motor.

Electrical connection

Work is only permitted to be carried out by qualified specialists and must to be carried out in accordance with local regulations.
Before work commences, ensure that all power is switched off and cannot be switched on again. This also applies to the auxiliary power circuits, e.g. anti-condense heaters.
Check that supply voltage and frequency are the same as rated data.
Motors can be used with a supply deviation of ± 5% voltage and ± 2% frequency, according to IEC60034-1.

Connection diagrams for main supply and accessory as PTC or heater are located inside the terminal box.

Connections must be made in such a way as to ensure that a permanently safe electrical connection is maintained, both for the main supply and the earth connection.
We recommend that crimped connections are made in accordance with IEC 60352-2.

Tightening torques for terminal board screws:

Thread	M5	M6	M8	M10	M12	M16	M20	M24
T.(Nm)	2.5	3.5	7	12	18	35	55	80

Ensure that the terminal box is clean and dry.
Unused glands must be closed with blind caps.
Check the terminal box gasket before it is remounted.

Maintenance

Inspect the motor at regular intervals, keep it clean and ensure free ventilation air flow, check the condition of shaft seals and replace if necessary. Both electrical and mechanical

connections must be checked and tightened if necessary.
Bearing size and type are specified on the rating plate. Motor types HMA3 and HMC3 is as standard with lifetime greased bearings in motors size ≤180 for cast iron and size ≤132 for aluminium. Motor types HMA2 and HMC2 is as standard with lifetime greased bearing in motors size ≤225.
Motor types MS and Y2E is as standard with lifetime greased bearing in motors size ≤160.

Typical duty hours for lifetime lubricated bearings.

Frame size	Poles	Typical lifetime
56 - 160	2 - 8	40,000h
180	2	35,000h
200	2	27,000h
225	2	23,000h
180 - 225	4 - 8	40,000h

Motors with a re-greasing system must be lubricated with high quality lithium complex grease, NLGI grade 2 or 3, with a temperature range of between -40°C to +150°C.
Motors are normal fitted with a data plate with greasing information; if it is missing use the following re-greasing intervals.

Frame size	Grease (g)	2 pole (h)	4 pole (h)	6 pole (h)	8 pole (h)
160	20	4200	7000	8500	8500
180	20	4200	7000	8500	8500
200	25	3100	6500	8500	8500
225	25	3100	6500	8500	8500
250	35	2000	6000	7000	7000
280	35	2000	6000	7000	7000
315	50	1500	5500	6500	6500
355	60	1000	4000	5000	6000
400	80	800	3000	4000	6000

Grease the motor while running, open the grease outlet plug and let the motor run 1-2 hours before the outlet grease plug is closed again.
Grease the motor for the first time during commissioning.

The following applies in general for both lifetime lubricated and re-lubricated bearings:
At 60Hz the time will be reduced by app. 20%.
Data for vertically mounted motors are half of the above values.

The table values are based on an ambient temperature of 25°C. The values must be halved for every 15K increase in bearing temperature.
Higher speed operations, e.g. frequency converter drive will require shorter greasing intervals. Typically, doubling the speed will reduce the values by 50%.

Special note for Atex Zone 22 and nA motors

Designation of motor according to IEC standard:
II 3D Ex tc IIIB T120°C
II 3G Ex nA IIC T3

The hazardous 3-phase asynchronous motors are in accordance with International standard IEC 60079-31 and IEC 60079-15.
Only one electrical installation may be installed in one specified area (zone).

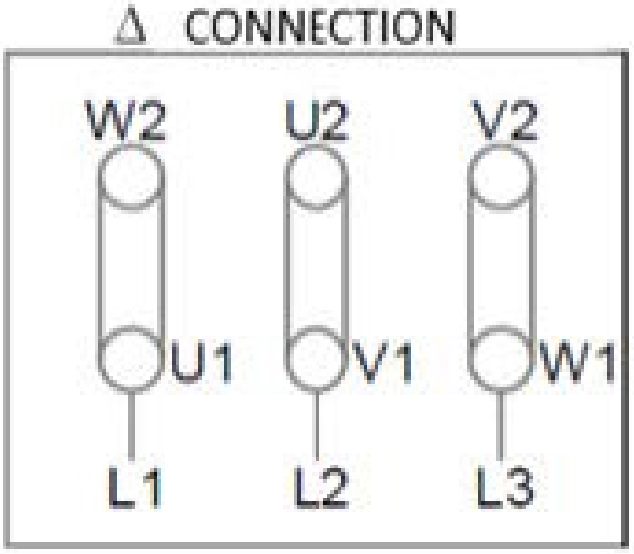
Only certificated cable glands may be used. Unused glands must be closed.
Connections must be made in such a way as to ensure that a permanently safe electrical connection is maintained, both for the main supply and earth connection.
Installations must be in accordance with actual standards for installation in hazardours area.

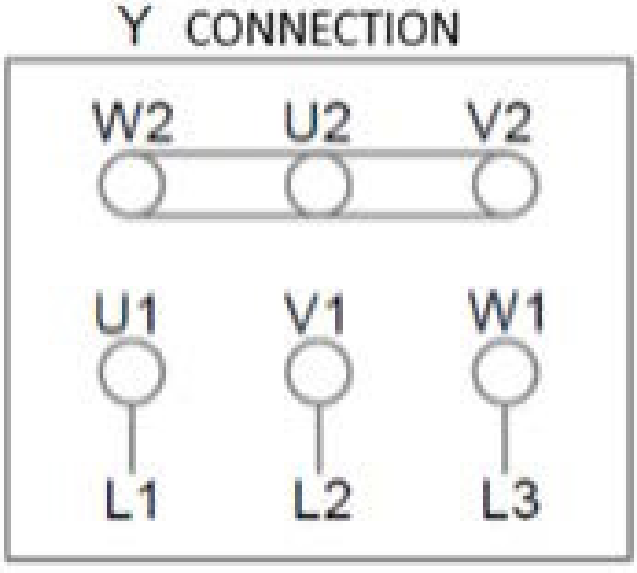
It is recommended that the IEC standard is followed according to temperature and dust on the motor surface.
The use of motors with so much surface dust that the motor temperature increases is not permitted.
Regularly cleaning is recommended.
The radial shaft sealing ring is part of the ATEX certification. It is important that the ring is always intact.
The shaft sealing must be regularly checked, and if dry it must be lubricated. It is recommended that the seal is re-lubricated regularly.
Always use the original seal ring when replaced.
Replacing bearings also means replacing the seals.

All machines must be inspected regularly for mechanical damage.
The user is responsible for changing parts in accordance with the lifetime of parts, in particular:
bearings, grease and lubrication of shaft sealing.

Maintenance, repairs and replacement on this type must only be carried out by qualified specialists.

Connection diagram
Anschlußdiagram
Anslutningdiagramm
Forbindelsesdiagram
Aansluitdiagram
Connection
Conexión
Collegamento
Schemat polacsen





EU Declaration of Conformity

The Manufacturer: SVEND HØYER A/S
Over Hadstenvej 42
DK 8370 Hadsten
Denmark

Hereby declares that

The products: HOYER MOTORS, 3-phase induction motors

Aluminum motors	MS 56 - 180
	HMAx 56 – 180
Cast iron motors	Y2E2 80 - 400
	HMCx 80 – 400

HOYER MOTORS, 1-phase induction motors

Aluminum motors	ML 56 – 112
	MY 63 – 112

Are in conformity with the following:

Standards: IEC/EN 60034 (All relevant standards on the IEC/EN 60034 series)
Directive: Low Voltage Directive 2014/35/
EU

Motor type HMAx and HMCx is also conformity with:

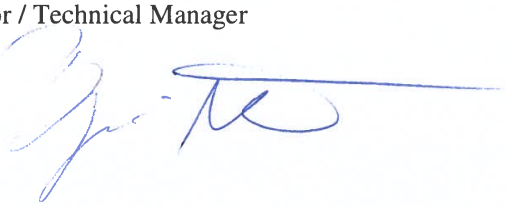
Standards: IEC/EN 60079-0:2018, IEC/EN 60079-0/A11:2013,
IEC/EN 60079-15:2010, IEC/EN 60079-31:2014
Directive: Eco design for electrical motors 2009/640/EC and 2014/4EU
ATEX directive 2014/34/EU
Ex II 3D Ex tc IIIB T120°C
Ex II 3G Ex nA IIC T3
CE marking: CE

This declaration of conformity is issued under the sole responsibility of the manufacturer.

I hereby declare that the equipment's named above have been designed to comply with the relevant sections of the above referenced specifications.

Signed by: Bjarne Nør / Technical Manager

December 2018:



1/3

x = 2, 3

HOYER

EXCEEDING EXPECTATIONS

Hoyer Motors, Motor Manual, April 2019

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