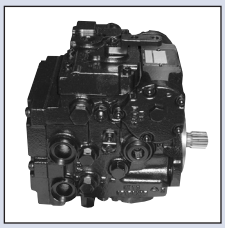
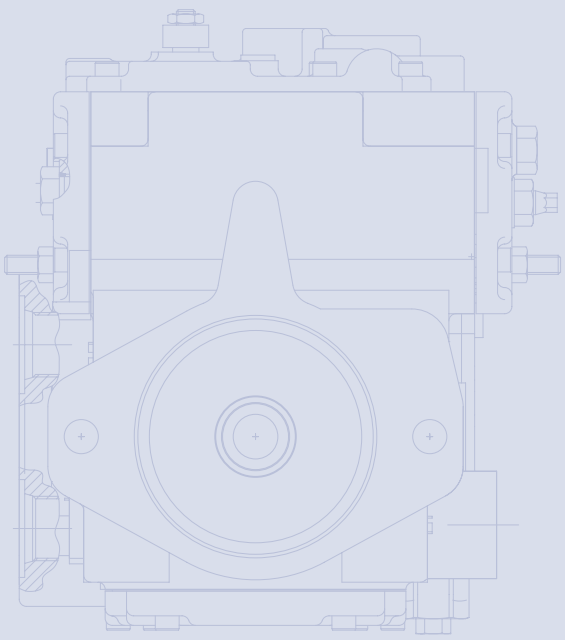
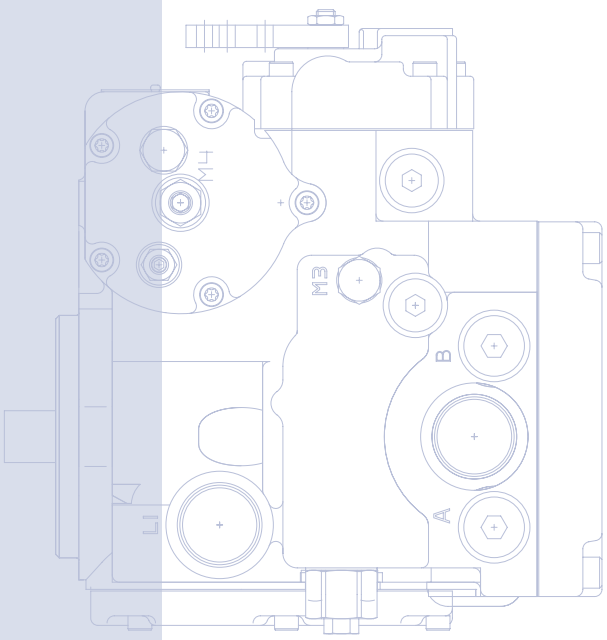
SAUER DANFOSS

Series 42 Axial Piston Pumps

Technical Information







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BASIC DESIGN

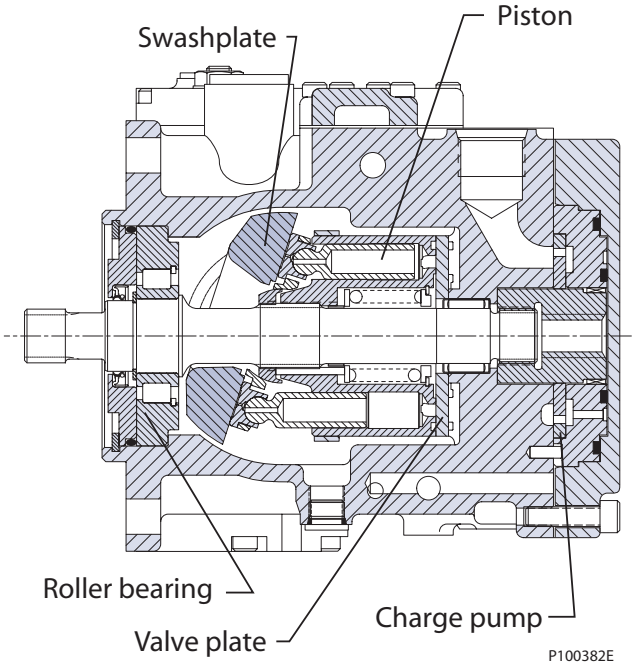
Series 42 pumps are advanced hydrostatic units for medium power applications with maximum loads of 415 bar [6017 psi] (28/41 cm^3) and 350 bar [5075 psi] (51 cm^3). You can combine these pumps with a suitable Sauer-Danfoss motor or other products in a system to transfer and control hydraulic power.

The Series 42 variable displacement pump is a compact, high power density unit, using the parallel axial piston/slipper concept in conjunction with a tiltable swashplate to vary the pump's displacement.

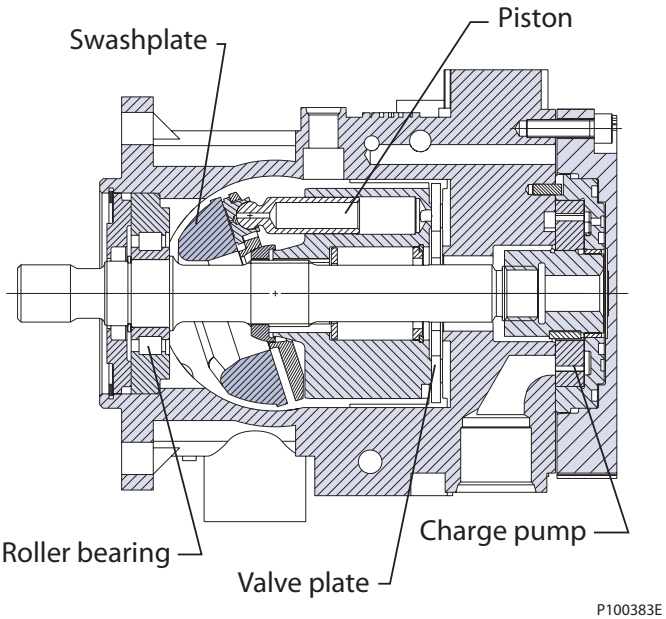
Reversing the angle of the swashplate reverses the flow of fluid from the pump, and reversing the direction of rotation of the motor output. Series 42 pumps provide an infinitely variable speed range between zero and maximum in both forward and reverse.

Series 42 pumps use a cradle swashplate design with a hydraulic servo control cylinder. Control is provided through a compact servo control system. A variety of servo controls are available. These include mechanically- or electrically-actuated feedback controls, hydraulic or electric proportional controls, and a three-position electric control. These controls feature low hysteresis and responsive performance.

28 cm^3 cross-sectional view

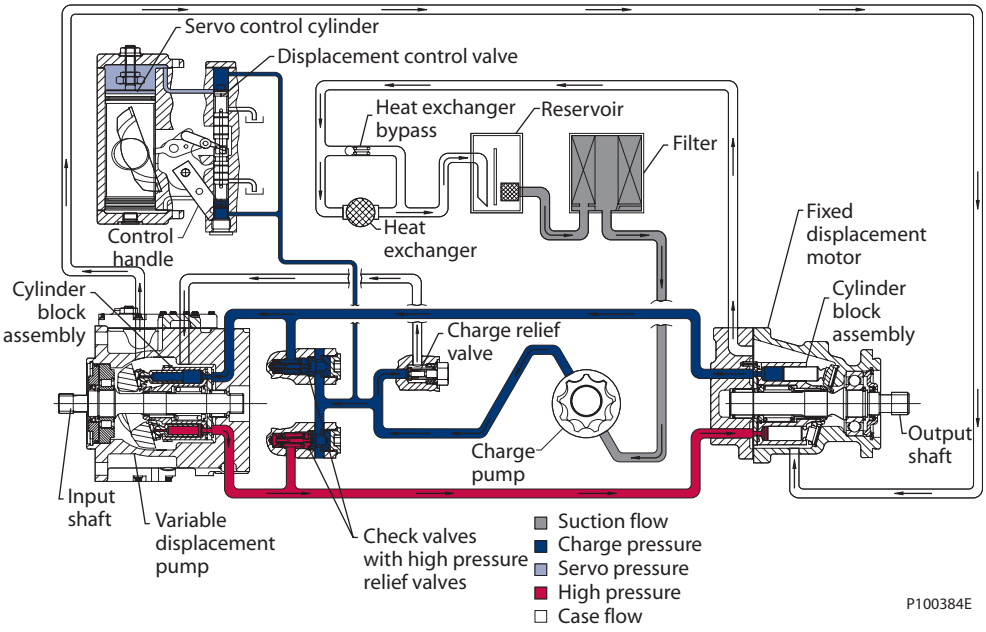


41/51 cm^3 cross-sectional view



SYSTEM DIAGRAM

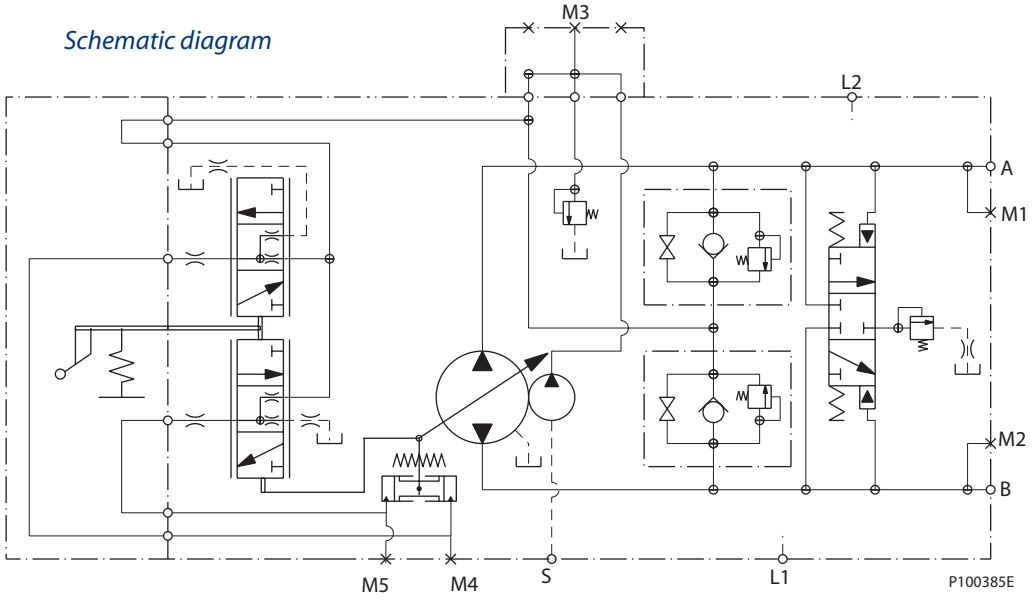
Pictorial circuit diagram



This illustration shows a Series 42 variable pump in a hydraulic circuit with a Series 40 - M35 fixed motor. The circuit is set up in a suction filtration configuration with pressure regulation valves included on the pump. Note the position of the reservoir and heat exchanger.

PUMP CIRCUIT

Schematic diagram



The illustration above shows a schematic of a Series 42 pump. System ports A and B connect to the high pressure work lines. Return fluid is received from its inlet port, pressurized, and discharged through the outlet port. Flow direction is determined by swashplate position. You can read system port pressure through ports M1 and M2. The pump has two case drains (L1 and L2) to ensure there is lubricating fluid in the system. This schematic includes a manual displacement control and loop flushing valve. For other control schematics see the related control section.

SYSTEM SPECIFICATIONS

General specifications

Pump type	In-line, axial piston, positive displacement pumps including cradle swashplate and servo control
Direction of input rotation	Clockwise or counterclockwise
Recommended installation position	Pump installation recommended with control position on the top or side. Consult Sauer-Danfoss for non conformance guidelines. The housing must always be filled with hydraulic fluid.
Filtration configuration	Suction or charge pressure filtration
Other system requirements	Independent braking system, suitable reservoir and heat exchanger.

Hardware features

Pump configuration	Single variable pump		
Displacement cm³/rev [in³/rev]	28 [1.71]	41 [2.50]	51 [3.11]
Weight kgf [lbf]	34.5 [76]	42 [92]	42 [92]
Mass moment of inertia kg•m² [lbf•ft²]	0.0018 [0.0013]	0.0036 [0.0027]	0.0038 [0.0028]
Type of front mounting flange (SAE flange size per SAE J744)	SAE B		
Port connections	SAE-twin ports, radial		
System pressure regulation bar [psi]	140-415 [2030-6017]		140-345 [2030-5003]
Displacement limiters	Option		
Input shaft options	Splined, tapered		
Auxiliary mounting pad (SAE pad per SAE J744)	SAE A (9 tooth and 11 tooth) SAE B (13 tooth and 15 tooth)		
Control options	MDC, FNR, NFPH, NFPE, EDC		
Filtration configuration	Suction or remote pressure filtration		
Loop flushing	Option		

SYSTEM PARAMETERS

Case pressure

Continuous pressure bar [psi]	3 [44]
Maximum pressure (cold start) bar [psi]	5 [73]

Pressure limits

Displacement cm³/rev	**28**	**41**	**51**
Rated pressure bar [psi]	350 [5075]	350 [5075]	325 [4713]
Maximum pressure bar [psi]	415 [6017]	415 [6017]	350 [5075]

Inlet pressure

Continuous pressure bar (absolute) [in Hg vacuum]	0.8 [6]
Minimum pressure (cold start) bar (absolute) [in Hg vacuum]	0.2 [24]

SYSTEM PARAMETERS (continued)

Speed limits

Displacement cm³/rev	**28**	**41**	**51**
Minimum speed min⁻¹ (rpm)	500	500	500
Rated speed at maximum displacement min⁻¹ (rpm)	3400	3200	2900
Maximum speed at maximum displacement min⁻¹ (rpm)	3750	3450	3400

Charge pump displacement and setting pressure

Charge pump		**28**	**41/51**
Internal cm³/rev [in³/rev]	**Standard**	11 [.67]	15.6 [.92]
External	**—**	Optional	Optional
Charge relief valve settings bar [psi]	**Standard** **Optional**	14 [203] 10-24 [145-348]	20 [290] 10-24 [145-348]

Theoretical flow

Displacement cm³/rev	**28**	**41**	**51**
Theoretical flow at rated speed l/min [US gal/min]	95.2 [25.1]	131 [34.6]	148 [39.1]

Check / high pressure relief valve

Options	No relief valve / check only	Relief valve / check
Settings bar [psi]	-	140-415 [2030-6017]

HYDRAULIC FLUID PARAMETERS

Fluid temperature range

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

Fluid cleanliness level

Required fluid cleanliness level	ISO 4406 Class 22/18/13
Recommended β_x-ratio for suction filtration	$\beta_{35\text{-}45} = 75$ ($\beta_{10} \geq 2$)
Recommended β_x-ratio for charge pressure filtration	$\beta_{15\text{-}20} = 75$ ($\beta_{10} \geq 10$)
Recommended inlet screen size for charge pressure filtration	100 µm-125 µm

Fluid viscosity

Minimum	7 mm²/s (cSt) [47 SUS]	Intermittent
Recommended operating range	12-60 mm²/s (cSt) [66-278 SUS]	
Maximum	1600 mm²/s (cSt) [7500 SUS]	Intermittent, cold start

SYSTEM REQUIREMENTS

Independent braking system

⚠ Warning

Unintended vehicle or machine movement hazard.

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

Reservoir

Design the system to accommodate maximum volume changes during all system operating modes and to promote de-aeration of the fluid as it passes through the tank.

Minimum reservoir volume is $^{5}/_{8}$ of the maximum charge pump flow per minute with a minimum fluid volume equal to $^{1}/_{2}$ of the maximum charge pump flow per minute. At the maximum return flow, this allows 30 seconds fluid dwell for removing entrained air. This is adequate for a closed reservoir (no breather) in most applications.

Position the reservoir outlet (pump inlet) above the bottom of the reservoir to take advantage of gravity separation and prevent large foreign particles from entering the charge inlet line. Use a 100 - 125 µm screen over the outlet port.

Position the reservoir inlet (fluid return) so that flow to the reservoir is discharged below the normal fluid level, and directed into the interior of the reservoir for maximum dwell and efficient de-aeration. Use a baffle (or baffles) between the inlet and outlet ports to promote de-aeration and reduce surging of the fluid.

SYSTEM PARAMETERS

Speed limits

Rated speed is the speed limit we recommend at full power condition and is the highest value at which you can expect normal life.

Maximum speed is the highest operating speed we permit. You cannot operate above this speed without risk of immediate failure and loss of drive line power and hydrostatic braking capacity (which may create a hazard). In mobile applications, you must apply this pump with a speed speed below the stated maximum. Consult **BLN-9884**, *Pressure and Speed Limits*, when determining speed limits for a particular application.

Inlet pressure

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

Theoretical output

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

SYSTEM PARAMETERS (continued)

Case pressure

Do not exceed the continuous case pressure rating. See *System parameters*, page 8 for pressure ratings. Momentary case pressure exceeding this rating is acceptable under cold start conditions, but still must stay below the maximum case pressure rating. External leakage due to damage to seals, gaskets, and/or housings will result when case pressure exceeds maximum limits.

System pressure

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

Applied pressure, high pressure relief valve or pressure limiter setting, is the chosen application pressure in the order code for the pump. This is the pressure at which the driveline generates the maximum pull or torque in the application.

Rated pressure is the design pressure for the pump. When components are sized properly, applications with applied pressures at or below this pressure yield satisfactory unit life. Rated pressure is not intended to be a continuous pressure. With Sauer-Danfoss approval, applied pressures above rated pressure are possible with a thorough duty cycle and application review.

Maximum pressure is the maximum applied pressure with Sauer-Danfoss approval. We require duty cycle analysis for all applied pressures above rated pressure.

Minimum low loop pressure is the lowest pressure allowed during charge pressure drop down under any circumstances.

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

HYDRAULIC FLUID PARAMETERS

Hydraulic fluid

Ratings and data are based on operating with hydraulic fluids containing inhibitors to prevent oxidation, rust, and foam. These fluids must possess good thermal and hydrolytic stability to prevent wear, erosion, and corrosion of the internal components. Fire resistant fluids are also suitable at modified operating conditions. Please see Sauer-Danfoss publication **520L0463,** *Hydraulic Fluids and Lubricants, Technical Information* for more information.

Do not mix different types of hydraulic fluids. Contact your Sauer-Danfoss representative for more information on fluid selection. The following hydraulic fluids are suitable:

- Hydraulic Oil ISO 11 158 - HM (Seal compatibility and vane pump wear resistance per DIN 51 524-2 must be met)
- Hydraulic Oil ISO 11 158 - HV (Seal compatibility and vane pump wear resistance per DIN 51 524-3 must be met)
- Hydraulic Oil DIN 51 524-2 - HLP• Hydraulic Oil DIN 51 524-3 - HVLP
- Automatic Transmission Fluid ATF A Suffix A (GM)
- Automatic Transmission Fluid Dexron II (GM), which meets Allison C-3 and Caterpillar TO-2 test
- Automatic Transmission Fluid M2C33F and G (Ford)
- Engine oils API Classification SL, SJ (for gasoline engines) and CI-4, CH-4, CG-4, CF-4 and CF (for diesel engines)
- Super Tractor Oil Universal (STOU) special agricultural tractor fluid

Temperature and viscosity

Ensure the application satisfies temperature and viscosity requirements concurrently. The data shown in the tables on page 9, *Hydraulic fluid parameters*, assume petroleum-based fluids.

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

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

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

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

SIZING EQUATIONS

Use these equations to help choose the right pump size and displacement 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]
Δp	=	$p_O - p_i$ (system pressure)	bar [psi]
n	=	Speed	min^{-1} (rpm)
η_v	=	Volumetric efficiency	
η_m	=	Mechanical efficiency	
η_t	=	Overall efficiency ($\eta_v \cdot \eta_m$)	

FLUID AND FILTRATION

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

Locate the filter on the inlet (suction filtration) or discharge (charge pressure filtration) side of the charge pump: Series 42 pumps are available with provisions for either configuration *see next page*.

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

Filter efficiency may be expressed in a Beta ratio (β_x). For simple suction-filtered closed circuit transmissions, and open circuit transmissions with return line filtration, use a filter with a β-ratio in the range of $\beta_{35\text{-}45} = 75$ ($\beta_{10} \geq 2$) or better. For some open and closed circuit systems that supply cylinders from the same reservoir, a considerably higher filter efficiency is necessary. This also applies to systems with gears or clutches using a common reservoir. For these systems, use a filter within the range of $\beta_{15\text{-}20} = 75$ ($\beta_{10} \geq 10$) or better.

Because each system is unique, only a thorough testing and evaluation program can fully validate the filtration system. Please see *Design Guidelines for Hydraulic Fluid Cleanliness Technical Information*, **520L0467** for more information.

FILTRATION CONFIGURATION

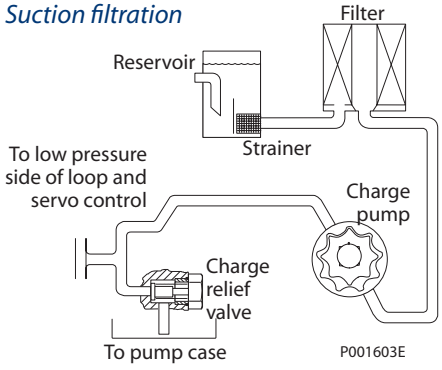
Suction filtration

The suction filter is in the circuit between the reservoir and the inlet to the charge pump as shown. All flow to the charge pump is filtered

Caution

Clogged filters can reduce the flow of charge fluid to the pump. Replace filters regularly before they become blocked.

Suction filtration

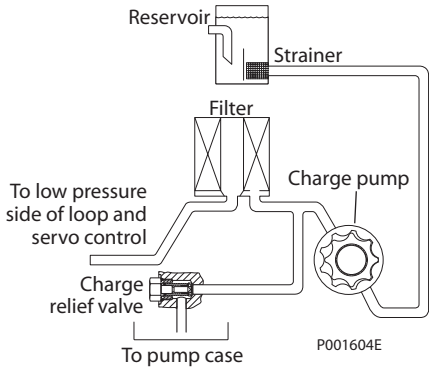


Partial-flow Charge Pressure Filtration

Charge pressure filtration is available on all Series 42 pumps. The pressure filter is remotely mounted and fits in the circuit after the charge pump, as shown. Charge pressure filtration can reduce inlet vacuum in cold start-ups and provides fluid filtration immediately upstream of the system loop and the control system.

In charge pressure filtration circuits, use non-bypass filters rated to at least 35 bar [508 psi] working pressure. Use a 100-125 µm screen located in the reservoir or in the charge inlet line when using charge pressure filtration.

Charge pressure filtration, partial flow



FILTRATION CONFIGURATION (continued)

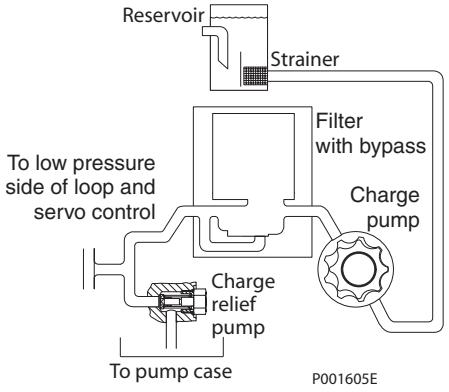
Incorporating the charge pressure relief valve ahead of the filter element achieves partial filter flow. Filter flow is just enough to satisfy the needs of the system loop and control. Insufficient flow through the filter results in inadequate charge pressure and affects machine performance. Select a filter capable of withstanding a pressure drop equal to charge pressure while maintaining the filter β_x-ratio at or above a value of one (no additional contaminants introduced into system).

Full-flow Charge Pressure Filtration

Incorporating the charge pressure relief valve behind the filter element acheives full filter flow. Total charge flow passes through the filter increasing the rate of contaminant removal from the system.

A filter bypass valve is necessary to prevent filter damage and to avoid contaminants from forcing through the filter media due to high pressure differentials across a clogged filter. In the event of high pressure drop associated with a blocked filter or cold start-up conditions, fluid can bypass the filter. Avoid working with an open bypass for extended periods. Use a visual or electrical dirt indicator. Proper filter maintenance is mandatory.

Charge pressure filtration, full flow



MOUNTING FLANGE LOADS

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

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

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

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

G-factors for sample applications

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

Allowable overhung load moments

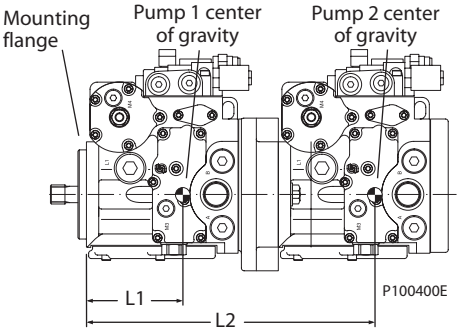
Displacement	Rated load moment (M_R)	Shock load moment (M_S)
28 cm^3/rev	1441 N•m [12750 in•lbf]	3413 N•m [30200 in•lbf]
41/51 cm^3/rev	1441 N•m [12750 in•lbf]	3413 N•m [30200 in•lbf]

Estimating overhung load moment

$$M_R = G_R \bullet (W_1L_1 + W_2L_2 + ... + W_nL_n)$$
$$M_S = G_S \bullet (W_1L_1 + W_2L_2 + ... + W_nL_n)$$

M_R = Rated load moment N•m [lbf•in]
M_S = Shock load moment N•m [lbf•in]
G_R = Rated (vibratory) acceleration (G-factors: unitless)
G_S = Maximum shock acceleration (G-factors: unitless)
W = Weight of the pump N [lbf]
L = Distance from the mounting flange to the center of gravity mm [in]

Overhung load moments



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EXTERNAL SHAFT LOAD AND BEARING LIFE

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

In vehicle propulsion drives with no external loads—where the speed, pressure, and swashplate angle are often changing—normal bearing B_{10} (90% survival) life exceeds the hydraulic unit life.

In non-propel drives, such as conveyors or fan drives, the operating speed and pressure may be nearly constant leading to a distinctive duty cycle compared to that of a propulsion drive. In these types of applications, we recommend a bearing life review. Series 42 pumps use bearings that can accept some incidental external radial and thrust loads. However, any amount of external load reduces the expected bearing life.

The allowable radial shaft loads are a function of the load position, orientation, and operating pressures of the hydraulic unit. In applications where you cannot avoid external shaft loads, minimize the impact on bearing life by orienting the load to the 90° or 270° position.

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

L = Distance from mounting flange to point of load
M_e = Maximum external moment
R_e = Maximum radial side load
T_{out} = Thrust load

Avoid thrust loads in T_{in} direction.

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

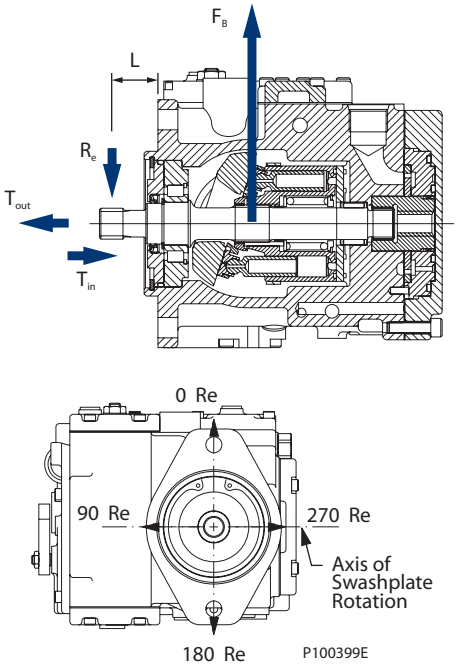
Use tapered output shafts or clamp-type couplings where radial shaft side loads are present.

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

Allowable shaft loads

Displacement cm³	28	41	51
M_e N•m [in•lbf]	98 [867]	111 [982]	90 [800]
T_{out} N [lbf]	1100 [250]	1100 [250]	1100 [250]

External shaft load orientation



HYDRAULIC UNIT LIFE

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

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

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

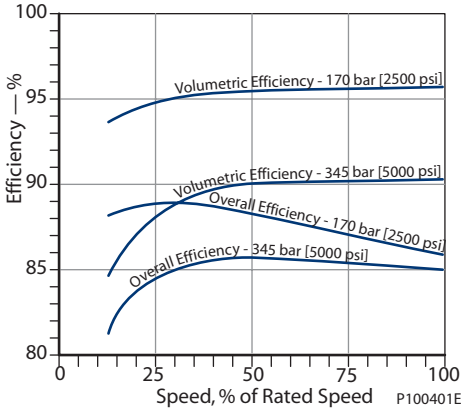
Series 42 pumps will meet satisfactory life expectancy if applied within the parameters specified in this bulletin. For more detailed information on hydraulic unit life see BLN-9884, *Pressure and Speed Limits.*

EFFICIENCY GRAPHS

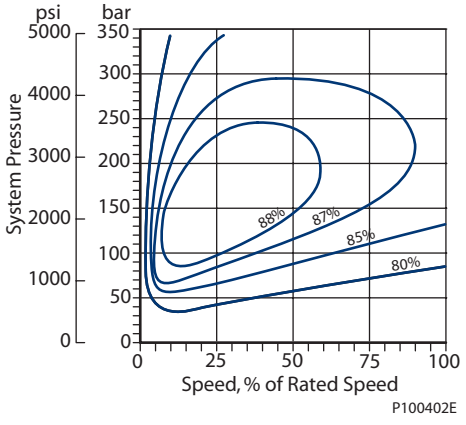
The performance graph below left provides typical volumetric and overall efficiencies for Series 42 pumps. These efficiencies apply for all Series 42 pumps at maximum displacement.

The performance map below right provides typical pump overall efficiencies at various operating parameters. These efficiencies also apply for all Series 42 pumps at maximum displacement.

*Pump performance as a function of operating speed at maximum displacement**



*Pump performance at select operating parameters at maximum displacement**



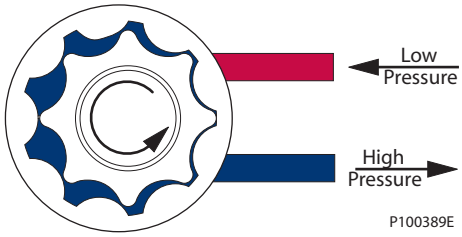
* Assumes viscosity in the continuous range

CHARGE PUMP

All Series 42 pumps applied in closed circuit installations require charge flow to make up for internal leakage, to maintain positive pressure in the main circuit, to provide flow for cooling, to replace any leakage losses from external valving or auxiliary systems, and to provide flow and pressure for the pump control system.

Many factors influence the charge flow requirements and the resulting charge pump size selection. These factors include system pressure, pump speed, pump swashplate angle, type of fluid, temperature, size of heat exchanger, length and size of hydraulic lines, control response characteristics, auxiliary flow requirements, hydraulic motor type, etc.

Gerotor Style Charge Pump



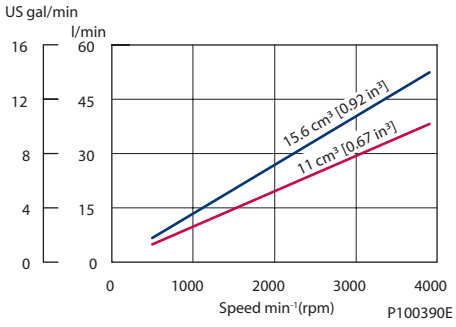
The total charge flow requirement is the sum of the charge flow requirements of each of the components in the system. When initially sizing and selecting hydrostatic units for an application, it is frequently not possible to have all of the information necessary to accurately evaluate all aspects of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

In most Series 42 applications a general guideline is that the charge pump displacement should be equal to or greater than 10% of the total displacement of all axial piston or bent-axis units in the system.

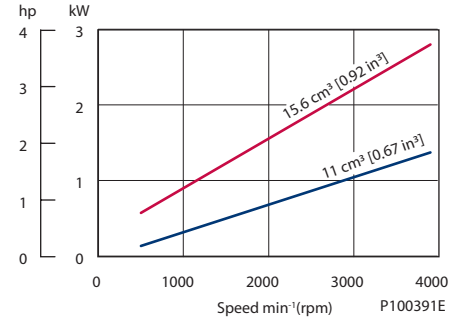
Series 42 pumps may be equipped with integral charge pumps. The available charge pump sizes should meet the needs of a majority of Series 42 applications.

Series 42 pumps are also available without charge pumps. When equipped without a charge pump, an external charge supply is required to ensure adequate charge pressure and cooling.

Charge pump output flow



Charge pump power requirements



CHARGE PUMP (continued)

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

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

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

You can find a charge pump sizing worksheet in *Selection of Driveline Components*, **BLN-9885**.

Charge pump sizing example:
A system consists of a single Series 42 - 28 Variable Pump driving two Series 40 -M35 Fixed Motors:

$TD = 28 + 35 + 35 = 98\ cm^3$
$CPD = 10\ \% \times TD = 9.8\ cm^3$

This requires a charge pump displacement of 9.8 cm^3 [0.59 in^3] or more. Sufficient charge flow for this application is provided by a 11 cm^3 [0.67 in^3] charge pump.

CHARGE RELIEF VALVE

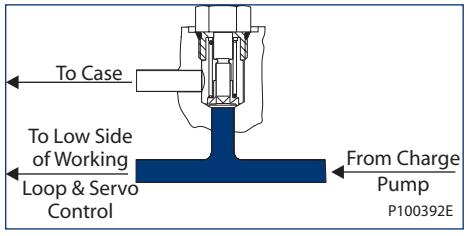
The charge relief valve maintains charge pressure at a designated level. Series 42 pumps come with direct-acting poppet style charge relief valves. The valve setting is set at the factory. The setting is screw adjustable.

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

The charge pressure setting for pumps without an internal charge pump is set with an assumed charge flow of 19 l/min (5 US gal/min). These units must have adequate charge flow supplied to the charge inlet in order to maintain charge pressure at all times.

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

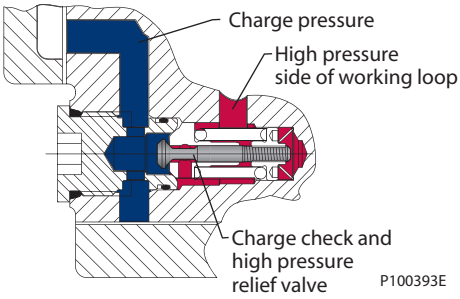
Charge relief valve



OVERPRESSURE PROTECTION

Series 42 pumps are available with a combination charge check and high pressure relief valve assembly. High pressure relief valves come in a range of settings as shown in the model code. You may specify individual port pressure settings. The high pressure relief valve settings are a differential pressure (referenced to charge pressure) and are set at 3.8 l/min (1 US gal/min) of flow.

Charge check and high pressure relief valve



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

Caution

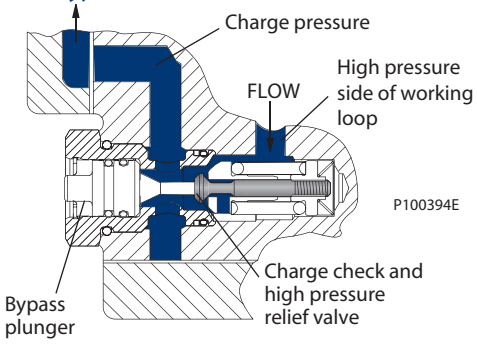
High pressure relief valves are for transient overpressure protection, not for continuous pressure control. Operation over relief valves for extended periods of time results in severe heat build up. High flows over relief valves may result in pressure levels exceeding the nominal valve setting and potential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

BYPASS VALVES

Series 42 pumps are available with an optional bypass function for use when pump shaft rotation is not possible. Use the bypass function to bypass fluid around the variable displacement pump. For example: you may move a disabled vehicle to a service location or winch it onto a trailer without operating the prime mover.

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

Charge check and high pressure relief valve with bypass



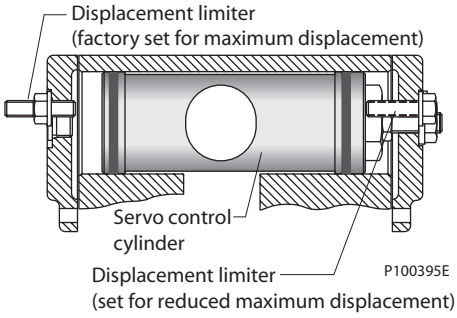
Caution

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

DISPLACEMENT LIMITERS

Series 42 pumps are available with adjustable mechanical displacement (stroke) limiters located in the servo covers. The maximum displacement of the pump can be limited to any value from its maximum displacement to zero in either direction. The limiters are factory set slightly beyond the maximum displacement of the pump. Displacement limiters may not be suited to all applications.

Series 42 pump displacement limiters



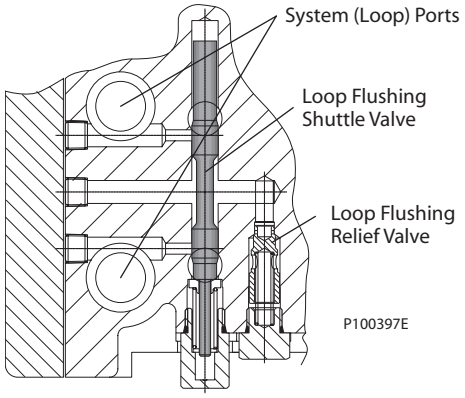
LOOP FLUSHING

Series 42 pumps have an integral loop flushing valve for circuits requiring the removal of excessive contamination or with high cooling requirements. We also provide an orificed loop flushing relief valve. The orifice controls loop flushing flow in most conditions. A combination of relief setting and orifice size controls flushing flow. For proper operation, ensure the loop flushing relief valve is set at or below the charge relief setting. Contact your Sauer-Danfoss representative for application assistance.

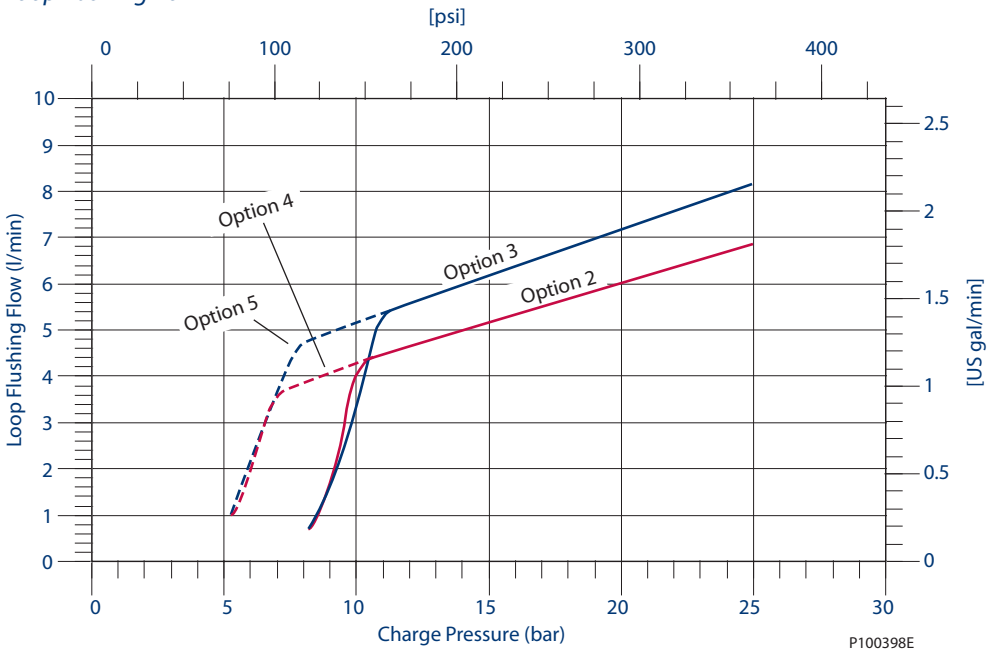
CAUTION

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

Loop flushing valve



Loop flushing flow



SPEED SENSOR

Series 42 pumps are available with a speed sensor option for direct measurement of pump input speed.

A special magnetic speed ring is pressed onto the outside diameter of the cylinder block and a Hall effect pulse pickup sensor is located in the pump housing. The sensor accepts supply voltage and outputs a digital pulse signal in response to the speed of the ring. The output changes its high/low state as the north and south poles of the permanently magnetized speed ring pass by the face of the sensor. The digital signal is generated at frequencies suitable for microprocessor based controls.

This sensor operates with a supply voltage of 4.5 to 15 Vdc, and requires a current of 12 mA at 5.0 Vdc under no load. Maximum operating current is 20 mA at 5 Vdc. Maximum operating frequency is 15 kHz. Output voltage in high state (V_{OH}) is sensor supply voltage minus 0.5 Vdc, minimum. Output voltage in low state (V_{OL}) is 0.5 Vdc, maximum.

Contact your Sauer-Danfoss representative for production availability on specific pump frame sizes, or for special speed sensor options.

Connecting pin designation:

Pin A : Supply voltage
Pin D : Direction of rotation
Pin B : Speed signal, digital
Pin C : Ground common

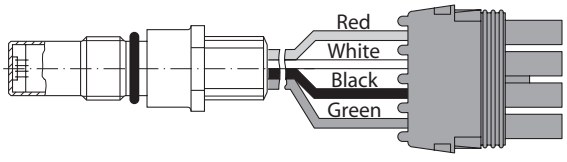
Speed ring data

Displacement cm³/rev	28	41	51
Pulses/rev	41	47	47

Technical data speed sensor

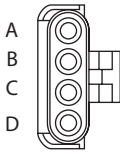
Supply voltage *	4.5-15 Vdc
Required current	12 mA at 5 Vdc (no load)
Maximum current	20 mA at 5 Vdc
Maximum frequency	15 kHz
Voltage high	Supply voltage -.5 Vdc
Voltage low	0.5 Vdc maximum
Temperature range	-40 to 110 °C [-40 to 250 °F]

Speed sensor with Packard Weather-Pack connector



Packard Weather-Pack
4 pin
(Supplied Connector)

Mating Connector
No.: K03379
Id.-No.: 505341



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SHAFT OPTIONS

Series 42 pumps are available with a variety of splined and tapered shaft ends. The accompanying table shows available shaft sizes and torque ratings. Maximum torque ratings are based on shaft torsional strength and assume a maximum of 200 000 load reversals.

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

Shaft availability and torque rating *

Shaft	Max. torque, 28 cm³	Max. torque, 41/51 cm³
13 tooth spline, 16/32 pitch	226 N•m [2000 in•lbf]	226 N•m [2000 in•lbf]
15 tooth spline, 16/32 pitch	362 N•m [3200 in•lbf]	362 N•m [3200 in•lbf]
19 tooth spline, 16/32 pitch	—	734 N•m [6500 in•lbf]
Tapered Ø25.4 mm [1 in] 1:8 taper	362 N•m [3200 in•lbf] **	362 N•m [3200 in•lbf] **

* The limitations of these input shafts constrain the allowable auxiliary coupling torque.
** Not recommended for all options. Contact your Sauer-Danfoss representative.

AUXILIARY MOUNTING PADS

Auxiliary mounting pads are available on all Series 42 pumps to mount auxiliary hydraulic pumps. We include a sealed (oil tight) shipping cover as standard equipment. The shipping cover seals case pressure and you can use it as a running cover if desired.

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

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

- All mounting pads meet SAE J744 specifications.
- The sum of main and auxiliary pump torque must not exceed stated maximum.
- All torque values assume a 58 R_c shaft spline hardness on mating pump shaft. Maximum torque is based on maximum torsional strength and 200 000 load reversals.
- Applications with severe vibratory or high G-force (shock) loading may require additional structural support to prevent leaks or mounting flange damage. Refer to *Mounting flange loads*, page 16 for additional information.

Auxiliary pad[1]

Pad size	Spline	Minimum spline length mm [in]	Maximum torque N•m [lbf•in]
SAE A	9 tooth 16/32 pitch	13.5 [0.53]	107 [950]
SAE A special	11 tooth 16/32 pitch	13.5 [0.53]	147 [1300]
SAE B	13 tooth 16/32 pitch	14.2 [0.56]	248 [2200]
SAE B-B	15 tooth 16/32 pitch	14.2 [0.56]	347 [3070]

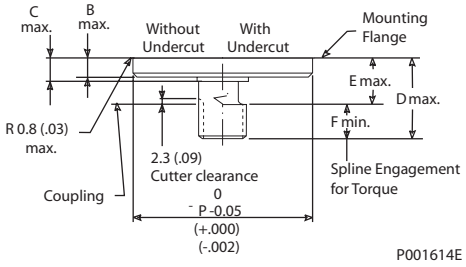
[1]Allowable Auxiliary coupling torque is subject to limitations of the input shaft.

AUXILIARY MOUNTING PADS (continued)

Auxiliary pump mating dimensions

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

This drawing provides the dimensions for the auxiliary pump mounting flange and shaft. Auxiliary pump mounting flanges and shafts with these dimensions are compatible with the auxiliary mounting pads on Series 42 pumps. For auxiliary pad dimensions, see *Auxiliary mounting pads*, page 51.



CONTROL SELECTION

Series 42 pumps use a servo control system with a vairety of control options. Manual and Electric Displacement Controls (MDC and EDC) are feedback controls that provide and maintain a set displacement for a given input. The MDC includes options for a Neutral Start Switch (NSS), backup alarm , and a solenoid override to neutral. Non-Feedback Proportional Electric or Hydraulic controls (NFPE, NFPH) and Forward-Neutral-Reverse (FNR) controls are available to control the pump without mechanical feedback.

All controls provide smooth, stepless positive control of the transmission in either direction. Optional servo supply and drain orifices are available for special response needs.

Typical control applications

Machine	Function	MDC	FNR	NFPH	NFPE	EDC
Roller / compactor	Propel Vibratory drive					
Asphalt paver	Propel Conveyor drive					
Skid steer loader	Propel					
Articulated loader	Propel					
Utility tractor	Propel					
Windrower	Propel					
Trencher	Propel Chain drive					
Ag sprayer	Propel					
Specialized harvesters (sod, fruit, nut, etc.)	Propel Auxiliary drive					
Commercial mower	Popel					
Rock drill	Propel					
Drill rig	Drill drive Pull down					
Sweeper	Propel Fan					
Aerial lift	Propel					
Fork lift	Propel					
Brush / stump cutter	Propel Cutter drive					
Airport vehicle	Propel					
Dumper	Propel					

MANUAL DISPLACEMENT CONTROL (MDC)

The Manual Displacement Control (MDC) converts a mechanical input signal to a hydraulic signal. The hydraulic signal positions the servo piston, tilting the swashplate to vary the pump's displacement and flow direction.

The position of the swashplate is proportional to the mechanical input signal. The control has mechanical feedback that regulates the servo valve in relation to swashplate position to maintain displacement at the commanded level regardless of changes in system pressure.

The servo control valve has variable geometry porting to regulate swashplate response relative to input command. The control performs small displacement change commands with maximum controllability throughout the entire stroking range of the pump. It completes large displacement change commands with rapid swashplate response. Optional servo supply and drain orifices are available for special response needs.

The control also has a full over-travel spool that allows input at a faster rate than swashplate movement without damage to the control. Any swashplate position error is fed back to the servo valve for instant correction.

Features and benefits of MDC

- The MDC is a high gain control: Small movements of the control handle move the servo valve to full open position porting maximum flow to the servo cylinder.
- The full over-travel spool design allows rapid changes in input signal without damaging the control mechanism.
- The MDC provides a fast response with low input force.
- Precision parts provide repeatable and accurate displacement settings.
- Mechanical feedback maintains pump displacement regardless of changes in system pressure.
- The operator is isolated from swashplate vibration.
- The swashplate and servo cylinder, as well as the control valve, are spring centered so the pump returns quickly to neutral in the absence of control input.

The pump returns to neutral:

- if the prime mover is shut down;
- if the external control linkage fails at the control handle;
- if there is a loss of charge pressure.

MANUAL DISPLACEMENT CONTROL (continued)

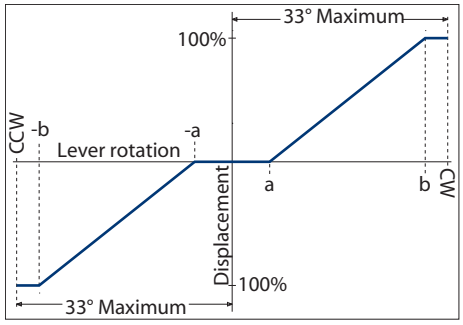
Control input signal

Moving the control handle to maximum displacement requires a torque of 1.36 ± 0.23 N•m [12 ± 2 in•lbf]. To prevent damage to the control, provide stops in the linkage to limit maximum travel torque. Maximum allowable input torque is 17 N•m [150 in•lbf].

Handle angle required for swashplate position

Swashplate position (see graphs)		
Configuration	**Swashplate movement begins (point a)**	**Full displacement reached (point b)**
Linear - standard	5.3°	28°
Linear - narrow	4.0°	24°

Pump displacement versus control lever rotation



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Response time

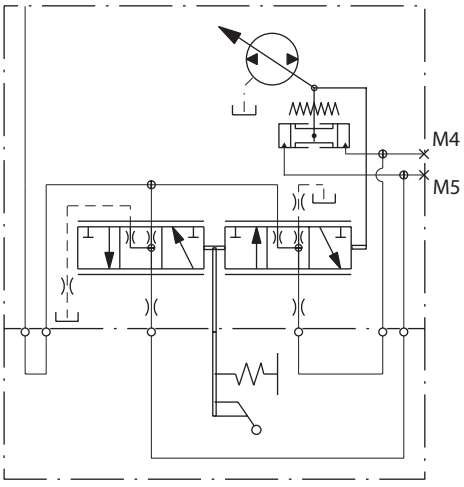
MDC response time (maximum to maximum)

Displacement cm³	Fast (no orifice)	Medium	Slow (standard)
28	0.5 sec.	1.3 sec.	2.5 sec.
41/51	0.6 sec.	1.6 sec.	2.5 sec.

You can tailor the time to change from zero to maximum displacement using orifices. Using orifices you can match swashplate response to the acceleration and deceleration requirements of your application. Verify proper orifice selection by testing.

Neutral to maximum swashplate response is approximately 60% of the time for maximum to maximum sawashplate travel. For other response times please contact your Sauer-Danfoss representative.

MDC schematic



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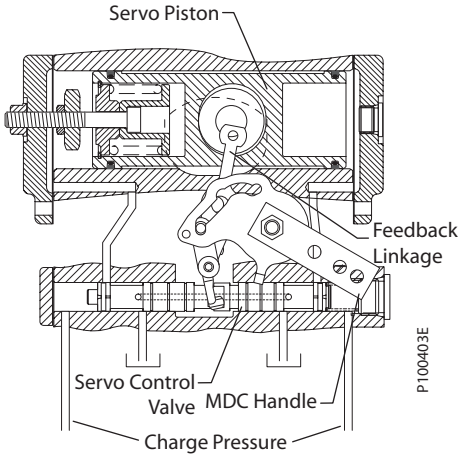
Cross-section of MDC



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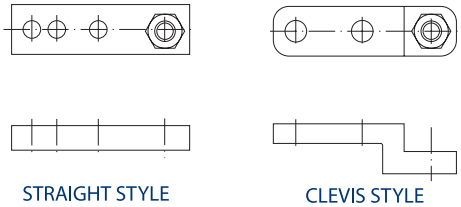
MANUAL DISPLACEMENT CONTROL (continued)

Control handles

Either straight or clevis (offset) style control handles are available for the MDC. The straight style handle minimizes the overall height of the pump and control. The clevis style handle provides additional clearance between the handle and control housing and works well for clevis style linkage installations.

Maximum allowable input torque at the control handle is 17 N•m (150 lbf•in). The maximum allowable bending moment is 4 N•m (35 in•lbf).

MDC handle options



Pump flow direction with MDC

Input shaft rotation	CW		CCW	
Handle of rotation	CW	CCW	CW	CCW
Port A flow	Out	In	In	Out
Port B flow	In	Out	Out	In
High pressure servo guage port	M4	M5	M4	M5

Electric solenoid override to neutral

This normally open solenoid valve C shunts both ends of the servo piston. This prevents the pump from stroking. When energized, the valve closes, allowing the pump to operate normally. This option is ideally suited for operator presence or auto-resume functions without prime mover shut down. This solenoid is available in 12 or 24 Vdc with 2 Amp. maximum current draw. It is available with DIN 43650 terminals or with a Packard Weather-Pack 2-way shroud connector.

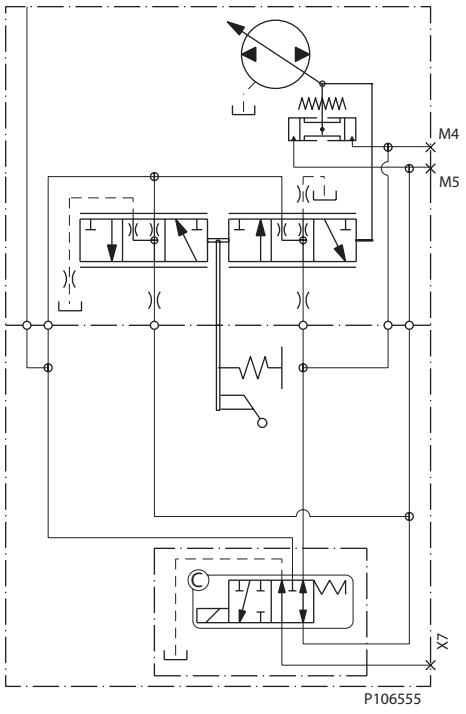
Electric override to neutral specifications

Solenoid state at override activation	De-energized
Voltage	12 or 24 Vdc
Maximum current	2 A

Emergency override to neutral with port for brake pressure release

This solenoid valve C operates as the override to neutral above, and drains a spring-applied, hydraulically-released brake (port X7). Energizing the valve allows the pump to operate as normal, while also charging port X7 to release the brake. This option is ideally suited for emergency stop functions without prime mover shut down. The solenoid is available in 12 or 24 Vdc with 2 Amp. maximum current draw. It is available with DIN 43650 terminals or with a Packard Weather-Pack 2-way shroud connector.

Hydraulic schematic for MDC with override options



MANUAL DISPLACEMENT CONTROL (continued)

Neutral Start Switch (NSS)

This option provides an electrical switch contact that is closed when the control handle is in its neutral (0°) position. The switch contact opens when the control handle rotates approximately 1.5° to 2° clockwise (CW) or counterclockwise (CCW) from neutral.

The switch is rated for 5 Amp. inductive load at 12 or 24 Vdc. It is available with screw terminals (no connector) or with a Packard Weather-Pack 2-way tower connector.

Neutral start switch specifications

Switch neutral position	Closed
Voltage	12 or 24 Vdc
Current rating	5 A
Neutral play	± 2°

Wire the NSS in series with the engine starting circuit to ensure the pump is in neutral position before allowing the engine to start.

Backup alarm switch option

Switch neutral position	Open
Voltage	12 or 24 Vdc
Current rating	2.5 A
Alarm direction	CW or CCW
Switch closes at	± 2.6 ~ 3.75°

NSS with Back-Up Alarm (BUA) switch

The BUA switch contact is open until the control handle rotates 2.6° to 3.75° from neutral. The BUA switch closes when the control handle rotates either clockwise (CW) or counterclockwise (CCW) from neutral (choose one direction only). The NSS function operates as described above.

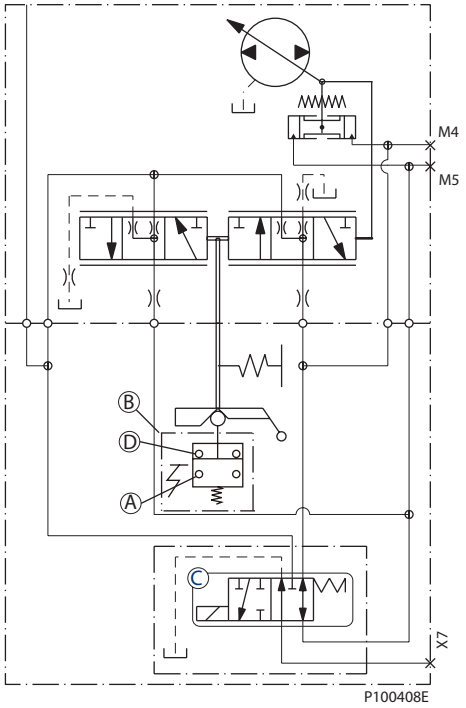
The BUA contacts are rated for 2.5 Amp. resistive load at 12 or 24 Vdc. The NSS contacts are rated for 5 Amp. inductive load at 12 or 24 Vdc. This switch is available with screw terminals (no connector) or with a Packard Weather-Pack 4-way tower connector.

Wire the NSS as described above. Wire the BUA switch in series with a back-up alarm to have the alarm sound when the operator moves the pump control handle into reverse.

Connectors

For available connectors and dimensions, see outline drawings: *Manual Displacement Control Options*, page 43.

Hydraulic schematic for MDC with override options and NSS



A. Backup alarm switch contacts (green wire) (closed in reverse)
B. Neutral start switch w/ backup alarm
C. Electric solenoid override to neutral w/ brake release
D. Neutral start switch contacts (black wire) (closed in neutral)

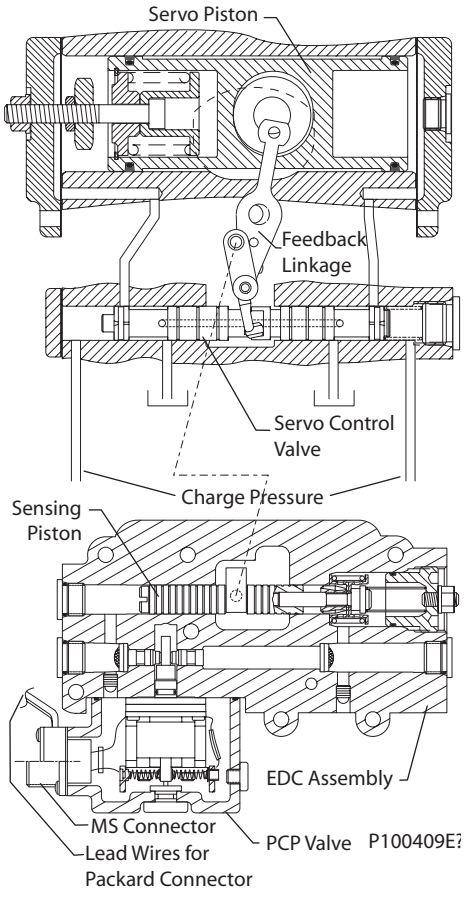
ELECTRICAL DISPLACEMENT CONTROL (EDC)

The Electrical Displacement Control (EDC) uses an electrohydraulic Pressure Control Pilot (PCP) stage to provide a differential pilot pressure. The PCP stage converts an electrical input signal to a hydraulic input signal to operate a spring centered sensing piston. The sensing piston produces a mechanical input to the servo control valve which ports hydraulic pressure to either side of the servo piston. The servo piston operates the swashplate varying the pump's displacement and flow direction.

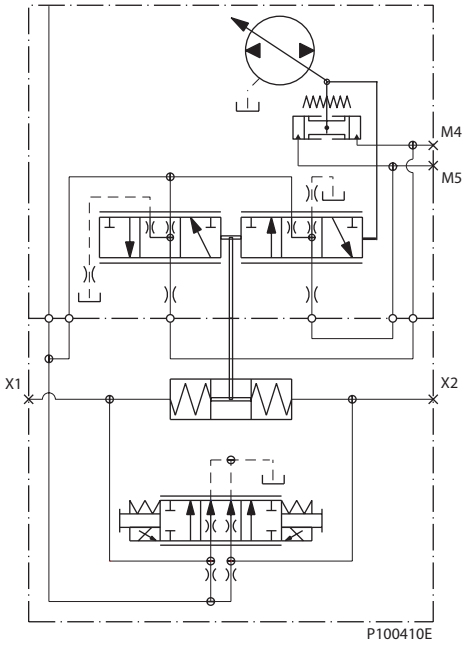
The position of the swashplate is proportional to the electrical input signal. The control has mechanical feedback that regulates the servo valve in relation to swashplate position to maintain displacement at the commanded level regardless of changes in system pressure. Any swashplate position error is fed back to the servo valve for instant correction.

The servo control valve has variable geometry porting to regulate swashplate response relative to input command. The control performs small displacement change commands with maximum controllability throughout the entire stroking range of the pump. It completes large displacement change commands with rapid swashplate response. Optional servo supply and drain orifices are available for special response needs.

Cross-section of EDC



EDC hydraulic schematic



Pump flow direction with EDC

Input shaft rotation	CW		CCW	
Voltage to pin:	A (C)	B (D)	A (C)	B (D)
Port A flow	Out	In	In	Out
Port B flow	In	Out	Out	In
High pressure servo gauge port	M4	M5	M4	M5
High pressure EDC pilot gauge	X2	X1	X2	X1

ELECTRICAL DISPLACEMENT CONTROL (continued)

Features and benefits of EDC

- The EDC is a high gain control. Small changes in input current move the servo valve to full open position porting maximum flow to the servo cylinder.
- Silicon oil filled pilot stage lengthens control life by preventing moisture ingression and dampening component vibrations.
- The majority of all EDC's are equipped with dual coil pilot stages. An optional low input current control is available, configured with single coil only. With the dual coil EDC, you may use a single coil or both coils, either in series or in parallel.
- A full over-travel servo valve allows rapid changes in input signal voltages without damaging the control mechanism.
- Precision parts provide repeatable and accurate displacement settings.
- Mechanical feedback maintains pump displacement regardless of changes in system pressure.
- The control does not require Pulse Width Modulation (PWM), although performance is optimum using a 200 Hz signal.
- The swashplate and servo cylinder, as well as the control valve, are spring centered so the pump returns quickly to neutral in the absence of control input.

The pump returns to neutral:
- if the prime mover is shut down;
- if the external control linkage fails at the control handle;
- if there is a loss of charge pressure.

Response time

You can tailor the time to change from zero to maximum displacement using orifices. Using orifices you can match swashplate response to the acceleration and deceleration requirements of your application. Verify proper orifice selection by testing.

EDC response time (maximum to maximum)

Displacement cm^3	Fast (no orifice)	Medium	Slow (standard)
28	0.5 sec.	1.3 sec.	2.5 sec.
41/51	0.6 sec.	1.6 sec.	2.5 sec.

Neutral to maximum swashplate response is approximately 60% of the time for maximum to maximum sawashplate travel. For other response times please contact your Sauer-Danfoss representative.

ELECTRICAL DISPLACEMENT CONTROL (continued)

Control input signal

The table relates input signal to swashplate position for each coil configuration. A system differential pressure of 3.5 bar [50 psi] defines the point of initial swashplate movement.

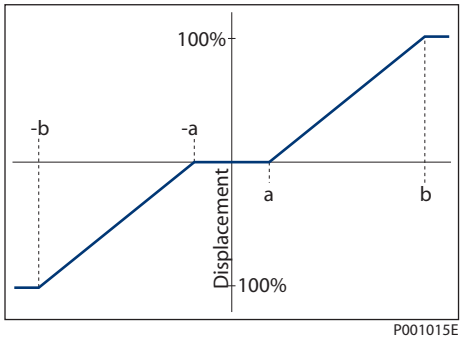
Coil options

There are two types of coils available: normal and low-current. The optional low input current control (5-18 mA) allows a microprocessor to drive the EDC directly without an amplifier.

Connectors and port locations

Refer to outline drawings: *Electrical displacement control (EDC) options*, page 49.

Pump displacement versus electrical signal



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EDC signal required for swashplate position

	Swashplate position		
Coil configuration	**Movement begins (point a) mA at VDC**	**Full displacement reached (point b) mA at VDC**	**Pin connection**
Single coil	14 ± 3	85 ±10	A+B or C+D
Single coil (low current)	5 ± .5	18 ± 1	A+B
Dual coil in series	7 ± 1.5	42.5 ± 5	A+D (connect C+B)
Dual coil in parallel	14 ± 3	85 ± 10	A C + B D

EDC input impedance

Coil type	Normal current	Low current
Coil resistance at 24 °C [75 °F]	Coil A/B: 20 Ω Coil C/D: 16 Ω	650 Ω
Resistance at 104°C [220 °F]	Coil A/B: 24 Ω Coil C/D: 20 Ω	850 Ω
Maximum input current	350 mA at 6 Vdc	46 mA at 30 Vdc

NON-FEEDBACK, PROPORTIONAL HYDRAULIC (NFPH) CONTROL

The Non-Feedback Proportional Hydraulic (NFPH) control is a hydraulic displacement control in which an input signal pressure directly controls the pump servo piston to set pump displacement.

Series 42 pumps with NFPH control have a special servo cylinder capable of providing proportional control with a hydraulic input.

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

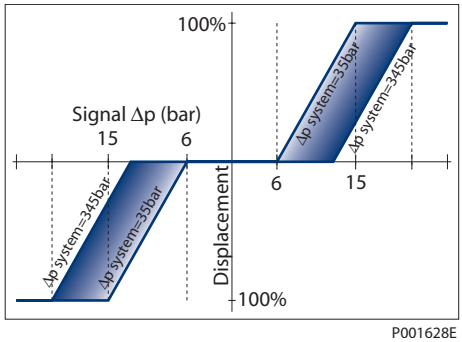
Features and benefits of the NFPH control

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

Connectors and port locations

Refer to outline drawings.

NFPH pump displacement to input signal



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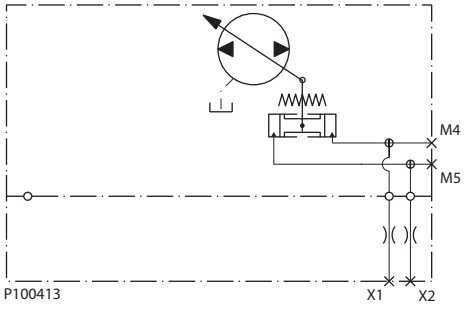
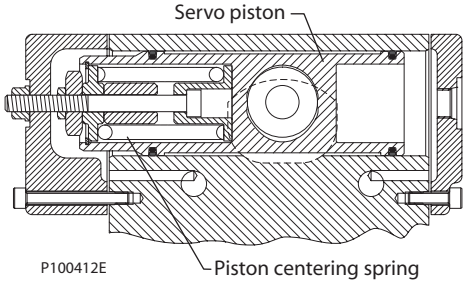
Non-feedback proportional hydraulic control schematic



Pump displacement versus signal pressure



Pump flow direction with NFPH control

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

NON-FEEDBACK, PROPORTIONAL ELECTRIC (NFPE) CONTROL

The Non-Feedback Proportional Electric (NFPE) control is an electric control in which an electric input signal activates one of two solenoids that port charge pressure to either side of the servo piston.

Series 42 pumps equipped with NFPE control have a special servo cylinder capable of providing proportional control with an electric input.

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

Features of the NFPE control

- Proportional electric control
- Eliminates mechanical linkage for flexibility of control design
- Power limiting characteristic reduces machine power requirements
- Smooth operation

Input signal requirements

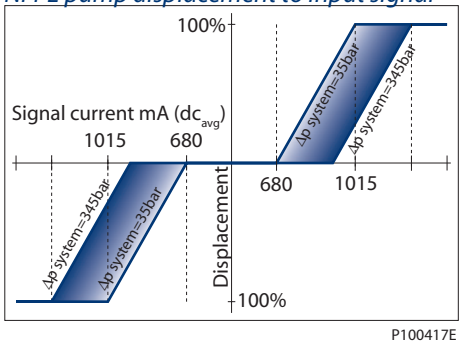
The NFPE control requires a 200 Hz Pulse-Width-Modulated (PWM) input current to optimize performance. The minimum PWM frequency is 80 Hz. Coil resistance is 5.6 Ω at 22°C. Limit current to 1.5A (12V dc)

The NFPE control uses AMP Junior Power Timer connectors. The solenoids are compatible with Sauer-Danfoss microprocessors, electric circuit boards, and control handles.

Connectors and port locations

Refer to outline drawings.

NFPE pump displacement to input signal



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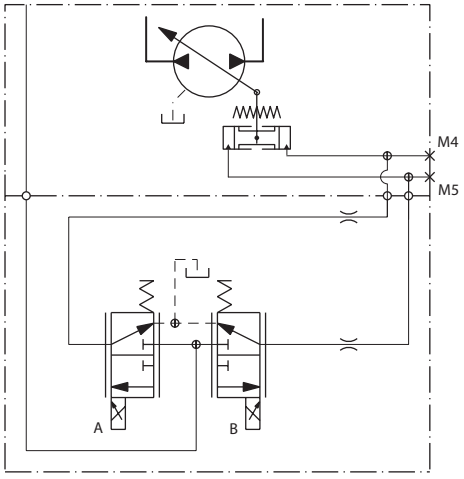
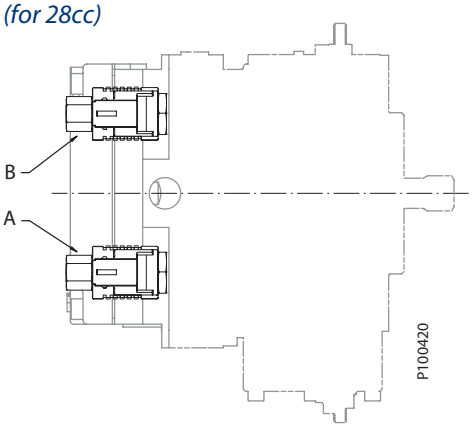
NFPE hydraulic schematic



P100416E

NFPE control on series 42 pump (for 28cc)



Pump flow direction with NFPE control

Input shaft rotation	CW		CCW	
Solenoid energized	A	B	A	B
Port A flow	Out	In	In	Out
Port B flow	In	Out	Out	In
High pressure servo gauge port	M4	M5	M4	M5

FORWARD, NEUTRAL, REVERSE, (FNR) CONTROL

The Forward-Neutral-Reverse (FNR) control uses a solenoid-operated 3-position, 4-way valve to control pump displacement and flow direction. The FNR control is a non-feedback, non-proportional, 3-position control.

When a solenoid is energized, charge pressure flows to one end of the pump servo piston, which strokes the swashplate to maximum angle. Which solenoid is energized determines the direction of pump flow (see table).

Features and benefits of FNR control

- Electric control
- If voltage is lost, the pump returns to neutral
- If charge pressure is lost, the pump returns to neutral
- Simple, low-cost design
- Ideal for applications that do not require proportional control

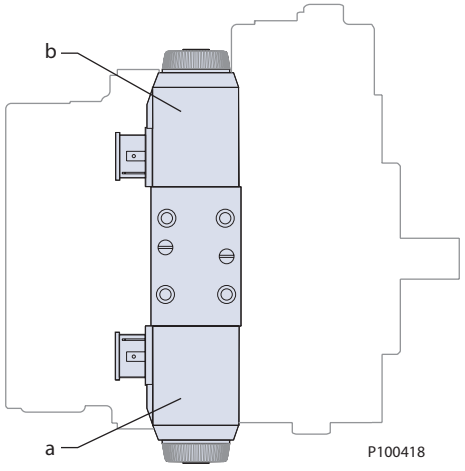
Input signal requirements

The solenoids are available in 12 or 24 Vdc. Maximum power is 30 Watts. They are available with DIN 43650 terminals. An AMP Jr. Power Timer connector is also available.

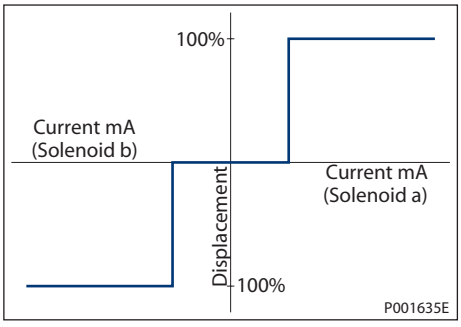
Connectors and port locations

Refer to outline drawings.

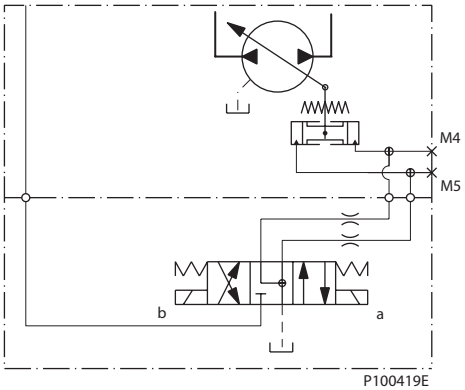
FNR on series 42 pump (for 41/51cc)



Pump displacement to electrical signal



FNR hydraulic schematic

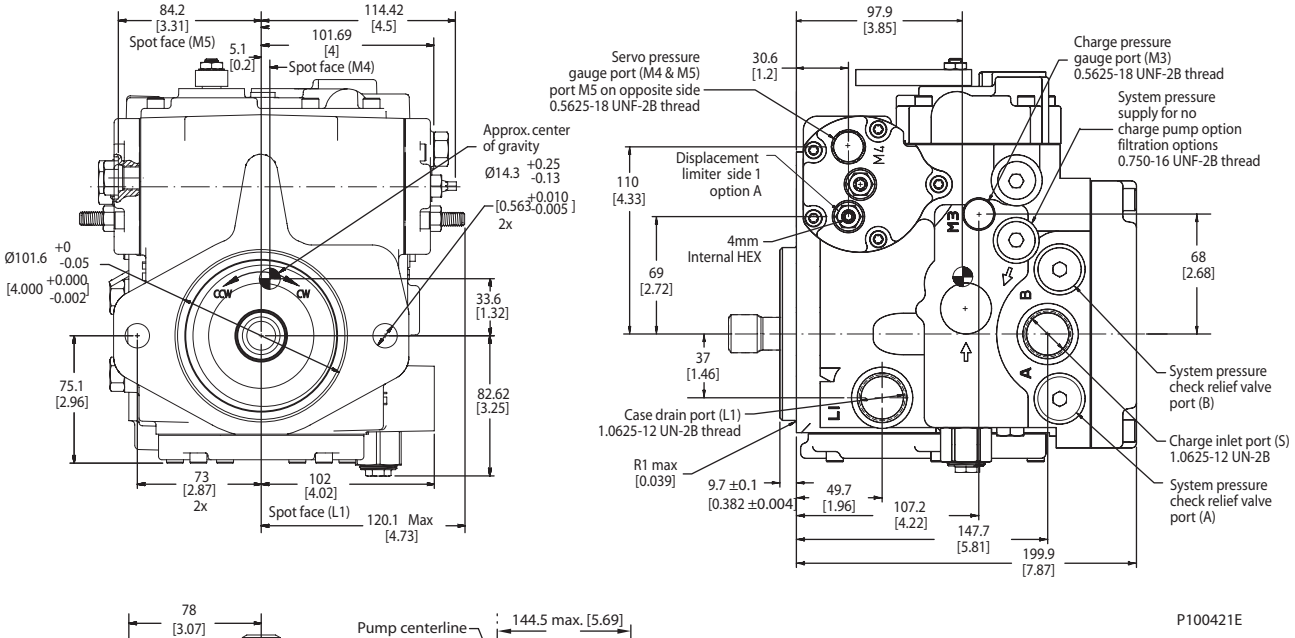


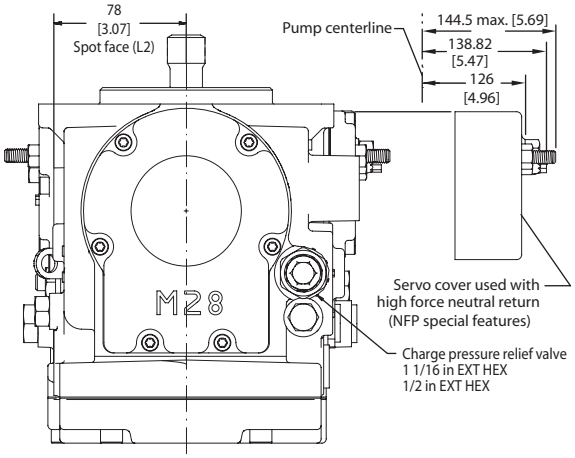
Pump flow direction with FNR control

Input shaft rotation	CW		CCW	
Solenoid energized	a	b	a	b
Port A flow	Out	In	In	Out
Port B flow	In	Out	Out	In
High pressure servo gage port	M4	M5	M4	M5

28 cm³ FRAME SIZE

Base unit with manual displacement control (MDC)





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*All SAE straight thread O-ring ports per SAE J1926/ISO 11926-1, unless otherwise specified.

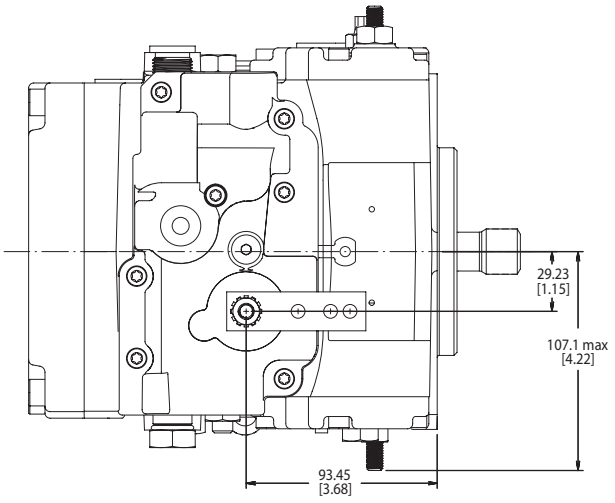
Determine rotation by viewing pump from the input shaft end. Contact your Sauer-Danfoss representative for specific installation drawings.

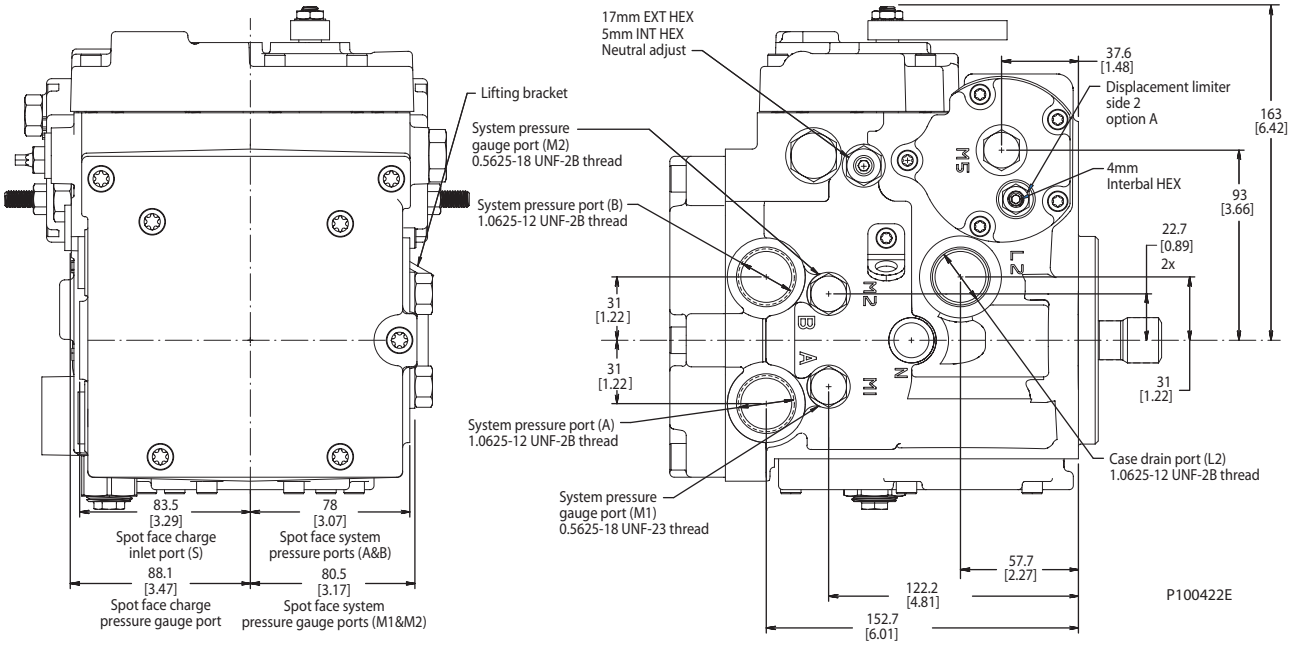
Adjustable displacement limiters

Shaft rotation	CW		CCW	
Displacement limiter side	1	2	1	2
Limited flow through port	B	A	A	B

Third-angle projection mm [in]

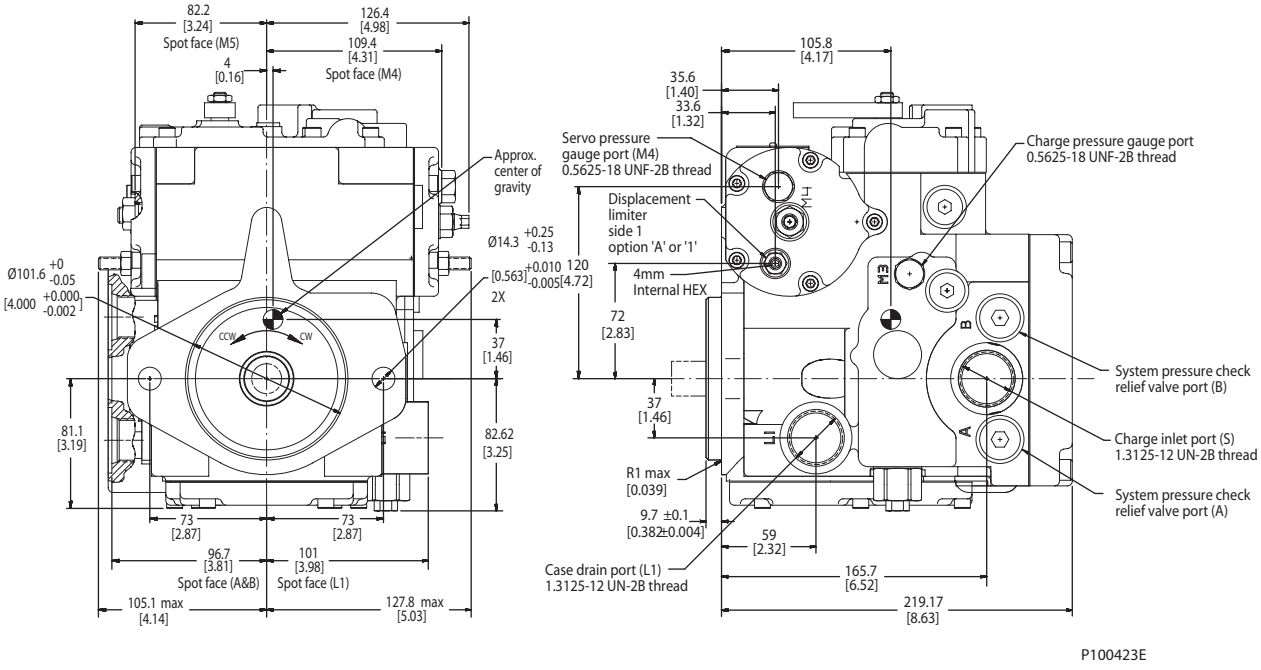
28 cm³ FRAME SIZE (continued)



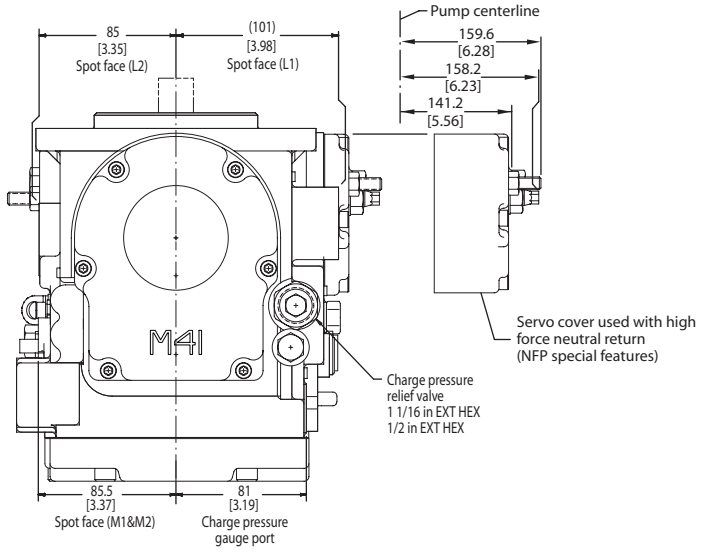


Third-angle projection mm [in]

41/51 cm³ FRAME SIZE — Base unit with manual displacement control (MDC)



P100423E



*All SAE straight thread O-ring ports per SAE J1926/ISO 11926-1, unless otherwise specified.

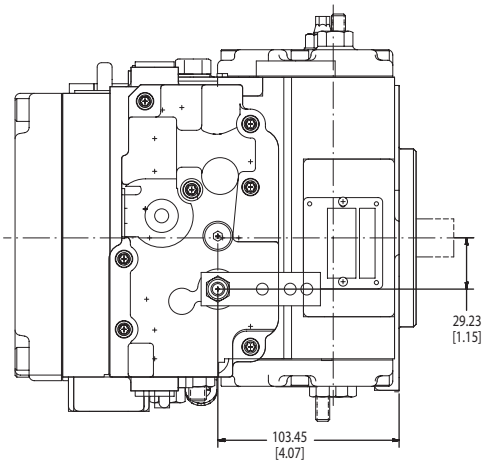
Determine rotation by viewing pump from the input shaft end. Contact your Sauer-Danfoss representative for specific installation drawings.

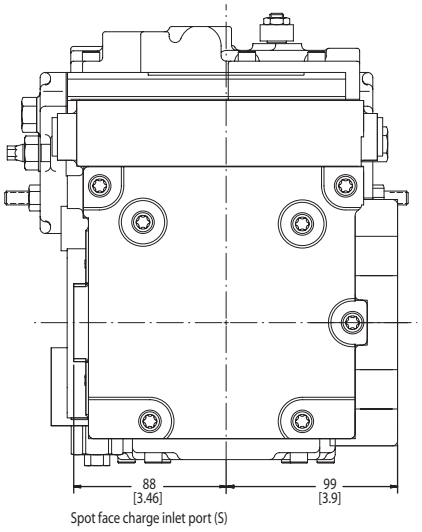
Adjustable displacement limiters

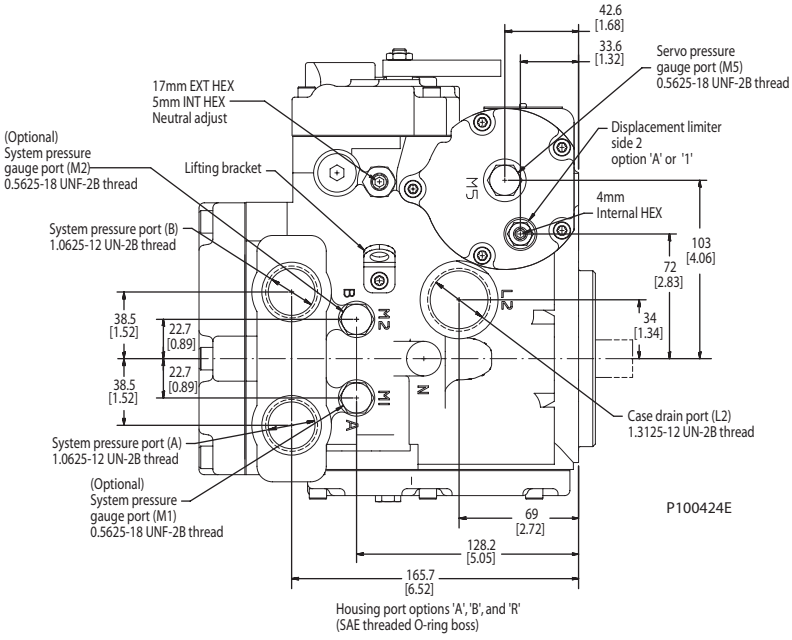
Shaft rotation	CW		CCW	
Displacement limiter side	1	2	1	2
Limited flow through port	B	A	A	B

Third-angle projection mm [in]

41/51 CM³ FRAME SIZE (continued)

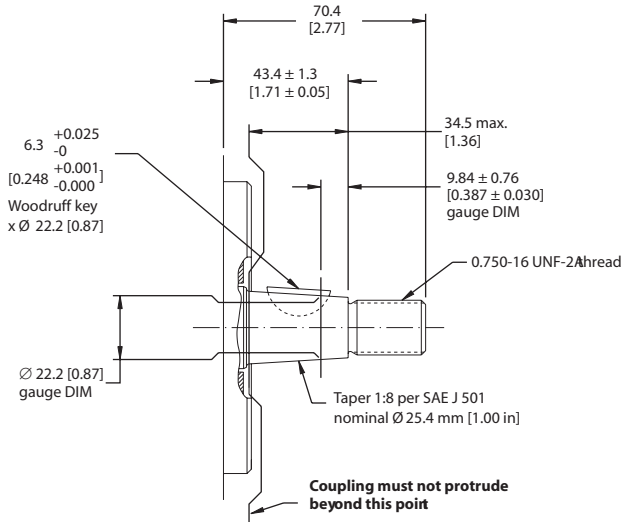




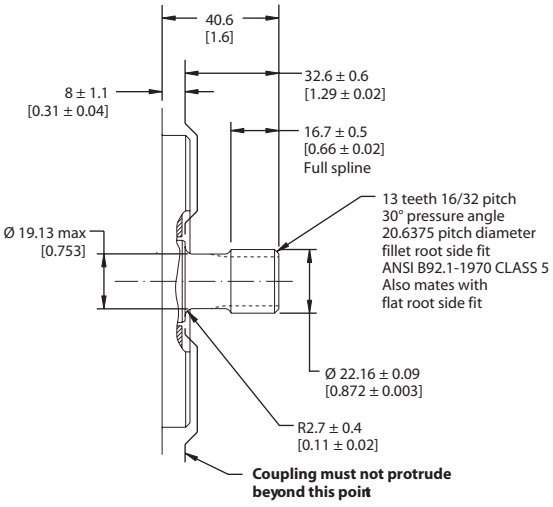


Third-angle projection mm [in]

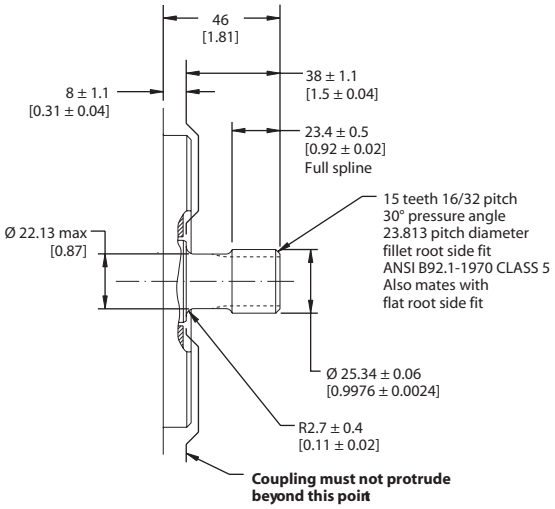
SHAFT OPTIONS



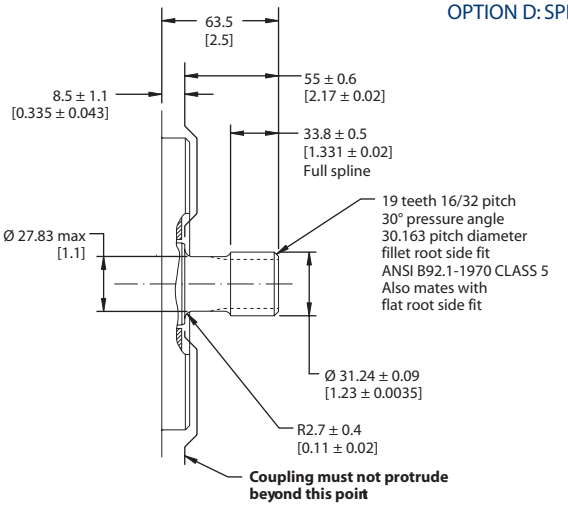
OPTION K: TAPERED SHAFT



OPTION C: SPLINED SHAFT



OPTION D: SPLINED SHAFT



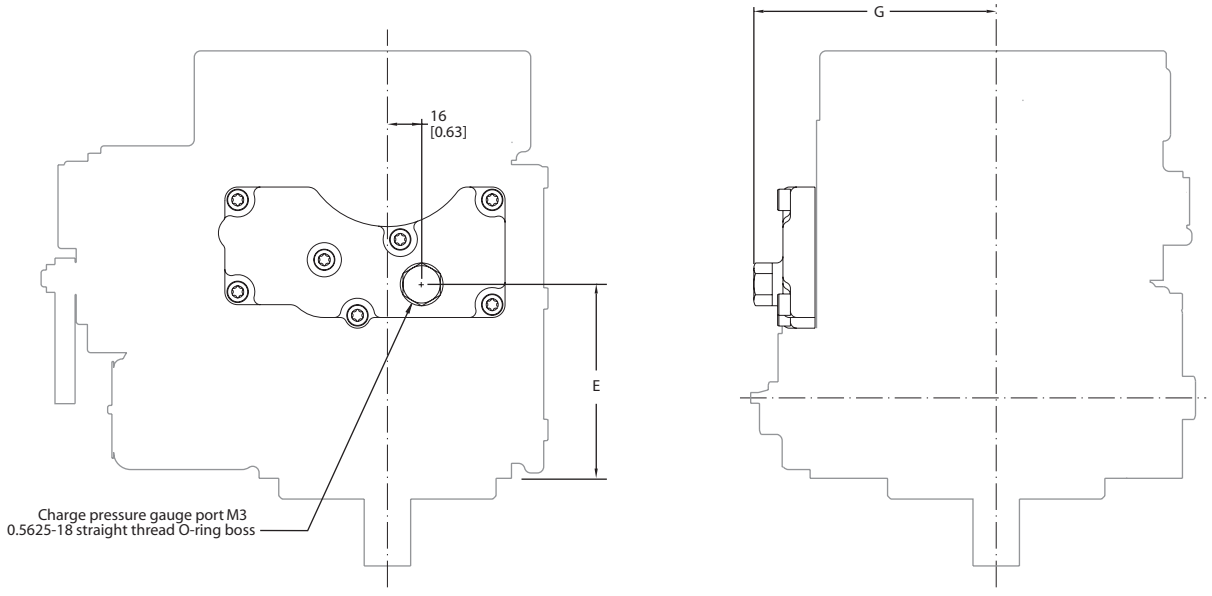
OPTION E: SPLINED SHAFT (41/51 cm³ models only)

Third-angle projection
mm [in]

P100588E

FILTRATION OPTIONS

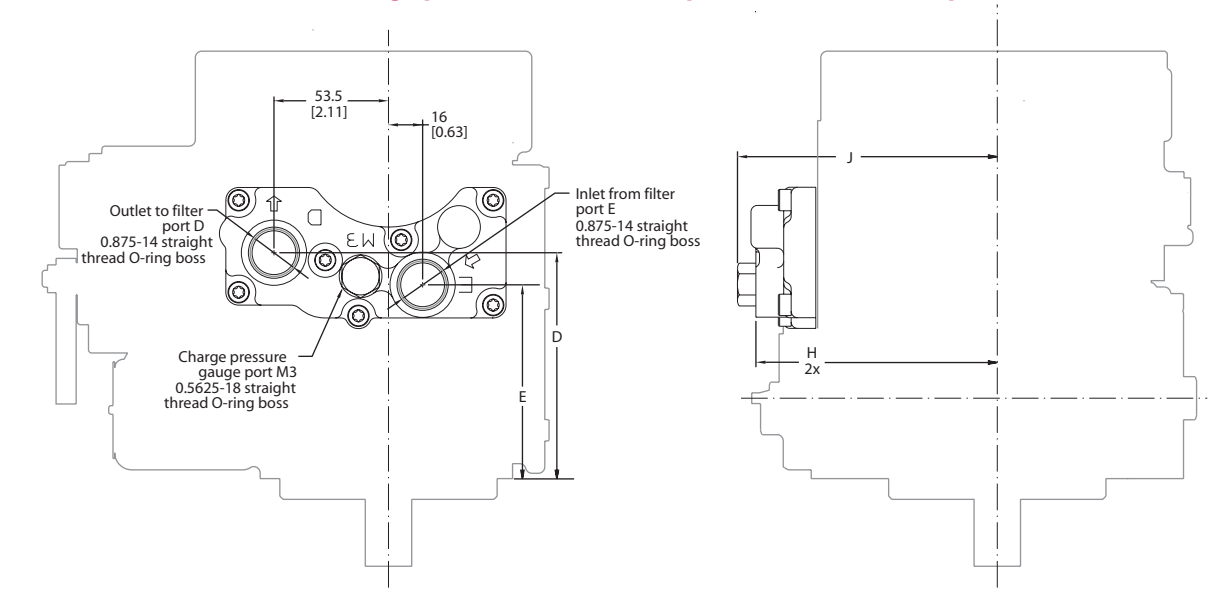
Suction filtration adapter - option G



Lettered dimensions

Frame size	E	G
28 cm³	90.7[3.57]	113 [4.45]
41/51 cm³	101[3.97]	118.5 [4.67]

Charge pressure filtration adapter - full filter flow - option B



Lettered dimensions

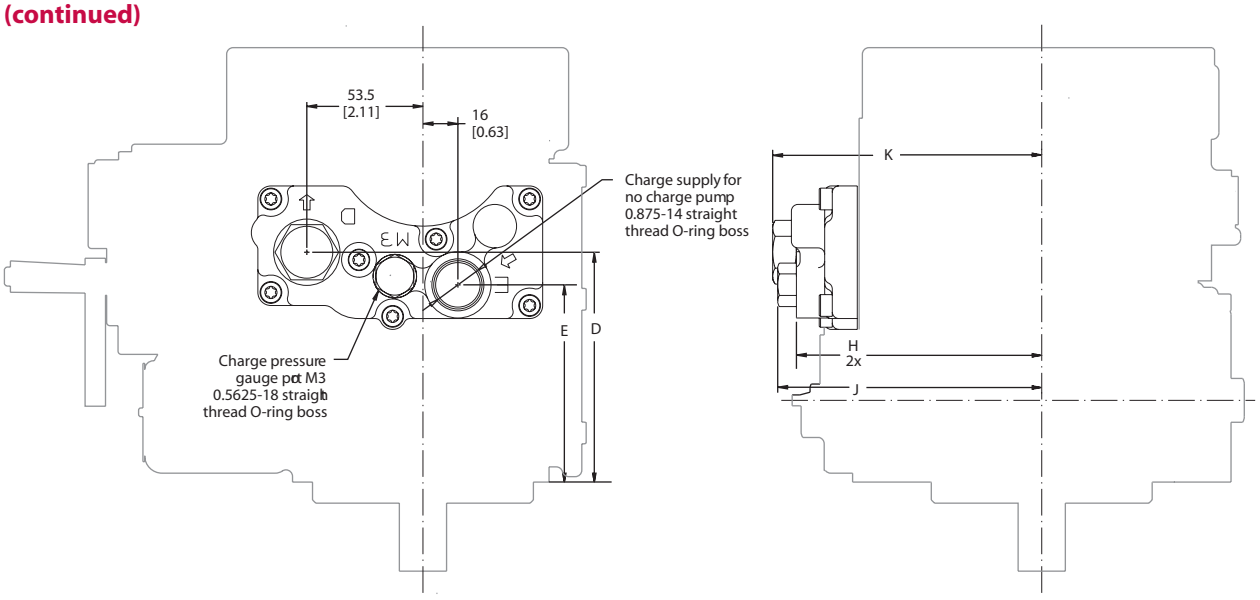
Frame size	D	E	H	J
28 cm³	105.7 [4.16]	91.2 [3.59]	112.4 [4.43]	123.3 [4.85]
41/51 cm³	116 [4.57]	101.5 [4.00]	117.9 [4.64]	128.8 [5.07]

*All SAE straight thread O-ring ports per SAE J1926/ISO 11926-1, unless otherwise specified.

Third-angle projection
mm [in]

FILTRATION OPTIONS (continued)

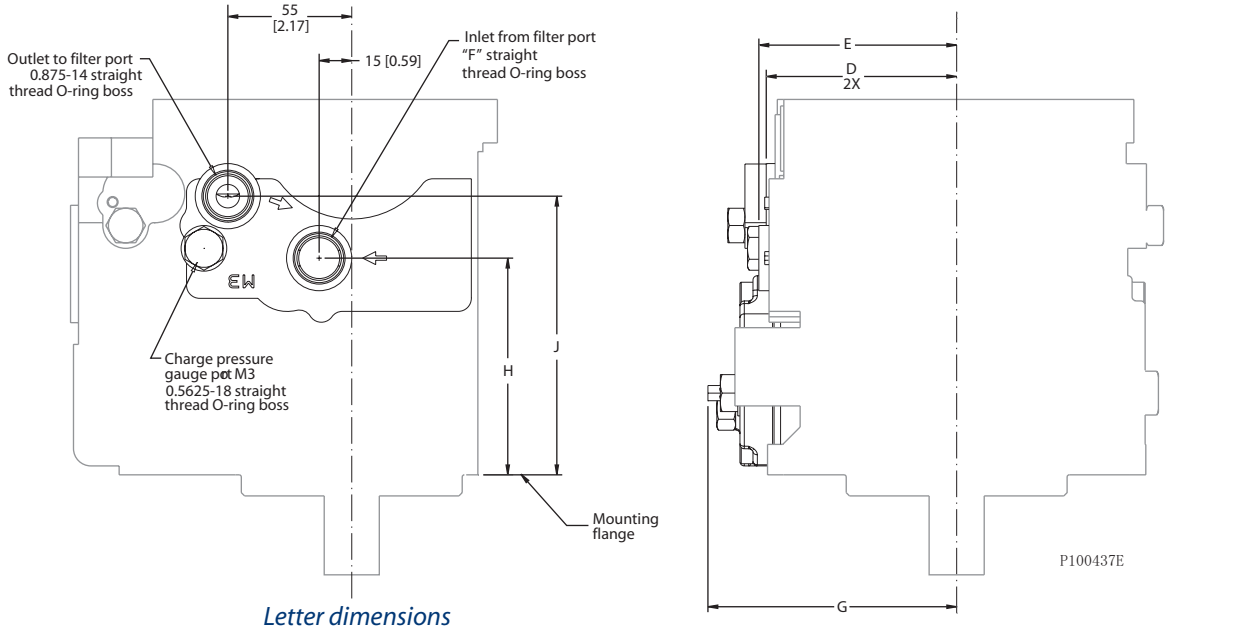
No charge pump - option X



Lettered dimensions

Frame size	D	E	H	J	K
28 cm³	105.7 [4.16]	91.2 [3.59]	112.4 [4.43]	123.3 [4.85]	125.7 [4.95]
41/51 cm³	116 [4.57]	101.5 [4.00]	117.9 [4.64]	128.8 [5.07]	131.3 [5.17]

Charge pressure filtration - full filter flow (no adapter) - option F



Letter dimensions

Frame size	D	E	F	G	H	J
28 cm³	87.6 [3.45]	91 [3.58]	.875 -14	114.42 [4.5]	99.7 [3.93]	129.2 [5.09]
41/51 cm³	93.5 [3.68]	95.3 [3.75]	.750 -16	122.12 [4.81]	110 [4.33]	141 [5.55]

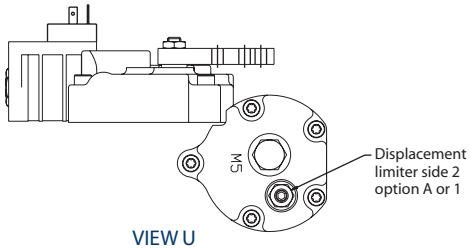
*All SAE straight thread O-ring ports per SAE J1926/ISO 11926-1, unless otherwise specified.

Third-angle projection
mm [in]

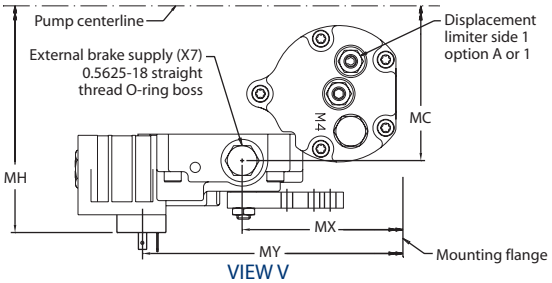
Installation drawings

CONTROL MODULES

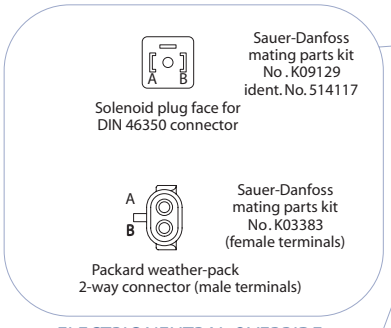
Manual displacement control (MDC) options



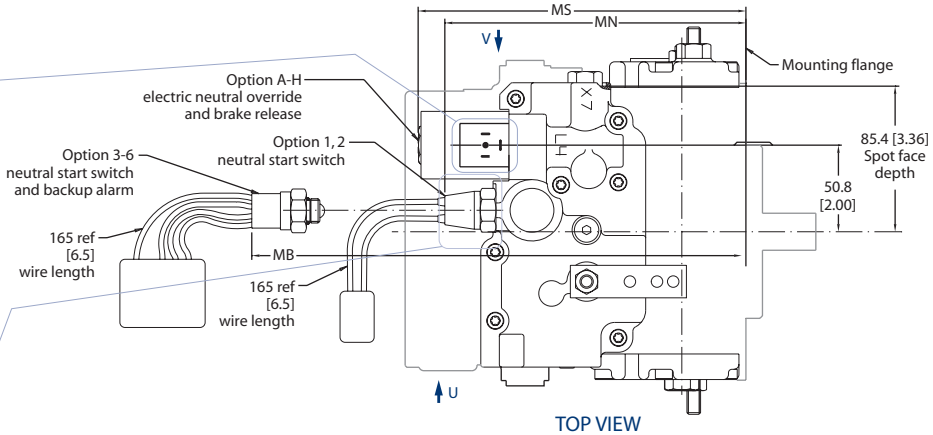
VIEW U
(LEFT SIDE VIEW)



VIEW V
(RIGHT SIDE VIEW)



ELECTRIC NEUTRAL OVERRIDE
AND BRAKE RELEASE CONNECTORS

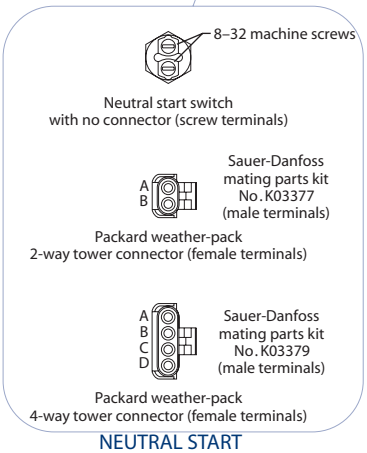


TOP VIEW
VARIABLE PUMP W/ DISPLACEMENT LIMITERS

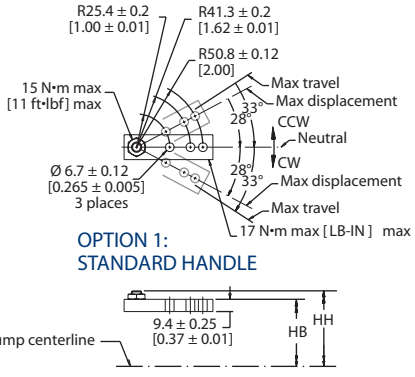
Manual displacement control dimensions

Frame size	MB	MC	MH	MN	MS	MX	MY
28 cm³	177.4 [6.98]	127.2 [5.01]	169.4 [6.67]	175.4 [6.91]	192.7 [7.58]	94.3 [3.71]	152.8 [6.02]
41/51 cm³	187.4 [7.38]	144.2 [5.68]	186.4 [7.34]	185.4 [7.30]	202.7 [7.98]	104.3 [4.11]	162.8 [6.41]

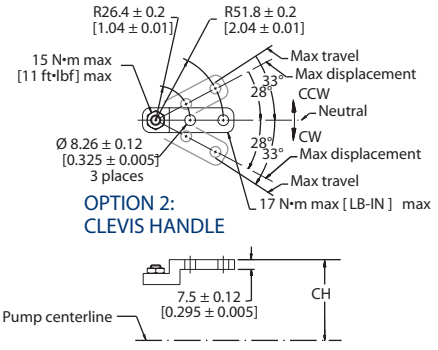
P100431E



NEUTRAL START
SWITCH CONNECTORS



OPTION 1:
STANDARD HANDLE



OPTION 2:
CLEVIS HANDLE

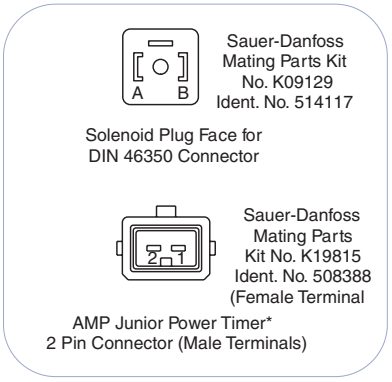
Control handle dimensions

Frame size	HB	HH	CH
28 cm³	156.4 [6.16]	163 [6.42]	166.1 [6.54]
41/51 cm³	173.4 [6.83]	180 [7.09]	183.1 [7.21]

Third-angle projection mm [in]

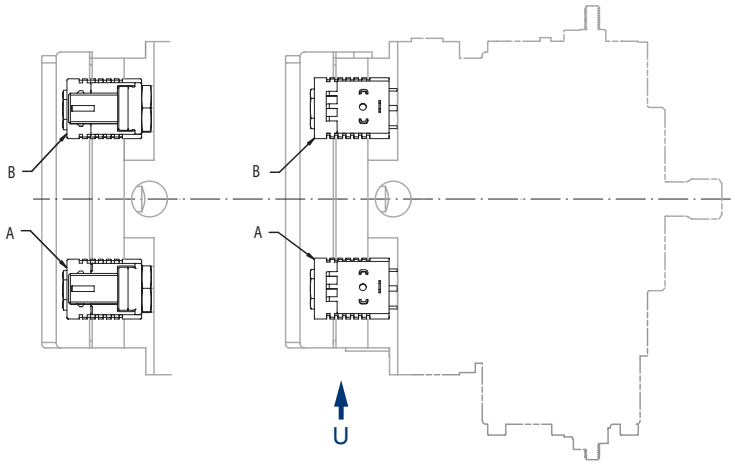
*All SAE straight thread O-ring ports per SAE J1926/ISO 11926-1, unless otherwise specified.

CONTROL MODULES (continued) **Electric control (FNR) options** **28 cm³**

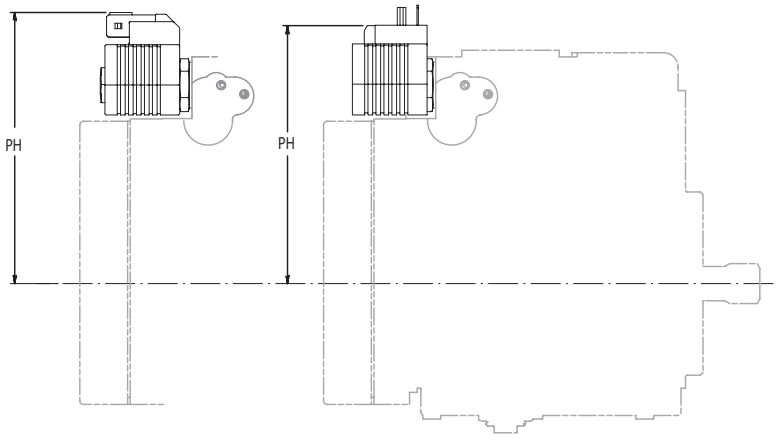


FNR CONNECTORS

* Special temperature requirements, see your Sauer-Danfoss representative when considering this option



TOP VIEW
VARIABLE PUMP W/ FNR CONTROL



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OPTION F
STYLE 8

OPTION F
STYLE 6&7

VIEW U
(LEFT SIDE VIEW)

Forward neutral reverse control dimensions

Frame size	Style	PH
28 cm³	Style 6 & 7	143.2 [5.64]
	Style 8	150.3 [5.92]

Pump flow direction with FNR control

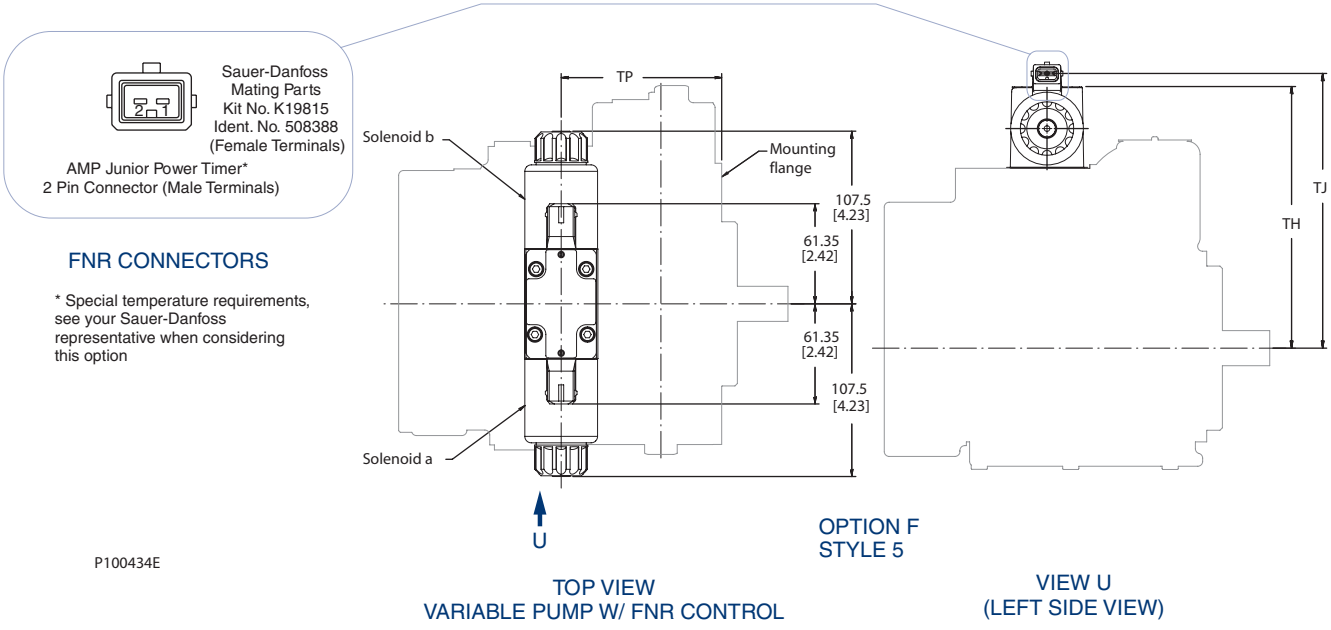
Input shaft rotation	CW		CCW	
Solenoid energized	A	B	A	B
Port A flow	Out	In	In	Out
Port B flow	In	Out	Out	In
High pressure servo gage port	M4	M5	M4	M5

Third-angle projection mm [in]

CONTROL MODULES (continued)

Three-position electric control (FNR) options

41/51 cm³



Forward neutral reverse control dimensions

Frame size	TP	TH	TJ
41/51 cm³	111.2 [4.38]	177.3 [6.98]	186.8 [7.35]

Pump flow direction with NFPE control

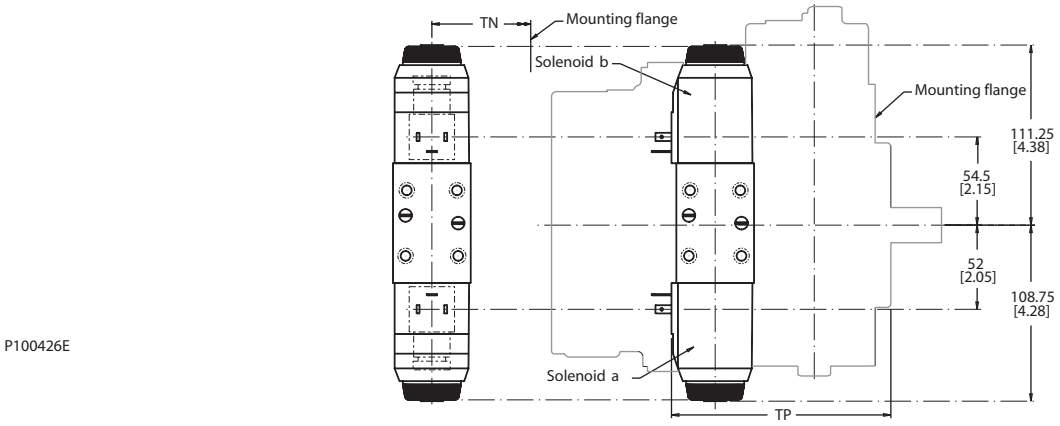
Input shaft rotation	CW		CCW	
Solenoid energized	a	b	a	b
Port A flow	Out	In	In	Out
Port B flow	In	Out	Out	In
High pressure servo gauge port	M4	M5	M4	M5

Third-angle projection mm [in]

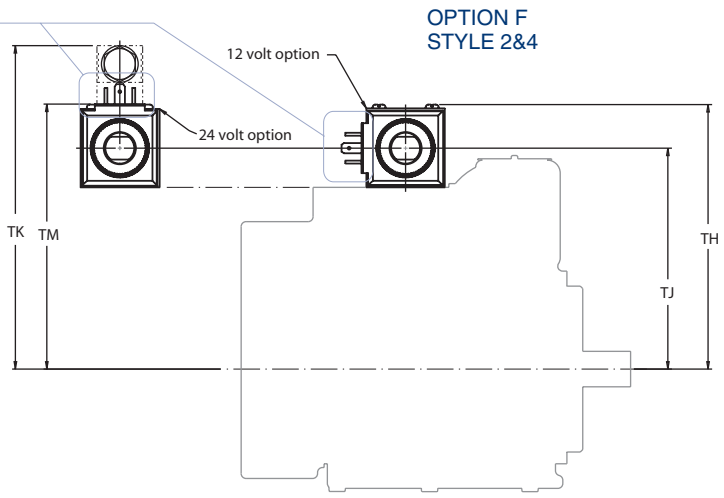
CONTROL MODULES (continued)

Three-position electric control (FNR) options

41/51 cm³



P100426E



Sauer-Danfoss
Mating Parts Kit
No. K09129
Ident. No. 514117

Solenoid Plug Face for
DIN 46350 Connector

FNR CONNECTORS

* Special temperature requirements, see your Sauer-Danfoss representative when considering this option

Forward neutral reverse control dimensions, 12 volt option

Frame size	TP	TH	TJ
41/51 cm³	138.2 [5.44]	179.6 [7.07]	152.9 [6.02]

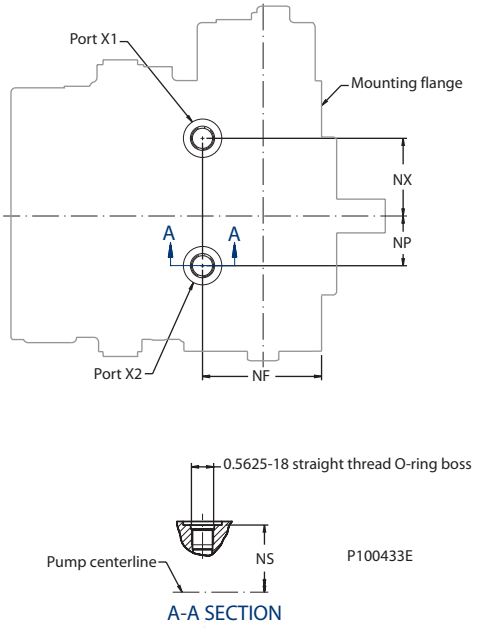
Forward neutral reverse control dimensions, 24 volt option

Frame size	TJ	TK	TM	TN
41/51 cm³	152.9 [6.02]	215.7 [8.49]	179.9 [7.08]	106.5 [4.19]

Third-angle projection
mm [in]

CONTROL MODULES (continued)

Non-feedback proportional hydraulic (NFPH) control options



Non-feedback proportional hydraulic control dimensions

Frame size	NF	NS	NP	NX
28 cm³	76.6 [3.02]	111.3 [4.38]	33 [1.30]	46 [1.81]
41/51 cm³	88 [3.46]	128.3 [5.05]	31 [1.22]	54 [2.13]

*All SAE straight thread O-ring ports per SAE J1926/ISO 11926-1, unless otherwise specified.

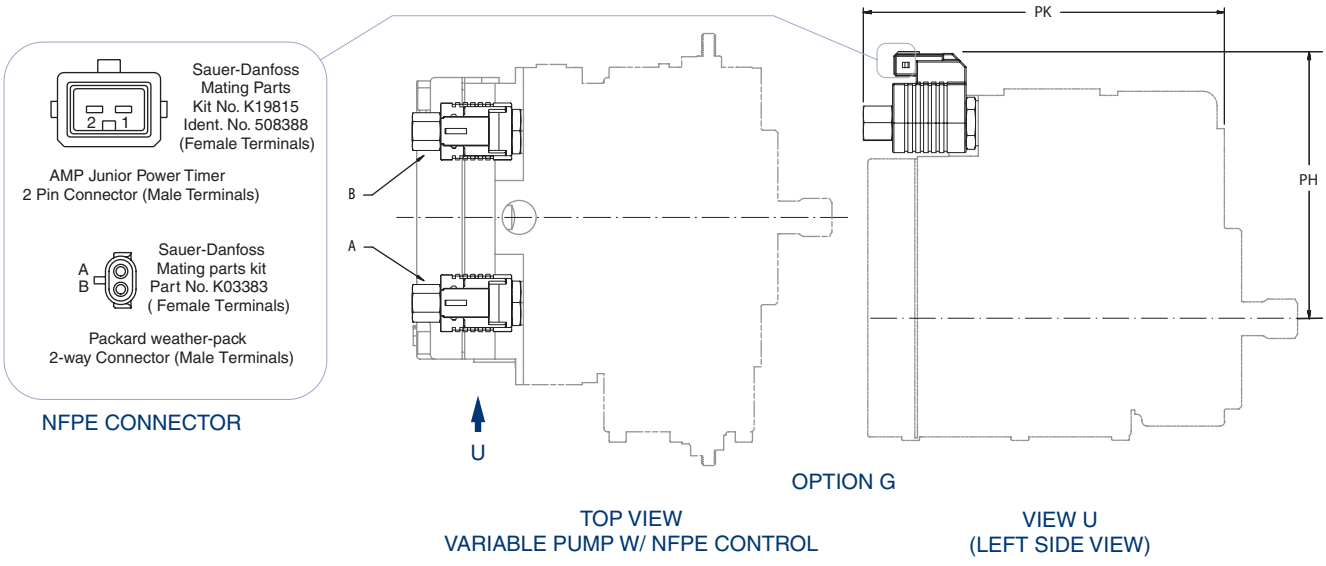
Determine rotation by viewing pump from the input shaft end. Contact your Sauer-Danfoss representative for specific installation drawings.

Third-angle projection mm [in]

CONTROL MODULES (continued)

Non-feedback proportional electric (NFPE) control options — 28 cm³

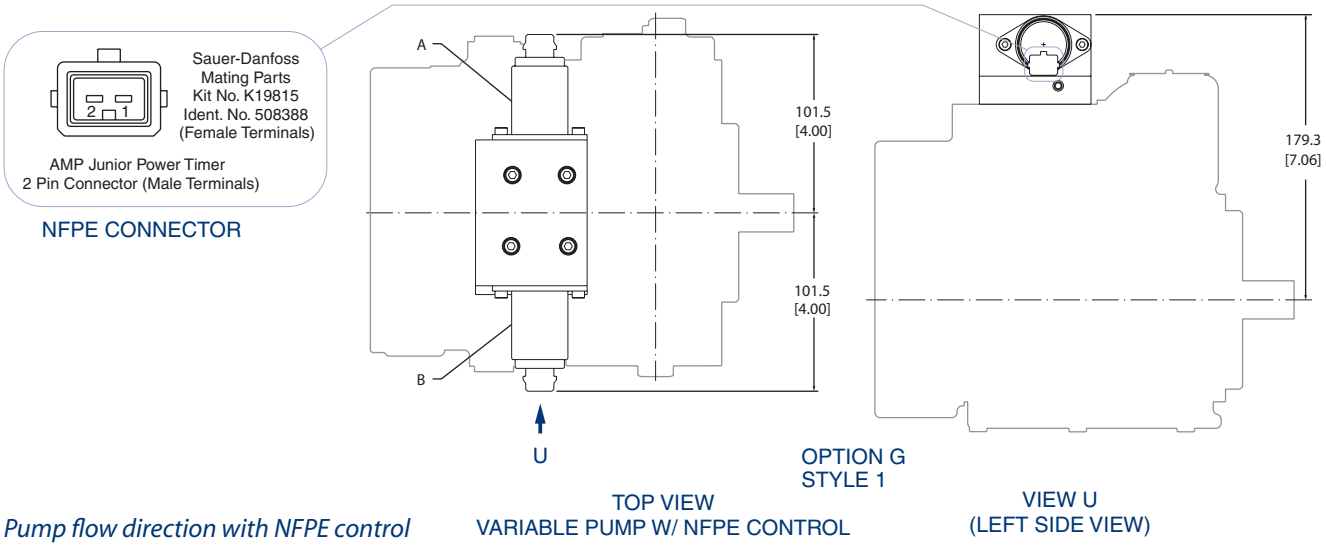
Dimensions: mm [in]



Manifold height

Frame Size	PH	PK
28 cm³ (AMP Jr Power Timer)	150.7 [5.93]	203.4 [8.00]
28 cm³ (Packard Weather-Pack)	144.6 [5.69]	203.4 [8.00]

Non-feedback proportional electric (NFPE) control options — 41/51 cm³



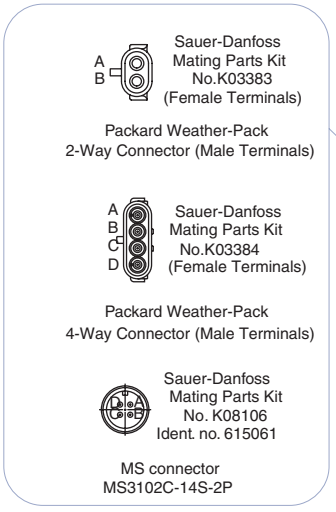
Pump flow direction with NFPE control

Input shaft rotation	CW		CCW	
Solenoid energized	A	B	A	B
Port A flow	Out	In	In	Out
Port B flow	In	Out	Out	In
High pressure servo gage port	M4	M5	M4	M5

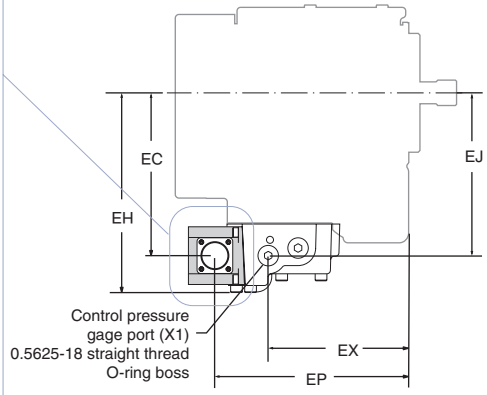
P100435E

Third-angle projection mm [in]

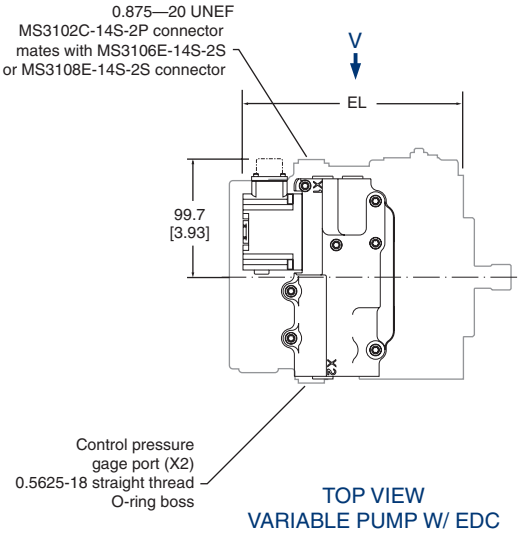
CONTROL MODULES (continued) **Electrical displacement control (EDC) options** **28 cm³**



EDC CONNECTORS



VIEW V
RIGHT SIDE VIEW
VARIABLE PUMP WITH EDC
MS CONNECTOR



TOP VIEW
VARIABLE PUMP W/ EDC
MS CONNECTOR

OPTION E

P100438E

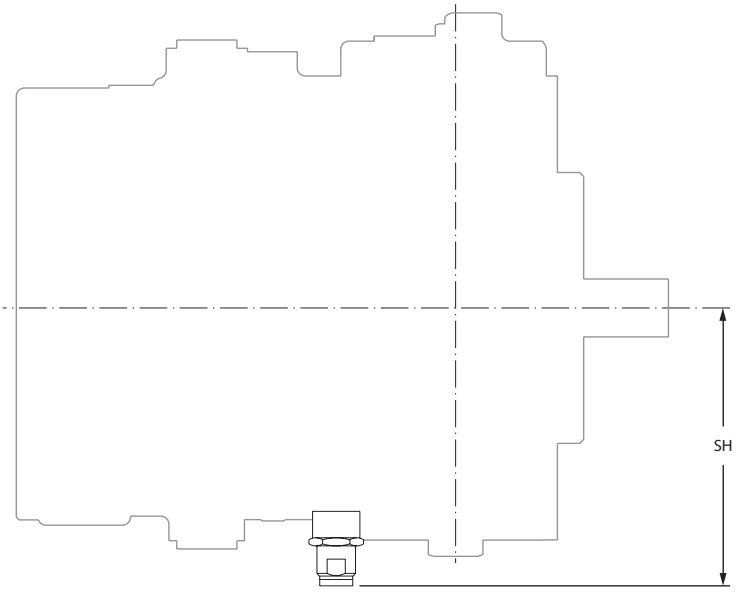
Electrical displacement control dimensions

Frame size	EC	EH	EJ	EL	EP	EX
28 cm³	138.7 [5.46]	170.2 [6.70]	138.7 [5.46]	188 [7.40]	165.7 [6.52]	119.9 [4.72]

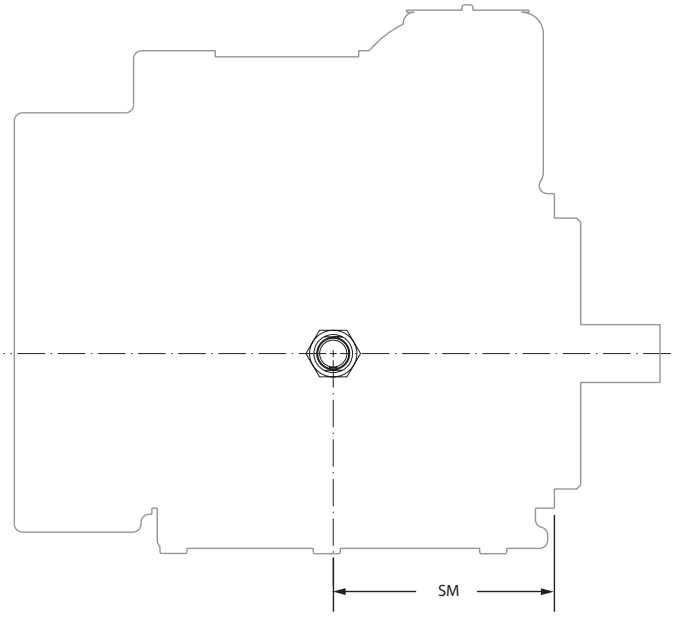
*All SAE straight thread O-ring ports per SAE J1926/ISO 11926-1, unless otherwise specified.

Third-angle projection
mm [in]

SPEED SENSOR OPTION

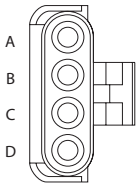


TOP VIEW



P100427E

LEFT SIDE VIEW



Sauer-Danfoss
Mating Parts Kit
No. K03379
(Male Terminals)

Packard Weather-Pack 4-Way Tower Connector
(Female Terminals)

Sauer-Danfoss
Mating Parts Kit
No. K14956 or Ident. No. 500724 (straight)
No. K14957 or Ident. No. 500725 (right angle)

Turck Eurofast 4 Pin Connector

Speed sensor height

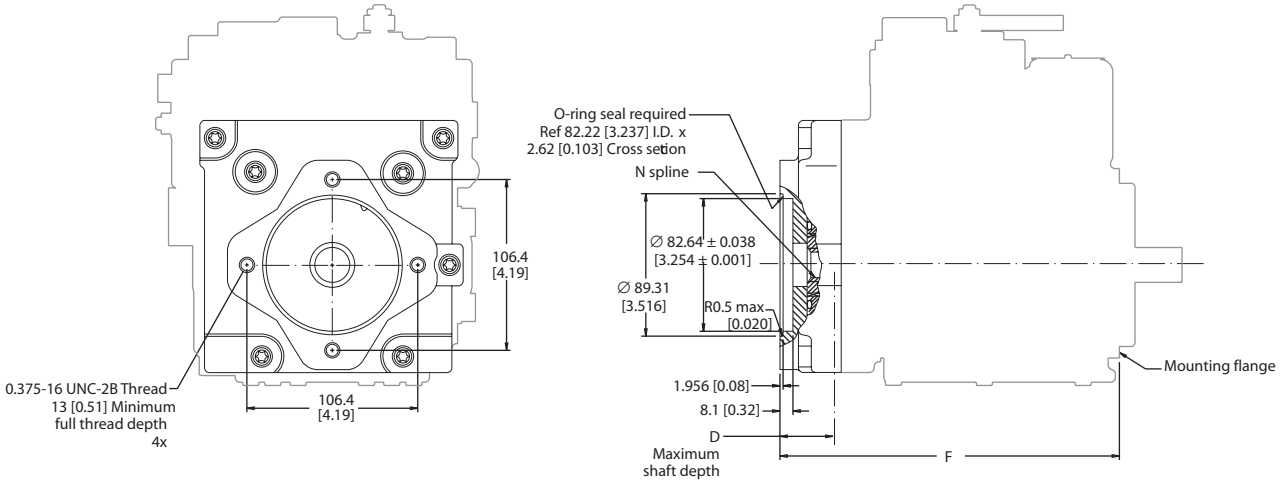
Frame size	SH	SM
28 cm³	104.24 [4.1]	81.7 [3.22]
41/51 cm³	107.84 [4.25]	89.35 [3.52]

Third-angle projection
mm [in]

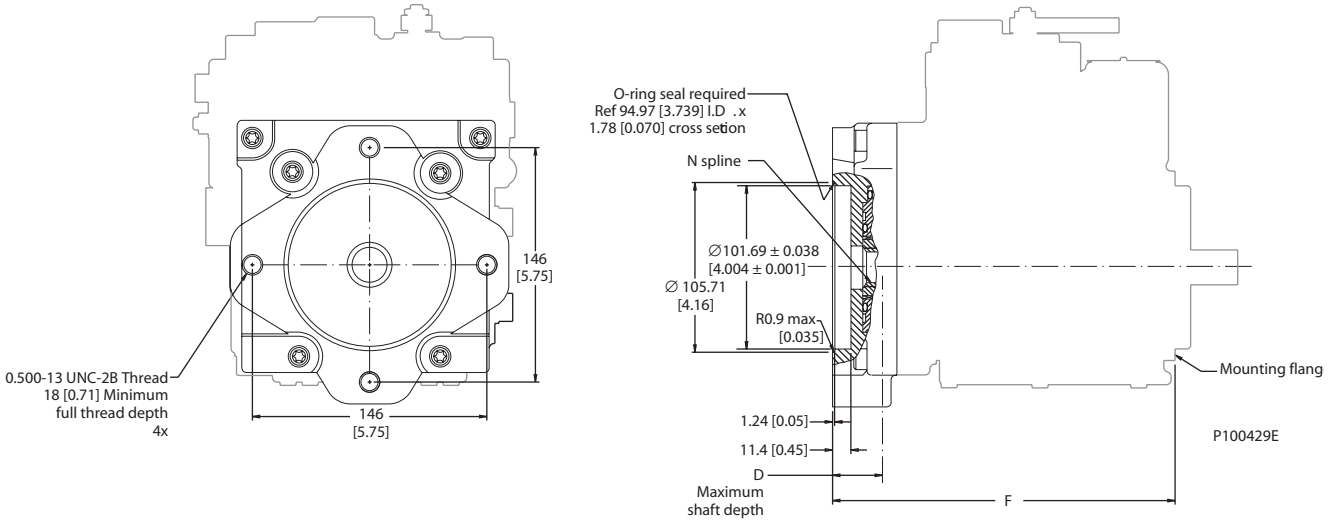
AUXILIARY MOUNTING PADS

Third-angle projection mm [in]

SAE A (OPTION A, OPTION T)



SAE B (OPTION B, OPTION V)



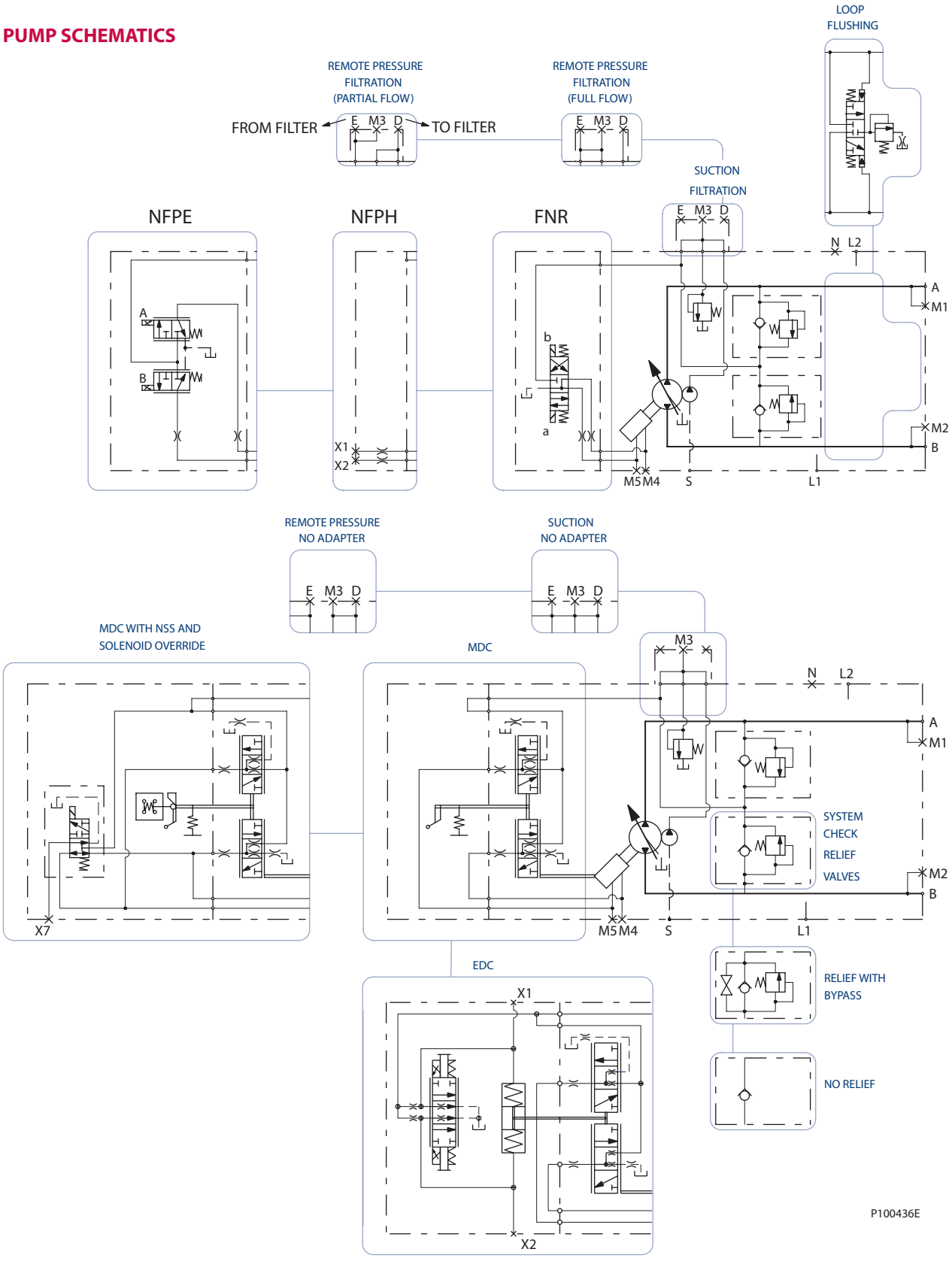
*All SAE straight thread O-ring ports per SAE J1926/ISO 11926-1, unless otherwise specified.

Determine rotation by viewing pump from the input shaft end. Contact your Sauer-Danfoss representative for specific installation drawings.

Auxiliary mounting flange and coupling options

Auxiliary mounting flange	Spline pitch diameter P	Number of teeth N	Dimension D		Dimension F	
			28 cm³	41/51 cm³	28 cm³	41/51 cm³
Option A	14.288 [0.563]	9	44 [1.73]	44 [1.73]	211.59 [8.33]	230.89 [9.09]
Option T	17.463 [0.688]	11	44 [1.73]	44 [1.73]	211.59 [8.33]	230.89 [9.09]
Option B	20.638 [0.813]	13	46 [1.81]	46 [1.81]	213.3 [8.40]	232.6 [9.16]
Option V	23.813 [0.9375]	15	46 [1.81]	46 [1.81]	213.3 [8.40]	232.6 [9.16]

PUMP SCHEMATICS



PUMP MODEL CODE

A	B	Y	C	D	E	F	Q	R	G	S	T	U	H	J	K	L	M	N	P
4	2	☐	☐☐	☐	■■■	■■	■	■	■	■	■	■	■	■■	■■	■	■	■	■■■	■■■

Legend:
● = Standard
❍ = Optional
– = Not Available

A *Product series*

Code	Description
A	Series 42

B *Rotation*

Code	Description	28	41	51
L	Pump, left hand rotation (CCW)			
R	Pump, right hand rotation (CW)			

Y *Displacement*

Code	cm³/rev [in³/rev]	28	41	51
28	28cc Revolution (1.71 CU. IN.) with or without speed sensing		–	–
41	41cc Revolution (2.50 CU. IN.) without speed sensing	–		–
4A	41cc Revolution (2.50 CU. IN.) with speed sensing	–		–
51	51cc Revolution (3.11 CU. IN.) without speed sensing	–	–	
5A	51cc Revolution (3.11 CU. IN.) with speed sensing	–	–	

C *Input Shaft Configuration*

Code	Description	28	41	51
C	13 teeth 16/32 pitch			
D	15 teeth 16/32 pitch			
E	19 teeth 16/32 pitch	–		
K	Tapered shaft **			

** Not recommended for all options.

PUMP MODEL CODE (continued)

A	B	Y	C	D	E	F	Q	R	G	S	T	U	H	J	K	L	M	N	P
4 2	■	■■	■	□□□□	■■	■	■	■	■	■	■	■	■■	■■	■	■	■	■■■	■■■

Legend:
● = Standard
❍ = Optional
– = Not Available

D *Control Type*

Control	Description		
No Control (Cover Plate): **N** = None (MDC/EDC) **M** = None (NFPE/FNR)	**D** = Shipping Cover	**N** = N/A	**N** = N/A
Manual Displacement: **A** = MDC, Standard **L** = MDC, NAR Deadband	Neutral Start Switch: **N**=None	Override to Neutral: **N**=None	Other Features: **N**=No Handle **3**=Std handle with low gain spool **5**=Clevis handle **A**=Clevis handle with low gain spool **B**=Std handle (Standard)
	NSS (only) **1**=Weather **2**=Term	Override to Neutral with Brake Release: Internal SOL **A**=12V, Weather **B**=12V, DIN **C**=24V, Weather **D**=24V, DIN **J**=12V, Deutsch **K**=24V, Deutsch	
	NSS+BAS with CW handle rotation: **3**=Weather **4**=Leads **7**=Deutsch		
	NSS+BAS with CCW handle rotation **5**=Weather **6**=Leads **8**=Deutsch		

Electrical displacement: (28cc only) **E**=EDC	Style: **1**=PCP style	Input: **A**=14-85 MA **B**=5-18 MA	Connector/spool: **3**=Weather, low gain spool **4**=MS, low gain spool **5**=Weather, high gain spool **6**=Weather, low gain spool **7**=Deutsch, low gain spool
	2=12 V Dual solenoid High current displacement control	**C**=350-1500 MA	**7**=Deutsch, low gain spool

3-Position FNR: **F**=FNR	Style: **2**=Bolt-on, 12 V, DIN (41/51cc only) **4**=Bolt-on, 24 V, DIN (41/51cc only) **5**=Bolt-on, Amp Jr (41/51cc only) **6**=Integral, 12 V DIN (28cc only) **7**=Integral, 24V DIN (28cc only) **8**=Integral, 12 V, Amp Jr (28cc only)	**N**=None	**N**=None

Non-feedback proportional **G**=NFP	Style: **1**=Electric - 12 V (Bolt-On) (41/51cc only) **2**=Electric - 12 V (Integral) (28cc only)	Input: **A**=680-1500 MA, 5-20 BAR	Connector: **1**=Amp Jr Power Timer **2**=Packard Weather-Pack (28cc only)
	3=Hydraulic style	**A**=5-20 BAR	**N**=N/A

PUMP MODEL CODE (continued)

A	B	Y	C	D	E	F	Q	R	G	S	T	U	H	J	K	L	M	N	P
4 2	■	■■	■	■■■■	□□	□	□	□	■	■	■	■	■■	■■	■	■	■	■■■	■■■

Legend:
● = Standard
❍ = Optional
– = Not Available

E *Control Response Time*

Control	Description	28	41	51
MDC, EDC:	**Servo A, drain A, drain B, servo B**			
00	Fast (No orifice)			
02	Medium (1.0, 4.0, 4.0, 1.0 mm)			
03	Slow (Standard) (0.8, 4.0, 4.0, 0.8 mm)			

Control	Description	28	41	51
NFPH, Integral NFPE, (28/41/51 cc) & Integral FNR Options(28cc only):	**Servos A and B**			
50	No Orifice (Standard)			
52	Medium 1.0 mm			
53	Slow 0.8 mm			

Bolt-on FNR & Bolt-on NFPE Options:	Servos A and B			
70	No Orifice	-		
72	Medium 1.0 mm	-		
73	Slow 0.8 mm	-		

F, Q, R *Port/housing style, Loop Flushing, Filtration*

Frame size	F: Port Style/Housing	Q: Loop Flushing/Cooling	R: Filtration
28cc	**MDC, EDC** (All feedback controls)		
	A=SAE Threaded O-ring Boss (No loop flushing, no filter pad, base housing)	**N**=None	**N**=None (External charge supply, No Adapter) **A**=Suction, No Adapter
	B=SAE Threaded O-ring Boss (Required for speed ring or sensor full featured housing)	**D**=Defeated loop flushing **2**=Loop flush/cool **3**=Loop flush/cool **4**=Loop flush/cool **5**=Loop flush/cool Please refer to page 22. *Loop flushing flow*	**B**=Remote Pressure (Full flow) with adapter
	C=SAE Threaded O-ring Boss (Loop flushing, no filter pad-base housing)	**D**=Defeated loop flushing **2**=Loop flush/cool **3**=Loop flush/cool **4**=Loop flush/cool **5**=Loop flush/cool Please refer to page 22. *Loop flushing flow*	**N**=None (External charge supply, no adapter) **A**=Suction, no adapter
	D=SAE Threaded O-ring boss (No loop flushing, integral full flow filtration)	**N**=None	**F**=Remote pressure (Full Flow), without adapter

PUMP MODEL CODE (continued)

A B Y C D E F Q R G S T U H J K L M N P
4 2 ▢

Legend:
● = Standard
❍ = Optional
– = Not Available

F, Q, R *Port/housing style, Loop Flushing, Filtration*

Frame Size	F: Port Style/Housing	Q: Loop FLushing/Cooling	R: Filtration
28cc	**NFPE & FNR** (Integral non-feedback proportional electric and 3 position controls)		
	U=SAE Threaded O-ring boss (Required for speed ring and sensor-full featured housing)	**D**=Defeated loop flushing **2**=Loop flush/cool **3**=Loop flush/cool **4**=Loop flush/cool **5**=Loop flush/cool Please refer to page 22. *Loop flushing flow*	**X**=None (external charge supply, with adapter) **G**=Suction, with adapter **B**=Remote pressure (Full flow), with adapter
	V=SAE Threaded O-ring boss (No Loop Flushing, Integral Full Flow Filtration, Not for use with speed sensor)	**N**=None	**F**=Remote pressure (Full flow), without adapter

28cc	**NFPH** (Non-feedback proportional hydraulic)		
	T=SAE Threaded O-ring Boss (No loop flushing, no filter pad-base housing)	**N**=None	**D**=Suction,No Adapter, No gauge port plug **M**=None (External charge special, no gauge port plug)
	P=SAE Threaded O-ring Boss (Required for speed ring or sensor-full featured housing)	**D**=Defeated loop flushing **2**=Loop flush/cool **3**=Loop flush/cool **4**=Loop flush/cool **5**=Loop flush/cool Please refer to page 22. *Loop flushing flow*	**X**=None (external charge supply, with adapter) **G**=Suction, with adapter **B**=Remote pressure (full flow), with adapter

41cc and 51cc	**MDC** (All feedback controls)		
	A=SAE threaded O-ring boss (No loop flushing, no filter pad housing)	**N**=None	**N**=None (External charge supply, no adapter) **A**=Suction, no adapter
	B=SAE threaded O-ring boss (Required for speed ring or sensor-full featured housing)	**D**=Defeated loop flushing **2**=Loop flush/cool **3**=Loop flush/cool **4**=Loop flush/cool **5**=Loop flush/cool Please refer to page 22. *Loop flushing flow*	**B**=Remote pressure (Full flow), with adapter
	C=SAE threaded O-ring boss (Loop flushing, no filter pad-base housing)	**D**=Defeated loop flushing **2**=Loop flush/cool **3**=Loop flush/cool **4**=Loop flush/cool **5**=Loop flush/cool Please refer to page 22. *Loop flushing flow*	**N**=None (External charge supply, no adapter) **A**=Suction, no adapter
	D=SAE threaded O-ring boss (No loop flushing, integral full flow filtration)	**N**=None	**F**=Remote pressure (Full flow), without adapter

PUMP MODEL CODE (continued)

A	B	Y	C	D	E	F	Q	R	G	S	T	U	H	J	K	L	M	N	P
4 2	■	■ ■	■	■ ■ ■	■ ■	○	○	○	■	■	■	■	■ ■	■ ■	■	■	■	■ ■ ■	■ ■ ■

Legend:
- ● = Standard
- ❍ = Optional
- – = Not Available

F, Q, R *Port/housing style, Loop Flushing, Filtration*

Frame Size	F: Port Style/Housing	Q: Loop FLushing/Cooling	R: Filtration
41cc and 51cc	**NFPE, FNR** (Electric non-feedback controls)		
	J=SAE Threaded O-ring boss (Required for speed ring and sensor full featured housing)	**D**=Defeated loop flushing **2**=Loop flush/cool **3**=Loop flush/cool **4**=Loop flush/cool **5**=Loop flush/cool Please refer to page 22. *Loop flushing flow*	**X**=None (external charge supply, with adapter) **G**=Suction, with adapter **B**=Remote pressure (full flow), with adapter **C**=Remote pressure (Partial flow), with adapter

41cc and 51cc	**NFPH** (Integral Control)		
	P=SAE Threaded O-ring boss (Required for speed ring or sensor-full featured housing)	**D**=Defeated loop flushing **2**=Loop flush/cool **3**=Loop flush/cool **4**=Loop flush/cool **5**=Loop flush/cool Please refer to page 22. *Loop flushing flow*	**X**=None (external charge supply, with adapter) **G**=Suction, with adapter **B**=Remote pressure (full flow), with adapter **C**=Remote pressure (Partial flow), with adapter

PUMP MODEL CODE (continued)

A	B	Y	C	D	E	F	Q	R	G	S	T	U	H	J	K	L	M	N	P
4 2																			

Frame Size	G: Charge/Implement Pump	S: Charge Relief Setting	T: Special Drive Features	U: Rear Auxiliary Mounting Pad
28cc and 41cc and 51cc	**A**=None (with no coupling, auxiliary pad options Y & Z) **N**=None (w/spacer - not available for rear auxiliary mounting pad option N) **2**=11cc **3**=15.6cc	**A**= 10 bar (145 psi) **B**=12 bar (174 psi) **C**=14 bar (203 psi) **D**=16 bar (232 psi) **E**=18bar (261psi) **F**=20 bar (290 psi) **G**=22 bar (319 psi) **H**=24 bar (348 psi) **P**=Defeated	**N**=None **1**=NFP with anti-stall **2**=NFP with standard CPRV and side driven servo (Displacement limiter option T only) **5**=NFP with standard CRPV	**Z**=None (With external charge, charge pump option A) **W**=SAE-A, 11 tooth short mount (28cc only) **R**=SAE A, 13 tooth (41/51cc only) **N**=None (not available w/charge pump option N) **A**=SAE-A, 9 tooth **B**=SAE-B, 13 tooth **V**=SAE B-B, 15 tooth **T**=SAE-A special, 11 tooth

PUMP MODEL CODE (continued)

Legend:
- ● = Standard
- ❍ = Optional
- – = Not Available

H *System Pressure Protection-Port A*

Code	Description	28	41	51
NN	None (Check valve only)			
14	140 bar (2030 psi) HPRV			
17	175 bar (2540 psi) HPRV			
19	190 bar (2755 psi) HPRV			
21	210 bar (3045 psi) HPRV			
23	230 bar (3330 psi) HPRV			
25	250 bar (3335 psi) HPRV			
28	280 bar (4060 psi) HPRV			
30	300 bar (4350 psi) HPRV			
32	325 bar (4715 psi) HPRV			
34	345 bar (5000 psi) HPRV			
36	360 bar (5220 psi) HPRV			–
38	385 bar (5580 psi) HPRV			–
41	415 bar (6020 psi) HPRV			–
00	No check valve, no HPRV			–

J *System Pressure Protection-Port B*

Code	Description	28	41	51
NN	None (Check valve only)			
14	140 bar (2030 psi) HPRV			
17	175 bar (2540 psi) HPRV			
19	190 bar (2755 psi) HPRV			
21	210 bar (3045 psi) HPRV			
23	230 bar (3330 psi) HPRV			
25	250 bar (3335 psi) HPRV			
28	280 bar (4060 psi) HPRV			
30	300 bar (4350 psi) HPRV			
32	325 bar (4715 psi) HPRV			
34	345 bar (5000 psi) HPRV			
36	360 bar (5220 psi) HPRV			–
38	385 bar (5580 psi) HPRV			–
41	415 bar (6020 psi) HPRV			–
00	No check valve, no HPRV			–

PUMP MODEL CODE (continued)

Legend:
- ● = Standard
- ❍ = Optional
- – = Not Available

K Loop bypass valve

Code	Description	28	41	51
N	None			
B	Bypass Valve			

L Displacement limiters - side 1

Code	Description	28	41	51
N	None			
A	Adjustable limiter set at max. displacement			
	Displacement limiters - NFP, Side 1			
0	None			
1	Adjustable limiter set at max displacement			

M *Displacement Limiters - Side 2*

Code	Description	28	41	51
N	None			
A	Adjustable limiter set at max. displacement			
	Displacement limiters - NFP, Side 2			
0	None			
1	Adjustable limiter set at max. displacement			

N *Special hardware*

Code	Description	28	41	51
NNN	None			

P *Special features*

Code	Description	28	41	51
NNN	None			

Notes

Notes

Notes

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