

2 Speed axial piston motor

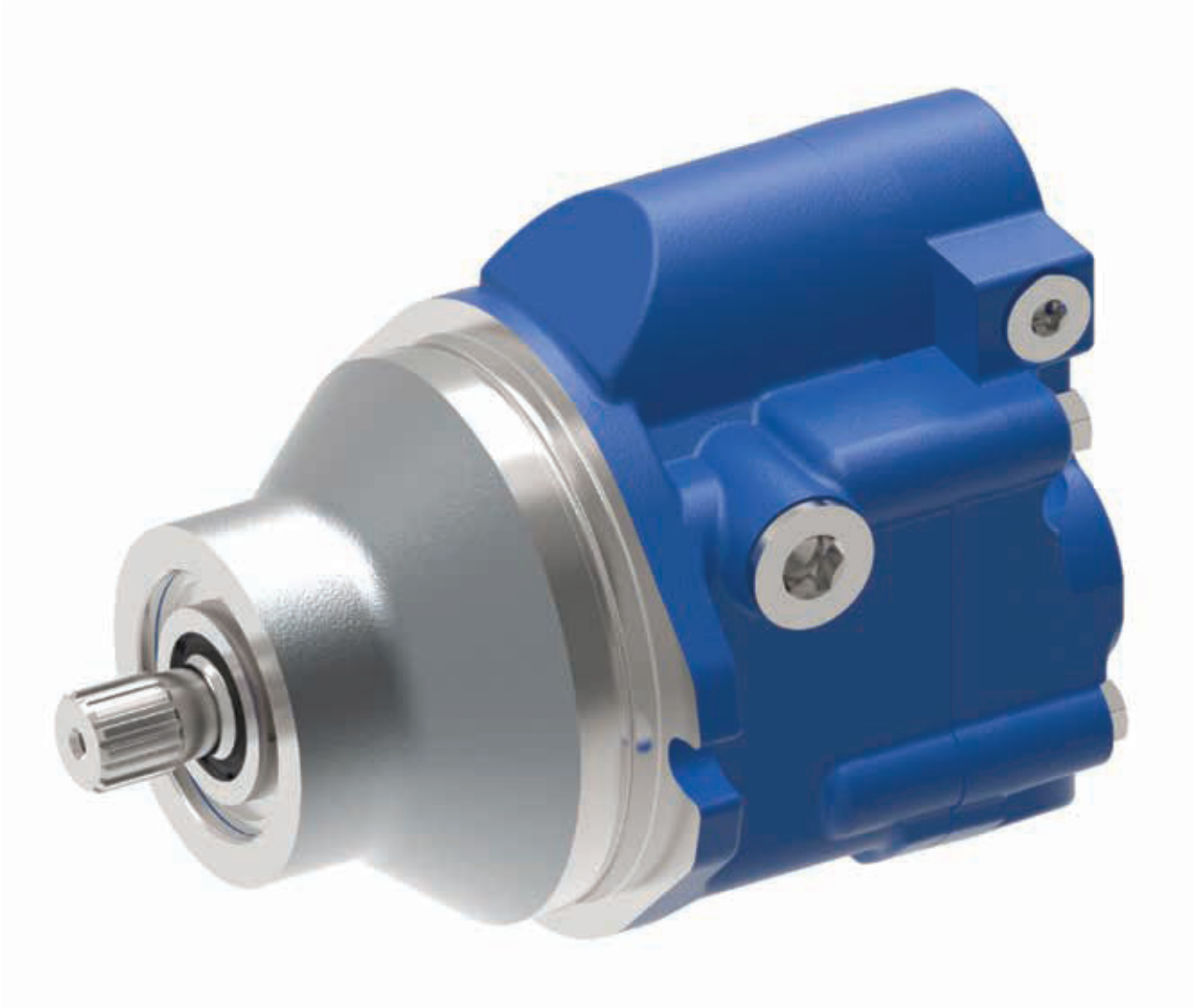


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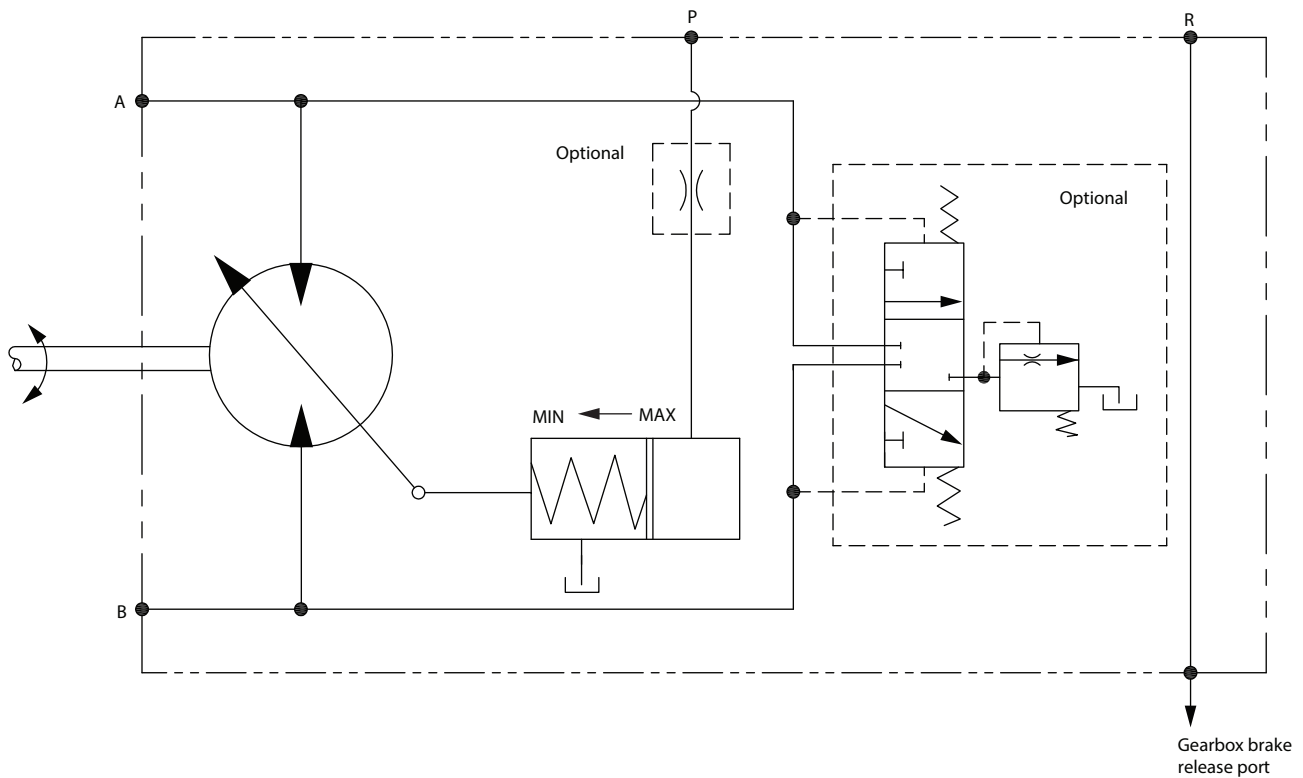
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Features

Danfoss Medium Duty Piston Motors convert hydraulic energy supplied by the pump to mechanical energy. These motors are uniquely suited to fit any application that requires continuous rotary motion at a remote location from the power source. Axial piston motors share the design advantages of piston pumps to provide long-lasting power in a lightweight, easily serviceable package. The table below provides an overview of features. For a complete list of options, refer to the Model Code section of a given motor displacement.

- Field proven rotating group design
- 2 speed option
- Direct hydraulic operated control
- Compact design
- Brake release port to use with gear box
- Planetary gear box option
- Hot oil shuttle & anti-cavitation check valve

Hydraulic schematic



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Technical specifications

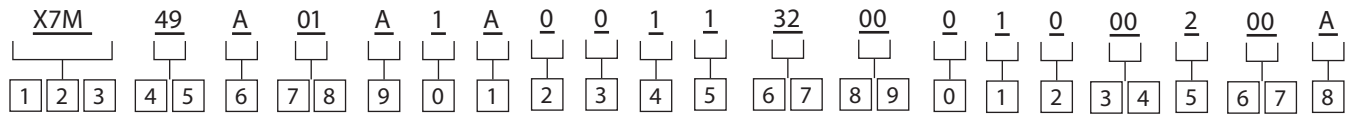
| Parameter | Unit | Model 374AKXXXXXA (41 cc) | Model 374AKXXXXXA (49 cc) |
|---|---|---|--|
| Displacement | cm ³ /r [in ³ /r] | 40.6 [2.48] | 49.2 [3.00] |
| Maximum displacement | cm ³ /r [in ³ /r] | 32.0 to 40.6 [1.95 to 2.48] | 43.3 to 49.2 [2.64 to 3.00] |
| Minimum displacement | cm ³ /r [in ³ /r] | 7.4 [0.45], 10 [0.61], 13 [0.79], 17 [1.037], 20.5 [1.25] | 16.30 [0.99], 20 [1.22], 22 [1.36], 26 [1.58], 29 [1.77], 32 [1.95] |
| Maximum rated speed at maximum displacement | rpm | 3500 | 3500 |
| Maximum rated speed at minimum displacement | rpm | 4500 | 4500 |
| Nominal pressure rating * | bar [psi] | 350 [5076] | 310 [4500] |
| Peak pressure rating ** | bar [psi] | 380 [5500] | 345 [5000] |
| Output torque (theoretical) | N-m / bar [lbf-in/1000 psi] | 0.65 [394] | 0.79 [480] |
| Shift pressure range | bar [psi] | 15 - 69 [220 to 1000] | 15 - 69 [220 to 1000] |
| Maximum allowable case pressure | bar [psi] | 3.45 [50] | 3.45 [50] |
| Viscosity - Minimum | cSt | 6 cSt | 6 cSt |
| Viscosity - Optimum working range | cSt | 10-39 cSt | 10-39 cSt |
| Viscosity - Maximum | cSt | 2158 cSt | 2158 cSt |
| Maximum Fluid Temp-Inlet | °C | 105 degree celcius | 105 degree celcius |
| Minimum Fluid Operating Temp | °C | -30 degree celcius | -30 degree celcius |
| Ambient Temperature | °C | -30 to 80 degree celcius | -30 to 80 degree celcius |
| Weight | lbs [kg] | 36 lbs [16.36 kgs] | 36 lbs [16.36 kgs] |
| Cleanliness | | 21/18/13 ISO/DIS 4406 (Class 9) | 21/18/13 ISO/DIS 4406 (Class 9) |

Notes:

* Nominal pressure : Max. delta system pressure at which component fatigue does not occur. (Motor life estimated by bearing life)

** Peak pressure : Max. operating pressure which is permissible for a short duration of time [t<1 sec]

Model code structure

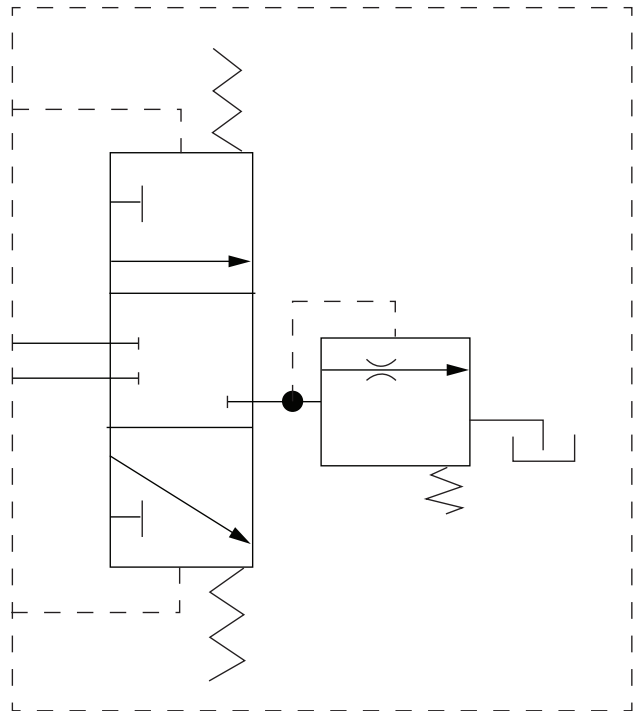


| | | | |
|-------|---|-------|--|
| 1 2 3 | Code title X7M X70 variable displacement piston motor | 07 | 737 cm ³ /r [0.45 in ³ /r] |
| 4 5 | Displacement 41 40.6 cm ³ /r [2.48 in ³ /r] 49 49.2 cm ³ /r [3.00 in ³ /r] | 10 | 10.65 cm ³ /r [0.65 in ³ /r] |
| 6 | Mounting flange A Plug-in mount | 11 | 11.47 cm ³ /r [0.70 in ³ /r] |
| 7 8 | Output shaft 01 15 Tooth 16/32 Spline 02 13 Tooth 16/32 Spline 03 Taper 1:8 Per SAE J501 | 13 | 13.44 cm ³ /r [0.82 in ³ /r] |
| 9 | Main ports sizing A M27 X 2 Metric O-Ring port (A & B) B 1.0625-12 UN-2B SAE o-ring port (A & B) | 16 | 16.30 cm ³ /r [1.00 in ³ /r] |
| 10 | Port orientation 1 Radial ports 2 Axial ports | 17 | 17.53 cm ³ /r [1.07 in ³ /r] |
| 11 | Motor control options A Single input directly operated, external control supply, without pilot valve | 20 | 20.48 cm ³ /r [1.25 in ³ /r] |
| 12 | Control solenoids 0 None | 22 | 22.45 cm ³ /r [1.37 in ³ /r] |
| 13 | Supply orifice 0 No orifice 1 0.53 [0.021] orifice | 26 | 26.85 cm ³ /r [1.64 in ³ /r] |
| 14 | Valving 0 No valves 1 Shuttle valve with loop flushing 2 Blocked shuttle valves 3 Anti cavitation valve, unidirectional LH (CCW) Rotation 4 Anti cavitation valve, unidirectional RH (CW) Rotation | 32 | 32.00 cm ³ /r [1.95 in ³ /r] |
| 15 | Flushing valve pressure setting 0 None 1 10.3-12.1 bar [150-175 PSI] 2 11.4-13.1 bar [165-190 PSI] 3 13.8-15.9 bar [200-230 PSI] 4 15.2-17.2 bar [220-250 PSI] 5 20.0-21.4 bar [290-310 PSI] | 18 19 | Maximum displacements 00 Catalogue motor displacement 33 33.1 cm ³ /r [2.02 in ³ /r] 35 35.6 cm ³ /r [2.17 in ³ /r] 38 38.0 cm ³ /r [2.32 in ³ /r] 43 43.3 cm ³ /r [2.64 in ³ /r] 45 45 cm ³ /r [2.75 in ³ /r] 47 47 cm ³ /r [2.87 in ³ /r] |
| 16 17 | Minimum displacements | 20 | Auxiliary mounting (rear) 0 No auxiliary mounting |
| | | 21 | Speed sensor option 0 No speed sensor 1 Speed sensor ready (plugged port) 2 With speed sensor |
| | | 22 | Shaft seal option 0 Standard nitrile |
| | | 23 24 | Special features 00 No special features |
| | | 25 | Paint 0 Do not paint (Anti rust conservation oil) 1 Painted primer blue (Per spec 209-13CD) 2 Painted primer black (Per spec 209-13B) 3 Green per spec 209-13K 4 Grey per spec 209-13P 5 Red per spec 209-13V 6 Yellow per spec 209-13BF 7 Bright yellow per spec 209-13CF |
| | | 26 27 | Identification 00 Standard |
| | | 28 | Design code A A |

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Loop flushing valve

The spring centered shuttle valve, located in the motor's end cover, moves to connect the low pressure side of the loop to the low pressure relief valve. When back pressure gets high enough the low pressure relief valve, in the end cover, opens and charge pump flow enters the motor case. Case flow flushes the pump and motor cases and helps keep the transmission cool. The low pressure relief valve in the motor's end cover typically has a lower setting than the charge pressure relief valve in the charge pump. This is so case flow will begin at the motor, go to the pump, and return to the reservoir.

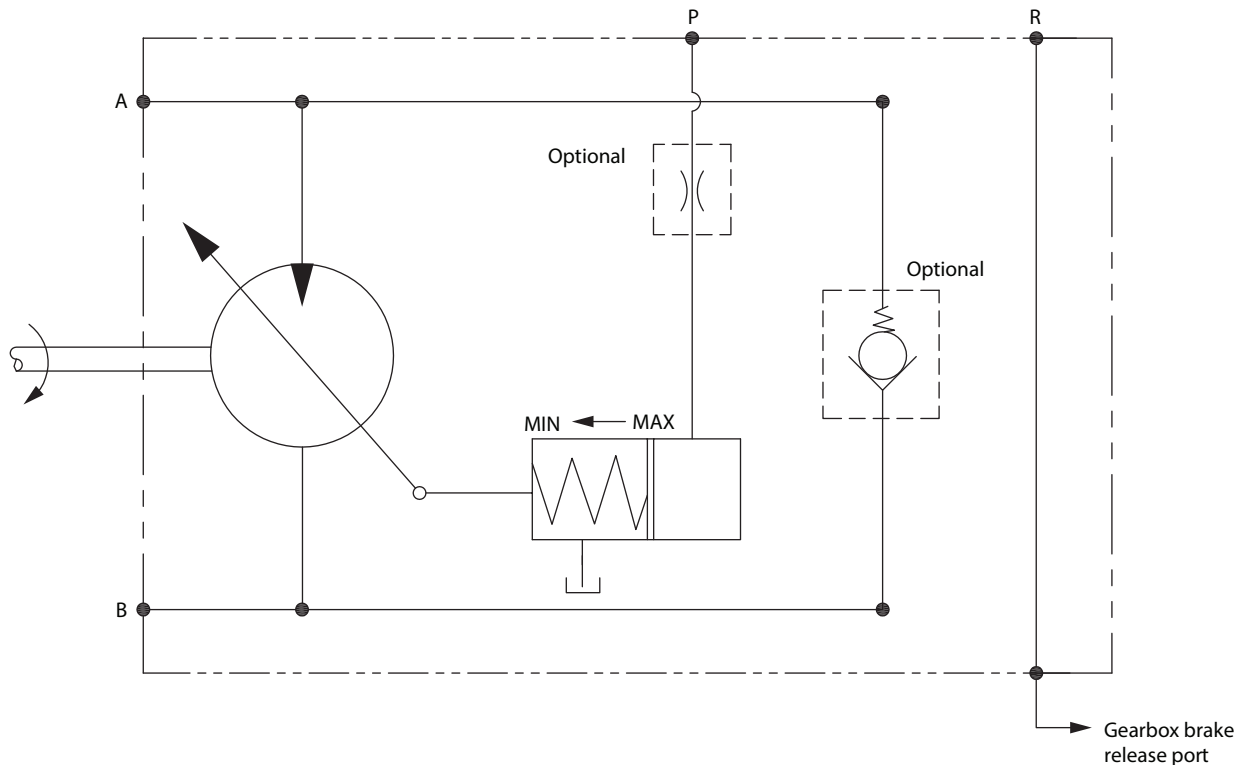


Anti cavitation valve

Anti-cavitation valve is to prevent the cavitation of the motor during deceleration and spin down. These are the conditions in which pump does not generate sufficient flow to fulfill motor requirements. Reduced flow creates vacuum at the motor suction which intern reduces pressure below partial pressure and arises cavitation. By introduction of the check valve in the circuit this condition will get eliminated as it

allow flow from delivery side back to suction side of motor. So, ultimately motor suction will get the required flow to run motor at desired speed.

- For this option the high pressure port needs to be defined upfront to get the correct motor rotation. Reversing the motor is not possible with this option.



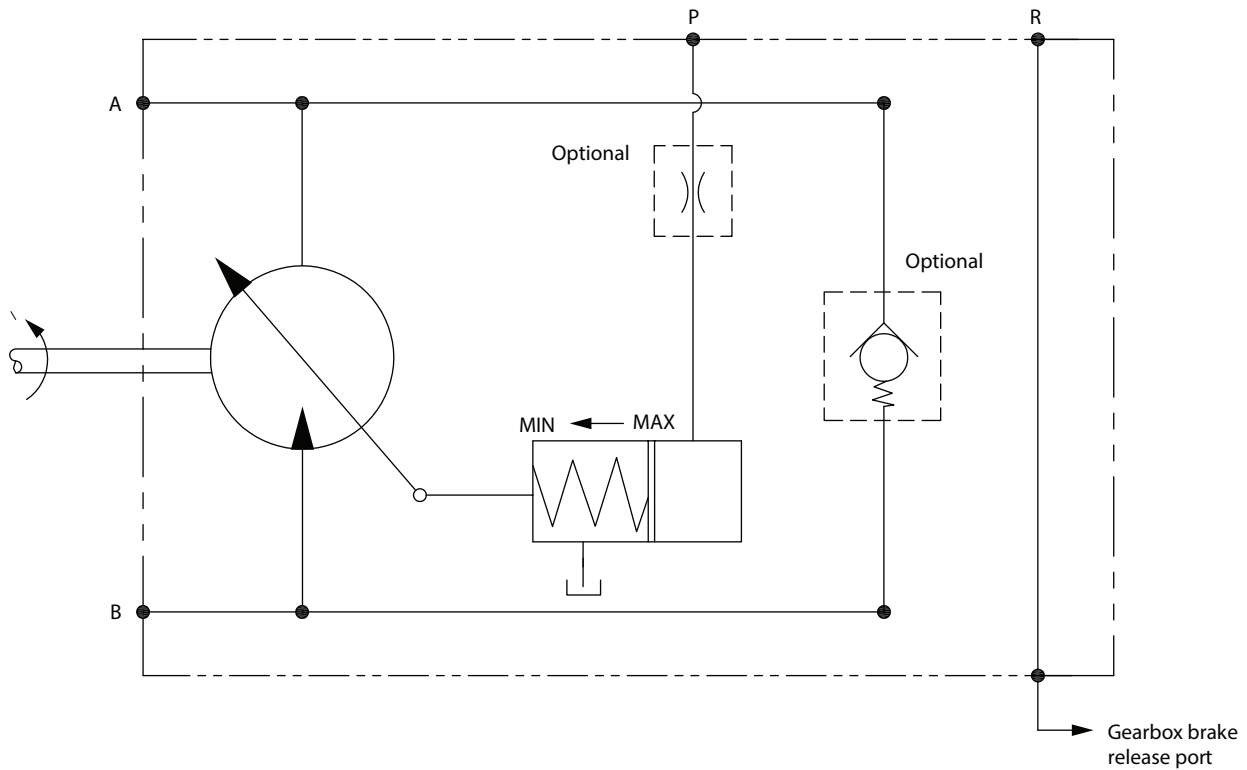
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Brake release port

X70 series plugin motors are provided with a brake release port to allow the user to make an access to the brake-release feature of the machine gear box from the rear side of the motor.

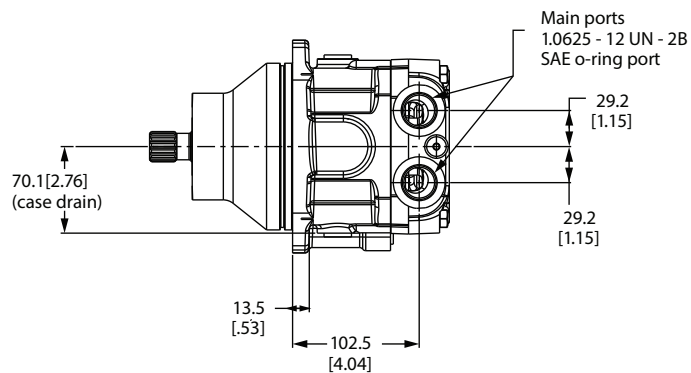
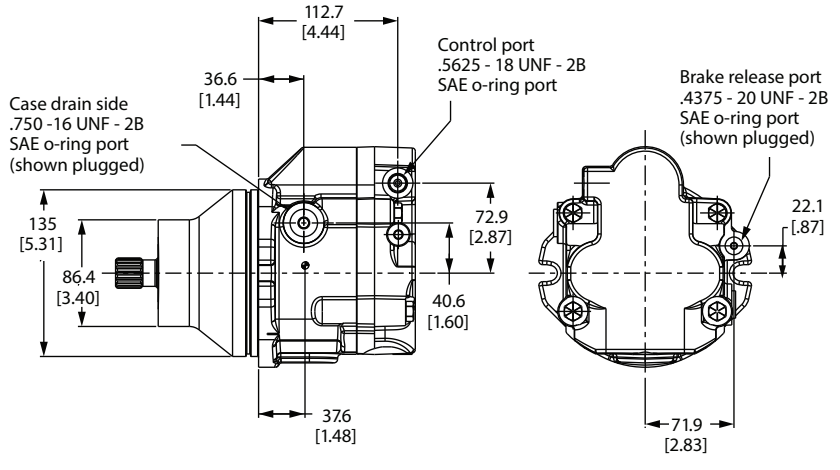
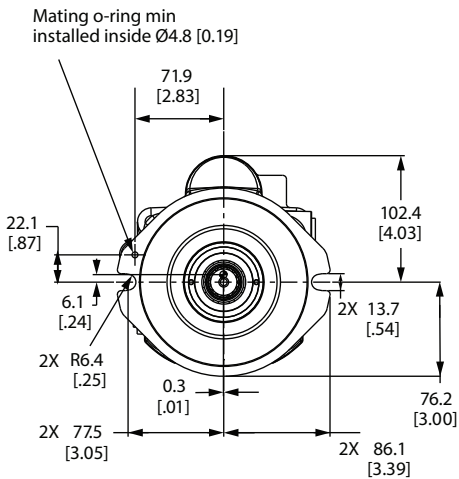
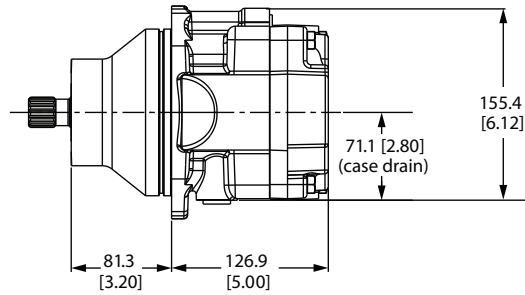
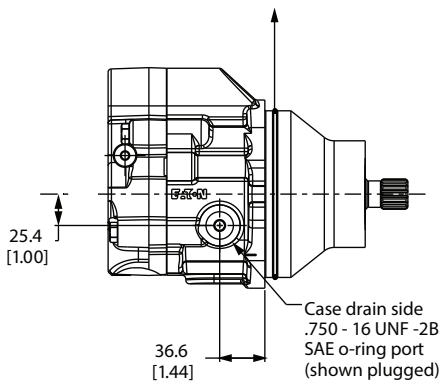
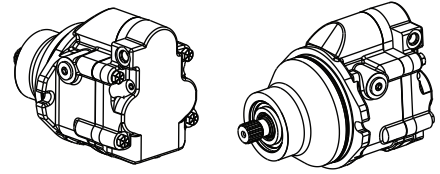
A brake release port is a simple passage provided on the motor to pass the fluid. For this, housing is provided with a rear-facing 7/16 in. SAE O-ring boss port. Refer the installation drawings for the specific positioning of the release port. Applications using this brake release port require an O-ring to seal the passage against the gear box.

While all motors will have the brake release port, not all gearboxes are compatible with this motor feature. Get in touch with your Danfoss representative in case of queries. The rated pressure for the brake release port on the motor housing is 250 bar (this does take into account the O-ring interface between the motor and gearbox). Check your gearbox for compatibility of this feature. If found as not compatible, do not connect this port to any fluid lines. Leave it plugged as shown in installation drawings.



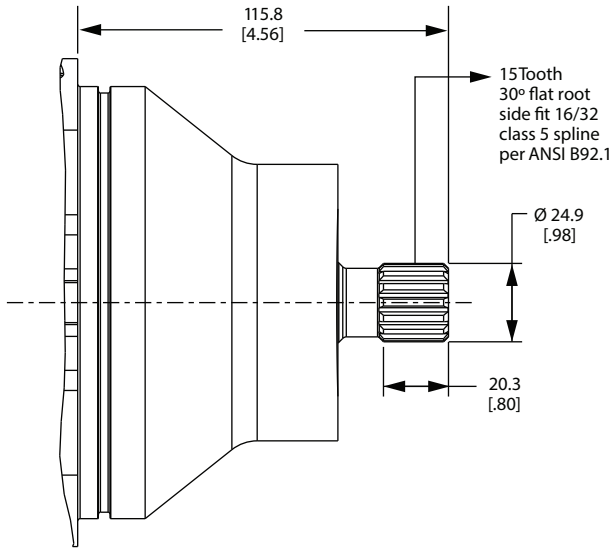
Motor installation drawings

Requires an o-ring: Viton 75 Durometer
 cross section -2.6 ± 0.07 [0.103 \pm 0.003]
 I.D. -126.6 ± 0.8 [4.987 \pm 0.035]



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Shaft installation drawings



Component selection

The long service life of Danfoss hydrostatic transmissions is largely dependent on the proper selection and installation of the components necessary for transmission operation.

The following components are necessary for transmission operation:

- Variable displacement pump
- Fixed or variable displacement motor
- Reservoir
- Filter
- Charge pump inlet line
- Pump and motor case drain lines
- High pressure lines
- Heat exchanger
- Heat exchanger bypass valve
- Reservoir return line

Variable displacement pump

Danfoss hydrostatic variable displacement pumps are an axial piston design. They are equipped with standard SAE mounts, shafts and port connections.

Fixed or variable displacement motor

Danfoss hydrostatic motors are an axial piston design. They are equipped with standard SAE mounts, shafts and port connections.

Sizing equations

For sizing/selecting the right pump for your application please carryout following basic calculations.

Output Flow (Q)

$$\text{lpm} = \frac{\text{cm}^3/\text{r} \times \text{rpm}}{1000} \quad \text{gpm} = \frac{\text{in}^3/\text{r} \times \text{rpm}}{231}$$

Input Power (P)

$$\text{kW} = \frac{\text{l/min} \times \text{bar}}{600} \quad \text{hp} = \frac{\text{gpm} \times \text{psi}}{1714}$$

Shaft Torque (M)

$$\text{N-m} = \frac{\text{bar} \times \text{cm}^3/\text{r}}{62.8} \quad \text{lb-in} = \frac{\text{psi} \times \text{in}^3/\text{r}}{6.28}$$

Shaft Speed (n)

$$\text{rpm} = \frac{1000 \times \text{l/min}}{\text{cm}^3/\text{r}} \quad \text{RPM} = \frac{231 \times \text{gpm}}{\text{in}^3/\text{r}}$$

Output Power (P)

$$\text{kW} = \frac{\text{N-m} \times \text{RPM}}{9549} \quad \text{hp} = \frac{\text{lb-in} \times \text{rpm}}{63,025}$$

Volumetric Displacement

$$\text{cm}^3/\text{r} = \frac{\text{lpm} \times 1000}{\text{rpm}} \quad \text{in}^3/\text{r} = \frac{\text{gpm} \times 231}{\text{rpm}}$$

Efficiencies

$$\text{Volumetric } N_v = \frac{\text{gpm actual}}{\text{gpm theoretical}}$$

$$\text{Mechanical } N_m = \frac{\text{lb-in actual}}{\text{lb-in theoretical}}$$

$$\text{Total } N_t = N_v \times N_m$$

Reservoir

The reservoir is an important part of the hydrostatic transmission system. It should provide adequate oil storage and allow easy oil maintenance.

The reservoir must hold enough oil to provide a continuous oil supply to the charge pump inlet. It must also have enough room for the hydraulic oil to expand as the system warms up. Consider charge pump flow when sizing the reservoir: One half (.5) minute times (X) the maximum charge pump flow should be the minimum oil volume in the reservoir. Maintaining this oil volume will give the oil a minimum of thirty (30) seconds in the reservoir. This will allow any entrained air to escape and contamination to settle out of the oil.

To allow for oil expansion, the reservoir's total volume should be at least six tenths (.6) minute times (X) the maximum charge pump flow.

The reservoir's internal structure should cut down turbulence and prevent oil aeration.

The line returning flow to the reservoir should be fitted with a diffuser to slow the incoming oil to 1 to 1.2 meters [3-4 feet] per second to help reduce turbulence. The return flow line should also be positioned so that returning oil enters the reservoir below the liquid surface. This will help reduce aeration and foaming of the oil.

The reservoir should have baffles between the return line and suction line. Baffles prevent return flow from immediately reentering the pump.

A sixty mesh screen placed across the suction chamber of the reservoir will act as a bubble separator. The screen should be placed at a 30° angle to the horizon.

The entrance to the suction line should be located well below the fluid surface so there is no chance of air being drawn into the charge pump inlet. However, the suction line entrance should not be located on the bottom of the reservoir where there may be a buildup of sediment. The suction line entrance should be flared and covered with a screen.

The reservoir should be easily accessible. The fill port should be designed to minimize the possibility of contamination during filling and to help prevent over filling. There should be a drain plug at the lowest point of the reservoir and it should also have a clean-out and inspection cover so the reservoir can be thoroughly cleaned after prolonged use. A vented reservoir should have a breather cap with a micronic filter.

Sealed reservoirs must be used at altitudes above 2500 feet.

These reservoirs should be fitted with a two-way micronic filter pressure cap to allow for fluid expansion and contraction.

In both cases the caps must be designed to prevent water from entering the reservoir during bad weather or machine washing.

A hydrostatic transmission with a well designed reservoir will run quieter, stay cleaner and last longer.

Filter

A filter must be used to keep the hydraulic fluid clean. Either a suction filter or a pressure side filter may be used. The filter must be a no-bypass type. System oil particle levels should not exceed ISO 18/15 per ISO 4406. Refer to Danfoss Hydraulic Fluid Recommendations.

Recommended filters

Pressure line – 5 micrometer

Suction line = 3 OR 5 micrometer

When a suction filter is used, its flow capacity must be large enough to prevent an excessive pressure drop between the reservoir and charge pump inlet. The pressure at the charge pump inlet port must not be less than 0,80 bar absolute [6 in. Hg.] at normal continuous operating temperatures.

Charge pump inlet line

The inlet line to the charge pump should be large enough to keep the pressure drop between the reservoir and charge pump inlet within the limits described in the filter section. Fittings will increase the pressure drop, so their number should be kept to a minimum. It is best to keep fluid velocities below 1,25 meters [4 feet] per second.

Fluid and temperature compatibility must be considered when selecting the inlet line.

Pump and motor case drain

The case drain lines should be large enough to limit the pump and motor case pressures (Medium Duty to 2 bar [25 PSI]) at normal operating temperatures. Fluid and temperature compatibility must also be considered when selecting the case drain lines.

High pressure lines

The high pressure lines that connect the pump and motor must be able to withstand the pressures generated in the high pressure loop.

Heat exchanger

Use of a heat exchanger is dependent on the transmission's duty cycle and on machine layout. The normal continuous operating fluid temperature measured in the pump and motor cases should not exceed 80°C [180°F] for most hydraulic fluids. The maximum fluid temperature should not exceed 107°C [225°F].

The heat exchanger should be sized to dissipate 25% of the maximum input power available to the transmission. It must also be sized to prevent the case pressures in the pump and motor from getting too high. Medium duty case pressure up to 2 bar [25 psi], at normal operating temperatures, are acceptable.

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Heat exchanger bypass valve

The heat exchanger bypass valve is a pressure and/or temperature valve in parallel with the heat exchanger. Its purpose is to prevent case pressures from getting too high. The heat exchanger bypass valve opens when the oil is thick, especially during cold starts.

Reservoir return line

The same general requirements that apply to case drain lines apply to the reservoir return line.

Bearing life estimation

Bearing life is defined as the length of time in terms of revolutions or time until a fatigue failure. Bearing load is calculated as a reaction which is derived from the moment created by the piston side load. Magnitude of the side load directly related to the speed and pressure at which a unit can be operated.

Bearing life is a function of the side loads coming on the bearings. Other factors such as fluid type, viscosity of fluid and cleanliness also affects the life of bearing.

If detail bearing life analysis is required, you can contact a Danfoss representative.

Installation requirements

The mounting orientation of pumps and motors is unrestricted provided the case drain of the pump and motor remain full. Position the case drain such that it assures an oil level at or above unit center line at start-up. The case drain line that carries the flow leaving the pump or motor should be connected to the highest drain port on each of the units. This assures that the pump and motor cases remain full.

The combined torque required to turn two or more pumps must not exceed the torque rating of the input drive shaft of the front piston pump. Installer to provide centering and a secure neutral for pump swashplate control shaft. An external support is recommended for all tandems.

Open loop circuits

Danfoss pumps and motors may be used in open loop circuits under certain operating conditions. Consult your Danfoss representative for details.

Hydraulic fluid recommendations

Introduction

Hydraulic fluids are one of the vital components of hydraulic system. Proper selection of oil assures satisfactory life and operation of system components. The purpose of this section is to provide readers with the knowledge required to select the appropriate fluids for use in systems that employ Danfoss hydraulic components

Viscosity and temperature

Viscosity is the measure of a fluid's resistance to flow. The **most important characteristics to consider when choosing** a fluid to be used in a hydraulic system is viscosity. The fluid must be thin enough to flow easily but thick enough to maintain adequate lubricating film between components and to maintain proper sealing at the operating temperatures of the hydraulic system.

For viscosity requirements, see table

Viscosity of any fluid is relative to temperature, as the fluid warms the viscosity decreases and vice versa. When choosing a fluid, it is important to consider the start-up and operating temperatures of the hydraulic system. A high VI fluid shows relatively small change of viscosity with temperature.

Lubricants used for hydraulic applications may contain viscosity index improvers (VII). They refer to these fluids as viscosity index improved or multi-viscosity fluids. The viscosity of these fluids may drop down in use due to shearing of VI improvers used in the formulations.

Anti-wear hydraulic oils containing polymeric thickeners, viscosity index improvers (VII) are generally used for wide band operating temperature applications. These fluids experience temporary and permanent viscosity loss during use in hydraulic system. Check the extent of viscosity loss (shear stability) to avoid hydraulic service below the recommended minimum viscosity. Oil with good shear stability is recommended for wide band temperature applications.

Multi-grade engine oils, ATFs, UTTOs, etc., also contain VIIs, and viscosity loss will be encountered during use.

Cleanliness

Cleanliness of the fluid in a hydraulic system is extremely important. More than 70% of all failures are caused by contamination. Danfoss recommends that the fluid used in its hydraulic components be maintained per ISO 4406. Cleanliness level requirements vary with the hydraulic components. The cleanliness of a hydraulic system is dictated by the cleanliness requirements of the most stringent component in the system.

Cleanliness requirements for specific products are given in the table.

OEM's and distributors who use Danfoss hydraulic components in their hydraulic systems should provide these requirements in their designs.

Contact Danfoss filter representative for filtration information.

Fluid maintenance

The condition of a fluid has a direct effect on the performance and reliability of the system. Maintaining proper fluid viscosity, cleanliness level, water content, and additive level is essential for excellent hydraulic system performance. Routine fluid condition monitoring is recommended.

Fluid selection

Premium grade anti-wear (AW) petroleum based hydraulic fluids will provide the best performance with Danfoss hydraulic components. Fluids that meet Danfoss Hydraulic Fluid Specification E-FDGN-TB002-E are considered good quality anti-wear hydraulic fluids. These fluids pass Danfoss Vickers* 35VQ25A high pressure vane pump test (Eaton ATS-373 test procedure, ASTM D 6973).

Automotive crank case oils with American Petroleum Institute (API) letter designation SF, SG, SH, SJ, or higher per SAE J 183 classes of oils are recommended for applications using Danfoss DG valves Automotive crankcase oils generally exhibit less shear stability compared to industrial anti-wear hydraulic fluids, which can result in higher loss of viscosity during service life.

Other mineral oil based lubricants commonly used in hydraulic systems are automatic transmission fluids (ATF) and universal tractor transmission oils (UTTO).

Synthetic hydrocarbon base stocks, such as polyalphaolefins (PAO) are also used to formulate hydraulic fluids, engine oils, ATFs and UTTOs Alternate fluids are recommended when specific properties, such as fire resistance biodegradability etc., are necessary for the application. Keep in mind that alternative fluids may differ from AW petroleum fluids in properties.

Additional notes

When choosing a hydraulic fluid, all the components in the system must be considered. Viscosity limitations have to meet the most stringent component requirements.

For any system where the fluid is non-petroleum oil, set the target one ISO code cleaner for each particle size, than that of petroleum fluids.

Keep adequate fluid level in the reservoir. Take fluid level reading when the system is cold.

For more details, refer to Danfoss Fluid Recommendation Document # 03-401-2010.

Contact your representative if you have specific questions about the fluid requirements of Danfoss hydraulic components

Viscosity & cleanliness recommendation

| Product | Minimum* | Optimum | Maximum | ISO Cleanliness |
|--|----------|--------------------------|----------------------|-----------------|
| Medium duty piston pumps (45 SUS) and motors charged systems | 6.0 cSt | 10 – 39 cSt (60-180 SUS) | 2158 cSt (10000 SUS) | 21/18/13 |

Note: *Minimum viscosity applies at intermittent condition of 10% of every minute. At viscosities lower than 70 sus, additional antiwear additives must be added to prevent premature wear. Please refer to Danfoss document 03-401 for further details.

Additional notes:

- Fluids too thick to flow in cold weather start-ups will cause pump cavitation and possible damage. Motor cavitation is not a problem during cold start-ups, except for two speed motors. Thick oil can cause high case pressures which in turn cause shaft seal problems.
- When choosing a hydraulic fluid, all the components in the system must be considered and the optimum viscosity range adjusted accordingly. For example, when a medium duty piston pump is combined with a Disk Valve Motor the optimum viscosity range becomes 100 - 180 SUS [20 - 39 cSt] and viscosity should never fall below 70 SUS [13 cSt].
- If the natural color of the fluid has become black it is possible that an overheating problem exists.
- If the fluid becomes milky, water contamination may be a problem.
- Take fluid level reading when the system is cold.
- Contact your Danfoss representative if you have specific questions about the fluid requirements of Danfoss hydraulic components.

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- Hydraulic integrated circuits (HICs)
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