INTRODUCTION

Sauer-Danfoss a world leader in hydraulic power systems has developed a family of axial piston pumps.

DESCRIPTION

Sauer-Danfoss axial piston variable displacement pumps are of swash plate design with variable flow capability suitable for hydrostatic transmissions with closed loop circuit. Tilting the swash plate to the opposite side of the neutral or zero displacement position reverses flow direction.

Sauer-Danfoss axial piston variable displacement pumps are well engineered and easy to handle.

The full-length shaft with a highly efficient tapered roller bearing arrangement offers a high loading capacity for external radical forces.

The hydro-mechanical servo displacement control maintains the selected swash plate position and hence pumps displacement.

Upon release of the control handle, the swash plate automatically returns to zero position and the flow reduces to zero.

High case pressures can be achieved without leakage even at the lowest temperatures by using suitable shaft seals.

The servo valve arrangement offers the facility to incorporate function regulators and remote control systems.

Axial piston units are designed for easy servicing. Complete dismantling and reassembly can be carried out with standard hand tools, and all components or sub-assemblies are replaceable.

Axial piston variable displacement pumps of the Sauer-Danfoss pattern are made by licensed producers worldwide, providing consistent service and fully interchangeable parts.

TYPICAL MARKETS

- Industrial
- Mining
- Transit Mixer
- Utility Vehicles
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AXIAL PISTON VARIABLE DISPLACEMENT PUMP

- Swash plate
- Control handle
- Servo valve (control valve)
- Charge pump
- Charge check valve
- Input shaft
- Shaft seal
- Cylinder block assembly
- Servo cylinder
Above figure shows schematically the function of a hydrostatic transmission using an axial piston variable displacement pump and a fixed displacement motor.

**Designation:**
1 = Variable displacement pump  
2 = Charge pump  
3 = Servo control valve  
4 = Charge check valve  
5 = Charge relief valve  
6 = Filter  
7 = Heat exchanger

**Ports:**
A, B = Main pressure ports (working loop)  
S = Suction port - charge pump  
L1, L2 = Drain ports  
M = Gauge port - charge pressure
**TECHNICAL PARAMETERS**

**Design**
Axial piston pump of swash plate design, with variable displacement.

**Type of mounting**
SAE four bolt flanges.

**Pipe connections**
Main pressure ports: SAE split flange
Remaining ports: SAE O-ring boss

**Direction of rotation**
Clockwise or counterclockwise (viewing from the input shaft).

**Installation position**
Optional; pump housing must be always filled with hydraulic fluid.

**External drain fluid loss**

![External drain fluid loss graph](image-url)

Typical values for 350 bar [5076 psi] and 18° swashplate angle
**HYDRAULIC PARAMETERS**

**System pressure range, input p₁**
Variable displacement pump:
Charge pressure nominal: 13 bar [189 psi] above case pressure
Charge pressure minimum: 8 bar [116 psi], intermittent only

Charge pump input pressure:
Min. allowable pressure, continuous = 0.75 bar [10.9 psi] absolute
Min. allowable pressure, intermittent = 0.50 bar [7.3 psi] absolute (for cold start)

Charge pump output pressure:
Max. operating pressure = 35 bar [508 psi] above case pressure

**System pressure range, output p₂**
Pressure on port A or B: Max. operating pressure = Δp = 420 bar [6092 psi]
Max. high pressure setting = Δp = 460 bar\(^1\) [6672 psi]
\(^1\)only with POR-valve

**Case pressure**
Max. rated pressure = 2.5 bar [36.3 psi]
Intermittent = 5.0 bar [72.5 psi]

**Hydraulic fluid**
Refer to Sauer-Danfoss publications *Hydraulic Fluids and Lubricants* and *Experience with Bio Fluids for biodegradable hydraulic fluids*.

**Hydraulic fluid temperature range**
\(\vartheta_{\text{min}} = -40 \degree \text{C} [-40 \degree \text{F}]\)
\(\vartheta_{\text{max}} = 95 \degree \text{C} [203 \degree \text{F}]\)

**Viscosity range**
\(\nu_{\text{min}} = 7 \text{ mm}^2/\text{s} \ [49 \text{ SUS*}]\)
\(\nu_{\text{max}} = 1000 \text{ mm}^2/\text{s} \ [4630 \text{ SUS*}]\) (intermittent cold start)
Recommended viscosity range: 12 - 60 mm\(^2\)/s \ [66 - 280 SUS*]

\(*\text{SUS (Saybolt Universal Second)}\)

**Filtration**
Required cleanliness level: ISO 4406 - 1999 Code 22/18/13 or better. Refer to Sauer-Danfoss publication *Hydraulic Fluids and Lubricants* and *Design Guideline for Hydraulic Fluid Cleanliness*.

**Shaft load**
The pump will accept radial and axial loads on its shaft, the maximum capacity being determined by direction and point of application of the load.
*Please contact your Sauer-Danfoss representative.*
### Technical data

<table>
<thead>
<tr>
<th></th>
<th>Frame size</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>070</td>
<td>089</td>
<td>334</td>
<td></td>
</tr>
<tr>
<td>Max. displacement</td>
<td>cm³ [in³]</td>
<td>69.8</td>
<td>89.0</td>
<td>333.7</td>
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<td></td>
<td></td>
<td>[4.26]</td>
<td>[5.43]</td>
<td>[20.36]</td>
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<tr>
<td>Charge pump displacement</td>
<td>options</td>
<td>cm³ [in³]</td>
<td>18.03</td>
<td>65.50</td>
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<tr>
<td></td>
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<td>[1.10]</td>
<td>[4.00]</td>
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<tr>
<td></td>
<td></td>
<td>12.30</td>
<td>[0.75]</td>
<td></td>
</tr>
<tr>
<td>Minimum speed</td>
<td>min⁻¹ (rpm)</td>
<td>500</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rated speed 1</td>
<td>min⁻¹ (rpm)</td>
<td>3200</td>
<td>2900</td>
<td>1900</td>
</tr>
<tr>
<td>Maximum swash plate angle</td>
<td>degree</td>
<td>±18</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mass moment of inertia of rotating group (without charge pump)</td>
<td>kg m² ⋅ 10⁻³ [lbf ft² ⋅ 10⁻³]</td>
<td>12.34</td>
<td>17.77</td>
<td>161.40</td>
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<tr>
<td></td>
<td></td>
<td>[292.8]</td>
<td>[421.7]</td>
<td>[3830.0]</td>
</tr>
<tr>
<td>Weight</td>
<td>kg [lb]</td>
<td>63 [139]</td>
<td>78 [172]</td>
<td>270 [595]</td>
</tr>
</tbody>
</table>

¹ for higher speeds contact your Sauer–Danfoss representative

### Determination of nominal pump size

Unit: Metric system: Inch system

| Pump output flow         | Q = \( \frac{V_s \cdot n \cdot \eta_v}{1000} \) l/min | Q = \( \frac{V_s \cdot n \cdot \eta_v}{231} \) [gpm] |
| Input torque            | M = \( \frac{V_s \cdot \Delta p}{20 \cdot \pi \cdot \eta_m} \) Nm | M = \( \frac{V_s \cdot \Delta p}{2 \cdot \pi \cdot \eta_m} \) [lbf•in] |
| Input power             | P = \( \frac{V_s \cdot n \cdot \Delta p}{600 000 \cdot \eta_t} \) kW | P = \( \frac{V_s \cdot n \cdot \Delta p}{396 000 \cdot \eta_t} \) [hp] |

Efficiency characteristic curves available on request.

\[
V_s = \text{Pump displacement per revolution \ [cm}^3 \ [in}^3\]
\[
n = \text{Pump speed \ [min}^{-1} \ [rpm]\]
\[
\Delta p = \text{Hydraulic pressure differential \ [bar \ [psid]}\]
\[
\Delta p = p_{HD} - p_{ND}\]
\[
\eta_v = \text{Pump volumetric efficiency}\]
\[
\eta_m = \text{Pump mechanical efficiency}\]
\[
\eta_t = \text{Pump total efficiency}\]
\[
p_{HD} = \text{High pressure \ [bar \ [psid]}\]
\[
p_{ND} = \text{Low pressure \ [bar \ [psid]}\]

8

DKMH.PN.315.A1.02 • 520L0517
Regulated by the control handle on the servo valve, the swash plate can be infinitely varied in both directions with the help of the servo system. The pump displacement resulting from any control handle position can be established using the figures on this page. The angle of the control handle for stroke initiation and for the final position of the stroke can vary from unit to unit within the range of the tolerance band. The inter-relation of flow direction, rotation of the pump and the control handle movement is shown below.

**Pump flow direction**
Flow direction changes with the direction of rotation and the control handle movement (see above).

![Diagram showing pump flow direction](image)

<table>
<thead>
<tr>
<th>Pump rotation</th>
<th>Movement of control handle in direction</th>
<th>Pressure port OUT</th>
<th>Pressure port IN</th>
</tr>
</thead>
<tbody>
<tr>
<td>Counterclockwise (L)</td>
<td>C</td>
<td>B</td>
<td>A</td>
</tr>
<tr>
<td></td>
<td>D</td>
<td>A</td>
<td>B</td>
</tr>
<tr>
<td>Clockwise (R)</td>
<td>C</td>
<td>A</td>
<td>B</td>
</tr>
<tr>
<td></td>
<td>D</td>
<td>B</td>
<td>A</td>
</tr>
</tbody>
</table>

**SERVO DISPLACEMENT CONTROL (LINEAR RESPONSE)**

**Technical Specification**

![Graphs showing technical specification](image)
Series 20 – Axial Piston Pumps
Technical Information

SERVO DISPLACEMENT CONTROL
(LINEAR RESPONSE)
(continued)

Reversing time
Time for the directional change of the flow from $Q_{\text{max}}$, across zero to $Q_{\text{max}}$, depending on the size of the control orifice fitted in the supply port to the servo valve (see below). The values given assume movement of the control handle directly from one end position to the other.

Adjustment time of handle: < minimum reversing time

Operating pressure: $\Delta p_2 = 210$ bar [3046 psi]

Speed: $n = 1450$ min$^{-1}$ (rpm)

System temperature: 50 °C [122 °F]

Viscosity: 35 mm$^2$/s [164 SUS]

Schematic diagram of servo valve with alternative orifice positions

<table>
<thead>
<tr>
<th>Frame size</th>
<th>Minimum reversing time (s) without orifice</th>
<th>Maximum reversing time (s) with orifice Ø 0.66 in supply port</th>
</tr>
</thead>
<tbody>
<tr>
<td>070</td>
<td>1.0</td>
<td>9.3</td>
</tr>
<tr>
<td>089</td>
<td>1.1</td>
<td>9.0</td>
</tr>
<tr>
<td>334</td>
<td>5.6</td>
<td>43.8</td>
</tr>
</tbody>
</table>

P000 056E
Series 20 – Axial Piston Pumps
Technical Information
Technical Specification

SERVO DISPLACEMENT CONTROL (LINEAR RESPONSE) (continued)

**Reset time**
Time for reducing the flow from either flow direction from $Q_{\text{max}}$ to 0 releasing the control handle.
Assuming no mechanical blockage of the control handle’s free return and assuming no orifices in the pilot ports:
Operating pressure: $\Delta p_2 = 210$ bar [3046 psi]
System temperature: $50 \, ^\circ\text{C} \; [122 \, ^\circ\text{F}]$
Viscosity: $35 \, \text{mm}^2/\text{s} \; [164 \, \text{SUS}]

<table>
<thead>
<tr>
<th>Frame size</th>
<th>Minimum reset time (s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>070</td>
<td>3.0</td>
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<tr>
<td>089</td>
<td>3.3</td>
</tr>
<tr>
<td>334</td>
<td>5.4</td>
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</table>

**Changing reversing and reset time**
Inserting one orifice in each of the pilot ports can extend the reversing time. The reset time will also be extended.
Inserting an orifice in one of the pilot ports only can extend the reversing time in one flow direction. The reset time will be extended only for this flow direction.
Series 20 – Axial Piston Pumps
Technical Information
Dimensions – Frame Size 070 and 089 cm³

OUTLINE DRAWING, CONFIGURATION PS, DISPLACEMENT CONTROL VML 1

* Minimum and maximum angle α, (see section servo displacement control).

** Shaft spline data: spline shaft with involute spline, according to SAE handbook, 1963, class 1, fillet root side fit.

View Z

Port "L1": Case drain port (use highest port as outlet)

Gauge port - servo cylinder pressure (both sides) 7/16-20 UNF-2B SAE straight thread O-ring boss

Charge pressure relief valve

Approximate centre of gravity

Shaft spline data:**

Pitch Ø = P
Pressure angle = 30°
Number of teeth = R
Pitch = S

Null position

Maximum displacement

Control handle

R 50.8

Serrated shaft

Port "S"

Port "B"

Coupling may not protrude beyond 48 mm maximum length of full spline

Minimum and maximum angle α, (see section servo displacement control).

Shaft spline data: spline shaft with involute spline, according to SAE handbook, 1963, class 1, fillet root side fit.
Max. torque for charge pump inlet port (7/8 -14 UNF - 2B) is 22 - 28 Nm [195 - 248 lbf-in].

<table>
<thead>
<tr>
<th>Frame size</th>
<th>Port A and B</th>
<th>Port L₁ and L₂</th>
<th>Port S</th>
<th>Port M</th>
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</thead>
</table>
Dimensions – Frame Size 070 and 089 cm³

OUTLINE DRAWING, CONFIGURATION PS, DISPLACEMENT CONTROL VML 1 (continued)

View X (for SPV 2/070 only)

Control handle shaft spline data: 64/128 pitch, 64 diametral pitch acc. to SAE handbook 1963
Number of teeth = 24

Outside diameter = 10.13 - 0.14
Number of teeth = 24

View X (for SPV 2/089 only)

Control handle shaft spline data: 64/128 pitch, 64 diametral pitch acc. to SAE handbook 1963
Number of teeth = 24

Outside diameter = 10.13 - 0.14
Number of teeth = 24

Dimensions

<table>
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<td>112</td>
<td>120</td>
<td>84</td>
<td>48</td>
<td>16</td>
<td>84</td>
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<tr>
<td>089</td>
<td>328</td>
<td>307</td>
<td>312</td>
<td>271</td>
<td>195</td>
<td>140</td>
<td>118</td>
<td>129</td>
<td>91</td>
<td>49</td>
<td>17.5</td>
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<td>85.8</td>
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<td>128.6</td>
<td>133</td>
<td>113</td>
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<td>089</td>
<td>77.7</td>
<td>128.7</td>
<td>115</td>
<td>119</td>
<td>65</td>
<td>95.2</td>
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<td>139.6</td>
<td>144</td>
<td>123</td>
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<th>FF [mm]</th>
<th>GG [mm]</th>
<th>HH [mm]</th>
<th>JJ [mm]</th>
<th>A [mm]</th>
<th>Charge pump [cm³]</th>
<th>Shaft spline</th>
<th>Bore diameter for shaft coupling</th>
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<tr>
<td>070</td>
<td>126</td>
<td>123</td>
<td>130</td>
<td>194</td>
<td>372</td>
<td>34.50 ± 0.17</td>
<td>33.338</td>
<td>16/32</td>
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<tr>
<td>089</td>
<td>140</td>
<td>134</td>
<td>148</td>
<td>194</td>
<td>358</td>
<td>37.68 ± 0.17</td>
<td>36.513</td>
<td>16/32</td>
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</tbody>
</table>

1 Short version available on request. Please contact your local Sauer-Danfoss representative.
Series 20 – Axial Piston Pumps

Technical Information

Dimensions – Frame Size 070 and 089 cm³

TAPERED SHAFT END

Depth, keygroove: 5,7 ± 0,1
Shaft, cone: 1 : 8

Coupling may not protrude beyond 81 mm maximum length of shaft

Designation:
1 = Variable Displacement pump
3 = Servo control valve
4 = Charge check valve
7 = Heat exchanger

Ports:
A, B = Main pressure ports
  (working loop)
L1, L2 = Drain ports
M = Gauge port - charge pressure

PUMP CONFIGURATION
AA 010, DISPLACEMENT CONTROL VML 1
Series 20 – Axial Piston Pumps  
Technical Information  
Dimensions – Frame Size 070 and 089 cm³
Series 20 – Axial Piston Pumps
Technical Information

Dimensions – Frame Size 334 cm³

* Minimum and maximum angle α, (see section servo displacement control).

** Shaft spline data: spline shaft with involute spline, according to SAE handbook, 1963, class 1, fillet root side fit.

View Z

Shaft spline data:
- Pitch Ø = 63.500
- Pressure angle = 30°
- Number of teeth = 27
- Pitch = 16/32
- Internal opening for grooving = 61.93 ± 0.062

Gauge port - servo cylinder pressure (both sides) 7/16-20 UNF-2B SAE straight thread

O-ring boss

Charge pressure relief valve

Gauge port - servo cylinder pressure (both sides) 7/16-20 UNF-2B SAE straight thread

O-ring boss

Charge pressure relief valve

Approximate centre of gravity

Coupling may not protrude beyond 48 mm maximum length of full spline

Null position

Maximum displacement

Control handle

View Z

Shaft spline data:
- Pitch Ø = 63.500
- Pressure angle = 30°
- Number of teeth = 27
- Pitch = 16/32
- Internal opening for grooving = 61.93 ± 0.062
### PUMP CONFIGURATION PS, DISPLACEMENT CONTROL VML 1 (continued)

#### View Y

- **Port A and B**: SAE flange, size 1 1/2 SAE split flange boss 6000 psi 4 threads SAE straight thread 5/8-11 UNC-2B 35 deep
- **Port L and L1**: 1 7/8-12 UNF-2B SAE straight thread O-ring boss
- **Port S**: SAE flange, size 1 1/4 SAE split flange boss 3000 psi 4 threads 7/16-14 UNC-2B 28 deep
- **Port M**: 7/16-20 UNF-2B SAE straight thread O-ring boss

#### View X

- **Control handle**: 1/4-20 UNC - 2A
- **Control handle shaft**: spline data 64/128 pitch, 64 diametral pitch acc. to SAE handbook 1963 Outside diameter = 10.13 mm
- **Number of teeth**: 24

---

**Frame size**: 334 cm³

#### Dimensions – Frame Size 334 cm³

- **SAE flange, size 1 1/2**: 6000 psi 4 threads 5/8-11 UNC-2B 35 deep
- **SAE flange, size 1 1/4**: 3000 psi 4 threads 7/16-14 UNC-2B 28 deep
- **SAE split flange boss**
- **SAE straight thread**
- **O-ring boss**
Series 20 – Axial Piston Pumps
Technical Information
Dimensions – Frame Size 334 cm³

**PUMP CONFIGURATION**
AA 010, DISPLACEMENT CONTROL VML 1

**Designation:**
1 = Variable Displacement pump
3 = Servo control valve
4 = Charge check valve
7 = Heat exchanger

**Ports:**
A, B = Main pressure ports (working loop)
S = Suction port – charge pump
L1, L2 = Drain ports
M = Gauge port - charge pressure

**Dimensions**

<table>
<thead>
<tr>
<th>Frame size</th>
<th>A mm [in]</th>
<th>B mm [in]</th>
<th>C mm [in]</th>
<th>Weight kg [lb]</th>
</tr>
</thead>
</table>
Sauer-Danfoss is a comprehensive supplier providing complete systems to the global mobile market.

Sauer-Danfoss serves markets such as agriculture, construction, road building, material handling, municipal, forestry, turf care, and many others.

We offer our customers optimum solutions for their needs and develop new products and systems in close cooperation and partnership with them.

Sauer-Danfoss specializes in integrating a full range of system components to provide vehicle designers with the most advanced total system design.

Sauer-Danfoss provides comprehensive worldwide service for its products through an extensive network of Authorized Service Centers strategically located in all parts of the world.

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