

Technical Information

Series 42 4T Axial Piston Tandem Pumps

Size 28/32



Revision history*Table of revisions*

Date	Changed	Rev
May 2024	Updated shaft options	0205
April 2024	Minor correction to NFPH control	0204
April 2024	Updated drawing - Auxiliary Mounting Pads B (P400500)	0203
November 2020	Minor update in Hydraulic Fluid Parameters	0202
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April 2017	First Edition	0101

Contents

General Discription

Basic Design.....	4
System Schematic.....	5

Technical Specifications

System Specifications.....	6
System Parameters.....	6
Hydraulic Fluid Parameters.....	7

Operating Parameters

System Requirements.....	8
System Parameters.....	8
Hydraulic Fluid Parameters.....	9
Sizing Equations.....	10

System Design Parameters

Fluid and Filtration.....	11
Filtration Configuration.....	11
Mounting Flange Loads.....	12
Estimating Overhung Load Moment.....	12
Case Drain.....	13
External Shaft Load and Bearing Life.....	13
Hydraulic Unit Life.....	14

Features and Options

Charge Pump.....	15
Charge Pump Sizing Example:.....	15
Charge Relief Valve.....	15
Overpressure Protection.....	16
Bypass Valve.....	17
Displacement Limiters.....	17
Shaft Options.....	17
Auxiliary Mounting Pads.....	18
Center Coupling.....	19
Non-feedback, proportional hydraulic control (NFPH).....	20
Features and Benefits of the NFPH control.....	21
Connectors and Port locations.....	21
NFPH Response Time.....	21

Installation Drawings

Port Description - Non-Feedback, Proportional Hydraulic (NFPH).....	22
Dimensions - Non-Feedback, Proportional Hydraulic (NFPH).....	24
Shaft Option.....	26
Displacement.....	26
By-Pass Valve.....	27
Auxiliary Mounting Pads.....	27

Model Code

Model Code: A, Y, Z.....	29
Model Code: FD, FX, RD, RX.....	30
Model Code: FE, RE.....	31
Model Code: FT, FH, FJ, FK, RT, RH, RJ, RK.....	32
Model Code: FL, RL, FM, RM.....	33
Model Code: C, F, S.....	34
Model Code: U, G, V.....	35
Model Code: N, P.....	36

General Discription

Basic Design

S42 Integrated Tandem Pumps (4T) are advanced hydrostatic units for medium power applications with maximum loads of 415 Bar [6017 psi] (28 cm³) and 350 Bar [5075 psi] (32 cm³). You can combine these pumps with a suitable Danfoss motor or other products in a system to transfer and control hydraulic power.

The 4T axial piston pump is a compact, high power density unit, using the parallel axial piston/slipper concept in conjunction with tiltable swashplates to vary the pumps' displacements.

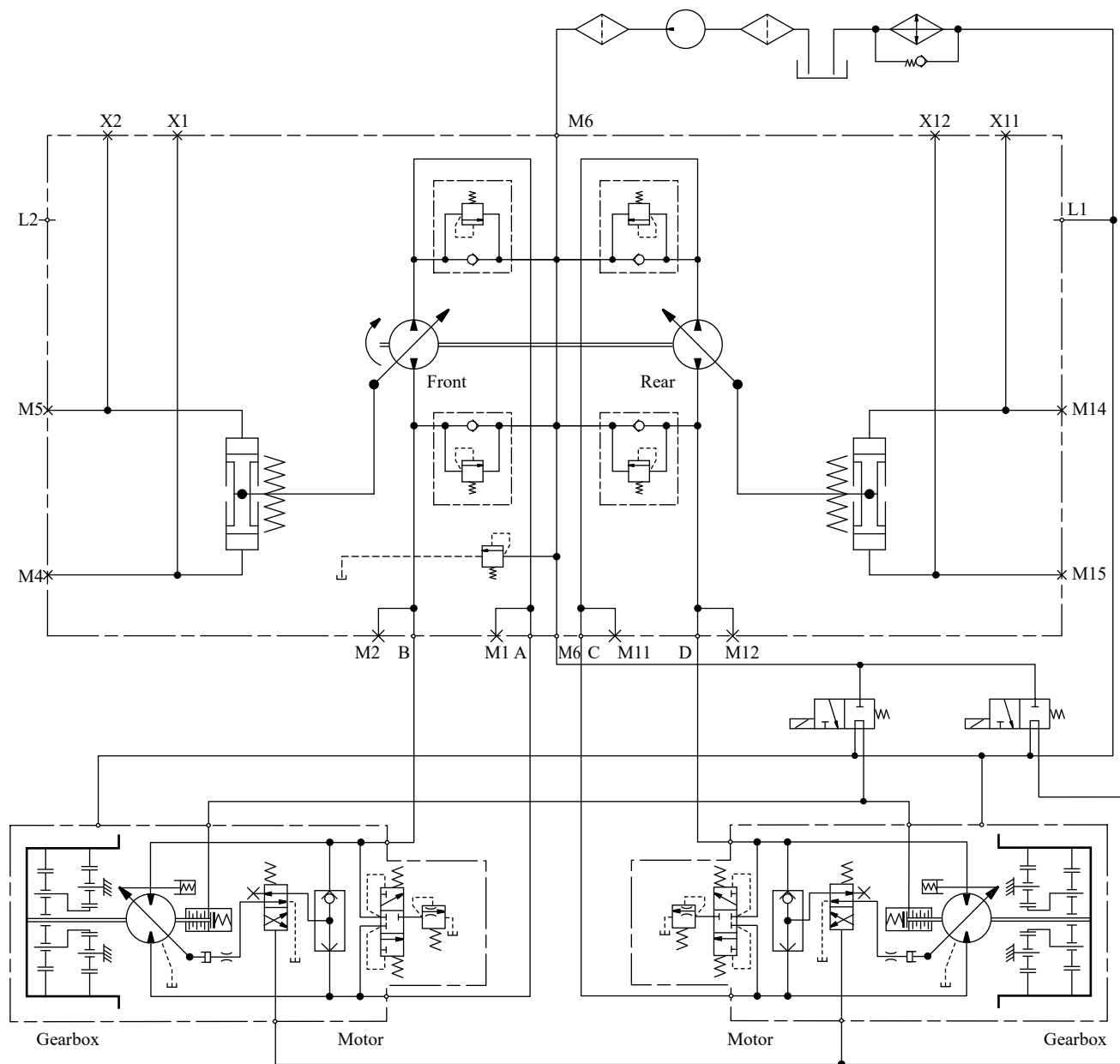
Reversing the angle of the swashplate reverses the flow of fluid from the pump, and reversing the direction of rotation of the motor output. 4T axial piston pumps provide an infinitely variable speed range between zero and maximum in both forward and reverse.

4T axial piston pumps use a cradle swashplate design with a hydraulic servo control cylinder. Control type is the Non-Feedback Proportional Hydraulic (NFPH) control, in which an input signal pressure directly controls the pump servo piston to set pump displacement.

General Discription

System Schematic

4T Axial Piston Pump



P400498

The illustration above shows a schematic of a 4T axial piston pump. System ports A, C and B, D connect to the high pressure work lines. Return fluid is received from its inlet port and discharged through the outlet port. Flow direction is determined by swashplate position. You can read system port pressure through ports M1 and M2. The pump has two case drains (L1 and L2) to ensure there is lubricating fluid in the system.

Technical Specifications

System Specifications

General Specifications

Feature	Series 42 4T
Pump type	In-line, axial piston, integrated tandem pumps including cradle swashplate and servo control
Direction of input rotation	Clockwise or counterclockwise
Recommended installation position	Pump installation recommended with control position on the top or side. Consult Danfoss for non conformance guidelines. The housing must always be filled with hydraulic fluid.
Other system requirements	Independent braking system, suitable reservoir and heat exchanger.

Hardware Features

Pump configuration		Integrated tandem pump	
Displacement	cm ³ [in ³]	28 [1.71] x 2	31.8 [1.94] x 2
Weight	kgf [lbf]	58 [128]	
Mass moment of inertia	kg•m ² [lbf•ft ²]	0.0031 [0.0023]	
Type of front mounting flange (SAE flange size per SAE J744)		2 Bolt SAE B	
Port connections		SAE-twin ports, radial, opposite side ports	
System pressure regulation	bar [psi]	210-415 [3045-6020]	210-345 [3045-4929]
Displacement limiters		Option	
Input shaft options		Splined	
Auxiliary mounting pad (SAE pad per SAE J744)		SAE A (9 tooth, 11 tooth and 13 tooth) SAE B (13 tooth)	
Control options		NFPH	
Loop flushing		None	

System Parameters

Case pressure

Continuous pressure	bar [psi]	3.4 [50]
Maximum pressure (cold start)	bar [psi]	10.3 [150]

Pressure Limits

Displacement	cm ³	28	32
Rated pressure	bar [psi]	350 [5075]	325 [4713]
Maximum pressure	bar [psi]	415 [6017]	350 [5075]

Technical Information
Series 42 4T Axial Piston Tandem Pumps Size 28/32

Technical Specifications

Speed Limits

Frame size	cm ³	28	32
Minimum speed	min ⁻¹ (rpm)	500	
Rated speed at maximum displacement	min ⁻¹ (rpm)	3400	3000
Maximum speed at maximum displacement	min ⁻¹ (rpm)	3750	3400

Charge Pump Displacement and Setting Pressure

Frame size		cm ³	28	32
Internal	-	cm ³ /rev [in ³ /rev]	none	none
Charge relief valve settings	Standard	bar [psi]	20 [290]	
	Optional		14-24 [203-340]	

Theoretical Flow

Frame size	cm ³	28	32
Theoretical flow at rated speed	l/min [US gal/min]	95.2 [25.1]	95.4 [25.2]

Check/high Pressure Relief Valve

Options	bar [psi]	No relief valve /check only	Relief valve / check
Setting		—	210-415 [3045-6020] or by setting available 210, 250, 280, 300, 325, 345, 360, 385, 415

Hydraulic Fluid Parameters

Fluid temperature range

Minimum	-40 °C [-40 °F]	Intermittent, cold start
Maximum continuous	104 °C [220 °F]	-
Maximum	115 °C [240 °F]	Intermittent

Fluid cleanliness level

Required fluid cleanliness level	ISO 4406 Class 22/18/13
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Fluid viscosity

Minimum	7.0 mm ² /s (cSt)	Intermittent
Recommended operating range	12-60 mm ² /s (cSt)	-
Maximum	1600 mm ² /s (cSt)	Intermittent, cold start

Operating Parameters

System Requirements

Independent braking system

Warning

Unintended vehicle or machine movement hazard. The loss of hydrostatic drive line power, in any mode of operation (forward, neutral, or reverse) may cause the system to lose hydrostatic braking capacity. You must provide a braking system, redundant to the hydrostatic transmission, sufficient to stop and hold the vehicle or machine in the event of hydrostatic drive power loss.

Reservoir

Design the system to accommodate maximum volume changes during all system operating modes and to promote de-aeration of the fluid as it passes through the tank. Minimum reservoir volume is 5/8 of the maximum charge pump flow per minute with a minimum fluid volume equal to 1/2 of the maximum charge pump flow per minute. At the maximum return flow, this allows 30 seconds fluid dwell for removing entrained air. This is adequate for a closed reservoir (no breather) in most applications. Position the reservoir outlet (pump inlet) above the bottom of the reservoir to take advantage of gravity separation and prevent large foreign particles from entering the charge inlet line. Use a 100 - 125 µm screen over the outlet port. Position the reservoir inlet (fluid return) so that flow to the reservoir is discharged below the normal fluid level, and directed into the interior of the reservoir for maximum dwell and efficient de-aeration. Use a baffle (or baffles) between the inlet and outlet ports to promote de-aeration and reduce surging of the fluid.

System Parameters

Speed limits

Rated speed is the speed limit we recommend at full power condition and is the highest value at which you can expect normal life. Maximum speed is the highest operating speed we permit. You cannot operate above this speed without risk of immediate failure and loss of drive line power and hydrostatic braking capacity (which may create a hazard). In mobile applications, you must apply this pump with a speed below the stated maximum. Consult *Pressure and Speed Limits*, BC152886484313, when determining speed limits for a particular application.

Inlet pressure

Control charge pump inlet conditions to achieve expected life and performance. Ensure a continuous inlet pressure of not less than 0.8 bar absolute (not more than 6 in Hg vacuum). Normal pressures less than 0.7 bar absolute (greater than 9 in Hg vacuum) indicate inadequate inlet design or a restricted filter. Pressures less than 0.7 bar absolute (greater than 9 in Hg vac) during cold start are possible, but should improve quickly as the fluid warms. Never exceed the maximum inlet vacuum.

Theoretical output

The theoretical maximum flow at rated speed is a simple function of pump displacement and speed. This is a good gauge for sizing a companion motor. This does not take into account losses due to leakage or variations in displacement.

Case pressure

Under normal operating conditions, the **rated case pressure** must not be exceeded. During cold start case pressure must be kept below maximum intermittent case pressure. Size drain plumbing accordingly.

Operating Parameters

System pressure

System pressure is the differential pressure between high pressure system ports. It is the dominant operating variable affecting hydraulic unit life. High system pressure, which results from high load, reduces expected life. Hydraulic unit life depends on the speed and normal operating, or weighted average, pressure that can only be determined from a duty cycle analysis.

Application pressure - is the high pressure relief or pressure limiter setting normally defined within the order code of the pump. This is the applied system pressure at which the driveline generates the maximum calculated pull or torque in the application. **Maximum Working Pressure** - is the highest recommended Application pressure.

Maximum working pressure is not intended to be a continuous pressure. Propel systems with Application pressures at, or below, this pressure should yield satisfactory unit life given proper component sizing.

Maximum pressure is the highest allowable Application pressure under any circumstance. Application pressures above Maximum Working Pressure will only be considered with duty cycle analysis and factory approval.

Minimum pressure must be maintained under all operating conditions to avoid cavitation.

Warning

All pressure limits are differential pressures referenced to low loop (charge) pressure. Subtract low loop pressure from gauge readings to compute the differential.

Hydraulic Fluid Parameters

Hydraulic fluid

Ratings and data are based on operating with hydraulic fluids containing inhibitors to prevent oxidation, rust, and foam. These fluids must possess good thermal and hydrolytic stability to prevent wear, erosion, and corrosion of the internal components.

Caution

Never mix hydraulic fluids of different types.

Temperature and viscosity

Ensure the application satisfies temperature and viscosity requirements concurrently. The data shown in the tables on [Hydraulic Fluid Parameters](#), assume petroleum-based fluids.

High temperature limits apply at the hottest point in the transmission, which is normally the case drain. Always run the pump at or below the continuous temperature. Never exceed maximum temperature.

Durability of transmission components is not affected by cold oil, but it may affect the ability of oil to flow and transmit power. Keep temperatures 16 °C [30 °F] above the pour point of the hydraulic fluid. The minimum temperature relates to physical properties of component materials.

For maximum unit efficiency and bearing life, keep fluid viscosity in the continuous viscosity range. During brief occasions of maximum ambient temperature and severe duty cycle operation, minimum viscosity may occur. The system should encounter maximum viscosity only at cold start.

Size heat exchangers to keep the fluid temperature and viscosity within these limits. Test the system to verify that these temperature limits are not exceeded.

Operating Parameters

Sizing Equations

Use these equations to help choose the right pump size and displacement for your application.

Based on SI units

Flow Output flow $Q = \frac{V_g \cdot n \cdot \eta_v}{1000}$ (l/min)

Torque Input torque $M = \frac{V_g \cdot \Delta p}{20 \cdot \pi \cdot \eta_m}$ (N·m)

Power Input power $P = \frac{M \cdot n \cdot \pi}{30\,000} = \frac{Q \cdot \Delta p}{600 \cdot \eta_t}$ (kW)

Based on US units

Output flow $Q = \frac{V_g \cdot n \cdot \eta_v}{231}$ (US gal/min)

Input torque $M = \frac{V_g \cdot \Delta p}{2 \cdot \pi \cdot \eta_m}$ (lbf·in)

Input power $P = \frac{M \cdot n \cdot \pi}{198\,000} = \frac{Q \cdot \Delta p}{1714 \cdot \eta_t}$ (hp)

Variables

SI units [US units]

V_g = Displacement per revolution cm³/rev [in³/rev]

P_o = Outlet pressure bar [psi]

P_i = Inlet pressure bar [psi]

Δp = $p_o - p_i$ (system pressure) bar [psi]

n = Speed min⁻¹ (rpm)

η_v = Volumetric efficiency

η_m = Mechanical efficiency

η_t = Overall efficiency ($\eta_v \cdot \eta_m$)

System Design Parameters

Fluid and Filtration

To prevent premature wear, use only new clean fluid. Use a filter capable of controlling fluid cleanliness to ISO 4406 Class 22/18/13 (SAE J1165).

Locate the filter on the inlet (suction filtration) or discharge (charge pressure filtration) side of the charge pump: 4T axial piston pumps are available with provisions for either configuration.

The selection of a filter depends on a number of factors including the contaminant ingress rate, the generation of contaminants in the system, the required fluid cleanliness, and the desired maintenance interval. Use filters that meet the above requirements of efficiency and capacity.

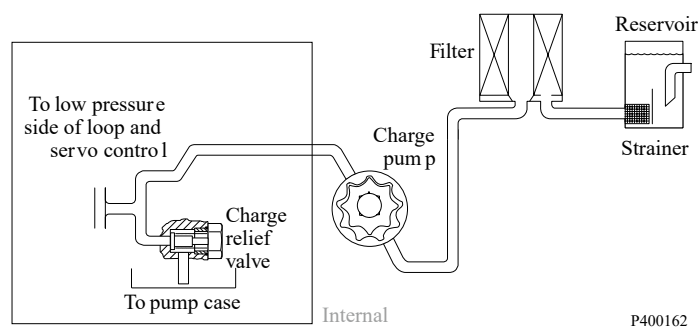
Filter efficiency can be measured with a Beta ratio (β_x). For simple suction-filtered closed circuit transmissions and open circuit transmissions with return line filtration, a filter with a β -ratio within the range of $\beta_{35-45} = 75$ ($\beta_{10} \geq 2$) or better has been found to be satisfactory. For some open circuit systems, and closed circuits with cylinders being supplied from the same reservoir, a higher filter efficiency is recommended. This also applies to systems with gears or clutches using a common reservoir. For these systems, a charge pressure or return filtration system with a filter β -ratio in the range of $\beta_{15-20} = 75$ ($\beta_{10} \geq 10$) or better is typically required.

Because each system is unique, only a thorough testing and evaluation program can fully validate the filtration system. Please see *Design Guidelines for Hydraulic Fluid Cleanliness*, BC152886482150, Technical Information for more information.

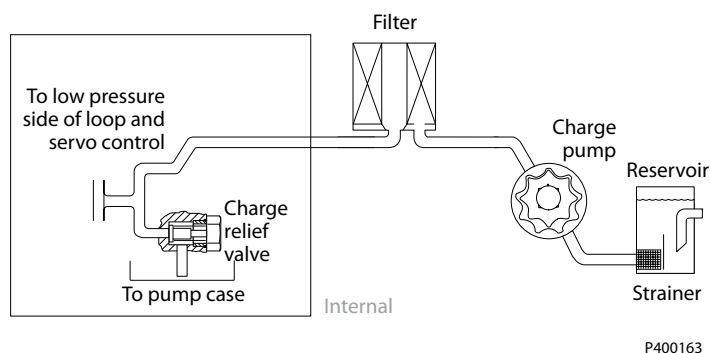
Filtration Configuration

Locate the filter on the inlet (Suction filtration) or discharge (Charge pressure filtration) side of the external charge pump.

Suction filtration



Charge pressure filtration, full flow



System Design Parameters

Mounting Flange Loads

Adding tandem mounted auxiliary pumps and/or subjecting pumps to high shock loads may result in excessive loading of the mounting flange. Design pump applications to stay within the allowable shock load and continuous load moments.

Shock load moment M_S is the result of an instantaneous jolt to the system. Rated (continuous) load moments M_R are generated by the typical vibratory movement of the application.

Estimated maximum and continuous acceleration factors for some typical applications are shown in the table.

[Applications which experience extreme resonant vibrations may require additional pump support. Exceeding the allowable overhung values listed below will require additional pump support.](#)

G-factors for sample applications

Application	Continuous (vibratory) acceleration (G_R)	Maximum (shock) acceleration (G_S)
Skid steer loader	4	10
Trencher (rubber tires)	3	8
Asphalt paver	2	6
Windrower	2	5
Turf care vehicle	1.5	4
Vibratory roller	6	10

Allowable overhung load moments

Rated load moment (M_R)	Shock load moment (M_S)
1441 N·m [12750 in·lbf]	3413 N·m [30200 in·lbf]

Estimating Overhung Load Moment

$$M_R = G_R (W_1 L_1 + W_2 L_2 + \dots + W_n L_n)$$

$$M_S = G_S (W_1 L_1 + W_2 L_2 + \dots + W_n L_n)$$

Where:

M_R Rated load moment N·m [lbf·in]

M_S Shock load moment N·m [lbf·in]

G_R Rated (vibratory) acceleration (G-factors: unitless)

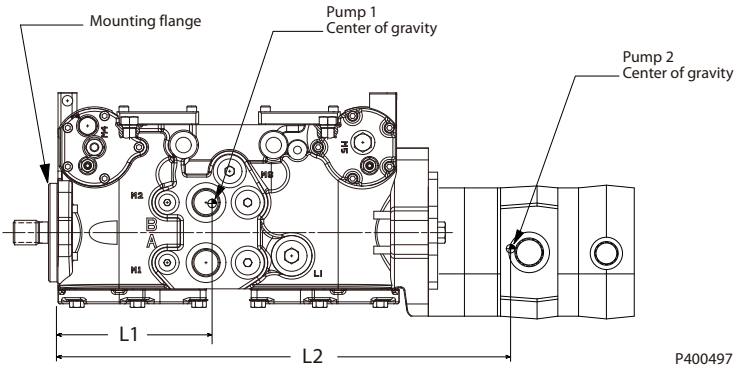
G_S Maximum shock acceleration (G-factors: unitless)

W Weight of the pump N [lbf]

L Distance from mounting flange to the center of gravity mm [in]

System Design Parameters

Overhung load moments



Case Drain

The front and rear pumps are connected by cast passages in the housing. The charge relief valve discharges oil into the front housing. In order to provide positive housing flow thru both pumps, use of rear case drain is required. The front case drain should only be used if the pumps are used as a common drain manifold for the vehicle whereas external drain flow is brought into the rear case port and discharged out the front.

External Shaft Load and Bearing Life

Bearing life is a function of speed, pressure, and swashplate angle, plus any external loads. Other factors that affect life include fluid type, viscosity, and cleanliness.

In vehicle propulsion drives with no external loads—where the speed, pressure, and swashplate angle are often changing—normal bearing B10 (90% survival) life exceeds the hydraulic unit life.

In non-propel drives, such as conveyors or fan drives, the operating speed and pressure may be nearly constant leading to a distinctive duty cycle compared to that of a propulsion drive. In these types of applications, we recommend a bearing life review. 4T axial piston pumps use bearings that can accept some incidental external radial and thrust loads. However, any amount of external load reduces the expected bearing life.

The allowable radial shaft loads are a function of the load position, orientation, and operating pressures of the hydraulic unit. In applications where you cannot avoid external shaft loads, minimize the impact on bearing life by orienting the load to the 0° or 180° position.

The maximum allowable radial load is calculated as: $R_e = M_e / L$

Where:

- L** Distance from mounting flange to point of load
- M_e** Maximum external moment
- R_e** Maximum radial side load
- T_{out}** Thrust load
- F_B** Load to cylinder block kit

Allowable shaft loads

Displacement (cm ³)	28	32
M_e (N·m [in·lbf]) N·m [in·lbf]	98 [867]	86 [763]
T_{OUT} (N [lbf])	1110 [250]	1110 [250]

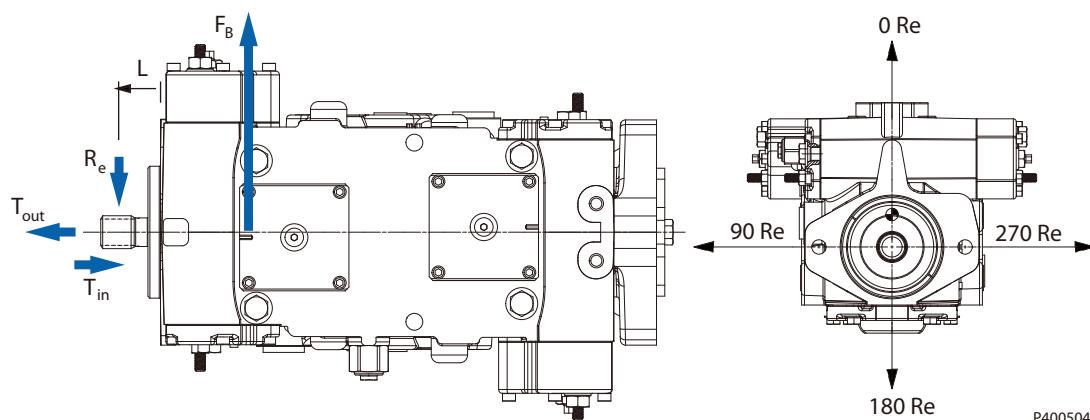
System Design Parameters

Avoid thrust loads in T_{in} direction.

If continuously applied external radial loads are 25% of the maximum allowable or more, or thrust loads are known to occur, contact your Danfoss representative for an evaluation of unit bearing life.

Use clamp-type couplings where radial shaft side loads are present.

External shaft load orientation



P400504

Use the table and drawing to determine maximum allowable radial loads (R_e), based on the maximum external moment (M_e) and the distance (L) from the mounting flange to the load.

Hydraulic Unit Life

Hydraulic unit life is the life expectancy of the hydraulic components. Hydraulic unit life is a function of speed and system pressure. However, system pressure is the dominant operating variable. High pressure, which results from high load, reduces expected life.

Design the hydraulic system to a projected machine duty cycle. Know the expected percentages of time at various loads and speeds. Ask your Danfoss representative to calculate an appropriate pressure based your hydraulic system design. If duty cycle data is not available, input power and pump displacement are used to calculate system pressure.

All pressure limits are differential pressures (referenced to charge pressure) and assume normal charge pressure.

4T axial piston pumps will meet satisfactory life expectancy if applied within the parameters specified in this bulletin. For more detailed information on hydraulic unit life see **BC152886484313**, *Pressure and Speed Limits*.

Features and Options

Charge Pump

An external charge pump is required on all 4T axial piston pumps units applied in closed circuit installations to make up for internal leakage, to maintain positive pressure in the main circuit, and to replace any leakage losses from external valving or auxiliary systems.

The total charge flow requirement is the sum of the charge flow requirement of each of the components in the system. When initially sizing and selecting hydrostatic units for an applications, it is frequently not possible to have all of the information necessary to accurately evaluate all aspects of charge pump size selection. The following procedure will assist the designer in arriving at an initial charge pump selection for a typical application.

In most 4T axial piston pump applications a general guideline is that the charge pump displacement (CPG) should be equal to or greater than 10% of the total displacement (TD) of all axial piston units in the system. This rule assumes that all units are of high speed, axial piston or bent axis design.

Particular application conditions may require a more detailed review of charge pump sizing. System features and conditions that may invalidate the 10% of displacement rule include (but are not limited to):

- Operation at low input speeds (below 1500 rpm)
- Shock loadings
- Excessively long system lines
- Auxiliary flow requirements
- Use of low speed, high torque motors

If a charge pump of sufficient displacement to meet the 10% of displacement rule is not available or if any of the above conditions exist which could invalidate the 10% rule, contact your Danfoss representative.

A charge pump sizing worksheet can be found in **BC157786484430**, *Selection of Driveline Components*.

Charge Pump Sizing Example:

A system consists of 4T 41cc Pump driving two Series 40 -M35 Fixed Motors:

- $TD = 41 + 41 + 35 + 35 = 152 \text{ cm}^3$
- $CPD = 10 \% \times TD = 15.2 \text{ cm}^3$

This requires a charge pump displacement of 15.2 cm^3 .

Charge Relief Valve

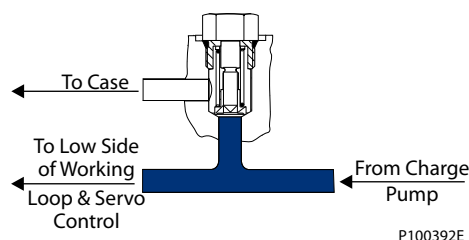
The charge relief valve maintains charge pressure at a designated level. 4T axial piston pumps come with direct-acting poppet style charge relief valves. The valve setting is set at the factory. The setting is screw adjustable.

The charge pressure settings are nominal values and are based on the charge flow across the charge relief valve with a fluid viscosity of $28 \text{ mm}^2/\text{s}$ (cSt) [130 SUS] and a pump input speed of 1800 min^{-1} (rpm). Actual charge pressure differs slightly from the nominal setting when different input speeds are used. The charge setting is a differential pressure (referenced to case pressure) and measured with the piston pump at zero swashplate angle (neutral). Charge pressure drops slightly when the pump is in stroke due to flow demands.

The charge pressure setting for pumps without an internal charge pump is set with an assumed charge flow of 38 l/min (10 US gal/min). These units must have adequate charge flow supplied to the charge inlet in order to maintain charge pressure at all times.

Features and Options

Charge Relief Valve



! Caution

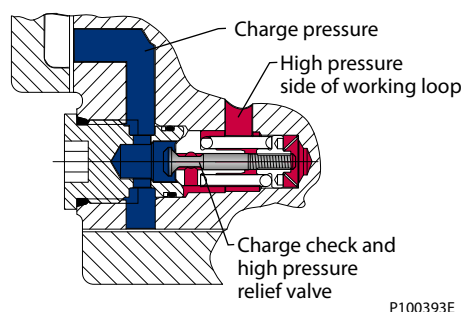
Incorrect charge pressure settings may result in the inability to build required system pressure, inability to control pump, and/or inadequate loop flushing flows. Maintain correct charge pressure under all operating conditions.

Overpressure Protection

4T axial piston pumps are available with a combination charge check and high pressure relief valve assembly. High pressure relief valves come in a range of settings as shown in the model code. You may specify individual port pressure settings. The high pressure relief valve settings are a differential pressure (referenced to charge pressure) and are set at 3.8 l/min (1 US gal/min) of flow.

We can equip pumps with charge check valves only, if high pressure relief valve protection is not necessary.

Charge Check and High Pressure Relief Valve



! Caution

High pressure relief valves are for transient overpressure protection, not for continuous pressure control. Operation over relief valves for extended periods of time results in severe heat build up. High flows over relief valves may result in pressure levels exceeding the nominal valve setting and potential damage to system components.

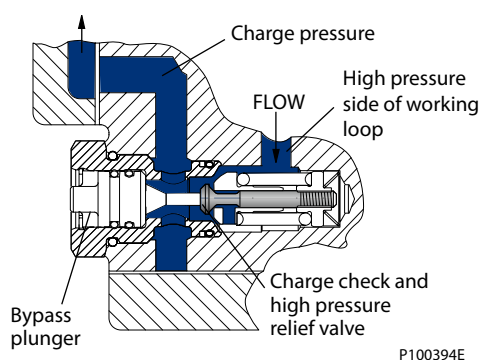
Features and Options

Bypass Valve

4T axial piston pumps are available with an optional bypass function for use when pump shaft rotation is not possible. Use the bypass function to bypass fluid around the variable displacement pump. For example: you may move a disabled vehicle to a service location or winch it onto a trailer without operating the prime mover.

The bypass valve is integral to the charge check/high pressure relief valve assembly. Depress the plungers located in the plugs of the valve assemblies to operate the bypass function. The valves remain open until the prime mover is started. Charge pressure automatically closes them.

Charge Check and High Pressure Relief Valve with Bypass



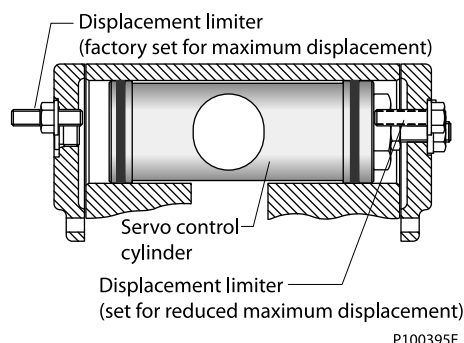
! Caution

Damage to the hydraulic system may result from operating without charge flow. Bypass valves are for moving a machine or vehicle for very short distances at very slow speeds. They are NOT tow valves.

Displacement Limiters

4T axial piston pumps are available with adjustable mechanical displacement (stroke) limiters located in the servo covers. The maximum displacement of the pump can be limited to any value from its maximum displacement to zero in either direction. The limiters are factory set slightly beyond the maximum displacement of the pump. Displacement limiters may not be suited to all applications.

Series 42 pump displacement limiters



Shaft Options

4T axial piston pumps are available with a variety of splined and tapered shaft ends. The accompanying table shows available shaft sizes and torque ratings. Maximum torque ratings are based on shaft torsional strength and assume a maximum of 200 000 load reversals.

Features and Options

Use ANSI B92.1 Class 5 mating splines for splined output shafts. Danfoss external splines are modified Class 5 fillet root side fit. The external spline major diameter and circular tooth thickness dimensions are reduced in order to insure a clearance fit with the mating spline.

Shaft Availability and Torque Rating*

Shaft	Max. torque
15 tooth spline, 16/32 pitch	362 N•m [3200 in•lbf]

* The limitations of these input shafts constrain the allowable auxiliary coupling torque.

Auxiliary Mounting Pads

Auxiliary mounting pads are available on all 4T axial piston pumps to mount auxiliary hydraulic pumps. We include a sealed (oil tight) shipping cover as standard equipment. The shipping cover seals case pressure and you can use it as a running cover if desired.

Since the auxiliary mounting pad operates under case pressure, you must use an O-ring to seal the auxiliary pump to the pad. The drive coupling is lubricated with oil from the main pump case.

Spline specifications and torque ratings are shown in the accompanying table.

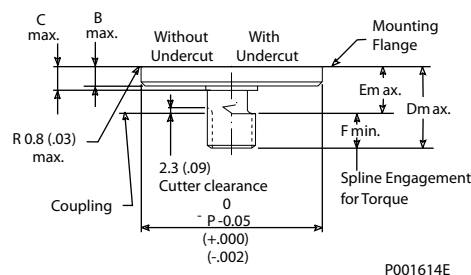
- All mounting pads meet SAE J744 specifications.
- The sum of main and auxiliary pump torque must not exceed stated maximum.
- All torque values assume a 58 Rc shaft spline hardness on mating pump shaft. Maximum torque is based on maximum torsional strength and 200 000 load reversals.
- Applications with severe vibratory or high G-force (shock) loading may require additional structural support to prevent leaks or mounting flange damage. Refer to [Mounting flange loads](#) for additional information.

Auxiliary Pad*

Pad size	Spline	Minimum spline length (mm [in])	Maximum torque (N•m [lbf•in])
SAE A	9 tooth 16/32 pitch	13.5 [0.53]	107 [950]
SAE A special	11 tooth 16/32 pitch	13.5 [0.53]	147 [1300]
SAE A special	13 tooth 16/32 pitch	14.2 [0.56]	248 [2200]
SAE B	13 tooth 16/32 pitch	14.2 [0.56]	248 [2200]

* Allowable Auxiliary coupling torque is subject to limitations of the input shaft.

This drawing provides the dimensions for the auxiliary pump mounting flange and shaft. Auxiliary pump mounting flanges and shafts with these dimensions are compatible with the auxiliary mounting pads on 4T axial piston pumps. For auxiliary pad dimensions, see [Auxiliary Mounting Pads](#).



Features and Options

Auxiliary pump mating dimensions

Pad Size	P	B	C	D	E	F
SAE A mm [in]	82.55 [3.250]	8.1 [0.32]	12.7 [0.500]	44 [1.73]	15 [0.59]	13.5 [0.53]
SAE B mm [in]	101.6 [4.000]	11.4 [0.45]	15.2 [0.60]	46 [1.81]	17.5 [0.69]	14.2 [0.56]

Center Coupling

The two pump shafts are connected with a center-section coupling that is a 22 tooth spline with a 24/48 pitch. The torque transmitted through the center coupling is the sum of the rear kit torque and the auxiliary pump torque. The maximum torque rating of the auxiliary pad may be reduced from the values in the above table due to center coupling limitations.

22 tooth Center-Section Coupling Torque Rating

Rating	Torque in N•m [lbf•in] 22T
Maximum	347 [3071]
Continuous	243 [2151]

Features and Options

Non-feedback, proportional hydraulic control (NFPH)

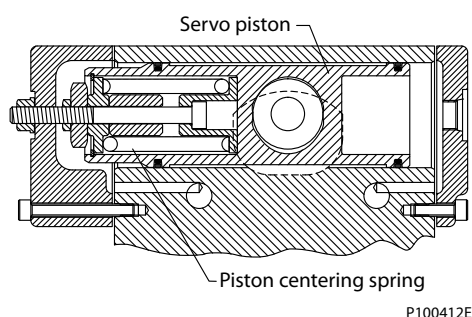
The non-feedback proportional hydraulic (NFPH) control is a hydraulic proportional control in which an input pressure signal directly controls the pump servo piston to achieve pump displacement.

4T pumps with NFPH control have a special servo cylinder capable of providing proportional control with a hydraulic input.

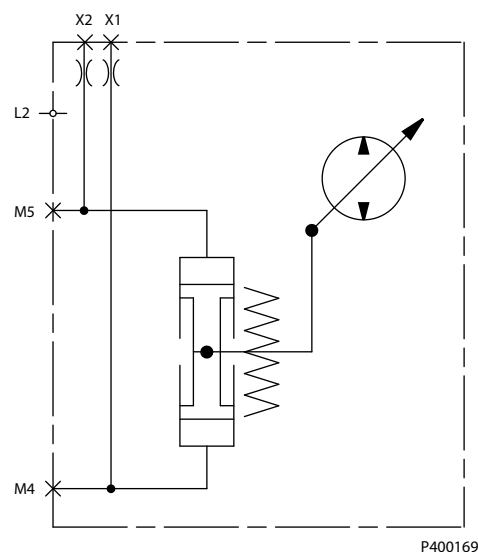
Swashplate position is proportional to the differential signal pressure at ports X1 and X2, but displacement is also dependent on pump speed and system pressure. This characteristic of non-feedback controls provides a natural power limiting function by reducing the pump swashplate angle as system pressure increases. The accompanying graph shows typical operating characteristics.

The system may require tuning through the pump orifice combinations, control pressure supply line sizing, actuation device output pressure and flow adjustments to achieve proper vehicle performance characteristics.

Pump displacement versus signal pressure



Non-feedback proportional hydraulic control schematic

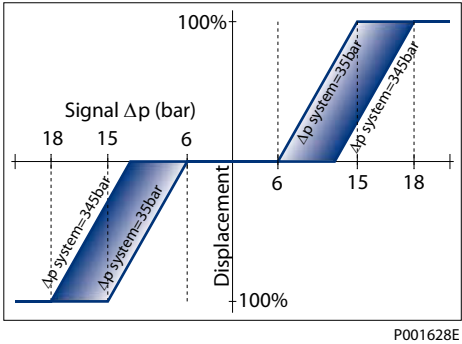


Pump flow direction with NFPH control

Input Shaft Rotation	CW		CCW	
High pressure at port:	X1	X2	X1	X2
Port A flow	Out	In	In	Out
Port B flow	In	Out	Out	In
High servo gauge port	M4	M5	M4	M5

Features and Options

NFPH pump displacement to Input signal



The Input Signal (Δp) values in the graph above are approximations at 1800 RPM and system delta pressures as indicated in the graph above. The values are dependent on input speed and delta pressure operating conditions.

Features and Benefits of the NFPH control

- Eliminates mechanical linkage for flexibility of control design
- Power limiting characteristic reduces machine power requirements
- Compatible with dual axis joysticks for dual path applications
- Smooth operation

Connectors and Port locations

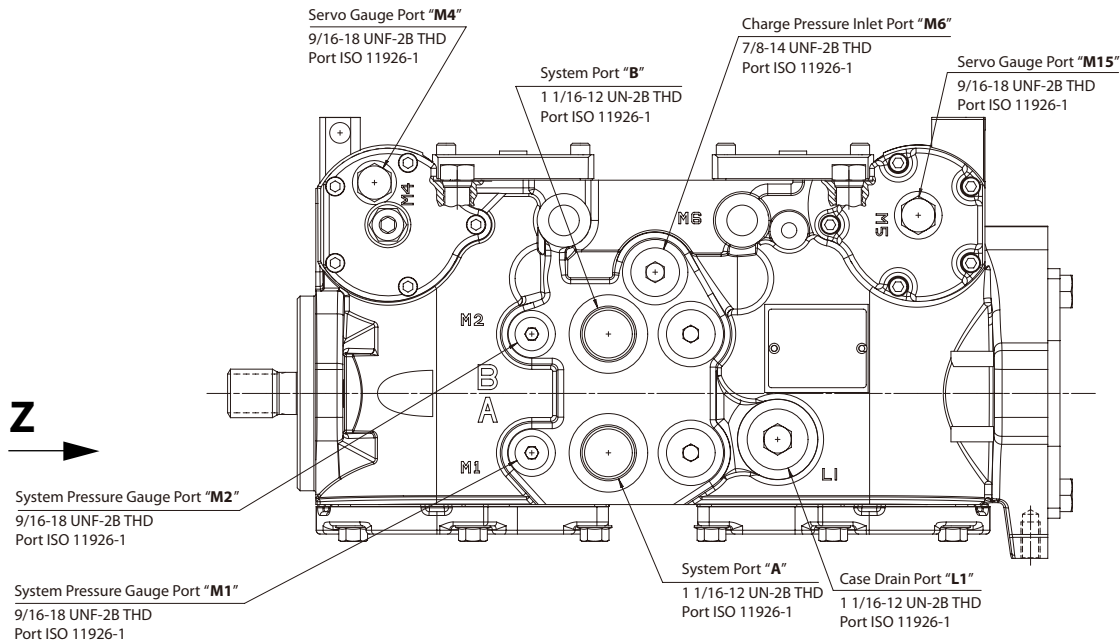
Refer to [outline drawings](#).

NFPH Response Time

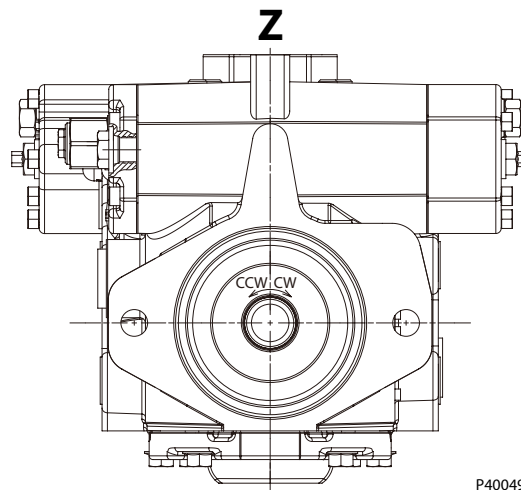
Fast (no orifice)	Slow (Ø0.8)	Medium (Ø1.0)	Special (Ø1.3)
0.6s	3.0s	1.3s	0.8s

Installation Drawings

Port Description - Non-Feedback, Proportional Hydraulic (NFPH)



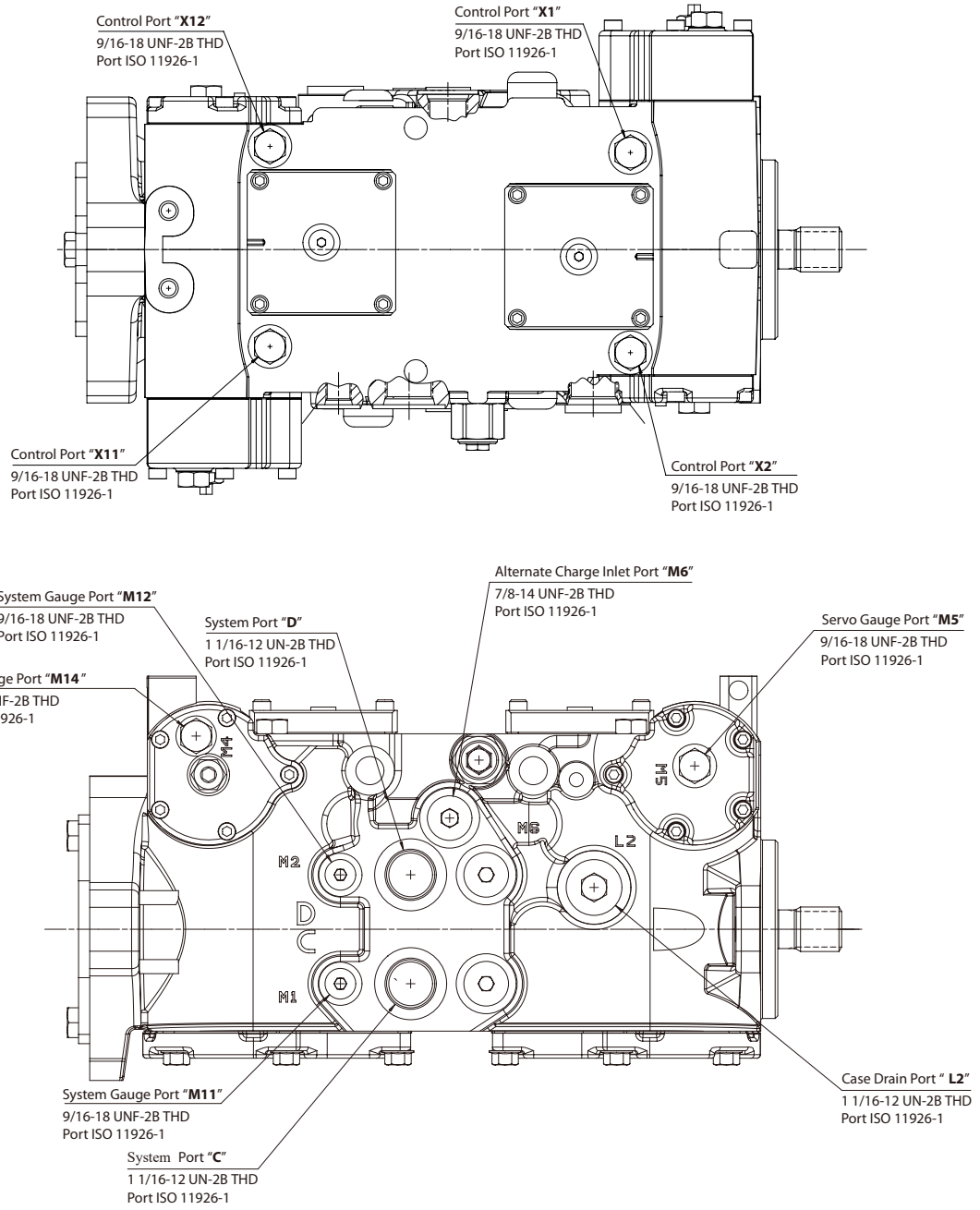
P400491



P400492

Port	Description	Sizes	Port	Description	Sizes
A	System port "A"	1 1/16 - 12	M6	Charge Pressure Inlet Port "M6"	7/8 - 14
B	System Port "B"	1 1/16 - 12	M6	Alternate Charge Inlet Port "M6"	7/8 - 14
C	System Port "C"	1 1/16 - 12	M11	System Gauge Port "M11"	9/16 - 18
D	System Port "D"	1 1/16 - 12	M12	System Gauge Port "M12"	9/16 - 18
L1	Case Drain Port "L1"	1 1/16 - 12	M14	Servo Gauge Port "M14"	9/16 - 18
L2	Case Drain Port "L2"	1 1/16 - 12	M15	Servo Gauge Port "M15"	9/16 - 18
M1	System Pressure Gauge Port "M1"	9/16 - 18	X1	Control Port "X1"	9/16 - 18
M2	System Pressure Gauge Port "M2"	9/16 - 18	X2	Control Port "X2"	9/16 - 18
M4	Servo Gauge Port "M4"	9/16 - 18	X11	Control Port "X11"	9/16 - 18
M5	Servo Gauge Port "M5"	9/16 - 18	X12	Control Port "X12"	9/16 - 18

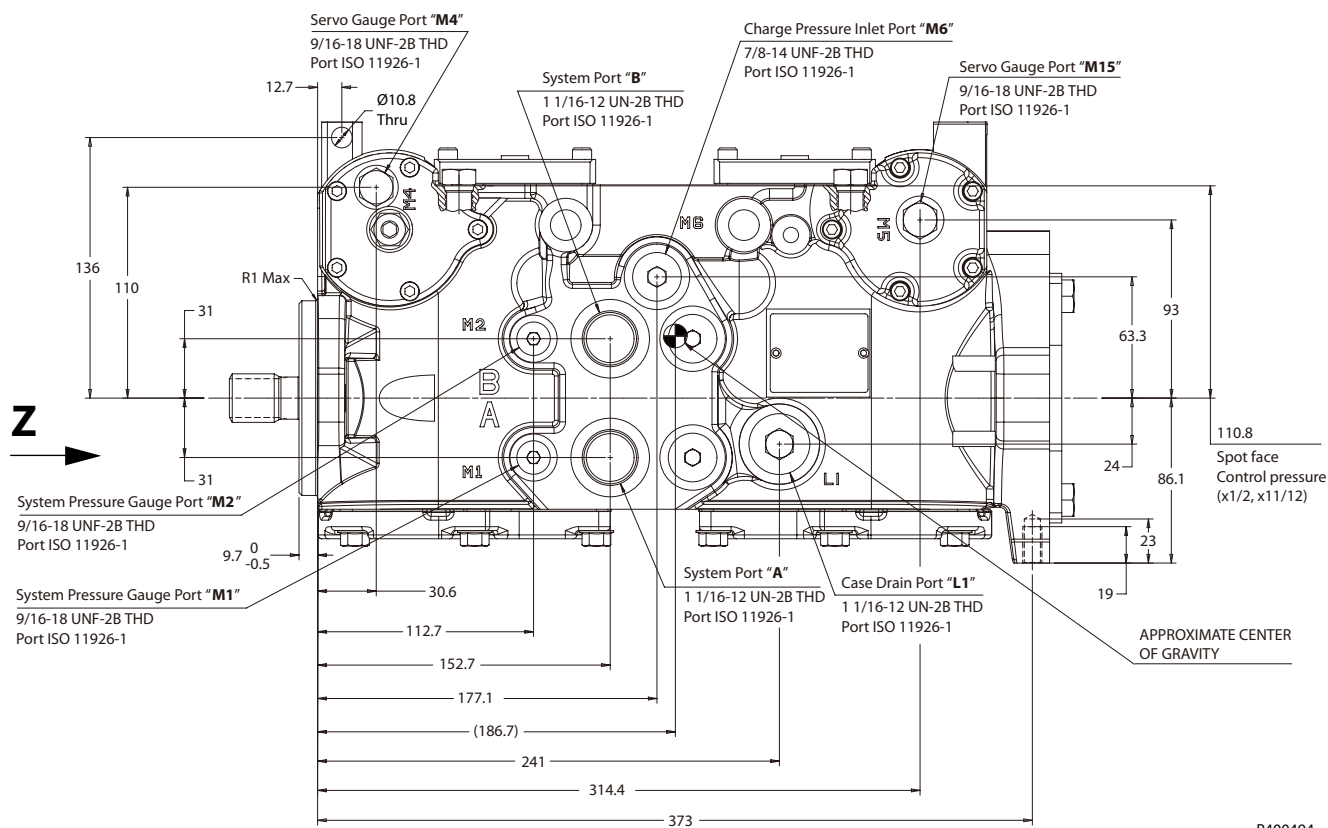
Installation Drawings



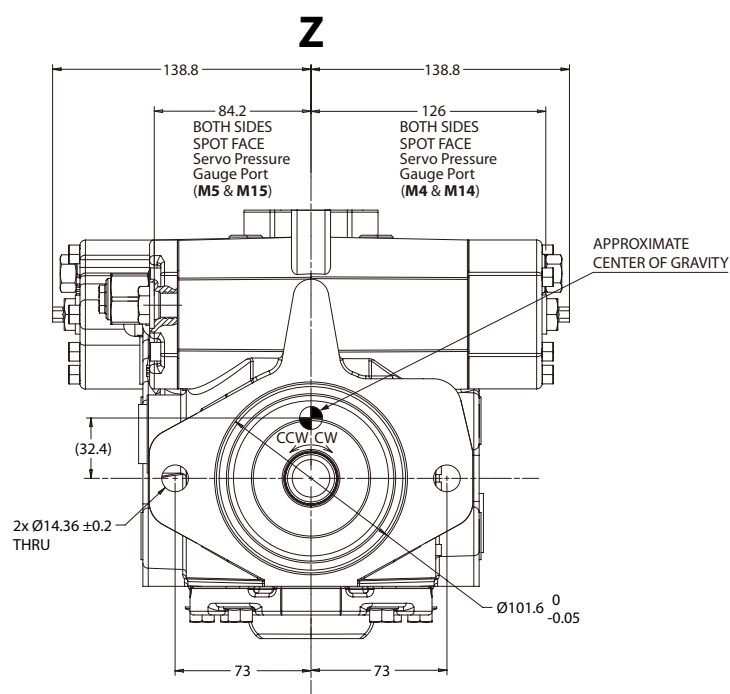
P400493

Installation Drawings

Dimensions - Non-Feedback, Proportional Hydraulic (NFPH)

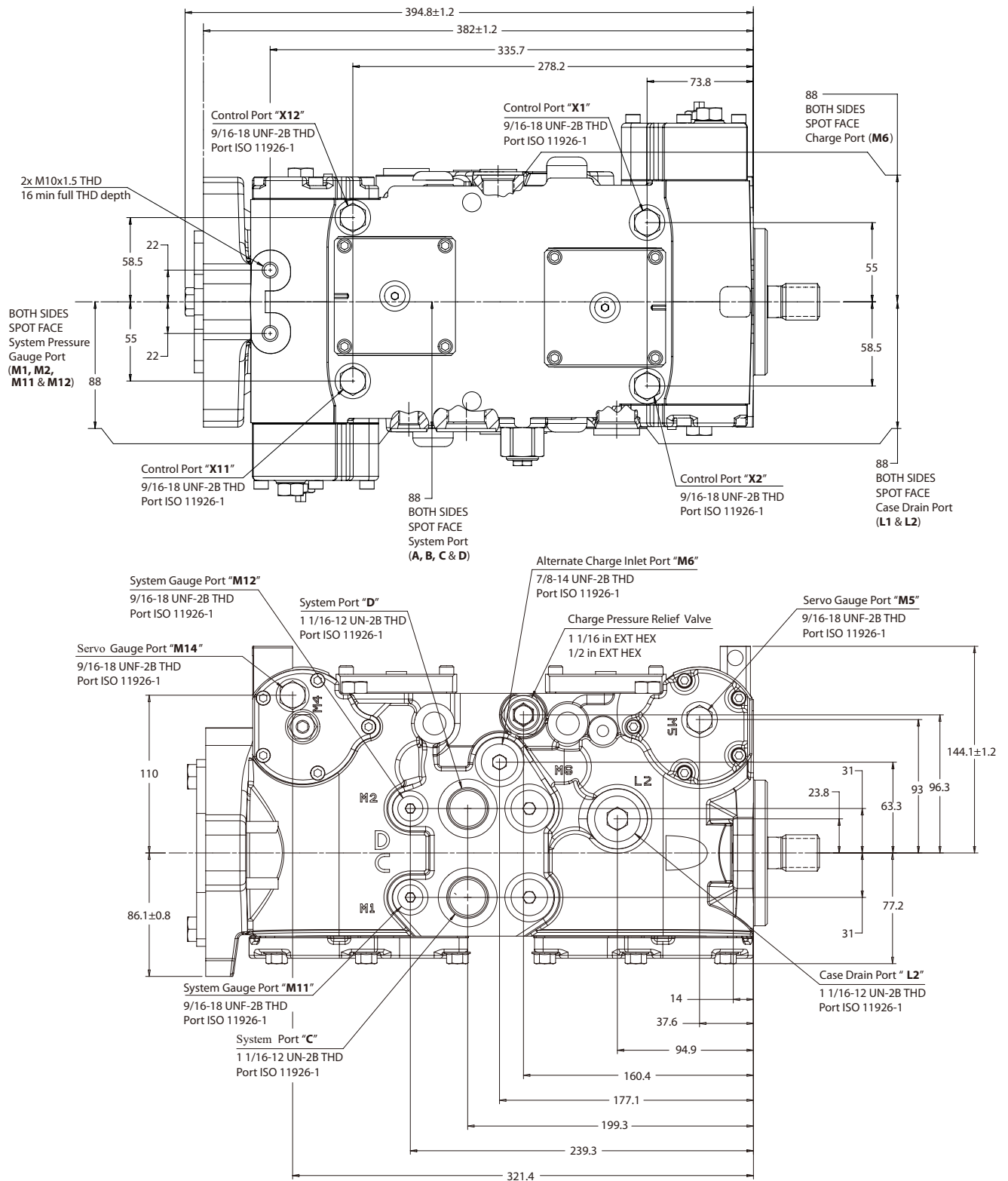


P400494



P400495

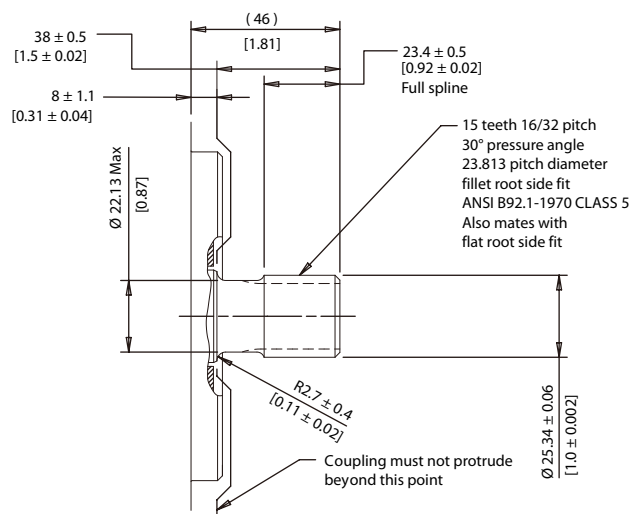
Installation Drawings



P400496

Installation Drawings

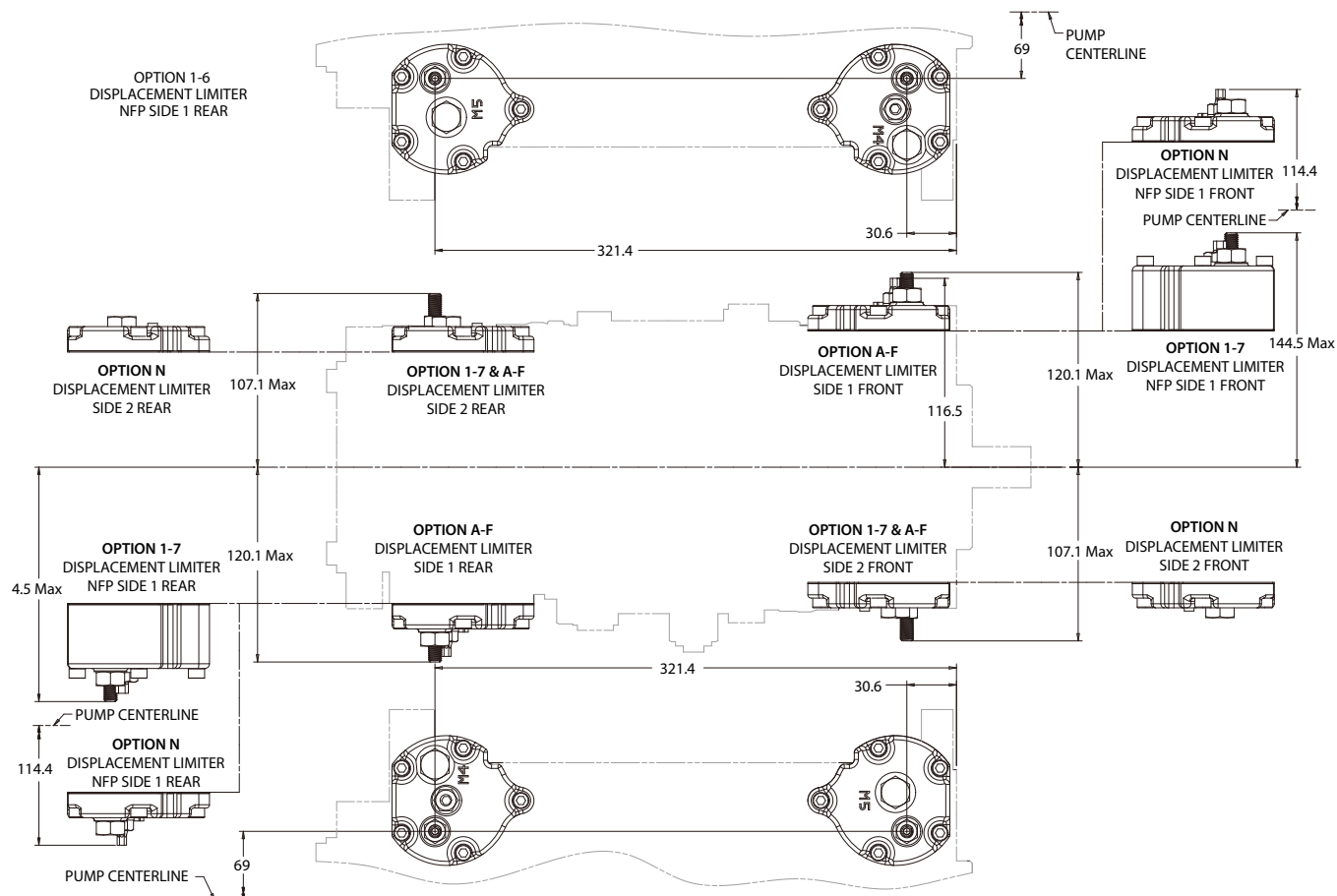
Shaft Option



SPLINED SHAFT

P400501

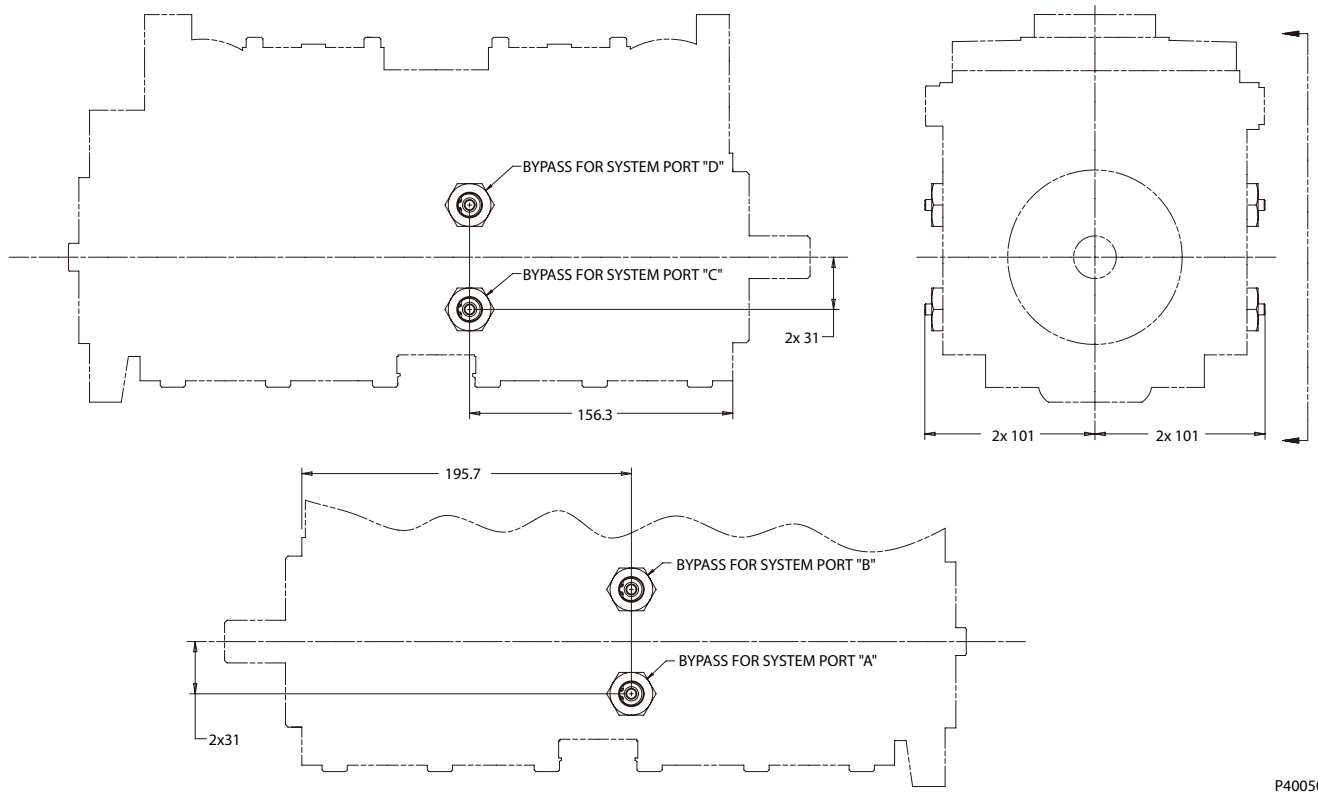
Displacement



P400505

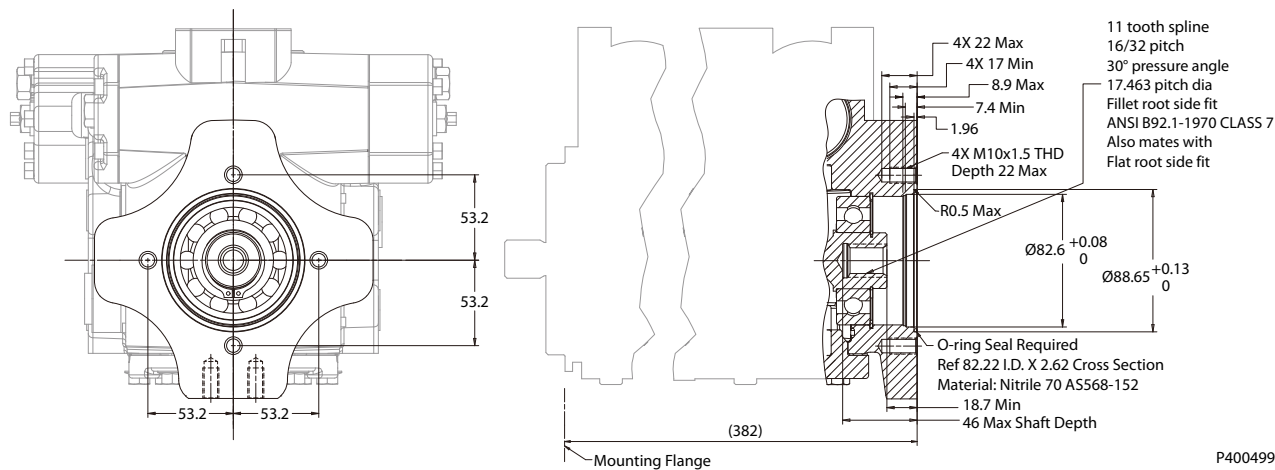
Installation Drawings

By-Pass Valve



P400506

Auxiliary Mounting Pads

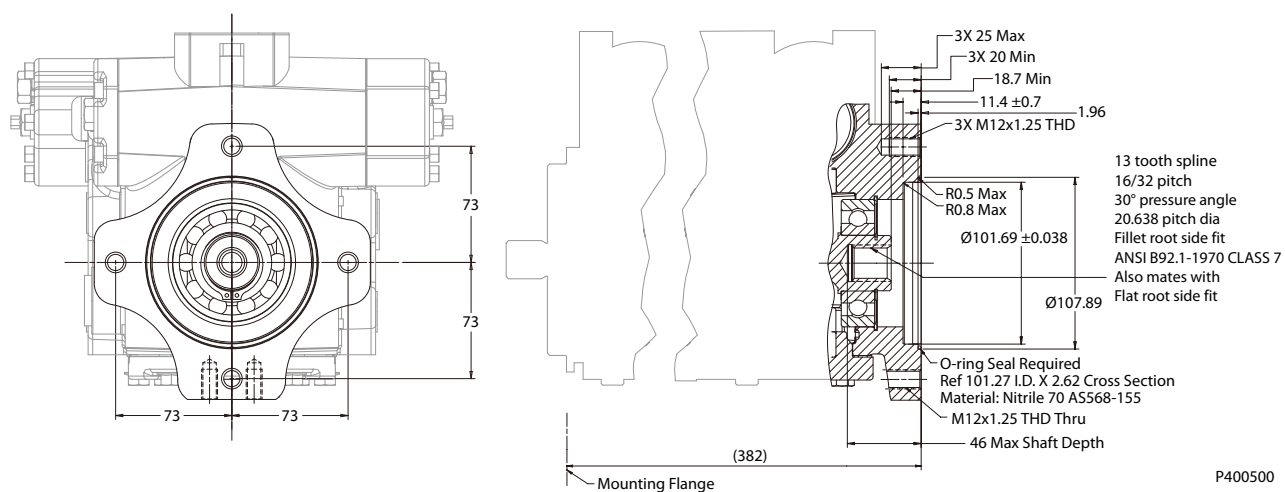


P400499

Auxiliary mounting flange and coupling options

Auxiliary mounting flange	Spline pitch diameter P	Number of teeth N
Option 1	17.463 [0.688] 16/32	11 tooth
Option 2	14.288 [0.563] 16/32	9 tooth

Installation Drawings



Auxiliary mounting flange and coupling options

Auxiliary mounting flange	Spline pitch diameter P	Number of teeth N
Option B	20.638 [0.813] 16/32	13 tooth

Model Code

Model Code: A, Y, Z

[illegible]

Product Series

Code	Description
-	4T axial piston pumps

A - Rotation

Code	Description
L	Pump, variable displacement, CCW rotation
R	Pump, variable displacement, CW rotation

Y,Z-Displacement

Code	cm ³ /rev [in ³ /rev]	Speed Sensing
28 BN	28cc/revolution (CU. IN.) x 2	none
32 CN	32cc/revolution (CU. IN.) x 2	none

Model Code: FD, FX, RD, RX

4 T A Y FD FX FE FT FH FJ FK FL FM Z RD RX RE RT RH RJ RK RL RM C F S U G V N P

FD, FX, RD, RX - Control Type

Control Type	Control Description		Control Features
Non-Feedback proportional	Style	Input	Other feature
G = NFP	3 = Hydraulic	N = Not Available	X = Not Applicable

Technical Information
Series 42 4T Axial Piston Tandem Pumps Size 28/32

Model Code

Model Code: FE, RE

4 T A Y FD FX FE FT FH FJ FK FL FM
Z RD RX RE RT RH RJ RK RL RM C F S U G V N P

(● = Standard, ○ = Optional)

FE, RE - Control Response Time

Code	Description	28	32
50=	No Orifice	●	●
52=	Medium, 1mm	●	●
53=	Slow, 0.8mm	●	●
55=	Fast, Special 1.3mm	●	●

Model Code

Model Code: FT, FH, FJ, FK, RT, RH, RJ, RK

	A	Y	FD	FX	FE	FT	FH	FJ	FK	FL	FM	
4	T											
		Z	RD	RX	RE	RT	RH	RJ	RK	RL	RM	C
												F
												S
												U
												G
												V
												N
												P

(● = Standard, ○ = Optional)

FT, RT - Special Drive Features

Code	Description	28	32
N	None	○	○
1	NFPH	●	●

FH, RH - System Pressure Protection Port A and C

Code	Description	28	32
NN	None (Check Valve Only)	●	●
21	210 bar (3045 psi)	●	●
25	250 bar (3625 psi)	●	●
28	280 bar (4060 psi)	●	●
30	300 bar (4350 psi)	●	●
32	325 bar (4715 psi)	●	●
34	345 bar (5000 psi)	●	●
36	360 bar (5220 psi)	●	-
38	385 bar (5585 psi)	●	-
41	415 bar (6020 psi)	●	-

FJ, RJ - System Pressure Protection Port B and D

Code	Description	28	32
NN	None (Check Valve Only)	●	●
21	210 bar (3045 psi)	●	●
23	230 bar (3330 psi)	●	●
25	250 bar (3625 psi)	●	●
28	280 bar (4060 psi)	●	●
30	300 bar (4350 psi)	●	●
32	325 bar (4715 psi)	●	●
34	345 bar (5000 psi)	●	●
36	360 bar (5220 psi)	●	-
38	385 bar (5585 psi)	●	-
41	415 bar (6020 psi)	●	-

FK, RK - Loop Bypass Valve

Code	Description	28	32
N	None	●	●
B	Bypass Valve	●	●

Technical Information
Series 42 4T Axial Piston Tandem Pumps Size 28/32

Model Code

Model Code: FL, RL, FM, RM

4
T
A
Y
FD
FX
FE
FT
FH
FJ
FK
FL
FM
Z
RD
RX
RE
RT
RH
RJ
RK
RL
RM
C
F
S
U
G
V
N
P

(● = Standard, ○ = Optional)

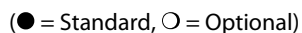
FL, RL - Displacement Limiters Side 1

Code	Description	28	32
0	None	●	●
1	Adjustable limiters set to max. displacement	●	●
2	Adjustable limiters set to 96% of max. displacement	●	●
3	Adjustable limiters set to 92% of max. displacement	●	●
4	Adjustable limiters set to 88% of max. displacement	●	●
5	Adjustable limiters set to 84% of max. displacement	●	●
6	Adjustable limiters set to 80% of max. displacement	●	●
7	Adjustable limiters set to 76% of max. displacement	●	●

FM, RM - Displacement limiters Side 2

Code	Description	28	32
0	None	●	●
1	Adjustable limiters set to max. displacement	●	●
2	Adjustable limiters set to 96% of max. displacement	●	●
3	Adjustable limiters set to 92% of max. displacement	●	●
4	Adjustable limiters set to 88% of max. displacement	●	●
5	Adjustable limiters set to 84% of max. displacement	●	●
6	Adjustable limiters set to 80% of max. displacement	●	●
7	Adjustable limiters set to 76% of max. displacement	●	●

Model Code: C, F, S



C - Shaft

Code	Description	28	32
D	15 teeth 16/32 pitch	●	●

F - Housing

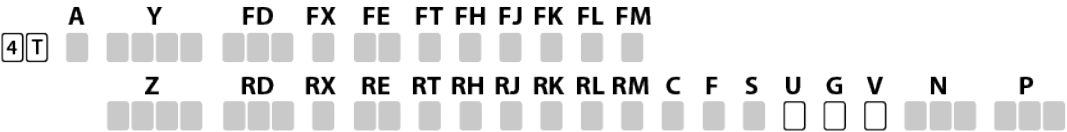
Code	Description	28	32
A	NFPH - Standard, B-mount Flang Aux PAD SAE-A Flange	●	●
B	NFPH - Standard, B-mount Flang Aux PAD SAE-B Flange	●	●

S - Charge Pressure Relief Setting

Code	Description	28	32
C	14 bar (203 psi)	○	○
D	16 bar (232 psi)	○	○
E	18 bar (261 psi)	○	○
F	20 bar (290 psi)	●	●
G	22 bar (319 psi)	●	●
H	24 bar (348 psi)	●	●
P	Defeated	●	●
R	14 bar (203 psi), Anti-stall	○	○
T	16 bar (232 psi), Anti-stall	○	○
V	18 bar (261 psi), Anti-stall	○	○
W	20 bar (290 psi), Anti-stall	●	●
X	22 bar (319 psi), Anti-stall	●	●
Z	24 bar (348 psi), Anti-stall	●	●

Model Code

Model Code: U, G, V



(● = Standard, ○ = Optional)

U - Auxiliary Mounting Pad

Code	Description	28	32
0	No Pad	●	●
1	SAE A 9T, All gear pump orientations, ship cover	●	●
2	SAE A 11T, All gear pump orientations, ship cover	●	●
3	SAE A 13T, Gear pump orientations, ship cover	○	○
4	SAE B 13T, Gear pump orientations, ship cover	●	●

G - Gear Pump

Code	Description	28	32
N	None	●	●

V - Gear Pump Orientation

Code	Description	28	32
N	Not Applicable	●	●

Model Code

Model Code: N, P

	A	Y		FD	FX	FE	FT	FH	FJ	FK	FL	FM
4	T											
		Z		RD	RX	RE	RT	RH	RJ	RK	RL	RM
										C	F	S
										U	G	V
											N	P

(● = Standard, ○ = Optional)

N - Special Hardware

Code	Description	28	32
NNR	None, CW rotation	●	●
NNL	None, CCW rotation	●	●

P - Special Feature Description (Non-Hardware)

Code	Tag Text Layout						Tag/Logo
N - Black (Standard)	N	Line 1	Line 2	Line 3	Line 4	Line 5	N - Danfoss Logo
		Order code (Standard)	Order code	Order code	Model #	Model #	

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- DCV directional control valves
- Electric converters
- Electric machines
- Electric motors
- Gear motors
- Gear pumps
- Hydraulic integrated circuits (HICs)
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- Hydrostatic pumps
- Orbital motors
- PLUS+1® controllers
- PLUS+1® displays
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- PLUS+1® software
- PLUS+1® software services, support and training
- Position controls and sensors
- PVG proportional valves
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