SAUER DANFOSS

HYNESUR
SUMINISTROS DE HIDRÁULICA Y NEUMÁTICA DEL SUR, S.L.

Series 45
Frame J
Axial Piston Open
Circuit Pumps

Technical
Information






Using this manual

ORGANIZATION AND HEADINGS

To help you quickly find information in this manual, the material is divided into sections, topics, subtopics, and details, with descriptive headings set in red type. Section titles appear at the top of every page in large red type. Topic headings appear in the left hand column in **BOLD RED CAPITAL LETTERS**. Subtopic headings appear in the body text in **bold red type** and detail headings in *italic red type*.

References (example: See *Topic xyz*, page XX) to sections, headings, or other publications are also formatted in *red italic type*. In **P**ortable **D**ocument **F**ormat (**PDF**) files, these references represent clickable hyperlinks that jump to the corresponding document pages.

TABLES, ILLUSTRATIONS, AND COMPLEMENTARY INFORMATION

Tables, illustrations, and graphics in this manual are identified by titles set in *blue italic type* above each item. Complementary information such as notes, captions, and drawing annotations are also set in blue type.

References (example: See *Illustration abc*, page YY) to tables, illustrations, and graphics are also formatted in *blue italic type*. In PDF files, these references represent clickable hyperlinks that jump to the corresponding document pages.

SPECIAL TEXT FORMATTING

Defined terms and acronyms are set in **bold black type** in the text that defines or introduces them. Thereafter, the terms and acronyms receive no special formatting.

Black italic type is used in the text to emphasize important information, or to set-off words and terms used in an unconventional manner or alternative context. *Red* and *blue italics* represent hyperlinked text in the PDF version of this document (see above).

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SAUER DANFOSS

Series 45 Axial Piston Open Circuit Pumps
Technical Information
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The Series 45 product family

OVERVIEW

Series 45 is a complete family of variable displacement, axial piston pumps for open circuit applications. Each frame within the Series 45 family is uniquely designed to optimize performance, size, and cost, matching the work function requirements of the demanding mobile equipment marketplace. This document gives only the detailed specifications and features for Frame J (45, 51, 60, 65, and 70 cm^3 displacements).
For complete technical information, refer to *Series 45 Open Circuit Axial Piston Pumps Technical Information*, **520L0519**.

DESIGN

High performance

- Displacements from 25 cm^3 - 147 cm^3 [1.53 - 8.97 in^3/rev]
- Speeds up to 3600 rpm
- Pressures up to 310 bar [4495 psi] continuous, and 400 bar [5800 psi] peak
- Variety of control system options including load sensing and pressure compensated
- Through-drive capability for multi-circuit systems
- Range of mounting flanges, shafts, and porting options for ease of installation

Latest technology

- Customer-driven using quality function deployment (QFD) and design for manufacturability (DFM) techniques
- Optimized valve plates for maximum efficiency and quiet operation
- Computer-modeled castings to optimize inlet conditions for maximum pump speed
- Compact package size minimizing installation space requirements
- Heavy-duty tapered roller bearings for long life
- Single piece rigid housing to reduce noise and leak paths
- Integrated controls for high speed response and system stability

Reliability

- Designed to rigorous standards
- Proven in both laboratory and field
- Manufactured to rigid quality standards
- Long service life
- Significantly fewer parts
- No gasketed joints
- Robust input shaft bearings to handle large external shaft loads
- Integrated gauge ports for monitoring operating conditions

TYPICAL APPLICATIONS

- Cranes
- Telescopic handlers
- Forklift trucks
- Wheel loaders
- Sweepers
- Backhoe loaders
- Forestry and agricultural machinery
- Fan drives
- Other uses

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THE SERIES 45 PRODUCT FAMILY

Basic units

The series 45 family of open circuit, variable piston pumps, offers a range of displacements from 25 to 147 cm^3/rev [1.53 to 8.97 in^3/rev]. With maximum speeds up to 3600 rpm and continuous operating pressures up to 310 bar [4495 psi], you can tailor product selection to the flow and pressure requirements of your individual application.

K/L Frame

J Frame

H Frame

G Frame

E Frame

General performance specifications for the series 45 pump family

Pump	**Displacement**		**Speed**			**Pressure**				**Theoretical flow (at rated speed)**		**Mounting**
			Continuous	**Max.**	**Min.**	**Continuous**		**Maximum**				
Model	cm^3	in^3	min^{-1} (rpm)	min^{-1} (rpm)	min^{-1} (rpm)	bar	psi	bar	psi	US gal/min	l/min	Flange
Frame L												
L25C	25	1.53	3200	3600	500	260	3770	350	5075	21.0	80.0	SAE B - 2 bolt
L30D	30	1.83	3200	3600	500	210	3045	300	4350	25.4	96.0	SAE B - 2 bolt
Frame K												
K38C	38	2.32	2650	2800	500	260	3770	350	5075	26.6	100.7	SAE B - 2 bolt
K45D	45	2.75	2650	2800	500	210	3045	300	4350	31.5	119.3	SAE B - 2 bolt
Frame H												
H57B	57	3.48	2600	3200	500	310	4495	400	5800	39.2	148.2	SAE B 2-bolt SAE C 4-bolt
H75D	75	4.58	2400	2800	500	210	3045	300	4350	47.6	180.0	SAE B 2-bolt SAE C 4-bolt
Frame J												
J45B	45	2.75	2800	3360	500	310	4495	400	5800	33.3	126.0	SAE B 2-bolt SAE C 4-bolt
J51B	51	3.11	2700	3240	500	310	4495	400	5800	36.4	137.7	SAE B 2-bolt SAE C 4-bolt
J60B	60	3.66	2600	3120	500	310	4495	400	5800	41.2	156.0	SAE B 2-bolt SAE C 4-bolt
J65C	65	3.97	2500	3000	500	260	3770	350	5075	42.9	162.6	SAE B 2-bolt SAE C 4-bolt
J75C	75	4.58	2400	2880	500	260	3770	350	5075	47.5	180.0	SAE B 2-bolt SAE C 4-bolt
Frame G												
G74B	74	4.52	2400	2800	500	310	4495	400	5800	46.9	177.6	SAE C 4-bolt
G90C	90	5.49	2200	2600	500	260	3770	350	5075	52.3	198.0	SAE C 4-bolt
Frame E												
E100B	100	6.10	2450	2880	500	310	4495	400	5800	64.7	245.0	SAE C 4-bolt
E130B	130	7.93	2200	2600	500	310	4495	400	5800	75.5	286.0	SAE C 4-bolt
E147C	147	8.97	2100	2475	500	260	3770	350	5075	81.5	308.7	SAE C 4-bolt

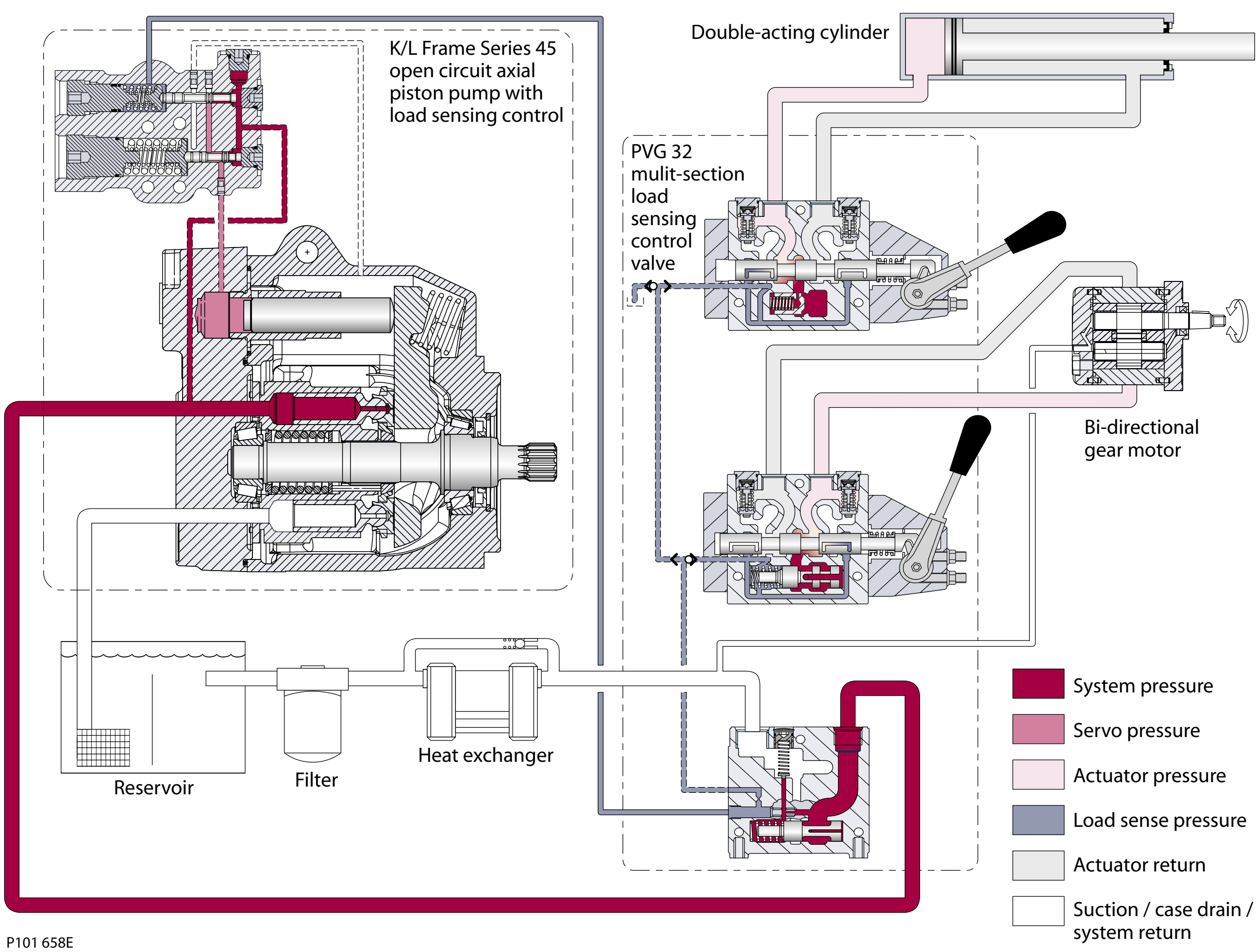
LOAD SENSING OPEN CIRCUIT SYSTEM

The pump receives fluid directly from the reservoir through the inlet line. A screen in the inlet line protects the pump from large contaminants. The pump outlet feeds a PVG-32 multi-section, load sensing, directional control valve. The PVG valve directs pump flow to the cylinder and gear motor. A heat exchanger cools the fluid returning from the valve. A filter cleans the fluid before it returns to the reservoir.

Flow in the circuit determines the speed of the actuators. The position of the PVG valve determines the flow demand. A hydraulic pressure signal (LS signal) communicates demand to the pump control. The pump control monitors the pressure differential between pump outlet and the LS signal, and regulates servo pressure to control the swashplate angle. Swashplate angle determines pump flow.

Actuator load determines system pressure. The pump control monitors system pressure and will decrease the swashplate angle to reduce flow if system pressure reaches the PC setting. A system relief valve in the PVG valve acts as a back-up to control system pressure.

Pictorial circuit diagram

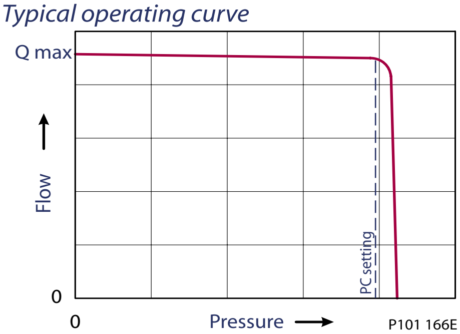


PRESSURE COMPENSATED CONTROLS

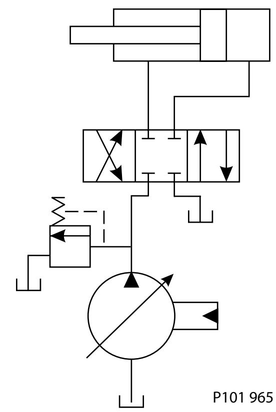
Operation

The PC control maintains constant system pressure in the hydraulic circuit by varying the output flow of the pump. Used with a closed center control valve, the pump remains in high pressure standby mode at the PC setting with zero flow until the function is actuated. This condition is often called a **dead head** condition.

Typical operating curve



Simple closed-center circuit



Once the closed center valve is opened, the PC control senses the immediate drop in system pressure and increases pump flow by increasing the swashplate angle. The pump continues to increase flow until system pressure reaches the PC setting. If system pressure exceeds the PC setting, the PC control reduces the swashplate angle to maintain system pressure by reducing flow. The PC control continues to monitor system pressure and changes swashplate angle to match the output flow with the work function pressure requirements.

If the demand for flow exceeds the capacity of the pump, the PC control directs the pump to maximum displacement. In this condition, actual system pressure depends on the actuator load.

For additional system protection, install a relief valve in the pump outlet line.

The *Features and options* section, page 30, includes control schematic diagrams, setting ranges, and response / recovery times for each control available. **Response** is the time (in milliseconds) for the pump to reach zero displacement when commanded by the control. **Recovery** is the time (in milliseconds) for the pump to reach full displacement when commanded by the control. Actual times can vary depending on application conditions.

Pressure compensated system characteristics

- Constant pressure and variable flow
- High pressure standby mode when flow is not needed
- System flow adjusts to meet system requirements
- Single pump can provide flow to multiple work functions
- Quick response to system flow and pressure requirements

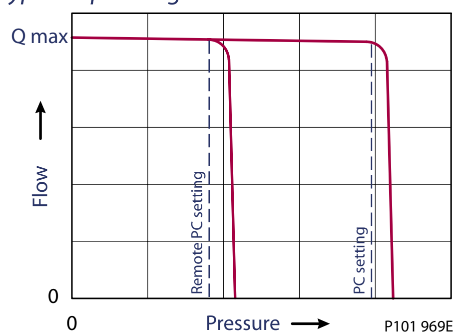
Typical applications for pressure compensated systems

- Constant force cylinders (bailers, compactors, refuse trucks)
- On/off fan drives

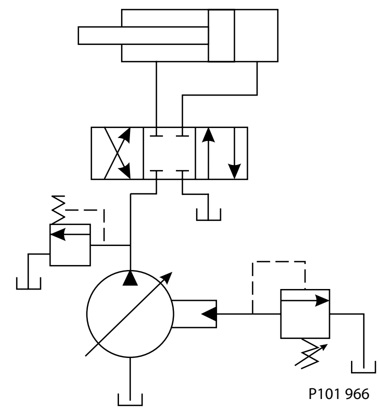
REMOTE PRESSURE COMPENSATED CONTROLS

The remote PC control is a two-stage control that allows multiple PC settings. Remote PC controls are commonly used in applications requiring low and high pressure PC operation.

Typical operating curve



Closed center circuit with remote PC



The remote PC control uses a pilot line connected to an external hydraulic valve. The external valve changes pressure in the pilot line, causing the PC control to operate at a lower pressure. When the pilot line is vented to reservoir, the pump maintains a low standby pressure of 15 to 20 bar [215 to 300 psi]. When pilot flow is blocked, the pump maintains pressure at the PC setting. An on-off solenoid valve can be used in the pilot line to create a low-pressure standby mode. A proportional solenoid valve, coupled with a microprocessor control, can produce an infinite range of operating pressures.

Size the external valve and plumbing for a pilot flow of 3.8 l/min [1 US gal/min]. For additional system protection, install a relief valve in the pump outlet

The *Features and options* section, page 30, includes control schematic diagrams, setting ranges, and response / recovery times for each control available. **Response** is the time (in milliseconds) for the pump to reach zero displacement when commanded by the control. **Recovery** is the time (in milliseconds) for the pump to reach full displacement when commanded by the control. Actual times can vary depending on application conditions.

Remote pressure compensated system characteristics

- Constant pressure and variable flow
- High or low pressure standby mode when flow is not needed
- System flow adjusts to meet system requirements
- Single pump can provide flow to multiple work functions
- Quick response to system flow and pressure requirements

Typical applications for remote pressure compensated systems

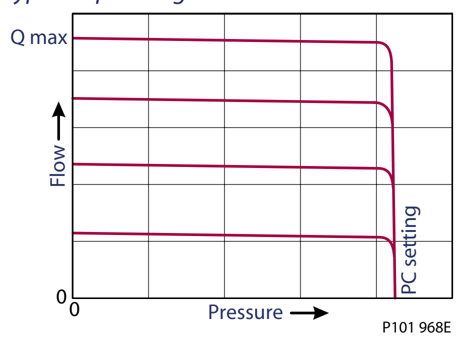
- Modulating fan drives
- Anti-stall control with engine speed feedback
- Front wheel assist

LOAD SENSING CONTROLS

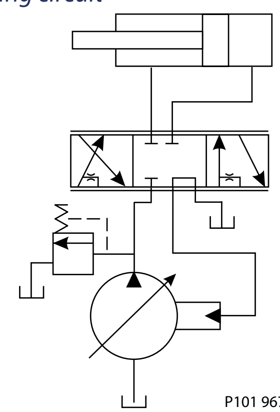
Operation

The LS control matches system requirements for both pressure and flow in the circuit regardless of the working pressure. Used with a closed center control valve, the pump remains in low-pressure standby mode with zero flow until the valve is opened. The LS setting determines standby pressure.

Typical operating curve



Load sensing circuit



Most load sensing systems use parallel, closed center, control valves with special porting that allows the highest work function pressure (LS signal) to feed back to the LS control. **Margin pressure** is the difference between system pressure and the LS signal pressure. The LS control monitors margin pressure to read system demand. A drop in margin pressure means the system needs more flow. A rise in margin pressure tells the LS control to decrease 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, if needed.

Integral PC function

The LS control also performs as a PC control, decreasing pump flow when system pressure reaches the PC setting. The pressure compensating function has priority over the load sensing function.

For additional system protection, install a relief valve in the pump outlet line.

The *Features and options* section, page 30, includes control schematic diagrams, setting ranges, and response / recovery times for each control available. **Response** is the time (in milliseconds) for the pump to reach zero displacement when commanded by the control. **Recovery** is the time (in milliseconds) for the pump to reach full displacement when commanded by the control. Actual times can vary depending on application conditions.

Load sensing system characteristics

- Variable pressure and flow
- Low pressure standby mode when flow is not needed
- System flow adjusted to meet system requirements
- Single pump can supply flow and regulate pressure for multiple circuits
- Quick response to system flow and pressure requirements

Typical applications for load sensing systems

- Priority steering
- Load independent flow control for boom lift, tilt, and rotation

FLUIDS

Ratings and performance data for Series 45 products are based on operating with premium hydraulic fluids containing oxidation, rust, and foam inhibitors. These include premium turbine oils, API CD engine oils per SAE J183, M2C33F or G automatic transmission fluids (ATF), Dexron II (ATF) meeting Allison C-3 or Caterpillar T0-2 requirements, and certain specialty agricultural tractor fluids. For more information on hydraulic fluid selection, see Sauer-Danfoss publications **520L0463** *Hydraulic Fluids and Lubricants, Technical Information*, and **520L465** *Experience with Biodegradable Hydraulic Fluids, Technical Information*.

VISCOSITY

Maintain fluid viscosity within the recommended range for maximum efficiency and bearing life. **Minimum viscosity** should only occur during brief occasions of maximum ambient temperature and severe duty cycle operation. **Maximum viscosity** should only occur at cold start: Limit speeds until the system warms up.

Fluid viscosity limits

Condition		mm²/s (cSt)	SUS
ν min.	continuous	9	58
	intermittent	6.4	47
ν max.	continuous	110	500
	intermittent (cold start)	1000	4700

TEMPERATURE

Maintain fluid temperature within the limits shown in the table. **Minimum temperature** relates to the physical properties of the component materials. Cold oil will not affect the durability of the pump components. However, it may affect the ability of the pump to provide flow and transmit power. **Maximum temperature** is based on material properties. Don't exceed it. Measure maximum temperature at the hottest point in the system. This is usually the case drain.

Temperature limits

Minimum (intermittent, cold start)	- 40° C [- 40° F]
Continuous	82° C [180° F]
Maximum	104° C [220° F]

Ensure fluid temperature and viscosity limits are concurrently satisfied.

INLET PRESSURE

Maintain inlet pressure within the limits shown in the table. Low inlet pressure (vacuum) may limit maximum pump speed and cause cavitation. Refer to *Inlet pressure vs. speed* charts for each displacement.

Inlet pressure limits

Minimum (continuous)	0.8 bar absolute [6.7 in. Hg vac.] (at reduced maximum speed)
Minimum (cold start)	0.5 bar absolute [15.1 in. Hg vac.]

CASE PRESSURE

Maintain case pressure within the limits shown in the table. The housing must always be filled with hydraulic fluid.

Case pressure limits

Maximum (continuous)	0.5 bar [7 psi] above inlet
Intermittent (cold start)	2 bar [29 psi] above inlet

Caution

Operating outside of inlet and case pressure limits will damage the pump. To minimize this risk, use full size inlet and case drain plumbing, and limit line lengths.

PRESSURE RATINGS

The table, *Ratings*, page 21, gives maximum and continuous pressure ratings for each displacement. Not all displacements within a given frame operate under the same pressure limits. Definitions of the operating pressure limits appear below.

System pressure is the differential pressure between the outlet and inlet ports. It is the dominant operating variable affecting hydraulic unit life. High system pressure, which results from high load, reduces expected life. System pressure must remain at or below rated pressure during normal operation to achieve expected life.

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.

Maximum (peak) working pressure is the highest intermittent pressure allowed. Maximum machine load should never exceed this pressure.

SPEED RATINGS

The table, *Ratings*, page 21, gives minimum, maximum, and rated speeds for each displacement. Not all displacements within a given frame operate under the same speed limits. Definitions of these speed limits appear below.

Rated speed is the maximum 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 outlet flow. Refer to *Inlet pressure vs. speed* charts for each displacement.

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

DUTY CYCLE AND PUMP LIFE

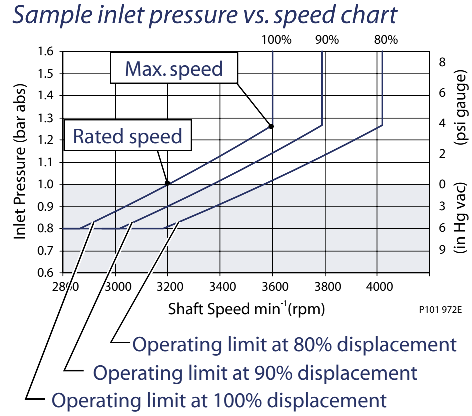
Knowing the operating conditions of your application is the best way to ensure proper pump selection. With accurate duty cycle information, your Sauer-Danfoss representative can assist in calculating expected pump life.

SPEED, FLOW, AND INLET PRESSURE

Inlet pressure vs. speed charts for each displacement 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 a given displacement. Operating at lower displacements allows greater speed or lower inlet pressure.

Sample inlet pressure vs. speed chart



INSTALLATION

Series 45 pumps may be installed in any position. To optimize inlet conditions, we recommend installing 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*, page 12)

Fill the pump housing and inlet line with clean fluid during installation. Connect the case drain line to the uppermost drain port (L1 or L2) 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*, page 12).

FILTRATION

To prevent damage to the pump, including premature wear, fluid entering the pump inlet must be free of contaminants. Series 45 pumps require system filtration capable of maintaining fluid cleanliness at ISO 4406-1999 class 22/18/13 or better.

Sauer-Danfoss does not recommend suction line filtration. Suction line filtration can cause high inlet vacuum, which limits pump operating speed. Instead we recommend a 125 µm (150 mesh) screen in the reservoir covering the pump inlet. 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. For more information, see Sauer-Danfoss publication **520L0467** *Design Guidelines for Hydraulic Fluid Cleanliness.*

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/sec [20 to 30 ft/sec]
Suction line	1 to 2 m/sec [4 to 6 ft/sec]
Case drain	3 to 5 m/sec [10 to 15 ft/sec]

Typical guidelines; obey all pressure ratings.

Velocity equations

SI units

Q = flow (l/min)
A = area (mm²)

$$\text{Velocity} = \frac{16.67 \cdot Q}{A} \quad \text{(m/sec)}$$

US units

Q = flow (US gal/min)
A = area (in²)

$$\text{Velocity} = \frac{0.321 \cdot Q}{A} \quad \text{(ft/sec)}$$

SHAFT LOADS

Series 45 pumps have tapered roller bearings capable of accepting external radial and thrust loads. The external radial shaft load limits are a function of the load position, orientation, and the operating conditions of the pump.

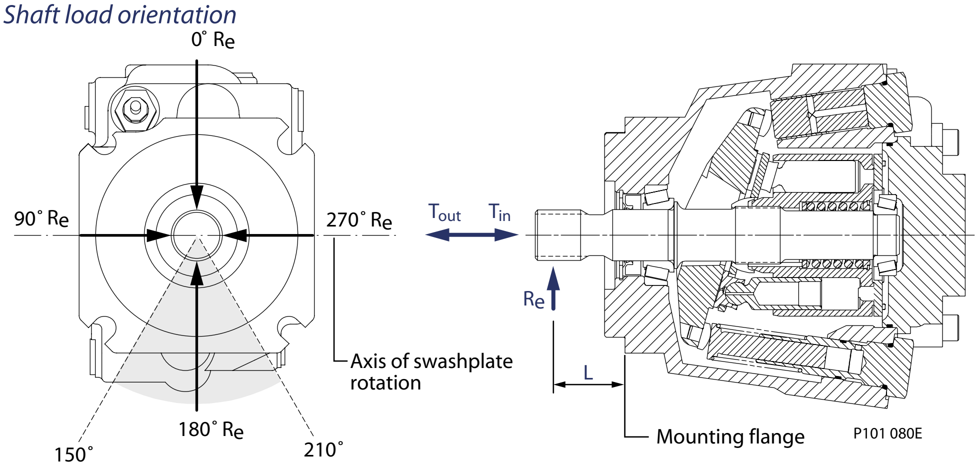
The maximum allowable radial load (R_e) is based on the maximum external moment (M_e) and the distance (L) from the mounting flange to the load. Compute radial loads using the formula below. The table, *Ratings*, page 21, gives maximum external moment (M_e) and thrust load (T_{in}, T_{out}) limits for each pump frame size and displacement.

Radial load formula

$$M_e = R_e \cdot L$$

L = Distance from mounting flange to point of load
M_e = Maximum external moment
R_e = Maximum radial side load

Shaft load orientation



BEARING LIFE

All shaft loads affect bearing life. In applications where external shaft loads can not be avoided, maximize bearing life by orientating the load between the 150° and 210° positions, as shown. We recommend tapered input shafts or clamp-type couplings for applications with radial shaft loads. The table, *Ratings*, page 21, gives B_{10} bearing life for each pump frame size and displacement.

MOUNTING FLANGE LOADS

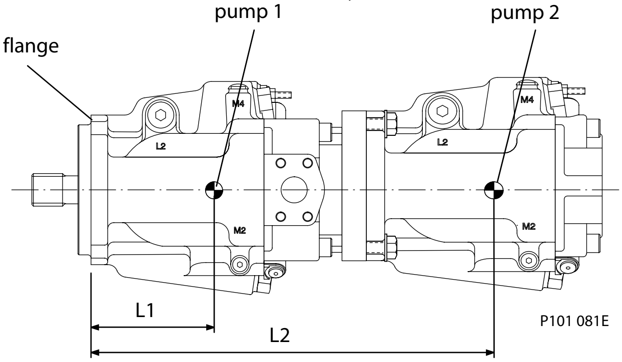
Adding auxiliary pumps and/or subjecting pumps to high shock loads may overload the pump mounting flange. The table, *Ratings*, page 21, gives allowable continuous and shock load moments. Applications with loads outside allowable limits require additional pump support.

- **Shock load moment** (M_s) is the result of an instantaneous jolt to the system.
- **Continuous load moments** (M_c) are generated by the typical vibratory movement of the application.

Estimating overhung load moments

Use the equations below to estimate the overhung load moments for multiple pump mounting. See *Installation drawings*, page 38, to find the distance from the mounting flange to the center of gravity. Refer to the table, *Features and options*, page 21, to find pump weight.

Overhung load example



Shock load formula $M_s = G_s \cdot K \cdot (W_1 \cdot L_1 + W_2 \cdot L_2 + \ldots W_n \cdot L_n)$

Continuous load formula $M_c = G_c \cdot K \cdot (W_1 \cdot L_1 + W_2 \cdot L_2 + \ldots W_n \cdot L_n)$

SI units

M_s = Shock load moment (N•m)
M_c = Continuous (vibratory) load moment (N•m)
G_s = Acceleration due to external shock (G's)
G_c = Acceleration due to continuous vibration (G's)
K = Conversion factor = 0.00981
W_n = Mass of n^{th} pump (kg)
L_n = Distance from mounting flange to n^{th} pump CG (mm)

US units

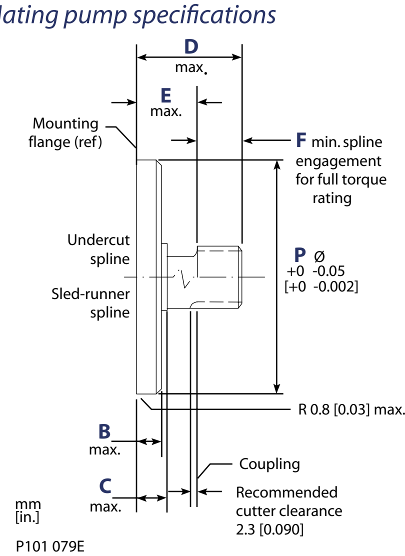
M_s = Shock load moment (lbf•in)
M_c = Continuous (vibratory) load moment (lbf•in)
G_s = Acceleration due to external shock (G's)
G_c = Acceleration due to continuous vibration (G's)
K = Conversion factor = 1
W_n = Weight of n^{th} pump (lb)
L_n = Distance from mounting flange to n^{th} pump CG (in)

AUXILIARY MOUNTING PADS

Auxiliary mounting pads are available for all radial ported Series 45 pumps. Since the auxiliary pad operates under case pressure, use an O-ring to seal the auxiliary pump mounting flange to the pad. Oil from the main pump case lubricates the drive coupling.

- All mounting pads meet SAE J744 Specifications.
- The combination of auxiliary shaft torque and main pump torque must not exceed the maximum pump input shaft rating. The table, *Input shafts*, page 32, gives input shaft torque ratings for each frame size.
- Applications subject to severe vibratory or shock loading may require additional support to prevent mounting flange damage. The table, *Ratings*, page 21, gives allowable continuous and shock load moments for each frame size.
- The drawing and table below give mating pump dimensions for each size mount. Refer to *Installation drawings*, page 38, for auxiliary mounting pad dimensions.

Mating pump specifications



Dimensions

	SAE A	SAE B	SAE C
P	82.55 [3.250]	101.60 [4.000]	127.00 [5.000]
B	6.35 [0.250]	9.65 [0.380]	12.70 [0.500]
C	12.70 [0.500]	15.20 [0.600]	23.37 [0.920]
D	58.20 [2.290]	53.10 [2.090]	55.60 [2.190]
E	15.00 [0.590]	17.50 [0.690]	30.50 [1.200]
F	13.50 [0.530]	14.20 [0.560]	18.30 [0.720]

INPUT SHAFT TORQUE RATINGS

Tables in the *Features and options* section give Maximum torque ratings for available input shafts. Ensure that your application respects these limits.

Maximum torque ratings are based on shaft strength. Do not exceed them. Maximum torque ratings assume oil-flooded couplings.

Coupling arrangements that are not oil-flooded provide a reduced torque rating. Contact your Sauer-Danfoss representative for proper torque ratings if your application involves non oil-flooded couplings.

Sauer-Danfoss recommends mating splines adhere to ANSI B92.1-Class 5. Sauer-Danfoss external splines are modified class 5 fillet root side fit. The external major diameter and circular tooth thickness dimensions are reduced to ensure a good clearance fit with the mating spline. The table, *Input shafts*, page 32, gives full spline dimensions and data.

UNDERSTANDING AND MINIMIZING SYSTEM NOISE

A table in the *Design and specifications* section gives sound levels for each displacement. Sound level data are collected at various operating speeds and pressures in a semi-anechoic chamber. Many factors contribute to the overall noise level of any application. Here is some information to help understand the nature of noise in fluid power systems, and some suggestions to help minimize it.

Noise is transmitted in fluid power systems in two ways: as fluid borne noise, and structure borne noise.

Fluid-borne noise (pressure ripple or pulsation) is created as pumping elements discharge oil into the pump outlet. It is affected by the compressibility of the oil, and the pump's ability to transition pumping elements from high to low pressure. Pulsations travel through the hydraulic lines at the speed of sound (about 1400 m/s [4600 ft/sec] in oil) until there is a change (such as an elbow) in the line. Thus, amplitude varies with overall line length and position.

Structure born noise is transmitted wherever the pump casing connects to the rest of the system. The way system components respond to excitation depends on their size, form, material, and mounting.

System lines and pump mounting can amplify pump noise. Follow these suggestions to help minimize noise in your application:

- Use flexible hoses.
- Limit system line length.
- If possible, optimize system line position to minimize noise.
- If you must use steel plumbing, clamp the lines.
- If you add additional support, use rubber mounts.
- Test for resonants in the operating range, if possible avoid them.

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

Flow

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

Torque

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

Power

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]

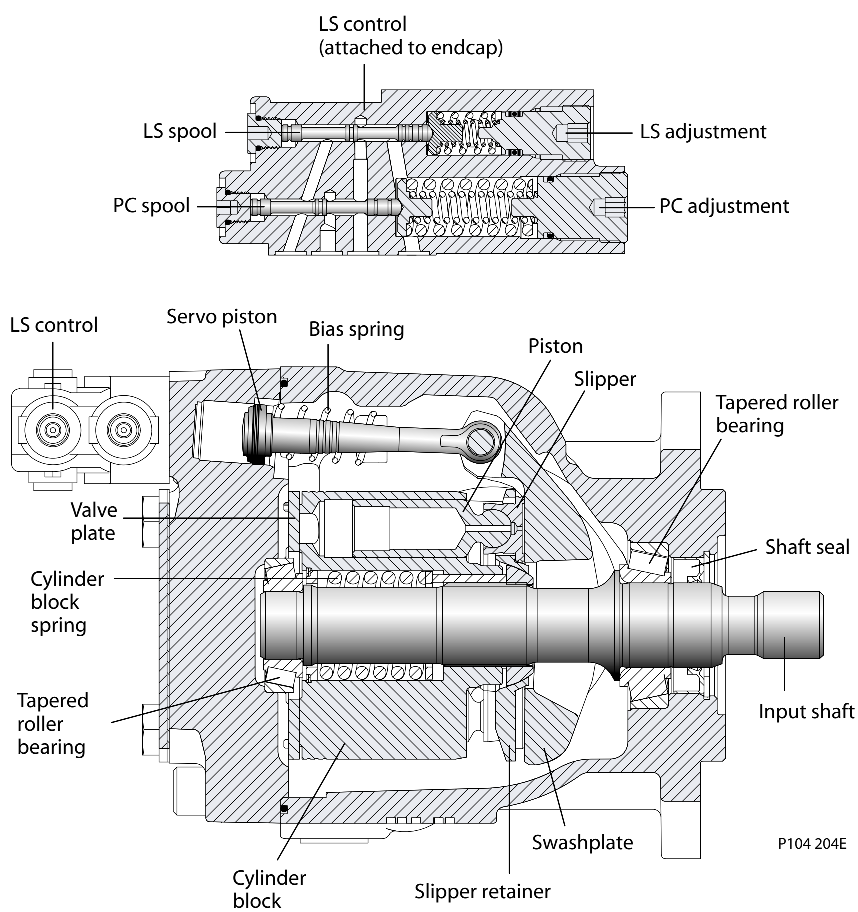
V_g	=	Displacement per revolution	cm^3/rev [in^3/rev]
p_O	=	Outlet pressure	bar [psi]
p_i	=	Inlet pressure	bar [psi]
Δp	=	$p_O - p_i$ (system pressure)	bar [psi]
n	=	Speed	min^{-1} (rpm)
η_v	=	Volumetric efficiency	
η_m	=	Mechanical efficiency	
η_t	=	Overall efficiency ($\eta_v \cdot \eta_m$)	

DESIGN

Series 45 Frame J pumps have a single servo piston design with a cradle-type swashplate set in polymer-coated journal bearings. A bias spring and internal forces increase swashplate angle. The servo piston decreases swashplate angle. Nine reciprocating pistons displace fluid from the pump inlet to the pump outlet as the cylinder block rotates on the pump input shaft. The block spring holds the piston slippers to the swashplate via the slipper retainer. The cylinder block rides on a bi-metal valve plate optimized for high volumetric efficiency and low noise. Tapered roller bearings support the input shaft and a viton lip-seal protects against shaft leaks.

An adjustable one spool (PC only, not shown) or two spool (LS and PC) control senses system pressure and load pressure (LS controls). The control ports system pressure to the servo piston to control pump output flow.

Frame J cross section



SAUER DANFOSS

Series 45 Axial Piston Open Circuit Pumps
Technical Information
Design and specifications

SPECIFICATIONS

For general operating parameters, including fluid viscosity, temperature, and inlet and case pressures, *see page 12*. For system design parameters, including installation, filtration, reservoir, and line velocities, *see page 14*.

Features and options

Feature		Unit	Model J45B	J51B	J60B	J65C	J75C
Maximum Displacement		cm³ [in³]	45 [2.75]	51 [3.11]	60 [3.66]	65 [3.97]	75 [4.58]
Flow at rated speed (theoretical)		l/min [US gal/min]	126.0 [33.3]	137.7 [36.4]	156.0 [41.2]	162.6 [42.9]	180.0 [47.5]
Input torque at maximum displacement (theoretical)		N•m/bar [lbf•in/1000 psi]	0.716 [436.9]	0.811 [495.1]	0.956 [583.6]	1.035 [631.4]	1.193 [728.1]
Mass moment of inertia of internal rotating components		kg•m² [slug•ft²]	0.00455 [0.00336]	0.00455 [0.00336]	0.00455 [0.00336]	0.00433 [0.00319]	0.00433 [0.00319]
Weight	Axial ports	kg [lb]	23.13 [51]				
	Radial ports		26.65 [58.8]				
Rotation			Clockwise, Counterclockwise				
Mounting			2 bolt SAE-B, 4 bolt SAE-C				
Auxiliary mounting (*See page 35*)			SAE-A, SAE-B, SAE-BB, SAE-C				
System ports (type)			SAE O-ring boss. 4-bolt split flange				
System ports (location)			Axial, Radial				
Control types (*See page 30*)			PC, Remote PC, LS, LS with internal bleed				
Shafts (*See page 32*)		Splined	13 tooth, 14 tooth, 15 tooth				
		Tapered	Ø 31.75 mm [1.25 in], 1:8 taper				
		Straight	Ø 31.75 mm [1.25 in]				
Displacement limiters			N/A				

For definitions of pressure and speed ratings, *see page 13*. For more information on external shaft loads, *see page 15*; mounting flange loads, *see page 16*.

Ratings

Rating		Units	Model J45B	J51B	J60B	J65C	J75C
Input speed[1]	minimum	min^{-1} (rpm)	500	500	500	500	500
	continuous		2800	2700	2600	2500	2400
	maximum		3360	3240	3120	3000	2880
Working pressure	continuous	bar [psi]	310 [4495]	310 [4495]	310 [4495]	260 [3770]	260 [3770]
	maximum		400 [5800]	400 [5800]	400 [5800]	350 [5075]	350 [5075]
External shaft loads	External moment (M_e)	N•m [lbf•in]	226 [2000]	226 [2000]	226 [2000]	226 [2000]	226 [2000]
	Thrust in (T_{in}), out (T_{out})	N [lbf]	2200 [495]	2200 [495]	2200 [495]	2200 [495]	2200 [495]
Bearing life	at 140 bar [2030 psi]	B_{10} hours	29 712	29 712	29 712	10 755	10 755
	at 210 bar [3045 psi]		6834	6834	6834	2474	2474
	at 260 bar [3770 psi]		3151	3151	3151	—	—
	at 310 bar [4495 psi]		1666	1666	1666	—	—
Mounting flange load moments	Vibratory (continuous)	N•m [lbf•in]	SAE-C: 1500 [14 000], SAE-B: 735 [6500]				
	Shock (max)		SAE-C: 5600 [50 000], SAE-B: 2600 [23 000]				

1. Continuous input speeds are valid at 1 bar absolute [0 in Hg vac] inlet pressure. Maximum input speeds require changing the inlet pressure or reducing pump displacement. See *Inlet pressure vs. speed* charts.

For more information on noise levels, *see page 18*.

Sound levels[2]

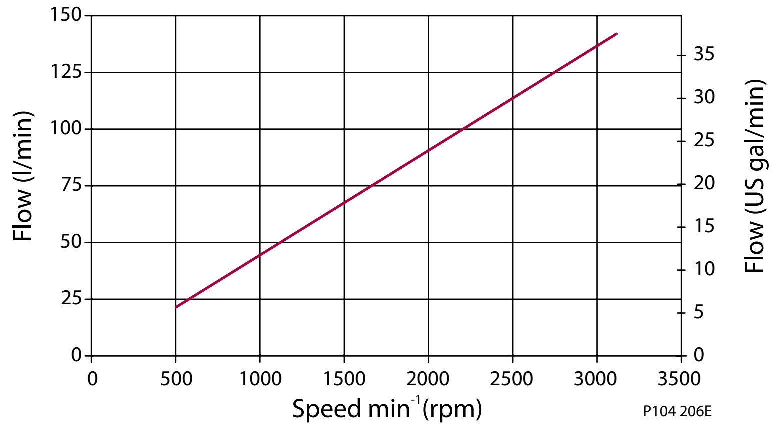
dB(A)	210 bar [3045 psi]		260 bar [3770 psi]		310 bar [4495 psi]	
Model	**1800 min^{-1} (rpm)**	**Rated speed**	**1800 min^{-1} (rpm)**	**Rated speed**	**1800 min^{-1} (rpm)**	**Rated speed**
J45B	75	79	77	80	76	80
J51B	75	79	77	78	77	78
J60B	75	79	77	79	76	79
J65C	75	78	77	77	—	—
J75C	77	78	77	77	—	—

2. Sound data was collected in a *semi-anechoic* chamber. Values have been adjusted (-3 dB) to reflect *anechoic* levels.

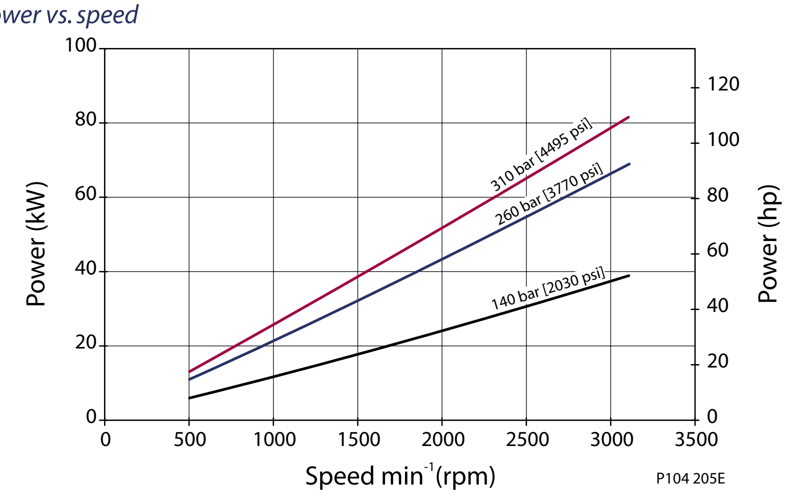
J45B

Flow and power data valid at 49°C [120°F] and viscosity of 17.8 mm²/sec [88 SUS].

Flow vs. speed

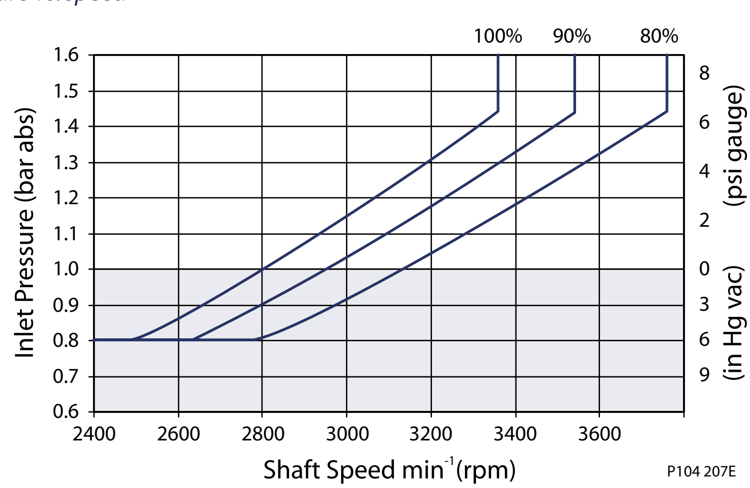


Input power vs. speed



The chart on the right shows allowable inlet pressure and speed at various displacements. Greater speeds and lower inlet pressures are possible at reduced displacement. Operating outside of acceptable limits reduces pump life.

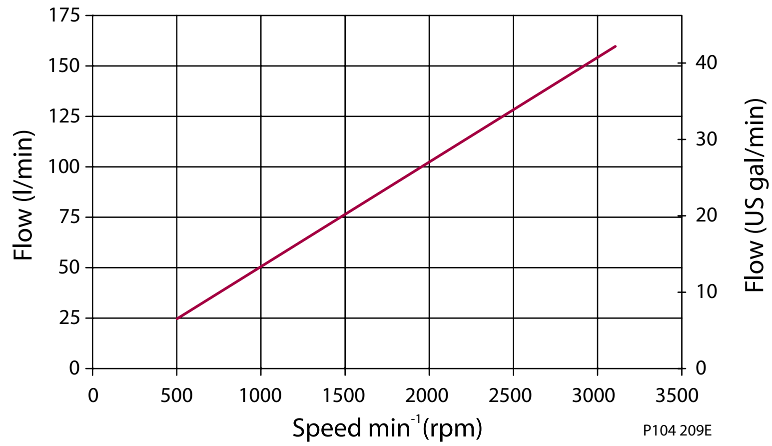
Inlet pressure vs. speed



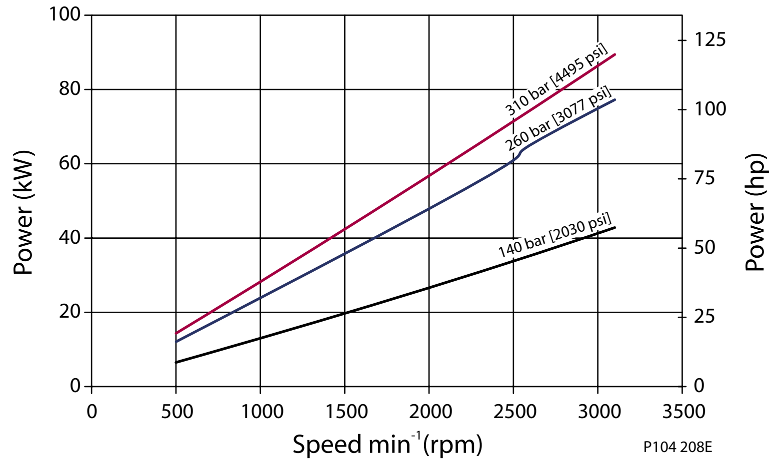
J51B

Flow and power data valid at 49°C [120°F] and viscosity of 17.8 mm²/sec [88 SUS].

Flow vs. speed

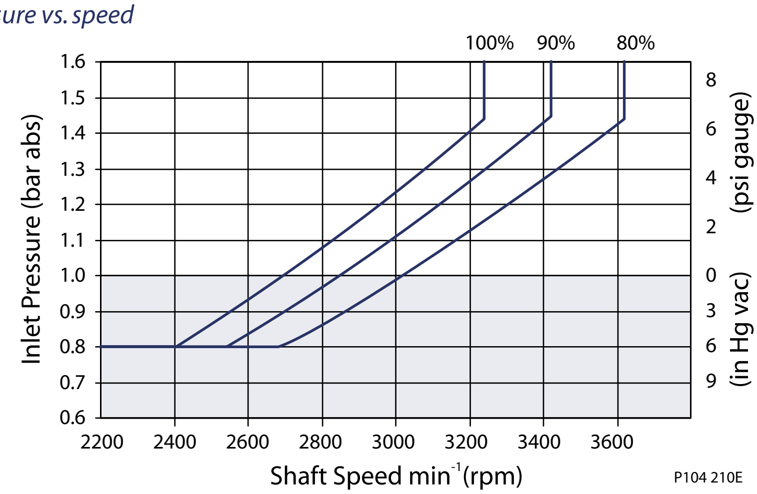


Input power vs. speed



The chart on the right shows allowable inlet pressure and speed at various displacements. Greater speeds and lower inlet pressures are possible at reduced displacement. Operating outside of acceptable limits reduces pump life.

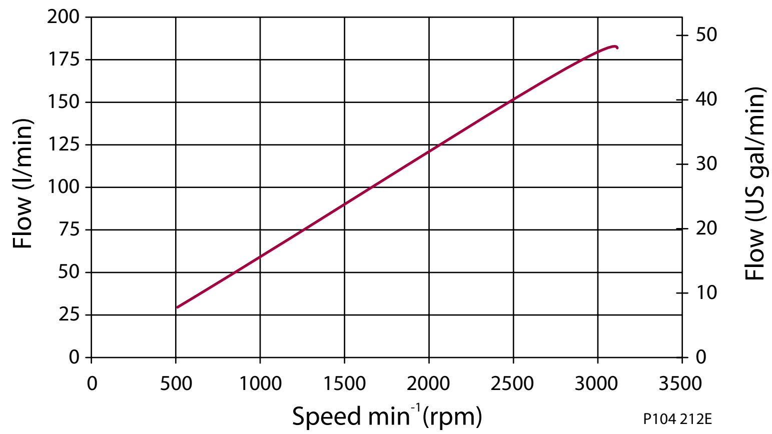
Inlet pressure vs. speed



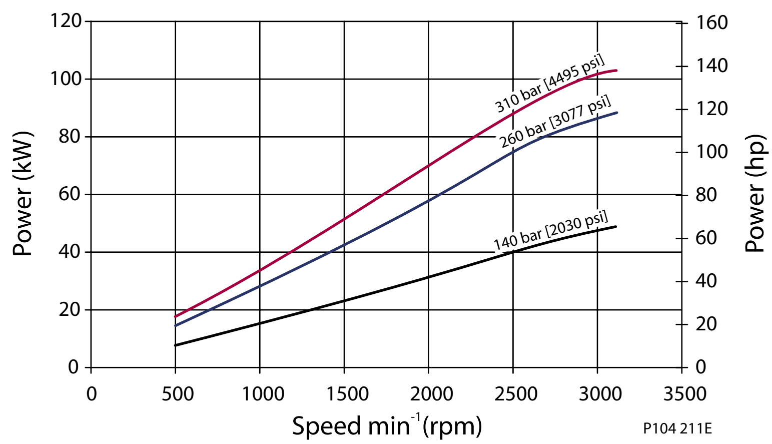
J60B

Flow and power data valid at 49°C [120°F] and viscosity of 17.8 mm²/sec [88 SUS].

Flow vs. speed

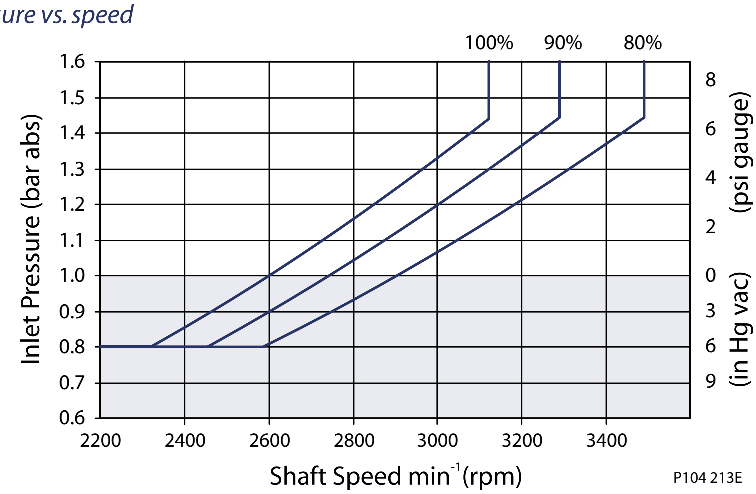


Input power vs. speed



Inlet pressure vs. speed

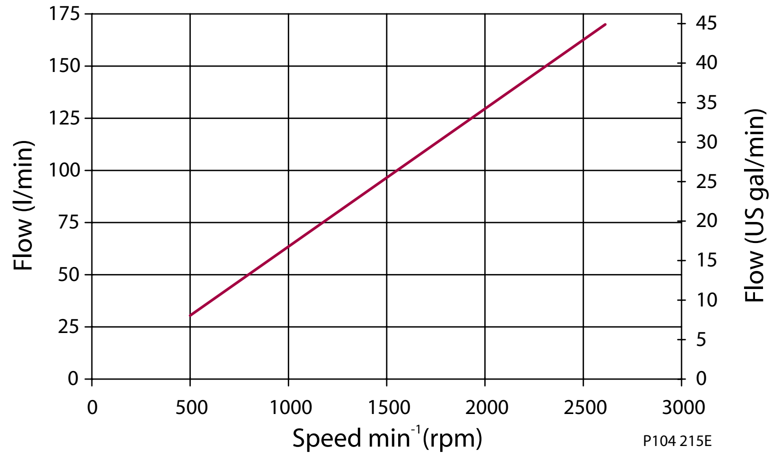
The chart on the right shows allowable inlet pressure and speed at various displacements. Greater speeds and lower inlet pressures are possible at reduced displacement. Operating outside of acceptable limits reduces pump life.



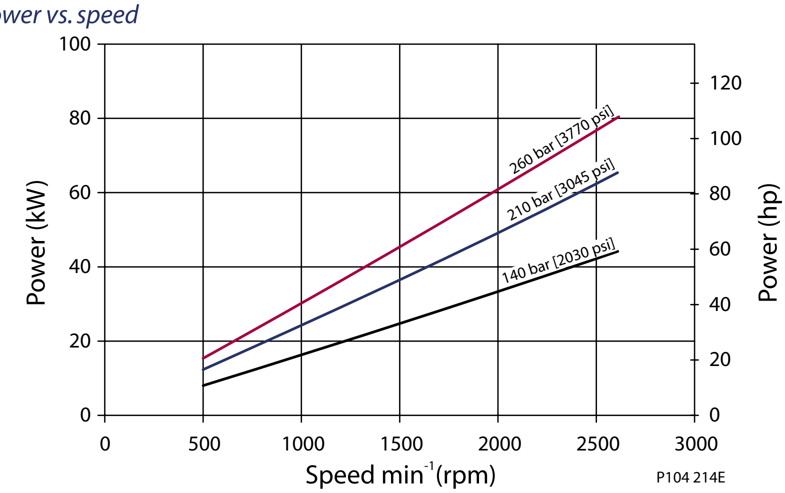
J65C

Flow and power data valid at 49°C [120°F] and viscosity of 17.8 mm²/sec [88 SUS].

Flow vs. speed

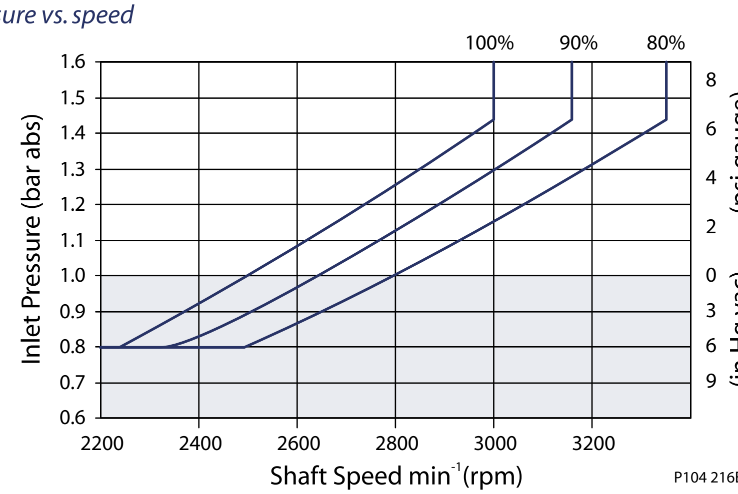


Input power vs. speed



The chart on the right shows allowable inlet pressure and speed at various displacements. Greater speeds and lower inlet pressures are possible at reduced displacement. Operating outside of acceptable limits reduces pump life.

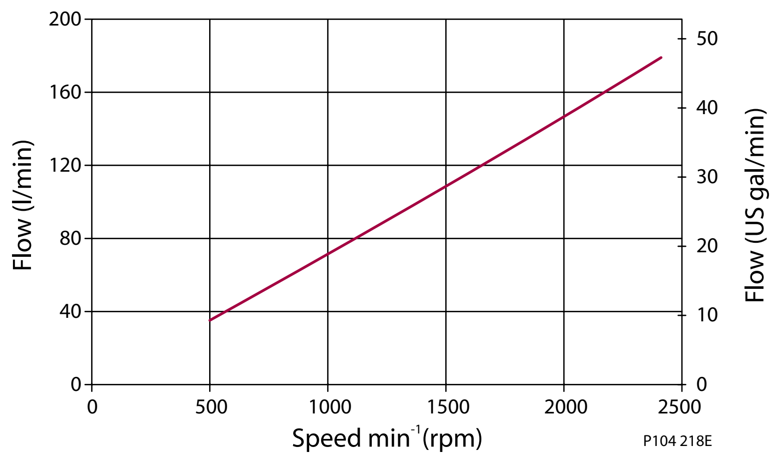
Inlet pressure vs. speed



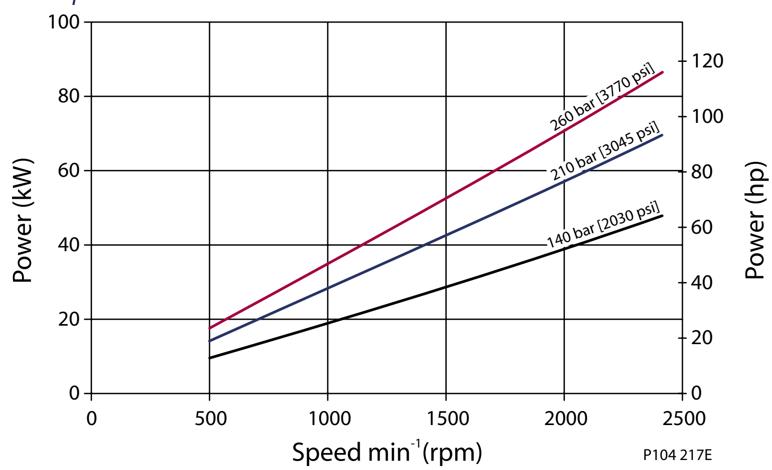
J75C

Flow and power data valid at 49°C [120°F] and viscosity of 17.8 mm²/sec [88 SUS].

Flow vs. speed

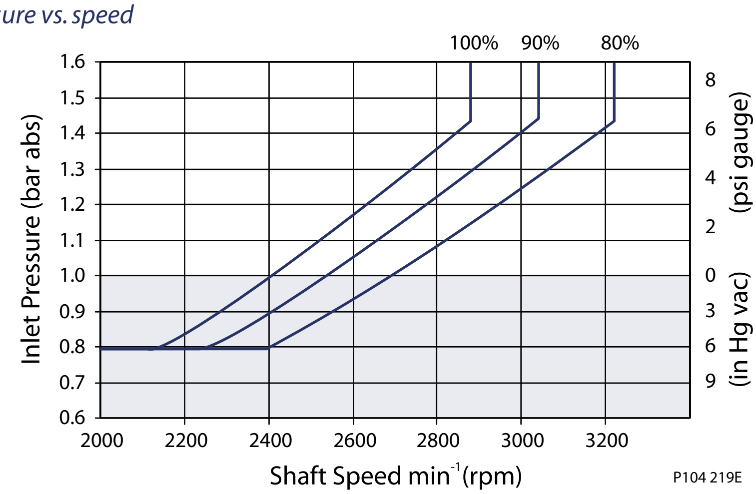


Input power vs. speed



The chart on the right shows allowable inlet pressure and speed at various displacements. Greater speeds and lower inlet pressures are possible at reduced displacement. Operating outside of acceptable limits reduces pump life.

Inlet pressure vs. speed



Back

Order code

OPTIONS

J (1 2 3), K (1 2 3)

R S P C D E F G H J1 2 3 K1 2 3 L M N

R Product

JR	J Frame, variable displacement open circuit pump

S Rotation

L	Left hand (counterclockwise)
R	Right hand (clockwise)

P Displacement and pressure rating

045B	045 cm^3/rev [2.75 in^3/rev], 310 bar [4495 psi] continuous working pressure
051B	051 cm^3/rev [3.11 in^3/rev], 310 bar [4495 psi] continuous working pressure
060B	060 cm^3/rev [3.66 in^3/rev], 310 bar [4495 psi] continuous working pressure
065C	065 cm^3/rev [3.97 in^3/rev], 260 bar [3077 psi] continuous working pressure
075C	075 cm^3/rev [4.58 in^3/rev], 260 bar [3077 psi] continuous working pressure

C Control type

PC	Pressure compensated control 100-280 bar [1450-4060 psi]
BC*	Pressure compensated control 290-310 bar [4205-4495 psi]
RP	Remote pressure compensated control 100-280 bar [1450-4060 psi]
BP*	Remote pressure compensated control 290-310 bar [4205-4495 psi]
LS	Load sensing / pressure compensating control 100-280 bar [1450-4060 psi]
BS*	Load sensing / pressure compensating control 290-310 bar [4205-4495 psi]
LB	Load sensing / pressure compensating control with internal bleed orifice 100-280 bar [1450-4060 psi]
BB*	Load sensing / pressure compensating control with internal bleed orifice 290-310 bar [4205-4495 psi]

* Use only with 45, 51, and 60 cm^3 displacements.

D PC setting (2 digit code, 10 bar increments)

Example	10 = 100 bar
10–26	100 to 260 bar [1450 to 3770 psi] (065C and 075C)
10–31	100 to 310 bar [1450 to 4495 psi] (045B, 051B and 060B)

E Load sensing setting (2 digit code, 1 bar increments)

Example	20 = 20 bar
10–30	10 to 30 bar [145 to 435 psi]
NN	Not applicable (use with PC, BC, RP, and BP controls)

F Not used

NN	Not applicable

G Pilot orifice

N	None (standard)

H Gain orifice

3	Standard orifice

OPTIONS (continued)

R S P C D E F G H J(1 2 3) K(1 2 3) L M N

J1 Input shaft

C2	13 tooth, 16/32 pitch (ANSI A92.1 1970 - Class 5)
C3	15 tooth, 16/32 pitch (ANSI A92.1 1970 - Class 5)
S1	14 tooth, 12/24 pitch (ANSI A92.1 1970 - Class 5)
K4	Ø 31.75 mm [1.25 in] straight key
TO	Ø 31.75 mm [1.25 in], 1:8 taper

J2 Auxiliary mounting flange type and coupling

N	None (Use with axial ported endcap options 2 and 3 below)
A	SAE-A, 9-tooth output spline
B	SAE-B, 13-tooth output spline
C	SAE-C, 14-tooth output spline
T	SAE-A, 11-tooth output spline
V	SAE-BB, 15-tooth output spline
R	Running cover (Radial ported endcap machined for aux. pad. Pad and coupling sold separately.)

J3 Endcap option (system port size and location)

Code	Port location	Port type	Inlet size	Outlet size
2	Radial	4-bolt split flange	50.8 mm [2.0 in]	25.4 mm [1.0 in]
3	Axial	O-ring boss	1 7/8 in.	1 5/16 in.
4	Axial	4-bolt split flange	50.8 mm [2.0 in]	25.4 mm [1.0 in]

K1 Shaft seal

A	Single lip seal, viton

K2 Mounting flange and housing port style

1	SAE-C 4-bolt, SAE O-ring boss housing ports
6	SAE-B 2-bolt, SAE O-ring boss housing ports

K3 Not used

N	Not applicable

L Displacement limiter

NNN	None

M Special hardware

NNN	None

N Special features

NNN	None

CONTROLS

Pressure compensated control (PC, BC)

Specifications

PC control setting range

Code	J45B, J51B, J60B	J65C, J75C
PC	100-280 bar [1450-4060 psi]	100-260 bar [1450-3770 bar]
BC	290-310 bar [4205-4495 psi]	N/A

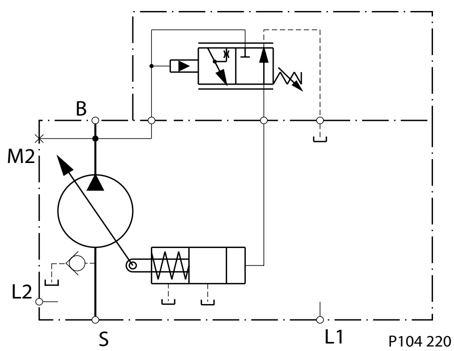
*Response/recovery times**

(ms)	J45B	J51B	J60B	J65B	J75B
Response	33	33	39	45	45
Recovery	140	150	170	140	150

* For definitions, *see page 9*.

Schematic diagram

PC schematic



Legend

B = Outlet
S = Inlet
L1, L2 = Case drain
M2 = System pressure gauge port

Remote PC Control (RP, BP)

Specifications

PC control setting range

Code	J45B, J51B, J60B	J65C, J75C
RP	100-280 bar [1450-4060 psi]	100-260 bar [1450-3770 bar]
BP	290-310 bar [4205-4495 psi]	N/A

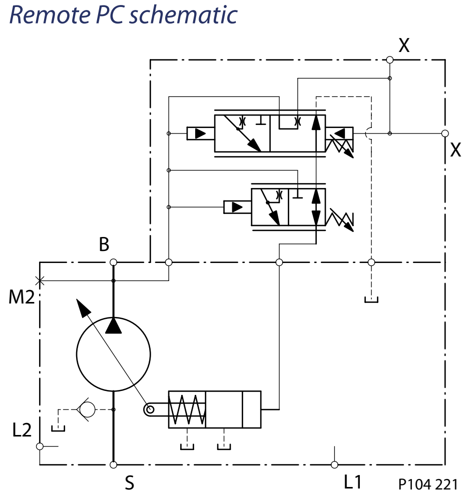
*Response/recovery times**

(ms)	J45B	J51B	J60B	J65B	J75B
Response	33	33	39	45	45
Recovery	140	150	170	140	150

* For definitions, *see page 10*.

Schematic diagram

Remote PC schematic



Legend

B = Outlet
S = Inlet
L1, L2 = Case drain
M2 = System pressure gauge port
X = Remote PC port

Attach remote PC valve at port X. Size the external valve and plumbing for a pilot flow of 3.8 l/min [1 US gal/min].

CONTROLS (continued)

Load sensing control (LS, BS)

Specifications

PC control setting range

Code	J45B, J51B, J60B	J65C, J75C
LS	100-280 bar [1450-4060 psi]	100-260 bar [1450-3770 bar]
BS	290-310 bar [4205-4495 psi]	N/A

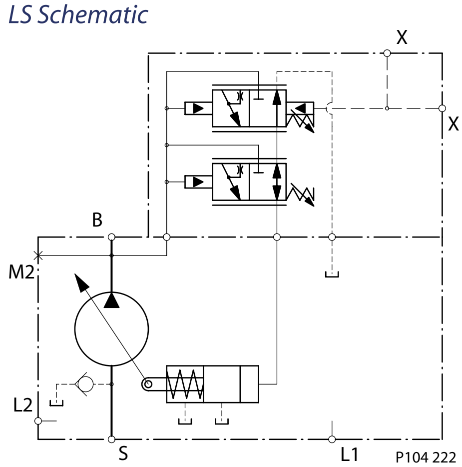
*Response/recovery times**

(MS)	J45B	J51B	J60B	J65B	J75B
Response	28	30	33	43	45
Recovery	111	125	140	101	140

* For definitions, *see page 11*.

Schematic diagram

LS Schematic



LS setting range

Model	bar	psi
All	10–30	145–435

Legend

B = Outlet
S = Inlet
L1, L2 = Case drain
M2 = System pressure gauge port
X = LS signal port

Load sensing control with internal bleed orifice (LB, BB)

Specifications

PC control setting range

Code	J45B, J51B, J60B	J65C, J75C
LB	100-280 bar [1450-4060 psi]	100-260 bar [1450-3770 bar]
BB	290-310 bar [4205-4495 psi]	N/A

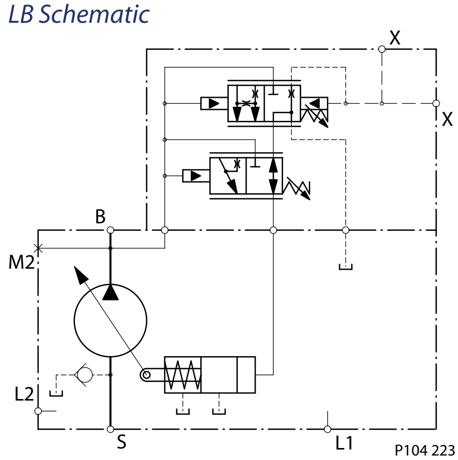
*Response/recovery times**

(MS)	J45B	J51B	J60B	J65B	J75B
Response	28	30	33	43	45
Recovery	111	125	140	101	140

* For definitions, *see page 11*.

Schematic diagram

LB Schematic



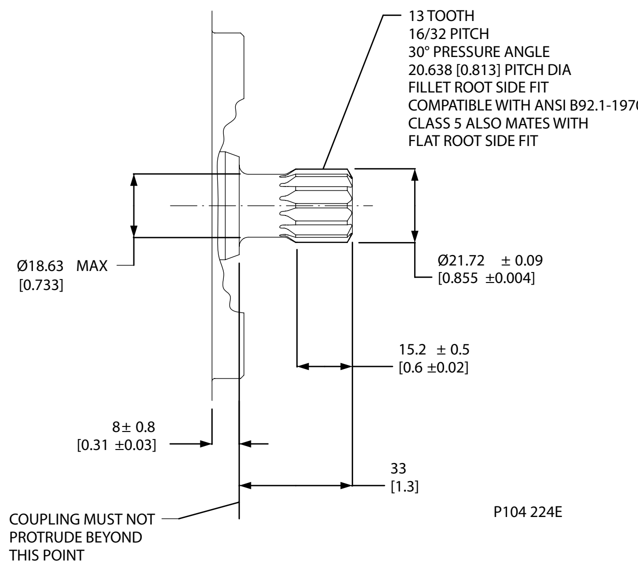
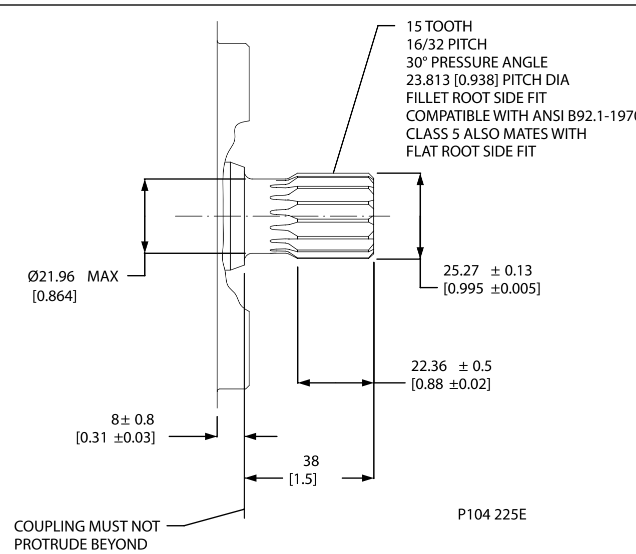
LS setting range

Model	bar	psi
All	10–30	145–435

Legend

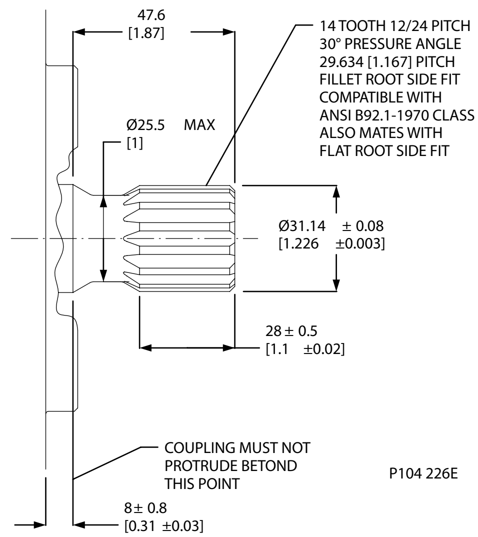
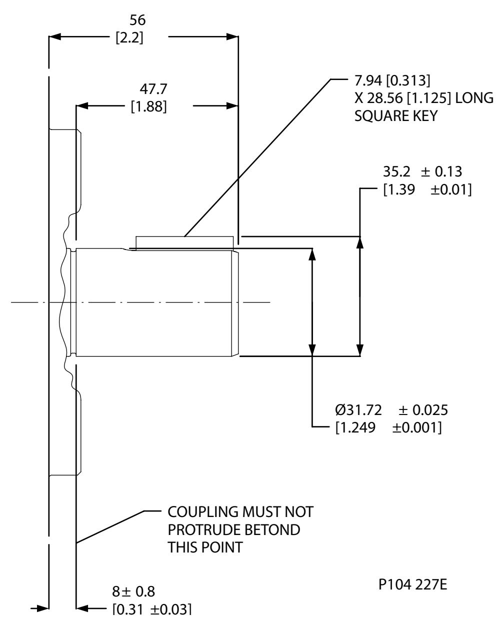
B = Outlet
S = Inlet
L1, L2 = Case drain
M2 = System pressure gauge port
X = LS signal port

INPUT SHAFTS

Code	Description	Maximum torque rating[1] N•m [lbf•in]	Drawing
C2	13 tooth spline 16/32 pitch (ANSI A92.1 1970 - Class 5) *For use with SAE-B*	288 [2546]	
C3	15 tooth spline 16/32 pitch (ANSI A92.1 1970 - Class 5) *For use with SAE-B*	404 [3575]	

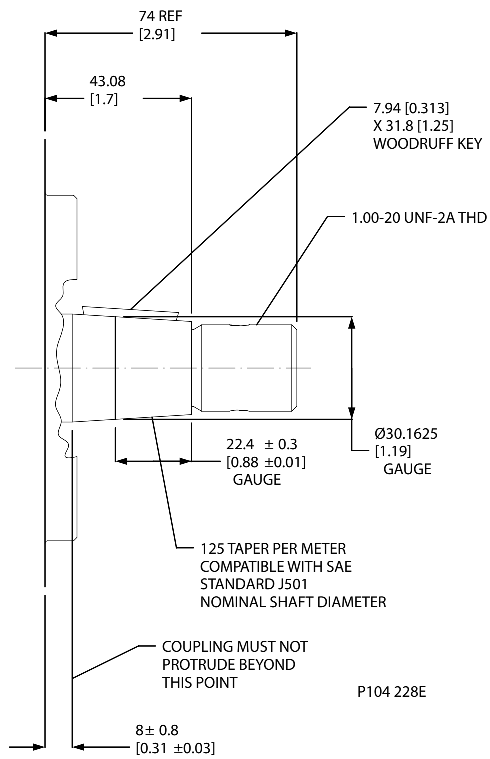
1. See *Input shaft torque ratings*, page 17 for an explaination of maximum torque.

INPUT SHAFTS (continued)

Code	Description	Maximum torque rating N•m [lbf•in]	Drawing
S1	14 tooth spline 12/24 pitch (ANSI A92.1 1970 - Class 5) *For use with SAE-C*	734 [6495]	
K4	Ø 31.75 mm [1.25 in] straight key *For use with SAE-C*	655 [5797]	

1. See *Input shaft torque ratings*, page 17 for an explaination of maximum torque.

INPUT SHAFTS (continued)

Code	Description	Maximum torque rating N•m [lbf•in]	Drawing
TO	Ø 31.75 mm [1.25 in] 1:8 taper *For use with SAE-C*	734 [6495]	

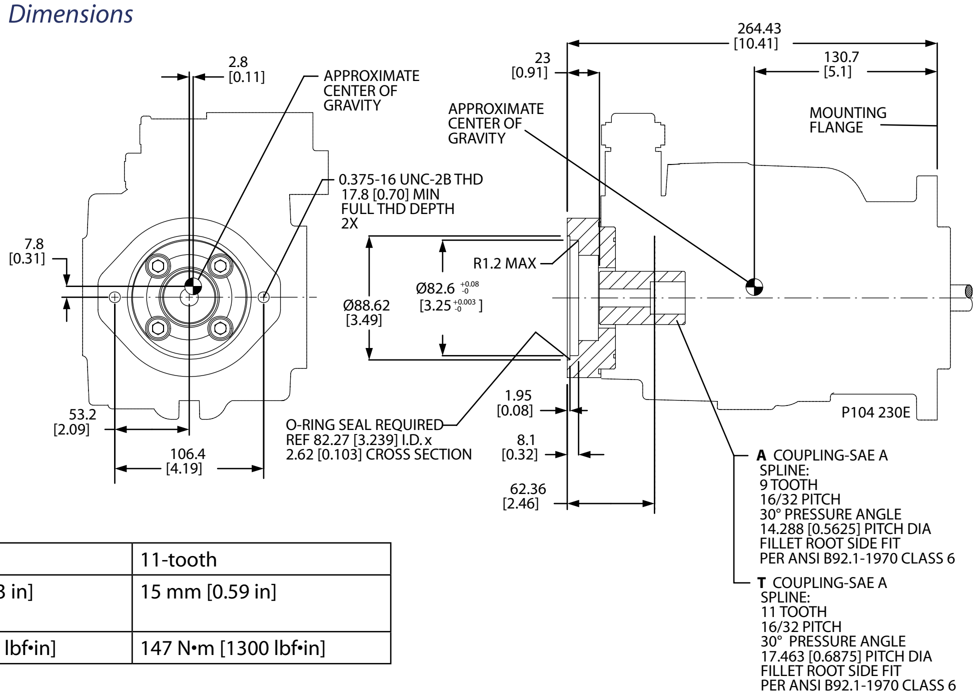
1. See *Input shaft torque ratings*, page 17 for an explaination of maximum torque.

AUXILIARY MOUNTING PADS

See page 17 for mating pump pilot and spline dimensions.

SAE-A auxiliary mounting pad (non-integral)

Dimensions



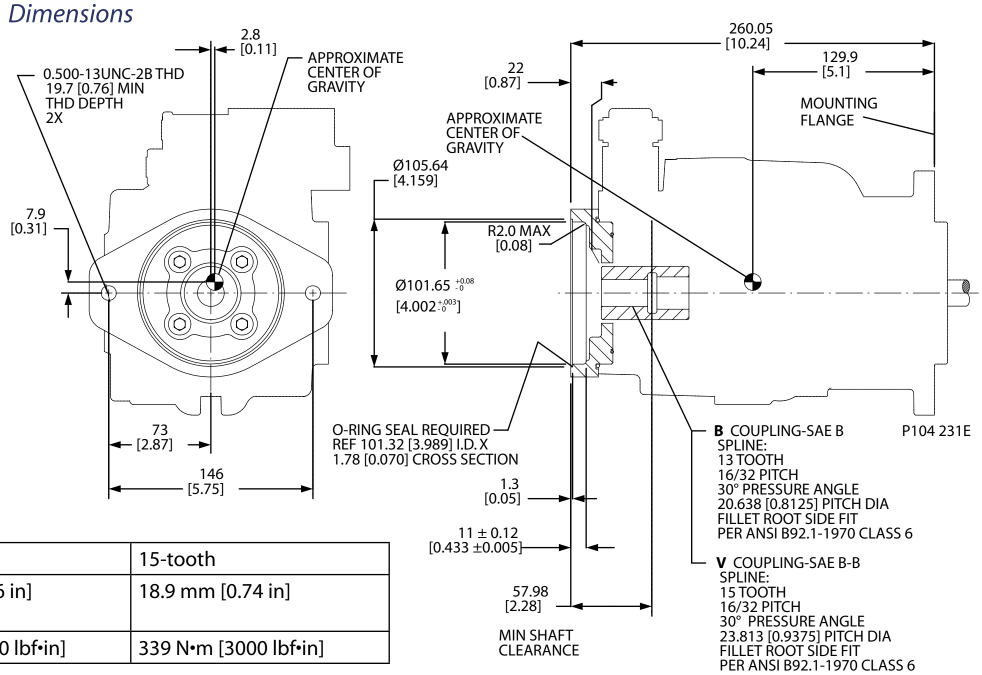
Specifications

Coupling	9-tooth	11-tooth
Spline minimum engagement	13.5 mm [0.53 in]	15 mm [0.59 in]
Maximum torque	107 N•m [950 lbf•in]	147 N•m [1300 lbf•in]

SAE-B auxiliary mounting pad

Dimensions

See page 17 for mating pump pilot and spline dimensions.



Specifications

Coupling	13-tooth	15-tooth
Spline minimum engagement	14.2 mm [0.56 in]	18.9 mm [0.74 in]
Maximum torque	249 N•m [2200 lbf•in]	339 N•m [3000 lbf•in]

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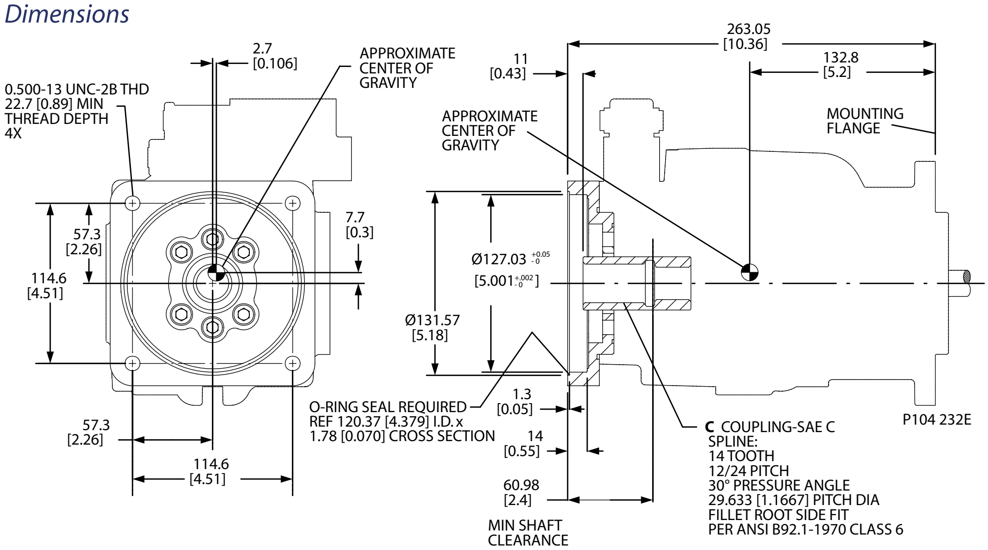
AUXILIARY MOUNTING PADS (continued)

See page 17 for mating pump pilot and spline dimensions.

SAE-C auxiliary mounting pad

Dimensions

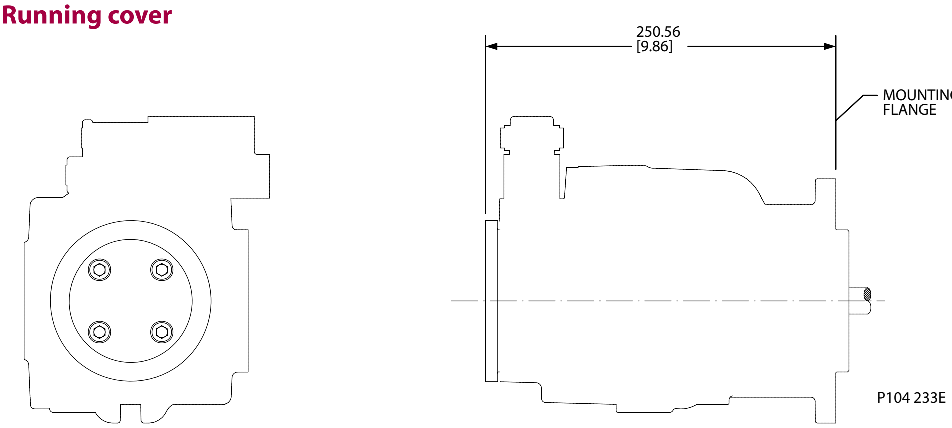


Specifications

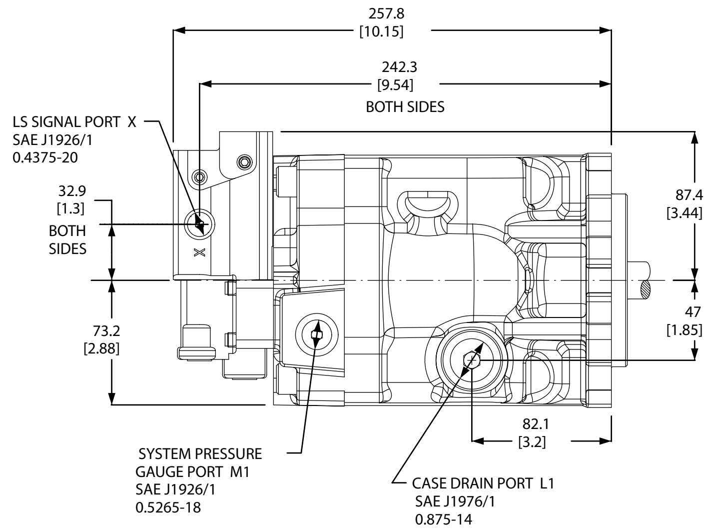
Coupling	14-tooth
Spline minimum engagement	18.3 mm [0.72 in]
Maximum torque	339 N•m [3000 lbf•in]

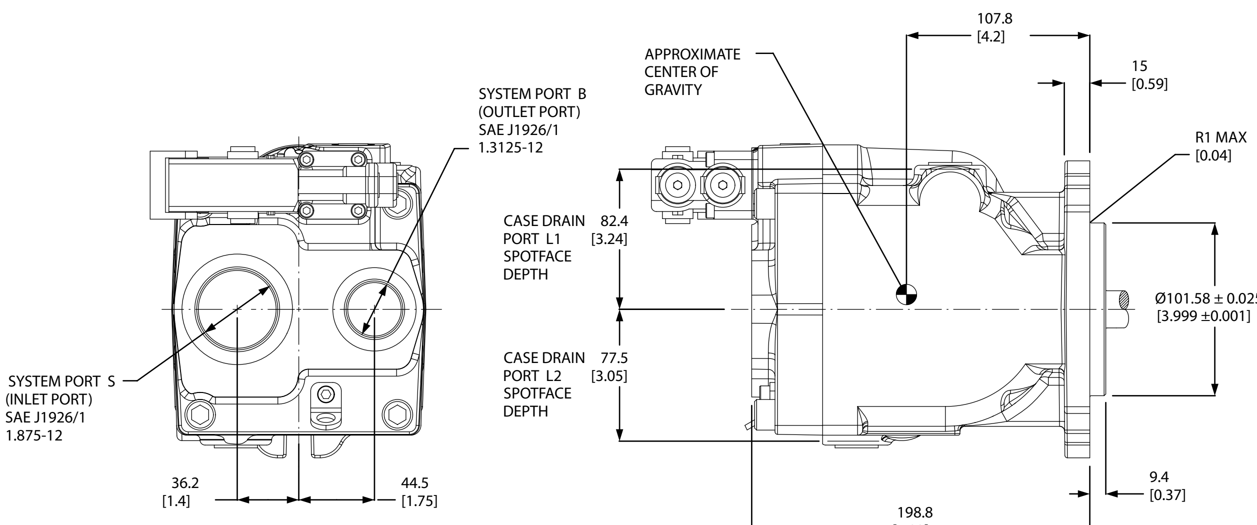
Running cover

Endcap and shaft machined to accommodate auxiliary mounting pads; pad and coupling not included. Conversion kits are available for installation in the field.

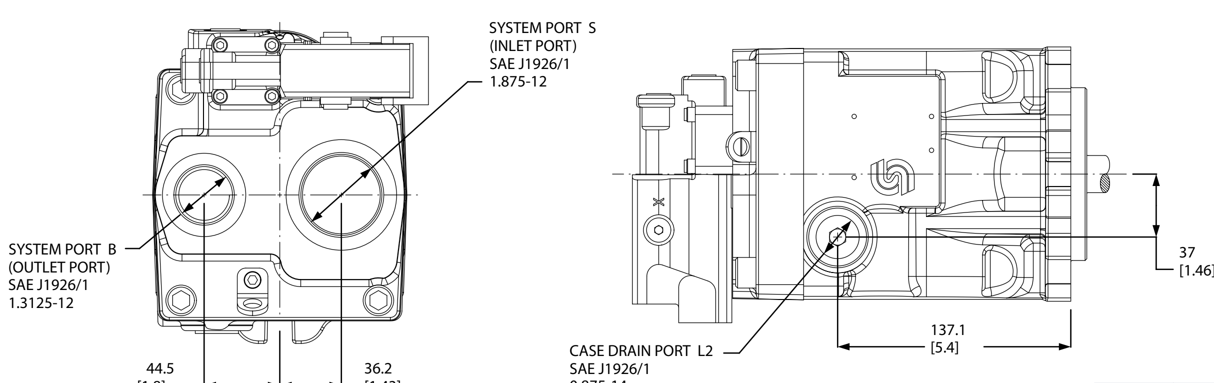


AXIAL PORTED ENDCAP





Clockwise rotation, O-ring boss ports

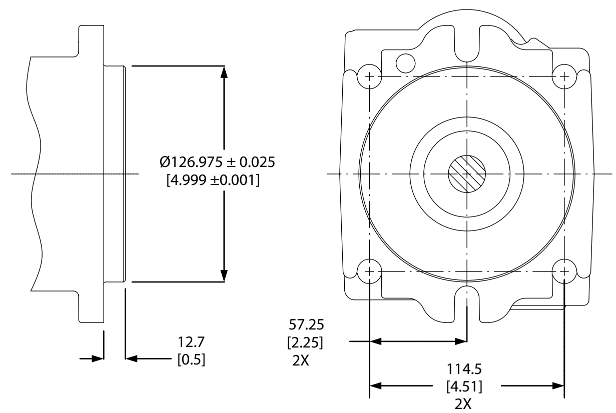


Counterclockwise rotation, O-ring boss ports

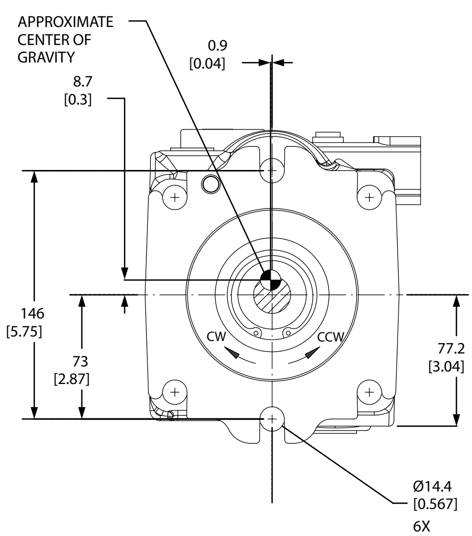
Third-angle projection
mm [in]

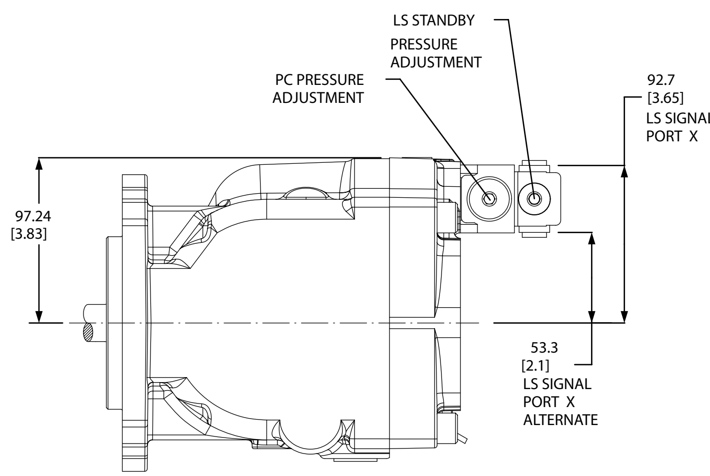
AXIAL PORTED ENDCAP (continued)

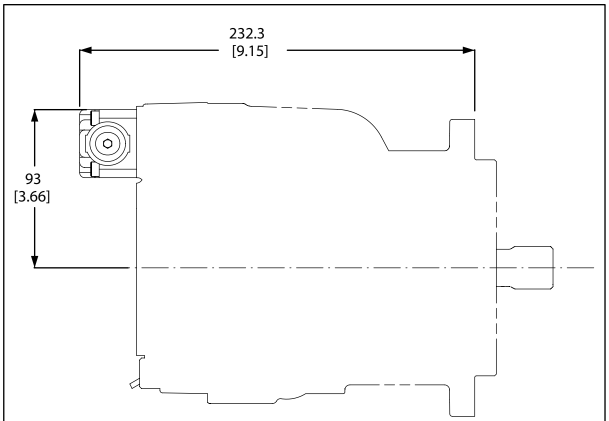
The drawings on these pages show dimensions for an SAE-B unit, except for the four-bolt housing drawing to the right. The only difference between an SAE-B unit and an SAE-C unit is the pilot shaft diameter on an SAE-B unit is smaller. All other dimensions are identical.



SAE-C four-bolt housing







PC only control

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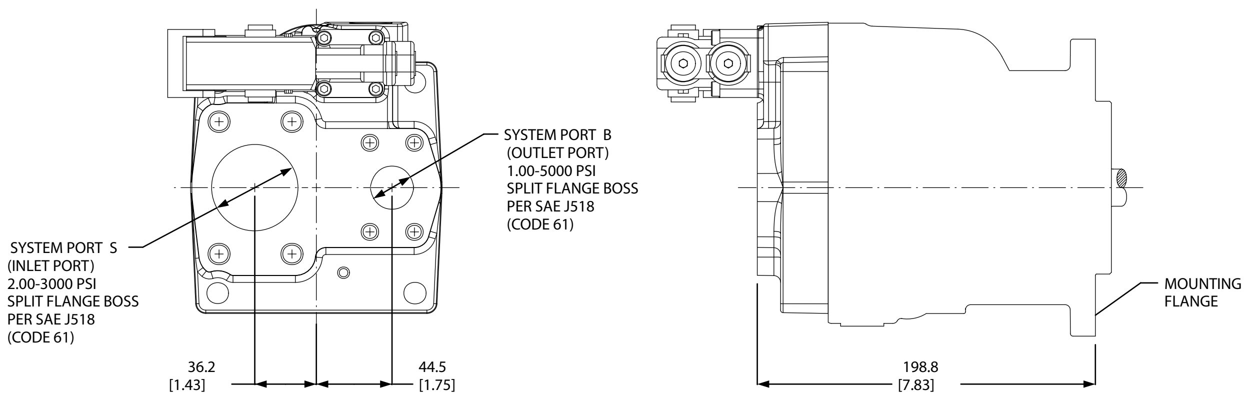
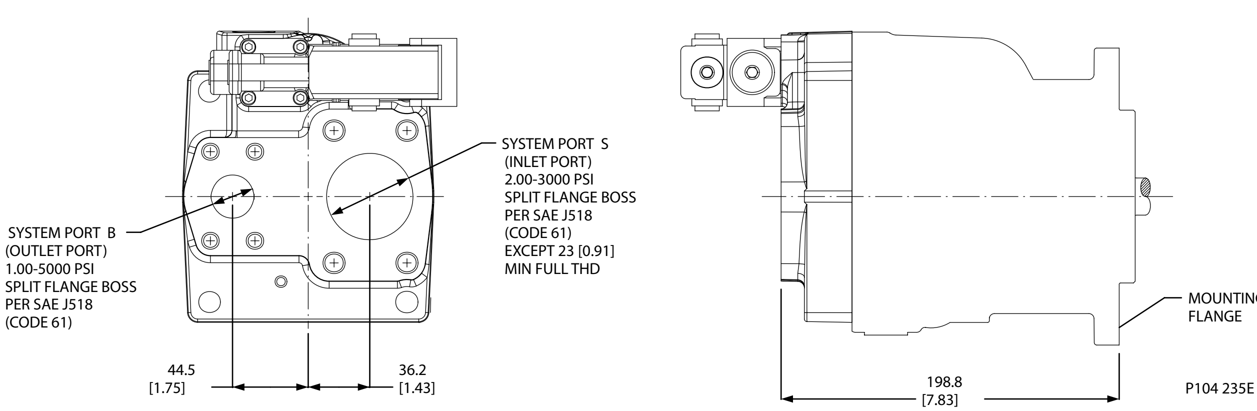
Third-angle projection
mm [in]

AXIAL PORTED ENDCAP (continued)



Clockwise rotation, split-flange ports



Counter clockwise rotation, split-flange ports

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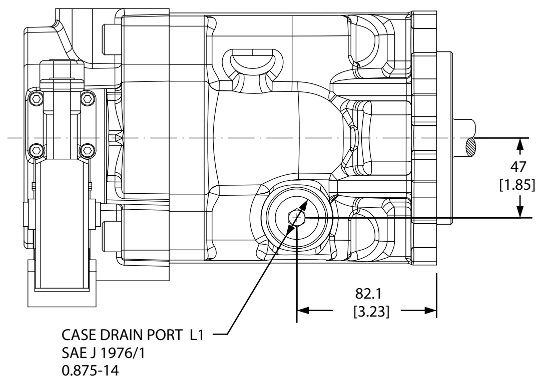
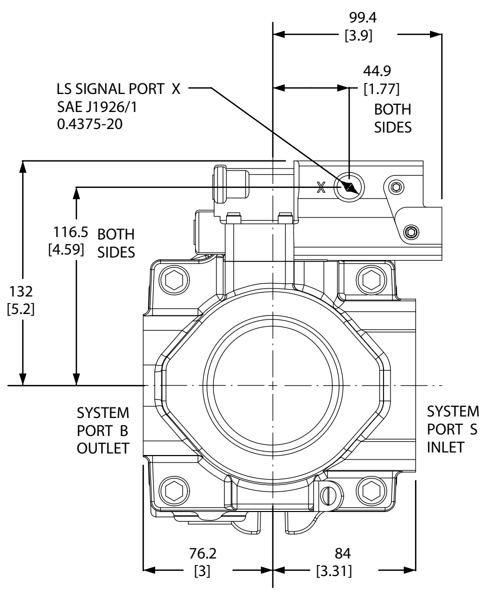
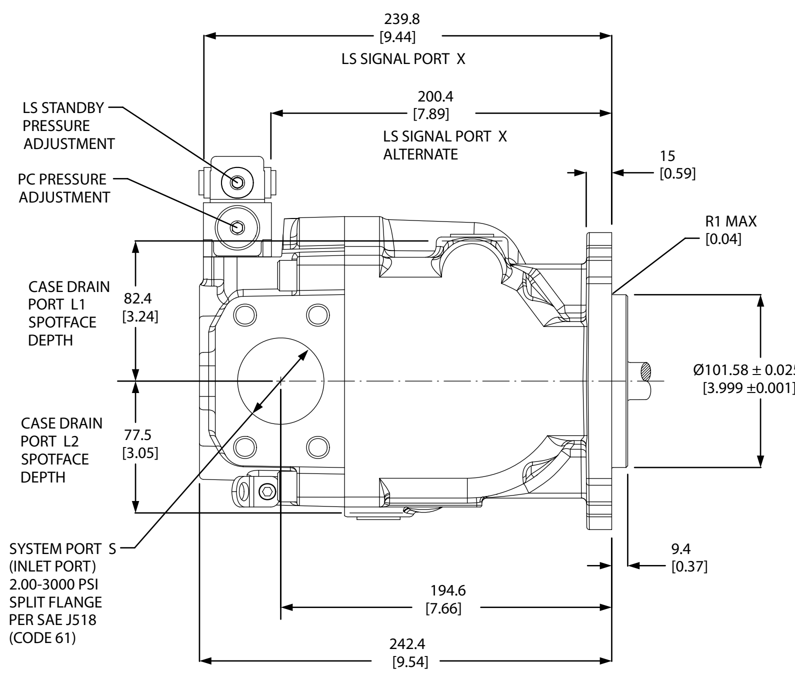
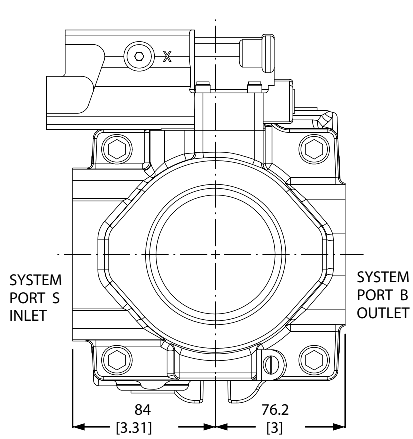
RADIAL PORTED ENDCAP



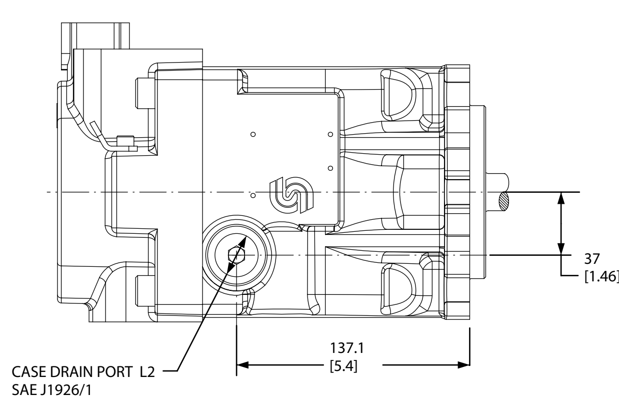


Counterclockwise rotation





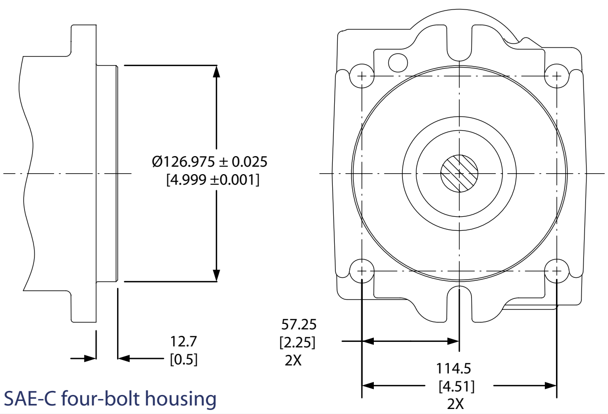
Clockwise rotation



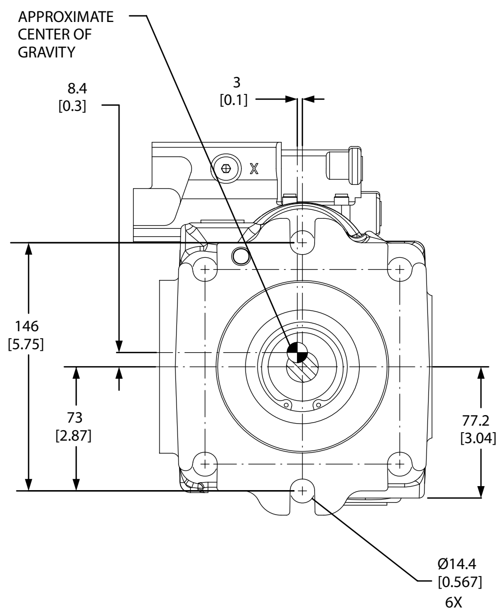
Third-angle projection
mm [in]

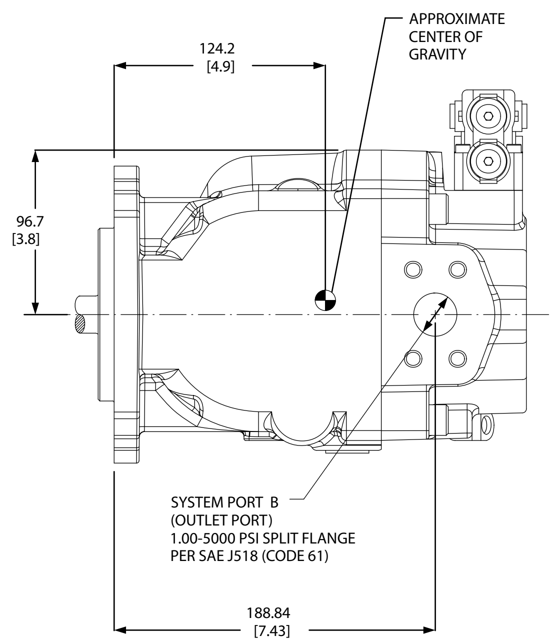
RADIAL PORTED ENDCAP (continued)

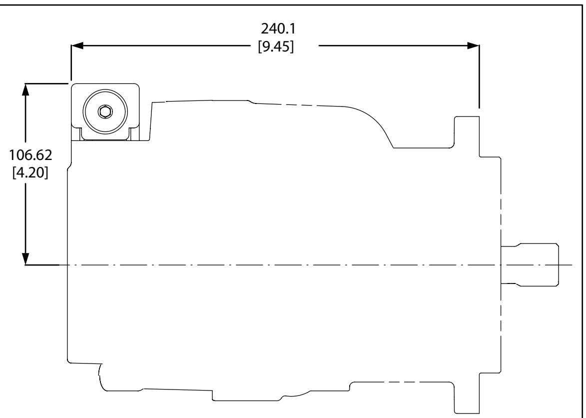
The drawings on these pages show dimensions for an SAE-B unit, except for the four-bolt housing drawing to the right. The only difference between an SAE-B unit and an SAE-C unit is the pilot shaft diameter on an SAE-B unit is smaller. All other dimensions are identical.



SAE-C four-bolt housing







PC only control

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Third-angle projection
mm [in]

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