ENGINEERING
TOMORROW

User Guide

Vickers® by Danfoss
PVMX Axial Variable Displacement Piston Pump

Up to 350 bar
28 cc/rev
(1.71 in^3/rev)
Variable Speed Drive Ready



VICKERS
by Danfoss

BC512730650494en-000101

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Introduction

Vickers by Danfoss PVMX series is an open circuit axial piston design. A variety of control options allow the pumps to perform most efficiently in a specific application. The efficiency of the pump controls allows down-sizing of system cooling needs, saving upfront costs in the machine. Alternatively, cooling capacity could be kept the same and the flow capability of the system increased, thus improving performance and customer satisfaction.

With a strong, proven rotating kit, the pump can be operated at 350 bar [5070 psi] continuous and can peak at 420 bar [6090 psi]. High-load bearings and a stiff drive shaft help provide long service life at rated industrial conditions, reducing operating and maintenance costs. The pump design incorporates control components that enable efficient over-center operation, improve the pump's responsiveness and stability, reduce wear on the swashplate by maintaining proper contact, and ensure minimum displacement.

A specialized design to reduce fluid borne and structure borne noise enables operation at a quietness level exceeding the requirements of today's demanding work conditions ensuring operator safety and comfort.





Typical Applications

- Mining machinery
- Injection molding machines
- Metal forming machines
- Oil and Gas Equipment
- Conveyor lines
- Primary metals
- Metal cutting equipment

Features and Benefits

- Quiet Pump Operation
- High Power density
- Over Center Operation
- Suitable for Variable-speed technology
- Multiple port types and input shaft options aid in flexibility of machine design
- Adjustable minimum and maximum displacement stop
- Long service life

Model Code Selection

P	V	M	X	0	2	8	R	*	*	*	*	*	*	*	*	0	*	*	A	-	*	*	*	*	*	*	*	*
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29

[1, 2, 3, 4] **Product Series**

PVMX – Variable Displacement Open circuit Piston Pump

[5, 6, 7] **Displacement**

028 – 28 cc/r [1.71 in^3/r]

[8] **Input Rotation**

R – Clockwise (Right hand)
L – Counter-clockwise (Left hand)

[9, 10] **Input Shaft**

05 – SAE B, Straight Keyed
06 – SAE B-B Straight Keyed
07 – SAE B, 13T Spline
08 – SAE B-B, 15T Spline
15 – DIN6885 Straight Keyed 25mm dia. Shaft
16 - DIN6885 Straight Keyed 22mm dia. Shaft

[11] **Mounting Flange**

B – SAE B 2-Bolt
M – ISO 3019/2 2-Bolt

[12] **Port Options**

1 – Main Ports SAE J514 Tube Ports (Drain port, Load Sense Port SAE J514)
2 – Main Ports SAE J518 Flange Ports (Drain port, Load Sense Port SAE J514)
3 – Main Ports ISO 6149-1 Tube Ports (Drain Port, Load Sense Port ISO 6149-1)
4 – Main Ports ISO 6162-1 Flange Ports (Drain Port, Load Sense Port ISO 6149-1)

[13, 14] **Control Type**

00 – None
A0 – Pressure Compensator
B0 – Pressure and Flow Compensator with Bleed Down Orifice
C0 – Pressure and Flow Compensator without Bleed Down Orifice
W0 – Remote Pressure Compensator

[15] **Pressure Compensator Setting**

0 – None
A – Default 70 bar (70 to 100 bar range)
B – Default 250 bar (100 to 280 bar range)
C – Default 300 bar (280 to 310 bar range)
D – Default 350 bar (310 to 350 bar range)

[16] **Flow Compensator Setting**

0 – None
1 – Default 20 bar (10 to 40 bar range)

[17] **Power Control Setting**

0 – None

[18] **Auxiliary Mounting**

0 – None
A – SAE A, 2-Bolt, 9T Spline
B – SAE A, 2-Bolt, 11T Spline
C – SAE B, 2-Bolt, 13T Spline
D – SAE B, 2-Bolt, 15T Spline
E – ISO 3019/2-80A2HW 2-Bolt 9T Spline
F – ISO 3019/2-80A2HW 2-Bolt 11T Spline
G – ISO 3019/2-100A2HW 2-Bolt 13T Spline
H – ISO 3019/2-100A2HW 2-Bolt 15T Spline

[19] **Paint**

0 – No paint
A – Black (default)

[20] **Design Code**

A – Design code A

[21] **Differentiator**

- –

[22] **Maximum Displacement Setting***

0 – No Max. Displacement Setting [Default]

[23] **Minimum Displacement Setting***

0 – No Min. Displacement Setting [Default]

[24, 25] **Pump Special Features***

00 – None
AA – Swash plate position sensor

[26, 27] **Control Special Features***

00 – None

[28] **Pump Certification***

0 – No certification

[29] **Customer Identification***

0 – None

*Please consult Danfoss for more options

Operating Parameters

Technical Specifications

Feature	Unit/Type	PVMX028
Maximum displacement	cm^3 [in^3]	28 [1.71]
Minimum input speed	rpm	200
Nominal input speed	rpm	3800*
Maximum input speed	rpm	4200*
Flow at nominal speed (theoretical)	l/min [US gal/min]	106.4 [292.28]
Nominal pressure	bar [psi]	350 [5076]
Maximum pressure	bar [psi]	420 [6092]
Input power at nom. input speed and nom. pressure	kW [HP]	31.5 [42]
Input torque at max displacement and nom. pressure	N•m/bar [lbf•in/1000 psi]	156 [1380]
Mass moment of inertia of internal rotating components	kg•m2 [slug•ft2]	$1.483x10^{-3}$ [$1.09x10^{-3}$]
Weight	kg [lb]	23 [50.7]

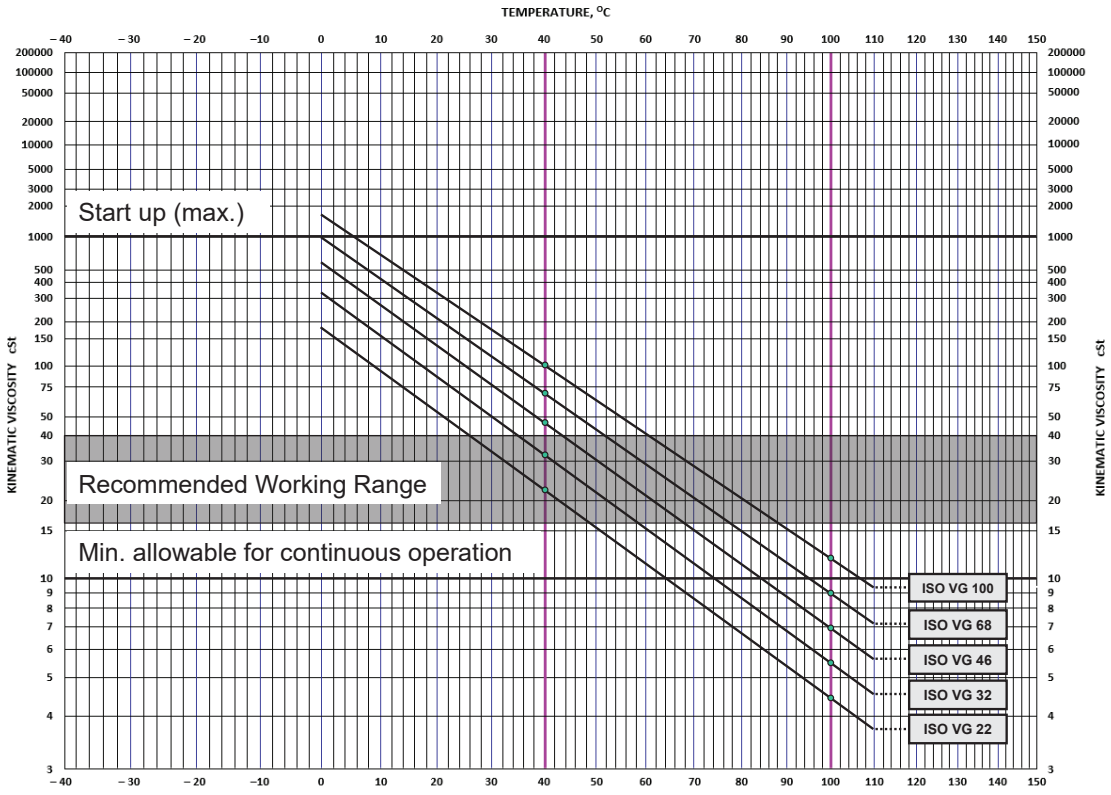
* - Refer to Inlet Pressure vs. Speed chart on page 6.

Fluid Specifications

PVMX is designed to operate with HLP mineral oil according to DIN 51524. Pumps can also be operated with Fire resistance fluids with derated pressure and speed conditions.

Viscosity

Condition	mm/s² (cSt)	SUS
Minimum continuous	16	83
Minimum intermittent	10	90
Maximum continuous	40	187
Maximum intermittent	1000	4550



Maintain fluid viscosity within the recommended range for maximum efficiency and pump life.
Minimum Viscosity - This should only occur during brief occasions of maximum ambient temperature and severe duty cycle operation.
Maximum Viscosity - This should only occur at cold start. Pump performance will be reduced. Limit speeds until the system warms up.

Operating Parameters

Temperature

Minimum (intermittent, cold start)	- 25° C	- 13° F
Continuous	82° C	180° F
Maximum intermittent	104° C	220° F

Oil temperature limits are defined at the pump's case drain. As a rule of thumb, under steady state conditions the case drain temperature is approximately 20 - 25 degrees Centigrade higher than the pump's inlet oil temperature.

Inlet Pressure

Minimum (continuous)	0.8 bar absolute	6.7 in. Hg vac.
Minimum (cold start)	0.5 bar absolute	15.1 in. Hg vac.

Disclaimer - Refer Inlet Pressure vs Speed Chart for speed limitation.

Case Pressure

Minimum (continuous)	0.5 bar above inlet	7 psi above inlet
Minimum (cold start)	2 bar above inlet	29 psi above inlet

Disclaimer - Refer Inlet Pressure vs Speed Chart for speed limitation.

Pressure ratings
Continuous working pressure is the average, regularly occurring operating pressure. Operating at or below this pressure should yield satisfactory product life. For all applications, the load should move below this pressure. This corresponds to the maximum allowable PC setting.

Maximum (peak*) working pressure is the highest intermittent pressure allowed. Maximum machine load should never exceed this pressure, and pressure overshoots should not exceed this pressure.
*Momentary system pressure spikes only. Less than 0.5 sec. Consult Danfoss for special application conditions.

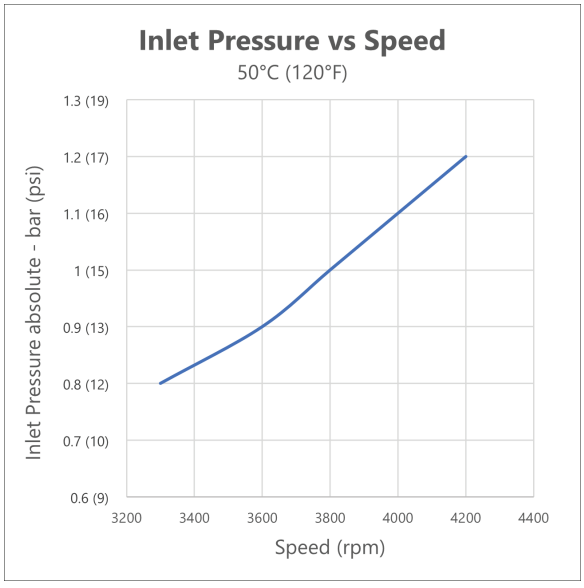
Speed ratings
Nominal speed is the fastest recommended operating speed at full displacement and 1 bar abs. [0 in Hg vac] inlet pressure. Operating at or below this speed should yield satisfactory product life.

Maximum speed is the highest recommended operating speed at full power conditions. Operating at or beyond maximum speed requires positive inlet pressure and/or a reduction of pump displacement. Refer to Inlet pressure vs. speed charts.

Minimum speed is the lowest operating speed allowed. Operating below this speed will not yield satisfactory performance.

Speed, flow, and inlet pressure
Inlet pressure vs. speed charts in each section show the relationship between speed, flow, and inlet pressure for each displacement. Use these charts to ensure your application operates within the prescribed range.

The charts define the area of inlet pressures and speeds allowed for maximum displacement. Operating at lower displacements allows greater speed or lower inlet pressure.



Design Parameters

Installation
PVMX pumps may be installed in any position. To optimize inlet conditions, install the pump at an elevation below the minimum reservoir fluid level. Design inlet plumbing to maintain inlet pressure within prescribed limits (see Inlet pressure limits).

Fill the pump housing and inlet line with clean fluid during installation. Connect the case drain line to the uppermost drain port to keep the housing full during operation. To allow unrestricted flow to the reservoir, use a dedicated drain line. Connect it below the minimum reservoir fluid level and as far away from the reservoir outlet as possible. Use plumbing adequate to maintain case pressure within prescribed limits (see Case pressure limits).

Filtration
To prevent damage to the pump, including premature wear, fluid entering the pump inlet must be free of contaminants. PVMX pumps require system filtration capable of maintaining fluid cleanliness at ISO 4406-1999 class 22/18/13 or better. Danfoss does not recommend suction line filtration. Suction line filtration can cause high inlet vacuum, which limits pump operating speed. Instead, a 125 µm (150 mesh) screen in the reservoir covering the pump inlet is recommended. This protects the pump from coarse particle ingestion. Return line filtration is the preferred method for open circuit systems. Consider these factors when selecting a system filter:

- Cleanliness specifications
- Contaminant ingression rates
- Flow capacity
- Desired maintenance interval

Typically, a filter with a beta ratio of $\beta 10 = 10$ is adequate. However, because each system is unique, only a thorough testing and evaluation program can fully validate the filtration system.

Reservoir
The reservoir provides clean fluid, dissipates heat, and removes entrained air from the hydraulic fluid. It allows for fluid volume changes associated with fluid expansion and cylinder differential volumes. Minimum reservoir capacity depends on the volume needed to perform these functions. Typically, a capacity of one to three times the pump flow (per minute) is satisfactory. Locate the reservoir outlet (suction line) near the bottom, allowing clearance for settling foreign particles. Place the reservoir inlet (return lines) below the lowest expected fluid level, as far away from the outlet as possible

Fluid velocity
Choose piping sizes and configurations sufficient to maintain optimum fluid velocity, and minimize pressure drops. This reduces noise, pressure drops, and overheating. It maximizes system life and performance.

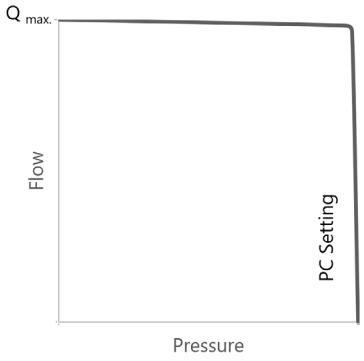
Recommended fluid velocities

System lines	6 to 9 m/s	20 to 30 ft/s
Suction lines	1.2 to 2 m/s	4 to 6 ft/s
Case drain	3 to 5 m/s	10 to 15 ft/s

Control Options

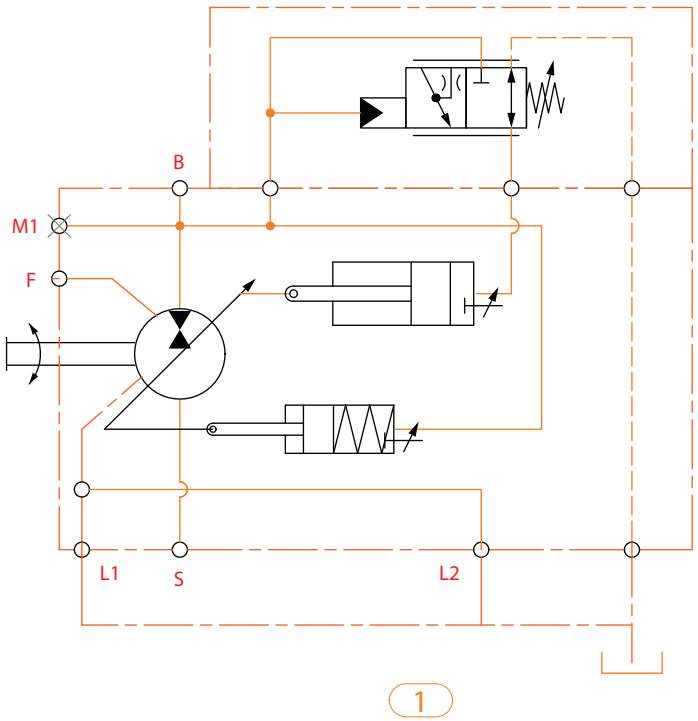
Pressure Compensator Control – A0

The pump provides a continuously modulated flow to meet changing load demands at a preadjusted compensator pressure. At pressures below the compensator setting, the pump operates at maximum displacement.



B - Outlet
S - Inlet
L1, L2 - Case Drain
M1 - System Pressure Gauge Port
F - Flushing Port

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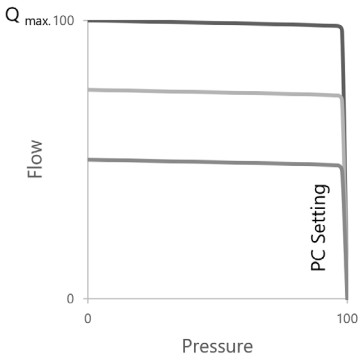


Control Options

Pressure and Flow Compensator (Load sense control)

A load sensing (LS) control in an axial piston pump is an intelligent control system that automatically adjusts pump output based on actual system demand by maintaining a constant pressure differential between pump outlet pressure and the highest load pressure in the system. This is achieved through a control mechanism consisting of a load sensing line that reads system pressure, a control piston adjusting the swashplate angle, and a spring-loaded compensator spool. When an actuator demands flow, its directional valve opens, communicating the load pressure back to the pump control through the LS line, which then adjusts pump displacement to maintain the preset pressure differential. This results in energy-efficient operation since the pump only produces the required flow and pressure, reduces heat generation, allows multiple actuator operation without interference, and ensures low power consumption during standby mode when the pump operates at minimal flow.

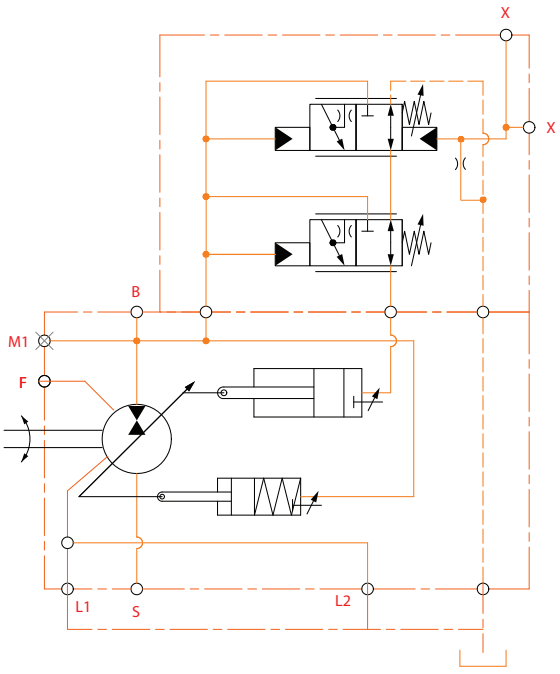
LS control with bleed orifice
The load sense signal line requires a bleed orifice to prevent high-pressure lockup of the pump control. Most load-sensing control valves include this orifice. An optional internal bleed orifice is available, for use with control valves that do not internally bleed the LS signal to tank.



With Bleed Down Orifice (B0)

B - Outlet
S - Inlet
L1, L2 - Case Drain
M1 - System Pressure Gauge Port
F - Flushing Port
X - Load Sense Signal Port

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Control Options

Without Bleed Down Orifice (C0)

B - Outlet

S - Inlet

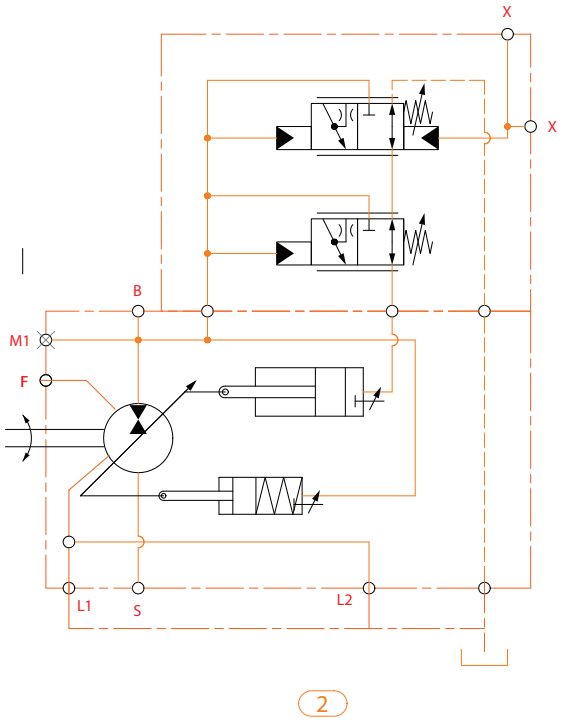
L1, L2 - Case Drain

M1 - System Pressure Gauge Port

F - Flushing Port

X - Load Sense Signal Port

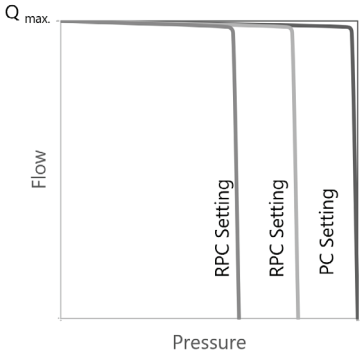
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Control Options

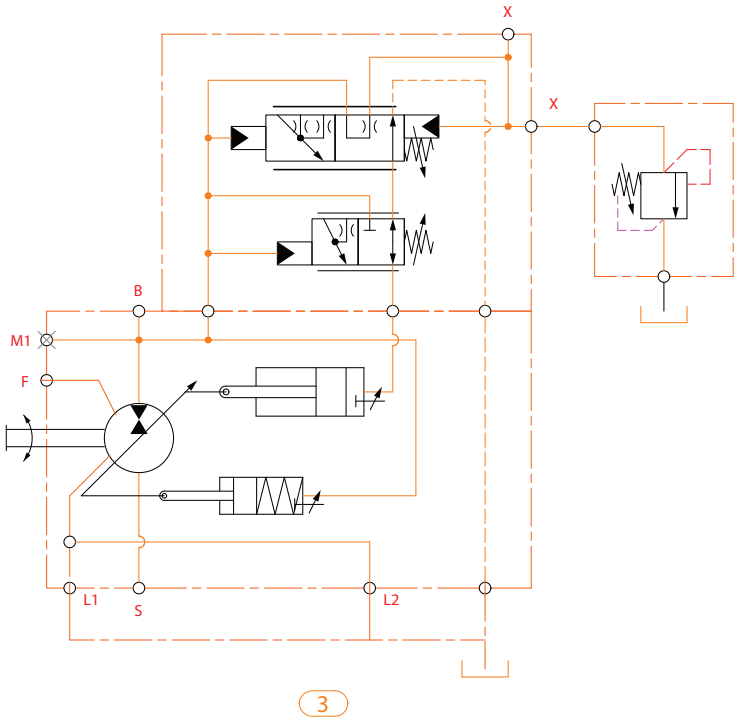
Remote Pressure Compensator (W0)

A remote pressure compensation is realized by connecting a remote relief valve to the remote pressure port "X" through necessary plumbing. The required outlet pressure can be set by adjusting remote relief valve setting. Once pressure reaches preset value, the remote relief valve opens, resulting in Remote Pressure Compensator spool movement due to pressure imbalance. This will de-stroke the pump to maintain the set pressure. Secondary pressure compensator is provided to limit the max. pressure setting as a fail-safe measure.
Remote relief valve is not included in supply scope of the pump.



B - Outlet
S - Inlet
L1, L2 - Case Drain
M1 - System Pressure Gauge Port
F - Flushing Port
X - Load Sense Signal Port /Remote Pressure Port

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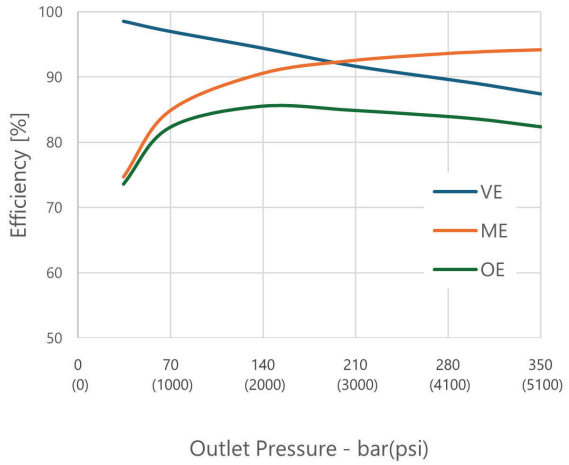


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Performance

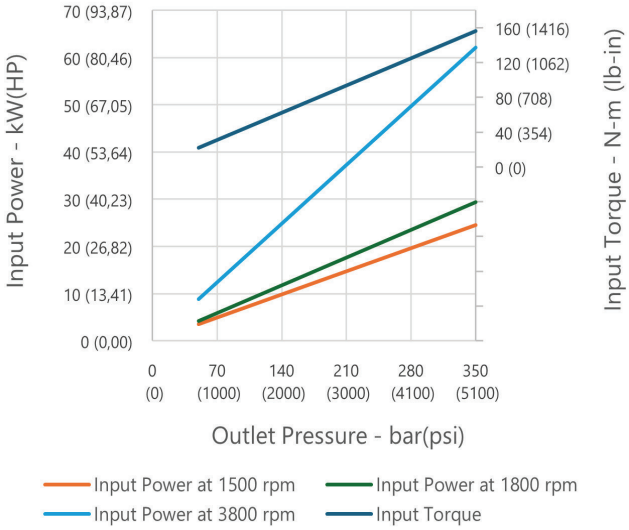
Efficiencies at 1800 r/min

50°C (120°F) and 1.0 bar absolute (0 psi gauge) inlet



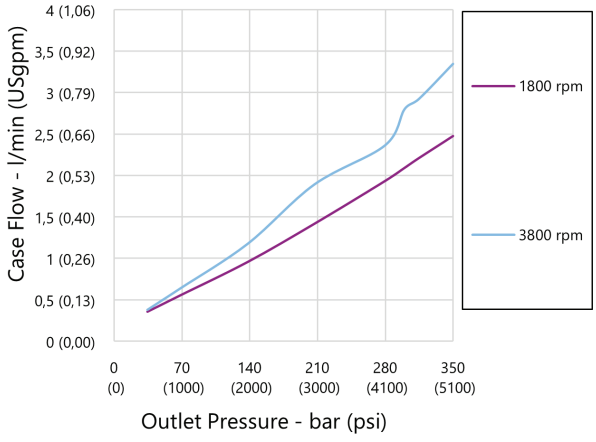
Input Torque and Power

50°C (120°F) and 1.0 bar absolute (0 psi gauge) inlet



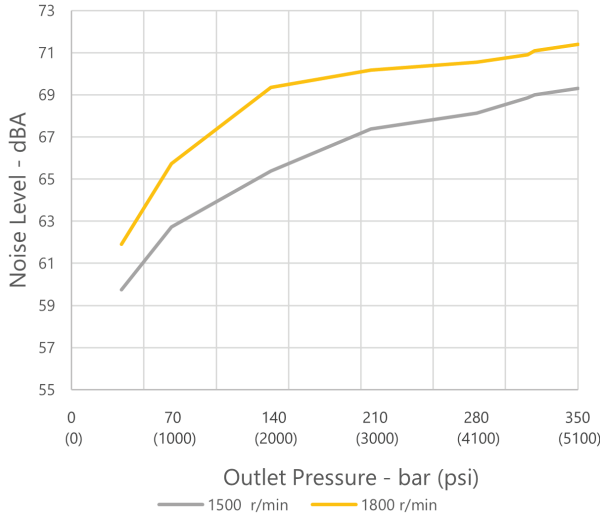
Case Flow Versus Outlet Pressure at Full Flow

50°C (120°F) and 1.0 bar absolute (0 psi gauge) inlet



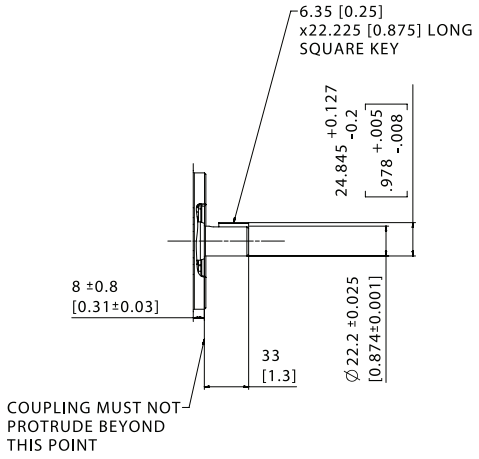
Typical Noise Levels at Full Flow

With Petroleum Oil (ISO VG 46) at 50°C

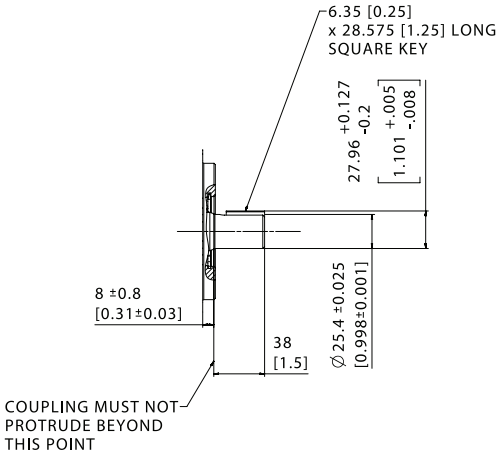


Shaft Options

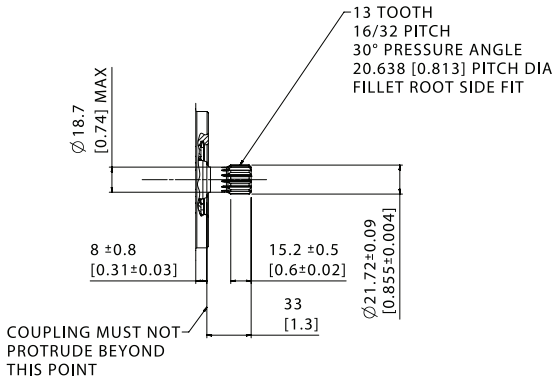
Code	Description
05	SAE J744-22-1, SAE B, STRAIGHT KEYED



Code	Description
06	SAE J744-25-1, SAE B-B, STRAIGHT KEYED 46[1.8] EXTENSION



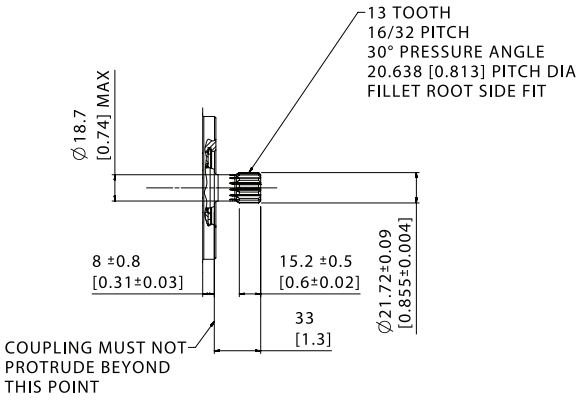
Code	Description
07	SAE J744-22-4, SAE B, 13T SPLINE



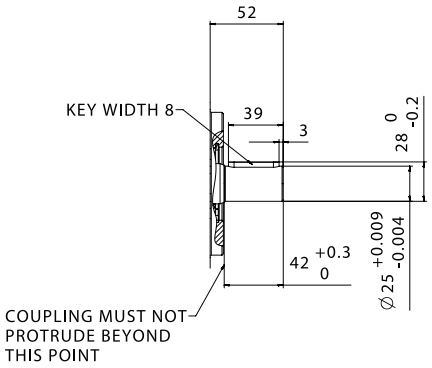
Shaft Options

SAE B J744-101-2 2-BOLT

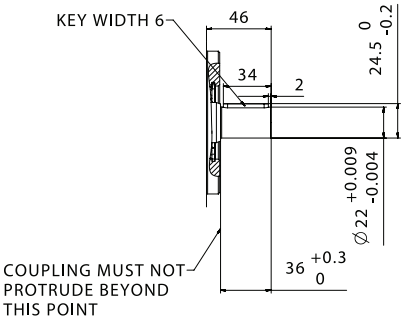
Code	Description
08	SAE J744-25-4, SAE B-B, 15T SPLINE



Code	Description
15	DIN6885 STRAIGHT KEYED 25MM DIAMETER SHAFT

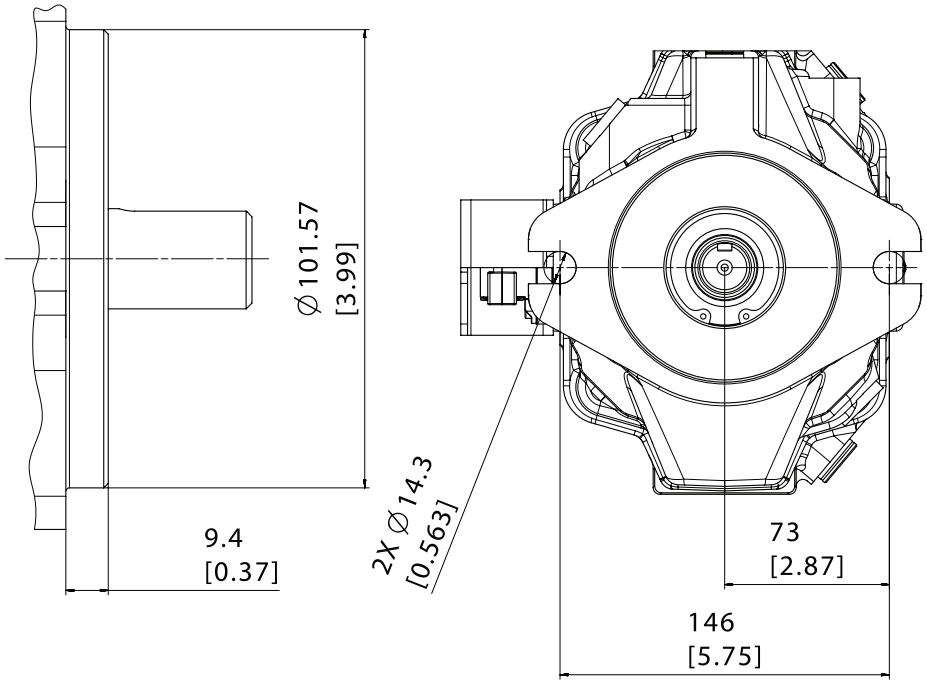


Code	Description
16	DIN6885 STRAIGHT KEYED 22MM DIAMETER SHAFT

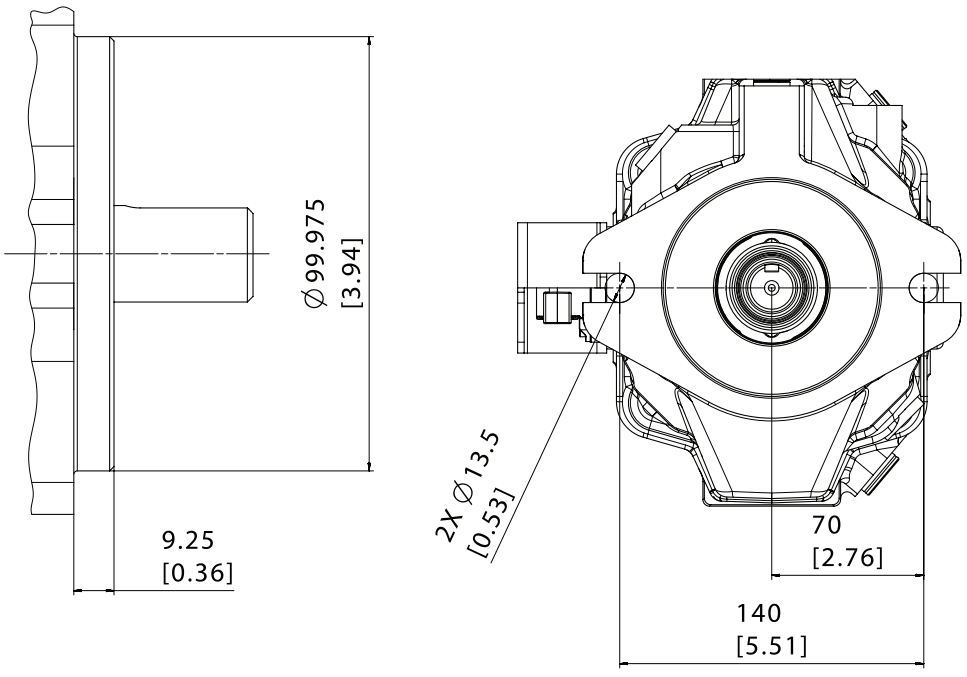


Mounting Flange Options

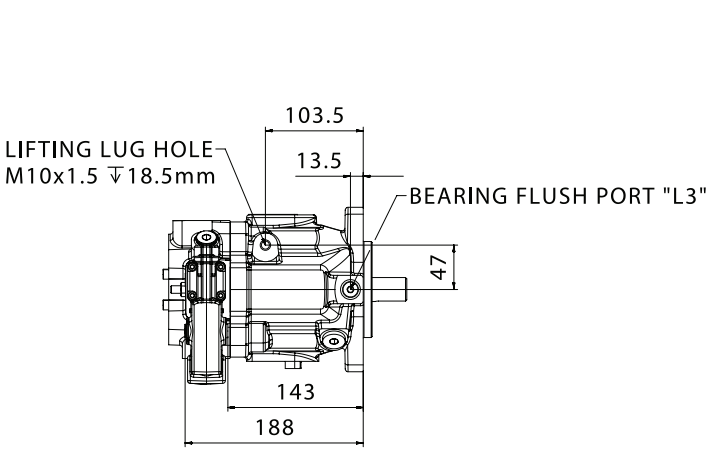
Code	Description
B	SAE B J744-101-2 2-BOLT

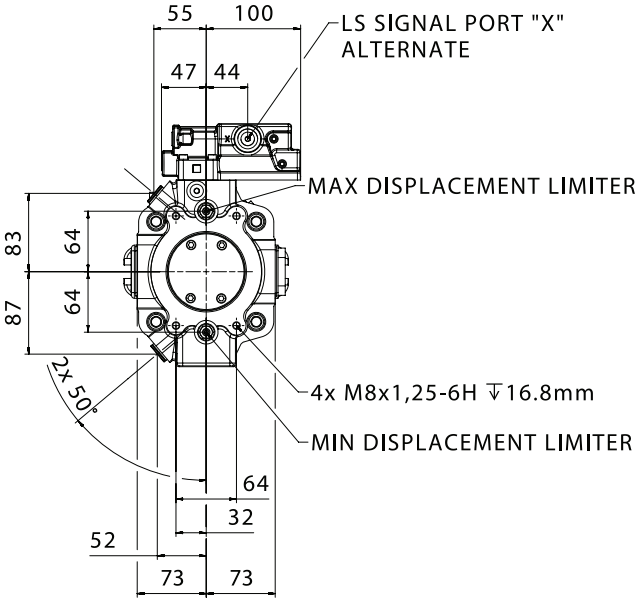


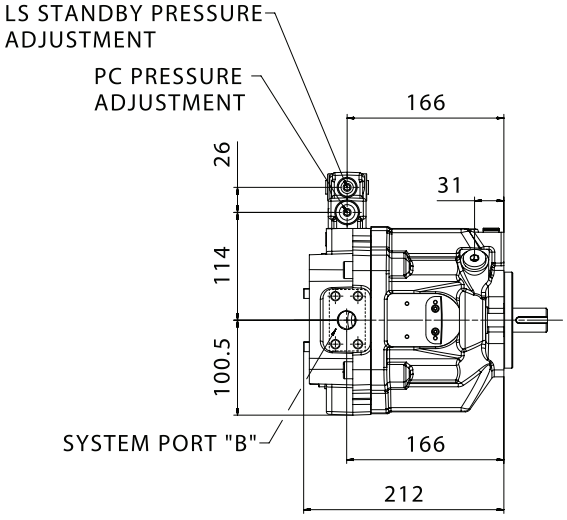
Code	Description
M	ISO 3019/2 - 100A2HW 2-BOLT

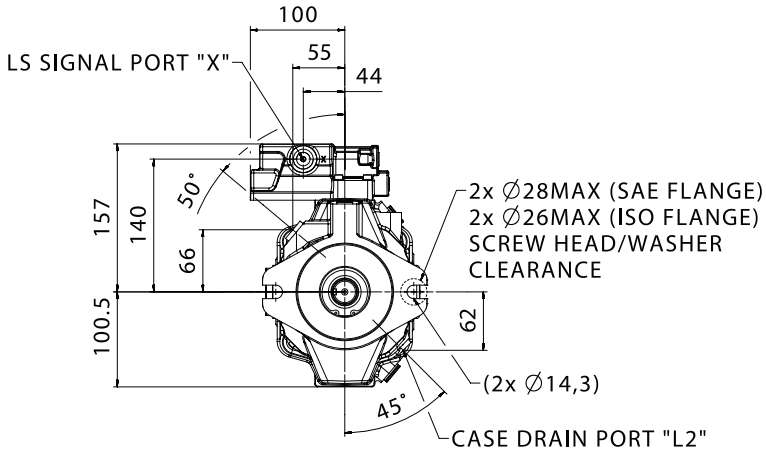


Installation Drawings

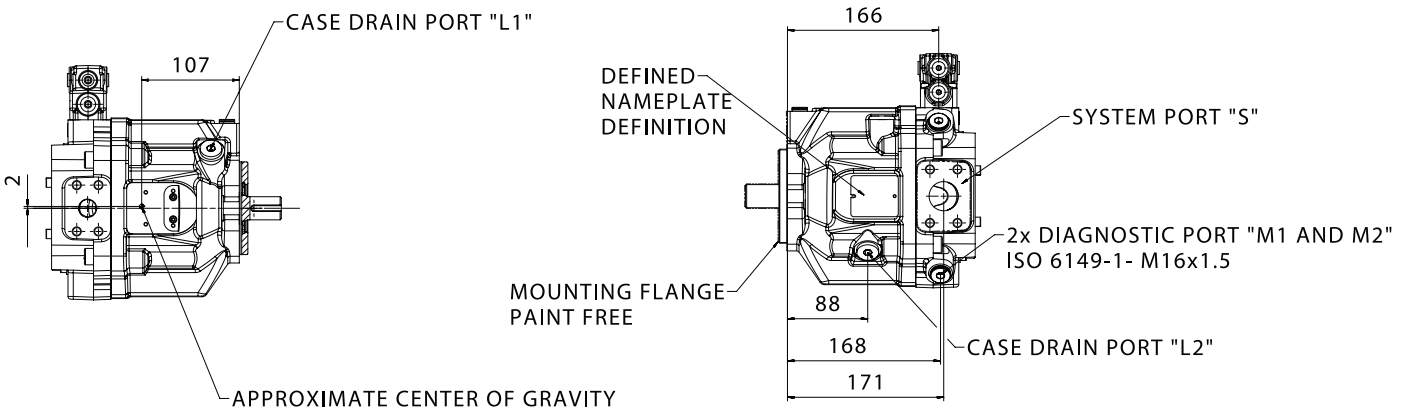


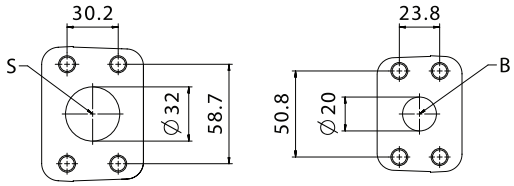






Installation Drawings





INCH AND METRIC FLANGE PORT

Inlet/Outlet Port Option

(per model code)	**Port Code**	**Inlet Port "S"**	**Outlet Port "B"**
Inch Tube	1	SAE J514 O-ring-20, 1 5/8-12 UNF-2B	SAE J514 O-ring-12, 1 1/16-12 UNF-2B
Inch Flange	2	SAE J518 Code 61, standard pressure.	SAE J518 Code 62, high pressure.
		1-1/4 inch diameter, 7/16-14 UNC-2B bolt holes	3/4 inch diameter, 3/8-16 UNC-2B bolt holes
Metric Tube	3	ISO 6149-1, M42 thread	ISO 6149-1, M27 thread
Metric Flange	4	ISO 6162-1, 32mm diameter, M10x25 bolt holes	ISO 6162-2, 20mm diameter, M10x20 bolt holes

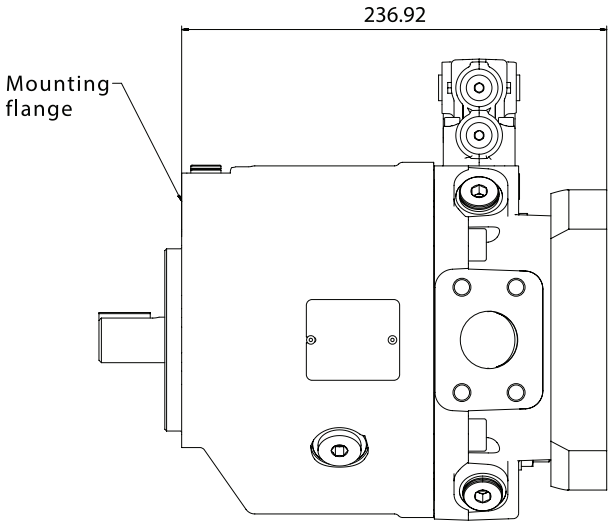
Drain, Load Sensing and Bearing Flushing Port

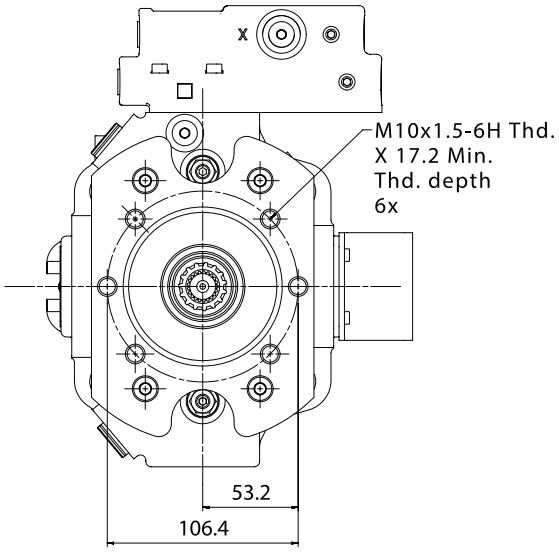
(per model code)	**Port Code**	**Drain Port "L1&L2"**	**Load Sensing Port "X"**	**Bearing Flush Port "L3"**
Inch Flange or Tube	1, 2	SAE J1926/1:3/4-16	ISO 11926-1 - 7/16-20, UNF-2B	SAE J1926/1:1/2-20
Metric Flange or Tube	3, 4	ISO 6149-1 O-ring,	ISO 6149-1 O-ring,	ISO 6149-1 O-ring,
		M18x1.5 thread	M12x1.5 thread	M12x1.5 thread

Installation Drawings

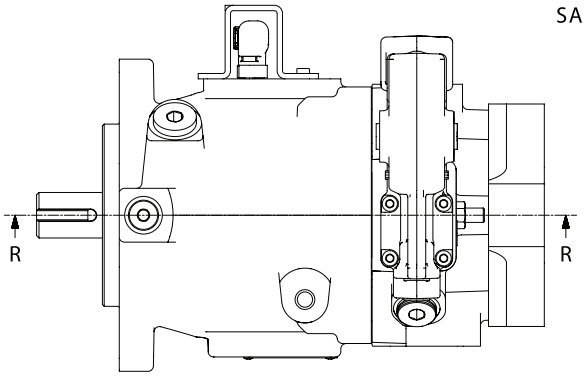
Thru-drive

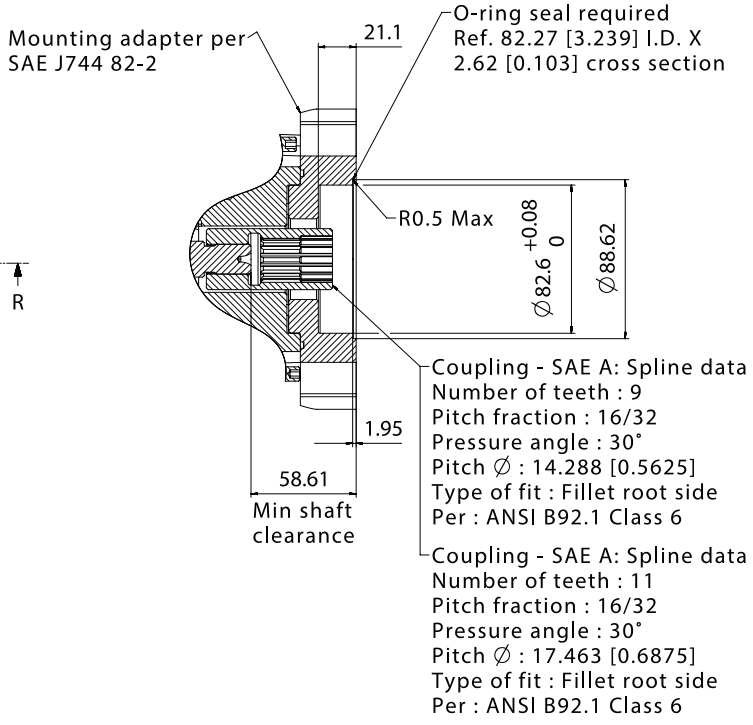
SAE A Adaptor Flange





R-R

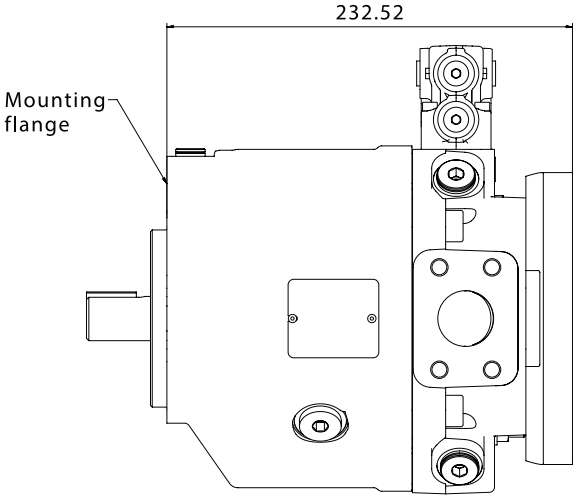


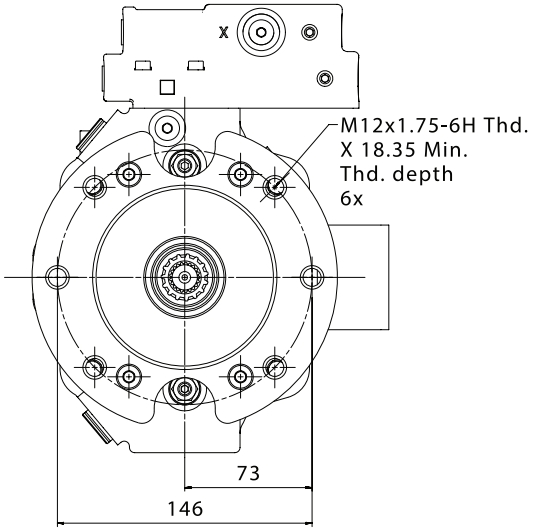


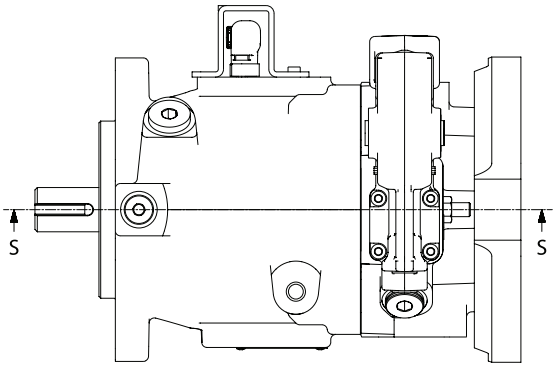
Installation Drawings

Thru-drive

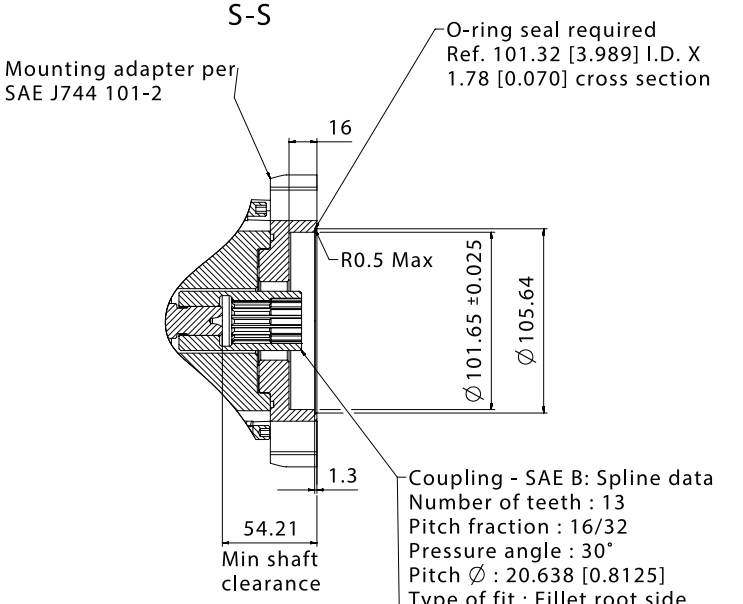
SAE B Adaptor Flange







S-S



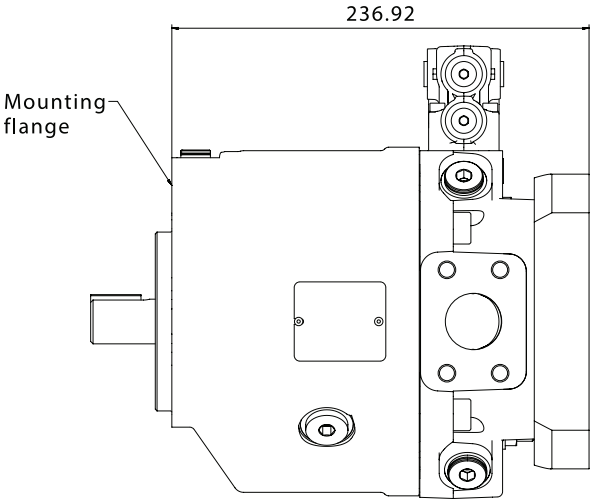
Coupling - SAE B: Spline data
Number of teeth : 13
Pitch fraction : 16/32
Pressure angle : 30˚
Pitch ∅ : 20.638 [0.8125]
Type of fit : Fillet root side
Per : ANSI B92.1 Class 6

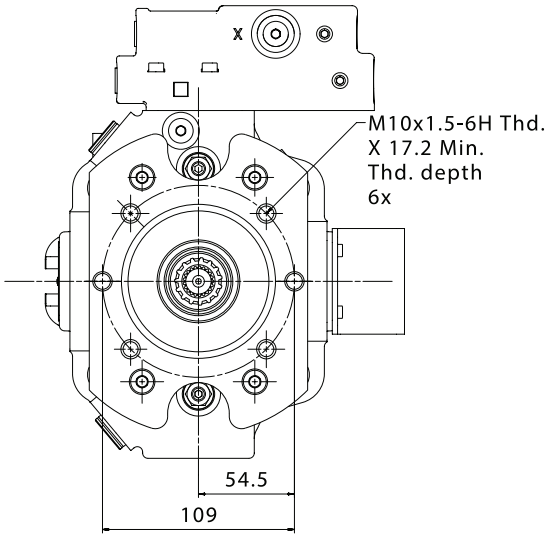
Coupling - SAE B-B: Spline data
Number of teeth : 15
Pitch fraction : 16/32
Pressure angle : 30˚
Pitch ∅ : 23.813 [0.9375]
Type of fit : Fillet root side
Per : ANSI B92.1 Class 6

Installation Drawings

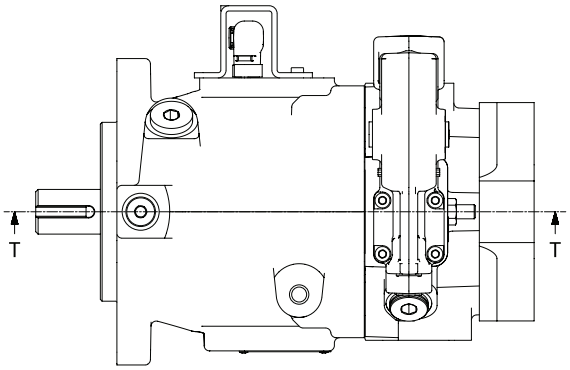
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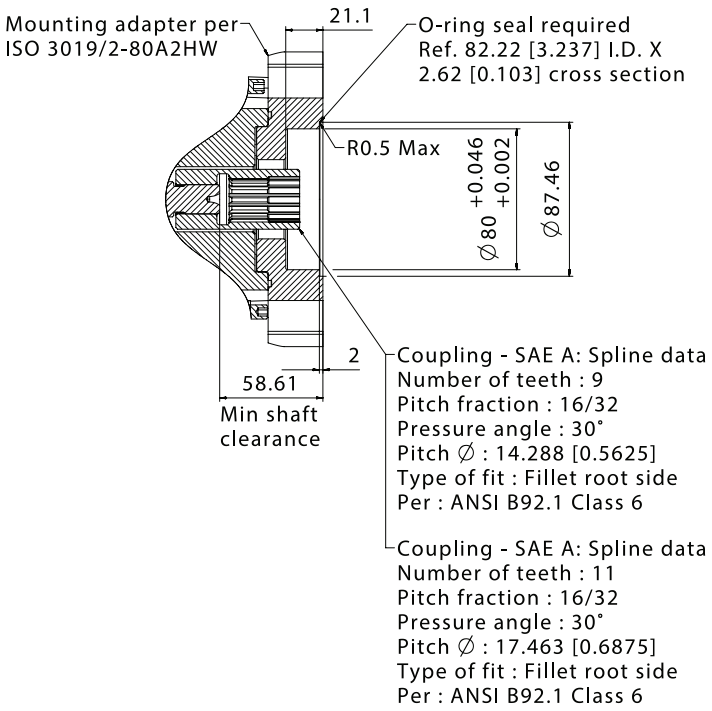
ISO 3019/2-80A2HW Adaptor Flange





T-T

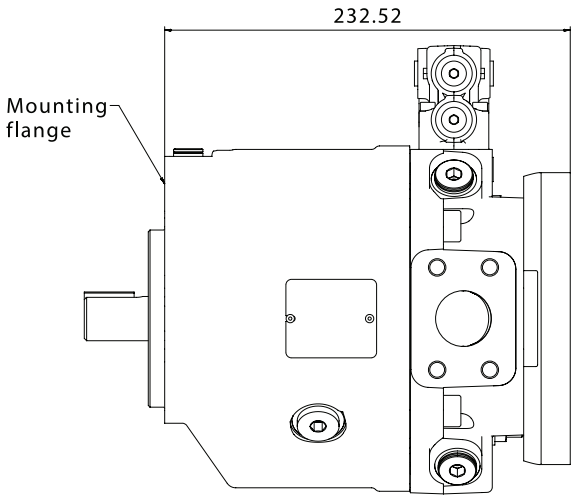


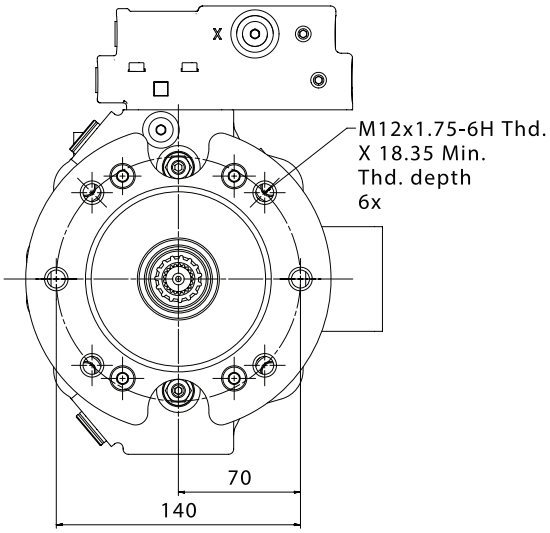


Installation Drawings

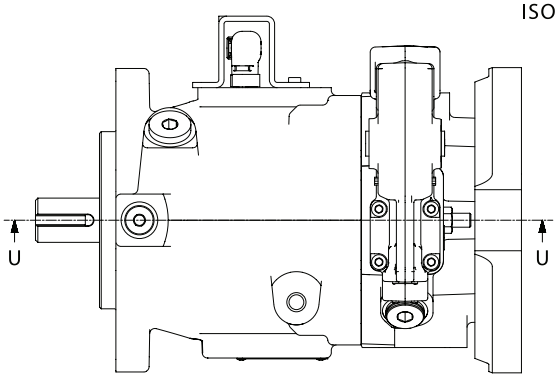
Thru-drive

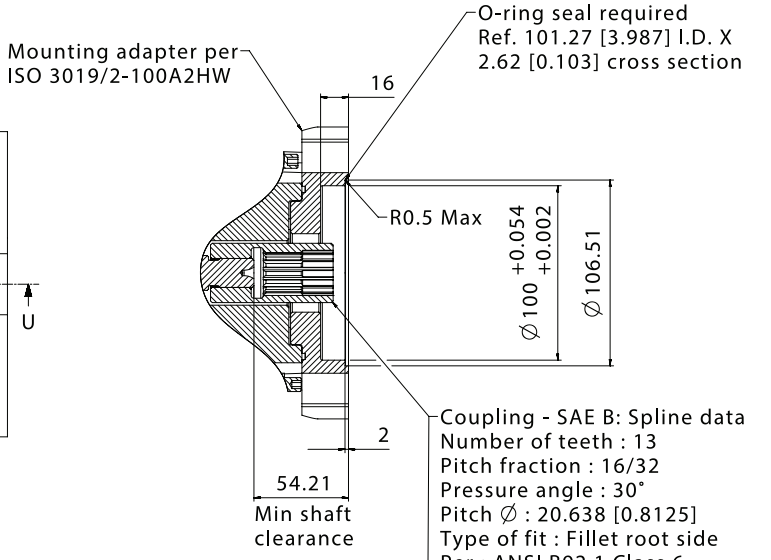
ISO 3019/2-100A2HW Adaptor Flange





U-U





Coupling - SAE B: Spline data
Number of teeth : 13
Pitch fraction : 16/32
Pressure angle : 30°
Pitch ∅ : 20.638 [0.8125]
Type of fit : Fillet root side
Per : ANSI B92.1 Class 6

Coupling - SAE B-B: Spline data
Number of teeth : 15
Pitch fraction : 16/32
Pressure angle : 30°
Pitch ∅ : 23.813 [0.9375]
Type of fit : Fillet root side
Per : ANSI B92.1 Class 6

Installation and Start-up

⚠ **Warning:** Care should be taken that mechanical and hydraulic resonances are avoided in the application of the pump. Such resonances can seriously compromise the life and/or safe operation of the pump.

Drive Data

Mounting attitude can be either horizontal or vertical, using the appropriate case drain ports to ensure that the case remains full of fluid at all times. Consult your local Danfoss Representative if a different arrangement is required.

In those cases where geometric tolerances of mounting are critical, or where specific tolerance ranges are required and not specified, consult Danfoss Engineering for specific limits.

Direction of shaft rotation, viewed from the prime mover end, must be as indicated in the model designation on the pump – either right hand (clockwise) or left hand (counterclockwise).

Direct coaxial drive through a flexible coupling is recommended. If drives imposing radial shaft loads are considered, please consult your Danfoss Representative.

Start-up Procedure

Make sure the reservoir and circuit are clean and free of dirt/debris prior to filling with hydraulic fluid.

Fill the reservoir with filtered oil and fill to a level sufficient enough to prevent vortexing at the suction connection to pump inlet. It is good practice to clean the system by flushing and filtering, using an external slave pump.

Caution: Before the pump is started, fill the case through the uppermost drain port with hydraulic fluid of the type to be used. The case drain line must be connected directly to the reservoir and must terminate below the oil level.

Once the pump is started, it should prime within a few seconds. If the pump does not prime, check to make sure that there are no restrictions between the reservoir and the inlet to the pump, that the pump is being rotated in the proper direction, and that there are no air leaks in the inlet line and connections. Also check to make sure that trapped air can escape at the pump outlet.

After the pump is primed, tighten the loose outlet connections, then operate for five to ten minutes (unloaded) to remove all trapped air from the circuit.

If the reservoir has a sight gage, make sure the fluid is clear – not milky.

Notes

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