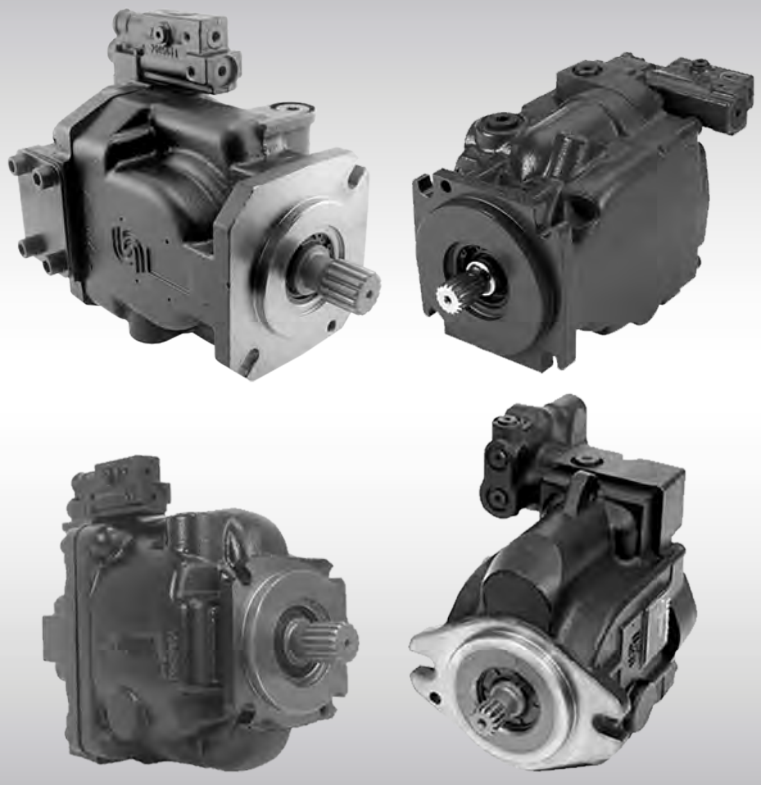
MAKING MODERN LIVING POSSIBLE

Technical Information

Series 45 Pumps



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Revision history

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Date	Changed	Rev
October 2014	Add ETL control and Angle Sensor	HB
July 2014	Danfoss layout	HA

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General information

Overview

Series 45 is a complete family of high performance variable displacement, axial piston pumps. Each frame is designed to exceed the demanding work function requirements of the mobile equipment marketplace. Each frame within the Series 45 family is uniquely designed to optimize performance, size, and cost.

Design

High Performance

- Displacements from 25 cm^3 - 147 cm^3 [1.53 - 8.97 in3/rev]
- Speeds up to 3600 rpm
- Pressures up to 310 bar [4495 psi]
- Variety of control system options including load sensing and pressure compensated

Latest Technology

- Customer-driven using quality function deployment (QFD) and design for manufacturability (DFM) techniques
- Optimized design maximizes 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 gasket joints
- Robust input shaft bearings to handle large external shaft loads
- Integrated gauge ports for monitoring operating conditions

Benefits

Reduced Installation Costs

- Through-drive capability for multi-circuit systems
- Range of mounting flanges, shafts and porting options for ease of installation
- Compact size minimizes installation space requirements
- Help meet engine emission standards
- Reduce engine size by managing power usage more effectively

General information

Reduce Operating Costs

- Optimize machine power usage to maximize fuel economy
- Simple design reduces service requirements
- Heavy duty taper roller shaft bearings provide long service life

Increased Customer Satisfaction

- Reduced noise for operator comfort
- High performance increases productivity

Reduced Heat Load on Cooling System

- High efficiency reduces hydraulic heat generation
- Allows for smaller cooling packages

Typical applications

- Cranes
- Telescopic handlers
- Forklift trucks
- Wheel loaders
- Sweepers
- Backhoe loaders
- Forestry and agricultural machinery
- Fan drives
- Paving Machines
- Mining Equipment
- Mowers
- Dozers
- Drilling Machines
- Mini-Excavators
- Other Applications

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 in3/rev]. With maximum speeds up to 3600 rpm and continuous operating pressures up to 310 bar [4495 psi], product selection is easily tailored to the flow and pressure requirements of individual applications.

General information

K/L Frame *J Frame* *F 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.	Cont.		Max.				
Frame	Model	cm3	in3	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 J	J45B	45	2.75	2800	3360	500	310	4495	400	5800	33.3	126.0	SAE B 2-bolt SAE C 2 and 4-bolt
	J51B	51	3.11	2700	3240	500	310	4495	400	5800	36.4	137.7	SAE B 2-bolt SAE C 2 and 4-bolt
	J60B	60	3.66	2600	3120	500	310	4495	400	5800	41.2	156.0	SAE B 2-bolt SAE C 2 and 4-bolt
	J65C	65	3.97	2500	3000	500	260	3770	350	5075	42.9	162.6	SAE B 2-bolt SAE C 2 and 4-bolt
	J75C	75	4.58	2400	2880	500	260	3770	350	5075	47.5	180.0	SAE B 2-bolt SAE C 2 and 4-bolt
Frame F	F74B	74	4.52	2400	2800	500	310	4495	400	5800	46.9	177.6	SAE B 2-bolt SAE C 4-bolt
	F90C	90	5.49	2200	2600	500	260	3770	350	5075	52.3	198	SAE B 2-bolt SAE C 4-bol
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

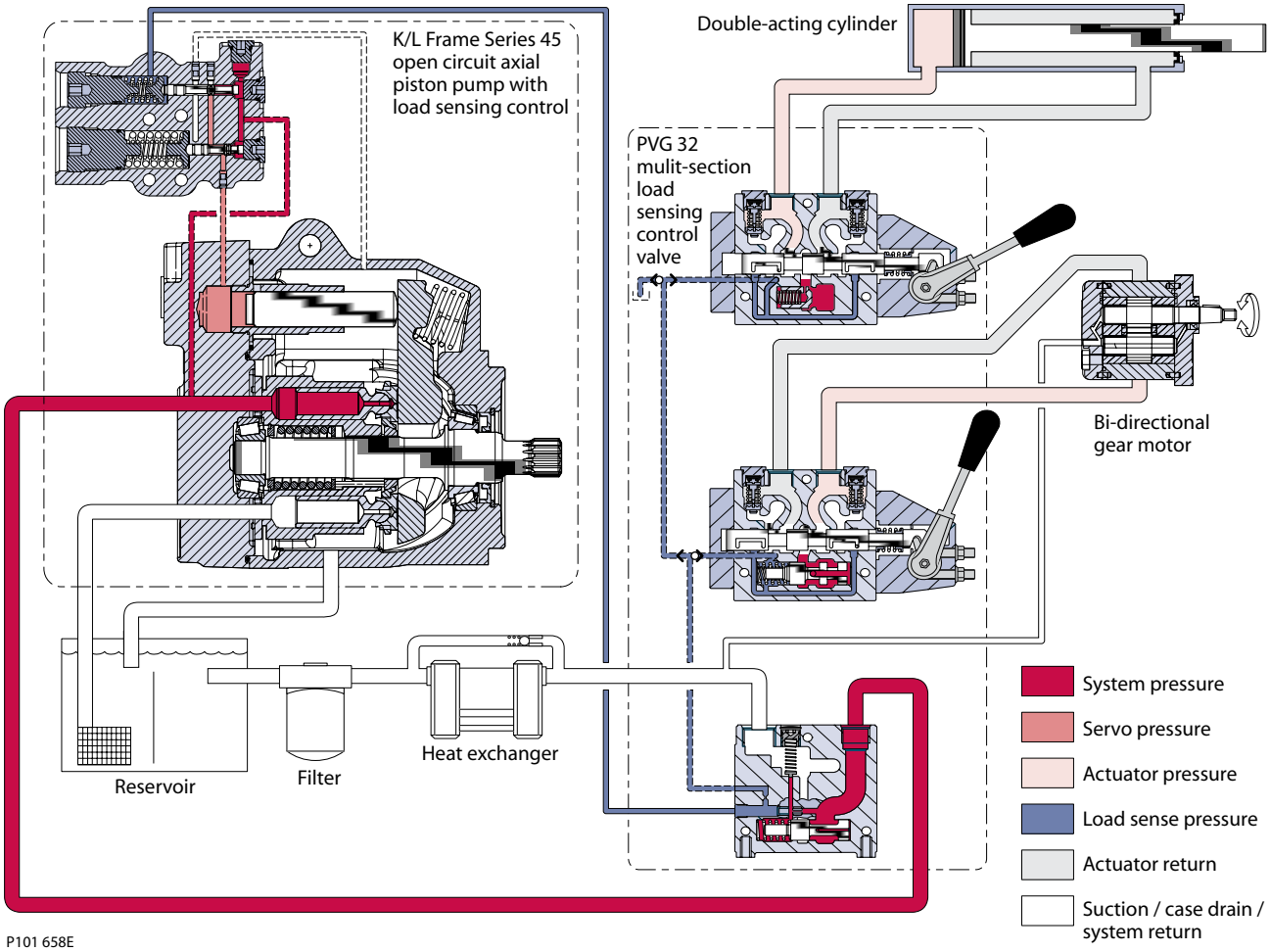
The pump receives fluid directly from the reservoir through the inlet line. A screen in the inlet line protects the pump from large contaminants. The pump outlet feeds directional control valves such as PVG-32's, hydraulic integrated circuits (HIC), and other types of control valves. The PVG valve directs pump flow to cylinders, motors and other work functions. 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.

General information

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 secondary system relief valve in the PVG valve acts as a back-up to control system pressure.

Pictorial circuit diagram



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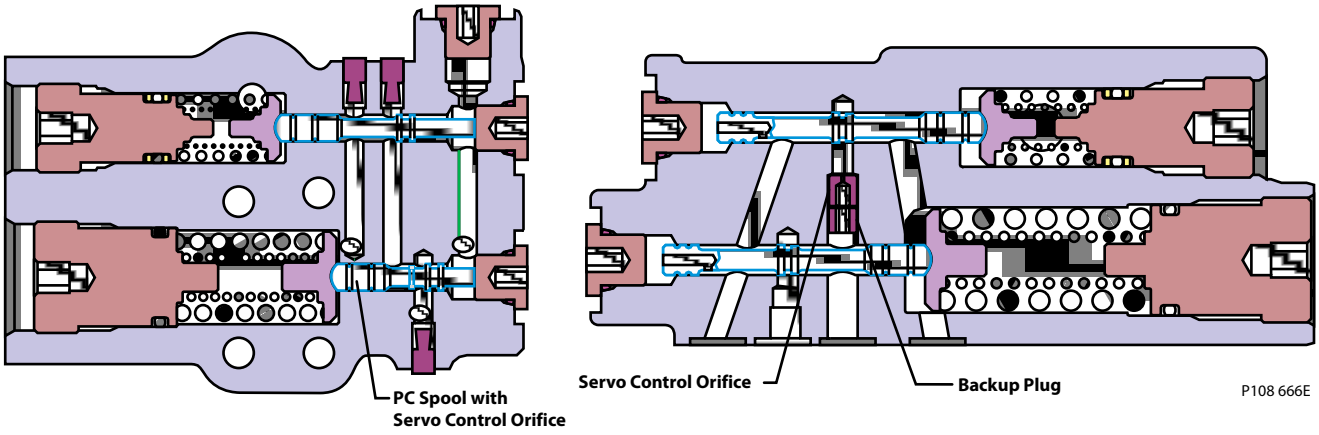
Servo Control Orifice

Servo Control Orifice Principle

Series 45 controls offer an optional servo control orifice (not available with Pressure Compensation only Controls) available to aid in tuning system performance. The optional servo control orifice restricts flow to and from the servo system in the pump, effectively pacing the motion of the servo system.

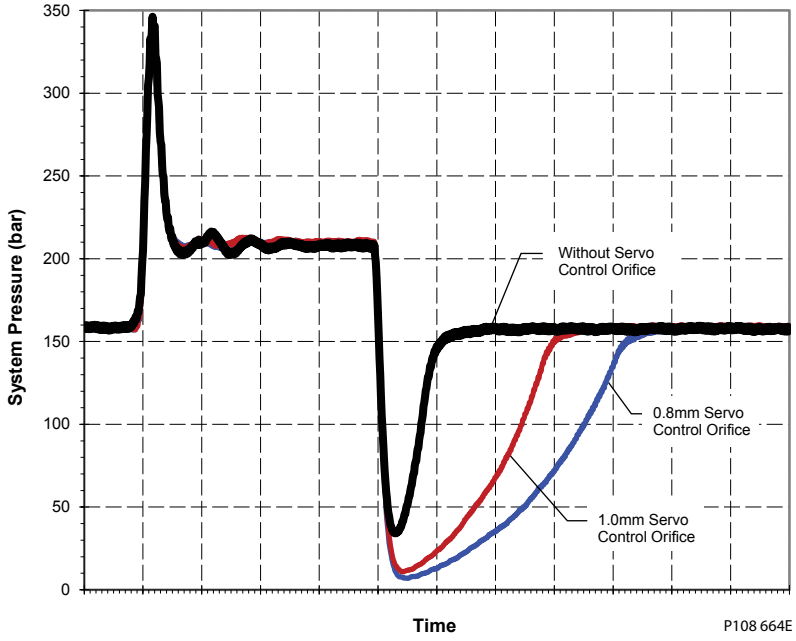
General information



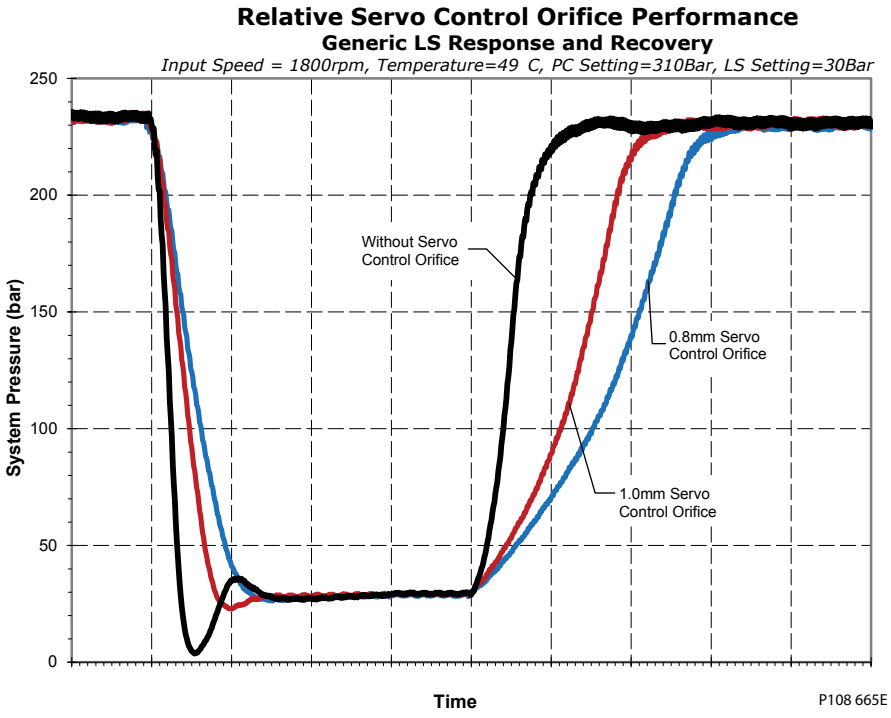
Servo Control Orifice Performance

The use of the Servo Control Orifice will provide additional pacing to the pump, while the response of the pump to pressure spikes remains unaffected. The Pressure Compensation Function response and recovery, as well as the Load Sense Function response and recovery are shown below, and outline the relative impact in response and recovery of the Servo Control Orifices. Note that these graphs are meant as a generic comparison only, and that unique effects on response and recovery behavior for each specific frame are shown later in this section.

Relative Servo Control Orifice Performance
Generic PC Response and Recovery
Input Speed=1800rpm, Temperature=49°C, PC Setting=210Bar, LS Setting=20Bar



General information



We recommend that systems experiencing instability use a Servo Control Orifice. Start with the largest size orifice available, and work down to the smaller size until the system is satisfactorily tuned. All Fan-Drive systems should start with a 0.8mm Servo Control Orifice if possible. Systems including motors are more likely to require the Servo Control Orifice option.

Pacing Factor

Use of a Servo Control Orifice adds a pacing factor to each Series 45 Frame, impacting the behavior of the pumps reactivity. This pacing factor can be multiplied by the specific Frame/Displacement/Control selection's response and recovery times, to determine the final paced response and recovery times. Unique response and recovery times can be found in each frame-specific chapter, in the desired control section. The paced response and recovery relationship is shown below.

Response (Damped)= Response (Specific Disp.Control) *Pacing Factor

Recovery (Damped)= Recovery (Specific Disp.Control) *Pacing Factor

Pacing Factors are unique to each orifice size, and can impact each frame differently. Below are the Pacing Factors for each Servo Control Orifice Size by frame.

Frame	Pacing Factors - Servo Control Orifice							
	1.0 mm Servo Control Orifice				0.8 mm Servo Control Orifice			
	PC Response	PC Recovery	LS Response	LS Recovery	PC Response	PC Recovery	LS Response	LS Recovery
E-Frame*	1 (No Effect)	2.3	2.0	2.0	1 (No Effect)	3.2	2.6	2.6
F-Frame*		2.3	2.0	2.0		3.2	2.6	2.6
J-Frame*		2.3	2.0	2.0		3.2	2.6	2.6
K-Frame**		2.3	2.3	2.3		3.7	3.1	3.1
L-Frame**		2.3	2.3	2.3		3.7	3.1	3.1

* PC Response from 160 bar to 210 bar, PC Recovery from 210 bar to 160 bar at 1800 rpm: LS Response from 230 bar to 30 bar, LS Recovery from 30 bar to 230 bar at 1800 rpm.
** PC Response from 160 bar to 210 bar, PC Recovery from 210 bar to 160 bar at 1800 rpm: LS Response from 160 bar to 20 bar, LS Recovery from 20 bar to 160 bar at 1800 rpm.

General information

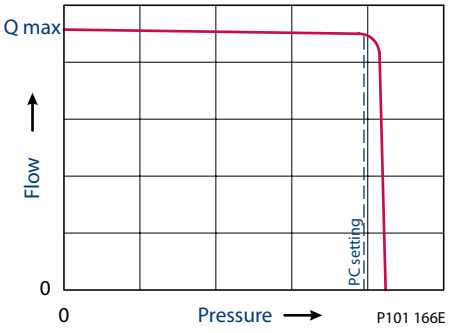
Hydraulic Controls

Pressure compensated controls

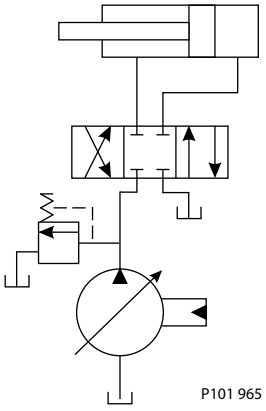
Operation

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.

Each section 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.

It is recommended that a relief valve be installed in the pump outlet for additional system protection

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

General information

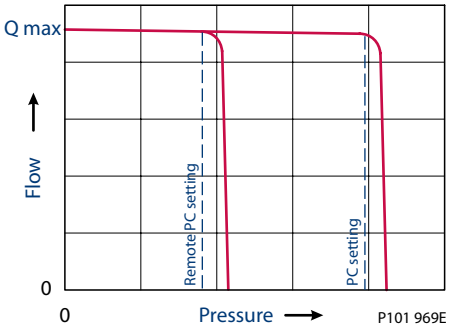
Typical applications for pressure compensated systems

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

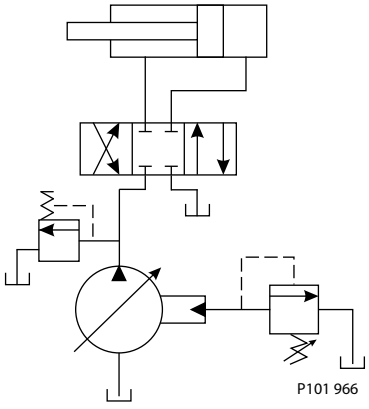
Remote pressure compensated controls

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 pressure at the load sense setting. 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 between the low pressure standby setting and the PC setting.

It is recommended that a relief valve be installed in the pump outlet for additional system protection.

Each section 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.

Size the external valve and plumbing for a pilot flow of 3.8 l/min [1 US gal/min].

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

General information

Typical applications for remote pressure compensated systems

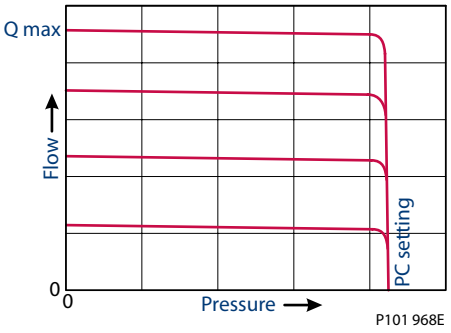
- Modulating fan drives
- Anti-stall control with engine speed feedback
- Front wheel assist
- Road rollers
- Combine harvesters
- Wood chippers

Load sensing controls

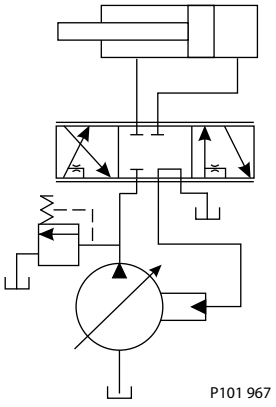
Operation

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, for use with control valves that do not internally bleed the LS signal to tank.

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.

It is recommended that a relief valve be installed in the pump outlet for additional system protection.

Each section 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.

General information

Load sensing system characteristics

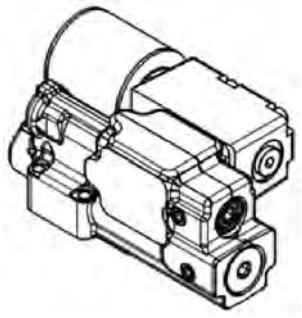
- Variable pressure and flow
- Low pressure standby mode when flow is not needed
- System flow adjusted to meet system requirements
- Lower torque requirements during engine start-up
- Single pump can supply flow and regulate pressure for multiple circuits
- Quick response to system flow and pressure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

Electric Controls

Electric Proportional Controls (EPC)

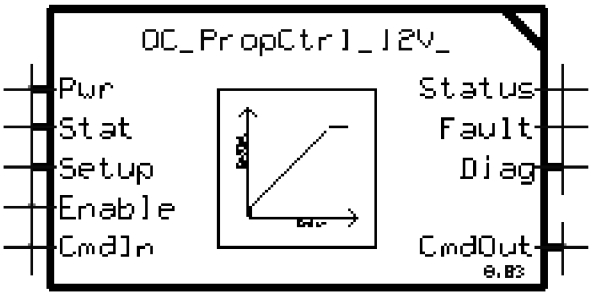
PLUS+1 Compliance

All Series 45 Electric controls have met and passed the Danfoss PLUS+1 compliance standard testing, and as such, this Series 45 control is PLUS+1 compliant. PLUS+1 compliance blocks are available on the Danfoss website, within the PLUS+1 Guide section.



Electric Proportional Control Principle

The Electric Proportional Control consists of a proportional solenoid integrated into a Remote Pressure Compensated control. This control allows the pump to be operated at any pressure limit between the Load Sense and Pressure Compensation settings by varying the current sent to the solenoid.



Reference individual frame sections for the margin (LS) setting vs low pressure standby relationship.

General information

Electric proportional controls have a unique relationship between margin (LS) setting and low pressure standby. This relationship is available in the electric proportional controls section for each frame.

For fan-drive systems, and systems with motors, use a minimum 15bar LS setting to enhance system stability. As the LS setting is reduced, the risk for system instability may be increased. A 20bar LS setting is recommended as a starting point for all new applications.

Electric Proportional Control Response/Recovery

S45 Electric Proportional Controls require the use of a servo control orifice, and are available with two possible servo control orifice options. The servo control orifice is used to enhance system stability, as well as dampen the pump reactiveness. A smaller orifice diameter will add dampening to the pump reactiveness, while a larger orifice will allow quicker pump reaction. Fan-Drive applications, as well as systems with the pump supplying motors, are recommended to use the 0.8mm diameter orifice to enhance system stability.

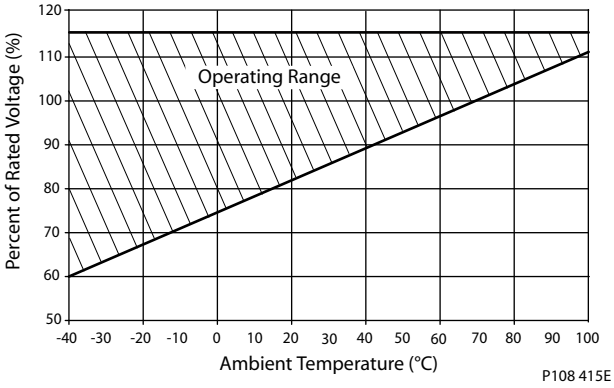
Module "G" Options for Electric Proportional Controls		
Frame	**"E" - 0.8mm Orifice**	**"F" - 1.0mm Orifice**
All Frames	•	•

Specific Electric Proportional Control Response/Recovery times are shown for the available servo control orifice options in the control section within each specific frame section. These times represent the response from 100bar to 200bar, and recovery from 200bar to 100bar. As the upper pressure approaches the PC setting, the PC function will begin to assist in clipping pressure overshoots during the pump's response, and will decrease the response times of the pump to equal those of the PC response.

Electric Proportional Control Pressure vs. Flow Characteristic

The Electric Proportional Controls continuous duty operating temperature range is shown below; this guideline should be followed as well as the maximum current limitations. Note that rated voltage refers to either a 12V or 24V coil. Under high temperature conditions, current required to operate the solenoid increases.

Continuous Duty Operating Temperature



Electric Proportional Control Characteristic – Normally Closed

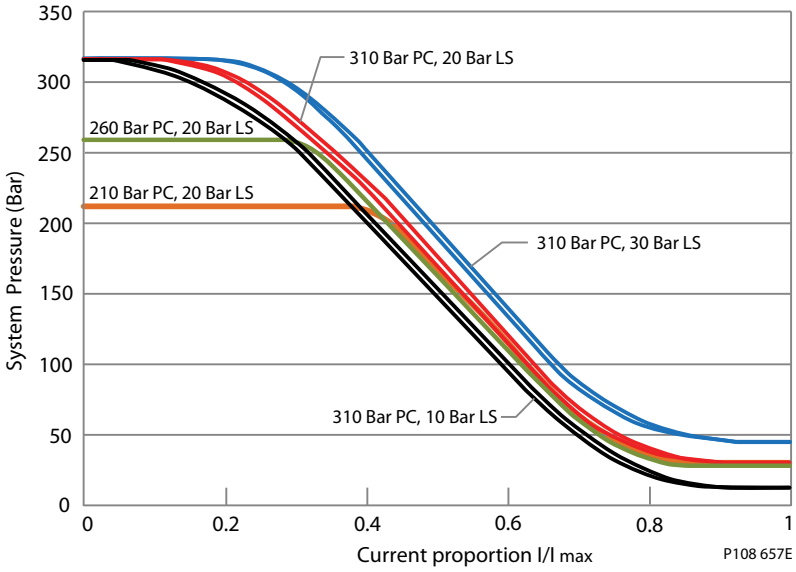
When an electric current is sent to the Normally Closed configuration control, the pump pressure decreases proportional to an increase in current. When the load in the system changes, the pump will adjust its displacement to maintain the pressure demanded by the controlling current. This control is especially useful for fan-drives, due to the direct relationship between fan-speed and pump pressure.

Due to the nature of Electric Proportional Controls, the relationship between current and pump pressure is unique for each individual PC/LS pressure setting combination. The relationship between different PC

General information

settings and different LS settings on the Pressure vs. Current Characteristic curve are shown below. The hydraulic schematic for the Normally Closed Electric Proportional control is shown below as well.

Operating Pressure vs. Input Current (N.C. EPC)



Solenoid Data – Normally Closed

Voltage	**12V**	**24V**
Maximum Current	1500 mA	665 mA
Inrush Current	1700 mA	800 mA
Coil Resistance @ 20°C [70°F]	7.1 Ω	28.5 Ω
PWM Range	200-300 Hz	
PWM Frequency (preferred)	250 Hz	
IP Rating (IEC 60529 | DIN 40050-9)	IP67	IP67
IP Rating (IEC 60529 | DIN 40050-9) with mating connector	IP69K	IP69K
Operating Temperature	Consistent with Pump Limits: -40°C (-40°F) to 104°C (220°F)	

The available Normally Closed Electric Proportional Controls for the Series 45 are shown below. The allowable Pressure Compensator (PC) and Load Sense (LS) pressure settings are provided for each frame in their respective sections.

Electric Proportional Controls Options – Normally Closed		**Frame**				
Code	Description	L	K	J	F	E
AH	Electric Proportional Pressure Control w/Pressure Comp. (NC,12VDC) Left			•	•	•
AL	Electric Proportional Pressure Control w/Pressure Comp. (NC,24VDC) Left			•	•	•
AV	Electric Proportional Pressure Control w/Pressure Comp. (NC,12VDC) Right			•	•	•
AK	Electric Proportional Pressure Control w/Pressure Comp. (NC,24VDC) Right			•	•	•
BH	Electric Proportional Pressure Control w/Pressure Comp. (NC,12VDC) [>280 bar] Left			•	•	•

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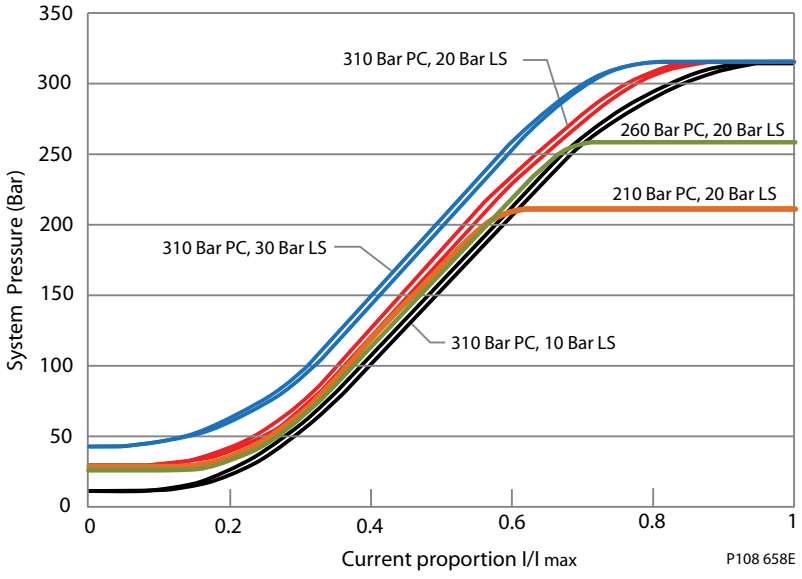
Electric Proportional Controls Options – Normally Closed		Frame				
BL	Electric Proportional Pressure Control w/Pressure Comp. (NC,24VDC) [>280 bar] Left			•	•	•
BM	Electric Proportional Pressure Control w/Pressure Comp. (NC,12VDC) [>280 bar] Right			•	•	•
BK	Electric Proportional Pressure Control w/Pressure Comp. (NC,24VDC) [>280 bar] Right			•	•	•
EM	Electric Proportional Pressure Control w/Pressure Comp. (NC,12VDC)	•	•			
EN	Electric Proportional Pressure Control w/Pressure Comp. (NC,24VDC)	•	•			
Notes:	1) Left = E-Frame: CW Only, F-Frame: CW Only, J-frame: CW Axial, CCW Radial 2) Right = E-Frame: CCW Only, F-Frame: CCW Only, J-frame: CCW Axial, CW Radial 3) K/L Frame Controls are not rotation dependent					

Electric Proportional Control Characteristic – Normally Open

When an electric current is sent to the normally open configuration control, the pump pressure increases proportional to an increase in current. When the load in the system changes, the pump will adjust its displacement to maintain the pressure demanded by the controlling current. This control is especially useful for fan-drives, due to the direct relationship between fan-speed and pump pressure.

Due to the nature of Electric Proportional Controls, the relationship between current and pump pressure is unique for each individual PC/LS pressure setting combination. The relationship between different PC settings and different LS settings on the Pressure vs. Current Characteristic curve are shown below. The hydraulic schematic for the Normally Open Electric Proportional control is shown below as well.

Operating Pressure vs. Input Current (N.O. EPC)



Solenoid Data – Normally Open

Voltage	12V	24V
Maximum Current	1500 mA	665 mA
Inrush Current	1700 mA	800 mA
Coil Resistance @ 20°C [70°F]	7.1 Ω	28.5 Ω
PWM Range	200-300 Hz	
PWM Frequency (preferred)	250 Hz	

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Solenoid Data – Normally Open (continued)

Voltage	12V	24V
IP Rating (IEC 60529 | DIN 40050-9)	IP67	IP67
IP Rating (IEC 60529 | DIN 40050-9) with mating connector	IP69K	IP69K
Operating Temperature	Consistent with Pump Limits: -40°C (-40°F) to 104°C (220°F)	

The available Normally Open Electric Proportional Controls for the Series 45 are shown below. The allowable Pressure Compensator (PC) and Load Sense (LS) pressure settings are provided for each frame in their respective sections. Note that for Electric Proportional Controls, the Load Sense setting describes the Low Pressure Standby value, not margin.

Electric Proportional Controls Options – Normally Open		Frame				
Code	Description	L	K	J	F	E
AX	Electric Proportional Pressure Control w/Pressure Comp. (NO,12VDC) Left			•	•	•
CL	Electric Proportional Pressure Control w/Pressure Comp. (NO,24VDC) Left			•	•	•
AW	Electric Proportional Pressure Control w/Pressure Comp. (NO,12VDC) Right			•	•	•
CK	Electric Proportional Pressure Control w/Pressure Comp. (NO,24VDC) Right			•	•	•
BX	Electric Proportional Pressure Control w/Pressure Comp. (NO,12VDC) [>280 bar] Left			•	•	•
DL	Electric Proportional Pressure Control w/Pressure Comp. (NO,24VDC) [>280 bar] Left			•	•	•
BW	Electric Proportional Pressure Control w/Pressure Comp. (NO,12VDC) [>280 bar] Right			•	•	•
DK	Electric Proportional Pressure Control w/Pressure Comp. (NO,24VDC) [>280 bar] Right			•	•	•
EK	Electric Proportional Pressure Control w/Pressure Comp. (NO,12VDC)	•	•			
EL	Electric Proportional Pressure Control w/Pressure Comp. (NO,24VDC)	•	•			
Notes:	1) Left = E-Frame: CW Only, F-Frame: CW Only, J-frame: CW Axial, CCW Radial 2) Right = E-Frame: CCW Only, F-Frame: CCW Only, J-frame: CCW Axial, CW Radial 3) K/L Frame Controls are not rotation dependent					

Electric On-Off Controls

PLUS+1 Compliance

All Series 45 Electric controls have met and passed the Danfoss PLUS+1 compliance standard testing, and as such, this Series 45 control is PLUS+1 compliant. PLUS+1 compliance blocks are available on the Danfoss website, within the PLUS+1 Guide section.

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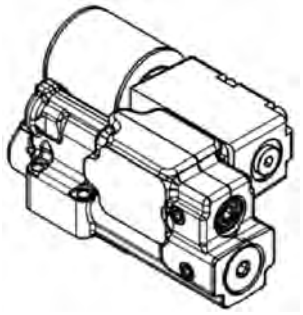
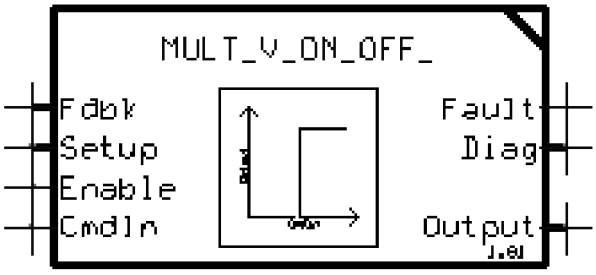


Electric On-Off Control Principle

The Electric On/Off Control consists of an On/Off solenoid integrated into a Remote Pressure Compensated control. This control allows the pump to be operated at either the Load Sense pressure setting when "On", or the Pressure Compensation pressure setting when "Off".



For fan-drive systems, and systems with motors, use a minimum 15bar LS setting to enhance system stability. As the LS setting is reduced, the risk for system instability may be increased. A 20bar LS setting is recommended as a starting point for all new applications.

Electric On-Off Control Response/Recovery

S45 Electric On/Off Controls are available with two servo control orifice options, as well as without an orifice. The servo control orifice is used to enhance system stability, as well as dampen the pump reactiveness. A smaller orifice diameter will add dampening to the pump reactiveness, while a larger orifice will allow quicker pump reaction.

Module "G" Options for Electric On/Off Controls			
Frame	**"E" - 0.8mm Orifice**	**"F" - 1.0mm Orifice**	**"N" - No Orifice**
All Frames	•	•	•

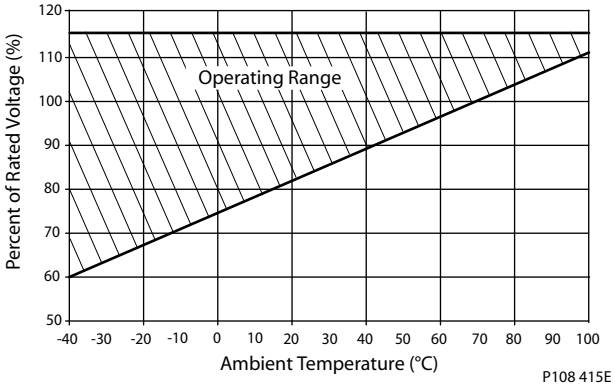
Specific Electric On/Off Control Response/Recovery times are shown for the available servo control orifice options in the control section within each specific frame section. These times represent the response from 75% of rated continuous pressure to 100% of rated continuous pressure, and recovery from 100% of rated continuous pressure to 75% of rated continuous pressure for N.C. configuration per SAE J745 (vice-versa for N.O). As the system pressure approaches the PC setting, the PC function will begin to assist in clipping pressure overshoots during the pump's response, and will decrease the response times of the pump to equal those of the PC response.

Electric On-Off Control Performance vs. Ambient Temperature Characteristic

The Electric On/Off Controls continuous duty operating temperature range is shown below; this guideline should be followed as well as the maximum current limitations. Note that rated voltage refers to either a 12V or 24V coil. Under high temperature conditions, current required to operate the solenoid increases.

General information

Continuous Duty Operating Temperature



Electric On-Off Control Characteristic – Normally Closed

The normally closed configuration On/Off control directs the pump to its Pressure Compensation pressure setting when no current is applied. When the required electric current is sent to the normally closed configuration control the pump pressure decreases to the Low-Pressure Standby setting. This control does not have Load Sense functionality, but rather acts as a Pressure Compensation control when not energized, or is directed to its low-pressure standby when energized. This control is especially useful for machine startups, as the pump can be directed to its Low-Pressure Standby setting during startup to reduce the load on engine starters.

Solenoid Data – Normally Closed

Voltage	**12V**	**24V**
Maximum Current	1500 mA	665 mA
Inrush Current	1700 mA	800 mA
Coil Resistance @ 20°C [70°F]	7.1 Ω	28.5 Ω
PWM Range	200-300 Hz	
PWM Frequency (preferred)	250 Hz	
IP Rating (IEC 60529 | DIN 40050-9)	IP67	IP67
IP Rating (IEC 60529 | DIN 40050-9) with mating connector	IP69K	IP69K
Operating Temperature	Consistent with Pump Limits: -40°C (-40°F) to 104°C (220°F)	

The available Normally Closed Electric On/Off Controls for the Series 45 are shown below. The allowable Pressure Compensator (PC) and Load Sense (LS) pressure settings are provided for each frame in their respective sections.

Electric On/Off Controls Options – Normally Closed		**Frame**				
Code	Description	L	K	J	F	E
AR	Electric On/Off Pressure Control w/Pressure Comp. (NC,12VDC) Left			•	•	•
CR	Electric On/Off Pressure Control w/Pressure Comp. (NC,24VDC) Left			•	•	•
AG	Electric On/Off Pressure Control w/Pressure Comp. (NC,12VDC) Right			•	•	•
AY	Electric On/Off Pressure Control w/Pressure Comp. (NC,24VDC) Right			•	•	•
BR	Electric On/Off Pressure Control w/Pressure Comp. (NC,12VDC) [>280 bar] Left			•	•	•
DR	Electric On/Off Pressure Control w/Pressure Comp. (NC,24VDC) [>280 bar] Left			•	•	•

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Electric On/Off Controls Options – Normally Closed		Frame				
BE	Electric On/Off Pressure Control w/Pressure Comp. (NC,12VDC) [>280 bar] Right			•	•	•
BG	Electric On/Off Pressure Control w/Pressure Comp. (NC,24VDC) [>280 bar] Right			•	•	•
EB	Electric On/Off Pressure Control w/Pressure Comp. (NC,12VDC)	•	•			
EE	Electric On/Off Pressure Control w/Pressure Comp. (NC,24VDC)	•	•			
Notes:	1) Left = E-Frame: CW Only, F-Frame: CW Only, J-frame: CW Axial, CCW Radial 2) Right = E-Frame: CCW Only, F-Frame: CCW Only, J-frame: CCW Axial, CW Radial 3) K/L Frame Controls are not rotation dependent					

Electric On/Off Control Characteristic – Normally Open

The Normally Open configuration On/Off control directs the pump to its Low-Pressure Standby setting when no current is applied. When the required electric current (end current) is sent to the Normally Open configuration control, the pump pressure increases to the Pressure Compensation pressure setting. This control does not have Load Sense functionality, but rather acts as a Pressure Compensation control when energized, or is directed to its Low-Pressure Standby when de-energized. This control is especially useful for machine startups, as the pump can be directed to its Low Pressure Standby setting during startup to reduce the load on engine starters.

Solenoid Data – Normally Open

Voltage	12V	24V
Maximum Current	1500 mA	665 mA
Inrush Current	1700 mA	800 mA
Coil Resistance @ 20°C [70°F]	7.1 Ω	28.5 Ω
PWM Range	200-300 Hz	
PWM Frequency (preferred)	250 Hz	
IP Rating (IEC 60529 | DIN 40050-9)	IP67	IP67
IP Rating (IEC 60529 | DIN 40050-9) with mating connector	IP69K	IP69K
Operating Temperature	Consistent with Pump Limits: -40°C (-40°F) to 104°C (220°F)	

The available Normally Open Electric On/Off Controls for the Series 45 Frame E are shown below, with the allowable Pressure Compensator (PC) pressure range provided for each control. All Electric On/Off Controls are available with the 10-40bar Load Sense (LS) setting range.

Electric On/Off Controls Options – Normally Open		Frame				
Code	Description	L	K	J	F	E
AN	Electric On/Off Pressure Control w/Pressure Comp. (NO,12VDC) Left			•	•	•
CN	Electric On/Off Pressure Control w/Pressure Comp. (NO,24VDC) Left			•	•	•
AF	Electric On/Off Pressure Control w/Pressure Comp. (NO,12VDC) Right			•	•	•
AT	Electric On/Off Pressure Control w/Pressure Comp. (NO,24VDC) Right			•	•	•
BN	Electric On/Off Pressure Control w/Pressure Comp. (NO,12VDC) [>280 bar] Left			•	•	•
DN	Electric On/Off Pressure Control w/Pressure Comp. (NO,24VDC) [>280 bar] Left			•	•	•
BF	Electric On/Off Pressure Control w/Pressure Comp. (NO,12VDC) [>280 bar] Right			•	•	•

General information

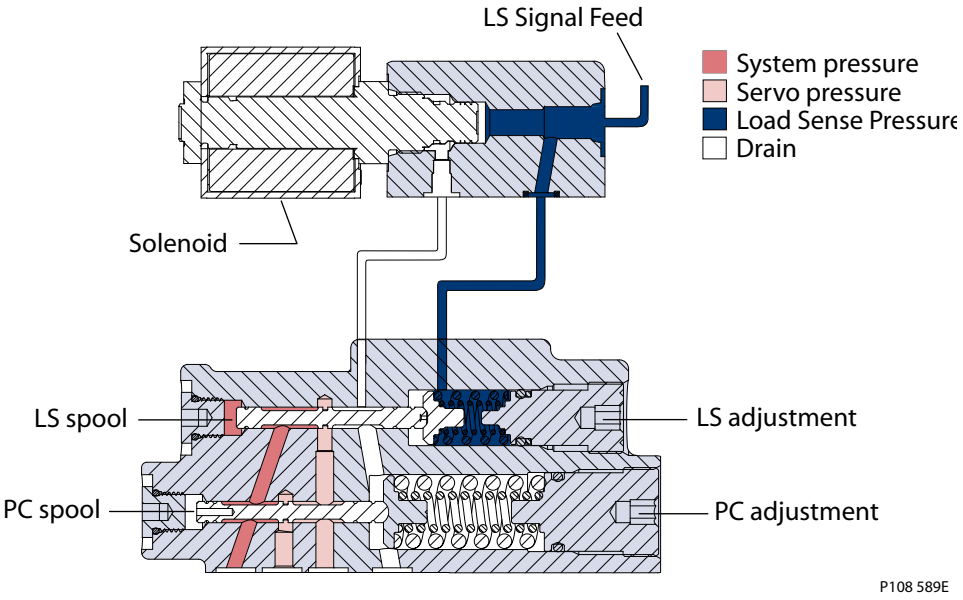
Electric On/Off Controls Options – Normally Open		Frame				
DF	Electric On/Off Pressure Control w/Pressure Comp. (NO,24VDC) [>280 bar] Right			•	•	•
EA	Electric On/Off Pressure Control w/Pressure Comp. (NO,12VDC)	•	•			
EG	Electric On/Off Pressure Control w/Pressure Comp. (NO,24VDC)	•	•			
Notes:	1) Left = E-Frame: CW Only, F-Frame: CW Only, J-frame: CW Axial, CCW Radial 2) Right = E-Frame: CCW Only, F-Frame: CCW Only, J-frame: CCW Axial, CW Radial 3) K/L Frame Controls are not rotation dependent					

Electric dump valve PC/LS controls

The electric dump valve pressure-compensated/load sense control allows the pump to operate as a PC/LS type control under normal operating conditions. The solenoid dump valve overrides the LS control, allowing the pump to operate in a Low-Pressure Standby mode. This function provides reduced horsepower and torque loss in certain situations. It may be particularly useful to reduce loads on a system during engine start.

When closed, the solenoid valve allows the control to act as a PC/LS control. When open, the solenoid valve allows flow from the incoming load sense pressure to dump to case. This reduces the pressure in the LS spring cavity, shifting the LS spool, and allows the pump to de-stroke to the Low-Pressure Standby condition. This control is for applications needing a PC/LS control with the ability to switch to Low-Pressure Standby electronically. The solenoid valve is only available in a normally closed configuration.

Electric Dump Control (frames E, F and J)

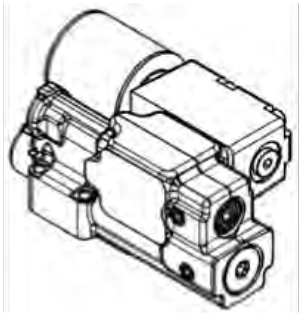


General information

Electronic Torque Limiting Controls (ETL)

PLUS+1 Compliance

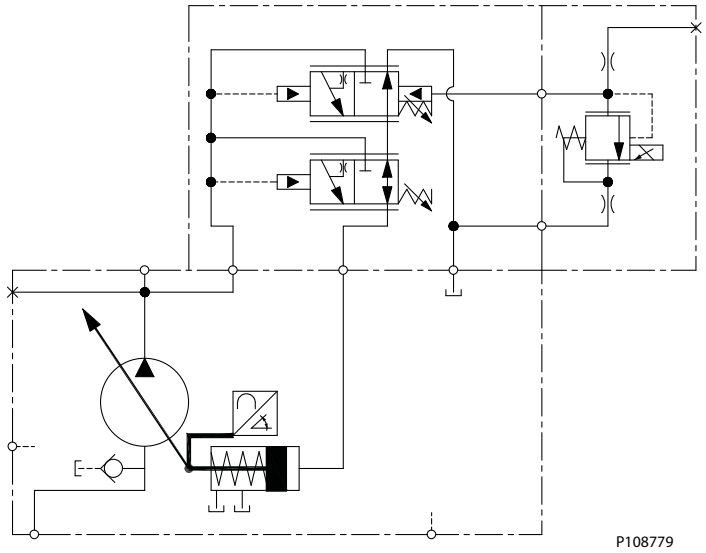
All Series 45 Electric controls have met and passed the Danfoss PLUS+1 compliance standard testing, and as such, this Series 45 control is PLUS+1 compliant. PLUS+1 compliance blocks (software) are available on the Danfoss website, within the PLUS+1 Guide section.



Electric Torque Limiting Control Principle

The Electronic Torque Limiting control consists of a normally closed proportional relief valve (PRV) integrated into a Pressure Compensated/Load Sensing control. This control operates as a PC/LS control, with the additional ability to limit load sense pressure using the integrated PRV by varying the current to the solenoid. When combined with an angle sensor, this control allows for a PC/LS control with electronic torque limiting.

J-frame pump with integrated ETL control



Pump torque consumption is a function of pump outlet pressure, pump displacement, and pump mechanical efficiency. When pump mechanical efficiency is considered constant, the pump torque can be limited when pump displacement is known and pump pressure is controlled. As pump displacement

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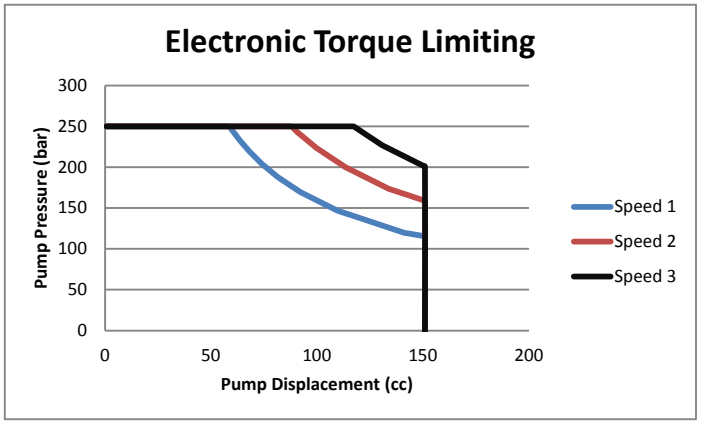
increases, the pump outlet pressure can be limited using the PRV to result in a constant torque limit. Pump outlet pressure is equal to the load sense pressure, which is limited with the PRV, plus the margin pressure setting of the pump.

$$Torque = \frac{Pump\ Outlet\ Pressure\ (bar) * Pump\ Displacement\ (\frac{cc}{rev})}{62.8 * Pump\ Mechanical\ Efficiency\ (\%)}$$

Electronic Torque Limiting Control Characteristic

The Electronic Torque Limiting control allows users to limit pump torque consumption electronically by combining a pressure limiting PRV and angle sensor. This torque limit can be changed with varying engine speeds (as shown in the Electronic Torque Limiting graph below), allowing the use of full engine torque at all engine speeds and increasing machine productivity. A microcontroller is required to store engine torque vs speed, receive the pump angle sensor signal, and then calculate and output the pump outlet pressure limit. The basic torque limiting control logic for a single engine speed is shown below. Danfoss offers a PLUS+1 subsystem application block for the Electronic Torque Limiting control option in combination with keyed MC-12 microcontroller hardware.



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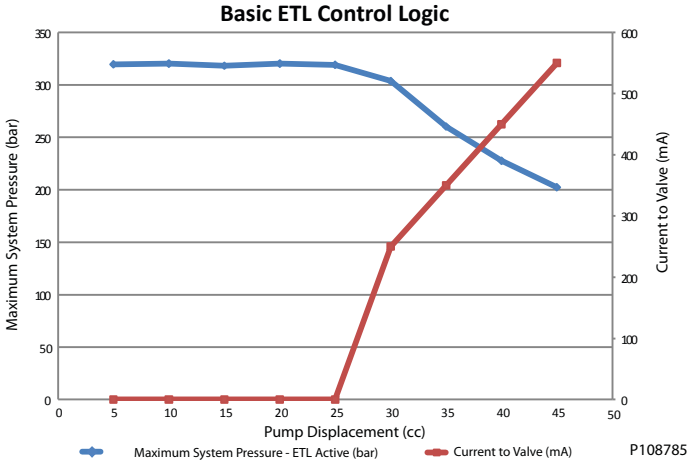

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General information

Electronic Torque Limiting Control Configuration

The Electronic Torque Limiting control options require the use of an angle sensor, and cannot be configured without. An angle sensor provides the pump displacement feedback which is required for limiting pump torque consumption.

Electronic Torque Limiting Control Options		**Frame**				
Code	Description	L	K	J	F	E
TA	Electronic Torque Limiting Control w/Pressure Compensation/Load Sensing (NC, 12VDC), Left			•	•	
TB	Electronic Torque Limiting Control w/Pressure Compensation/Load Sensing (NC, 24VDC), Left			•	•	
TC	Electronic Torque Limiting Control w/Pressure Compensation/Load Sensing (NC, 12VDC), (>280bar) Left			•	•	
TD	Electronic Torque Limiting Control w/Pressure Compensation/Load Sensing (NC, 24VDC), (>280bar) Left			•	•	
TE	Electronic Torque Limiting Control w/Pressure Compensation/Load Sensing (NC, 12VDC), Right			•	•	
TF	Electronic Torque Limiting Control w/Pressure Compensation/Load Sensing (NC, 24VDC), Right			•	•	
TG	Electronic Torque Limiting Control w/Pressure Compensation/Load Sensing (NC, 12VDC), (>280bar) Right			•	•	
TH	Electronic Torque Limiting Control w/Pressure Compensation/Load Sensing (NC, 24VDC), (>280bar) Right			•	•	

Notes:

1) Left = F-Frame: CW Only, J-frame: CW Axial, CCW Radial

2) Right = F-Frame: CCW Only, J-frame: CCW Axial, CW Radial

H Gain Orifice

		J Frame					F Frame	
		S45B	S51B	S60B	S65C	S75C	074B	090C
C	0.8 mm diameter Electronic Torque Limiting Control Orifice (with standard orifice)	•	•	•	•	•	•	•

S45 Electronic Torque Limiting Controls require the use of an LS Signal Line Orifice. The LS Signal Line Orifice is used to enhance system stability, as well as allow the limiting of torque throughout the full range of pump pressure and flow. The standard 1.0mm orifice is best suited for use in a wide variety of applications. Please contact your Danfoss representative for further information on the availability of additional LS Signal Line Orifice sizes.

The angle sensor option requires a housing which is modified for installation of the sensor (K-module), and swashplate which is modified for the magnet carrier to be mounted to (M-module). These options are as follows.

Code	**Description**	**Frame**			
K Module - Housing		L	K	J	F
A1R	SAE-C Flange 4-bolt, SAE O-ring boss ports, Single seal, Angle Sensor				•
A2R	SAE-C Flange 4-bolt, SAE O-ring boss ports, Single seal, Angle Sensor			•	
AFR	SAE-C Flange 2-bolt @45°, SAE O-ring boss ports, Single Seal, Angle Sensor			•	
M Module – Special Hardware					
ANS	Angle Sensor Hardware			•	•

Solenoid Data - Normally Closed

Voltage	**12 Vdc**	**24 Vdc**
Maximum Current	1500 mA	665 mA

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Solenoid Data - Normally Closed (continued)

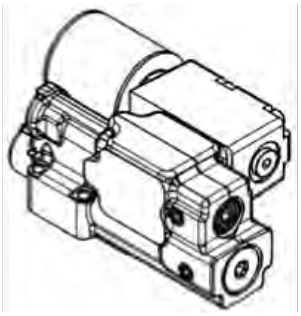
Voltage	12 Vdc	24 Vdc
Inrush Current	1700 mA	800 mA
Coil Resistance @ 20 Deg C [70 Deg F]	7.1 Ohms	28.5 Ohms
PWM Range	200 - 300 Hz	
PWM Frequency (preferred)	250 Hz	
IP Rating (IEC 60529 | DIN 40050-9)	IP67	IP67
IP Rating (IEC 60529 | DIN 40050-9) with mating connector	IP69K	IP69K
Operating Temperature	Consistent with pump limits: -40 Deg C [-40 Deg F] to 104 Deg C [220 Deg F]	

For angle sensor electrical data see *Angle Sensor Functionality* on page 30

Angle Sensor

PLUS+1 Compliance

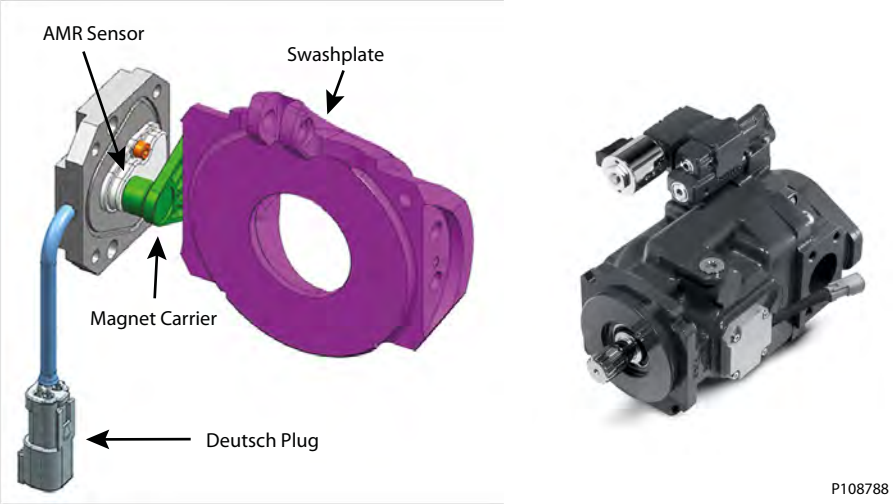
The Electric Angle Sensor has met and passed the Danfoss PLUS+1 compliance standard testing, and as such, this Angle Sensor is PLUS+1 compliant. PLUS+1 compliance blocks are available on the Danfoss website, within the PLUS+1 Guide section.



Angle Sensor Principle

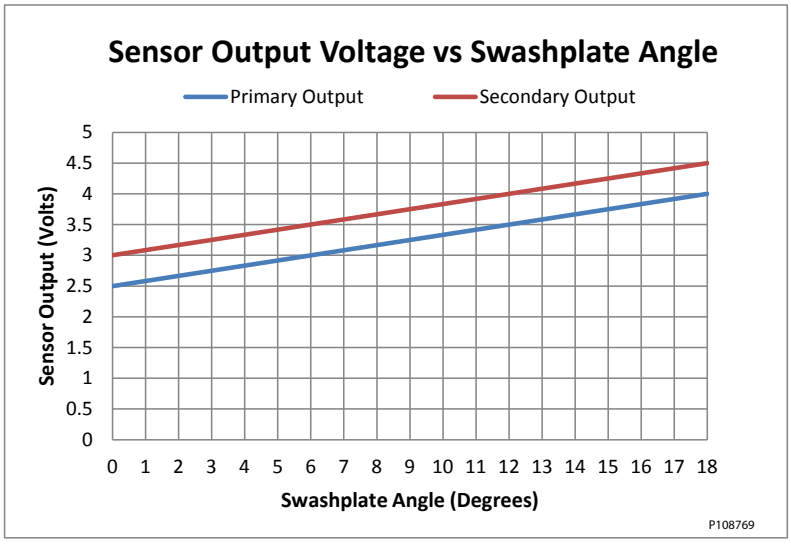
The Series 45 Angle Sensor option allows users to measure the angle of pump displacement. The angle sensor is an electronic sensor mounted to the housing of the pump, which reads the pump stroke angle based on the swashplate position. Interfacing with the angle sensor is achieved through a 4-pin Deutsch DTM04-4P plug attached to a flexible connection cable. The sensor is mounted to the pump within an aluminum housing to prevent magnetic interference.

General information



Angle Sensor Characteristic

The angle sensor package incorporates two sensors, allowing two analog signal outputs for improved accuracy and troubleshooting. The sensor is mounted to the right side of the pump, when looking at the pump from the input shaft. This mounting configuration yields a unique voltage versus swashplate angle characteristic curve shown below.



The angle sensor option requires a housing which is modified for installation of the sensor (K-module), and swashplate which is modified for the magnet carrier to be mounted to (M-module). These options are as follows.

Code	Description	Frame			
K Module - Housing		L	K	J	F
A1R	SAE-C Flange 4-bolt, SAE O-ring boss ports, Single seal, Angle Sensor				•
A2R	SAE-C Flange 4-bolt, SAE O-ring boss ports, Single seal, Angle Sensor			•	
AFR	SAE-C Flange 2-bolt @45°, SAE O-ring boss ports, Single Seal, Angle Sensor			•	
M Module – Special Hardware					
ANS	Angle Sensor Hardware			•	•

General information

Angle Sensor Calibration

A 2-point calibration of the sensor is recommended, with points measured at pump standby, and maximum pump stroke. Maximum pump stroke can be achieved when the pump input shaft is not being turned, as Series 45 pumps are biased to maximum displacement. In some cases the pump may need to be turned momentarily to ensure the pump is in the maximum displacement position; this can be achieved through a momentary switching of the engine starter on/off.

Angle Sensor Functionality

The Series 45 angle sensor option is intended for functionality such as electronic torque limiting, duty cycle measurement, troubleshooting, etc. The angle sensor is PLUS+1 compliant with an available hardware compliance block.

Angle Sensor Intended Functionality:

- Electronic Torque Limiting
- Duty Cycle Recording
- Troubleshooting

Angle Sensor Unsupported Functionality:

- Displacement/Flow Control

Angle Sensor Data - Electrical

Characteristic	Min.	Typ.	Max.	Unit	Note
Supply (V+)	4.75	5	5.25	Vdc	Sensor is Ratiometric in the voltage range
Supply protection	-	-	28	Vdc	Sensor will switch off above 5.5 V
Supply current drawn	-	22	25	mA	Sensor Supply at 5V
Output short circuit current (VDD to SIG 1/2 and GND to SIG 1/2)	-	-	7.5	mA	Additional 7.5 mA for each sensor signal, total sensor 7.5*2+22=37 mA typical for FSO
Sensitivity in sensing range at calibration temperature for primary and secondary sensor	70.02	78	85.8	mV/Degree	
Resolution	-	0.03°	-	degree	11 bit Output channel
Hysteresis		NA		degree	Design of Sensor eliminates any mechanical hysteresis.
Environment Temperature range	-40/-40	80/176	104/220	C°/F°	If temperature limits are exceeded, the sensor will function at a reduced level of performance.
Operating temperature range	20/68	50/122	95/203	C°/F°	Temperature of oil.
Storage temperature	-40/-40		125/257	C°/F°	
Accuracy for Primary & Secondary signals throughout Operating Temperature Range when calibrated at 50 deg C		±0.65° Primary ±0.85° Secondary		degree	Includes linearity, temperature drift and repeatability. Does not include the error due to offsets and different ferrous environment.
Refresh rate of the sensor			100	microseconds	Internal ADC Refresh Rate

Assignments of connector pins

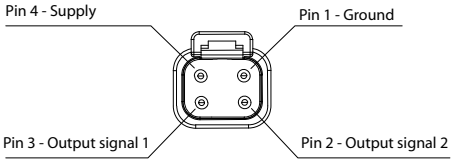
Pin 1: Ground (GND)

Pin 2: Output signal 2 (SIG2) – Secondary signal

Pin 3: Output signal 1 (SIG1) – Primary signal

Pin 4: Supply (V+)

General information



Charge Pump Circuits

This section includes two general circuits for providing charge pressure to Series 45 pumps.

Example Circuit #1

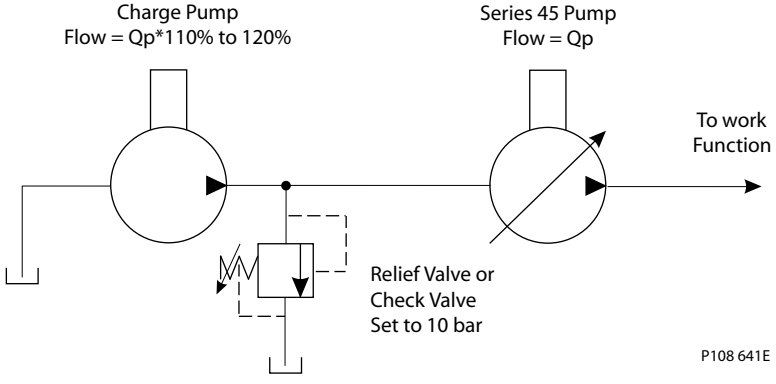
Example Circuit #1 shows a generic open circuit charging layout.

In applications where the Series 45 pump does not have the required inlet pressure available, an external charge pump may be used to increase the inlet pressure to an acceptable level. Scenarios in which this may occur include a layout with the pump above the reservoir, high altitude conditions, etc.

For circuit type #1, follow these recommendations:

- Size the charge pump so that its flow is 10 to 20% greater than the Series 45 flow rate at worst case conditions
- Include a relief valve or check valve, as shown, between the charge pump and S45 pump with an initial pressure setting of up to 10 bar; if aeration at the inlet of the S45 pump is still present, increase the relief/cracking pressure up to 20 bar (maximum).

Generic open circuit



Example Circuit #2

Example Circuit #2 shows a semi-closed circuit charging layout.

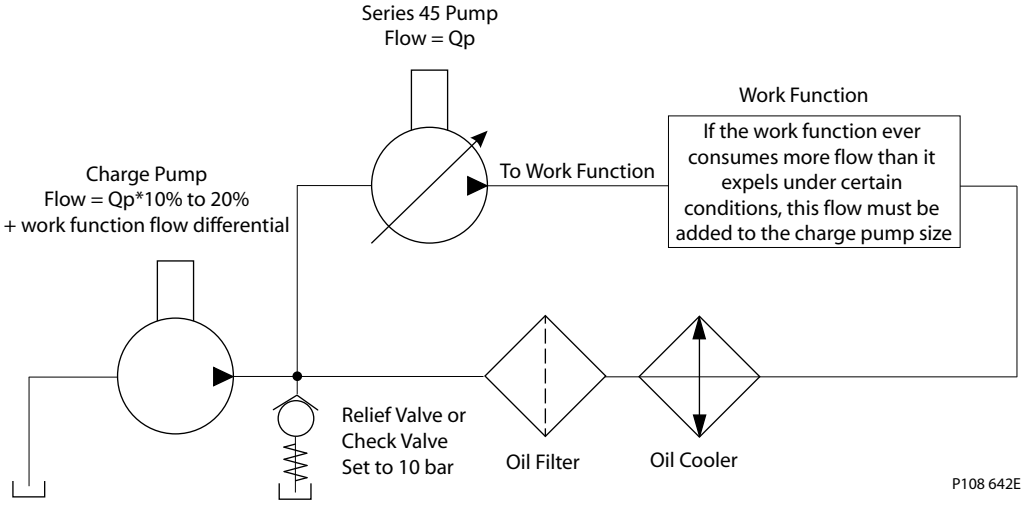
In applications where the Series 45 pump does not have the required inlet pressure available, an external charge pump may be used to increase the inlet pressure to an acceptable level. Scenarios in which this may occur include a layout with the pump above the reservoir, high altitude conditions, etc.

For circuit type #2, follow these recommendations:

General information

- Determine if the work function ever consumes more flow than it expels (for example: double acting or single acting cylinders). If so, determine the maximum flow differential in/out of the work function.
- Size the charge pump so that its flow is 10-20% of the Series 45 pump flow at worst case conditions, and increase this size by any work function flow differential which may occur.
- An inline oil cooler may be required for this type of circuit.
- Include an oil filter after the oil cooler; this ensures that any sediment in the oil cooler that may be dislodged due to vibration or any other reason is caught in the filter.
- Include a relief valve or check valve between the charge pump and S45 pump with an initial pressure setting of up to 10 bar; if aeration at the inlet of the S45 pump is still present, increase the relief/ cracking pressure up to 20 bar (maximum).

Semi-closed circuit



Operating parameters

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 Danfoss publication **520L0463** Hydraulic Fluids and Lubricants, Technical Information, and **520L0465** Experience with Biodegradable Hydraulic Fluids, Technical Information.

Viscosity

Fluid viscosity limits

Condition		mm^2/s (cSt)	SUS
v min.	continuous	9	58
	intermittent	6.4	47
v max.	continuous	110	500
	intermittent (cold start)	1000	4700

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.

General information

Maximum Viscosity – This should only occur at cold start. Pump performance will be reduced. Limit speeds until the system warms up.

Temperature

Temperature limits

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

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.

Ensure fluid temperature and viscosity limits are concurrently satisfied.

Inlet pressure

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.]

Maintain inlet pressure within the limits shown in the table. Refer to Inlet pressure vs. speed charts for each displacement.

Case pressure

Case pressure limits

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

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

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 specification tables in each section give maximum 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.

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.

General information

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. *See *Duty cycle and pump life*.

Speed ratings

The specification tables in each section give 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 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 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

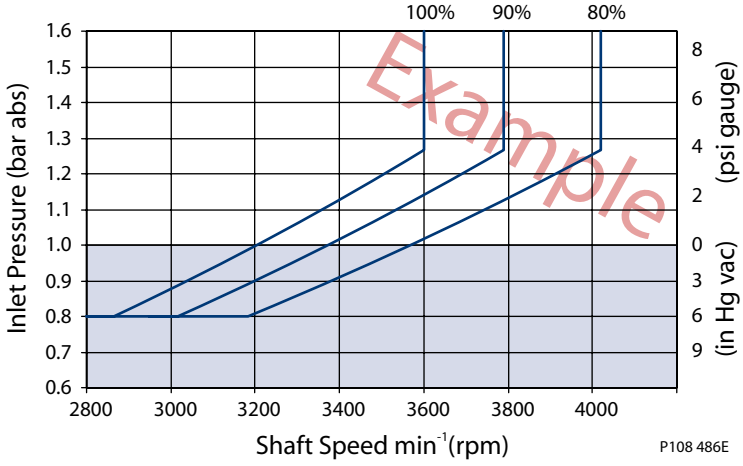
Knowing the operating conditions of your application is the best way to ensure proper pump selection. With accurate duty cycle information, your Danfoss representative can assist in calculating expected pump life.

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 a given displacement. Operating at lower displacements allows greater speed or lower inlet pressure.

Sample inlet pressure vs. speed chart



Operating limit at 80% displacement

Operating limit at 90% displacement

Operating limit at 100% displacement

General information

Design parameters

Installation

Series 45 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 (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,).

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.

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 β10 = 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 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.

General information

Velocity equations

SI units

Q = flow (l/min)

A = area (mm^2)

Velocity = (16.67•Q)/A (m/sec)

US units

Q = flow (US gal/min)

A = area (in^2)

Velocity = (0.321•Q)/A (ft/sec)

Shaft loads

Series 45 pumps have tapered roller bearings capable of accepting external radial and thrust (axial) 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. Tables in each section give maximum external moment (M_e) and thrust (axial) load (T_{in} , T_{out}) limits for each pump frame size and displacement.

Radial load formula

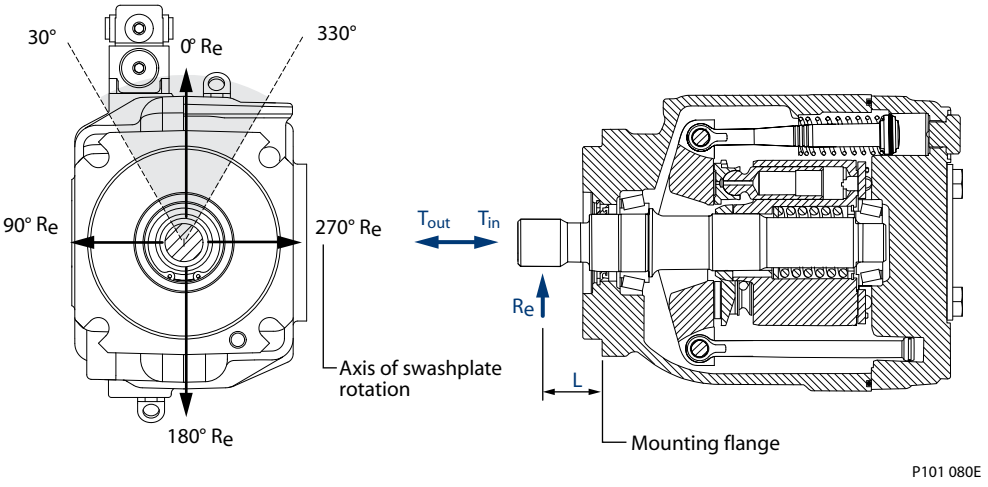
$M_e = R_e \cdot L$

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 30° and 330° positions, as shown. Tapered input shafts or clamp-type couplings are recommended for applications with radial shaft loads.

General information

Mounting flange loads

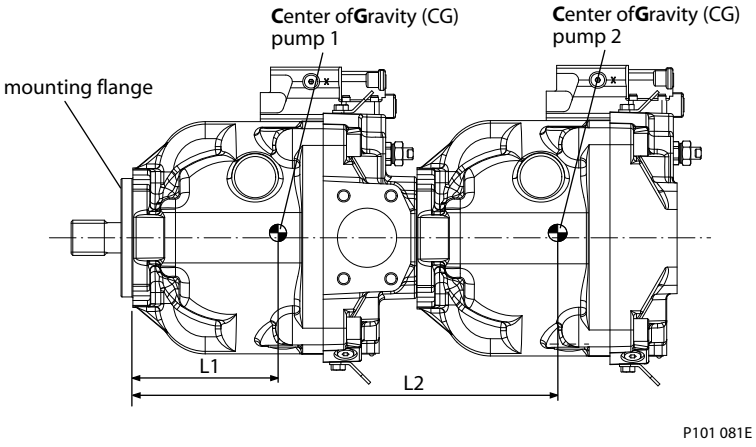
Adding auxiliary pumps and/or subjecting pumps to high shock loads may overload the pump mounting flange. Tables in each section give allowable continuous and shock load moments for each frame size. Applications with loads outside allowable limits require additional pump support.

- *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 in each section to find the distance from the mounting flange to the center of gravity for each frame size. Refer to the technical specifications in each section to find pump weight.

Overhung load example



Shock load formula

$M_s = G_s \cdot K \cdot (W_1 \cdot L_1 + W_2 \cdot L_2 + ... W_n \cdot L_n)$

Continuous load formula

$M_c = G_c \cdot K \cdot (W_1 \cdot L_1 + W_2 \cdot L_2 + ... W_n \cdot L_n)$

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 nth pump (kg)

L_n = Distance from mounting flange to nth 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 nth pump (lb)

General information

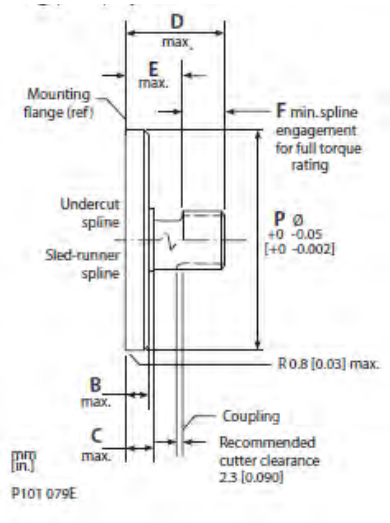
L_n = Distance from mounting flange to nth pump CG (in)

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. Tables in each section give 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. Tables in each section give 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 in each section 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

Input shaft tables in each section give maximum torque ratings for available input shafts. Ensure that your application respects these limits.

General information

Maximum torque ratings are based on shaft strength. Do not exceed them.

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

Danfoss recommends mating splines adhere to ANSI B92.1-Class 5. 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. Tables in each section give full spline dimensions and data.

Understanding and minimizing system noise

Charts in each section give sound levels for each frame size and 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. Below 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-borne 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.

Understanding and minimizing system instability

Knowing the operating conditions and system setup of your application is the best way to ensure a stable system. All fan-drive circuits should use a choke orifice to ensure system stability. With accurate system information, your Danfoss representative can assist you in the selection of a servo control orifice.

General information

Sizing equations

Use these equations to help select the right pump size, displacement and power requirements for your application:

	Based on SI units	Based on US units
Flow	Output flow $Q = \frac{V_g \cdot n \cdot \eta_v}{1000}$ (l/min)	Output flow $Q = \frac{V_g \cdot n \cdot \eta_v}{231}$ (US gal/min)
Torque	Input torque $M = \frac{V_g \cdot \Delta p}{20 \cdot \pi \cdot \eta_m}$ (N·m)	Input torque $M = \frac{V_g \cdot \Delta p}{2 \cdot \pi \cdot \eta_m}$ (lbf·in)
Power	Input power $P = \frac{M \cdot n \cdot \pi}{30\,000} = \frac{Q \cdot \Delta p}{600 \cdot \eta_t}$ (kW)	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]

$\Delta p = p_O - p_i$ (system pressure) bar [psi]

n = Speed min^3 (rpm)

η_v = Volumetric efficiency

η_m = Mechanical efficiency

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

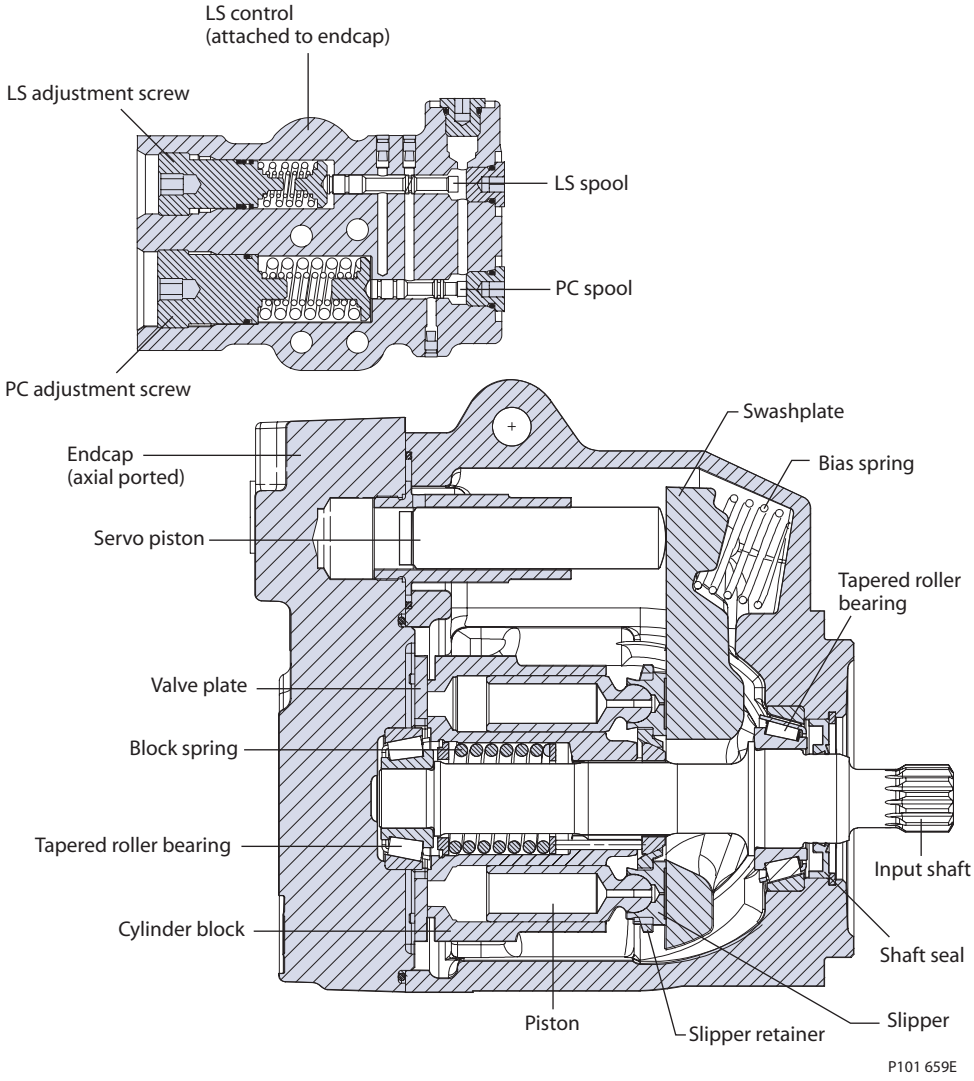
Frames L and K

Design

Series 45 Frame L and K 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 remote PC) control senses system pressure and load pressure (LS controls). The control ports system pressure to the servo piston, adjusting swashplate angle to control pump output flow.

Frame K/L cross section



Frames L and K

Technical Specifications

			L Frame		K Frame	
		Unit	**L25C**	**L30D**	**K38C**	**K45D**
Maximum Displacement		cm^3 [in^3]	25 [1.53]	30 [1.83]	38 [2.32]	45 [2.75]
Working Input Speed	Minimum	min -1 (rpm)	500	500	500	500
	Continuous		3200	3200	2650	2650
	Maximum		3600	3600	2800	2800
Working Pressure	Continuous	bar [psi]	260 [3770]	210 [3045]	260 [3770]	210 [3045]
	Maximum		350 [5075]	300 [4350]	350 [5075]	300 [4350]
Flow at rated speed (theoretical)		l/min [US gal/min]	80 [21]	96 [25.4]	100.7 [26.6]	119.3 [31.5]
Input torque at maximum displacement (theoretical) at 49° C [120°F]		N•m/bar [lbf•in/1000 psi]	0.398 [243]	0.477 [291]	0.605 [369]	0.716 [438]
Mass moment of inertia of internal rotating components		$kg•m^2$ [$slug•ft^2$]	0.00169 [0.00125]	0.00161 [0.00119]	0.00184 [0.00135]	0.00203 [0.00150]
Weight	Axial ports	kg [lb]	19 [42]			
	Radial ports		24 [53]			
External Shaft Loads	External moment (Me)	N•m [lbf•in]	61 [540]	61 [540]	76 [673]	76 [673]
	Thrust in (Tin), out (Tout)	N [lbf]	1000 [225]	1000 [225]	1200 [270]	1200 [270
Mounting flange load moments	Vibratory (continuous)	N•m [lbf•in]	1005 [8895]			
	Shock (maximum)		3550 [31420]			

Order code

Code description

Code	Description
R	Product Frame, Variable Open Circuit Pump
S	Rotation
P	Displacement
C	Control Type
D	Pressure Compensator Setting
E	Load Sense Setting
F	Not Used
G	Choke Orifice
H	Gain Orifice
J	Input Shaft/Auxiliary Mount/Endcap
K	Shaft Seal/Front Mounting Flange/Housing Ports
L	Displacement Limiter
M	Special Hardware
N	Special Features

Frames L and K

R Frame

		L Frame		K Frame	
		025C	**030D**	**038C**	**045D**
KR	K Frame, variable displacement open circuit pump			•	•
LR	L Frame, variable displacement open circuit pump	•	•		

S Rotation

		L Frame		K Frame	
		025C	030D	038C	045D
L	Left Hand (counterclockwise)	•	•	•	•
R	Right Hand (clockwise)	•	•	•	•

P Displacement

025C	025 cm^3/rev [1.53 in^3/rev]	•			
030D	030 cm^3/rev [1.83 in^3/rev]		•		
038C	038 cm^3/rev [2.32 in^3/rev]			•	
045D	045 cm^3/rev [2.75 in^3/rev]				•

C Control type

		L Frame		K Frame	
		025C	030D	038C	045D
PC	Pressure Compensator	•	•	•	•
RP	Remote Pressure Compensator	•	•	•	•
LB	Load Sensing/Pressure Comp. w/Bleed Orifice	•	•	•	•
LS	Load Sensing/Pressure Compensator	•	•	•	•
EA	Electric On/Off w/Pressure Comp. (NO, 12VDC)	•	•	•	•
EG	Electric On/Off w/Pressure Comp. (NO, 24VDC)	•	•	•	•
EB	Electric On/Off w/Pressure Comp. (NC, 12VDC)	•	•	•	•
EE	Electric On/Off w/Pressure Comp. (NC, 24VDC)	•	•	•	•
EK	Electric Proportional Pressure Control w/Pressure Comp. (NO,12VDC)	•	•	•	•
EL	Electric Proportional Pressure Control w/Pressure Comp. (NO,24VDC)	•	•	•	•
EM	Electric Proportional Pressure Control w/Pressure Comp. (NC,12VDC)	•	•	•	•
EN	Electric Proportional Pressure Control w/Pressure Comp. (NC,24VDC)	•	•	•	•

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

Example	25 = 250 bar (3625 psi)				
10–21	100 to 210 bar [1450 to 3045 psi]	•	•	•	•
22-26	220 to 260 bar [3190 to 3771 psi]	•		•	

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

Example	20 = 20 bar (290 psi)				
12–36	12 to 36 bar [174 to 522 psi]	•	•	•	•
NN	Not applicable (pressure compensated only controls)	•	•	•	•

Frames L and K

F Not used

NN	Not applicable	•	•	•	•

G Servo Control Orifice

N	None (standard)	•	•	•	•
E	0.8 mm diameter - Electrical proportional controls only	•	•	•	•
F	1.0 mm dismeter - Electrical proportional controls only	•	•	•	•
J	0.8 mm diameter - All other controls	•	•	•	•
K	1.0 mm dismeter - All other controls	•	•	•	•

H Gain Orifice

3	1.0 mm diameter	•	•	•	•

J Input Shaft

C2	13 tooth, 16/32 pitch
C3	15 tooth, 16/32 pitch
K1	0.875 inch straight keyed
K2	0.875 inch straight keyed (long)
T1	1.0 inch Taper

Auxiliary Mount/Endcap Style

Auxiliary Description	Endcap Style	Inlet Porting	Outlet Porting	Endcap Description	Code
None	Axial	O-Ring Boss	O-Ring Boss	Inlet - SAE O-Ring boss port (1.875 inch threads) Outlet - SAE O-Ring boss port (1.3125 inch threads) Control - Left Side	NF
None	Axial	Split Flange	Split Flange	Inlet - Code 61 Split Flange Port 4 Bolt (1.25 inch port 0.4375 inch threads) Outlet - Code 61 Split Flange Port 4 Bolt (1 inch port 0.375 inch threads) Control - Left Side	NM
None	Axial	Split Flange	Split Flange	Inlet - Code 61 Split Flange Port 4 Bolt (1.25 inch port M10 threads) Outlet - Code 61 Split Flange Port 4 Bolt (1 inch port M10 threads) Control - Left Side	NP
None	Radial	O-Ring Boss	O-Ring Boss	Inlet - SAE O-Ring boss port (1.875 inch threads) Outlet - SAE O-Ring boss port (1.3125 inch threads) Control - Right Side	NG
None	Radial	Split Flange	Split Flange	Inlet - Code 61 Split Flange Port 4 Bolt (1.5 inch port 0.5 inch threads) Outlet - Code 61 Split Flange Port 4 Bolt (1 inch port 0.375 inch threads) Control - Right Side	NK
None	Radial	Split Flange	Split Flange	Inlet - Code 61 Split Flange Port 4 Bolt (1.5 inch port M12 threads) Outlet - Code 61 Split Flange Port 4 Bolt (1 inch port M10 threads) Control - Right Side	NR

Frames L and K

Auxiliary Mount/Endcap Style (continued)

Running Cover	Radial	O-Ring Boss	O-Ring Boss	Inlet - SAE O-Ring boss port (1.875 inch threads) Outlet - SAE O-Ring boss port (1.3125 inch threads) Control - Right Side	RG
Running Cover	Radial	Split Flange	Split Flange	Inlet - Code 61 Split Flange Port 4 Bolt (1.5 inch port 0.5 inch threads) Outlet - Code 61 Split Flange Port 4 Bolt (1 inch port 0.375 inch threads) Control - Right Side	RK
SAE-A, 11 teeth	Radial	O-Ring Boss	O-Ring Boss	Inlet - SAE O-Ring boss port (1.875 inch threads) Outlet - SAE O-Ring boss port (1.3125 inch threads) Control - Right Side	TG
SAE-A, 9 teeth	Radial	O-Ring Boss	O-Ring Boss	Inlet - SAE O-Ring boss port (1.875 inch threads) Outlet - SAE O-Ring boss port (1.3125 inch threads) Control - Right Side	AG
SAE-A, 9 teeth	Radial	Split Flange	Split Flange	Inlet - Code 61 Split Flange Port 4 Bolt (1.5 inch port 0.5 inch threads) Outlet - Code 61 Split Flange Port 4 Bolt (1 inch port 0.375 inch threads) Control - Right Side	AK
SAE-B, 13 teeth	Radial	O-Ring Boss	O-Ring Boss	Inlet - SAE O-Ring boss port (1.875 inch threads) Outlet - SAE O-Ring boss port (1.3125 inch threads) Control - Right Side	BG
SAE-B, 13 teeth	Radial	Split Flange	Split Flange	Inlet - Code 61 Split Flange Port 4 Bolt (1.5 inch port 0.5 inch threads) Outlet - Code 61 Split Flange Port 4 Bolt (1 inch port 0.375 inch threads) Control - Right Side	BK
SAE-B, 13 teeth	Radial	Split Flange	Split Flange	Inlet - Code 61 Split Flange Port 4 Bolt (1.5 inch port M12 threads) Outlet - Code 61 Split Flange Port 4 Bolt (1 inch port M10 threads) Control - Right Side	BR
SAE-BB, 15 teeth	Radial	O-Ring Boss	O-Ring Boss	Inlet - SAE O-Ring boss port (1.875 inch threads) Outlet - SAE O-Ring boss port (1.3125 inch threads) Control - Right Side	VG
SAE-BB, 15 teeth	Radial	Split Flange	Split Flange	Inlet - Code 61 Split Flange Port 4 Bolt (1.5 inch port 0.5 inch threads) Outlet - Code 61 Split Flange Port 4 Bolt (1 inch port 0.375 inch threads) Control - Right Side	VK

J Input Shaft/Auxiliary Mount/Endcap

Available Combinations

	L Frame		K Frame	
	025C	**030D**	**038C**	**045D**
C2AG*	•	•	•	•
C2BG*	•	•	•	•
C2NF*	•	•	•	•
C2NG**	•	•	•	•
C2NK**			•	•

Frames L and K

	L Frame		K Frame	
	025C	030D	038C	045D
C2NM**			•	•
C2NP**			•	•
C2NR*			•	•
C2RG*	•	•	•	•
C2TG*	•	•	•	•
C3AG*	•	•	•	•
C3AK**			•	•
C3BG*	•	•	•	•
C3NF*	•	•	•	•
C3NG**	•	•	•	•
C3NK**			•	•
C3RG*	•	•	•	•

* PLB or AAA Displacement limiter options only

	L Frame		K Frame	
	025C	030D	038C	045D
C3TG*	•	•	•	•
C3VG*			•	•
K1AG*	•	•		
K1NF*	•	•	•	•
K1NG**	•	•	•	•
K1RG*	•	•		
K2AG*	•	•	•	•
K2BG*	•	•	•	•
K2NF*	•	•	•	•
K2NG**	•	•	•	•
K2NM**			•	•
K2RG*	•	•	•	•
T1BG*			•	•
T1NF*	•	•	•	•
T1NG**	•	•	•	•
T1RG*	•	•	•	•

** KNB Displacement limiter options only

K Shaft seal

		L Frame		K Frame	
		025C	030D	038C	045D
A	Single (Viton)	•	•	•	•

Frames L and K

K Mounting flange and housing port style

6	SAE-B Flange 2-bolt/SAE O-ring boss ports	•	•	•	•

K Not used

N	Not applicable	•	•	•	•

L Displacement limiter

AAA	Adjustable, factory set at max angle	•	•	•	•
KNB	None	•	•	•	•
PLB	None (plugged)	•	•	•	•

M Special hardware

NNN	None	•	•	•	•

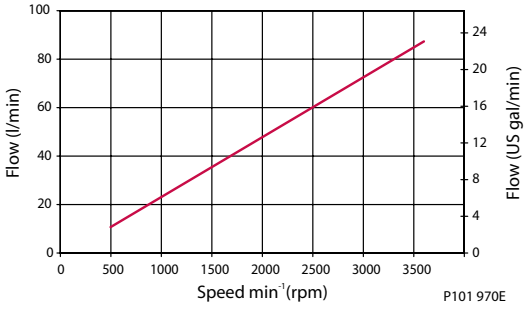
N Special features

NNN	None	•	•	•	•

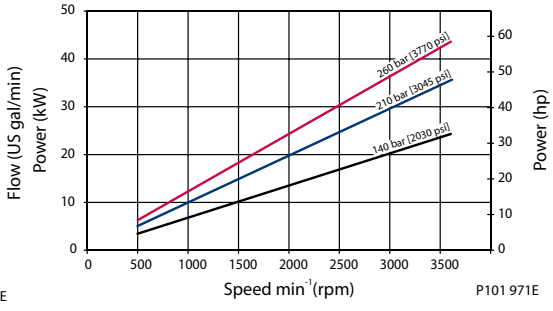
Performance L25C

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

Flow vs. speed

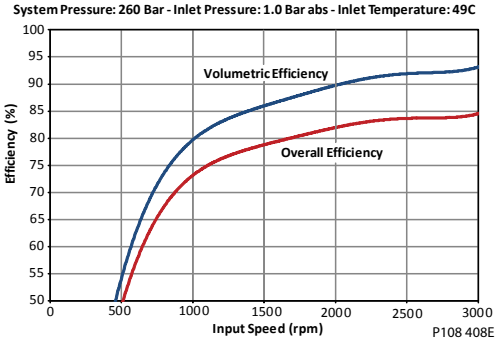


Input power vs. speed

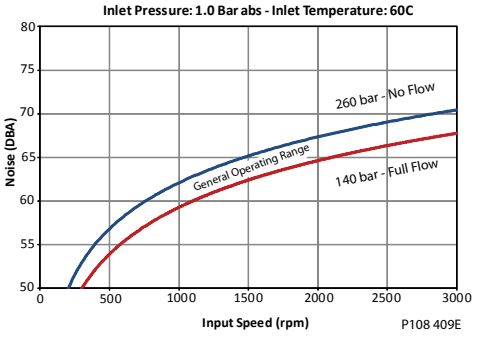


Frames L and K

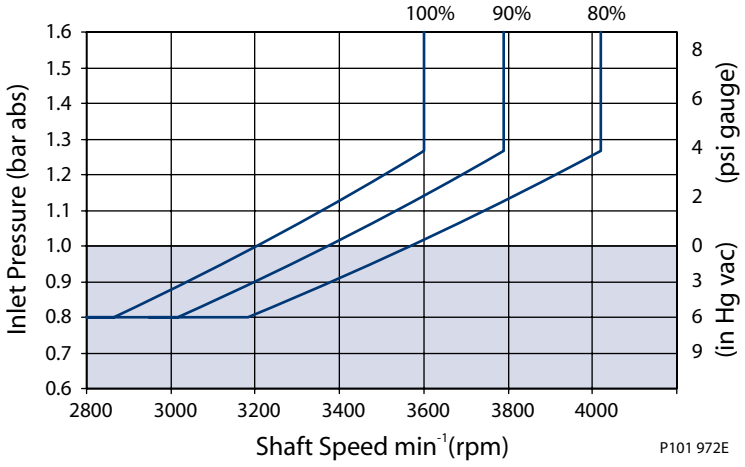
Efficiency



Noise



Inlet pressure vs. speed



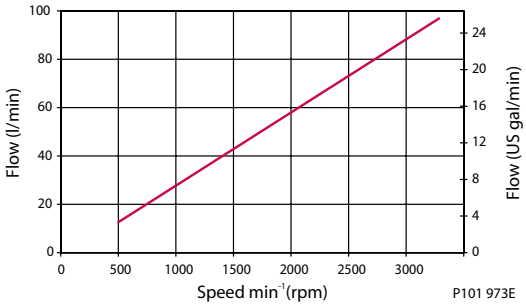
The chart above shows allowable inlet pressure and speed at various displacements. Greater speeds and lower inlet pressures are possible at reduced displacement. Operating outside of acceptable limits reduces pump life.

Performance L30D

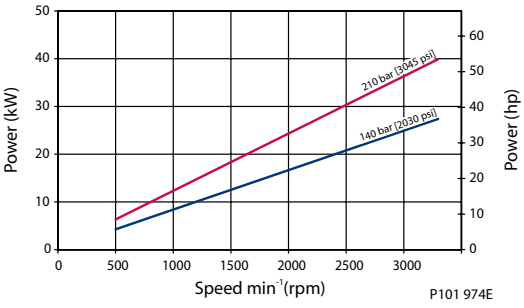
Flow and power data valid at 49°C [120°F] and viscosity of 17.8 mm²/sec [88 SUS].

Frames L and K

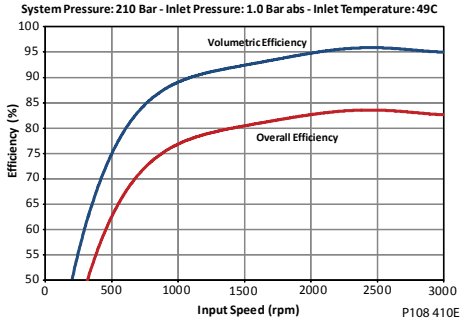
Flow vs. speed



Input power vs. speed



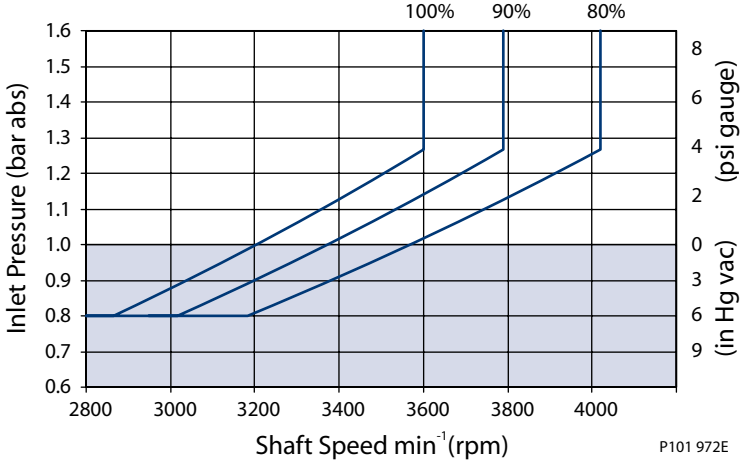
Efficiency



Noise

dB(A)	210 bar [3045 psi]	
	1800 min-1 (rpm)	Rated Speed
L30D	66	70

Inlet pressure vs. speed



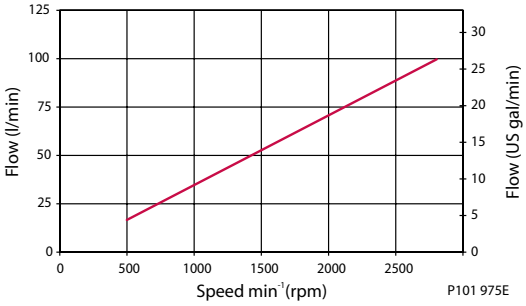
Frames L and K

The chart above 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.

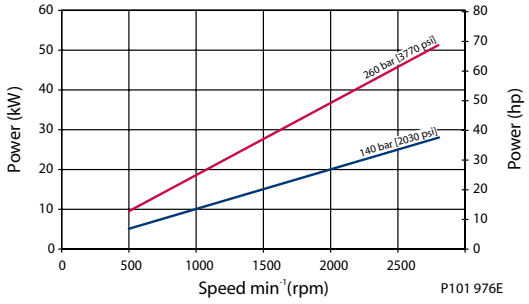
Performance K38C

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

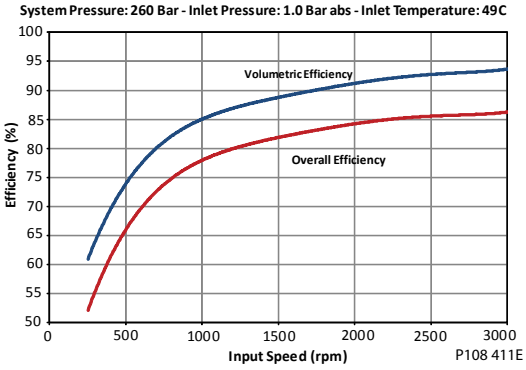
Flow vs. speed



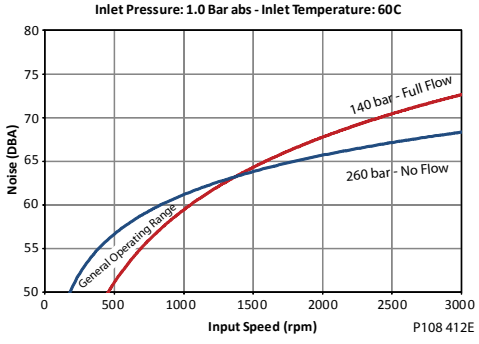
Input power vs. speed



Efficiency

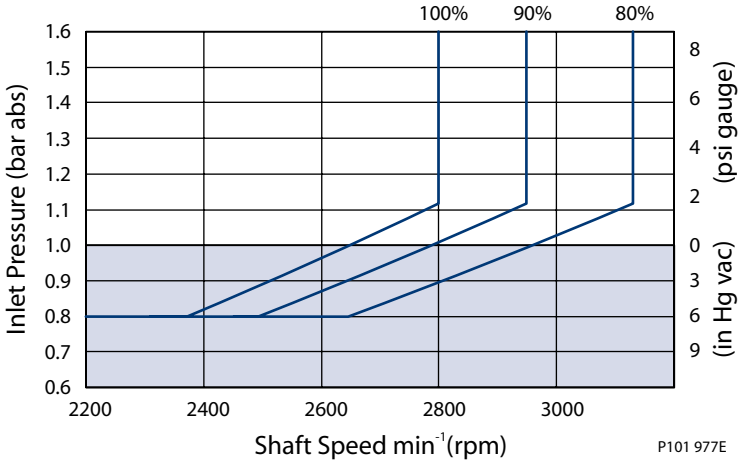


Noise



Frames L and K

Inlet pressure vs. speed

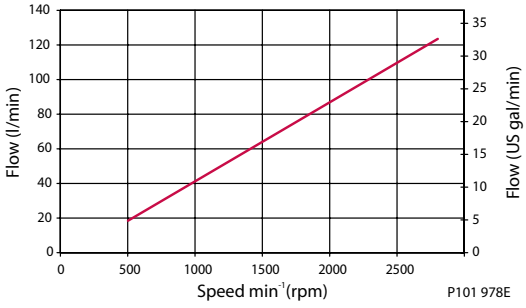


The chart above shows allowable inlet pressure and speed at various displacements. Greater speeds and lower inlet pressures are possible at reduced displacement. Operating outside of acceptable limits reduces pump life.

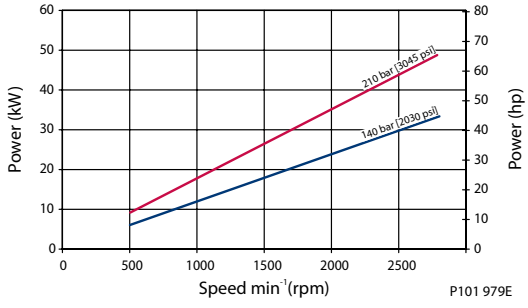
Performance K45D

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

Flow vs. speed

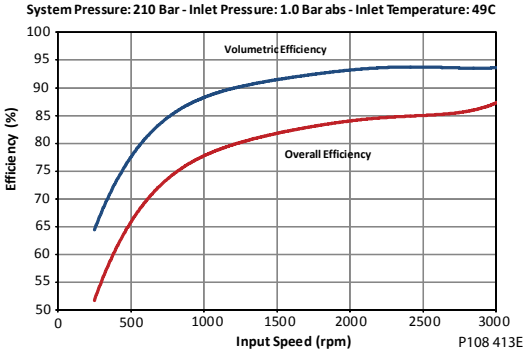


Input power vs. speed

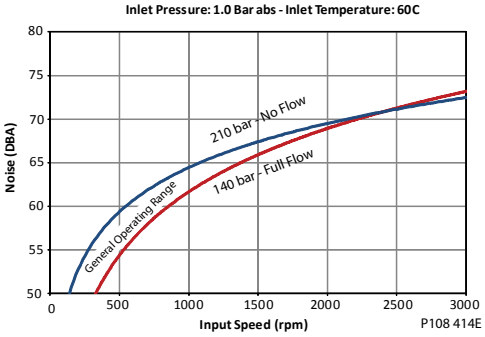


Frames L and K

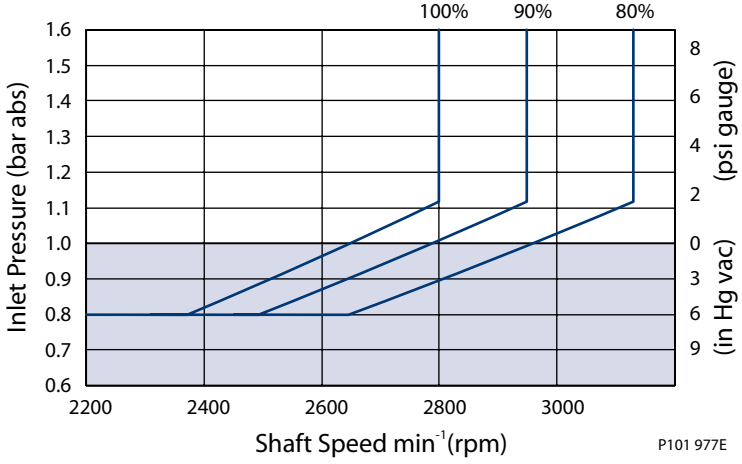
Efficiency



Noise



Inlet pressure vs. speed



The chart above 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.

Hydrauilic Controls

Pressure Compensated Controls

Response/Recovery Times

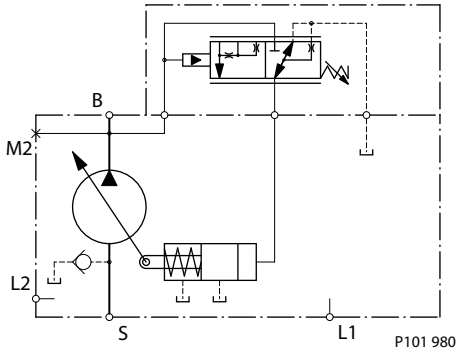
(ms)	Response	Recovery
L25C	30	90
L30D	30	100
K38C	30	105
K45D	30	110

Frames L and K

PC Setting Range

Model	bar	psi
L25C	100–260	1450–3770
L30D	100–210	1450–3045
K38C	100–260	1450–3770
K45D	100–210	1450–3045

Schematic



B = Outlet

S = Inlet

L1, L2 = Case drain

M2 = System pressure gauge port

Remote Pressure Compensated Controls

Response/Recovery Times

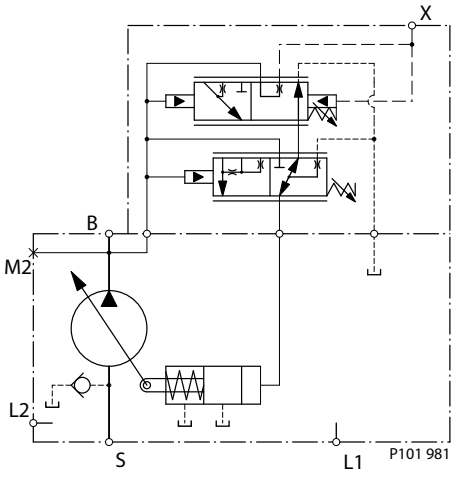
(ms)	Response	Recovery
L25C	30	90
L30D	30	100
K38C	30	105
K45D	30	110

PC Setting Range

Model	bar	psi
L25C	100–260	1450–3770
L30D	100–210	1450–3045
K38C	100–260	1450–3770
K45D	100–210	1450–3045

Frames L and K

Schematic



B = Outlet

S = Inlet

L1, L2 = Case drain

M2 = System pressure gauge port

X = Remote PC port

Load Sensing/Pressure Compensated Controls

Response/Recovery Times

(ms)	Response	Recovery
L25C	30	70
L30D	30	70
K38C	30	80
K45D	30	80

PC Setting Range

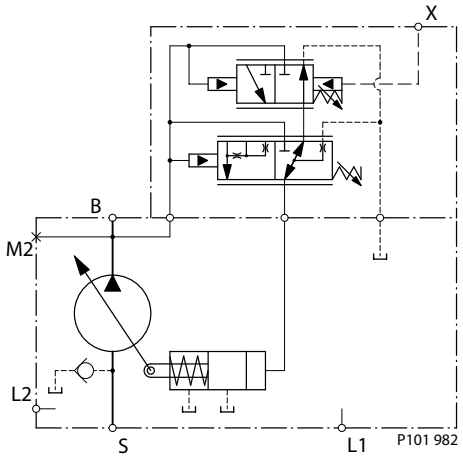
Model	bar	psi
L25C	100–260	1450–3770
L30D	100–210	1450–3045
K38C	100–260	1450–3770
K45D	100–210	1450–3045

LS setting range

Model	bar	psi
All	12-40	174-580

Frames L and K

Schematic



B = Outlet

S = Inlet

L1, L2 = Case drain

M2 = System pressure gauge port

X = LS signal port

Load Sensing Control with Bleed Orifice /Pressure Compensated

Response/Recovery Times

(ms)	Response	Recovery
L25C	30	70
L30D	30	70
K38C	30	80
K45D	30	80

PC Setting Range

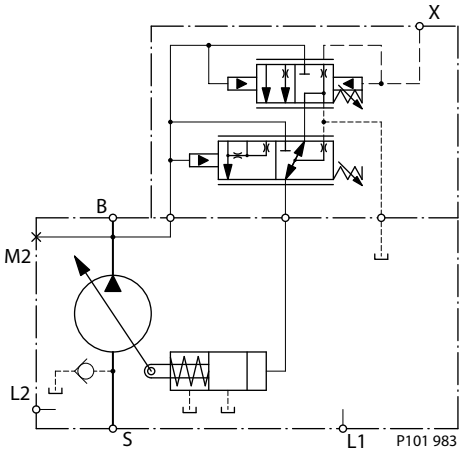
Model	bar	psi
L25C	100–260	1450–3770
L30D	100–210	1450–3045
K38C	100–260	1450–3770
K45D	100–210	1450–3045

LS setting range

Model	bar	psi
All	12-40	174-580

Frames L and K

LB Schematic



B = Outlet

S = Inlet

L1, L2 = Case drain

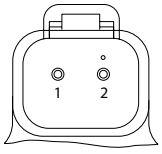
M2 = System pressure gauge port

X = LS signal port

Electric Controls

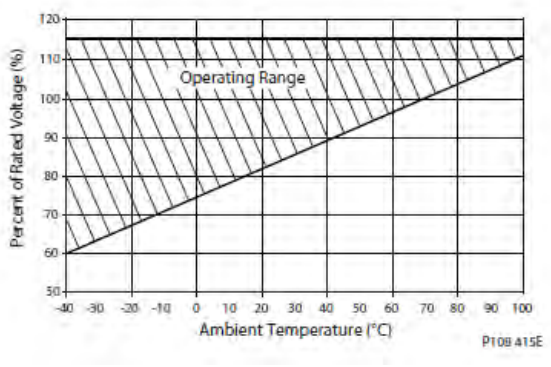
Connectors

Description	Quantity	Ordering Number
Mating Connector	1	Deutsch® DT06-2S
Wedge Lock	1	Deutsch® W25
Socket Contact (16 and 18 AWG)	2	Deutsch® 0462-201-16141
Danfoss mating connector kit	1	K29657



Frames L and K

Continuous Duty Operating Range



Solenoid Data - Normally Closed

Voltage	12V	24V
Threshold Control [mA] (260/210 bar PC setting, oil temp X)	400/600	200/300
End Current [mA] (20 bar LS setting, oil temp X)	1200	600

Solenoid Data - Normally Open

Voltage	12V	24V
Threshold Control [mA] (20 bar LS setting, oil temp X)	0	0
End Current [mA] (260/210 bar PC setting, oil temp X)	1000/1100	500/550

Hysteresis

Frame	Hysteresis
L25C, K38C	Input hysteresis <4% (control current): Output hysteresis <4.5% (system pressure)
L30D, K45D	Input hysteresis <4% (control current): Output hysteresis <4.5% (system pressure)

Normally Closed Electric On/Off with Pressure Compensation Controls

*Response/Recovery times**

(msec)	Response	Recovery
L25C	50	140
L30D	50	130
K38C	50	140
K45D	50	130

* Without servo control orifice: response/recovery from solenoid energized/de-energized.

PC setting range

Frame	EB (12V)	EE (24V)
L25C	100-260 bar [1450-3370] psi	100-260 bar [1450-3370] psi
K38C		

Frames L and K

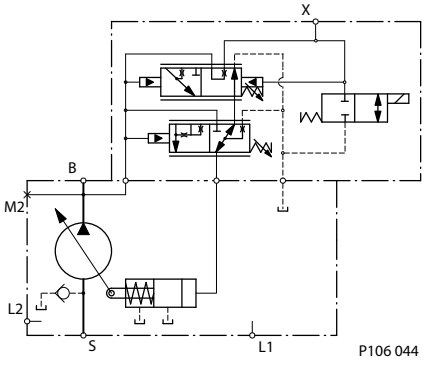
PC setting range (continued)

Frame	EB (12V)	EE (24V)
L30D	100-210 bar [1450-3045] psi	100-210 bar [1450-3045] psi
K45D		

LS setting range

Model	bar	psi
All	12 - 40	[174 - 580]

Schematic



B = Outlet

S = Inlet

L1, L2 = Case drain

M2 = System pressure gauge port

X = Load Sense Port

For fan-drive systems, and systems with motors, select an LS setting no less than15 bar to enhance system stability. As the LS setting is reduced, the risk for system instability may be increased. A 20 bar LS setting is recommended as a starting point for all new applications.

Normally Open Electric On/Off with Pressure Compensation Controls

*Response/Recovery times**

(msec)	Response	Recovery
L25C	50	140
L30D	50	130
K38C	50	140
K45D	50	130

* Without servo control orifice: response/recovery from solenoid energized/de-energized.

PC setting range

Frame	EA (12V)	EG (24V)
L25C	100-260 bar [1450-3370] psi	100-260 bar [1450-3370] psi
K38C		

Frames L and K

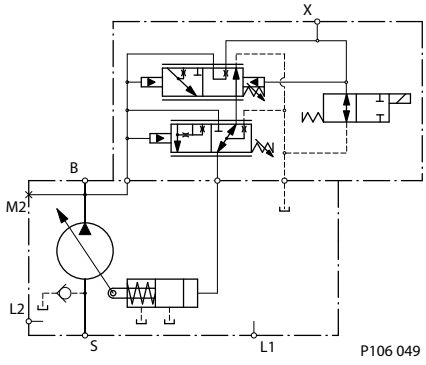
PC setting range (continued)

Frame	EA (12V)	EG (24V)
L30D	100-210 bar [1450-3045] psi	100-210 bar [1450-3045] psi
K45D		

LS setting range

Model	bar	psi
All	12 - 40	[174 - 580]

Schematic



B = Outlet

S = Inlet

L1, L2 = Case drain

M2 = System pressure gauge port

X = Load Sense Port

For fan-drive systems, and systems with motors, select an LS setting no less than15 bar to enhance system stability. As the LS setting is reduced, the risk for system instability may be increased. A 20 bar LS setting is recommended as a starting point for all new applications.

Normally Closed Electric Proportional with Pressure Compensation Controls

Response/Recovery times

	0.8mm Orifice		1.0mm Orifice	
(msec)	Response	Recovery	Response	Recovery
L25C	80	610	70	380
L30D	60	610	55	380
K38C	80	550	70	380
K45D	60	550	55	380

PC setting range

Frame	EM (12V)	EN (24V)
L25C	100-260 bar [1450-3370] psi	100-260 bar [1450-3370] psi
K38C		

Frames L and K

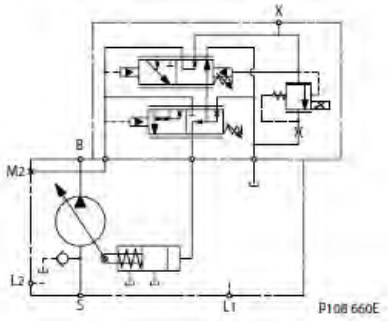
PC setting range (continued)

Frame	EM (12V)	EN (24V)
L30D	100-210 bar [1450-3045] psi	100-210 bar [1450-3045] psi
K45D		

LS setting range

Model	bar	psi
All	12 - 40	[174 - 580]

Schematic



B = Outlet

S = Inlet

L1, L2 = Case drain

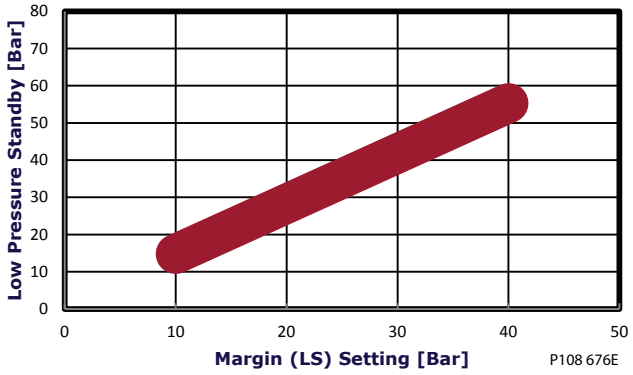
M2 = System pressure gauge port

X = Load Sense Port

For fan-drive systems, and systems with motors, select an LS setting no less than15 bar to enhance system stability. As the LS setting is reduced, the risk for system instability may be increased. A 20 bar LS setting is recommended as a starting point for all new applications.

Electric proportional controls have a unique relationship between margin (LS) setting and low pressure standby. See the graph below for this relationship.

Frames K, L Electric Proportional Control
Low Pressure Standby



Frames L and K

Normally Open Electric Proportional with Pressure Compensation Controls

Response/Recovery times

	0.8mm Orifice		1.0mm Orifice	
(msec)	Response	Recovery	Response	Recovery
L25C	80	610	70	380
L30D	60	610	55	380
K38C	80	550	70	380
K45D	60	550	55	380

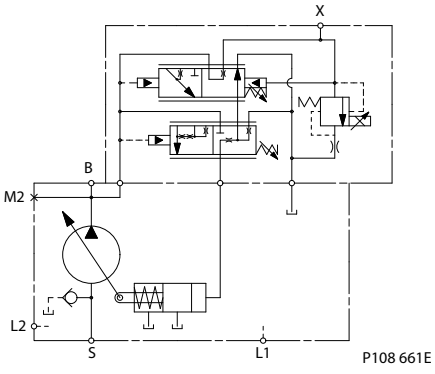
PC setting range

Frame	EK (12V)	EL (24V)
L25C	100-260 bar [1450-3370] psi	100-260 bar [1450-3370] psi
K38C		
L30D	100-210 bar [1450-3045] psi	100-210 bar [1450-3045] psi
K45D		

LS setting range

Model	bar	psi
All	12 - 40	[174 - 580]

Schematic



B = Outlet

S = Inlet

L1, L2 = Case drain

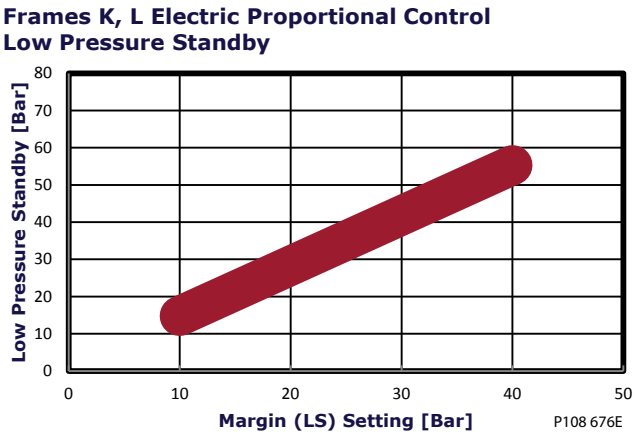
M2 = System pressure gauge port

X = Load Sense Port

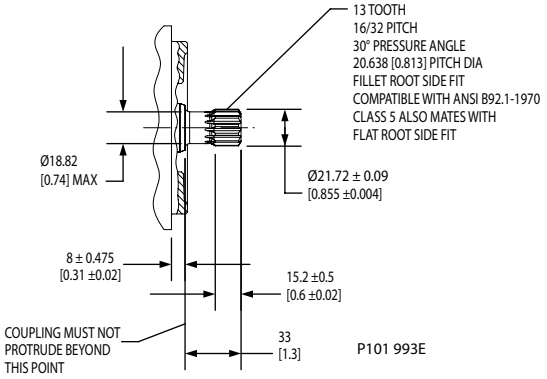
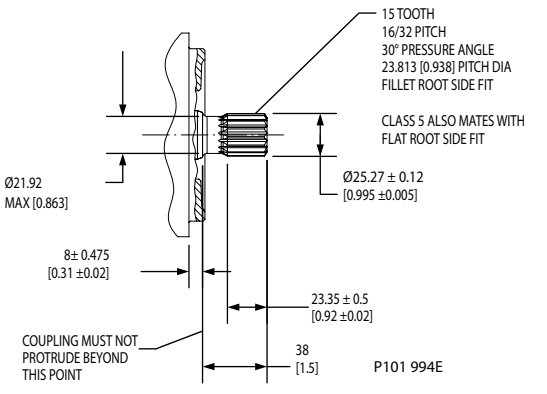
For fan-drive systems, and systems with motors, select an LS setting no less than15 bar to enhance system stability. As the LS setting is reduced, the risk for system instability may be increased. A 20 bar LS setting is recommended as a starting point for all new applications.

Electric proportional controls have a unique relationship between margin (LS) setting and low pressure standby. See the graph below for this relationship.

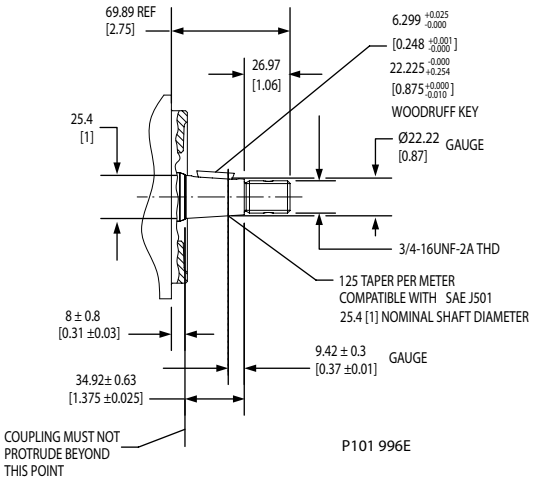
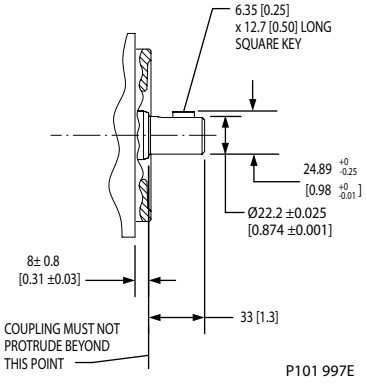
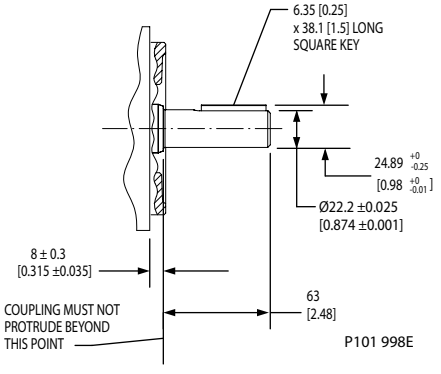
Frames L and K



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)	288 [2546]	
C3	15 tooth spline 16/32 pitch (ANSI A92.1 1970 - Class 5)	404 [3575]	

Frames L and K

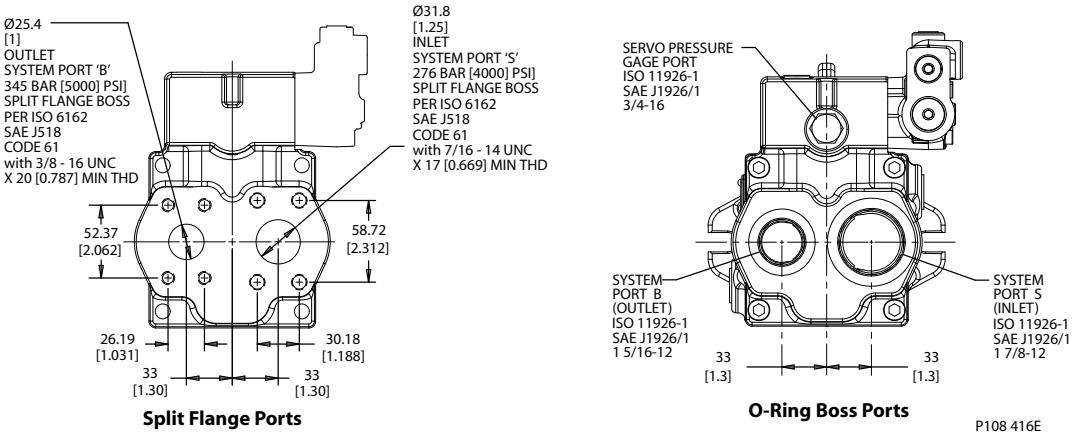
Code	Description	Maximum torque rating[1] N•m [lbf•in]	Drawing
T1	Ø 25.4 mm [1 in] 1:8 taper (SAE J501)	362 [3200]	
K1	Ø 22.23 mm [0.875 in] 33 mm [1.3 in]	305 [2700]	
K2	Ø 22.23 mm [0.875 in] 63 mm [2.48 in] long	305 [2700]	

1. See *Input shaft torque ratings* for an explanation of maximum torque.

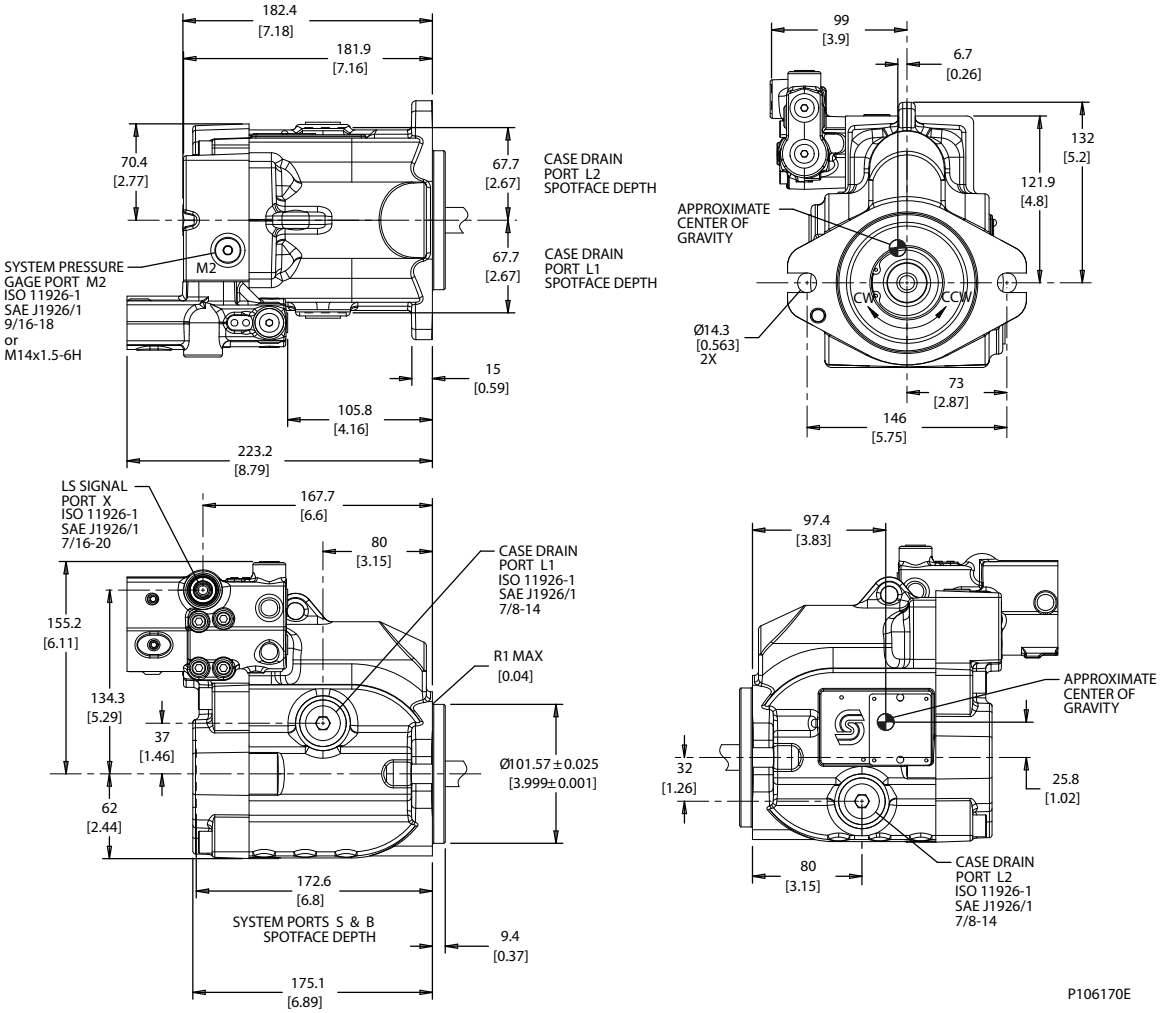
Frames L and K

Installation drawings

Axial Ported Endcap

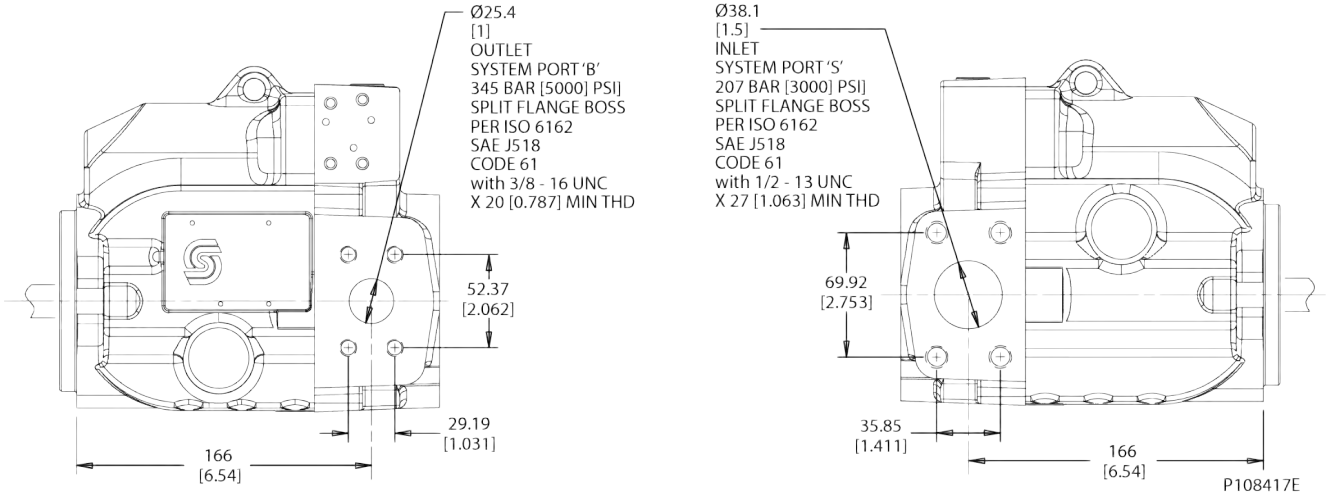


Axial Ported Endcap Installation Dimensions

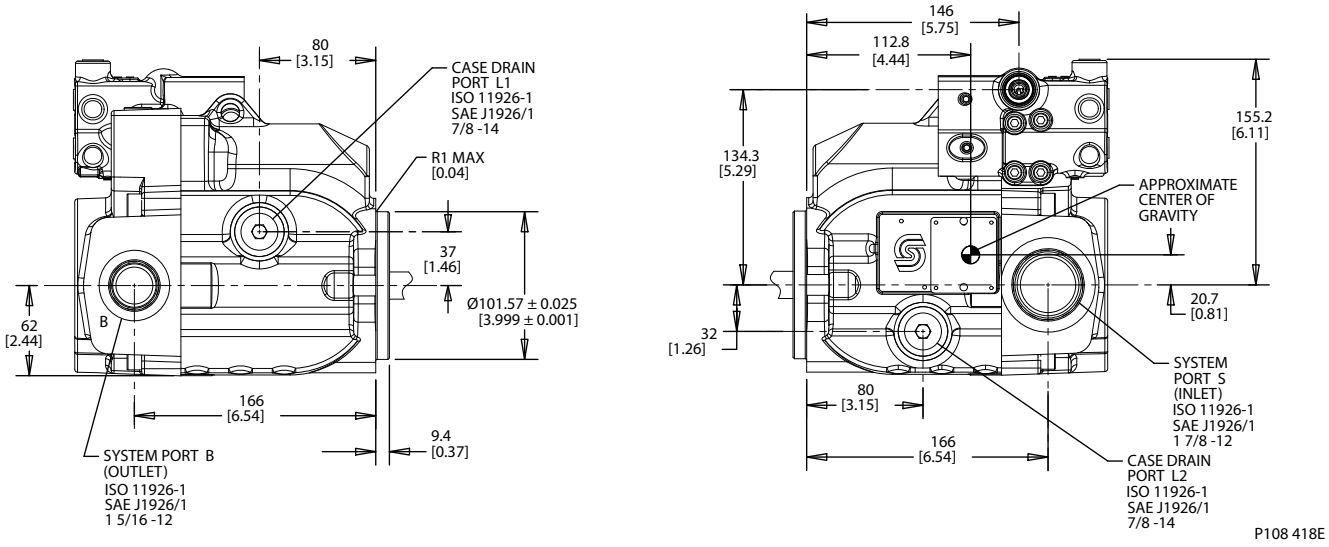


Frames L and K

Radial Ported Endcap Split Flange Ports

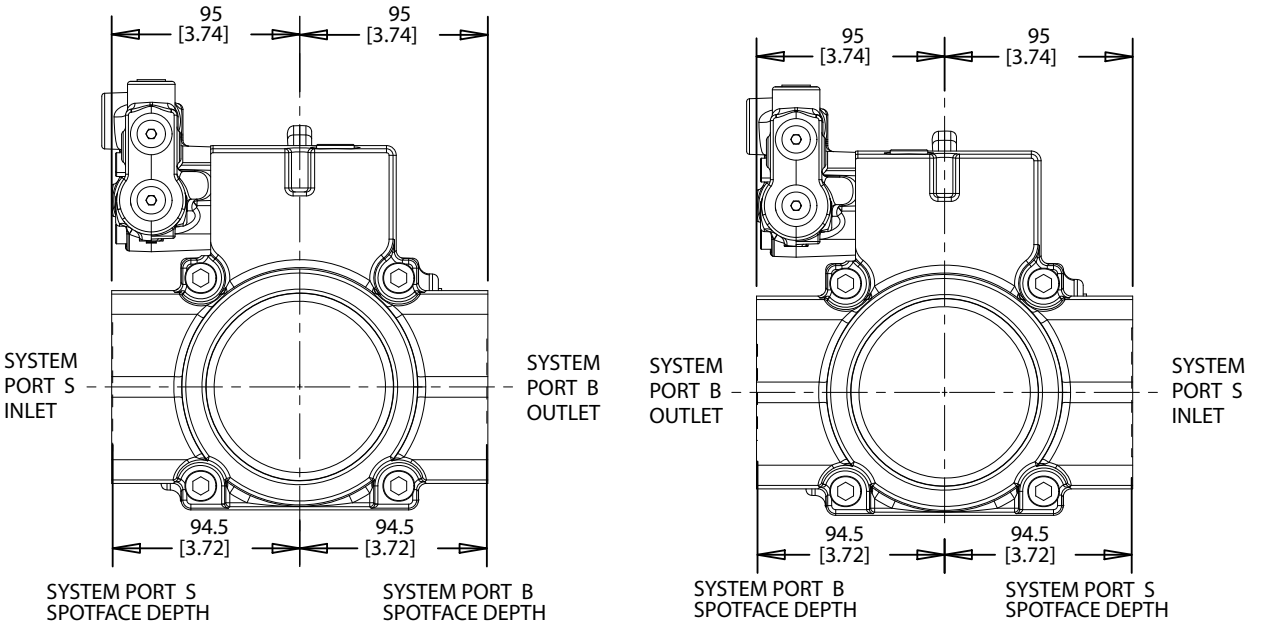


Radial Ported Endcap O-ring Boss Ports



Frames L and K

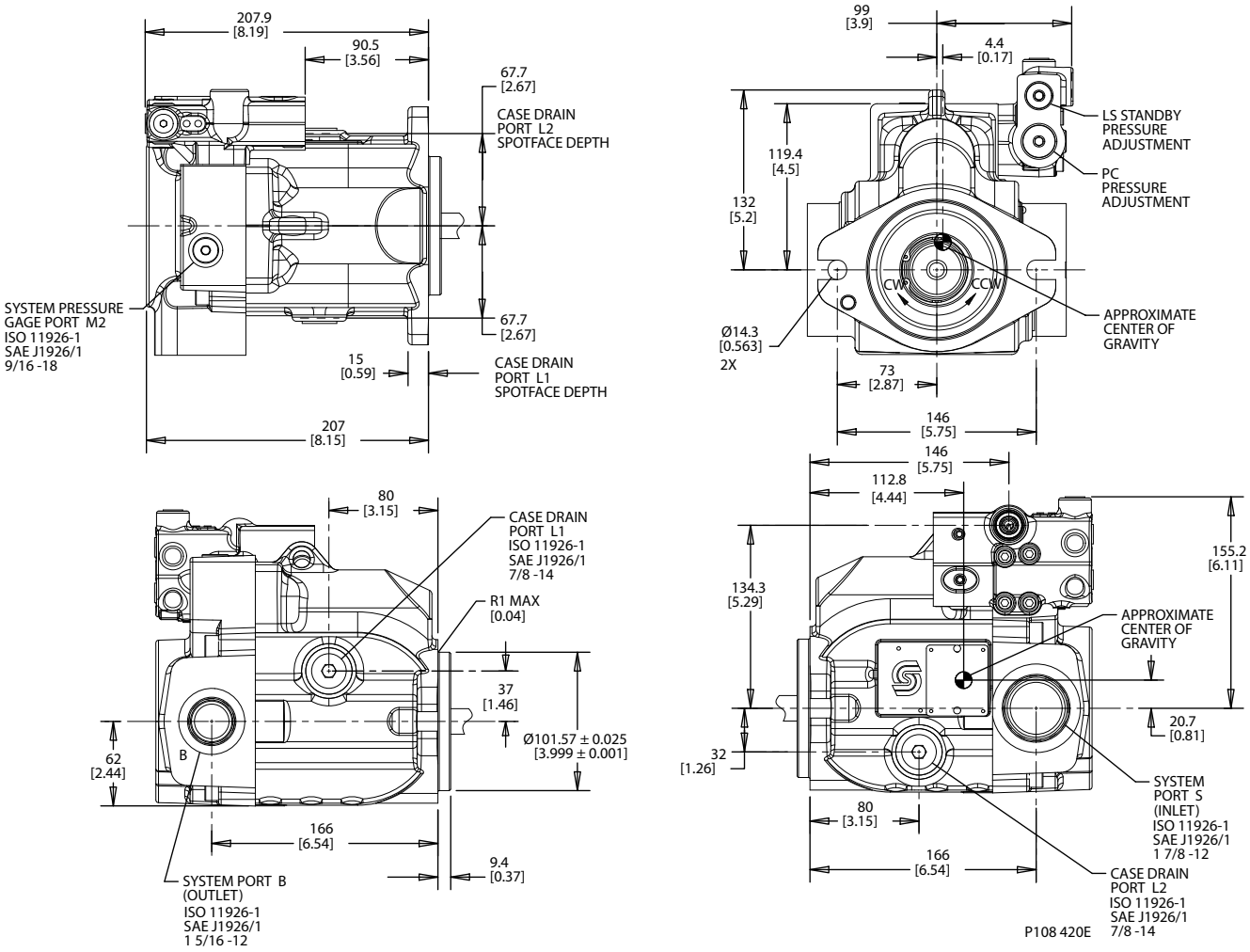
Radial Ported Endcap Rear View



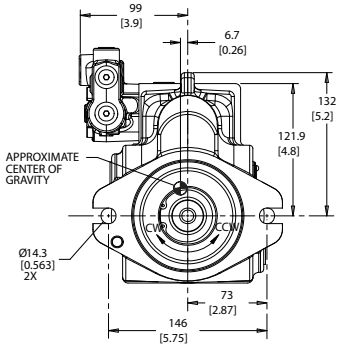
Right Hand Rotation (CW) **Left Hand Rotation (CCW)** P108 419E

Frames L and K

Radiall Ported Endcap Installation Dimensions



Front Mounting Flange - SAE-B two bolt

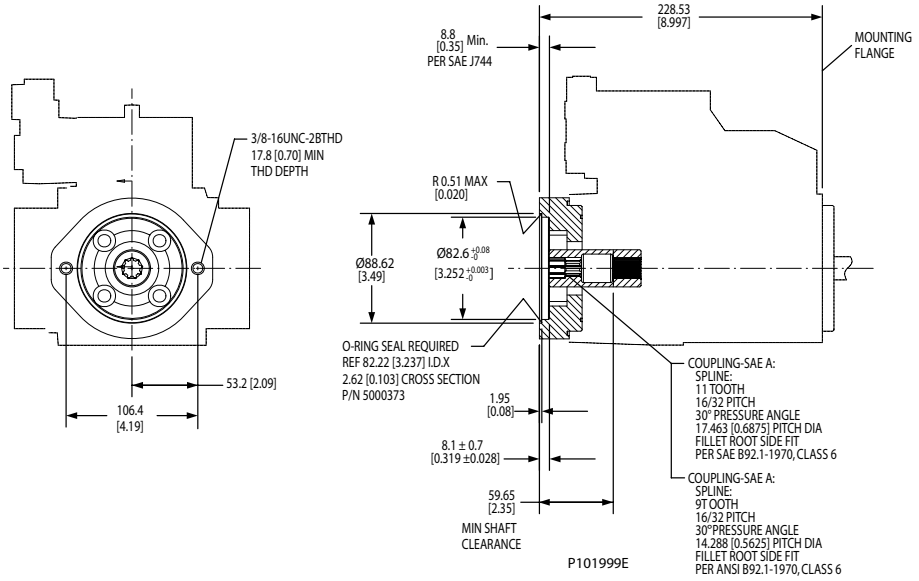


P108 421E

Frames L and K

Auxiliary Mounting Pads

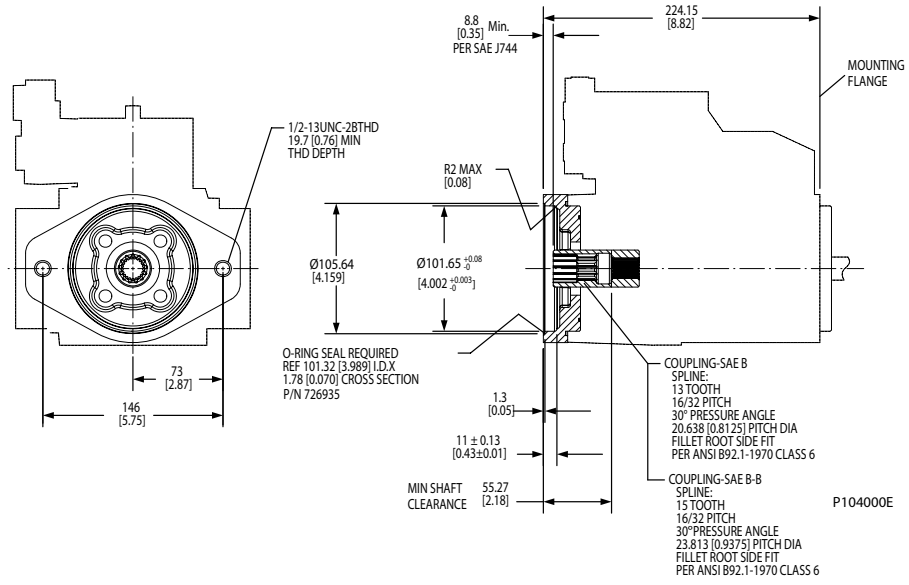
SAE-A auxiliary mounting pad



Specifications

Coupling	9-tooth	11-tooth
Spline minimum engagement	12.6 mm [0.50 in]	13.5 mm [0.53 in]
Maximum torque	107 N•m [950 lbf•in]	147 N•m [1300 lbf•in]

SAE-B auxiliary mounting pad



Specifications

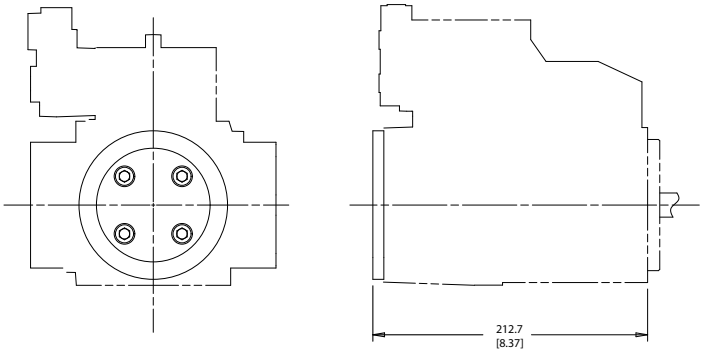
Coupling	13-tooth	15-tooth
Spline minimum engagement	13.2 mm [0.52 in]	16.1 mm [0.63 in]

Frames L and K

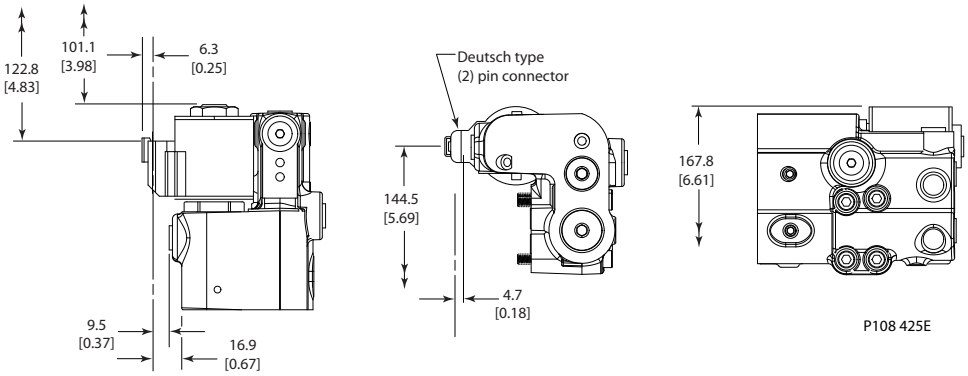
Specifications (continued)

Maximum torque	171 N•m [1512 lbf•in]	171 N•m [1512 lbf•in]

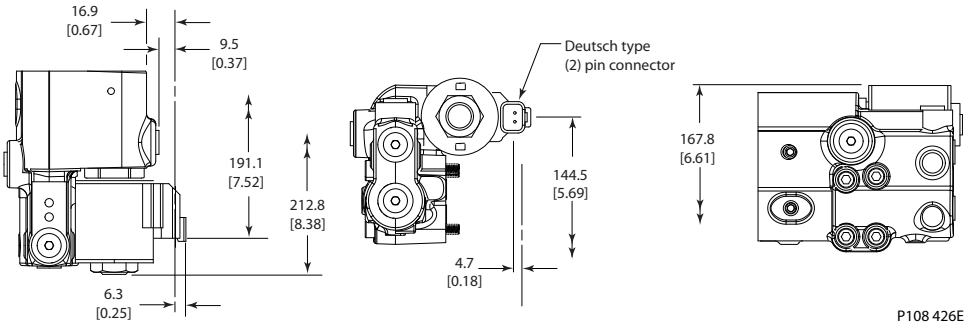
Auxiliary Mounting Pad - Running Cover



Electric Solenoid, Left Side



Electric Solenoid, Right Side

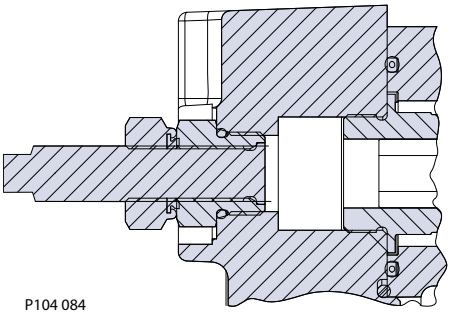


Displacement limiter

L and K Frame open circuit pumps are available with an optional adjustable displacement limiter. This adjustable stop limits the pump's maximum displacement.

Frames L and K

Cross-Section



P104 084

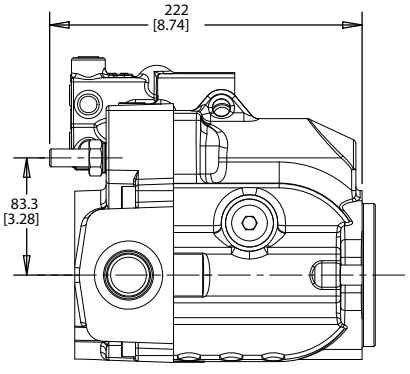
Setting range

L25C	0 to 25 cm³ [0 to 1.53 in³]
L30D	0 to 30 cm³ [0 to 1.83 in³]
K38C	0 to 38 cm³ [0 to 2.32 in³]
K45D	0 to 45 cm³ [0 to 2.75 in³]

Displacement per turn

L25C	1.20 cm³/rev [0.07 in³/rev]
L30D	1.43 cm³/rev [0.09 in³/rev]
K38C	1.81 cm³/rev [0.11 in³/rev]
K45D	2.15 cm³/rev [0.13 in³/rev]

Installation Dimensions



P104 065E

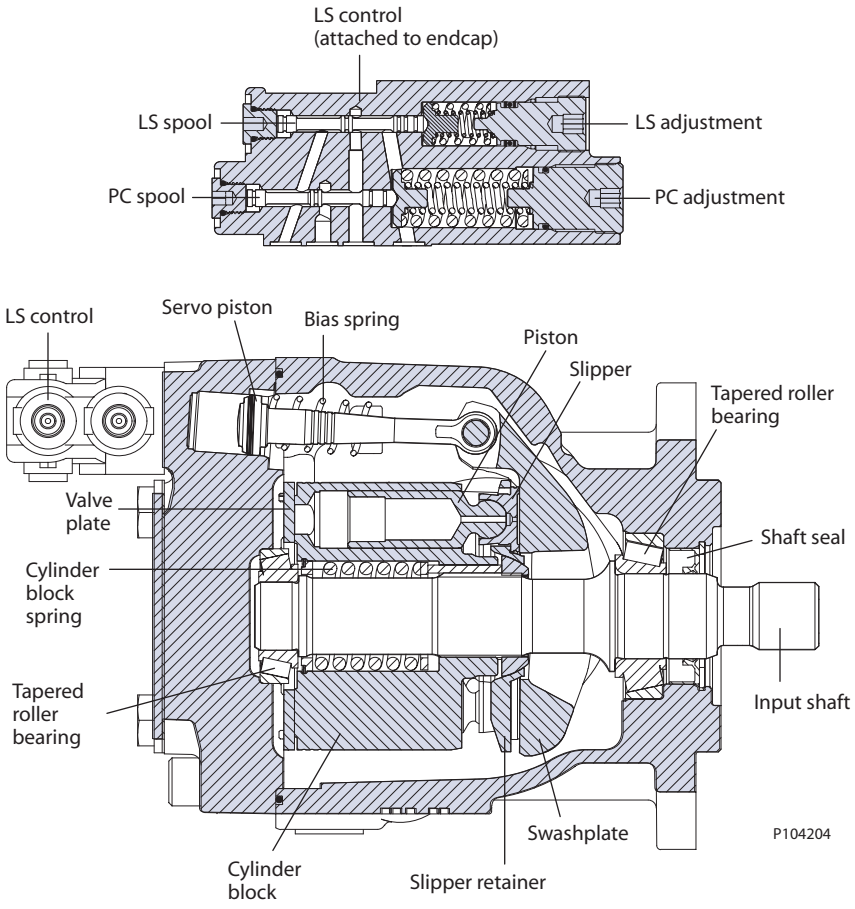
Frame J

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



Frame J

Technical Specifications

			J Frame				
		Unit	**S45B**	**S51B**	**S60B**	**S65C**	**S75C**
Maximum Displacement		cm^3 [in^3]	45 [2.75]	51 [3.11]	60 [3.66]	65 [3.97]	75 [4.58]
Working Input Speed	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 [4500]	310 [4500]	310 [4500]	260 [3770]	260 [3770]
	Maximum		400 [5800]	400 [5800]	400 [5800]	350 [5075]	350 [5075]
Flow at rated speed (theoretical)		l/min [US gal/min]	126 [33.3]	138 [36.4]	156 [41.2]	162 [42.9]	180 [47.5]
Input torque at maximum displacement (theoretical) at 49° C [120°F]		N•m/bar [lbf•in/1000 psi]	0.717 [437.4]	0.812 [495.7]	0.955 [583.2]	1.035 [631.8]	1.194 [729]
Mass moment of inertia of internal rotating components		$kg•m^2$ [$slug•ft^2$]	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]	23.1 [51.0]				
	Radial ports		27.3 [60.2]				
External Shaft Loads	External moment (Me)	N•m [lbf•in]	226 [2000]	226 [2000]	226 [2000]	226 [2000]	226 [2000]
	Thrust in (Tin), out (Tout)	N [lbf]	2200 [495]	2200 [495]	2200 [495]	2200 [495]	2200 [495]
Mounting flange load moments	Vibratory (continuous)	N•m [lbf•in]	SAE-C: 1500 [13300], SAE-B: 735 [6600]				
	Shock (maximum)		SAE-C: 5600 [49600], SAE-B: 2600 [23100]				

Order code

Code description

Code	Description
R	Product Frame, Variable Open Circuit Pump
S	Rotation
P	Displacement
C	Control Type
D	Pressure Compensator Setting
E	Load Sense Setting
F	Not Used
G	Choke Orifice
H	Gain Orifice
J	Input Shaft/Auxiliary Mount/Endcap
K	Shaft Seal/Front Mounting Flange/Housing Ports
L	Displacement Limiter
M	Special Hardware
N	Special Features

Frame J

R Product

		J Frame				
		S45B	S51B	S60B	S65C	S75C
JR	J Frame, variable displacement open circuit pump	•	•	•	•	•

S Rotation

L	Left Hand (counterclockwise)	•	•	•	•	•
R	Right Hand (clockwise)	•	•	•	•	•

P Displacement

S45B	045 cm^3/rev [2.75 in^3/rev]	•				
S51B	051 cm^3/rev [3.11 in^3/rev]		•			
S60B	060 cm^3/rev [3.66 in^3/rev]			•		
S65C	065 cm^3/rev [3.97 in^3/rev]				•	
S75C	075 cm^3/rev [4.58 in^3/rev]					•

C Control type

		J Frame				
		S45B	S51B	S60B	S65C	S75C
PC	Pressure Compensator	•	•	•	•	•
BC*	Pressure Compensator [>280 bar]	•	•	•		
RP	Remote Pressure Compensator	•	•	•	•	•
BP*	Remote Pressure Compensator [>280 bar]	•	•	•		
LS	Load Sensing/Pressure Comp.	•	•	•	•	•
BS*	Load Sensing/Pressure Comp. [>280 bar]	•	•	•		
LB	Load Sensing/Pressure Comp. with internal bleed orifice	•	•	•	•	•
BB*	Load Sensing/Pressure Comp. with internal bleed orifice [>280 bar]	•	•	•		
AN	Electric On/Off w/Pressure Comp. (NO, 12VDC) Left	•	•	•	•	•
CN	Electric On/Off w/Pressure Comp. (NO, 24VDC) Left	•	•	•	•	•
AR	Electric On/Off w/Pressure Comp. (NC, 12VDC) Left	•	•	•	•	•
CR	Electric On/Off w/Pressure Comp. (NC, 24VDC) Left	•	•	•	•	•
AF	Electric On/Off w/Pressure Comp. (NO, 12VDC) Right	•	•	•	•	•
AT	Electric On/Off w/Pressure Comp. (NO, 24VDC) Right	•	•	•	•	•
AG	Electric On/Off w/Pressure Comp. (NC, 12VDC) Right	•	•	•	•	•
AY	Electric On/Off w/Pressure Comp. (NC, 24VDC) Right	•	•	•	•	•
BN*	Electric On/Off w/Pressure Comp. (NO, 12VDC) [>280 bar] Left	•	•	•		
DN*	Electric On/Off w/Pressure Comp. (NO, 24VDC) [>280 bar] Left	•	•	•		
BR*	Electric On/Off w/Pressure Comp. (NC, 12VDC) [>280 bar] Left	•	•	•		
DR*	Electric On/Off w/Pressure Comp. (NC, 24VDC) [>280 bar] Left	•	•	•		
BF*	Electric On/Off w/Pressure Comp. (NO, 12VDC) [>280 bar] Right	•	•	•		
DF*	Electric On/Off w/Pressure Comp. (NO, 24VDC) [>280 bar] Right	•	•	•		
BE*	Electric On/Off w/Pressure Comp. (NC, 12VDC) [>280 bar] Right	•	•	•		
BG*	Electric On/Off w/Pressure Comp. (NC, 24VDC) [>280 bar] Right	•	•	•		

Frame J

C Control type (continued)

		J Frame				
		S45B	S51B	S60B	S65C	S75C
AX	Electric Proportional Pressure Control w/Pressure Comp. (NO,12VDC) Left	•	•	•	•	•
CL	Electric Proportional Pressure Control w/Pressure Comp. (NO,24VDC) Left	•	•	•	•	•
AH	Electric Proportional Pressure Control w/Pressure Comp. (NC,12VDC) Left	•	•	•	•	•
AL	Electric Proportional Pressure Control w/Pressure Comp. (NC,24VDC) Left	•	•	•	•	•
AW	Electric Proportional Pressure Control w/Pressure Comp. (NO,12VDC) Right	•	•	•	•	•
CK	Electric Proportional Pressure Control w/Pressure Comp. (NO,24VDC) Right	•	•	•	•	•
AV	Electric Proportional Pressure Control w/Pressure Comp. (NC,12VDC) Right	•	•	•	•	•
AK	Electric Proportional Pressure Control w/Pressure Comp. (NC,24VDC) Right	•	•	•	•	•
BX*	Electric Proportional Pressure Control w/Pressure Comp. (NO,12VDC) [>280 bar] Left	•	•	•		
DL*	Electric Proportional Pressure Control w/Pressure Comp. (NO,24VDC) [>280 bar] Left	•	•	•		
BH*	Electric Proportional Pressure Control w/Pressure Comp. (NC,12VDC) [>280 bar] Left	•	•	•		
BL*	Electric Proportional Pressure Control w/Pressure Comp. (NC,24VDC) [>280 bar] Left	•	•	•		
BW*	Electric Proportional Pressure Control w/Pressure Comp. (NO,12VDC) [>280 bar] Right	•	•	•		
DK*	Electric Proportional Pressure Control w/Pressure Comp. (NO,24VDC) [>280 bar] Right	•	•	•		
BM*	Electric Proportional Pressure Control w/Pressure Comp. (NC,12VDC) [>280 bar] Right	•	•	•		
BK*	Electric Proportional Pressure Control w/Pressure Comp. (NC,24VDC) [>280 bar] Right	•	•	•		
FA*	Electric On/Off Dump valve w/Pressure Comp. + Load Sense (NC, 12VDC) Right	•	•	•		
FB*	Electric On/Off Dump valve w/Pressure Comp. + Load Sense (NC, 12VDC) Left	•	•	•	•	•
FE*	Electric On/Off Dump valve w/Pressure Comp. + Load Sense (NC, 24VDC), Left	•	•	•	•	•
TA	Electric Torque Limiting w/Pressure Comp. (NC,12VDC) Left	•	•	•	•	•
TB	Electric Torque Limiting w/Pressure Comp. (NC,24VDC) Left	•	•	•	•	•
TC	Electric Torque Limiting w/Pressure Comp. (NC,12VDC) Left	•	•	•	•	•
TD	Electric Torque Limiting w/Pressure Comp. (NC,24VDC) Left	•	•	•	•	•
TE	Electric Torque Limiting w/Pressure Comp. (NC,12VDC) Right	•	•	•	•	•
TF	Electric Torque Limiting w/Pressure Comp. (NC,24VDC) Right	•	•	•	•	•
TG	Electric Torque Limiting w/Pressure Comp. (NC,12VDC) Right	•	•	•	•	•
TH	Electric Torque Limiting w/Pressure Comp. (NC,24VDC) Right	•	•	•	•	•

Left - E-Frame: CW Only, F-Frame: CW Only, J-frame: CW Axial, CCW Radial

Right - E-Frame: CCW Only, F-Frame: CCW Only, J-frame: CCW Axial, CW Radial

* Not available on 65cc and 75cc pumps

Frame J

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

		J Frame				
		S45B	S51B	S60B	S65C	S75C
Example	25 = 250 bar (3625 psi)					
10–26	100 to 260 bar [1450 to 3771 psi]	•	•	•	•	•
27-28	270 to 280 bar [3916 to 4061 psi]	•	•	•		
29-31	290-310 bar [4206 to 4496 psi]	•	•	•		

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

Example	20 = 20 bar (290 psi)					
10-40	10 to 40 bar [175 to 580 psi]	•	•	•	•	•
NN	Not applicable (pressure compensated only controls)	•	•	•	•	•

F Not used

NN	Not applicable	•	•	•	•	•

G Servo Control Orifice

N	None (standard)	•	•	•	•	•
E	0.8 mm diameter	•	•	•	•	•
F	1.0 mm diameter	•	•	•	•	•

H Gain Orifice

3	1.0 mm diameter (standard orifice)	•	•	•	•	•
C	0.8 mm diameter LS signal line orifice for ETL use (with standard orifice)	•	•	•	•	•

Additional LS signal line orifice size options are available for necessary system tuning requirements. Contact your Danfoss representative for further information.

J Input Shaft

C2	13 tooth, 16/32 pitch
C3	15 tooth, 16/32 pitch

Auxiliary Mount/Endcap Style

Auxiliary Description	Endcap Style	Inlet Porting	Outlet Porting	Endcap Description	Code
None	Axial	O-Ring Boss	O-Ring Boss	Inlet - SAE O-Ring boss port (1.875 inch threads) Outlet - SAE O-Ring boss port (1.3125 inch threads)	NH
None	Axial	Split Flange	Split Flange	Inlet - Code 61 Split Flange Port 4 Bolt (2 inch port 0.5 inch threads) Outlet - Code 61 Split Flange Port 4 Bolt (1 inch port 0.375 inch threads)	N9
None	Axial	Split Flange	Split Flange	Inlet - Code 61 Split Flange Port 4 Bolt (2 inch port 0.5 inch threads) Outlet - Code 61 Split Flange Port 4 Bolt (1 inch port 0.375 inch threads), w/ Disp. Limiter	NZ

Frame J

Auxiliary Mount/Endcap Style (continued)

None	Radial	Split Flange	Split Flange	Inlet - Code 61 Split Flange Port 4 Bolt (2 inch port 0.5 inch threads) Outlet - Code 61 Split Flange Port 4 Bolt (1 inch port 0.375 inch threads)	NE
None	Radial	Split Flange	Split Flange	Inlet - Code 61 Split Flange Port 4 Bolt (2 inch port M12 metric threads) Outlet - Code 61 Split Flange Port 4 Bolt (1 inch port M10 metric threads)	NX
None	Radial	Split Flange	Split Flange	Inlet - Code 61 Split Flange Port 4 Bolt (2 inch port 0.5 inch threads) Outlet - Code 61 Split Flange Port 4 Bolt (1 inch port 0.375 inch threads), w/ Disp. Limiter, Large servo bore	NV
Running Cover	Radial	Split Flange	Split Flange	Inlet - Code 61 Split Flange Port 4 Bolt (2 inch port 0.5 inch threads) Outlet - Code 61 Split Flange Port 4 Bolt (1 inch port 0.375 inch threads)	RE
Running Cover	Radial	Split Flange	Split Flange	Inlet - Code 61 Split Flange Port 4 Bolt (2 inch port 0.5 inch threads) Outlet - Code 61 Split Flange Port 4 Bolt (1 inch port 0.375 inch threads), w/ Disp. Limiter	RF
SAE-A, 11 teeth	Radial	Split Flange	Split Flange	Inlet - Code 61 Split Flange Port 4 Bolt (2 inch port 0.5 inch threads) Outlet - Code 61 Split Flange Port 4 Bolt (1 inch port 0.375 inch threads)	TE
SAE-A, 11 teeth	Radial	Split Flange	Split Flange	Inlet - Code 61 Split Flange Port 4 Bolt (2 inch port 0.5 inch threads) Outlet - Code 61 Split Flange Port 4 Bolt (1 inch port 0.375 inch threads) with integral SAE "A" Aux. pad (0.375 inch threads)	TY
SAE-A, 11 teeth	Radial	Split Flange	Split Flange	Inlet - Code 61 Split Flange Port 4 Bolt (2 inch port 0.5 inch threads) Outlet - Code 61 Split Flange Port 4 Bolt (1 inch port 0.375 inch threads)	TF
SAE-A, 11 teeth	Radial	Split Flange	Split Flange	Inlet - Code 61 Split Flange Port 4 Bolt (2 inch port M12 threads) Outlet - Code 62 Split Flange Port 4 Bolt (1 inch port M10 threads) with integral SAE "A" Aux. pad (0.375 inch threads)	TZ
SAE-A, 9 teeth	Radial	Split Flange	Split Flange	Inlet - Code 61 Split Flange Port 4 Bolt (2 inch port 0.5 inch threads) Outlet - Code 61 Split Flange Port 4 Bolt (1 inch port 0.375 inch threads)	AE
SAE-A, 9 teeth	Radial	Split Flange	Split Flange	Inlet - Code 61 Split Flange Port 4 Bolt (2 inch port 0.5 inch threads) Outlet - Code 61 Split Flange Port 4 Bolt (1 inch port 0.375 inch threads) with displacement limiter	AF
SAE-A, 9 teeth	Radial	Split Flange	Split Flange	Inlet - Code 61 Split Flange Port 4 Bolt (2 inch port 0.5 inch threads) Outlet - Code 61 Split Flange Port 4 Bolt (1 inch port 0.375 inch threads) with integral SAE "A" Aux. pad (0.375 inch threads)	AY

Frame J

Auxiliary Mount/Endcap Style (continued)

SAE-A, 9 teeth	Radial	Split Flange	Split Flange	Inlet - Code 61 Split Flange Port 4 Bolt (2 inch port M12 threads) Outlet - Code 61 Split Flange Port 4 Bolt (1 inch port M10 threads)	AX
SAE-B, 13 teeth	Radial	Split Flange	Split Flange	Inlet - Code 61 Split Flange Port 4 Bolt (2 inch port 0.5 inch threads) Outlet - Code 61 Split Flange Port 4 Bolt (1 inch port 0.375 inch threads)	BE
SAE-B, 13 teeth	Radial	Split Flange	Split Flange	Inlet - Code 61 Split Flange Port 4 Bolt (2 inch port 0.5 inch threads) Outlet - Code 61 Split Flange Port 4 Bolt (1 inch port 0.375 inch threads), w/ Disp. Limiter	BV
SAE-B, 13 teeth	Radial	Split Flange	Split Flange	Inlet - Code 61 Split Flange Port 4 Bolt (2 inch port M12 threads) Outlet - Code 61 Split Flange Port 4 Bolt (1 inch port M10 threads)	BX
SAE-BB, 15 teeth	Radial	Split Flange	Split Flange	Inlet - Code 61 Split Flange Port 4 Bolt (2 inch port 0.5 inch threads) Outlet - Code 61 Split Flange Port 4 Bolt (1 inch port 0.375 inch threads)	VE
SAE-BB, 15 teeth	Radial	Split Flange	Split Flange	Inlet - Code 61 Split Flange Port 4 Bolt (2 inch port 0.5 inch threads) Outlet - Code 61 Split Flange Port 4 Bolt (1 inch port 0.375 inch threads), w/ Disp. Limiter	VF
SAE-BB, 15 teeth	Radial	Split Flange	Split Flange	Inlet - Code 61 Split Flange Port 4 Bolt (2 inch port M12 threads) Outlet - Code 61 Split Flange Port 4 Bolt (1 inch port M10 threads)	VX
SAE-BB, 15 teeth	Radial	Split Flange	Split Flange	Inlet - Code 61 Split Flange Port 4 Bolt (2 inch port M12 threads) Outlet - Code 61 Split Flange Port 4 Bolt (1 inch port M10 threads), Large servo bore	DX
SAE-C, 14 teeth	Radial	Split Flange	Split Flange	Inlet - Code 61 Split Flange Port 4 Bolt (2 inch port 0.5 inch threads) Outlet - Code 61 Split Flange Port 4 Bolt (1 inch port 0.375 inch threads)	CE
SAE-C, 14 teeth	Radial	Split Flange	Split Flange	Inlet - Code 61 Split Flange Port 4 Bolt (2 inch port 0.5 inch threads) Outlet - Code 61 Split Flange Port 4 Bolt (1 inch port 0.375 inch threads), w/ Disp. Limiter	CF
SAE-C, 14 teeth	Radial	Split Flange	Split Flange	Inlet - Code 61 Split Flange Port 4 Bolt (2 inch port M12 threads) Outlet - Code 61 Split Flange Port 4 Bolt (1 inch port M10 threads)	CX

J Input Shaft/Auxiliary Mount/Endcap

Available Combinations

	J Frame				
	S45B	**S51B**	**S60B**	**S65C**	**S75C**
JC2AE*	•	•	•	•	•
JC2AY*	•	•	•	•	•

Frame J

	J Frame				
	S45B	S51B	S60B	S65C	S75C
JC2BE*	•	•	•	•	•
JC2BF**	•	•	•	•	•
JC2CE*	•	•	•	•	•
JC2N9*	•	•	•	•	•
JC2NE*	•	•	•	•	•
JC2NH*	•	•	•	•	•
JC2NV**	•	•	•	•	•
JC2NZ*	•	•	•	•	•
JC2RE*	•	•	•	•	•
JC2RF**	•	•	•	•	•
JC2TE*	•	•	•	•	•
JC2TF**	•	•	•	•	•
JC2TY*	•	•	•	•	•
JC2VE*	•	•	•	•	•
JC3AE*	•	•	•	•	•
JC3AF**	•	•	•	•	•
JC3AY*	•	•	•	•	•
JC3BE*	•	•	•	•	•
JC3BF**	•	•	•	•	•
JC3CE*	•	•	•	•	•
JC3N9*	•	•	•	•	•
JC3NE*	•	•	•	•	•
JC3NH*	•	•	•	•	•
JC3NV**	•	•	•	•	•
JC3NX*	•	•	•	•	•
JC3NZ*	•	•	•	•	•
JC3RE*	•	•	•	•	•
JC3RF**	•	•	•	•	•
JC3TE*	•	•	•	•	•
JC3TZ*	•	•	•	•	•
JC3VE*	•	•	•	•	•
JK4AE*	•	•	•	•	•
JK4AF**	•	•	•	•	•
JK4BE*	•	•	•	•	•
JK4BF**	•	•	•	•	•
JK4CE*	•	•	•	•	•
JK4CF**	•	•	•	•	•
JK4N9*	•	•	•	•	•
JK4NE*	•	•	•	•	•
JK4NH*	•	•	•	•	•
JK4NV**	•	•	•	•	•

Frame J

	J Frame				
	S45B	S51B	S60B	S65C	S75C
JK4NZ*	•	•	•	•	•
JK4RE*	•	•	•	•	•

* NNN Displacement limiter options only

	J Frame				
	S45B	S51B	S60B	S65C	S75C
JK4RF**	•	•	•	•	•
JK4TE*	•	•	•	•	•
JK4VE*	•	•	•	•	•
JS1AE*	•	•	•	•	•
JS1AF**	•	•	•	•	•
JS1AY*	•	•	•	•	•
JS1BE*	•	•	•	•	•
JS1BF**	•	•	•	•	•
JS1CE*	•	•	•	•	•
JS1CF**	•	•	•	•	•
JS1DX*	•	•	•	•	•
JS1N9*	•	•	•	•	•
JS1NE*	•	•	•	•	•
JS1NH*	•	•	•	•	•
JS1NV**	•	•	•	•	•
JS1NX*	•	•	•	•	•
JS1NZ*	•	•	•	•	•
JS1RE*	•	•	•	•	•
JS1RF**	•	•	•	•	•
JS1TE*	•	•	•	•	•
JS1TF**	•	•	•	•	•
JS1VE*	•	•	•	•	•
JS1VF*	•	•	•	•	•
JT0AE*	•	•	•	•	•
JT0BE*	•	•	•	•	•
JT0BF*	•	•	•	•	•
JT0CE*	•	•	•	•	•
JT0N9*	•	•	•	•	•
JT0NE*	•	•	•	•	•
JT0NH*	•	•	•	•	•
JT0NV**	•	•	•	•	•
JT0NZ*	•	•	•	•	•
JT0RE*	•	•	•	•	•
JT0TE*	•	•	•	•	•
JT0VE*	•	•	•	•	•

Frame J

	J Frame				
	S45B	S51B	S60B	S65C	S75C
JT0VF**	•	•	•	•	•

** FFF Displacement limiter options only

K Shaft seal

		J Frame				
		S45B	S51B	S60B	S65C	S75C
A	Single (Viton)	•	•	•	•	•

K Mounting flange and housing port style

2	SAE-C Flange 4-bolt/SAE O-ring boss port	•	•	•	•	•
8	SAE-B Flange 2-bolt/SAE O-ring boss ports	•	•	•	•	•
9	SAE-C Flange 2-bolt/SAE O-ring boss ports	•	•	•	•	•
F	SAE-C Flange 2-bolt rotated 90° SAE O-ring boss ports	•	•	•	•	•

K Angle Sensor Housing

N	Not applicable	•	•	•	•	•
R	Angle Sensor Housing, Right Hand Side	•	•	•	•	•

L Displacement limiter

NNN	None	•	•	•	•	•
FFF	Adjustable, factory set at max angle	•	•	•	•	•

M Special hardware

JJJ	None	•	•	•	•	•
ANS	Angle Sensor Swashplate	•	•	•	•	•

N Special features

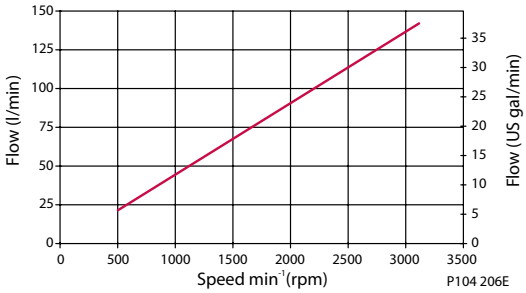
NNN	None	•	•	•	•	•

Performance J45B

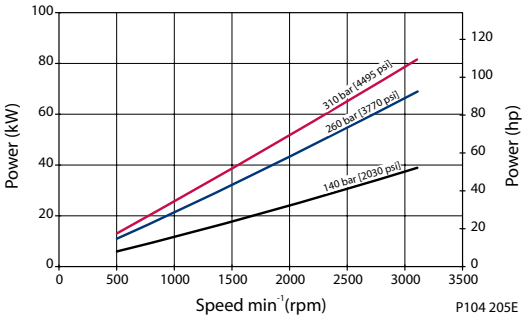
Flow and power data valid at 49°C [120°F] and viscosity of 17.8 mm^2/sec [88 SUS].

Frame J

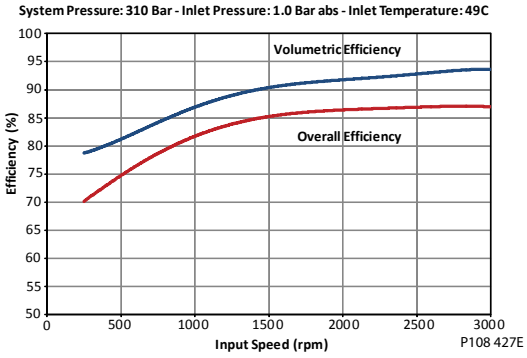
Flow vs. speed



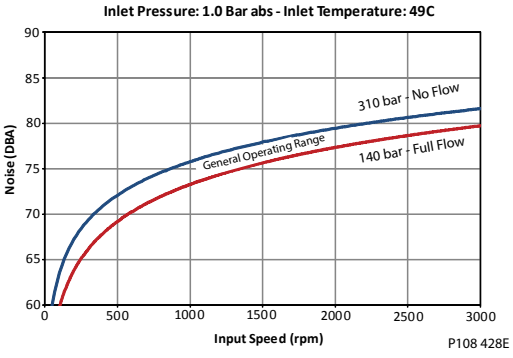
Input power vs. speed



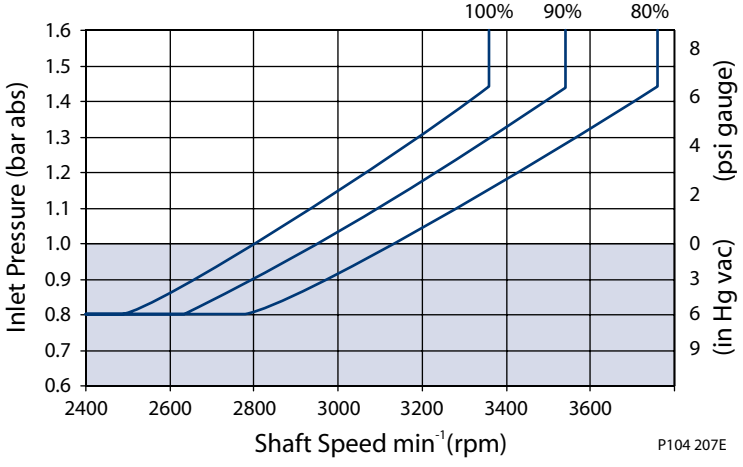
Efficiency



Noise



Inlet pressure vs. speed



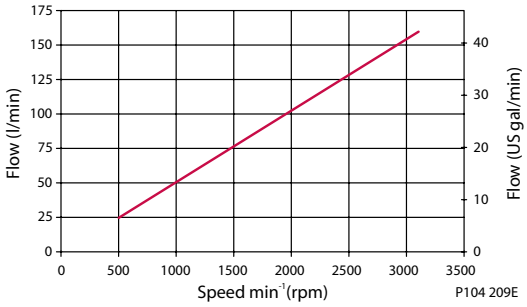
The chart above shows allowable inlet pressure and speed at various displacements. Greater speeds and lower inlet pressures are possible at reduced displacement. Operating outside of acceptable limits reduces pump life.

Frame J

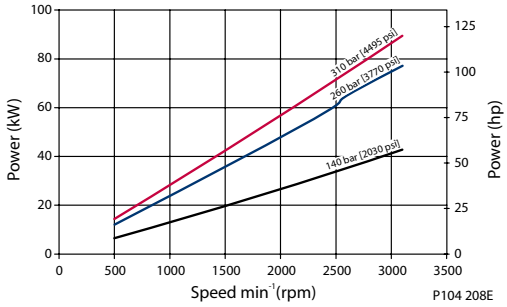
Performance J51B

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

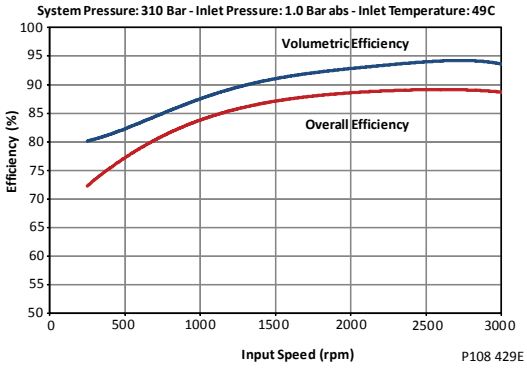
Flow vs. speed



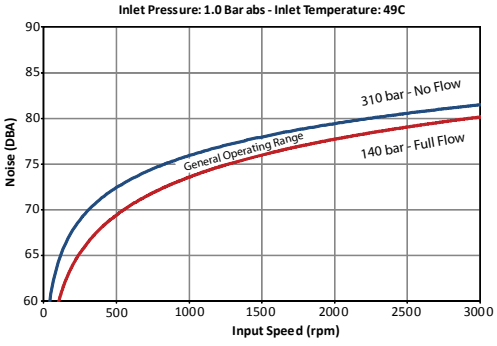
Input power vs. speed



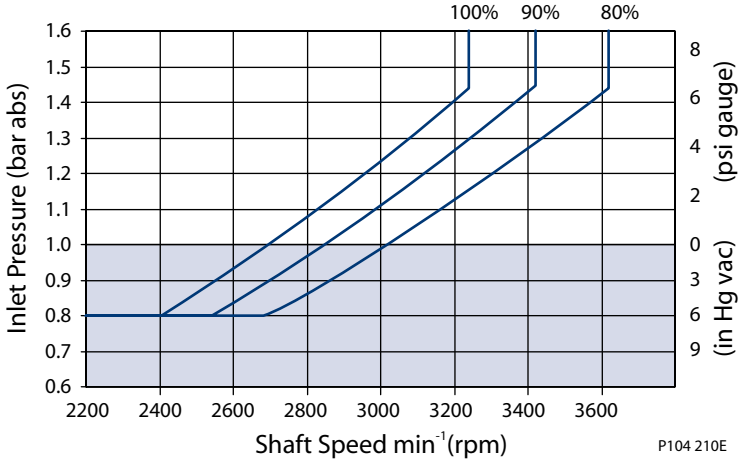
Efficiency



Noise



Inlet pressure vs. speed



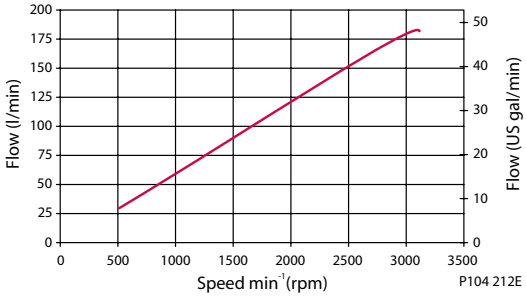
Frame J

The chart above 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.

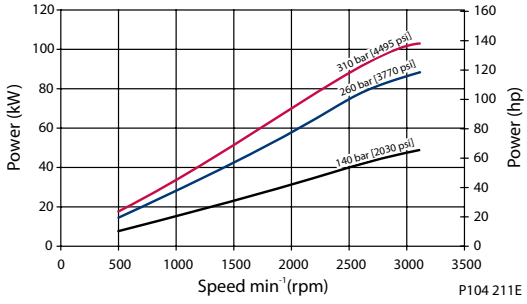
Performance J60B

Flow and power data valid at 49°C [120°F] and viscosity of 17.8 mm^2/sec [88 SUS].

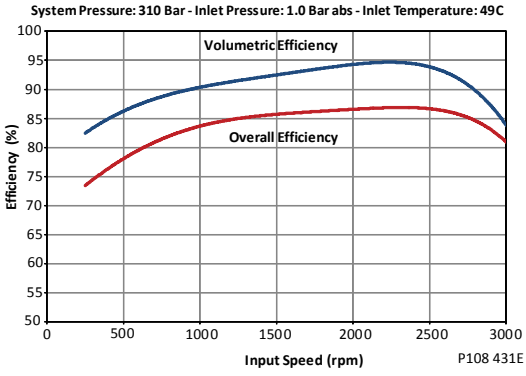
Flow vs. speed



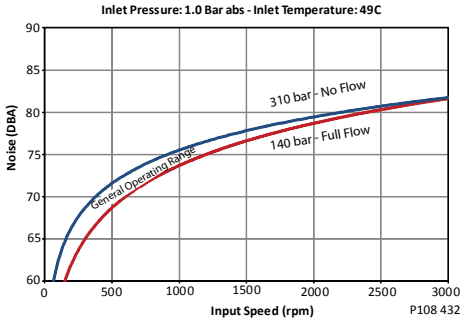
Input power vs. speed



Efficiency

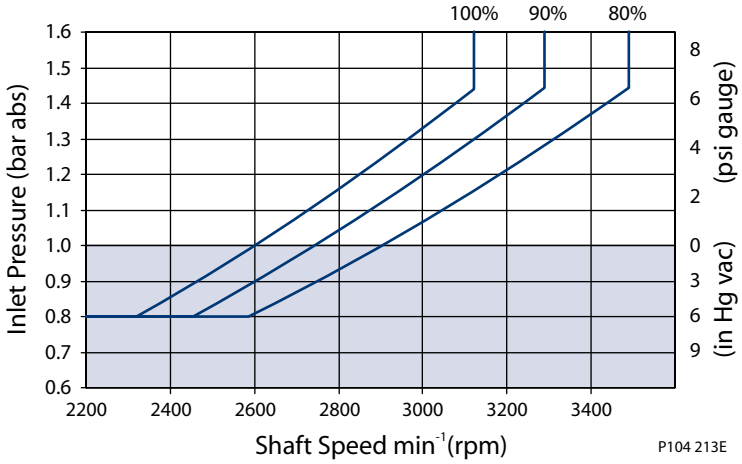


Noise



Frame J

Inlet pressure vs. speed

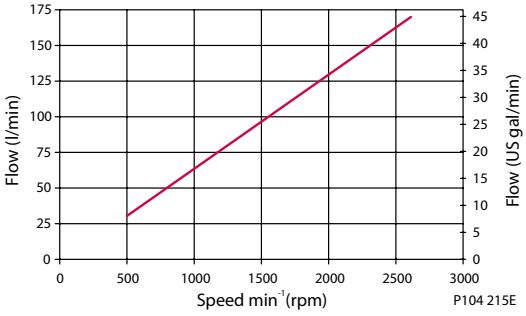


The chart above shows allowable inlet pressure and speed at various displacements. Greater speeds and lower inlet pressures are possible at reduced displacement. Operating outside of acceptable limits reduces pump life.

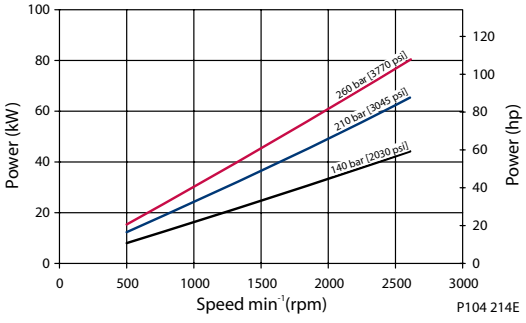
Performance J65C

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

Flow vs. speed

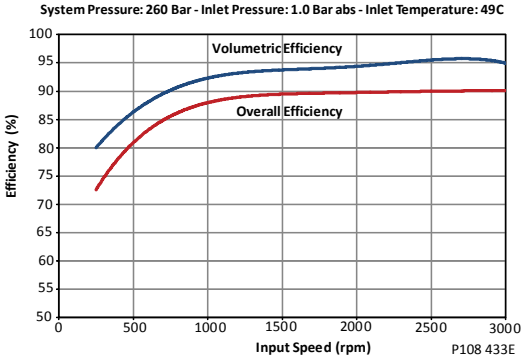


Input power vs. speed

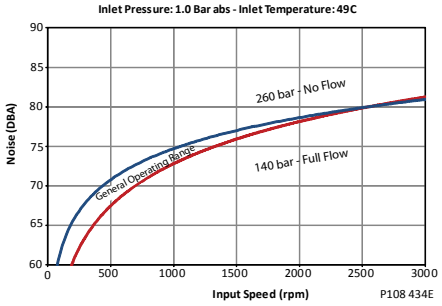


Frame J

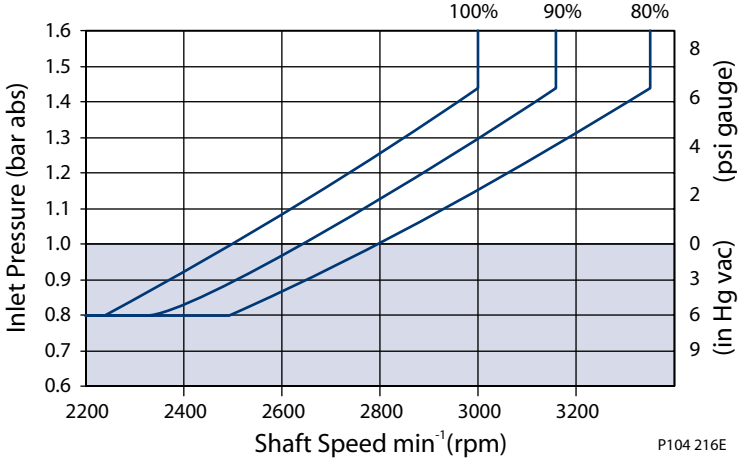
Efficiency



Noise



Inlet pressure vs. speed



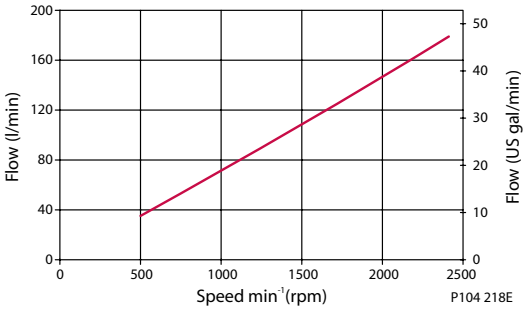
The chart above shows allowable inlet pressure and speed at various displacements. Greater speeds and lower inlet pressures are possible at reduced displacement. Operating outside of acceptable limits reduces pump life.

Performance J75C

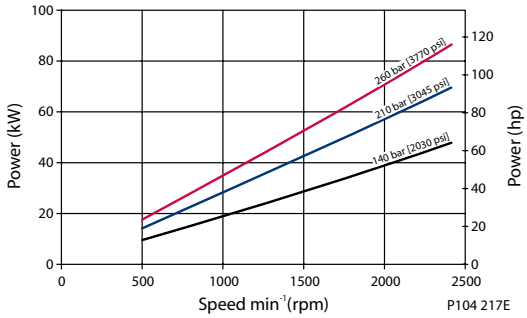
Flow and power data valid at 49°C [120°F] and viscosity of 17.8 mm^2/sec [88 SUS].

Frame J

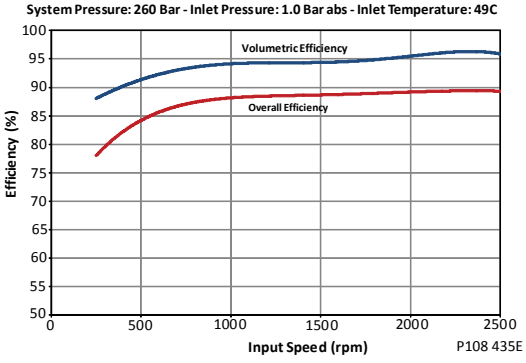
Flow vs. speed



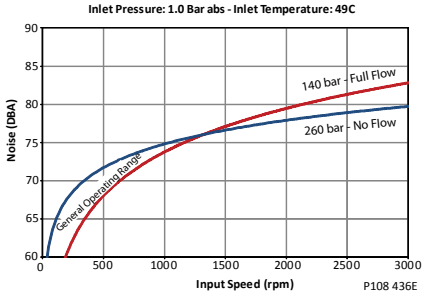
Input power vs. speed



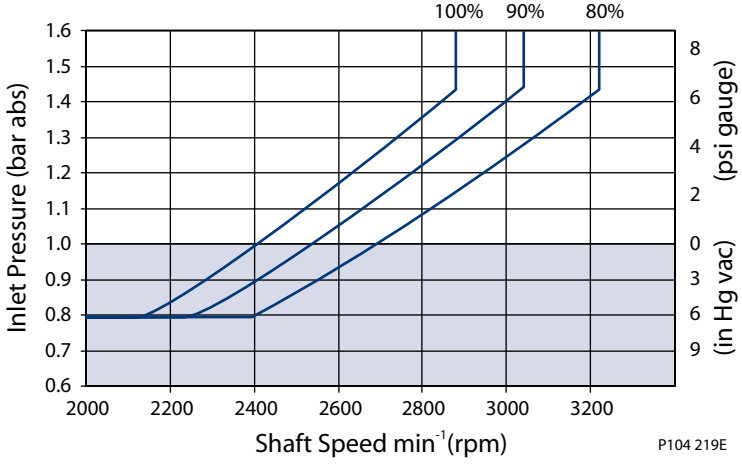
Efficiency



Noise



Inlet pressure vs. speed



The chart above 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.

Frame J

Hydrauilic Controls

Pressure Compensated Controls

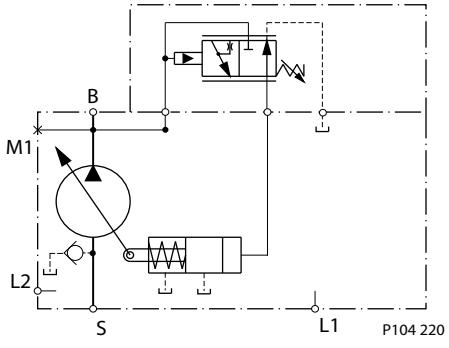
*Response/Recovery Times**

(msec)	Response	Recovery
J45B	33	140
J51B	33	150
J60B	39	170
J65C	45	140
J75C	45	150

PC Setting range

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

Schematic



B = Outlet

S = Inlet

L1, L2 = Case drain

M1* = System pressure gauge port

* M1 port is available on axially ported endcaps only

Remote Pressure Compensated Controls

*Response/Recovery Times**

(msec)	Response	Recovery
J45B	33	140

Frame J

Response/Recovery Times (continued)*

(msec)	Response	Recovery
J51B	33	150
J60B	39	170
J65C	45	140
J75C	45	150

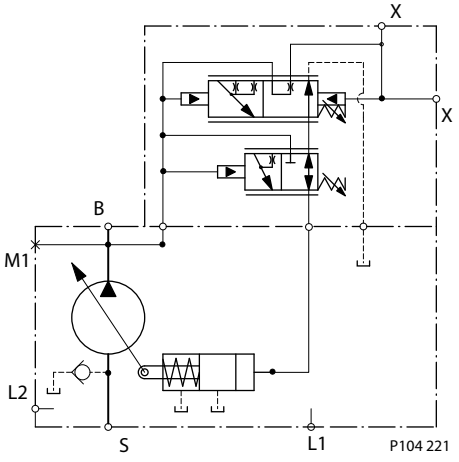
PC Setting Range

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

LS Setting range

Model	bar	psi
All	10-40	145-580

Schematic



B = Outlet

S = Inlet

L1, L2 = Case drain

X = Remote PC port

M1* = System pressure gauge port

* M1 port is available on axially ported endcaps only

Frame J

Load sensing/Pressure compensated Controls

*Response/Recovery Times**

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

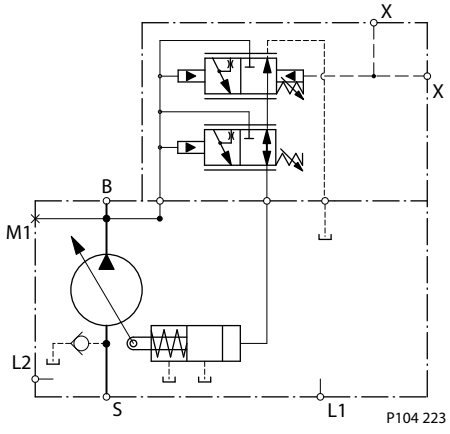
PC control setting range

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

LS setting range

Model	bar	psi
All	10-40	145–580

Schematic



B = Outlet

S = Inlet

L1, L2 = Case drain

X = LS signal port

M1* = System pressure gauge port

Frame J

* M1 port is available on axially ported endcaps only

Load sensing Control with Bleed Orifice/ Pressure Compensated

*Response/Recovery Times**

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

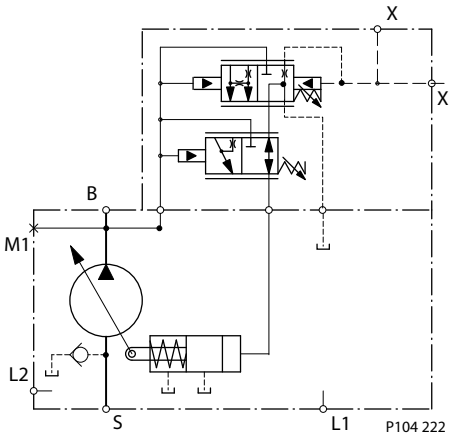
PC control setting range

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

LS setting range

Model	bar	psi
All	10-40	145–580

Schematic



B = Outlet

S = Inlet

L1, L2 = Case drain

X = LS signal port

Frame J

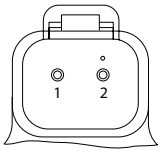
M1* = System pressure gauge port

* M1 port is available on axially ported endcaps only

Electric Controls

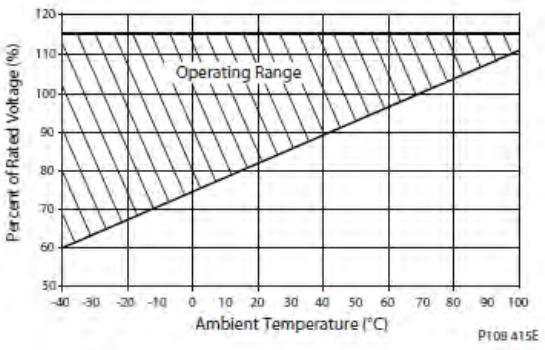
Connectors

Description	Quantity	Ordering Number
Mating Connector	1	Deutsch® DT06-2S
Wedge Lock	1	Deutsch® W25
Socket Contact (16 and 18 AWG)	2	Deutsch® 0462-201-16141
Danfoss mating connector kit	1	K29657



P003 480

Continuous Duty Operating Range



Solenoid Data - Normally Closed

Voltage	12V	24V
Threshold Control [mA] (310/260 bar PC setting, oil temp X)	200/400	100/200
End Current [mA] (20 bar LS setting, oil temp X)	1200	600

Solenoid Data - Normally Open

Voltage	12V	24V
Threshold Control [mA] (20 bar LS setting, oil temp X)	0	0
End Current [mA] (260/310 bar PC setting, oil temp X)	1000/1100	500/550

Frame J

Hysteresis

Frame	Hysteresis
J45B, J51B, J60B	Input hysteresis <4% (control current): Output hysteresis <4.5% (system pressure)
J65C, J75C	Input hysteresis <4% (control current): Output hysteresis <4.5% (system pressure)

Normally Closed Electric On/Off with Pressure Compensation Controls

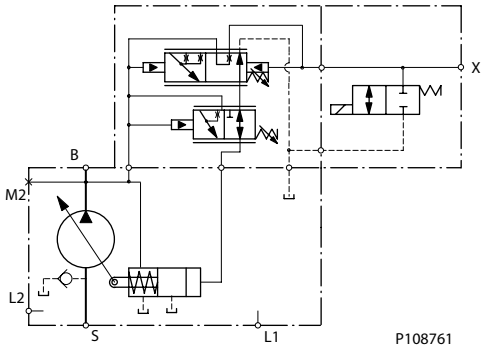
*Response/Recovery times**

(msec)	Response	Recovery
J45B	33	140
J51B	33	150
J60B	39	170
J65C	45	140
J75C	45	150

* Without servo control orifice

For fan-drive systems, and systems with motors, select an LS setting no less than15 bar to enhance system stability. As the LS setting is reduced, the risk for system instability may be increased. A 20 bar LS setting is recommended as a starting point for all new applications.

Schematic



B = Outlet

S = Inlet

L1, L2 = Case drain

M2 = System pressure gauge port

X = Load Sense Port

LS setting range

Model	bar	psi
All	10 - 40	[145 - 580]

Frame J

PC setting range

Frame	AG, AR (12V)	BE, BR (12V)	AY, CR (24V)	BG, DR (24V)
J45B	100-280 bar [1450-4060] psi	290-310 bar [4205-4495] psi	100-280 bar [1450-4060] psi	290-310 bar [4205-4495] psi
J51B				
J60B				
J65C	100-260 bar [1450-3770] psi	Not Available	100-260 bar [1450-3770] psi	Not Available
J75C				

Normally Open Electric On/Off with Pressure Compensation Controls

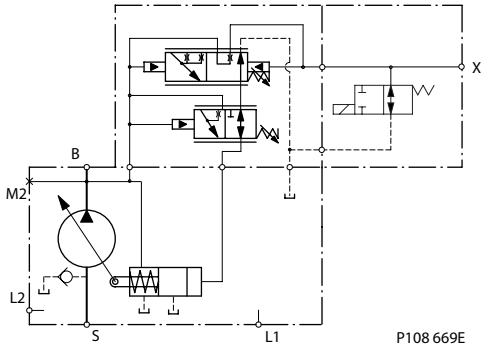
*Response/Recovery times**

(msec)	Response	Recovery
J45B	33	140
J51B	33	150
J60B	39	170
J65C	45	140
J75C	45	150

* Without servo control orifice

For fan-drive systems, and systems with motors, select an LS setting no less than15 bar to enhance system stability. As the LS setting is reduced, the risk for system instability may be increased. A 20 bar LS setting is recommended as a starting point for all new applications.

Schematic



B = Outlet

S = Inlet

L1, L2 = Case drain

M2 = System pressure gauge port

X = Load Sense Port

LS setting range

Model	bar	psi
All	10 - 40	[145 - 580]

Frame J

PC setting range

Frame	AF, AN (12V)	BF, BN (12V)	AT, CN (24V)	DF, DN (24V)
J45B	100-280 bar [1450-4060] psi	290-310 bar [4205-4495] psi	100-280 bar [1450-4060] psi	290-310 bar [4205-4495] psi
J51B				
J60B				
J65C	100-260 bar [1450-3770] psi	Not Available	100-260 bar [1450-3770] psi	Not Available
J75C				

Normally Closed Electric Proportional with Pressure Compensation Controls

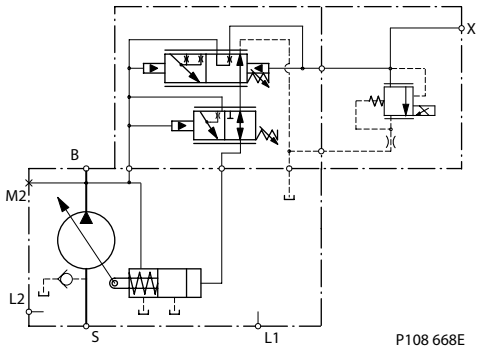
Response/Recovery times

	0.8mm Orifice		1.0mm Orifice	
(msec)	Response	Recovery	Response	Recovery
J45B	33	425	33	325
J51B	33	455	33	325
J60B	39	515	39	395
J65C	45	425	45	325
J75C	45	455	45	350

LS setting range

Model	bar	psi
All	10 - 40	[145 - 580]

Schematic



B = Outlet

S = Inlet

L1, L2 = Case drain

M2 = System pressure gauge port

X = Load Sense Port

Frame J

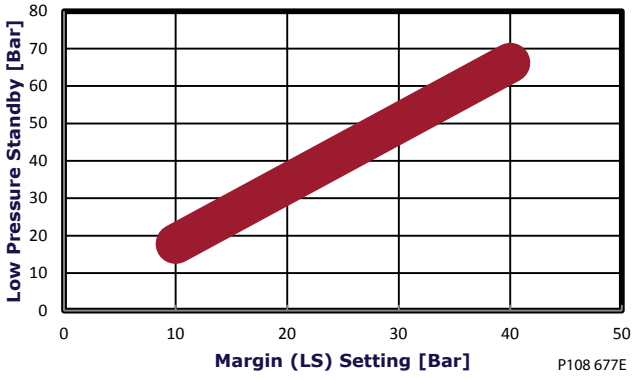
PC setting range

Frame	AH, AV (12V)	BH, BM (12V)	AK, AL (24V)	BK, BL (24V)
J45B	100-280 bar [1450-4060] psi	290-310 bar [4205-4495] psi	100-280 bar [1450-4060] psi	290-310 bar [4205-4495] psi
J51B				
J60B				
J65C	100-260 bar [1450-3770] psi	Not Available	100-260 bar [1450-3770] psi	Not Available
J75C				

For fan-drive systems, and systems with motors, select an LS setting no less than15 bar to enhance system stability. As the LS setting is reduced, the risk for system instability may be increased. A 20 bar LS setting is recommended as a starting point for all new applications.

Electric proportional controls have a unique relationship between margin (LS) setting and low pressure standby. See the graph below for this relationship.

Frames E, F, J Electric Proportional Control
Low Pressure Standby



Normally Open Electric Proportional with Pressure Compensation Controls

Response/Recovery times

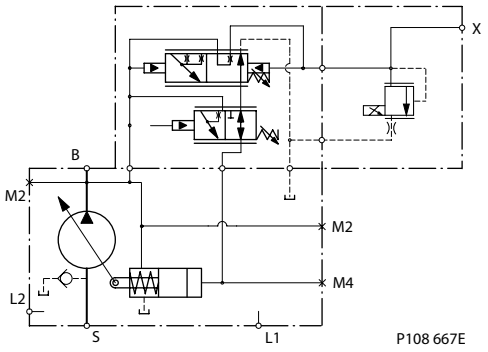
	0.8mm Orifice		1.0mm Orifice	
(msec)	Response	Recovery	Response	Recovery
J45B	33	425	33	325
J51B	33	455	33	325
J60B	39	515	39	395
J65C	45	425	45	325
J75C	45	455	45	350

LS setting range

Model	bar	psi
All	10 - 40	[145 - 580]

Frame J

Schematic



B = Outlet

S = Inlet

L1, L2 = Case drain

M2 = System pressure gauge port

X = Load Sense Port

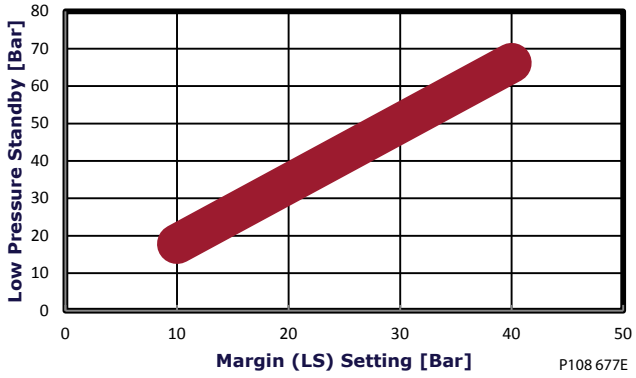
PC setting range

Frame	AW, AX (12V)	BW, BX (12V)	CK, CL (24V)	DK, DL (24V)
J45B	100-280 bar [1450-4060] psi	290-310 bar [4205-4495] psi	100-280 bar [1450-4060] psi	290-310 bar [4205-4495] psi
J51B				
J60B				
J65C	100-260 bar [1450-3770] psi	Not Available	100-260 bar [1450-3770] psi	Not Available
J75C				

For fan-drive systems, and systems with motors, select an LS setting no less than15 bar to enhance system stability. As the LS setting is reduced, the risk for system instability may be increased. A 20 bar LS setting is recommended as a starting point for all new applications.

Electric proportional controls have a unique relationship between margin (LS) setting and low pressure standby. See the graph below for this relationship.

Frames E, F, J Electric Proportional Control Low Pressure Standby



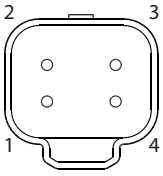
Frame J

Normally Closed Electric Torque Limiting Control with Pressure Compensation Controls

*Response/Recovery Times**

(msec)	Response	Recovery
J45B	33	140
J51B	33	150
J60B	39	170
J65C	45	140
J75C	45	150

Pin location



P200 151

Pinout

Pin	Description
1	Supply -
2	Ouput signal 2 - Secondary Signal
3	Output signal 1 - Primary Signal
4	Supply +

PC setting range

Frame	TA, TE (12V)	TC, TG (12V)	TB, TF (24V)	TD, TH (24V)
J45B	100-280 bar [1450-4060] psi	290-310 bar [4205-4495] psi	100-280 bar [1450-4060] psi	290-310 bar [4205-4495] psi
J51B				
J60B				
J65C	100-260 bar [1450-3770] psi	Not Available	100-260 bar [1450-3770] psi	Not Available
J75C				

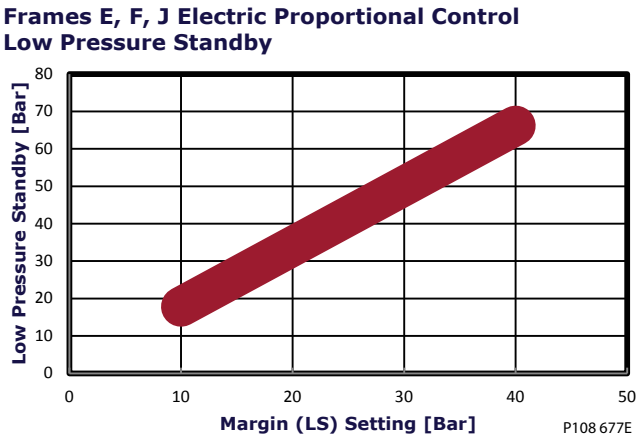
LS setting range

Model	bar	psi
All	10 - 40	[145 - 580]

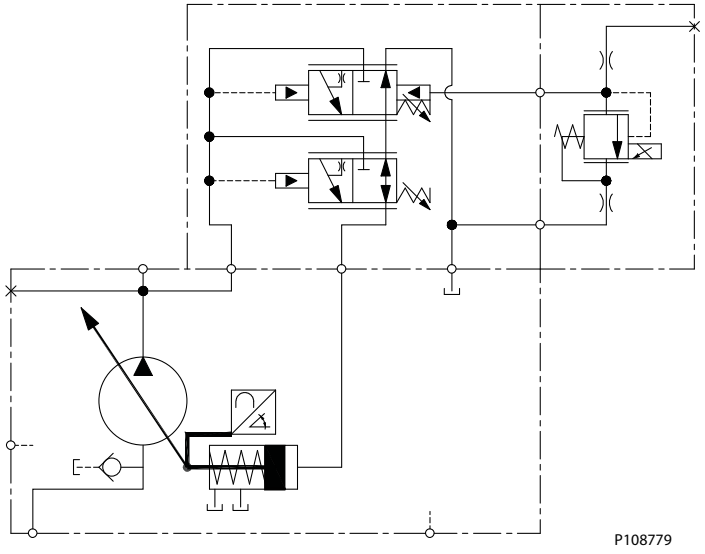
For fan-drive systems, and systems with motors, select an LS setting no less than15 bar to enhance system stability. As the LS setting is reduced, the risk for system instability may be increased. A 20 bar LS setting is recommended as a starting point for all new applications.

Electric Torque Limiting controls have a unique relationship between margin (LS) setting and low pressure standby. See the graph below for this relationship.

Frame J

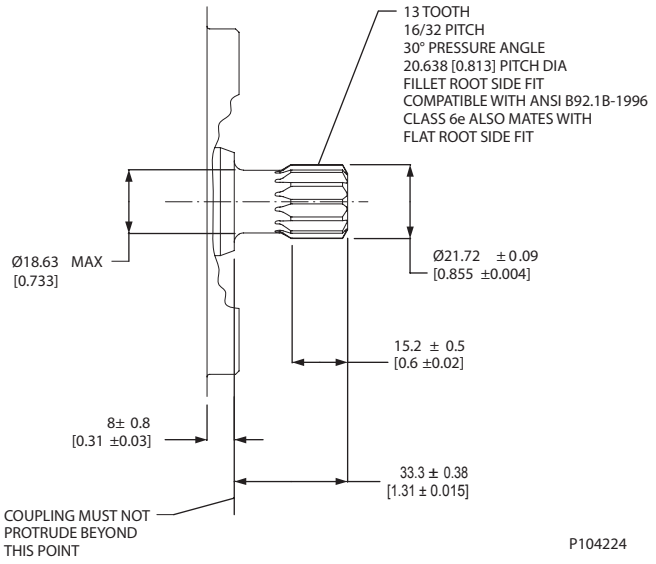
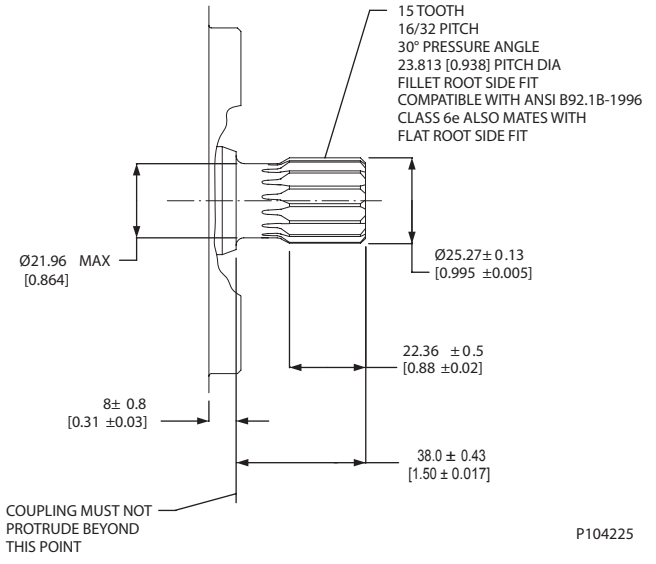


J-frame pump with integrated ETL control



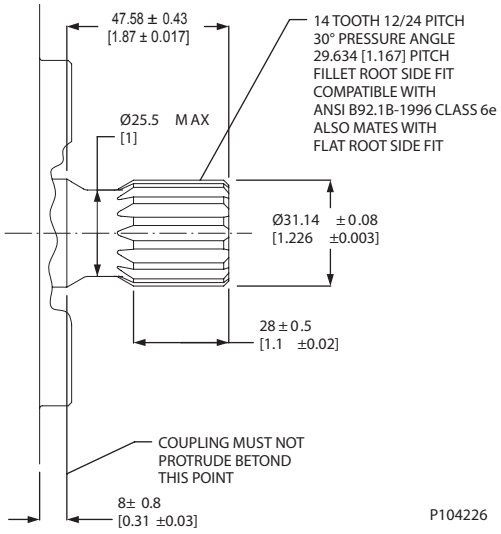
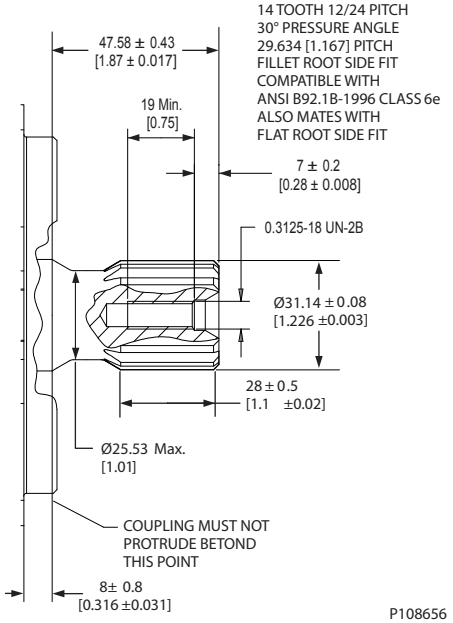
Frame J

Input shafts

Code	Description	Maximum torque rating[1] N•m [lbf•in]	Drawing
C2	13 tooth spline 16/32 pitch (ANSI A92.1B 1996 - Class 6e) For use with SAE-B	288 [2546]	
C3	15 tooth spline 16/32 pitch (ANSI A92.1B 1996 - Class 6e) For use with SAE-B	404 [3575]	

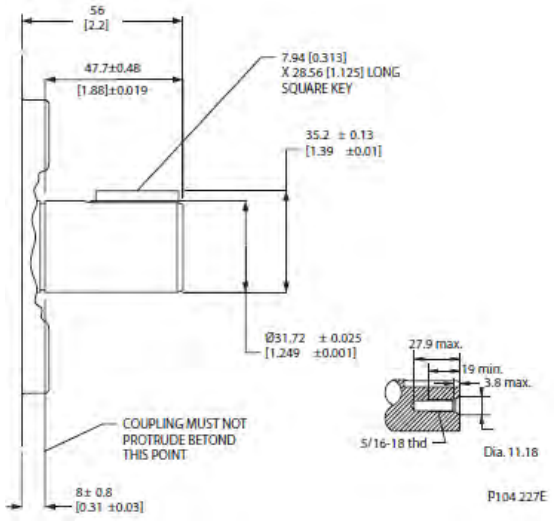
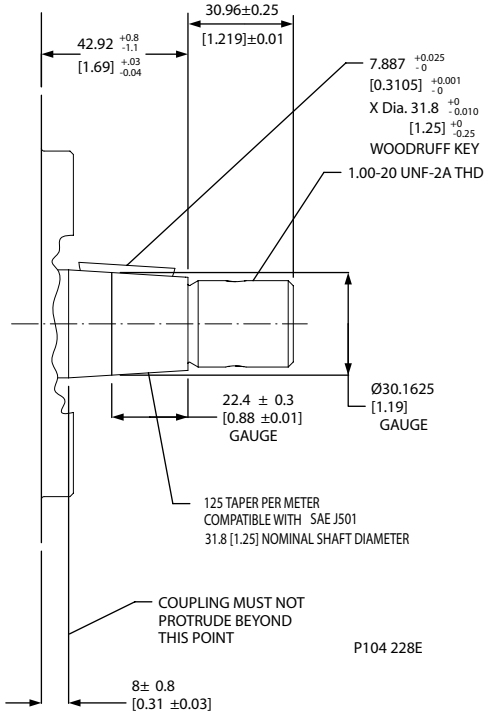
1. See *Input shaft torque ratings* for an explanation of maximum torque.

Frame J

Code	Description	Maximum torque rating[1] N•m [lbf•in]	Drawing
S1	14 tooth spline 12/24 pitch (ANSI A92.1B 1996 - Class 6e)	800 [7080]	
S5	14 tooth spline 12/24 pitch (ANSI A92.1B 1996 - Class 6e)	800 [7080]	

1. See *Input shaft torque ratings* for an explanation of maximum torque.

Frame J

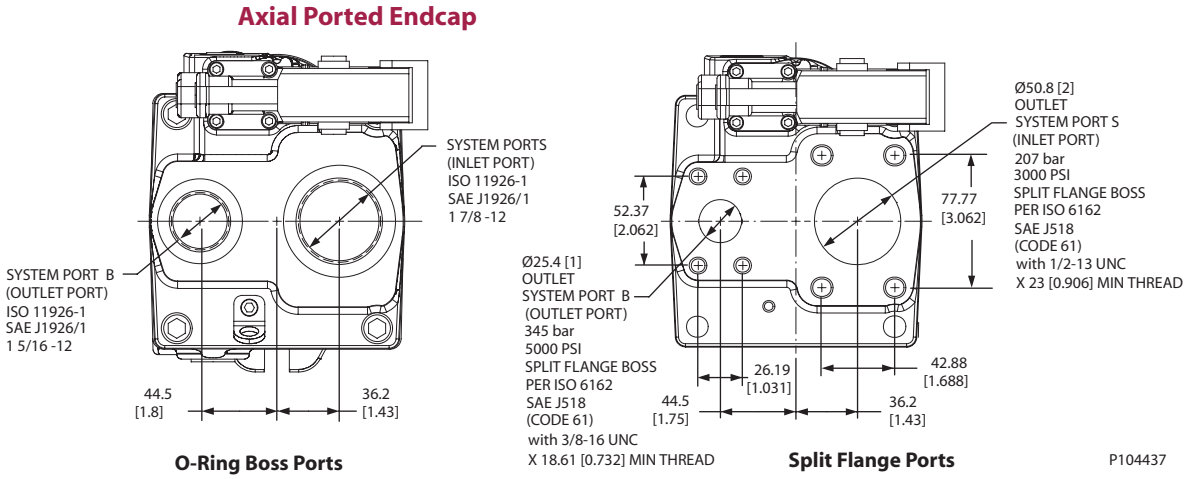
Code	Description	Maximum torque rating[1] N•m [lbf•in]	Drawing
K4	Ø 31.75 mm [1.25 in] straight key	655 [5797]	
TO	Ø 31.75 mm [1.25 in] 1:8 taper	734 [6495]	

1. See *Input shaft torque ratings* for an explanation of maximum torque.

Frame J

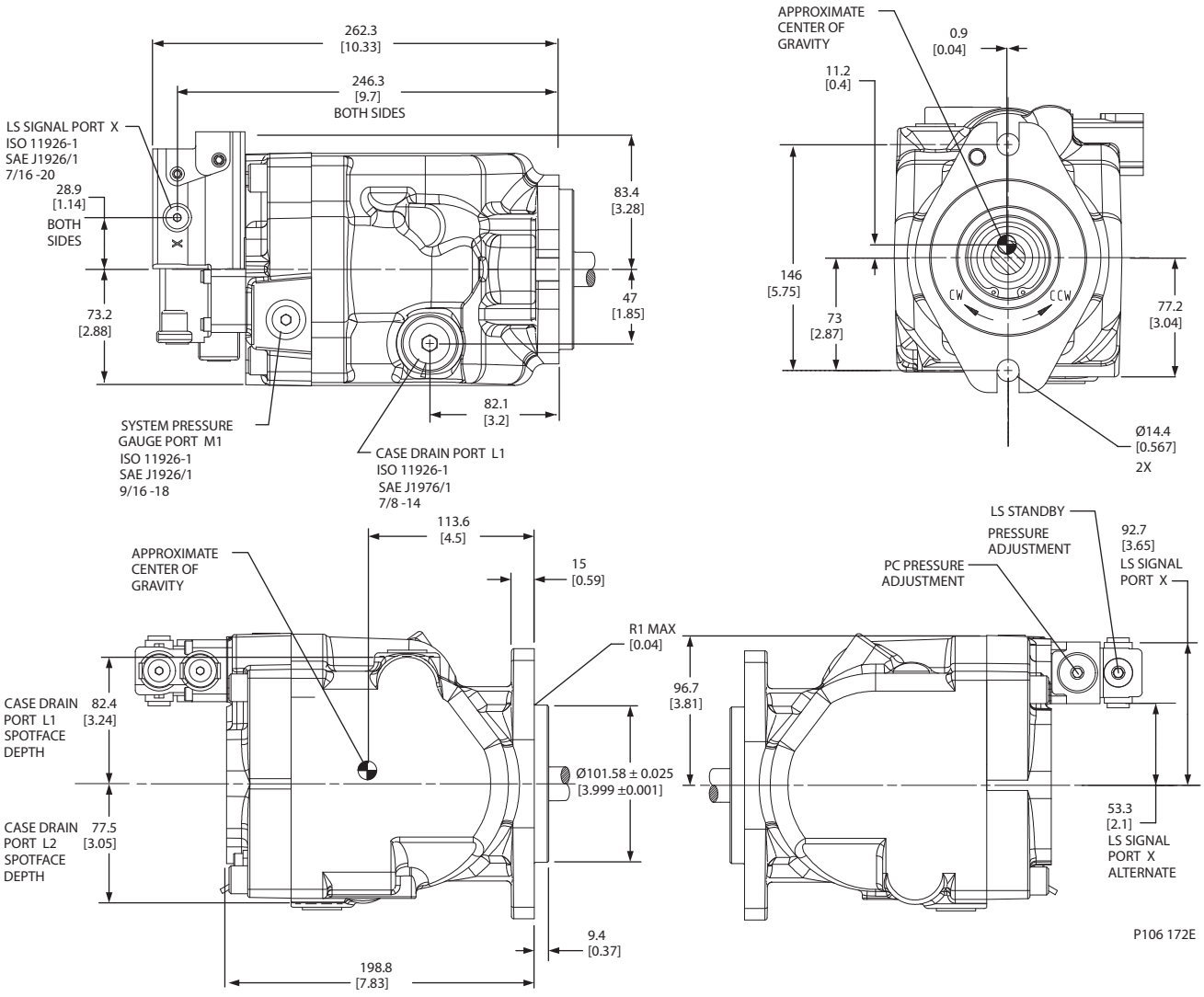
Installation drawings

Axial Ported Endcap



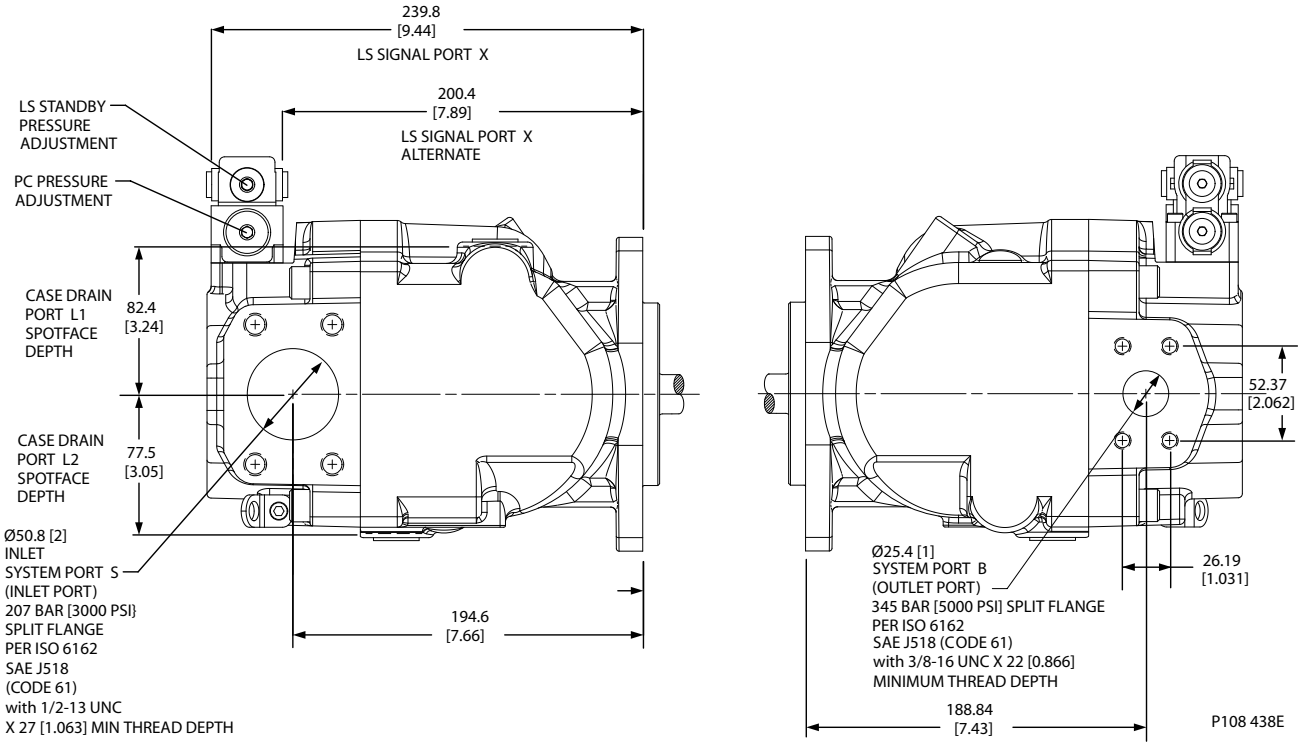
Frame J

Axial Ported Endcap Installation Dimensions



Frame J

Radial Ported Endcap Split Flange Ports

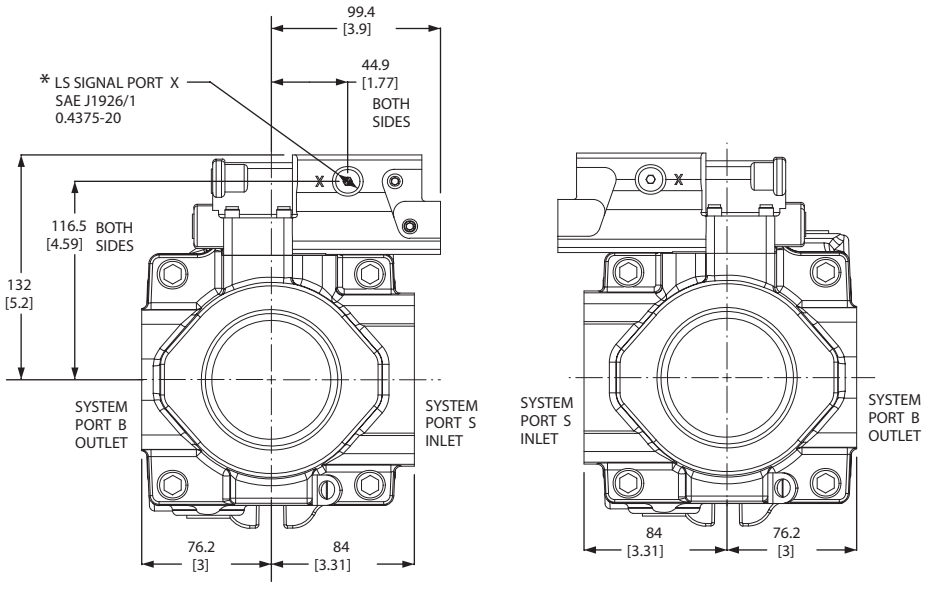


Frame J

Radial Ported Endcap Rear View

Radial Ported Endcap Rear View

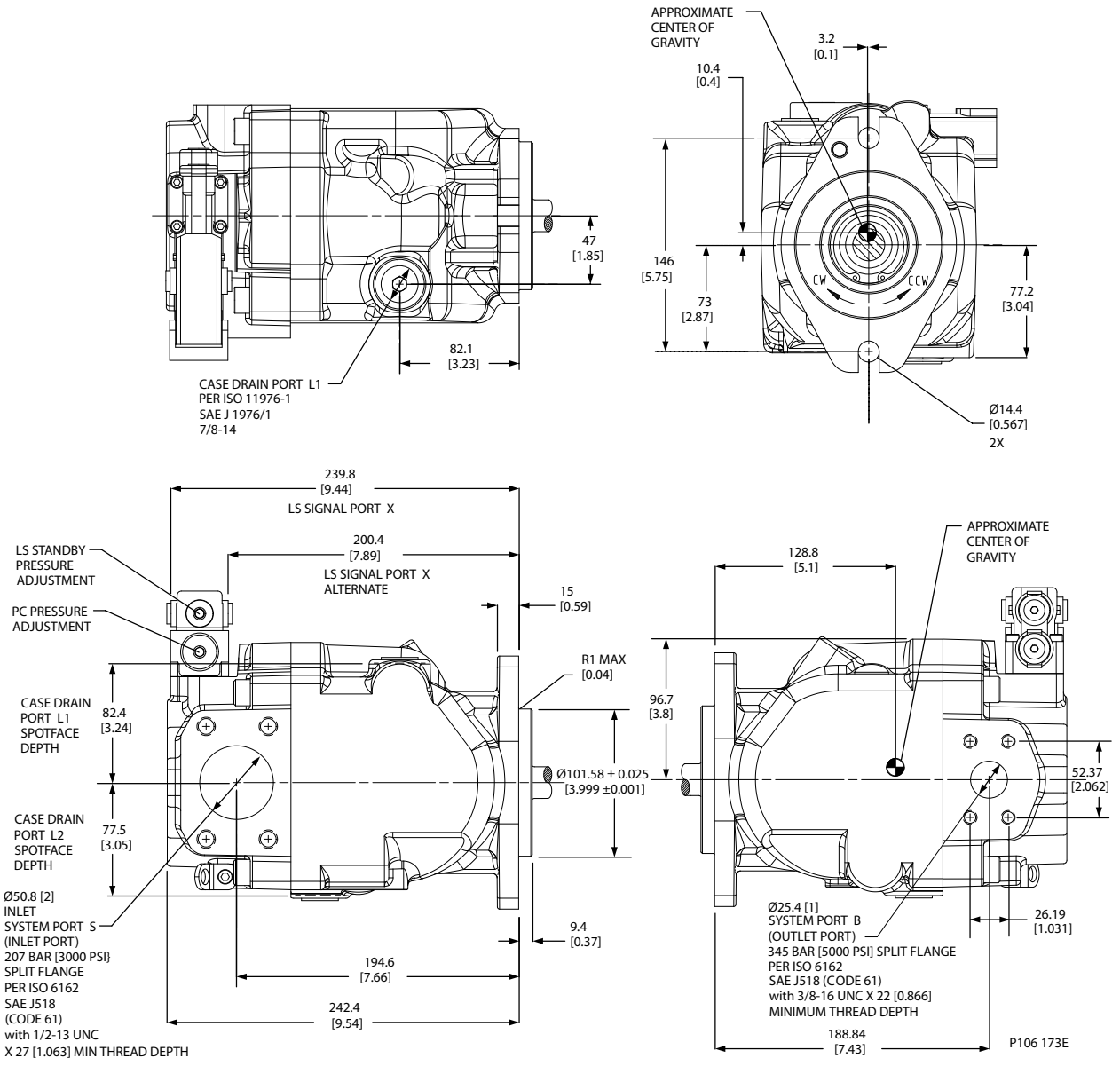
* Interference with internal components will occur if fitting depth in port X is greater than 11.8 mm [0.465 in]



Left Hand Rotation (CCW) **Right Hand Rotation (CW)** P108438

Frame J

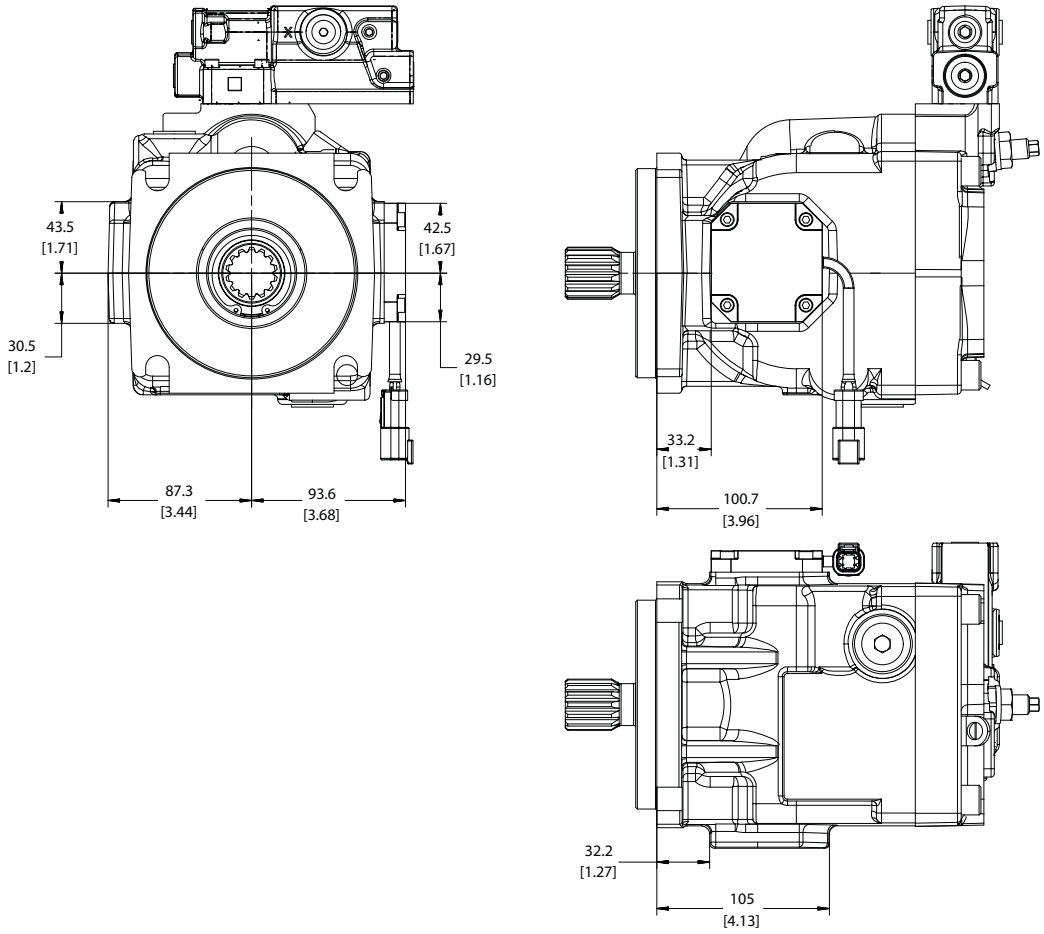
Radial Ported Endcap Installation Dimensions



Frame J

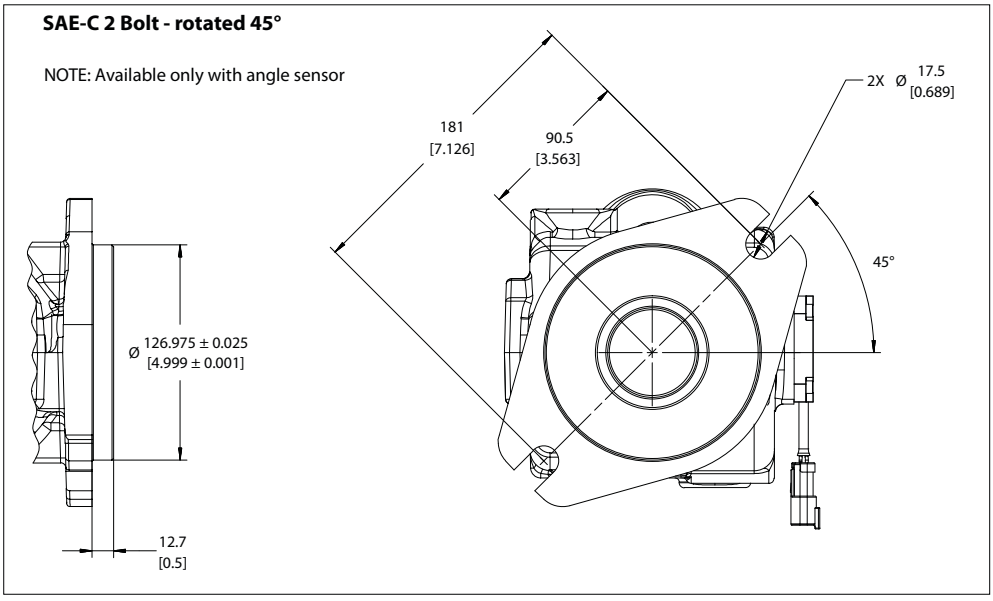
Right Angle Sensor Position Installation Dimensions

SAE-C 4 Bolt



SAE-C 2 Bolt - rotated 45°

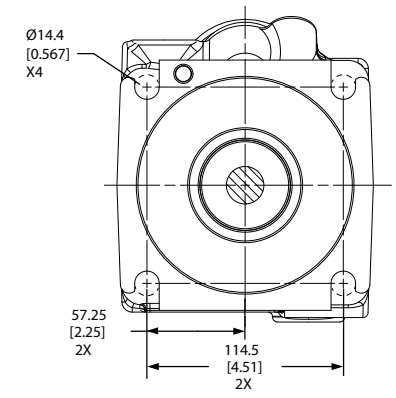
NOTE: Available only with angle sensor



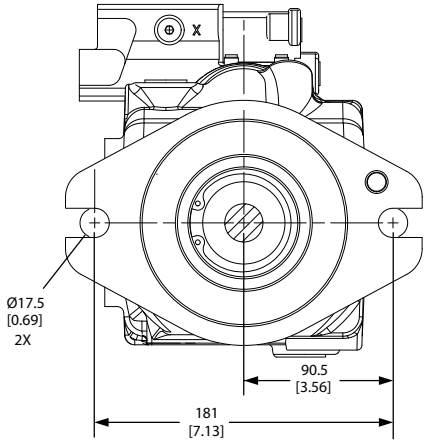
P108780

Frame J

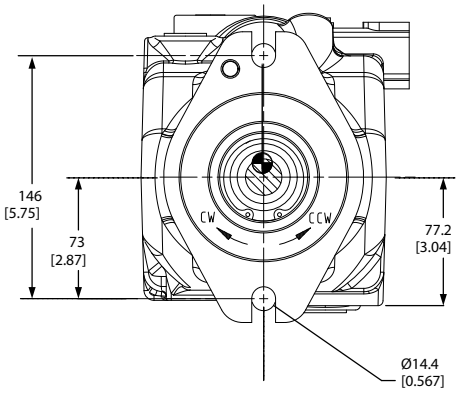
Front Mounting Flange



SAE-C 4 Bolt



SAE-C 2 Bolt



SAE-B 2 Bolt

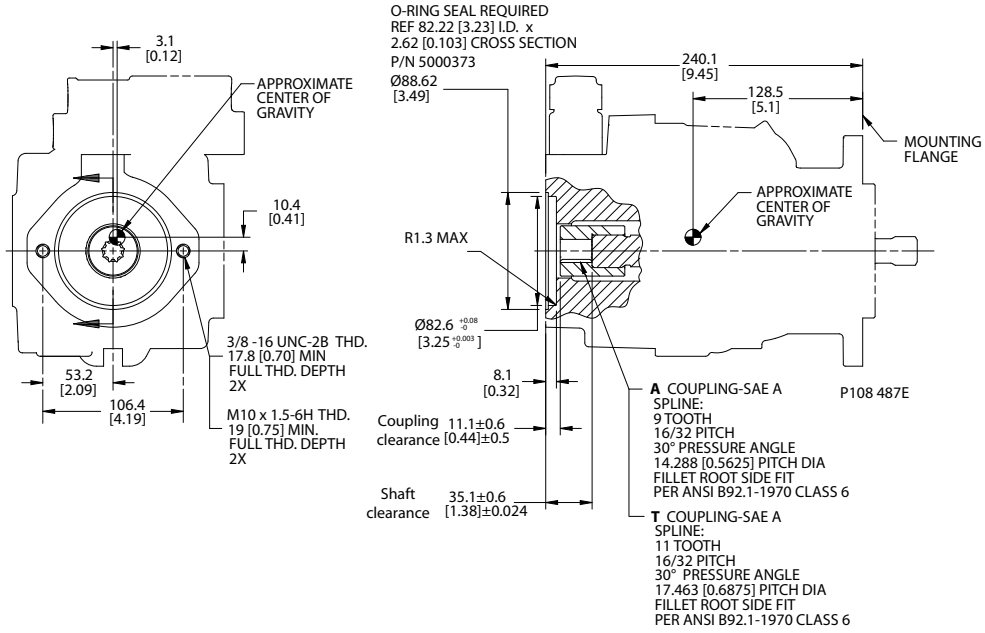
P108 440E

Frame J

Auxiliary mounting pads

SAE-A auxiliary mounting pad (integrated)

Dimensions



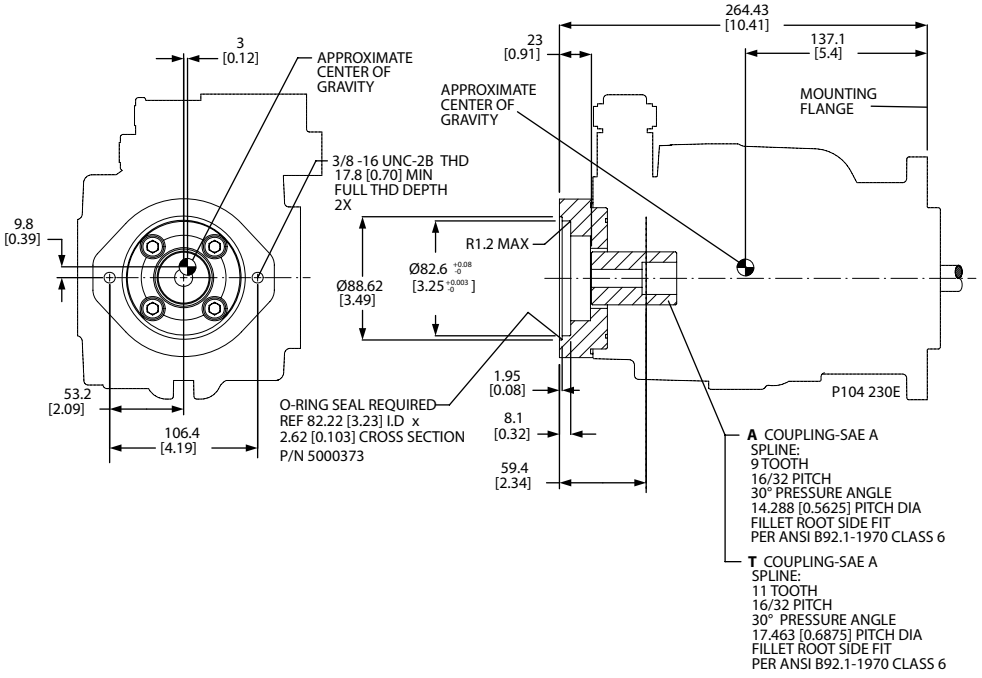
Specifications

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]

Frame J

SAE-A auxiliary mounting pad (non-integral)

Dimensions



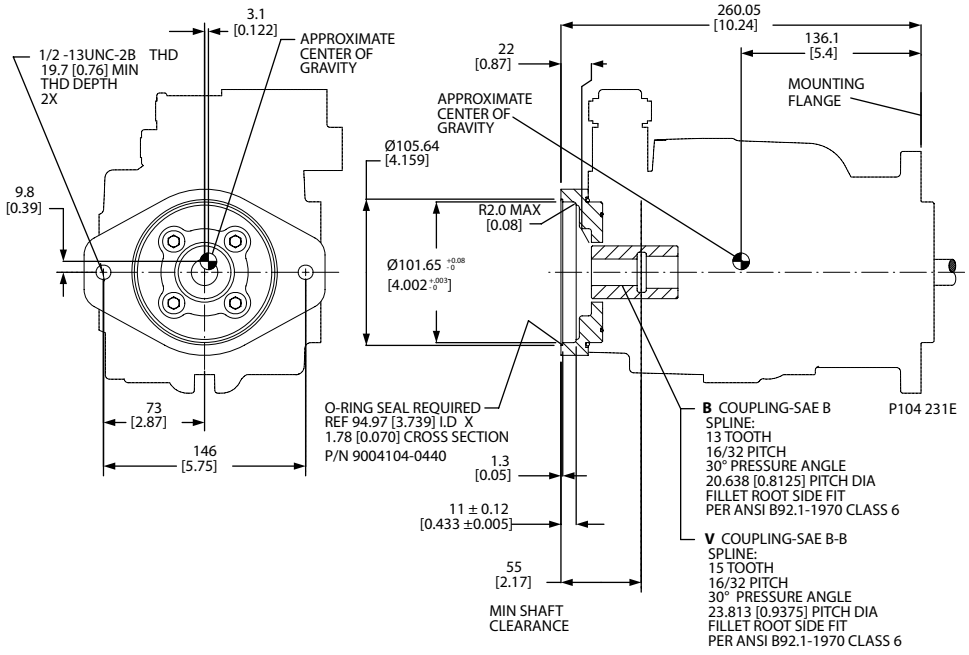
Specifications

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]

Frame J

SAE-B auxiliary mounting pad

Dimensions

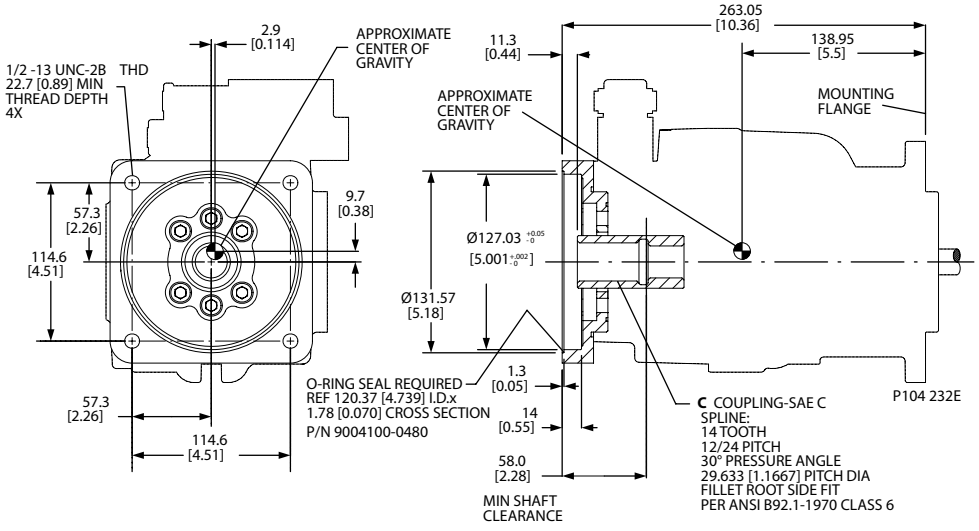


Specifications

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]

SAE-C auxiliary mounting pad

Dimensions



Specifications

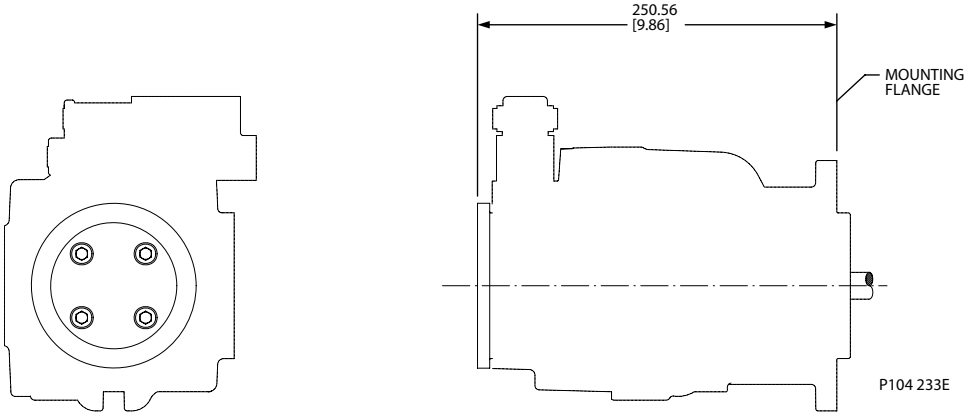
Coupling	14-tooth

Frame J

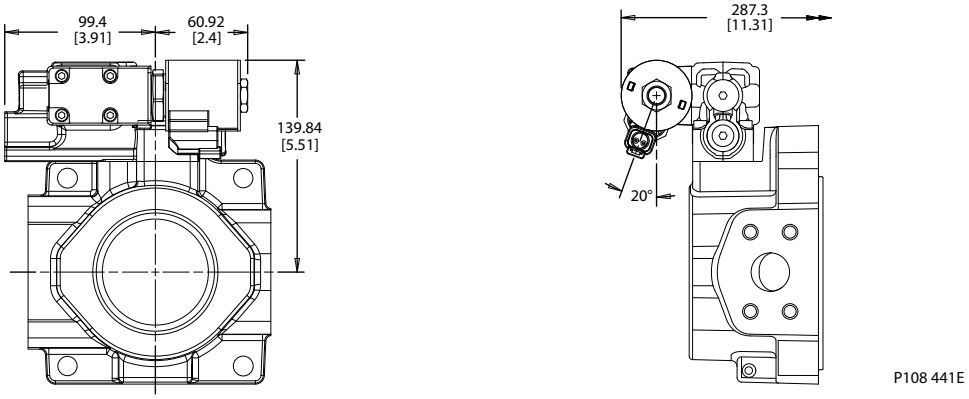
Specifications (continued)

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

Running cover

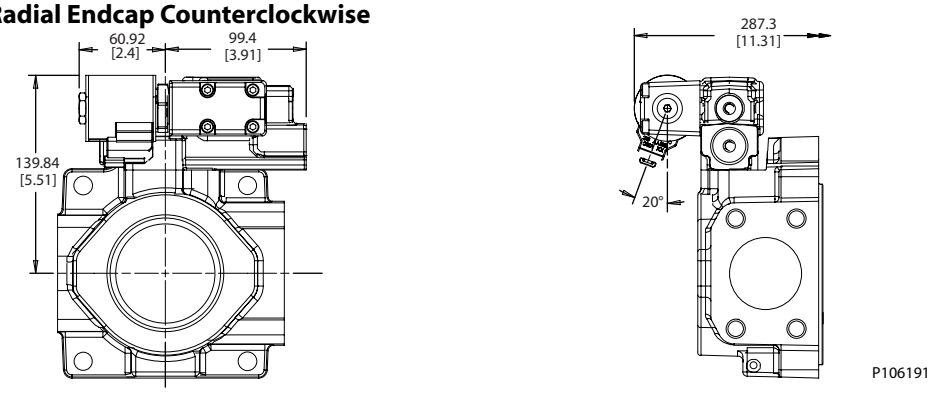


Radial Endcap Clockwise



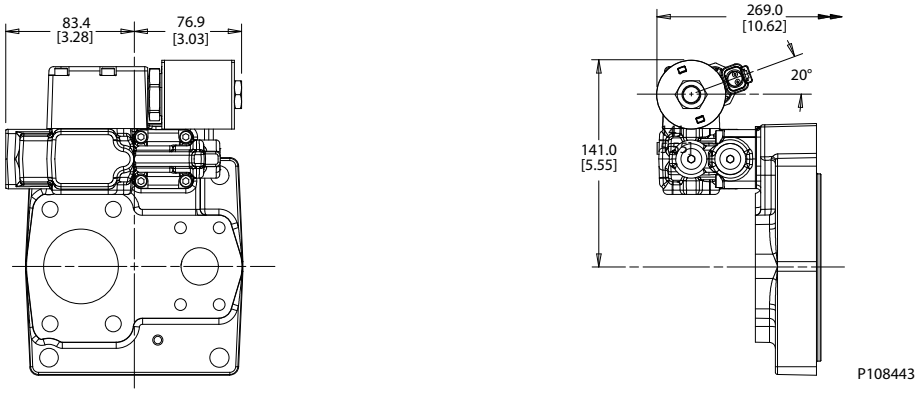
Radial Endcap Counterclockwise

Radial Endcap Counterclockwise

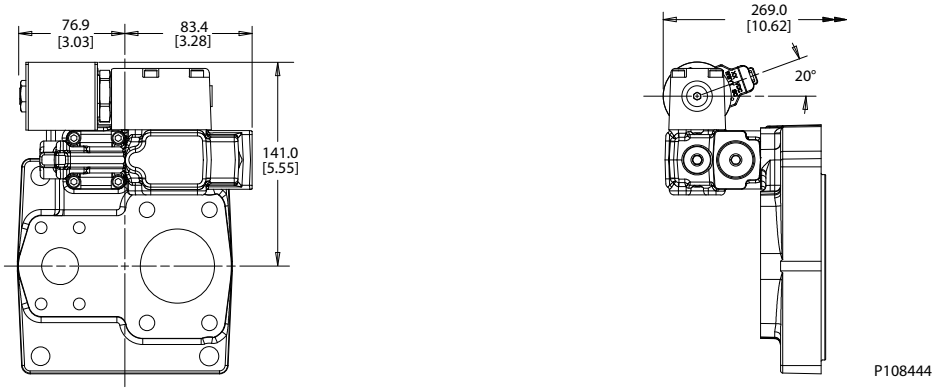


Frame J

Axial Endcap Clockwise



Axial Endcap Counterclockwise



Displacement limiter

J Frame open circuit pumps are available with an optional adjustable displacement limiter. This adjustable stop limits the pump's maximum displacement.

Setting range

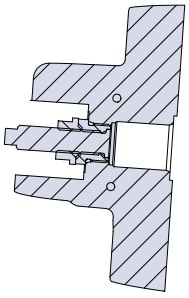
J45B	8.4 to 45 cm^3 [0.51 to 2.75 in^3]
J51B	13.7 to 51 cm^3 [0.84 to 3.11 in^3]
J60B	16.8 to 60 cm^3 [1.03 to 3.66 in^3]
J65B	25.4 to 65 cm^3 [1.55 to 3.97 in^3]
J75B	28.4 to 75 cm^3 [1.73 to 4.58 in^3]

Displacement per turn

J45B	6.2 cm^3/rev [0.38 in^3/rev]
J51B	6.2 cm^3/rev [0.38 in^3/rev]
J60B	6.2 cm^3/rev [0.38 in^3/rev]
J65B	7.2 cm^3/rev [0.44 in^3/rev]
J75B	7.2 cm^3/rev [0.44 in^3/rev]

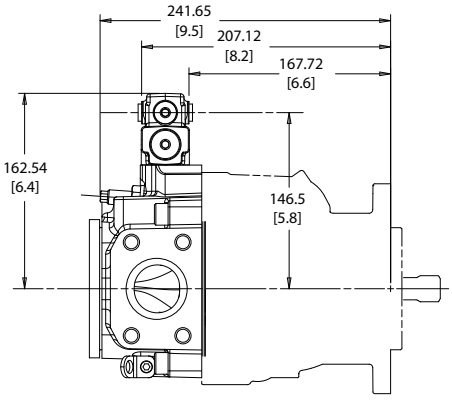
Frame J

Displacement limiter cross-section



P106 727E

Displacement limiters are only available for endcap options V and W.



P106 728E

Third-angle projection mm [in]

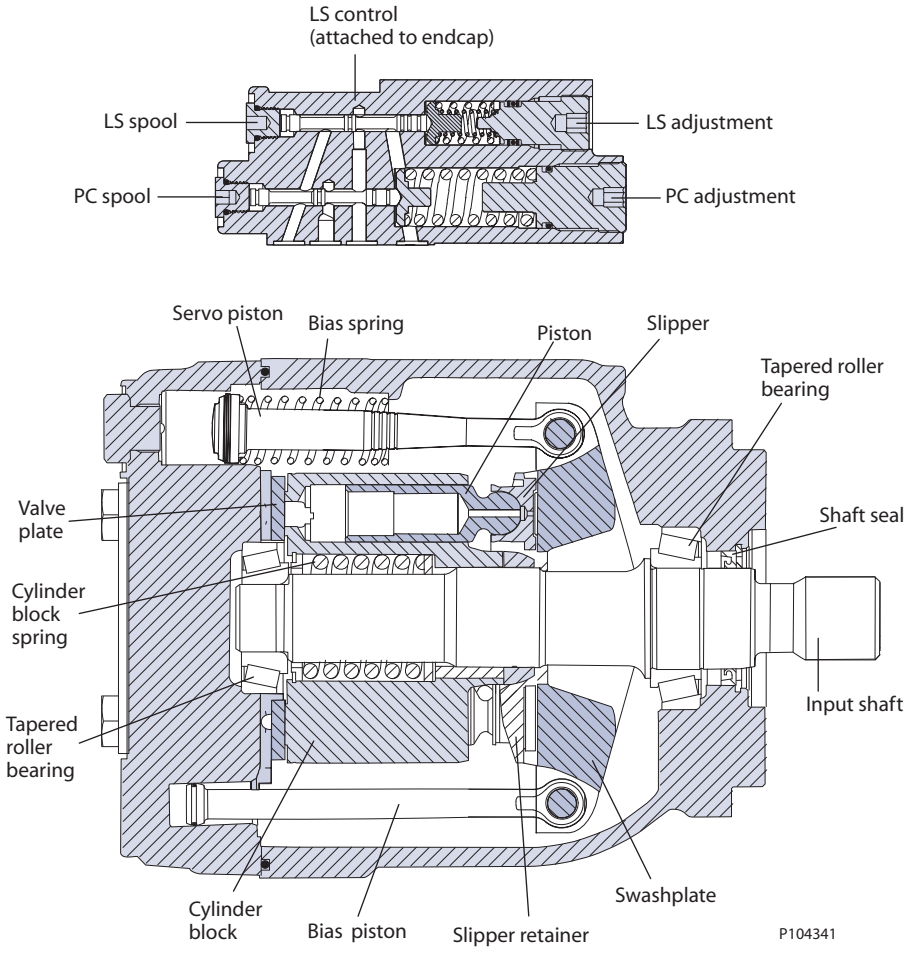
Frame F

Design

Series 45 Frame F 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 F cross section



Frame F

Technical Specifications

			F Frame	
		Unit	**074B**	**090C**
Maximum Displacement		cm^3 [in^3]	74 [4.52]	90 [5.49]
Working Input Speed	Minimum	min -1 (rpm)	500	500
	Continuous		2400	2200
	Maximum		2800	2600
Working Pressure	Continuous	bar [psi]	310 [4500]	260 [3770]
	Maximum		400 [5800]	350 [5075]
Flow at rated speed (theoretical)		l/min [US gal/min]	178 [46.9]	198 [52.3]
Input torque at maximum displacement (theoretical) at 49° C [120°F]		N•m/bar [lbf•in/1000 psi]	1.178 [719.3]	1.433 [874.8]
Mass moment of inertia of internal rotating components		$kg•m^2$ [$slug•ft^2$]	0.0063 [0.00465]	0.0065 [0.00479]
Weight	Axial ports	kg [lb]	29.5 [65.0]	
	Radial ports		32.6 [71.9]	
External Shaft Loads	External moment (Me)	N•m [lbf•in]	300 [2655]	300 [2655]
	Thrust in (Tin), out (Tout)	N [lbf]	2900 [652]	2900 [652]
Mounting flange load moments	Vibratory (continuous)	N•m [lbf•in]	3730 [33 100]	
	Shock (maximum)		13220 [117 100]	

Order code

Code description

Code	Description
R	Product Frame, Variable Open Circuit Pump
S	Rotation
P	Displacement
C	Control Type
D	Pressure Compensator Setting
E	Load Sense Setting
F	Not Used
G	Choke Orifice
H	Gain Orifice
J	Input Shaft/Auxiliary Mount/Endcap
K	Shaft Seal/Front Mounting Flange/Housing Ports
L	Displacement Limiter
M	Special Hardware
N	Special Features

Frame F

R Product

		F Frame	
		074B	090C
FR	F Frame, variable displacement open circuit pump	•	•

S Rotation

L	Left Hand (counterclockwise)	•	•
R	Right Hand (clockwise)	•	•

R Displacement

074B	074 cm3/rev [4.52 in3/rev]	•	
090C	090 cm3/rev [5.49 in3/rev]		•

C Control type

		074B	090C
PC	Pressure Compensator	•	•
BC*	Pressure Compensator [>280 bar]	•	
RP	Remote Pressure Compensator	•	•
BP*	Remote Pressure Compensator [>280 bar]	•	
LS	Load Sensing/Pressure Comp.	•	•
BS*	Load Sensing/Pressure Comp. [>280 bar]	•	
LB	Load Sensing/Pressure Comp. with internal bleed orifice	•	•
BB*	Load Sensing/Pressure Comp. with internal bleed orifice [>280 bar]	•	
AN	Electric On/Off w/Pressure Comp. (NO, 12VDC) Left	•	•
CN	Electric On/Off w/Pressure Comp. (NO, 24VDC) Left	•	•
AR	Electric On/Off w/Pressure Comp. (NC, 12VDC) Left	•	•
CR	Electric On/Off w/Pressure Comp. (NC, 24VDC) Left	•	•
AF	Electric On/Off w/Pressure Comp. (NO, 12VDC) Right	•	•
AT	Electric On/Off w/Pressure Comp. (NO, 24VDC) Right	•	•
AG	Electric On/Off w/Pressure Comp. (NC, 12VDC) Right	•	•
AY	Electric On/Off w/Pressure Comp. (NC, 24VDC) Right	•	•
BN*	Electric On/Off w/Pressure Comp. (NO, 12VDC) [>280 bar] Left	•	
DN*	Electric On/Off w/Pressure Comp. (NO, 24VDC) [>280 bar] Left	•	
BR*	Electric On/Off w/Pressure Comp. (NC, 12VDC) [>280 bar] Left	•	
DR*	Electric On/Off w/Pressure Comp. (NC, 24VDC) [>280 bar] Left	•	
BF*	Electric On/Off w/Pressure Comp. (NO, 12VDC) [>280 bar] Right	•	
DF*	Electric On/Off w/Pressure Comp. (NO, 24VDC) [>280 bar] Right	•	
BE*	Electric On/Off w/Pressure Comp. (NC, 12VDC) [>280 bar] Right	•	
BG*	Electric On/Off w/Pressure Comp. (NC, 24VDC) [>280 bar] Right	•	
AX	Electric Proportional Pressure Control w/Pressure Comp. (NO,12VDC) Left	•	•
CL	Electric Proportional Pressure Control w/Pressure Comp. (NO,24VDC) Left		•
AH	Electric Proportional Pressure Control w/Pressure Comp. (NC,12VDC) Left	•	•
AL	Electric Proportional Pressure Control w/Pressure Comp. (NC,24VDC) Left	•	•

Frame F

C Control type (continued)

		074B	090C
AW	Electric Proportional Pressure Control w/Pressure Comp. (NO,12VDC) Right	•	•
CK	Electric Proportional Pressure Control w/Pressure Comp. (NO,24VDC) Right	•	•
AV	Electric Proportional Pressure Control w/Pressure Comp. (NC,12VDC) Right	•	•
AK	Electric Proportional Pressure Control w/Pressure Comp. (NC,24VDC) Right	•	•
BX*	Electric Proportional Pressure Control w/Pressure Comp. (NO,12VDC) [>280 bar] Left	•	
DL*	Electric Proportional Pressure Control w/Pressure Comp. (NO,24VDC) [>280 bar] Left	•	
BH*	Electric Proportional Pressure Control w/Pressure Comp. (NC,12VDC) [>280 bar] Left	•	
BL*	Electric Proportional Pressure Control w/Pressure Comp. (NC,24VDC) [>280 bar] Left	•	
BW*	Electric Proportional Pressure Control w/Pressure Comp. (NO,12VDC) [>280 bar] Right	•	
DK*	Electric Proportional Pressure Control w/Pressure Comp. (NO,24VDC) [>280 bar] Right	•	
BM*	Electric Proportional Pressure Control w/Pressure Comp. (NC,12VDC) [>280 bar] Right	•	
BK*	Electric Proportional Pressure Control w/Pressure Comp. (NC,24VDC) [>280 bar] Right	•	
FA*	Electric On/Off Dump valve w/Pressure Comp. + Load Sense (NC, 12VDC) Right	•	•
FB*	Electric On/Off Dump valve w/Pressure Comp. + Load Sense (NC, 12VDC) Left	•	•
TA	Electric Torque Limiting w/Pressure Comp. (NC,12VDC) Left	•	•
TB	Electric Torque Limiting w/Pressure Comp. (NC,24VDC) Left	•	•
TC	Electric Torque Limiting w/Pressure Comp. (NC,12VDC) Left	•	•
TD	Electric Torque Limiting w/Pressure Comp. (NC,24VDC) Left	•	•
TE	Electric Torque Limiting w/Pressure Comp. (NC,12VDC) Right	•	•
TF	Electric Torque Limiting w/Pressure Comp. (NC,24VDC) Right	•	•
TG	Electric Torque Limiting w/Pressure Comp. (NC,12VDC) Right	•	•
TH	Electric Torque Limiting w/Pressure Comp. (NC,24VDC) Right	•	•

Left - E-Frame: CW Only, F-Frame: CW Only, J-frame: CW Axial, CCW Radial

Right - E-Frame: CCW Only, F-Frame: CCW Only, J-frame: CCW Axial, CW Radial

* Not available on 90cc pumps

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

		F Frame	
		074B	090C
Example	25 = 250 bar (3625 psi)		
10–26	100 to 260 bar [1450 to 3771 psi]	•	•
27-28	270 to 280 bar [3916 to 4061 psi]	•	
29-31	290-310 bar [4206 to 4496 psi]	•	

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

Example	20 = 20 bar (290 psi)		
10-40	10 to 34 bar [145 to 508 psi]	•	•
NN	Not applicable (pressure compensated only controls)	•	•

F Not used

NN	Not applicable	•	•

Frame F

G Servo Control Orifice

N	None (standard)	•	•
E	0.8 mm diameter	•	•
F	1.0 mm diameter	•	•

H Gain Orifice

3	1.0 mm diameter (standard orifice)	•	•
C	0.8 mm diameter LS signal line orifice for ETL use (with standard orifice)	•	•

Additional LS signal line orifice size options are available for necessary system tuning requirements. Contact your Danfoss representative for further information.

J Input Shaft

S1	14 tooth 12/24 pitch
S2	17 tooth, 12/24 pitch
K4	1.25 inch straight keyed

Auxiliary Mount/Endcap Style

Auxiliary Description	Endcap Style	Inlet Porting	Outlet Porting	Endcap Description	Code
None	Axial	Split Flange	Split Flange	Inlet - Code 61 Split Flange Port 4 Bolt (2 inch port 0.5 inch threads) Outlet - Code 61 Split Flange Port 4 Bolt (1 inch port 0.375 inch threads)	N4
None	Radial	Split Flange	Split Flange	Inlet - Code 61 Split Flange Port 4 Bolt (2 inch port 0.5 inch threads) Outlet - Code 61 Split Flange Port 4 Bolt (1 inch port 0.375 inch threads)	N2
Running Cover	Radial	Split Flange	Split Flange	Inlet - Code 61 Split Flange Port 4 Bolt (2 inch port 0.5 inch threads) Outlet - Code 61 Split Flange Port 4 Bolt (1 inch port 0.375 inch threads)	R2
SAE-A, 9 teeth	Radial	Split Flange	Split Flange	Inlet - Code 61 Split Flange Port 4 Bolt (2 inch port 0.5 inch threads) Outlet - Code 61 Split Flange Port 4 Bolt (1 inch port 0.375 inch threads)	A2
SAE-A, 11 teeth	Radial	Split Flange	Split Flange	Inlet - Code 61 Split Flange Port 4 Bolt (2 inch port 0.5 inch threads) Outlet - Code 61 Split Flange Port 4 Bolt (1 inch port 0.375 inch threads)	T2
SAE-B, 13 teeth	Radial	Split Flange	Split Flange	Inlet - Code 61 Split Flange Port 4 Bolt (2 inch port 0.5 inch threads) Outlet - Code 61 Split Flange Port 4 Bolt (1 inch port 0.375 inch threads)	B2
SAE-BB, 15 teeth	Radial	Split Flange	Split Flange	Inlet - Code 61 Split Flange Port 4 Bolt (2 inch port 0.5 inch threads) Outlet - Code 61 Split Flange Port 4 Bolt (1 inch port 0.375 inch threads)	V2
SAE-C, 14 teeth	Radial	Split Flange	Split Flange	Inlet - Code 61 Split Flange Port 4 Bolt (2 inch port 0.5 inch threads) Outlet - Code 61 Split Flange Port 4 Bolt (1 inch port 0.375 inch threads)	C2

J Input Shaft/Auxiliary Mount/Endcap

Available Combinations

	F Frame	
	074B	**090C**
K4A2	•	•
K4B2	•	•
K4C2	•	•
K4N2	•	•
K4N4	•	•

Frame F

	F Frame	
	074B	090C
K4R2	•	•
K4T2	•	•
K4V2	•	•
S1A2	•	•
S1B2	•	•
S1C2	•	•
S1N2	•	•
S1N4	•	•
S1R2	•	•
S1T2	•	•
S1V2	•	•

	F Frame	
	074B	090C
S2A2	•	•
S2B2	•	•
S2C2	•	•
S2N2	•	•
S2N4	•	•
S2R2	•	•
S2T2	•	•
S2V2	•	•

K Shaft seal

		F Frame	
		074B	090C
A	Single (Viton)	•	•

K Mounting flange and housing port style

1	SAE-C Flange 4-bolt/SAE O-ring boss ports (available with or without angle sensor)	•	•
3	SAE-B Flange 2-bolt/SAE O-ring boss ports (not available with angle sensor)	•	•

K Angle Sensor Housing

N	Without angle sensor	•	•
R	Angle Sensor Housing, Right Hand Side	•	•
* When viewing pump from input shaft, control oriented on top			

L Displacement limiter

NNN	None (plugged)	•	•
AAA	Adjustable, factory set at max angle	•	•

Frame F

M Special hardware

NNN	None	•	•
ANS	Angle sensor hardware	•	•

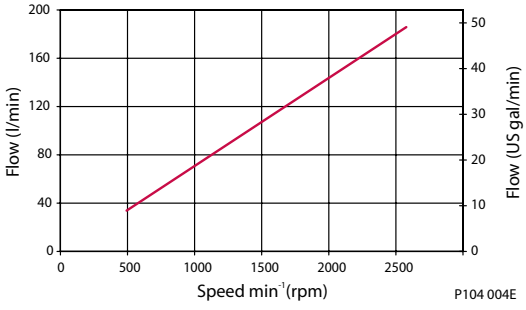
N Special features

NNN	None	•	•

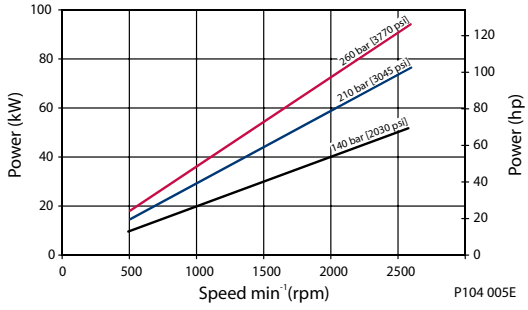
Performance F74B

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

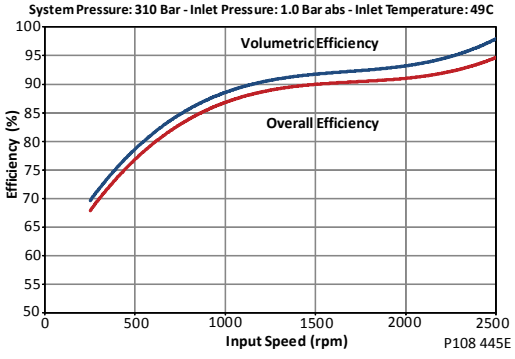
Flow vs. speed



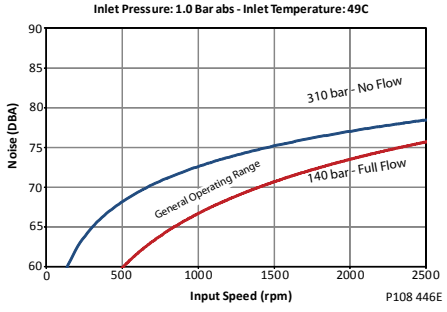
Input power vs. speed



Efficiency

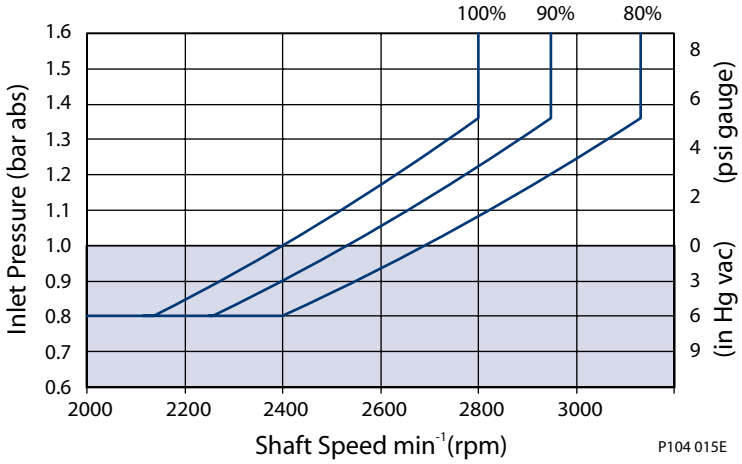


Noise



Frame F

Inlet pressure vs. speed

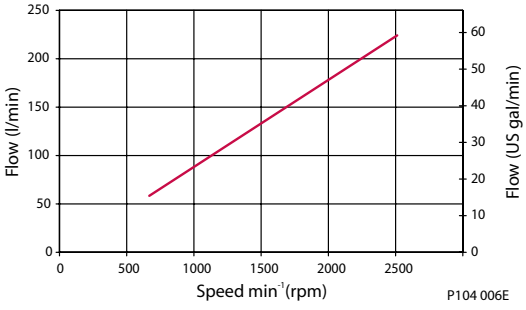


The chart above shows allowable inlet pressure and speed at various displacements. Greater speeds and lower inlet pressures are possible at reduced displacement. Operating outside of acceptable limits reduces pump life.

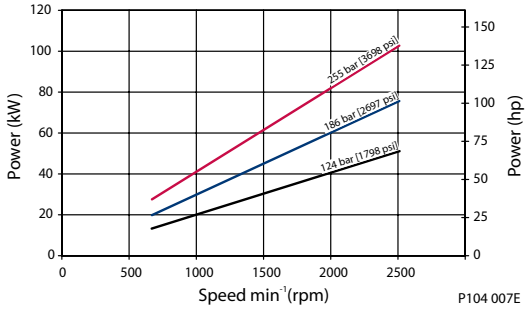
Performance F90C

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

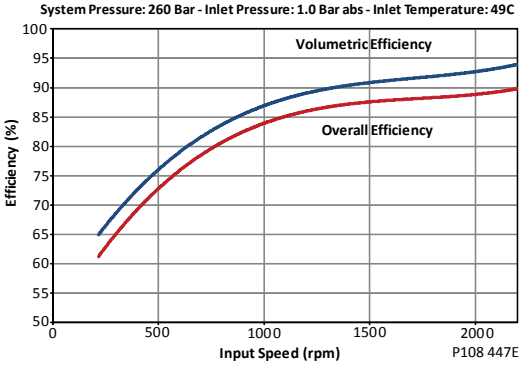
Flow vs. speed



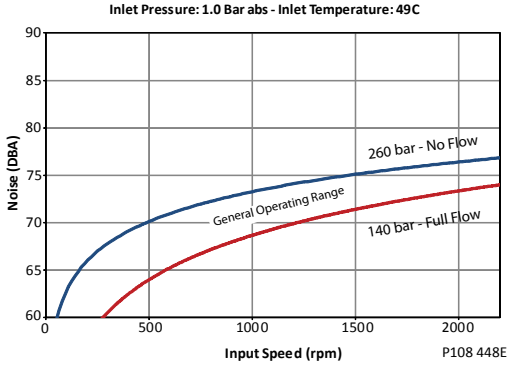
Input power vs. speed



Efficiency

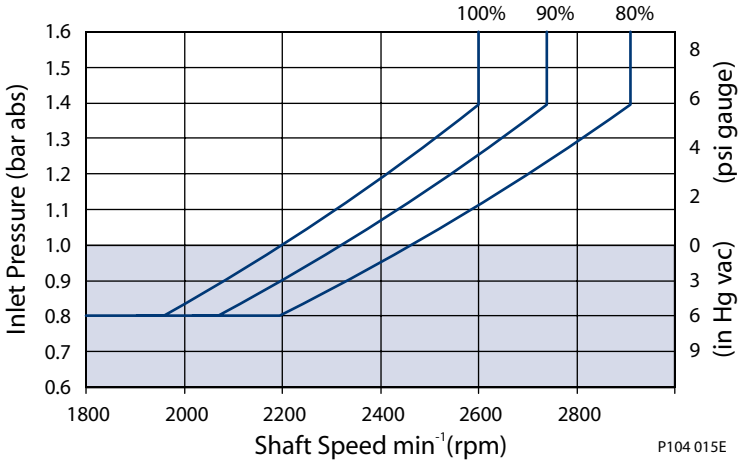


Noise



Frame F

Inlet pressure vs. speed



The chart above 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.

Hydraulic Controls

Pressure Compensated Controls

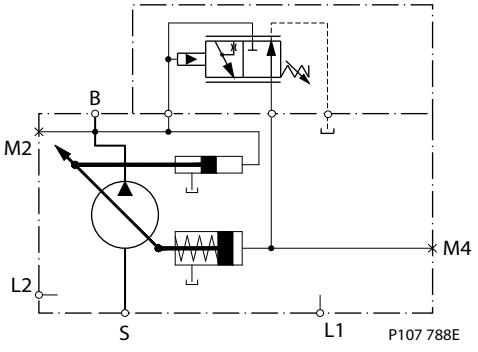
Response/recovery times

(msec)	Response	Recovery
F74B	35	120
F90C	35	135

PC setting range

Model	PC	BC
F74B	100-280 bar [1450-4060 psi]	290-310 bar [4205-4495 psi]
F90C	100-260 bar [1450-3770 psi]	N/A

Schematic



B = Outlet

S = Inlet

Frame F

L1, L2 = Case drain

M2 = System pressure gauge port

M4 = Servo pressure gauge port

Remote Pressure Compensated Controls

Response/recovery times

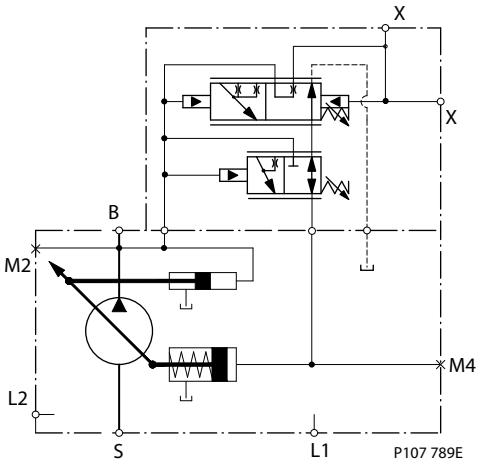
(msec)	Response	Recovery
F74B	35	120
F90C	35	135

PC setting range

Model	RP	BP
F74B	100-280 bar [1450-4060 psi]	290-310 bar [4205-4495 psi]
F90C	100-260 bar [1450-3770 psi]	N/A

An LS Setting of 20 is required for this control

Remote PC schematic



B = Outlet

S = Inlet

L1, L2 = Case drain

M2 = System pressure gauge port

M4 = Servo pressure gauge port

X = Remote PC port

Load Sensing/Pressure Compensated Controls

*Response/recovery times**

(msec)	Response	Recovery
F74B	35	135

Frame F

Response/recovery times (continued)*

(msec)	Response	Recovery
F90C	45	135

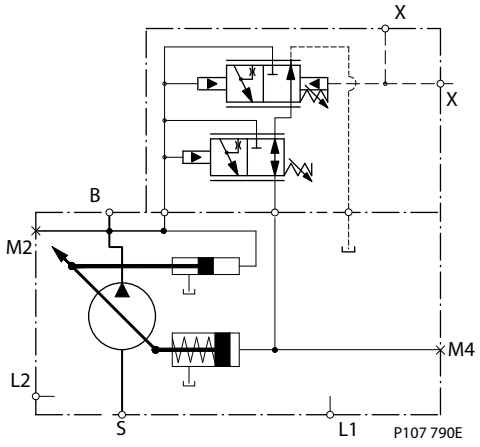
PC setting range

Model	bar	psi
F74B	100-280 bar [1450-4060 psi]	290-310 bar [4205-4495 psi]
F90C	100-260 bar [1450-3770 psi]	N/A

LS setting range

Model	bar	psi
All	10–30	145–435

Schematic



B = Outlet

S = Inlet

L1, L2 = Case drain

M2 = System pressure gauge port

M4 = Servo pressure gauge port

X = LS signal port

Load Sensing Control with Bleed Orifice/Pressure Compensated

*Response/recovery times**

(msec)	Response	Recovery
F74B	35	135
F90C	40	135

Frame F

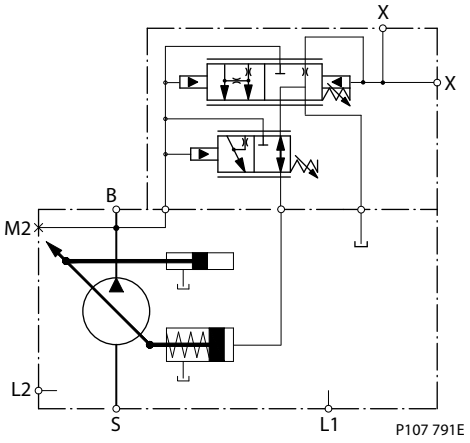
PC setting range

Model	LB	BB
F74B	100-280 bar [1450-4060 psi]	290-310 bar [4205-4495 psi]
F90C	100-260 bar [1450-3770 psi]	N/A

LS setting range

Model	bar	psi
All	10–34	145–508

Schematic



B = Outlet

S = Inlet

L1, L2 = Case drain

M2 = System pressure gauge port

M4 = Servo pressure gauge port

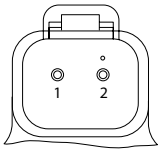
X = LS signal port

Electric Controls

Connectors

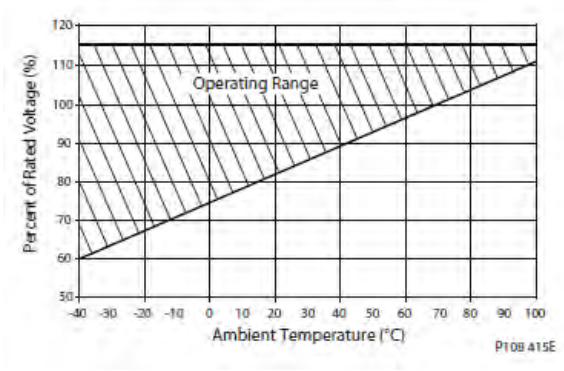
Description	Quantity	Ordering Number
Mating Connector	1	Deutsch® DT06-2S
Wedge Lock	1	Deutsch® W25
Socket Contact (16 and 18 AWG)	2	Deutsch® 0462-201-16141
Danfoss mating connector kit	1	K29657

Frame F



P003 480

Continuous Duty Operating Range



Solenoid Data - Normally Closed

Voltage	12V	24V
Threshold Control [mA] (310/260 bar PC setting, oil temp X)	200/400	100/200
End Current [mA] (20 bar LS setting, oil temp X)	1200	600

Solenoid Data - Normally Open

Voltage	12V	24V
Threshold Control [mA] (20 bar LS setting, oil temp X)	0	0
End Current [mA] (260/310 bar PC setting, oil temp X)	1000/1100	500/550

Hysteresis

Frame	Hysteresis
F74B	Input hysteresis <4% (control current): Output hysteresis <4.5% (system pressure)
F90C	Input hysteresis <4% (control current): Output hysteresis <4.5% (system pressure)

Normally Closed Electric On/Off with Pressure Compensation Controls

*Response/Recovery times**

(msec)	Response	Recovery
F74B	35	120
F90C	35	135

* Without servo control orifice

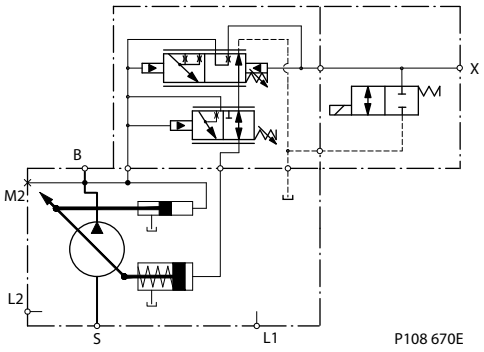
Frame F

LS setting range

Model	bar	psi
All	10 - 40	[145 - 580]

For fan-drive systems, and systems with motors, select an LS setting no less than15 bar to enhance system stability. As the LS setting is reduced, the risk for system instability may be increased. A 20 bar LS setting is recommended as a starting point for all new applications.

Schematic



B = Outlet

S = Inlet

L1, L2 = Case drain

M2 = System pressure gauge port

X = Load Sense Port

PC setting range

Frame	AG, AR (12V)	BE, BR (12V)	AY, CR (24V)	BG, DR (24V)
F74B	100-280 bar [1450-4060] psi	290-310 bar [4205-4495] psi	100-280 bar [1450-4060] psi	290-310 bar [4205-4495] psi
F90C	100-260 bar [1450-3770] psi	Not Available	100-260 bar [1450-3770] psi	Not Available

Normally Open Electric On/Off with Pressure Compensation Controls

*Response/Recovery times**

(msec)	Response	Recovery
F74B	35	120
F90C	35	135

* Without servo control orifice

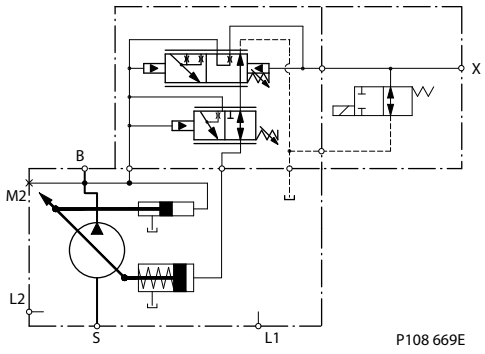
LS setting range

Model	bar	psi
All	12 - 40	[174 - 580]

For fan-drive systems, and systems with motors, select an LS setting no less than15 bar to enhance system stability. As the LS setting is reduced, the risk for system instability may be increased. A 20 bar LS setting is recommended as a starting point for all new applications.

Frame F

Schematic



B = Outlet

S = Inlet

L1, L2 = Case drain

M2 = System pressure gauge port

X = Load Sense Port

PC setting range

Frame	AF, AN (12V)	BF, BN (12V)	AT, CN (24V)	DF, DN (24V)
F74B	100-280 bar [1450-4060] psi	290-310 bar [4205-4495] psi	100-280 bar [1450-4060] psi	290-310 bar [4205-4495] psi
F90C	100-260 bar [1450-3770] psi	Not Available	100-260 bar [1450-3770] psi	Not Available

Normally Closed Electric Proportional with Pressure Compensation Controls

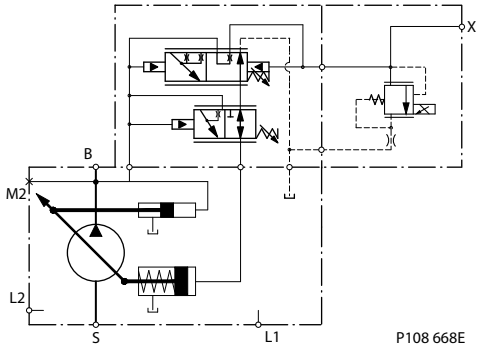
Response/Recovery times

	0.8mm Orifice		1.0mm Orifice	
(msec)	Response	Recovery	Response	Recovery
F74B	35	365	35	280
F90C	35	410	35	315

LS setting range

Model	bar	psi
All	10 - 40	[145 - 580]

Schematic



Frame F

B = Outlet

S = Inlet

L1, L2 = Case drain

M2 = System pressure gauge port

X = Load Sense Port

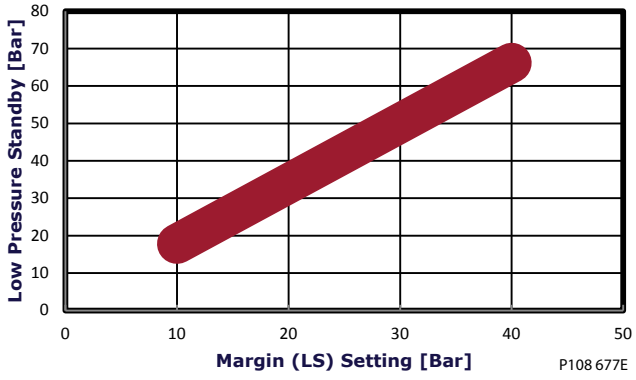
PC setting range

Frame	AH, AV (12V)	BH, BM (12V)	AK, AL (24V)	BK, BL (24V)
F74B	100-280 bar [1450-4060] psi	290-310 bar [4205-4495] psi	100-280 bar [1450-4060] psi	290-310 bar [4205-4495] psi
F90C	100-260 bar [1450-3770] psi	Not Available	100-260 bar [1450-3770] psi	Not Available

For fan-drive systems, and systems with motors, select an LS setting no less than15 bar to enhance system stability. As the LS setting is reduced, the risk for system instability may be increased. A 20 bar LS setting is recommended as a starting point for all new applications.

Electric proportional controls have a unique relationship between margin (LS) setting and low pressure standby. See the graph below for this relationship.

Frames E, F, J Electric Proportional Control Low Pressure Standby



Normally Open Electric Proportional with Pressure Compensation Controls

Response/Recovery times

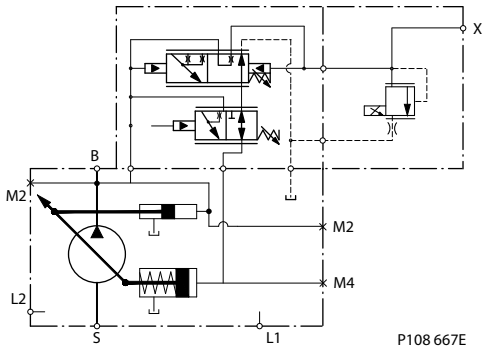
	0.8mm Orifice		1.0mm Orifice	
(msec)	Response	Recovery	Response	Recovery
F74B	35	365	35	280
F90C	35	410	35	315

LS setting range

Model	bar	psi
All	10 - 40	[145 - 580]

Frame F

Schematic



B = Outlet

S = Inlet

L1, L2 = Case drain

M2 = System pressure gauge port

X = Load Sense Port

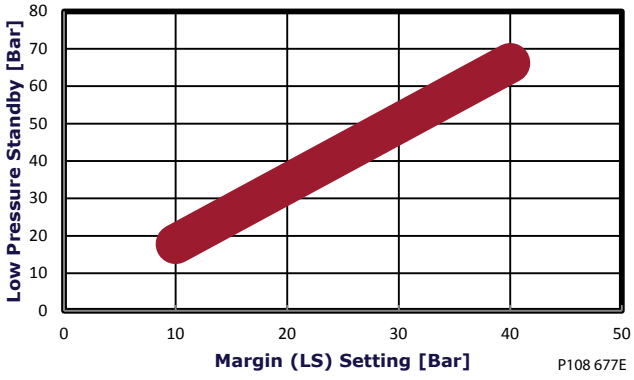
PC setting range

Frame	AW, AX (12V)	BW, BX (12V)	CK, CL (24V)	DK, DL (24V)
F74B	100-280 bar [1450-4060] psi	290-310 bar [4205-4495] psi	100-280 bar [1450-4060] psi	290-310 bar [4205-4495] psi
F90C	100-260 bar [1450-3770] psi	Not Available	100-260 bar [1450-3770] psi	Not Available

For fan-drive systems, and systems with motors, select an LS setting no less than15 bar to enhance system stability. As the LS setting is reduced, the risk for system instability may be increased. A 20 bar LS setting is recommended as a starting point for all new applications.

Electric proportional controls have a unique relationship between margin (LS) setting and low pressure standby. See the graph below for this relationship.

Frames E, F, J Electric Proportional Control Low Pressure Standby



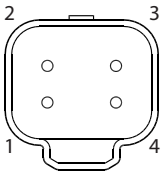
Frame F

Normally Closed Electric Torque Limiting Control with Pressure Compensation Controls

Response/recovery times

(msec)	Response	Recovery
F74B	35	120
F90C	35	135

Pin location



P200 151

Pinout

Pin	Description
1	Supply -
2	Ouput signal 2 - Secondary Signal
3	Output signal 1 - Primary Signal
4	Supply +

PC setting range

Frame	TA, TE (12V)	TC, TG (12V)	TB, TF (24V)	TD, TH (24V)
F74B	100-280 bar [1450-4060] psi	290-310 bar [4205-4495] psi	100-280 bar [1450-4060] psi	290-310 bar [4205-4495] psi
F90C	100-260 bar [1450-3770] ps	Not Available	100-260 bar [1450-3770] ps	Not Available

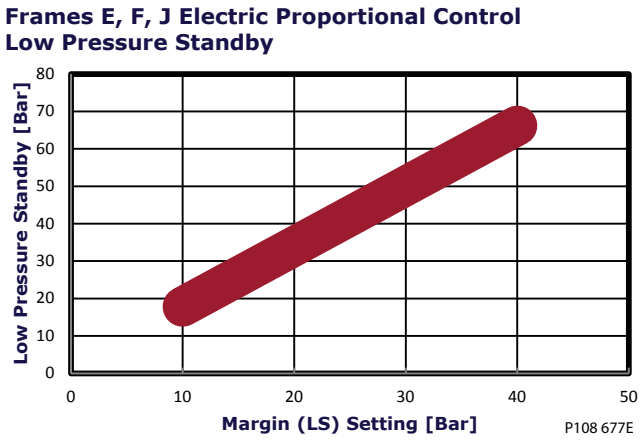
LS setting range

Model	bar	psi
All	10 - 40	[145 - 580]

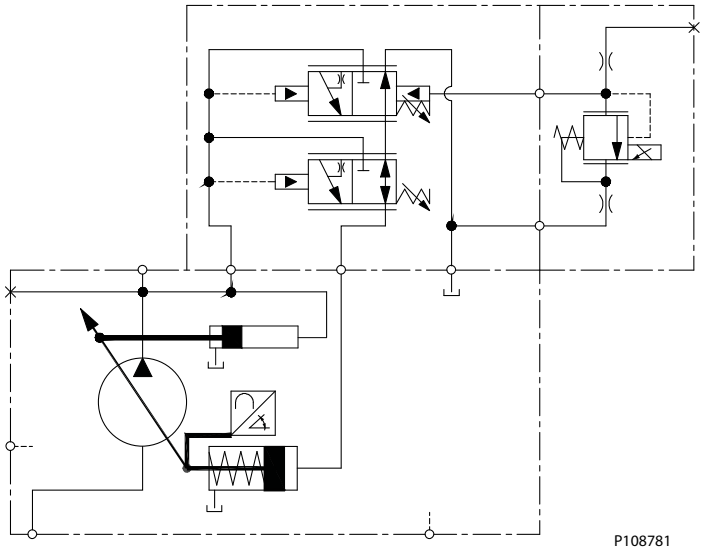
For fan-drive systems, and systems with motors, select an LS setting no less than15 bar to enhance system stability. As the LS setting is reduced, the risk for system instability may be increased. A 20 bar LS setting is recommended as a starting point for all new applications.

Electric Torque Limiting controls have a unique relationship between margin (LS) setting and low pressure standby. See the graph below for this relationship.

Frame F



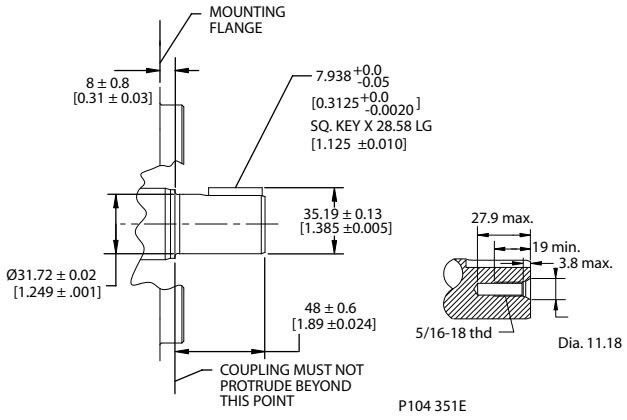
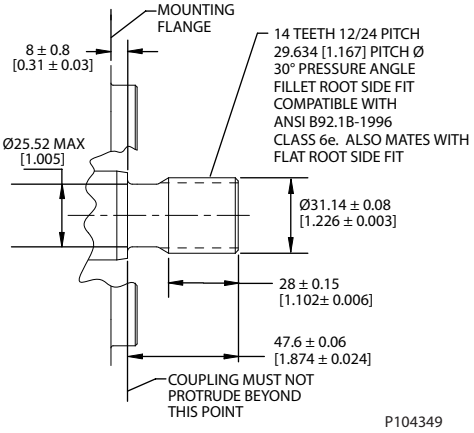
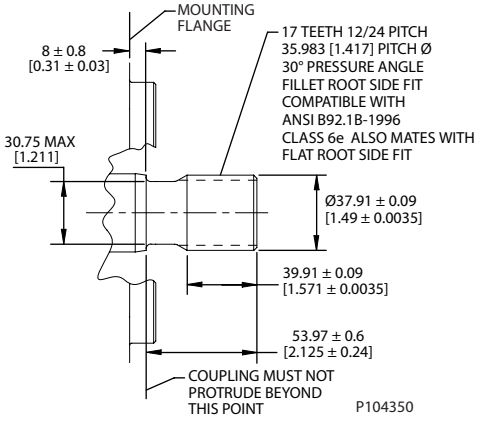
F-frame pump with integrated ETL control



Frame F

Input shafts

Shaft data

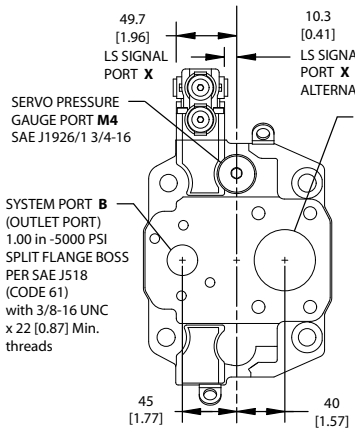
Code	Description	Maximum torque rating[1] N•m [lbf•in]	Drawing
K4	Ø 31.75 mm [1.25 in] Straight keyed	734 [6495]	
S1	14 tooth spline 12/24 pitch (ANSI B92.1B 1996 - Class 6e)	800 [7080]	
S2	17 tooth spline 12/24 pitch (ANSI B92.1B 1996 - Class 6e)	1150 [10178]	

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

Frame F

Installation drawings

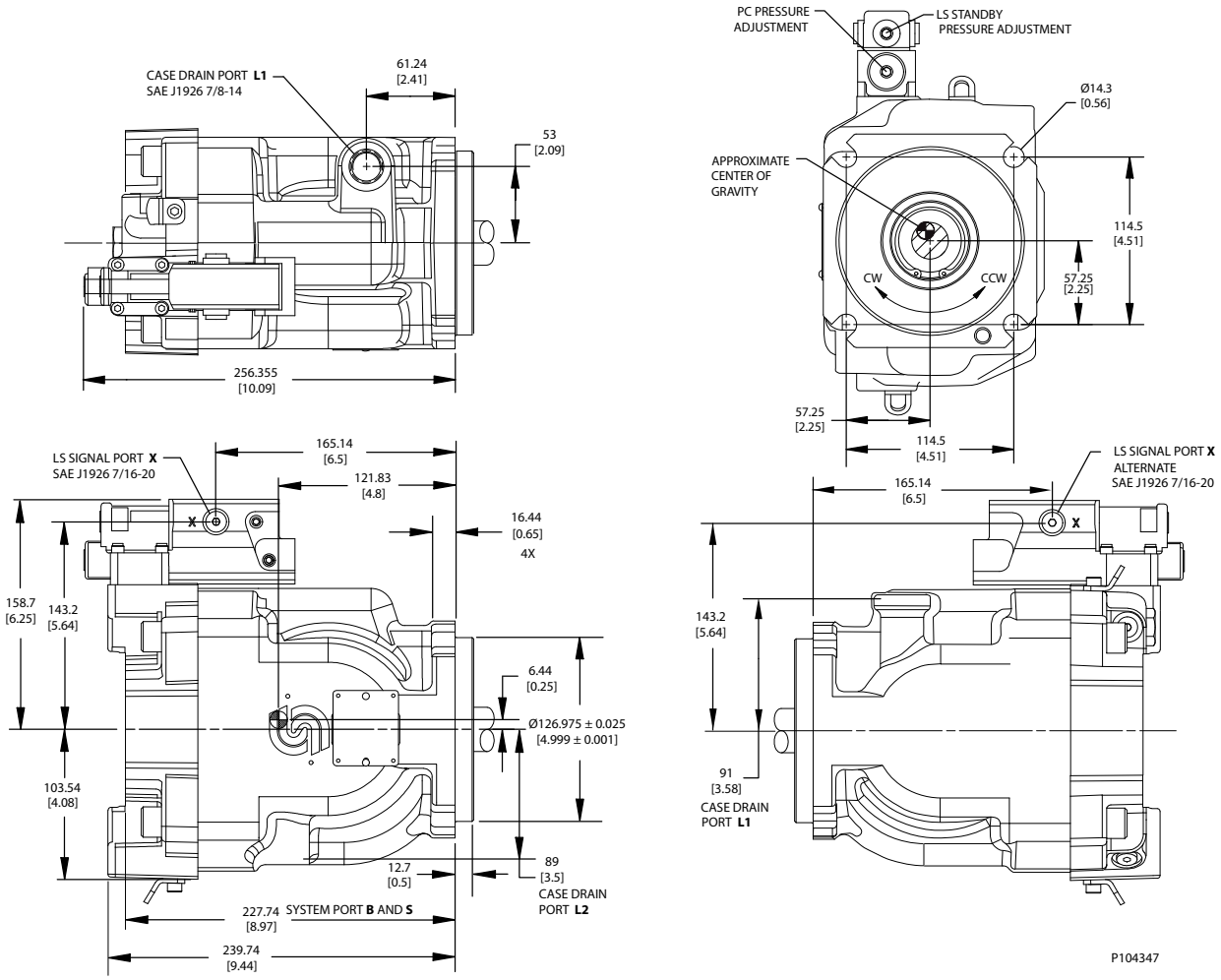
Axial Ported Endcap



Split Flange Ports

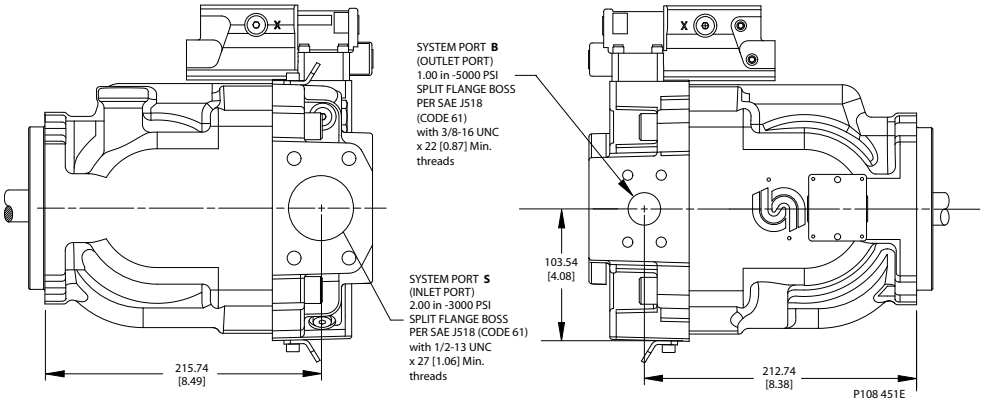
P108 450E

Axial Ported Endcap Installation Dimensions

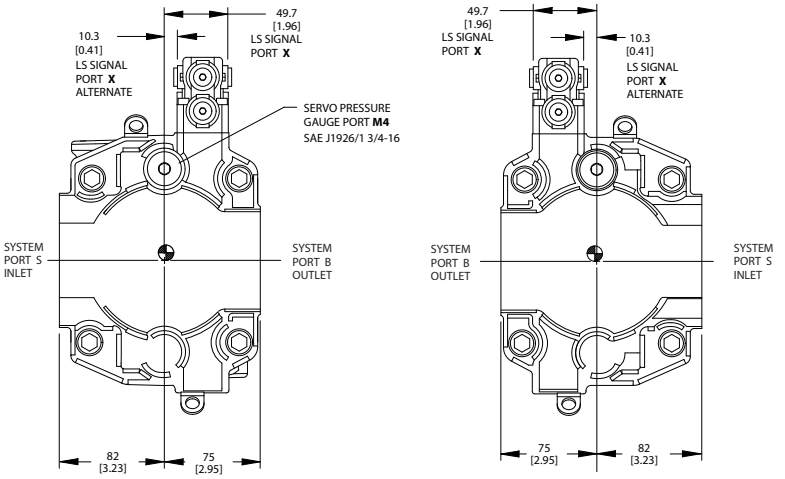


Frame F

Radial Ported Endcap Split Flange Ports

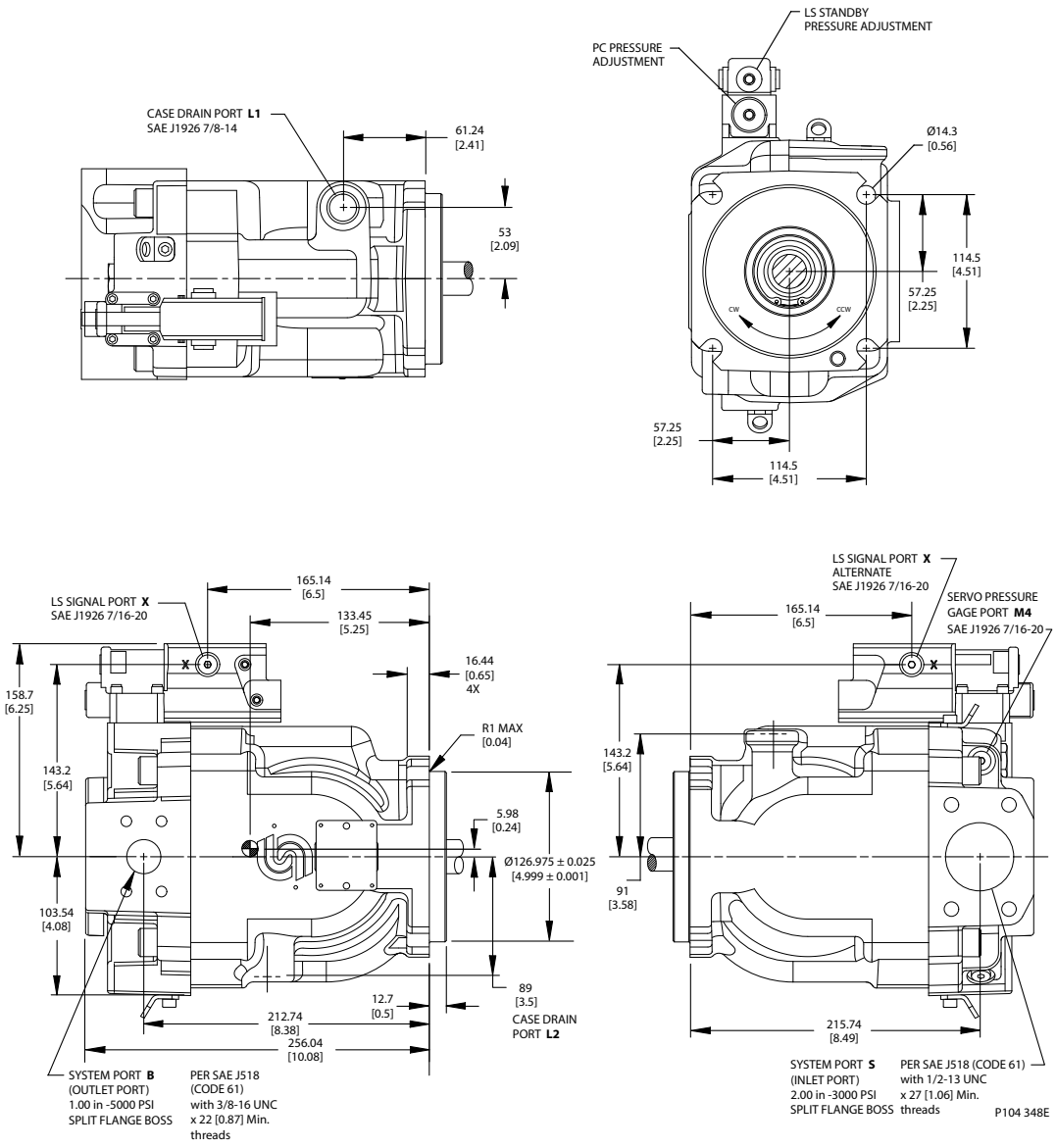


Radial Ported Endcap Rear View



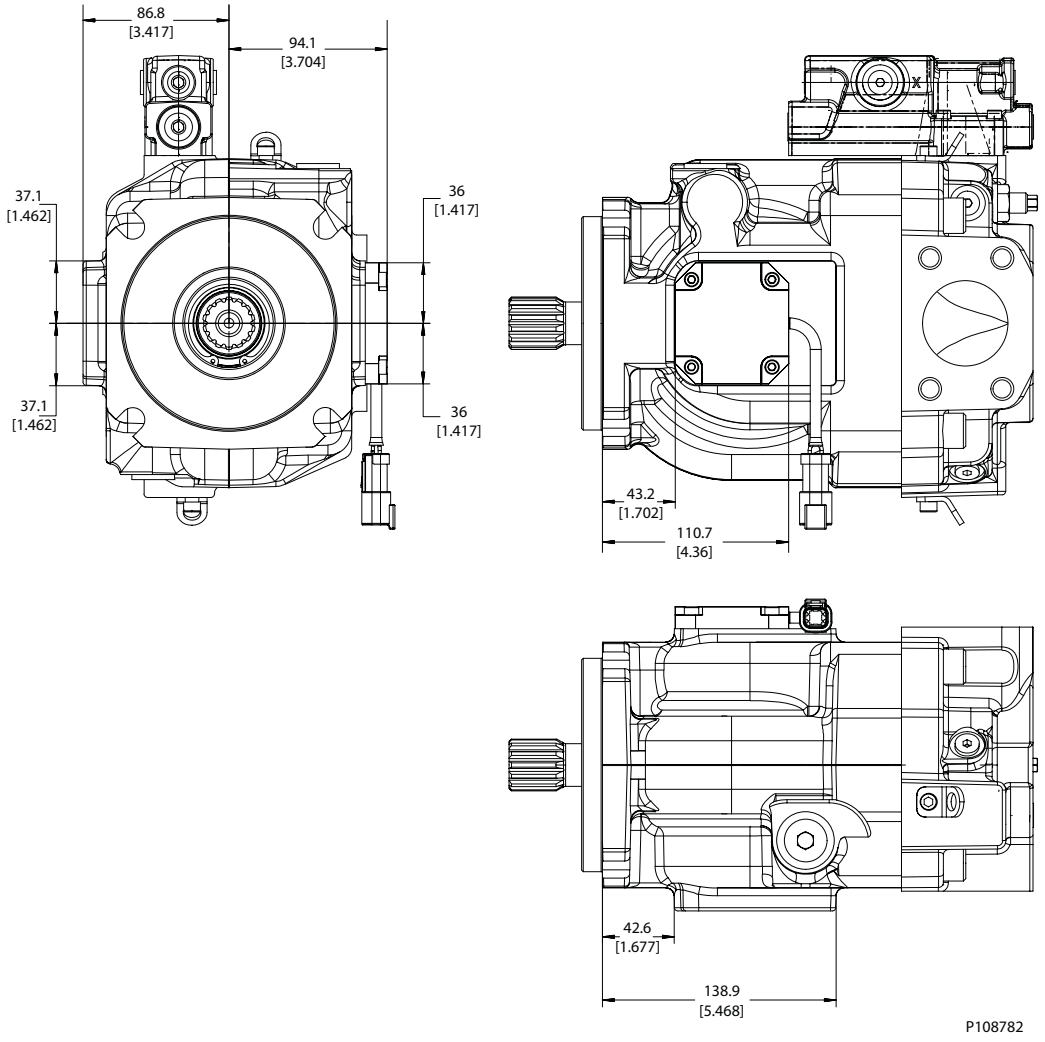
Frame F

Radial Ported Endcap Installation Dimensions



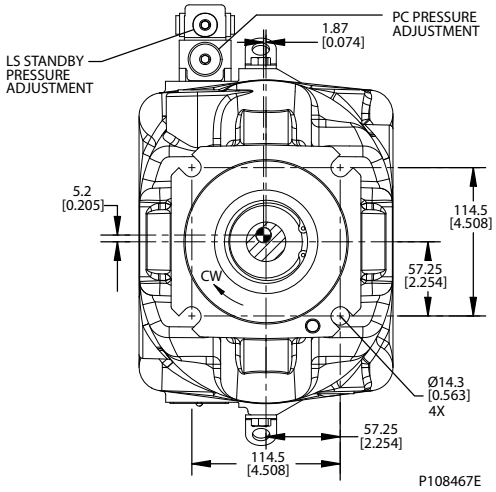
Frame F

Right Angle Sensor Position Installation Dimensions



Frame F

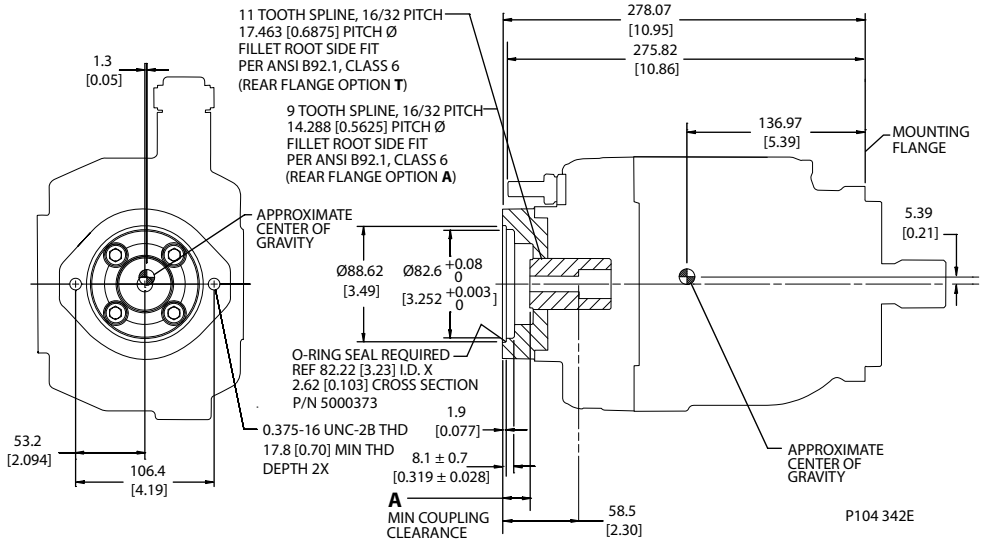
Front Mounting Flange



Auxiliary mounting pads

SAE-A auxiliary mounting pad

Dimensions



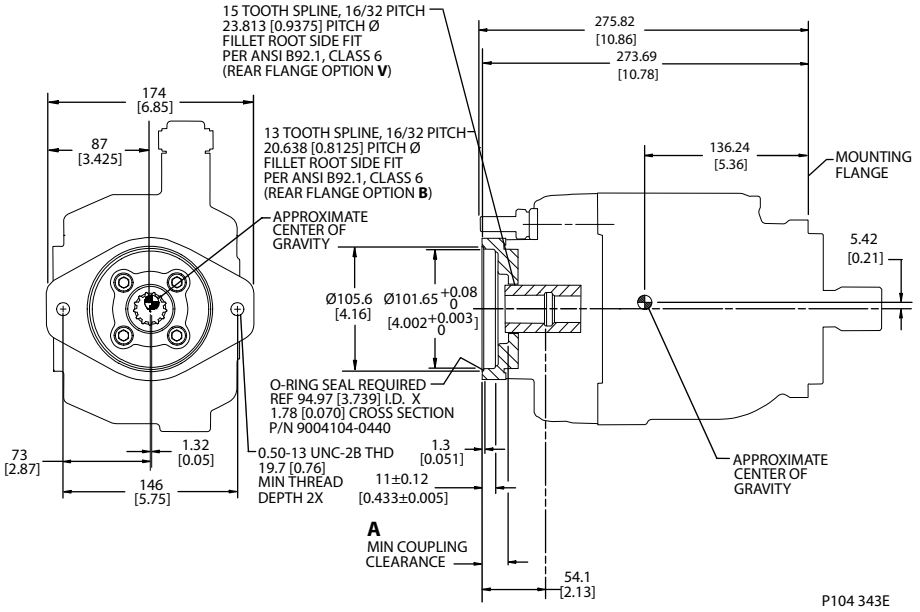
Specifications

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]
Dimension A	14.9 mm [0.59 in]	16.1 mm [0.63 in]

Frame F

SAE-B auxiliary mounting pad

Dimensions

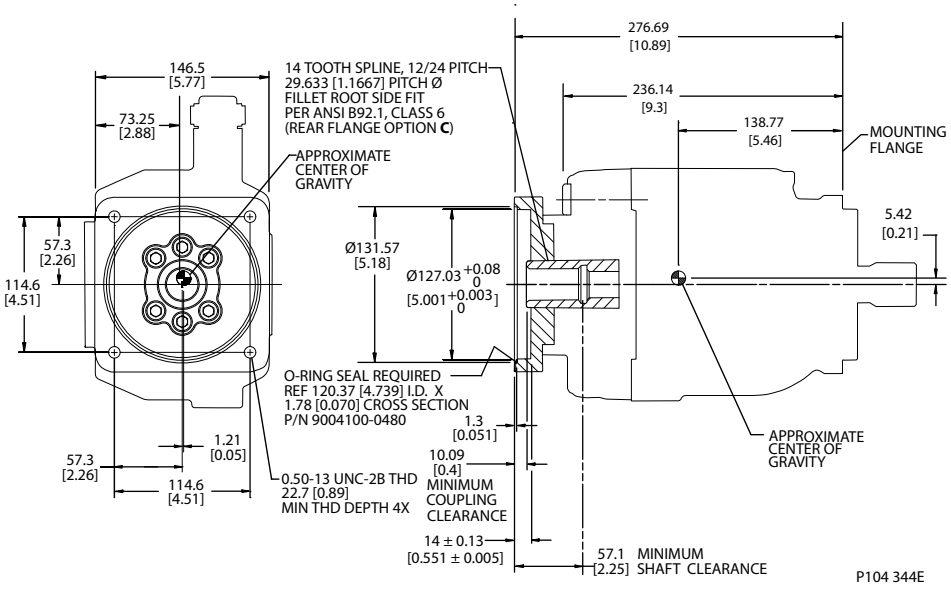


Specifications

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]
Dimension A	20.7 mm [0.81 in]	12.7 mm [0.5 in]

SAE-C auxiliary mounting pad

Dimensions



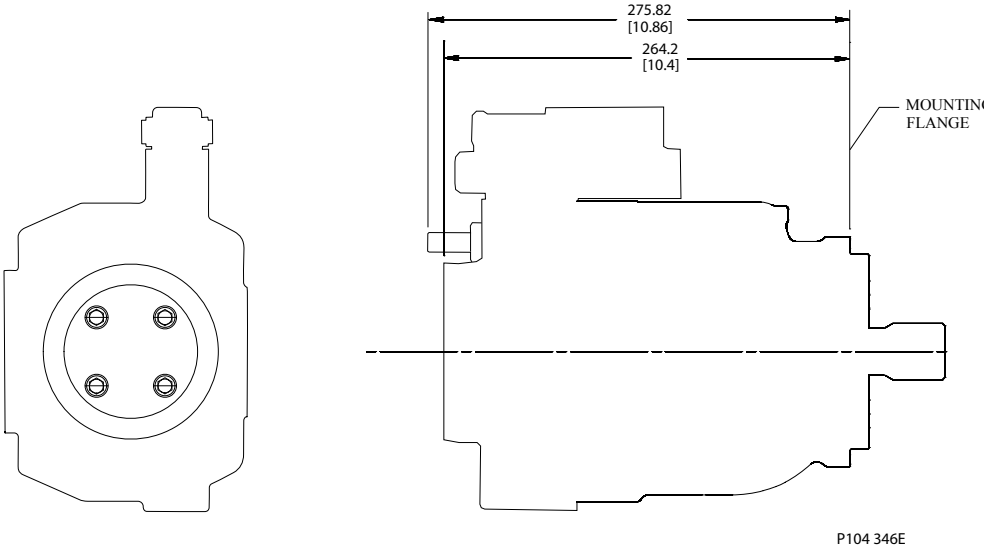
Frame F

Specifications

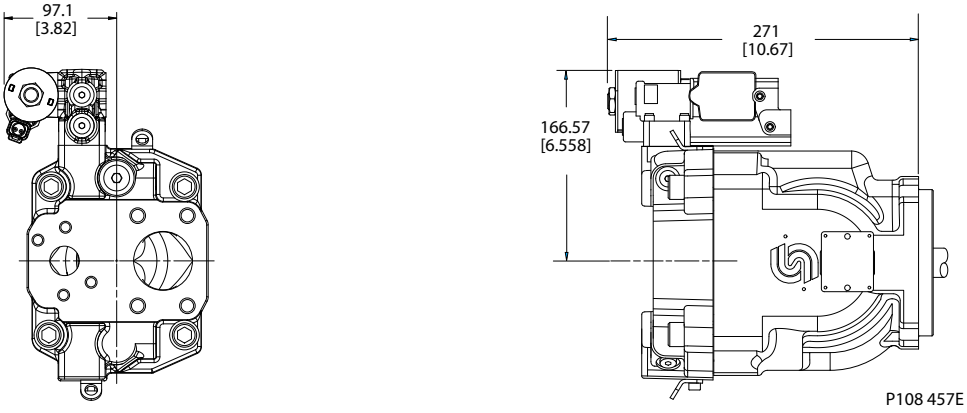
Coupling	14-tooth
Spline minimum engagement	18.3 mm [0.72 in]
Maximum torque	339 N•m [3000 lbf•in]

Running Cover

Dimensions

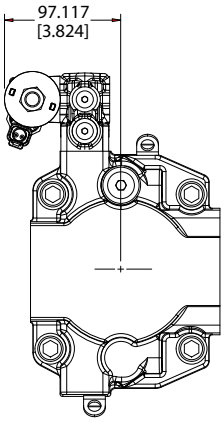


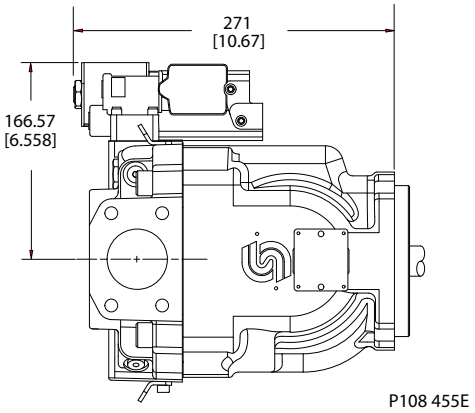
Radial Endcap Clockwise



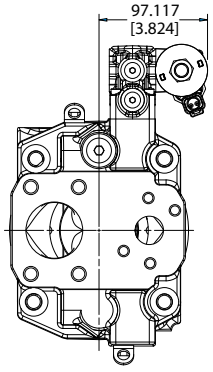
Frame F

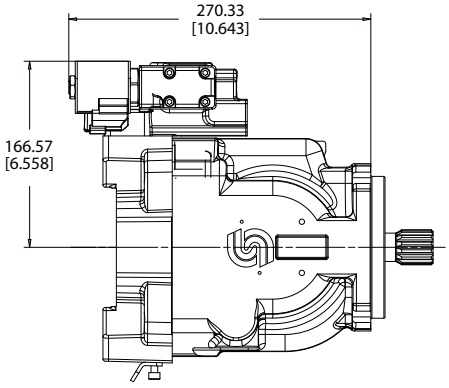
Radial Endcap Counterclockwise



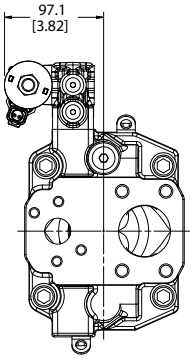


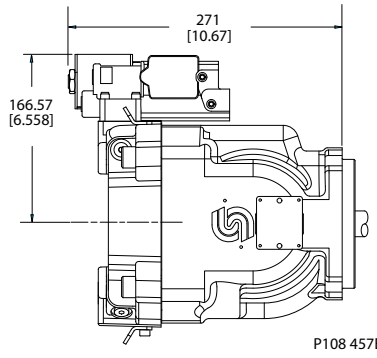
Axial Endcap Clockwise





Axial Endcap Counterclockwise





Displacement limiter

Series 45 F90C and F74B open circuit pumps are available with an optional adjustable displacement limiter. This adjustable stop limits the pump's maximum displacement.

Setting range

F90C	45.6 to 90 cm^3 [2.78 to 5.49 in^3]

Frame F

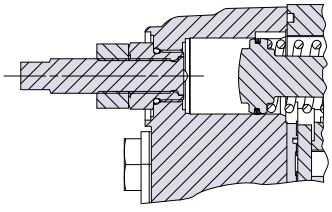
Setting range (continued)

F74B	34.1 to 74 cm³ [1.92 to 4.52 in³]

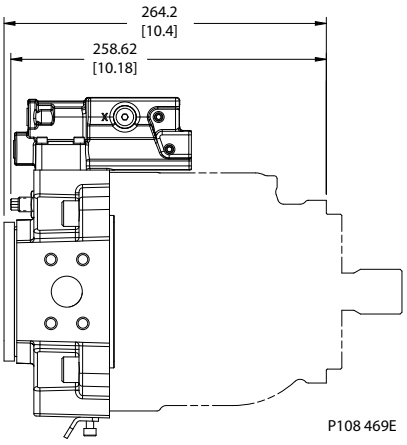
Displacement per turn

F90C	6.8 cm³/rev [0.41 in³/rev]
F74B	6.1 cm³/rev [0.37 in³/rev]

Displacement limiter cross-section



P104 345



P108 469E

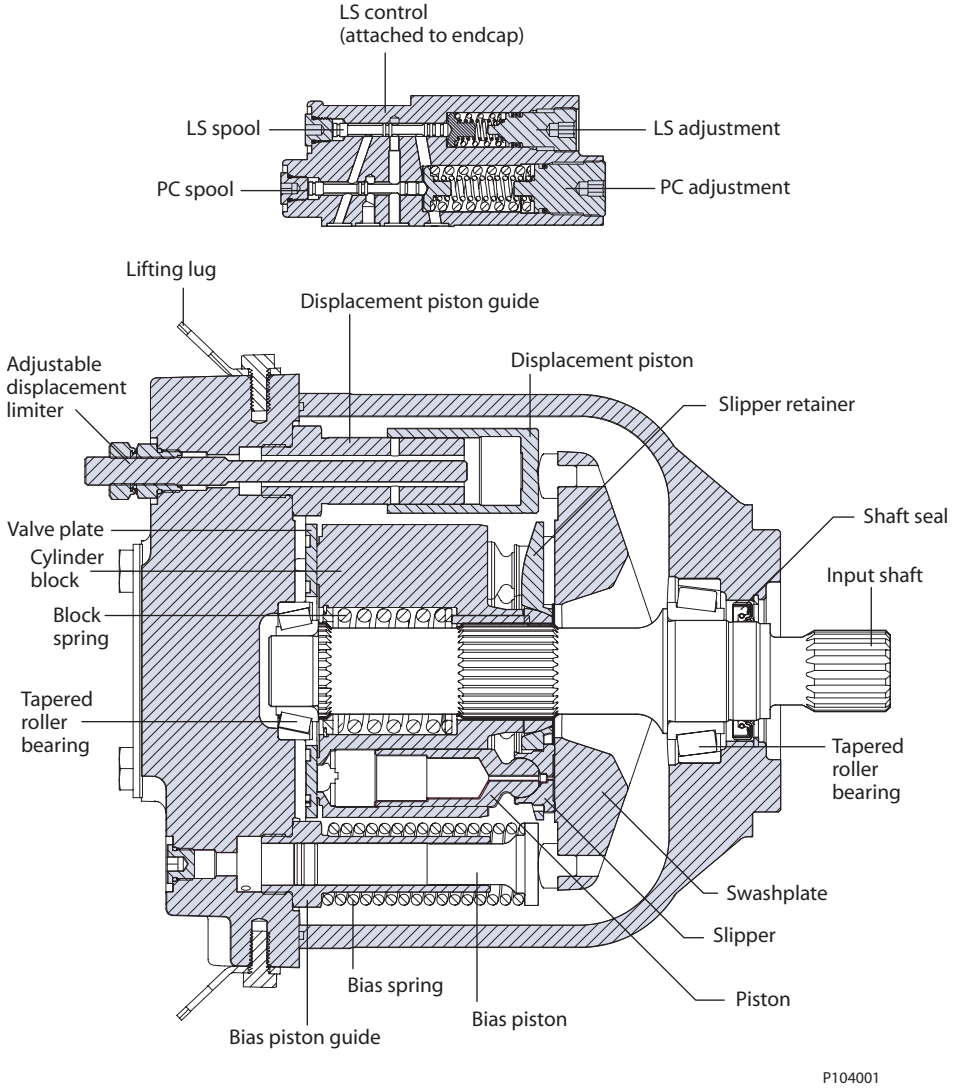
Frame E

Design

Series 45 Frame E 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 E cross section



Frame E

Technical Specifications

			E Frame		
		Unit	**100B**	**130B**	**147C**
Maximum Displacement		cm^3 [in^3]	100 [6.1]	130 [7.93]	147 [8.97]
Working Input Speed	Minimum	min -1 (rpm)	500	500	500
	Continuous		2450	2200	2100
	Maximum		2880	2600	2475
Working Pressure	Continuous	bar [psi]	310 [4500]	310 [4500]	260 [3770]
	Maximum		400 [5800]	400 [5800]	350 [5075]
Flow at rated speed (theoretical)		l/min [US gal/min]	245 [64.7]	286 [75.6]	309 [81.6]
Input torque at maximum displacement (theoretical) at 49° C [120°F]		N•m/bar [lbf•in/1000 psi]	1.592 [972]	2.07 [1263.6]	2.341 [1428.8]
Mass moment of inertia of internal rotating components		$kg•m^2$ [$slug•ft^2$]	0.0128 [0.00944]	0.0128 [0.00944]	0.0128 [0.00944]
Weight	Axial ports	kg [lb]	52.0 [115.0]		
	Radial ports		56.0 [123.3]		
External Shaft Loads	External moment (Me)	N•m [lbf•in]	455 [4027]	360 [3186]	396 [3505]
	Thrust in (Tin), out (Tout)	N [lbf]	2846 [640]	1735 [390]	2113 [475]
Mounting flange load moments	Vibratory (continuous)	N•m [lbf•in]	1920 [17000]		
	Shock (maximum)		6779 [60000]		

Order code

Code description

Code	Description
R	Product Frame, Variable Open Circuit Pump
S	Rotation
P	Displacement
C	Control Type
D	Pressure Compensator Setting
E	Load Sense Setting
F	Not Used
G	Choke Orifice
H	Gain Orifice
J	Input Shaft/Auxiliary Mount/Endcap
K	Shaft Seal/Front Mounting Flange/Housing Ports
L	Displacement Limiter
M	Special Hardware
N	Special Features

Frame E

R Product

		E Frame		
		100B	130B	147C
ER	E Frame, variable displacement open circuit pump	•	•	•

S Rotation

L	Left Hand (counterclockwise)	•	•	•
R	Right Hand (clockwise)	•	•	•

P Displacement

100B	100 cm^3/rev [6.10 in^3/rev]	•		
130B	130 cm^3/rev [7.93 in^3/rev]		•	
147C	147 cm^3/rev [8.97 in^3/rev]			•

C Control type

		100B	130B	147C
PC	Pressure Compensator	•	•	•
BC*	Pressure Compensator [>280 bar]	•	•	
RP	Remote Pressure Compensator	•	•	•
BP*	Remote Pressure Compensator [>280 bar]	•	•	
LS	Load Sensing/Pressure Comp.	•	•	•
BS*	Load Sensing/Pressure Comp. [>280 bar]	•	•	
LB	Load Sensing/Pressure Comp. with internal bleed orifice	•	•	•
BB*	Load Sensing/Pressure Comp. with internal bleed orifice [>280 bar]	•	•	
AN	Electric On/Off w/Pressure Comp. (NO, 12VDC) Left	•	•	•
CN	Electric On/Off w/Pressure Comp. (NO, 24VDC) Left	•	•	•
AR	Electric On/Off w/Pressure Comp. (NC, 12VDC) Left	•	•	•
CR	Electric On/Off w/Pressure Comp. (NC, 24VDC) Left	•	•	•
AF	Electric On/Off w/Pressure Comp. (NO, 12VDC) Right	•	•	•
AT	Electric On/Off w/Pressure Comp. (NO, 24VDC) Right	•	•	•
AG	Electric On/Off w/Pressure Comp. (NC, 12VDC) Right	•	•	•
AY	Electric On/Off w/Pressure Comp. (NC, 24VDC) Right	•	•	•
BN*	Electric On/Off w/Pressure Comp. (NO, 12VDC) [>280 bar] Left	•	•	
DN*	Electric On/Off w/Pressure Comp. (NO, 24VDC) [>280 bar] Left	•	•	
BR*	Electric On/Off w/Pressure Comp. (NC, 12VDC) [>280 bar] Left	•	•	
DR*	Electric On/Off w/Pressure Comp. (NC, 24VDC) [>280 bar] Left	•	•	
BF*	Electric On/Off w/Pressure Comp. (NO, 12VDC) [>280 bar] Right	•	•	
DF*	Electric On/Off w/Pressure Comp. (NO, 24VDC) [>280 bar] Right	•	•	
BE*	Electric On/Off w/Pressure Comp. (NC, 12VDC) [>280 bar] Right	•	•	
BG*	Electric On/Off w/Pressure Comp. (NC, 24VDC) [>280 bar] Right	•	•	
AX	Electric Proportional Pressure Control w/Pressure Comp. (NO,12VDC) Left	•	•	•

Frame E

C Control type (continued)

		100B	130B	147C
CL	Electric Proportional Pressure Control w/Pressure Comp. (NO,24VDC) Left		•	•
AH	Electric Proportional Pressure Control w/Pressure Comp. (NC,12VDC) Left	•	•	•
AL	Electric Proportional Pressure Control w/Pressure Comp. (NC,24VDC) Left	•	•	•
AW	Electric Proportional Pressure Control w/Pressure Comp. (NO,12VDC) Right	•	•	•
CK	Electric Proportional Pressure Control w/Pressure Comp. (NO,24VDC) Right	•	•	•
AV	Electric Proportional Pressure Control w/Pressure Comp. (NC,12VDC) Right	•	•	•
AK	Electric Proportional Pressure Control w/Pressure Comp. (NC,24VDC) Right	•	•	•
BX*	Electric Proportional Pressure Control w/Pressure Comp. (NO,12VDC) [>280 bar] Left	•	•	
DL*	Electric Proportional Pressure Control w/Pressure Comp. (NO,24VDC) [>280 bar] Left	•	•	
BH*	Electric Proportional Pressure Control w/Pressure Comp. (NC,12VDC) [>280 bar] Left	•	•	
BL*	Electric Proportional Pressure Control w/Pressure Comp. (NC,24VDC) [>280 bar] Left	•	•	
BW*	Electric Proportional Pressure Control w/Pressure Comp. (NO,12VDC) [>280 bar] Right	•	•	
DK*	Electric Proportional Pressure Control w/Pressure Comp. (NO,24VDC) [>280 bar] Right	•	•	
BM*	Electric Proportional Pressure Control w/Pressure Comp. (NC,12VDC) [>280 bar] Right	•	•	
BK*	Electric Proportional Pressure Control w/Pressure Comp. (NC,24VDC) [>280 bar] Right	•	•	
FA*	Electric On/Off Dump valve w/Pressure Comp. + Load Sense (NC, 12VDC) Right	•	•	•
FB*	Electric On/Off Dump valve w/Pressure Comp. + Load Sense (NC, 12VDC) Left	•	•	•
FE*	Electric On/Off Dump valve w/Pressure Comp. + Load Sense (NC, 24VDC), Left	•	•	•

Left - E-Frame: CW Only, F-Frame: CW Only, J-frame: CW Axial, CCW Radial

Right - E-Frame: CCW Only, F-Frame: CCW Only, J-frame: CCW Axial, CW Radial

* Not available on 147cc pumps

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

		E Frame		
		100B	130B	147C
Example	25 = 250 bar (3625 psi)			
10–26	100 to 260 bar [1450 to 3771 psi]	•	•	•
27-28	270 to 280 bar [3916 to 4061 psi]	•	•	
29-31	290-310 bar [4206 to 4496 psi]	•	•	

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

Example	20 = 20 bar (290 psi)			
10-34	10 to 34 bar [145 to 508 psi]	•	•	•
NN	Not applicable (pressure compensated only controls)	•	•	•

F Not used

NN	Not applicable	•	•	•

Frame E

G Servo Control Orifice

N	None (standard)	•	•	•
E	0.8 mm diameter	•	•	•
F	1.0 mm diameter	•	•	•

H Gain Orifice

3	1.0 mm diameter	•	•	•

J Input Shaft

K5	1.5 inch straight keyed
S1	14 tooth 12/24 pitch
S2	17 tooth, 12/24 pitch
S4	13 tooth, 8/16 pitch

Auxiliary Mount/Endcap Style

Auxiliary Description	Endcap Style	Inlet Porting	Outlet Porting	Endcap Description	Code
None	Axial	Split Flange	Split Flange	Inlet - Code 61 Split Flange Port 4 Bolt (2.5 inch port 0.5 inch threads) Outlet - Code 62 Split Flange Port 4 Bolt (1.25 inch port 0.5 inch threads)	NL
None	Radial	Split Flange	Split Flange	Inlet - Code 61 Split Flange Port 4 Bolt (2.5 inch port 0.5 inch threads) Outlet - Code 62 Split Flange Port 4 Bolt (1.25 inch port 0.5 inch threads)	NP
Running Cover	Radial	Split Flange	Split Flange	Inlet - Code 61 Split Flange Port 4 Bolt (2.5 inch port 0.5 inch threads) Outlet - Code 62 Split Flange Port 4 Bolt (1.25 inch port 0.5 inch threads)	RP
SAE-A, 11 teeth	Radial	Split Flange	Split Flange	Inlet - Code 61 Split Flange Port 4 Bolt (2.5 inch port 0.5 inch threads) Outlet - Code 62 Split Flange Port 4 Bolt (1.25 inch port 0.5 inch threads)	TP
SAE-A, 9 teeth	Radial	Split Flange	Split Flange	Inlet - Code 61 Split Flange Port 4 Bolt (2.5 inch port 0.5 inch threads) Outlet - Code 62 Split Flange Port 4 Bolt (1.25 inch port 0.5 inch threads)	AP
SAE-B, 13 teeth	Radial	Split Flange	Split Flange	Inlet - Code 61 Split Flange Port 4 Bolt (2.5 inch port 0.5 inch threads) Outlet - Code 62 Split Flange Port 4 Bolt (1.25 inch port 0.5 inch threads)	BP
SAE-B, 14 teeth	Radial	Split Flange	Split Flange	Inlet - Code 61 Split Flange Port 4 Bolt (2.5 inch port 0.5 inch threads) Outlet - Code 62 Split Flange Port 4 Bolt (1.25 inch port 0.5 inch threads)	LP
SAE-BB, 13 teeth/with M12 thread	Radial	Split Flange	Split Flange	Inlet - Code 61 Split Flange Port 4 Bolt (2.5 inch port M12 metric threads) Outlet - Code 62 Split Flange Port 4 Bolt (1.25 inch port M12 metric threads)	U6

Frame E

Auxiliary Mount/Endcap Style (continued)

SAE-BB, 15 teeth	Radial	Split Flange	Split Flange	Inlet - Code 61 Split Flange Port 4 Bolt (2.5 inch port 0.5 inch threads) Outlet - Code 62 Split Flange Port 4 Bolt (1.25 inch port 0.5 inch threads)	VP
SAE-C, 14 teeth	Radial	Split Flange	Split Flange	Inlet - Code 61 Split Flange Port 4 Bolt (2.5 inch port 0.5 inch threads) Outlet - Code 62 Split Flange Port 4 Bolt (1.25 inch port 0.5 inch threads)	CP
SAE-CC, 17 teeth	Radial	Split Flange	Split Flange	Inlet - Code 61 Split Flange Port 4 Bolt (2.5 inch port 0.5 inch threads) Outlet - Code 62 Split Flange Port 4 Bolt (1.25 inch port 0.5 inch threads)	WP

J Input Shaft/Auxiliary Mount/Endcap

Available Combinations

	E Frame		
	100B	**130B**	**147C**
K5AP	•	•	•
K5BP	•	•	•
K5CP	•	•	•
K5NL	•	•	•
K5NP	•	•	•
K5RP	•	•	•
K5VP	•	•	•
S1AP	•	•	•
S1BP	•	•	•
S1CP	•	•	•
S1LP	•	•	•
S1NL	•	•	•
S1NP	•	•	•
S1RP	•	•	•
S1TP	•	•	•
S1VP	•	•	•
S2AP	•	•	•

	E Frame		
	100B	**130B**	**147C**
S2BP	•	•	•
S2CP	•	•	•
S2NL	•	•	•
S2NP	•	•	•
S2RP	•	•	•
S2TP	•	•	•
S2VP	•	•	•

Frame E

	E Frame		
	100B	130B	147C
S2WP	•	•	•
S4AP	•	•	•
S4BP	•	•	•
S4CP	•	•	•
S4NL	•	•	•
S4NP	•	•	•
S4RP	•	•	•
S4U6	•	•	•
S4TP	•	•	•
S4VP	•	•	•
S4WP	•	•	•

K Shaft seal

		E Frame		
		100B	130B	147C
A	Single (Viton)	•	•	•

K Mounting flange and housing port style

1	SAE-C Flange 4-bolt/SAE O-ring boss ports	•	•	•

K Not used

N	Not applicable	•	•	•

L Displacement limiter

NNN	None (plugged)	•	•	•
AAA	Adjustable, factory set at max angle	•	•	•

M Special hardware

NNN	None	•	•	•

N Special features

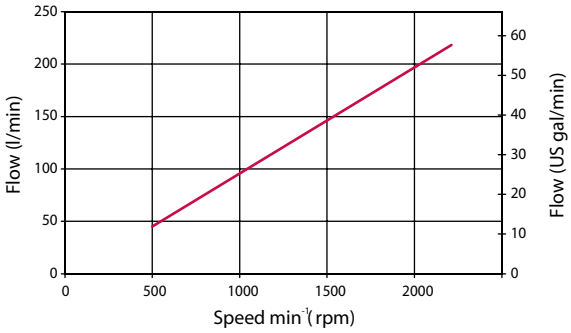
NNN	None	•	•	•

Performance E100B

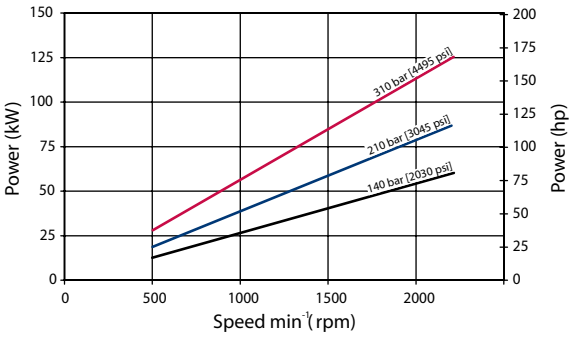
Flow and power data valid at 49°C [120°F] and viscosity of 17.8 mm^2/sec [88 SUS].

Frame E

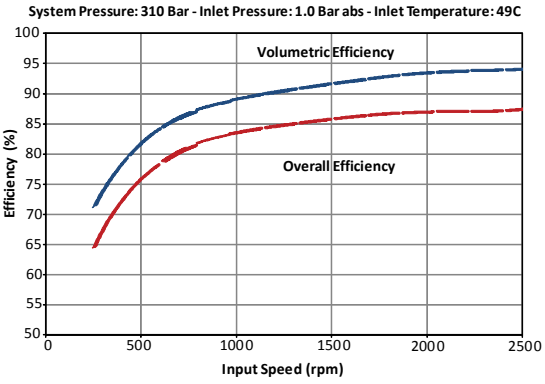
Flow vs. speed



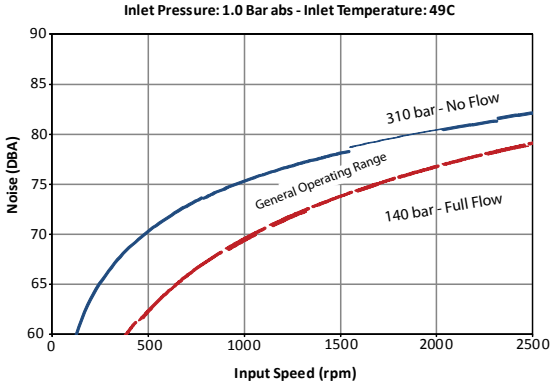
Input power vs. speed



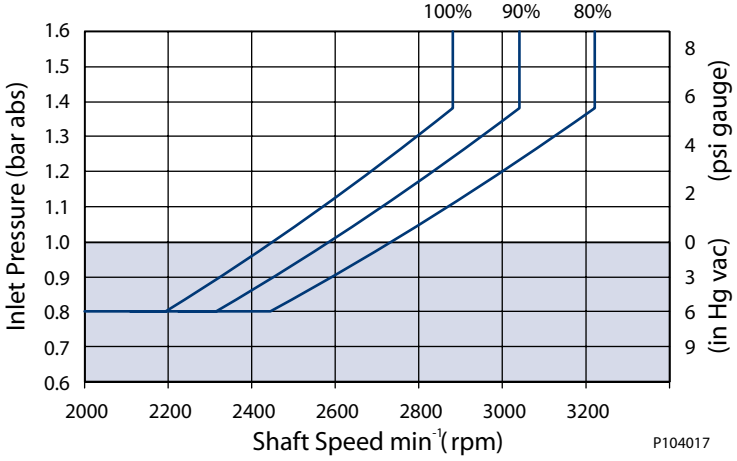
Efficiency



Noise



Inlet pressure vs. speed



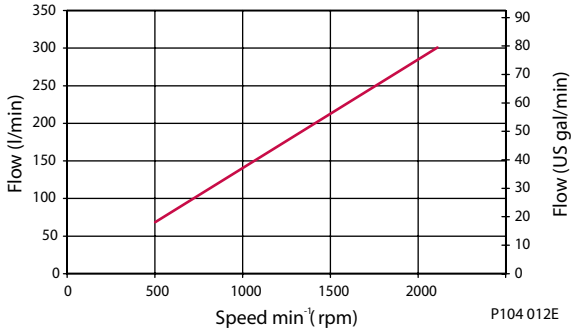
The chart above shows allowable inlet pressure and speed at various displacements. Greater speeds and lower inlet pressures are possible at reduced displacement. Operating outside of acceptable limits reduces pump life.

Performance E130B

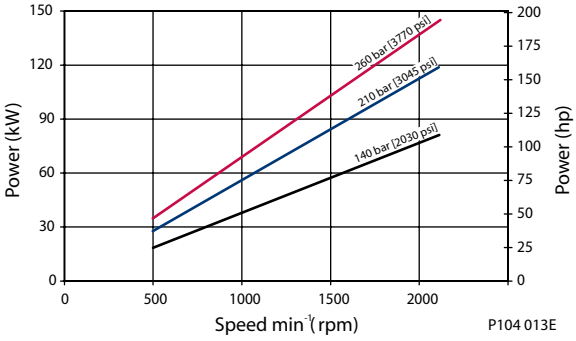
Flow and power data valid at 49°C [120°F] and viscosity of 17.8 mm²/sec [88 SUS].

Frame E

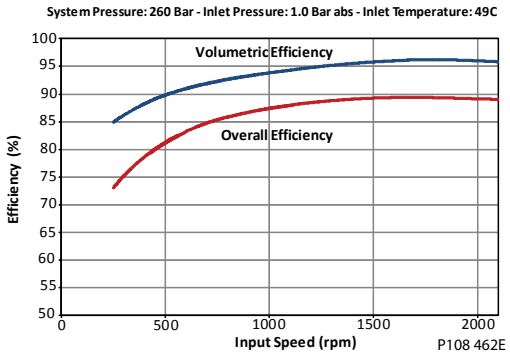
Flow vs. speed



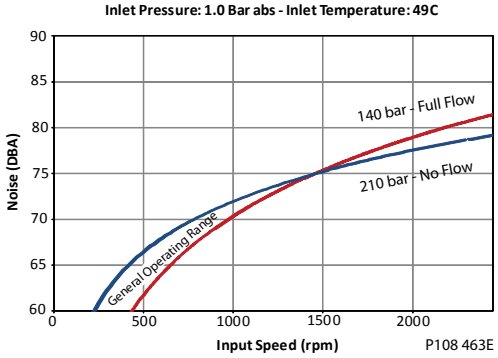
Input power vs. speed



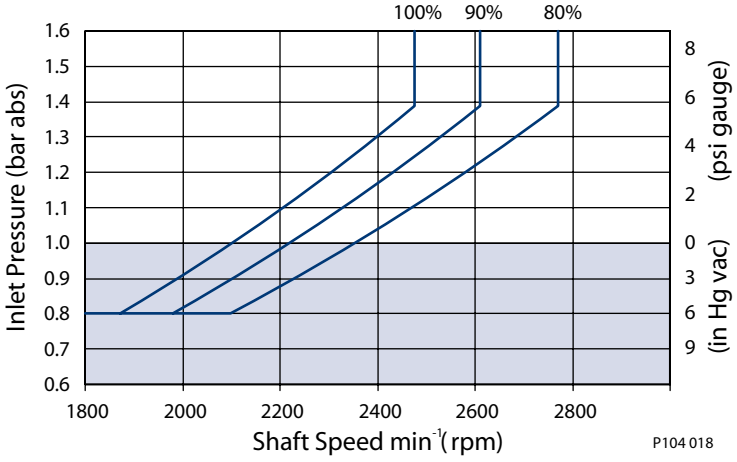
Efficiency



Noise



Inlet pressure vs. speed



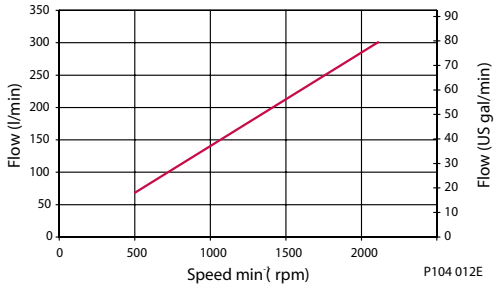
The chart above shows allowable inlet pressure and speed at various displacements. Greater speeds and lower inlet pressures are possible at reduced displacement. Operating outside of acceptable limits reduces pump life.

Performance E147C

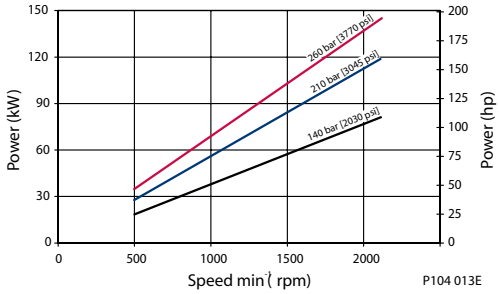
Flow and power data valid at 49°C [120°F] and viscosity of 17.8 mm²/sec [88 SUS].

Frame E

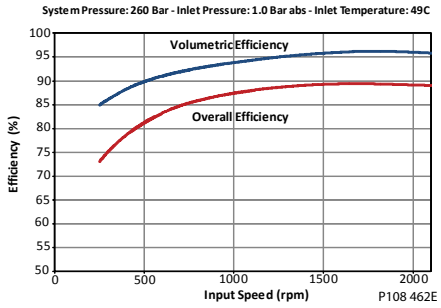
Flow vs. speed



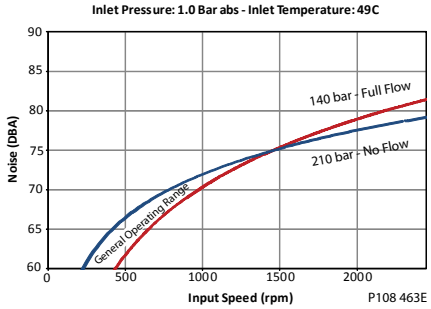
Input power vs. speed



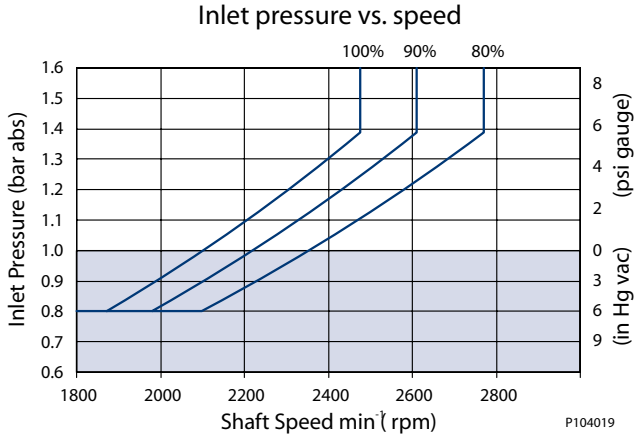
Efficiency



Noise



Inlet pressure vs. speed



The chart above 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.

Hydraulic Controls

Pressure Compensated Controls

Response/recovery times

(ms)	Response	Recovery
E100B	45	175

Frame E

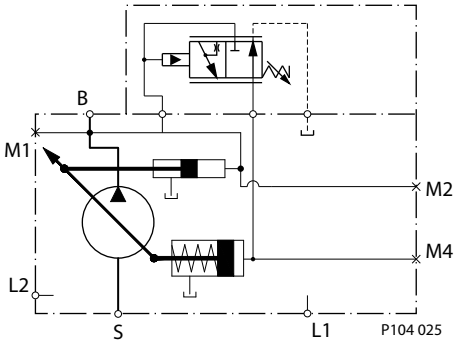
Response/recovery times (continued)

(ms)	Response	Recovery
E130B	55	175
E147C	60	190

PC Setting range

Model	PC	BC
E100B	100-280 bar [1450-4060 psi]	290-310 bar [4205-4495 psi]
E130B	100-280 bar [1450-4060 psi]	290-310 bar [4205-4495 psi]
E147C	100-260 bar [1450-3770 psi]	N/A

Schematic



B = Outlet

S = Inlet

L1, L2 = Case drain

M2 = System pressure gauge port

M4 = Servo pressure gauge port

Remote Pressure Compensated Controls

Response/recovery times

(ms)	Response	Recovery
E100B	45	175
E130B	55	175
E147C	60	190

PC Setting range

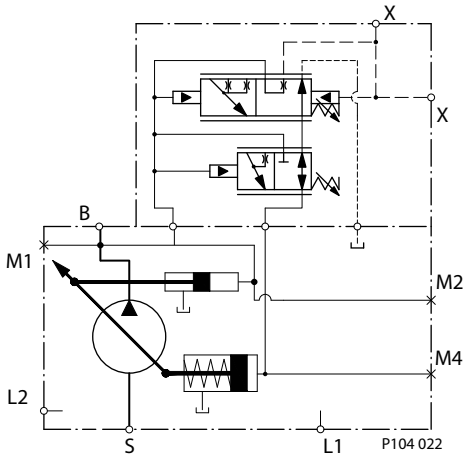
Model	RP	BP
E100B	100-280 bar [1450-4060 psi]	290-310 bar [4205-4495 psi]
E130B	100-280 bar [1450-4060 psi]	290-310 bar [4205-4495 psi]

Frame E

PC Setting range (continued)

Model	RP	BP
E147C	100-260 bar [1450-3770 psi]	N/A

Schematic



B = Outlet

S = Inlet

L1, L2 = Case drain

M2 = System pressure gauge port

M4 = Servo pressure gauge port

X = Remote PC port

Load Sensing/Pressure Compensated

Response/recovery times

(ms)	Response	Recovery
E100B	45	200
E130B	50	200
E147C	60	200

PC Setting range

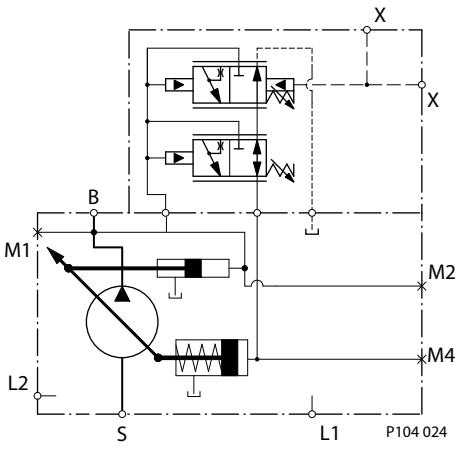
Model	LS	BS
E100B	100-280 bar [1450-4060 psi]	290-310 bar [4205-4495 psi]
E130B	100-280 bar [1450-4060 psi]	290-310 bar [4205-4495 psi]
E147C	100-260 bar [1450-3770 psi]	N/A

Frame E

LS setting range

Model	bar	psi
All	10–30	145–435

Schematic



B = Outlet

S = Inlet

L1, L2 = Case drain

M2 = System pressure gauge port

M4 = Servo pressure gauge port

X = LS signal port

Load Sensing Control with Bleed Orifice/Pressure Compensated

*Response/recovery times**

(msec)	Response	Recovery
F74B	35	135
F90C	40	135

PC setting range

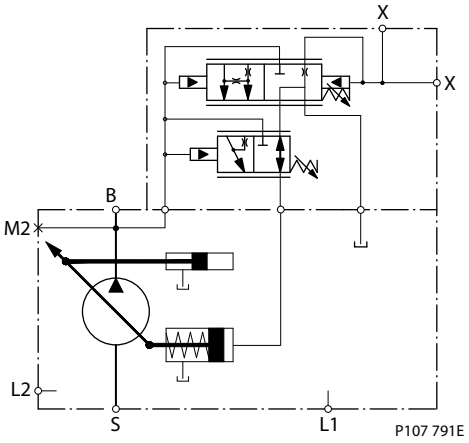
Model	LB	BB
F74B	100-280 bar [1450-4060 psi]	290-310 bar [4205-4495 psi]
F90C	100-260 bar [1450-3770 psi]	N/A

LS setting range

Model	bar	psi
All	10–34	145–508

Frame E

Schematic



B = Outlet

S = Inlet

L1, L2 = Case drain

M2 = System pressure gauge port

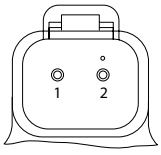
M4 = Servo pressure gauge port

X = LS signal port

Electric Controls

Connectors

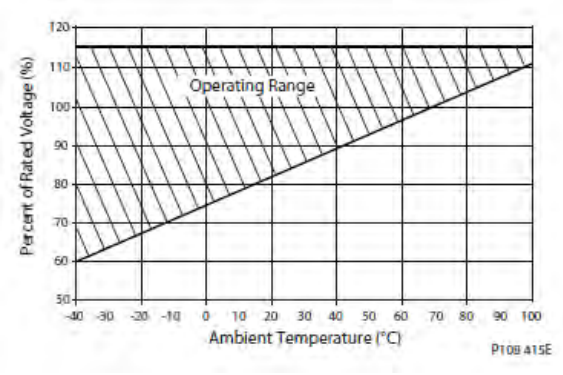
Description	Quantity	Ordering Number
Mating Connector	1	Deutsch® DT06-2S
Wedge Lock	1	Deutsch® W25
Socket Contact (16 and 18 AWG)	2	Deutsch® 0462-201-16141
Danfoss mating connector kit	1	K29657



P003 480

Frame E

Continuous Duty Operating Range



Solenoid Data - Normally Closed

Voltage	12V	24V
Threshold Control [mA] (310/260 bar PC setting, oil temp X)	200/400	100/200
End Current [mA] (20 bar LS setting, oil temp X)	1200	600

Solenoid Data - Normally Open

Voltage	12V	24V
Threshold Control [mA] (20 bar LS setting, oil temp X)	0	0
End Current [mA] (260/310 bar PC setting, oil temp X)	1000/1100	500/550

Hysteresis

Frame	Hysteresis
E100B, E130B	Input hysteresis <4% (control current): Output hysteresis <4.5% (system pressure)
E147C	Input hysteresis <4% (control current): Output hysteresis <4.5% (system pressure)

Normally Closed Electric On/Off with Pressure Compensation Controls

*Response/Recovery times**

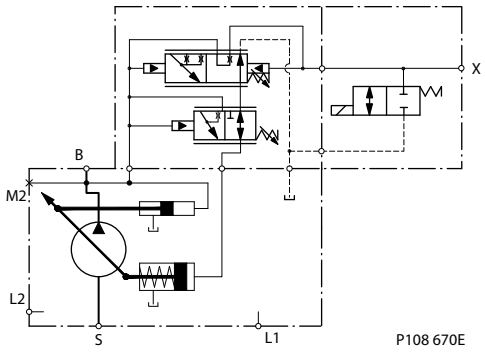
(msec)	Response	Recovery
E100B	45	175
E130B	55	175
E147C	60	190

* Without servo control orifice

For fan-drive systems, and systems with motors, select an LS setting no less than15 bar to enhance system stability. As the LS setting is reduced, the risk for system instability may be increased. A 20 bar LS setting is recommended as a starting point for all new applications.

Frame E

Schematic



B = Outlet

S = Inlet

L1, L2 = Case drain

M2 = System pressure gauge port

X = Load Sense Port

LS setting range

Model	bar	psi
All	10 - 40	[145 - 580]

PC setting range

Frame	AG, AR (12V)	BE, BR (12V)	AY, CR (24V)	BG, DR (24V)
E100B	100-280 bar [1450-4060] psi	290-310 bar [4205-4495] psi	100-280 bar [1450-4060] psi	290-310 bar [4205-4495] psi
E130B				
E147C	100-260 bar [1450-3770] psi	Not Available	100-260 bar [1450-3770] psi	Not Available

Normally Open Electric On/Off with Pressure Compensation Controls

*Response/Recovery times**

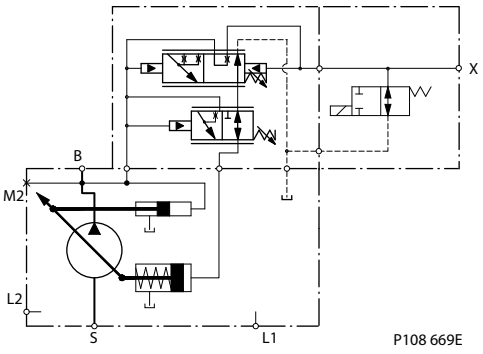
(msec)	Response	Recovery
E100B	45	175
E130B	55	175
E147C	60	190

* Without servo control orifice

For fan-drive systems, and systems with motors, select an LS setting no less than15 bar to enhance system stability. As the LS setting is reduced, the risk for system instability may be increased. A 20 bar LS setting is recommended as a starting point for all new applications.

Frame E

Schematic



B = Outlet

S = Inlet

L1, L2 = Case drain

M2 = System pressure gauge port

X = Load Sense Port

LS setting range

Model	bar	psi
All	10 - 40	[145 - 580]

PC setting range

Frame	AF, AN (12V)	BF, BN (12V)	AT, CN (24V)	DF, DN (24V)
E100B	100-280 bar [1450-4060] psi	290-310 bar [4205-4495] psi	100-280 bar [1450-4060] psi	290-310 bar [4205-4495] psi
E130B				
E147C	100-260 bar [1450-3770] psi	Not Available	100-260 bar [1450-3770] psi	Not Available

Normally Closed Electric Proportional with Pressure Compensation Controls

Response/Recovery times

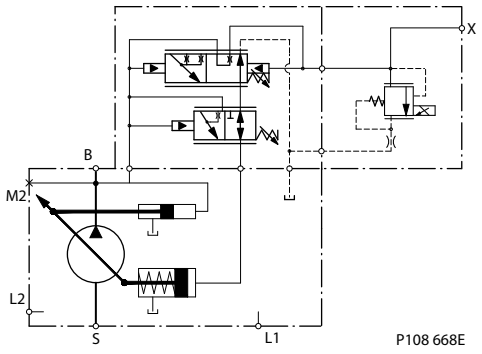
	0.8mm Orifice		1.0mm Orifice	
(msec)	Response	Recovery	Response	Recovery
E100B	45	530	45	405
E130B	55	530	55	405
E147C	60	580	60	440

LS setting range

Model	bar	psi
All	10 - 40	[145 - 580]

Frame E

Schematic



B = Outlet

S = Inlet

L1, L2 = Case drain

M2 = System pressure gauge port

X = Load Sense Port

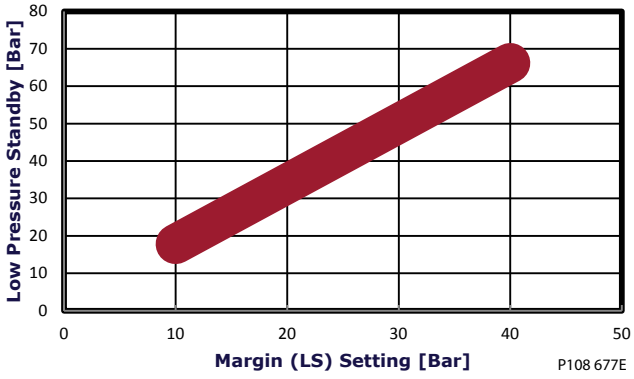
PC setting range

Frame	AH, AV (12V)	BH, BM (12V)	AK, AL (24V)	BK, BL (24V)
E100B E130B	100-280 bar [1450-4060] psi	290-310 bar [4205-4495] psi	100-280 bar [1450-4060] psi	290-310 bar [4205-4495] psi
E147C	100-260 bar [1450-3770] psi	Not Available	100-260 bar [1450-3770] psi	Not Available

For fan-drive systems, and systems with motors, select an LS setting no less than15 bar to enhance system stability. As the LS setting is reduced, the risk for system instability may be increased. A 20 bar LS setting is recommended as a starting point for all new applications.

Electric proportional controls have a unique relationship between margin (LS) setting and low pressure standby. See the graph below for this relationship.

Frames E, F, J Electric Proportional Control
Low Pressure Standby



Frame E

Normally Open Electric Proportional with Pressure Compensation Controls

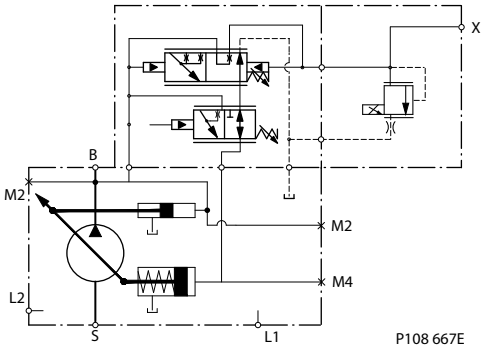
Response/Recovery times

	0.8mm Orifice		1.0mm Orifice	
(msec)	Response	Recovery	Response	Recovery
E100B	45	530	45	405
E130B	55	530	55	405
E147C	60	580	60	440

LS setting range

Model	bar	psi
All	10 - 40	[145 - 580]

Schematic



B = Outlet

S = Inlet

L1, L2 = Case drain

M2 = System pressure gauge port

X = Load Sense Port

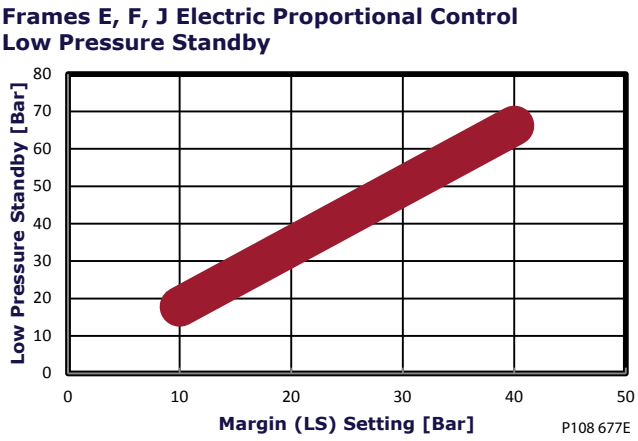
PC setting range

Frame	AW, AX (12V)	BW, BX (12V)	CK, CL (24V)	DK, DL (24V)
E100B	100-280 bar [1450-4060] psi	290-310 bar [4205-4495] psi	100-280 bar [1450-4060] psi	290-310 bar [4205-4495] psi
E130B				
E147C	100-260 bar [1450-3770] psi	Not Available	100-260 bar [1450-3770] psi	Not Available

For fan-drive systems, and systems with motors, select an LS setting no less than15 bar to enhance system stability. As the LS setting is reduced, the risk for system instability may be increased. A 20 bar LS setting is recommended as a starting point for all new applications.

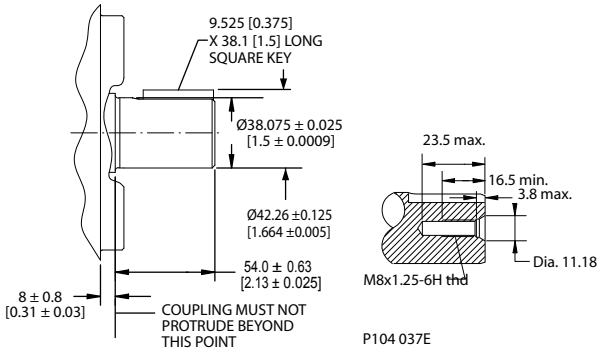
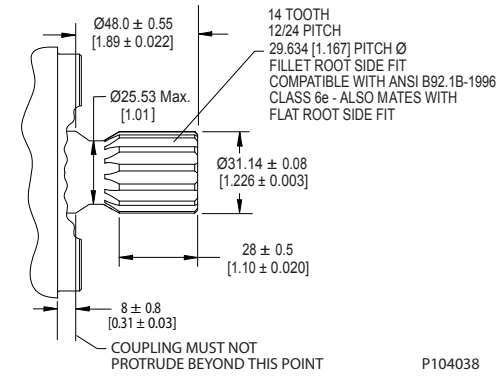
Electric proportional controls have a unique relationship between margin (LS) setting and low pressure standby. See the graph below for this relationship.

Frame E



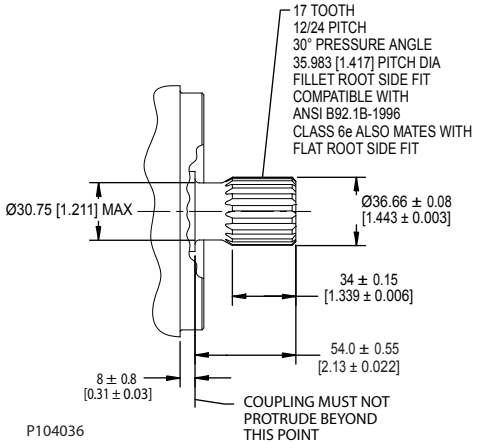
Input shafts

Shaft data

Code	Description	Maximum torque rating[1] N•m [lbf•in]	Drawing
K5	Ø 38.08 mm [1.5 in] Straight keyed	1161 [10 270]	
S1	14-tooth spline 12/24 pitch (ANSI B92.1B 1996 - Class 6e)	800 [7080]	

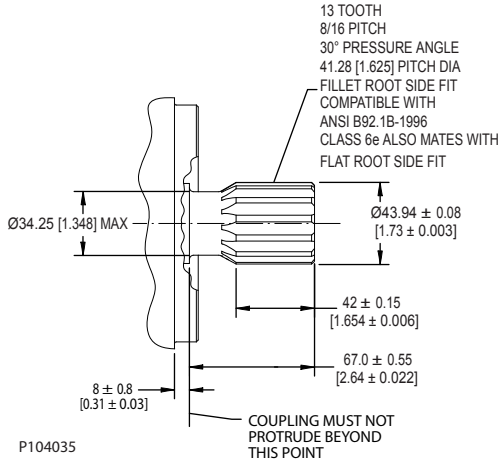
Frame E

Shaft data (continued)

Code	Description	Maximum torque rating[1] N•m [lbf•in]	Drawing
S2	17-tooth spline 12/24 pitch (ANSI B92.1B 1996 - Class 6e)	1150 [10178]	

1. See *Input shaft torque ratings* for an explanation of maximum torque.

Shaft data

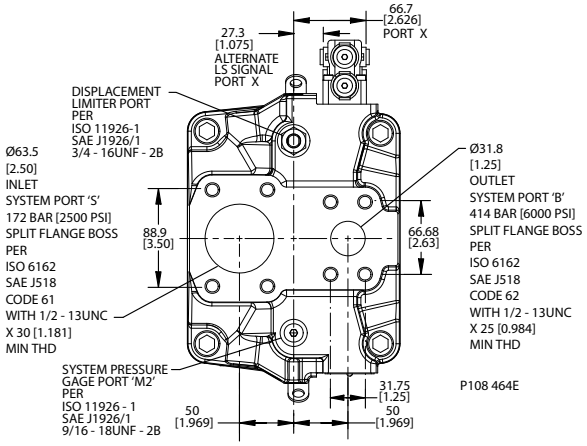
Code	Description	Maximum torque rating[1] N•m [lbf•in]	Drawing
S4	13-tooth spline 8/16 pitch (ANSI B92.1B 1996 - Class 6e)	1560 [13 807]	

1. See *Input shaft torque ratings* for an explanation of maximum torque.

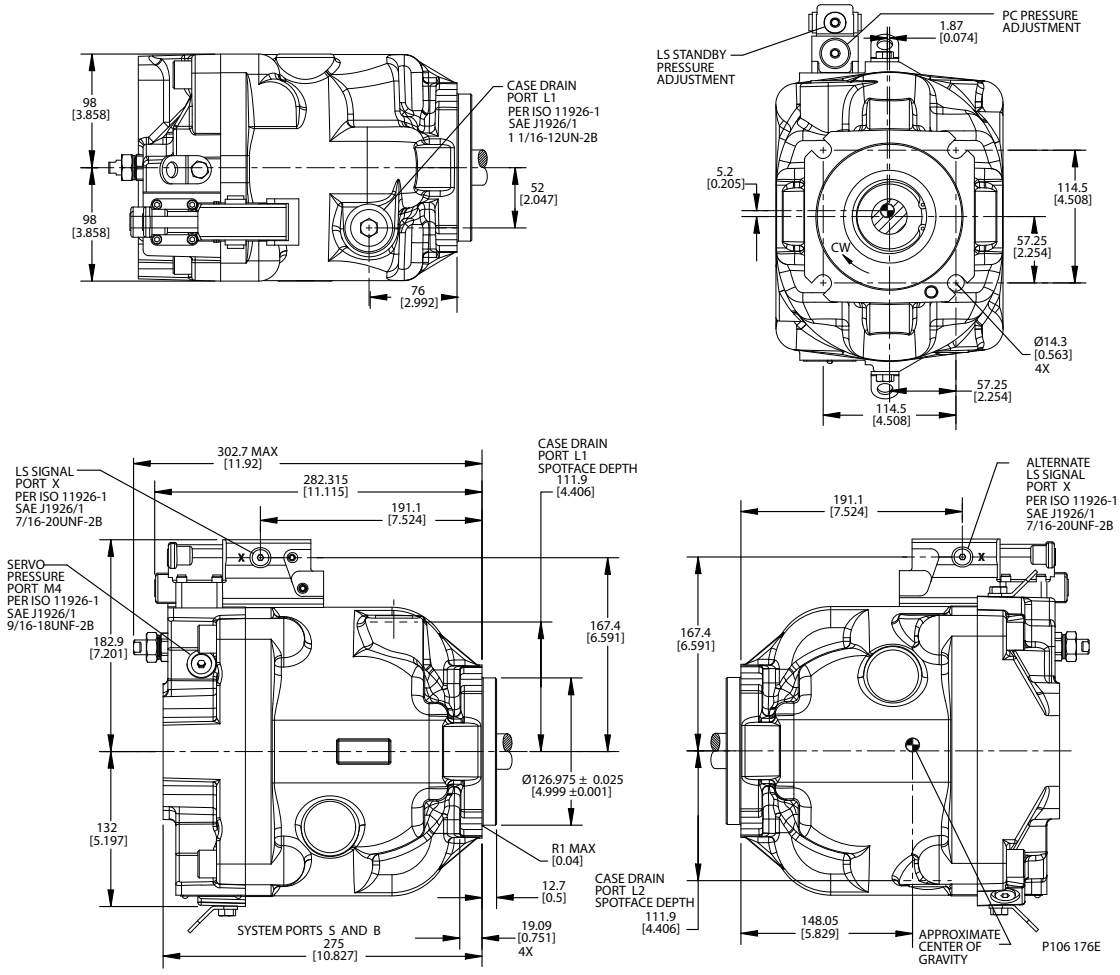
Frame E

Installation drawings

Axial Ported Endcap

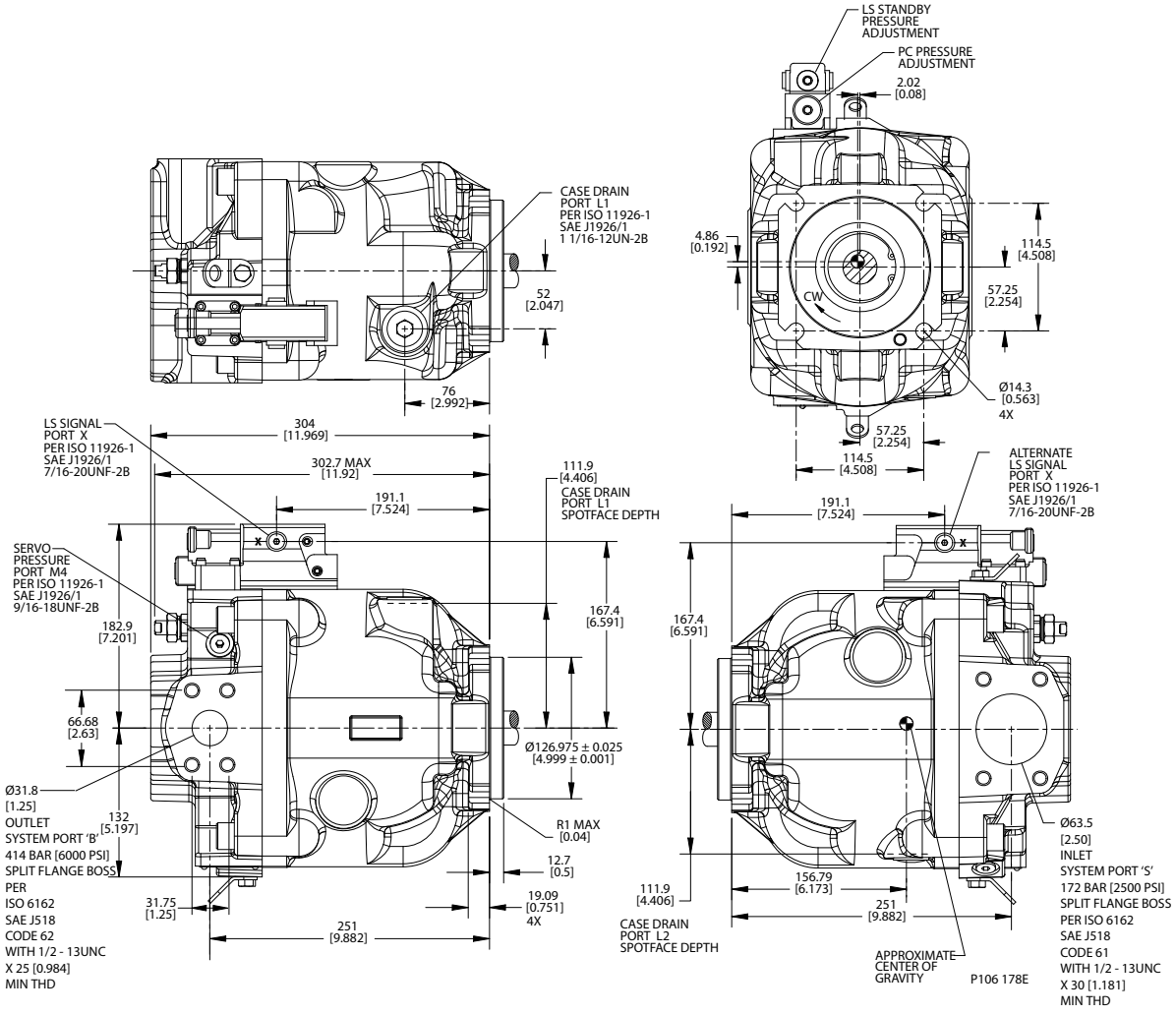


Axial Ported Endcap Installation Dimensions



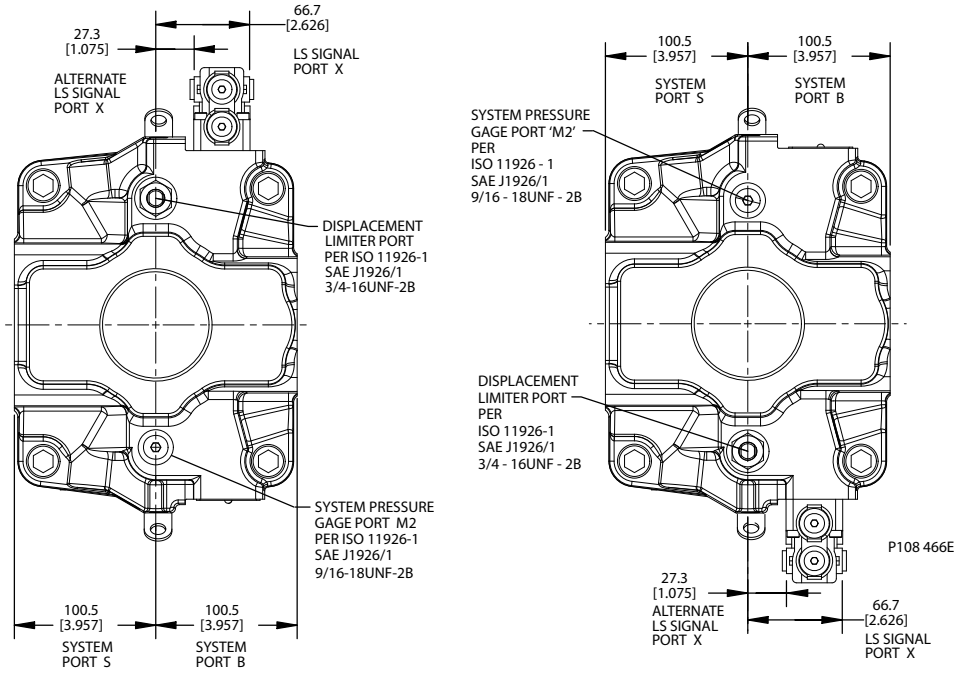
Frame E

Radial Ported Endcap Installation Dimensions

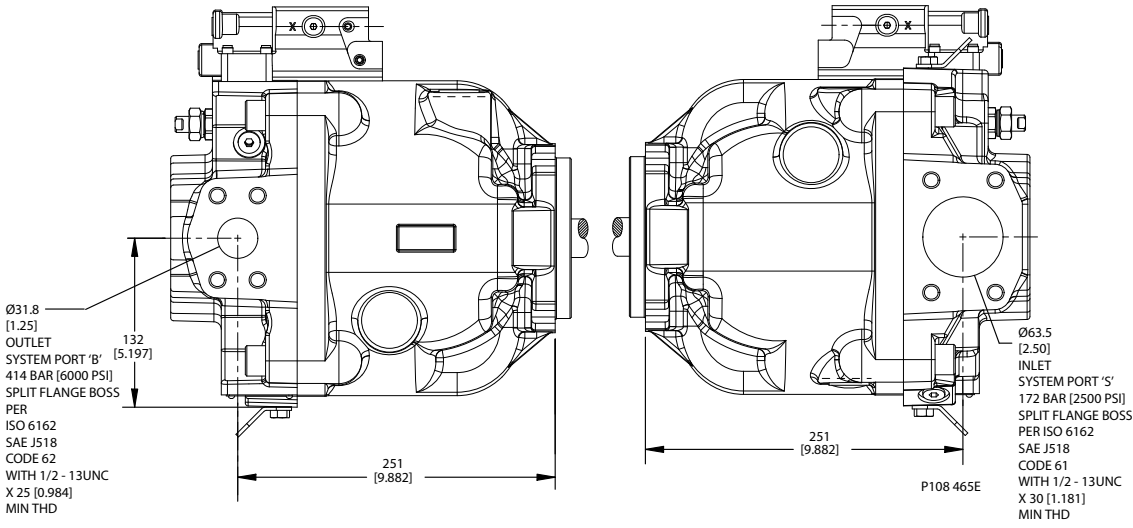


Frame E

Radial Ported Endcap Rear View

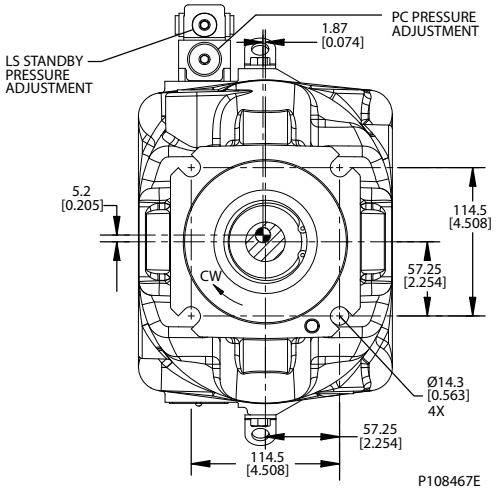


Radial Ported Endcap Split Flange Ports



Frame E

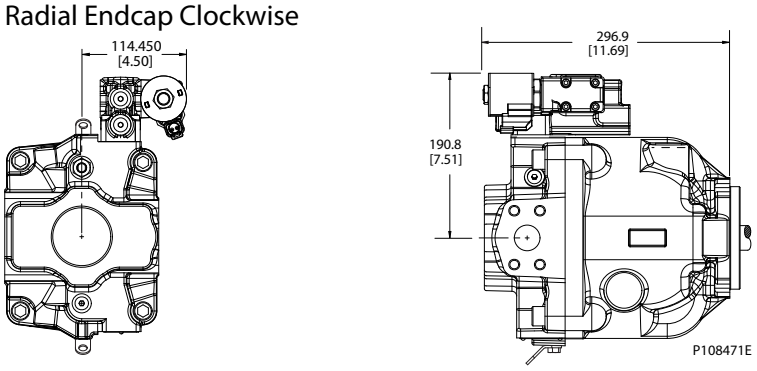
Front Mounting Flange



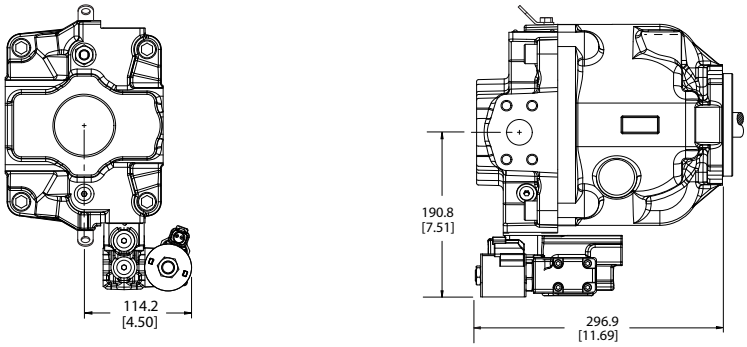
Frame E

Endcap Dimensions

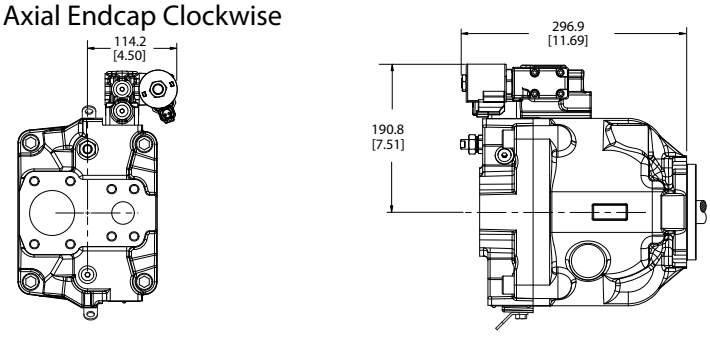
Radial Endcap Clockwise



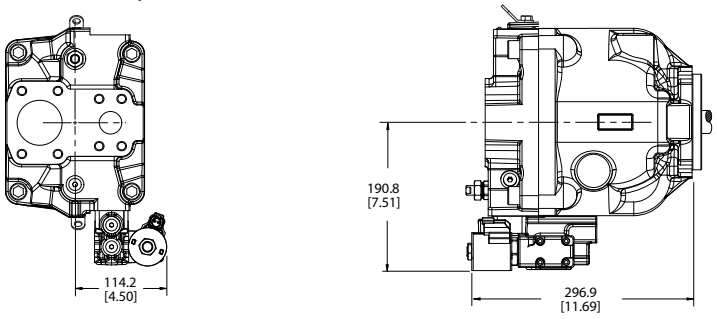
Radial Endcap Counterclockwise



Axial Endcap Clockwise



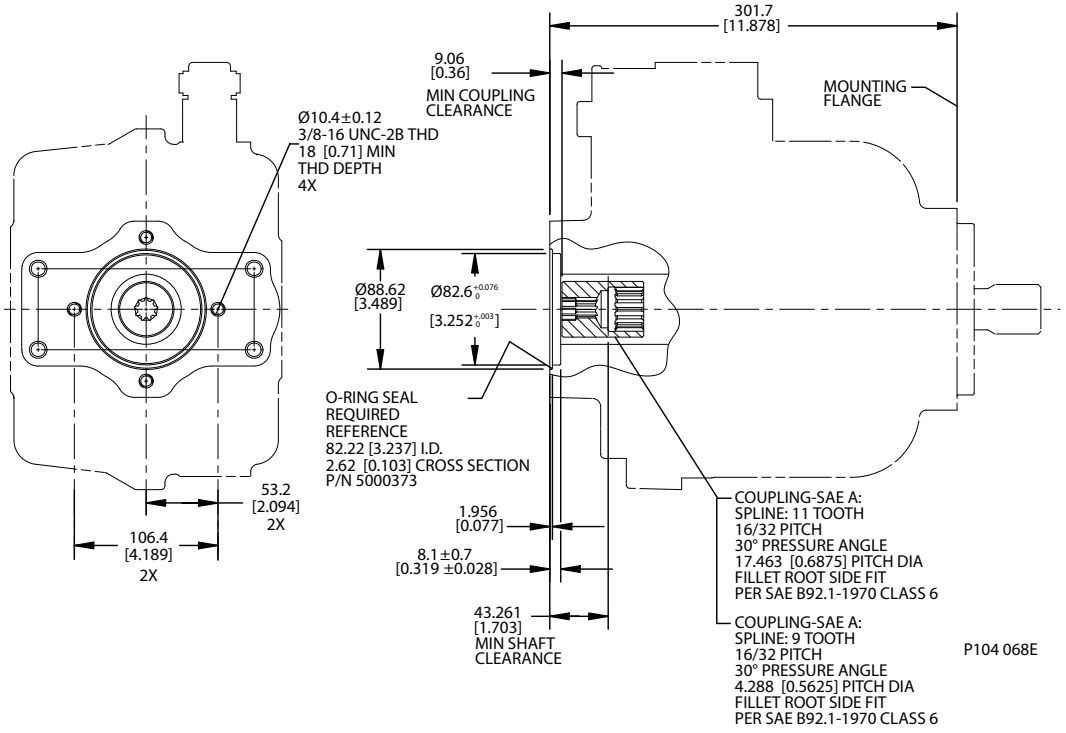
Axial Endcap Counterclockwise



Frame E

Auxiliary mounting pads

SAE-A Dimensions

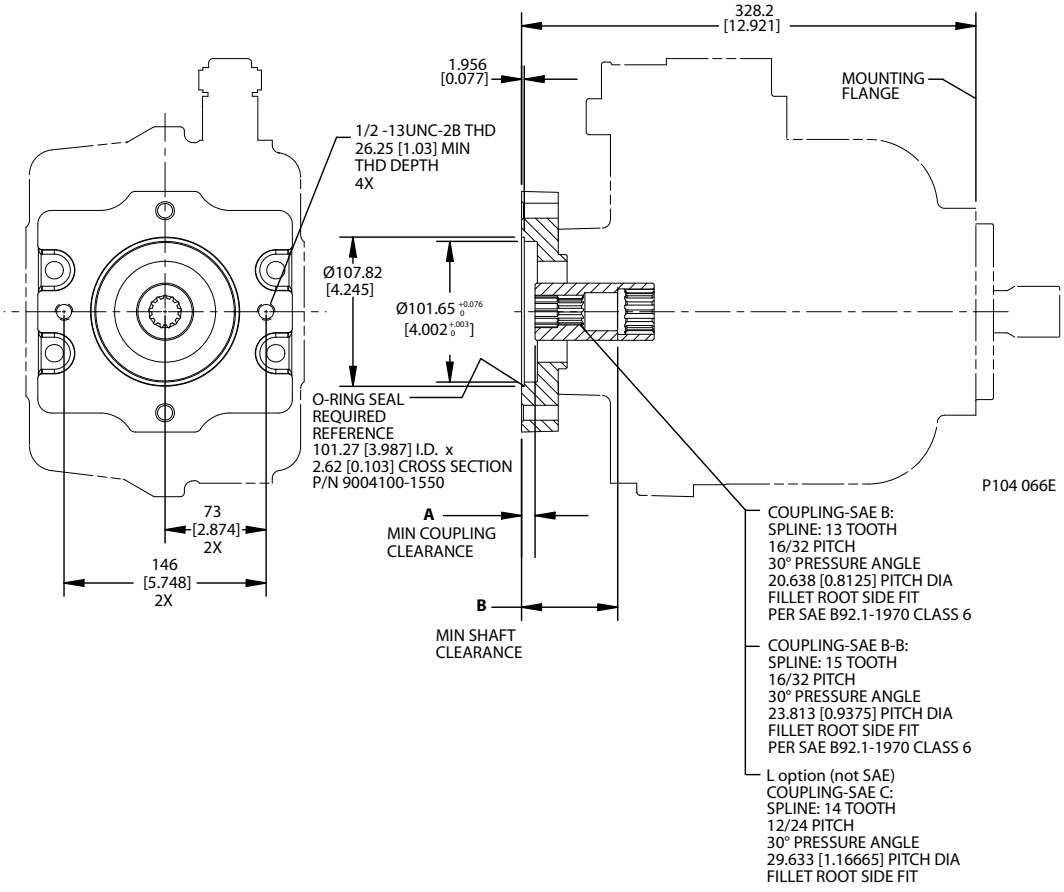


Specifications

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

Frame E

SAE-B Dimensions

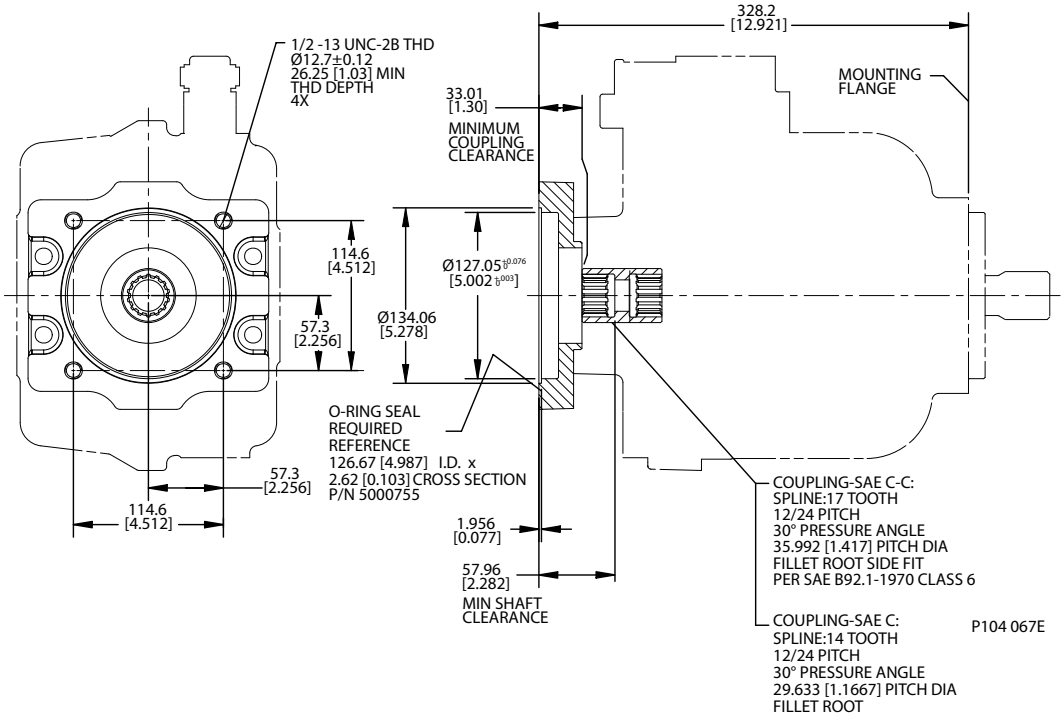


Specifications

Coupling	13 tooth	15 tooth	14 tooth
Spline Minimum Engagement	14.2 [0.559]	16.1 [0.634]	18.3 [0.720]
Maximum Torque	249 N•m [2200 lbf•in]	339 N•m [3000 lbf•in]	452 N•m [4000 lbf•in]
Dimension A	9.67 [0.38]	9.67 [0.38]	33.01 [1.30]
Dimension B	69.46 [2.74]	69.46 [2.74]	57.96 [2.282]

Frame E

SAE-C Dimensions



Specifications

Coupling	14-tooth	17-tooth
Spline minimum engagement	18.3 mm [0.72 in]	18.3 mm [0.72 in]
Maximum torque	452 N•m [4000 lbf•in]	452 N•m [4000 lbf•in]

Displacement Limiters

E Frame open circuit pumps are available with an optional adjustable displacement limiter. This adjustable stop limits the pump's maximum displacement.

Setting range

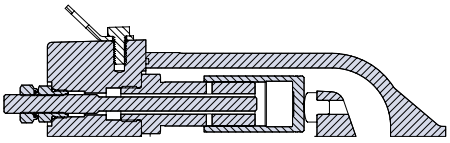
E100B	40 to 100 cm^3 [2.44 to 6.1 in^3]
E130B	70 to 130 cm^3 [4.27 to 7.93 in^3]
E147C	87 to 147 cm^3 [5.31 to 8.97 in^3]

Displacement per turn

E100B	8.4 cm^3/rev [0.51 in^3/rev]
E130B	8.4 cm^3/rev [0.51 in^3/rev]
E147C	8.4 cm^3/rev [0.51 in^3/rev]

Frame E

Displacement limiter cross-section



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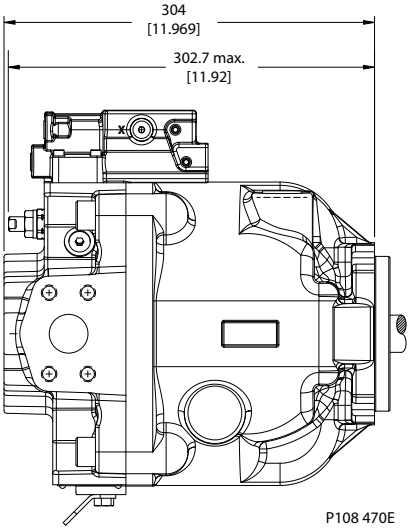
Dimensions



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