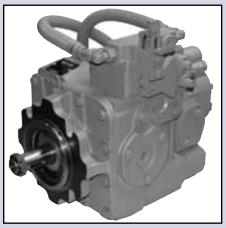
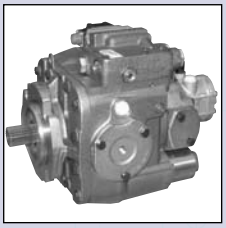
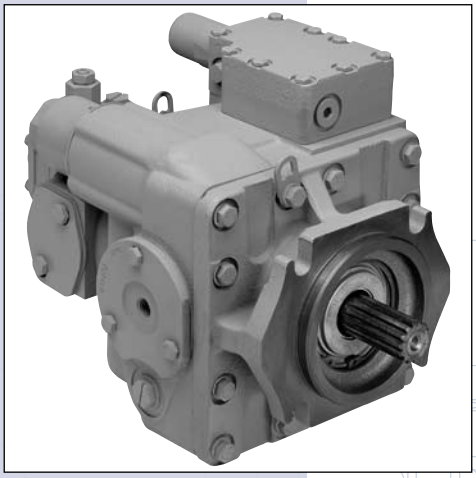
SAUER DANFOSS

Series 20
Axial Piston Pumps

Technical Information







Series 20 Axial Piston Pumps
Technical Information
General Description

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

© 2011 Sauer-Danfoss. All rights reserved.

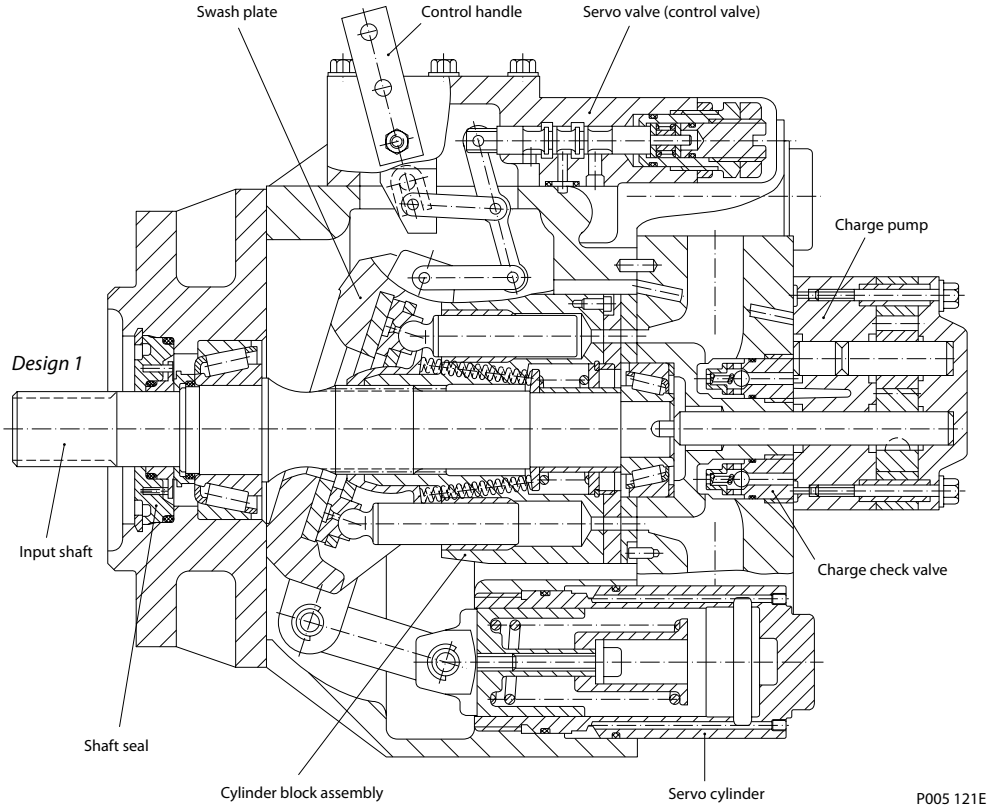
Sauer-Danfoss accepts no responsibility for possible errors in catalogs, brochures and other printed material. Sauer -Danfoss reserves the right to alter its products without prior notice. This also applies to products already ordered provided that such alterations can be made without affecting agreed specifications. All trademarks in this material are properties of their respective owners. Sauer-Danfoss, the Sauer-Danfoss logotype, the Sauer-Danfoss S-icon, PLUS+1™, What really matters is inside® and Know-How in Motion™ are trademarks of the Sauer-Danfoss Group.

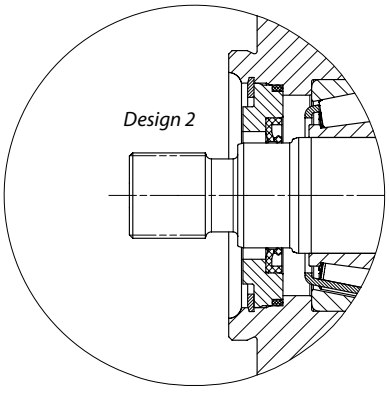
Front cover illustrations: F005 104, F000 248, F000 150, F000 249

Series 20 Axial Piston Pumps
Technical Information
Contents

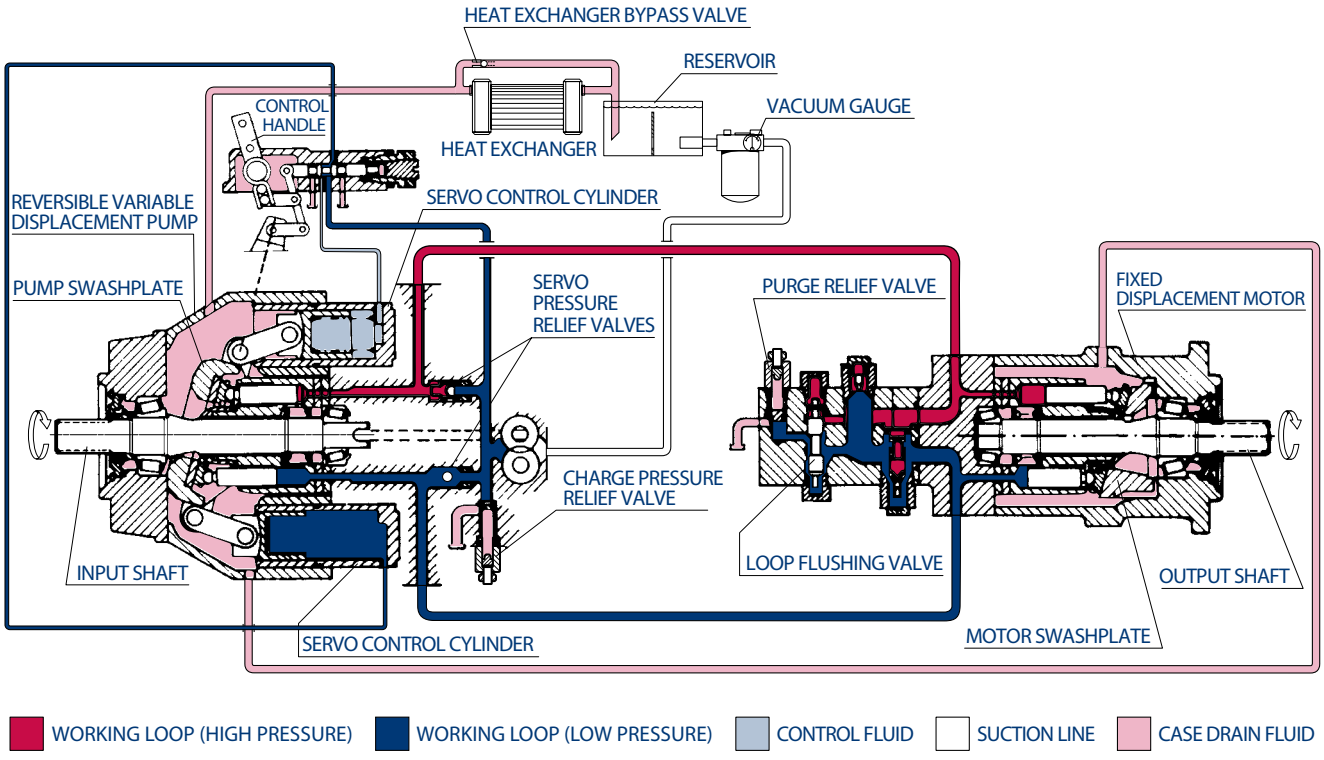
Axial Piston Variable Displacement Pump

Sectional View





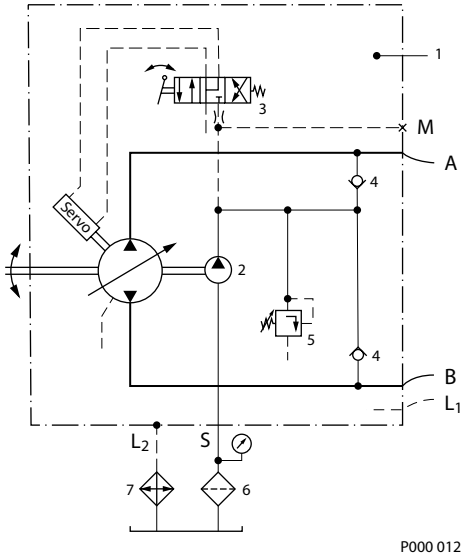
Pump and Motor Circuit Description



P000 027E

Above figure shows schematically the function of a hydrostatic transmission using an axial piston variable displacement pump and a fixed displacement motor.

Pump Circuit Schematic



P000 012

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.

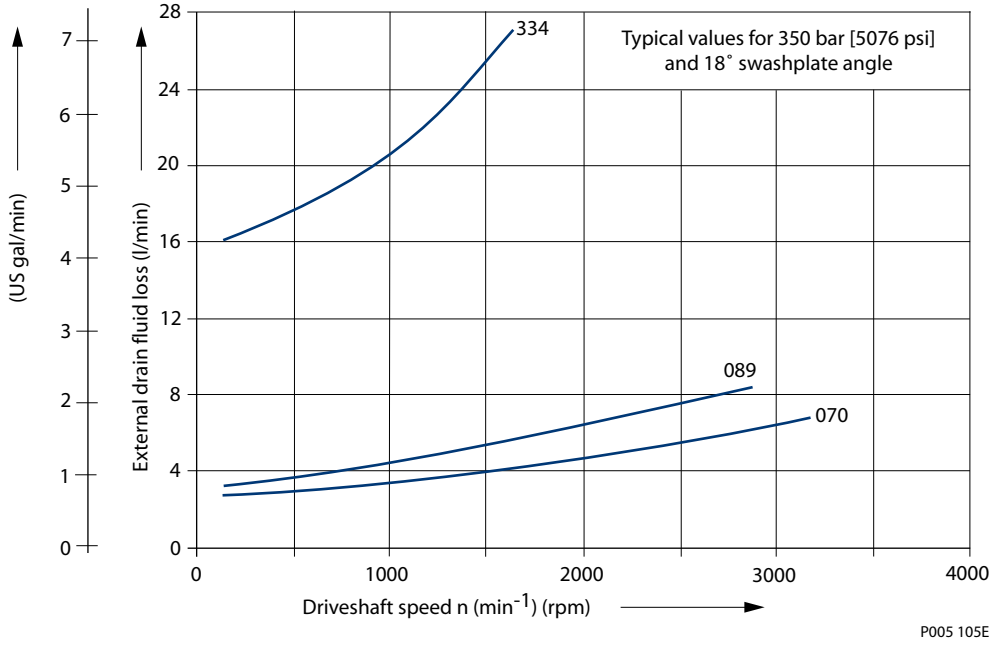
Type of mounting
SAE four bolt flanges.

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



Hydraulic Parameters

System pressure range, input p_1

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 p_2

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 fluids

Refer to Sauer-Danfoss publications *Hydraulic Fluids and Lubricants,* **520L0463** and *Experience with Biodegradable Hydraulic Fluids,* **520L0465**.

Temperature range

ϑ_{min} = - 40 °C [- 40 °F]
ϑ_{max} = 95 °C [203 °F]

Viscosity range

ν_{min} = 7 mm²/s [49 SUS*]
ν_{max} = 1000 mm²/s [4630 SUS*] (intermittent cold start)
Recommended viscosity range: 12 - 60 mm²/s [66 - 280 SUS*]

*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,* **520L0463** and *Design Guideline for Hydraulic Fluid Cleanliness,* **520L0467**.

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.

Hydraulic Parameters (continued)

Technical Data

Parameter		Units	Frame size 070	089	334
Max. displacement		cm^3 [in^3]	69.8 [4.26]	89.0 [5.43]	333.7 [20.36]
Charge pump displacement	options	cm^3 [in^3]	18.03 [1.10]		65.50 [4.00]
			12.30 [0.75]		–
Minimum speed		min^{-1} (rpm)	500		
Rated speed 1		min^{-1} (rpm)	3200	2900	1900
Maximum swash plate angle		degree	±18		
Mass moment of inertia of rotating group (without charge pump)		kg $m^2 \cdot 10^{-3}$ [lbf $ft^2 \cdot 10^{-3}$]	12.34 [292.8]	17.77 [421.7]	161.40 [3830.0]
Weight		kg [lb]	63 [139]	78 [172]	270 [595]

[1] for higher speeds contact your Sauer–Danfoss representative.

Determination of Nominal Pump Sizes

Use these formulae to determine the nominal pump size for a specific application:

Based on SI units

Output flow: $Q = \frac{Vg \cdot n \cdot \eta_v}{1000}$ l/min

Input torque: $M = \frac{Vg \cdot \Delta p}{20 \cdot \pi \cdot \eta_m}$ N•m

Input power: $P = \frac{M \cdot n}{9550} = \frac{Q \cdot \Delta p}{600 \cdot \eta_t}$ kW

Based on US units

$Q = \frac{Vg \cdot n \cdot \eta_v}{231}$ [US gal/min]

$M = \frac{Vg \cdot \Delta p}{2 \cdot \pi \cdot \eta_m}$ [lbf•in]

$P = \frac{M \cdot n}{63.025} = \frac{Q \cdot \Delta p}{1714 \cdot \eta_t}$ [hp]

Variables: SI units [US units]

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

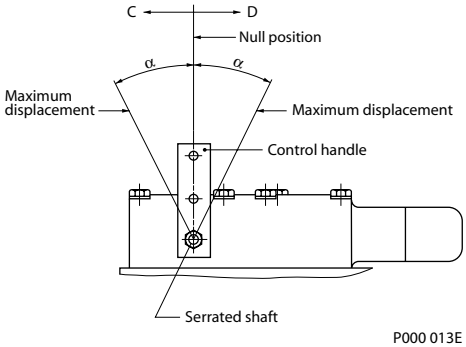
Servo Displacement Control (linear response)

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

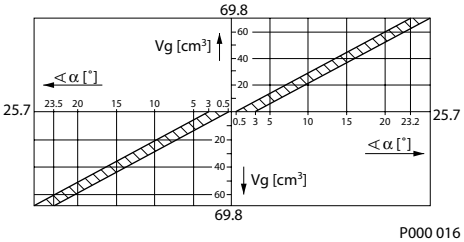
Flow direction changes with the direction of rotation and the control handle movement (see *besides*).

Pump rotation	Movement of control handle in direction	Pressure port OUT	Pressure port IN
CCW (Left)	C	B	A
	D	A	B
CW (Right)	C	A	B
	D	B	A



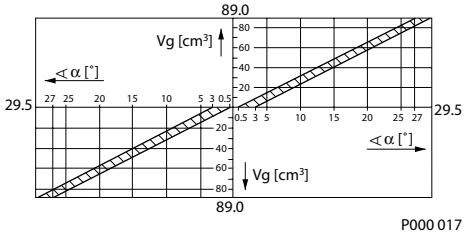
P000 013E

SPV2/070



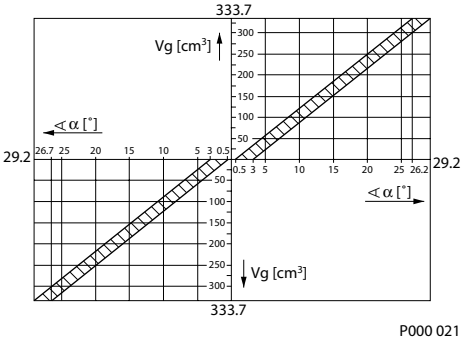
P000 016

SPV2/089



P000 017

SPV2/334



P000 021

Servo Displacement Control (linear response) (continued)

Reversing time

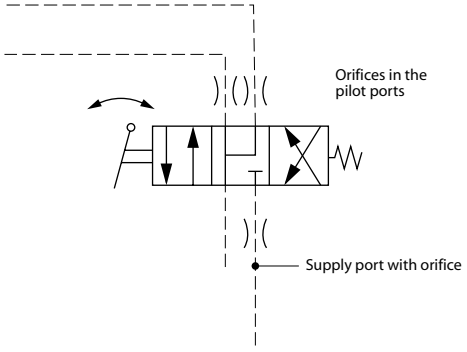
Time for the directional change of the flow from Q_{max} , across zero to Q_{max} , depending on the size of the control orifice fitted in the supply port to the servo valve (see *below*).

The values given assume movement of the control handle directly from one end position to the other.

Adjustment time of handle: < minimum reserving time
Operating pressure: Δp_2 = 210 bar [3046 psi]
Speed: n = 1450 min^{-1} (rpm)
System temperature: 50 °C [122 °F]
Viscosity: 35 mm^2/s [164 SUS]

Frame size	Minimum reversing time (s) without orifice	Maximum reversing time (s) with orifice Ø 0.66 in supply port
070	1.0	9.3
089	1.1	9.0
334	5.6	43.8

Schematic diagram of servo valve with alternative orifice positions



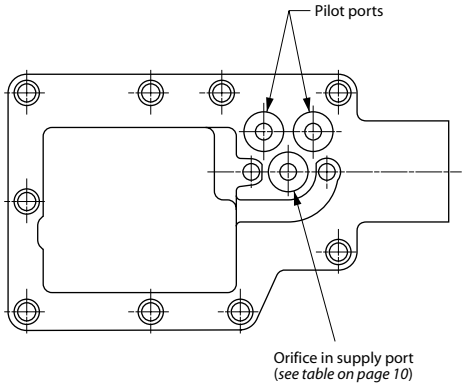
Servo Displacement Control (linear response) (continued)

Reset time

Time for reducing the flow from either flow direction from Q_{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: Δp_2 = 210 bar [3046 psi]
System temperature: 50 °C [122 ° F]
Viscosity: 35 mm²/s [164 SUS]

Servo valve counter bored recesses for orifice insert



Frame size	Minimum reset time (s)
070	3.0
089	
334	5.4

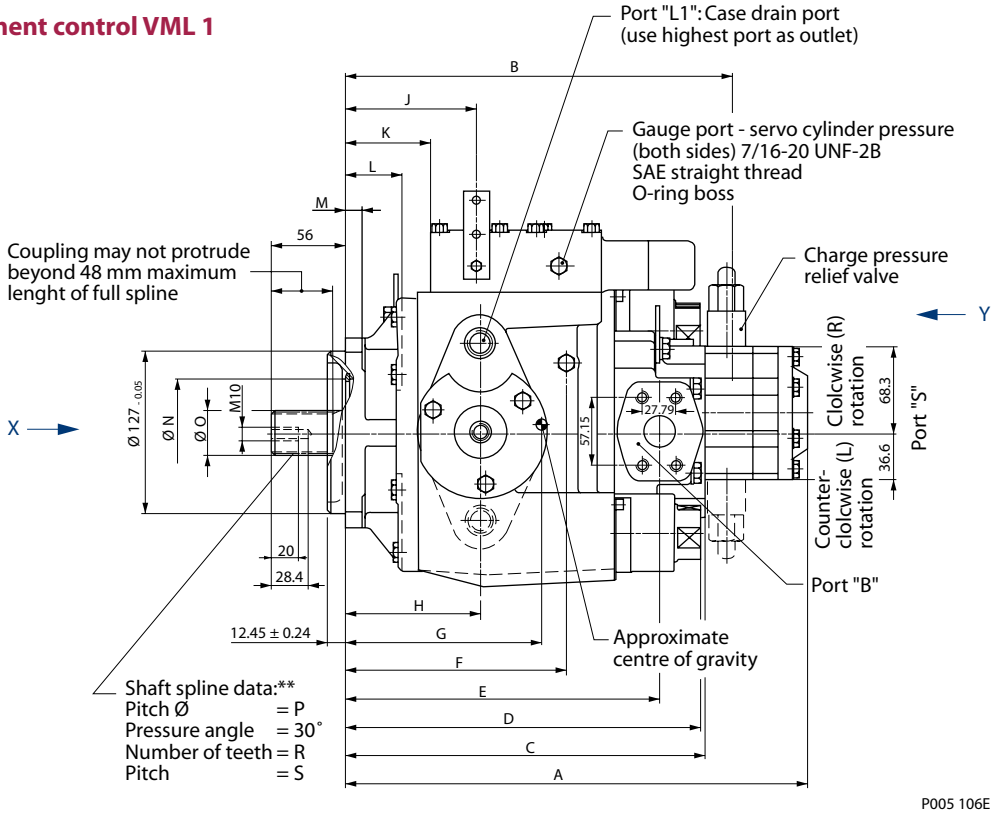
Changing reversing and reset time

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.

Dimensions – Frame Size 070 and 089 cm³

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.

Dimensions - mm [in]

Frame size	B	C	D	E	F	G	H	J	K	L	M	Ø N
070	315 [12.402]	294 [11.575]	305 [12.008]	259 [10.197]	188 [7.402]	146 [5.748]	112 [4.409]	120 [4.724]	84 [3.307]	48 [1.890]	16 [0.630]	84 [3.307]
089	328 [12.913]	307 [12.087]	312 12.283]	271 [10.669]	195 [7.677]	140 [5.512]	118 [4.646]	129 [5.079]	91 [3.583]	49 [1.929]	17.5 [0.689]	98 [3.858]

Frame size	A[1]		Shaft spline				Bore Ø for shaft coupling
	Charge pump						
	12 cm³	18 cm³	Ø O	Ø P	R	S	
070	372 [14.646]	381 [15.000]	34.50 -0.17 [1.358 -0.0067]	33.338 [1.313]	21 [0.827]	16/32	31.75 +0.062 [1.250 +0.0024]
089	358 [14.094]	394 [15.512]	37.68 -0.17 [1.483 -0.0067]	36.513 [1.438]	23 [0.906]	16/32	34.95 +0.062 [1.376 +0.0024]

[1] Short version available on request. Please contact your local Sauer-Danfoss representative.

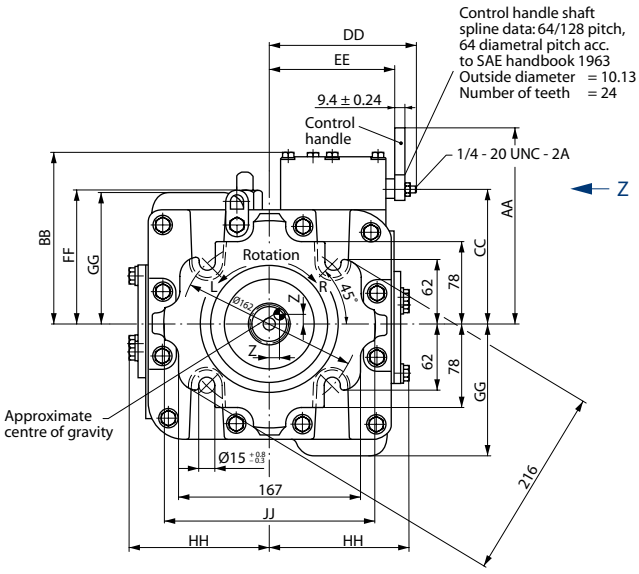
Dimensions - mm [in]

Frame size	T	U	V	W	X	Y	Z
070	71.4 [2.811]	112.7 [4.437]	105 [4.134]	108 [4.252]	60.5 [2.382]	85.8 [3.378]	9.5 [0.374]
089	77.7 [3.059]	128.7 [5.067]	115 [4.528]	119 [4.685]	65 [2.559]	95.2 [3.748]	12.7 [0.500]

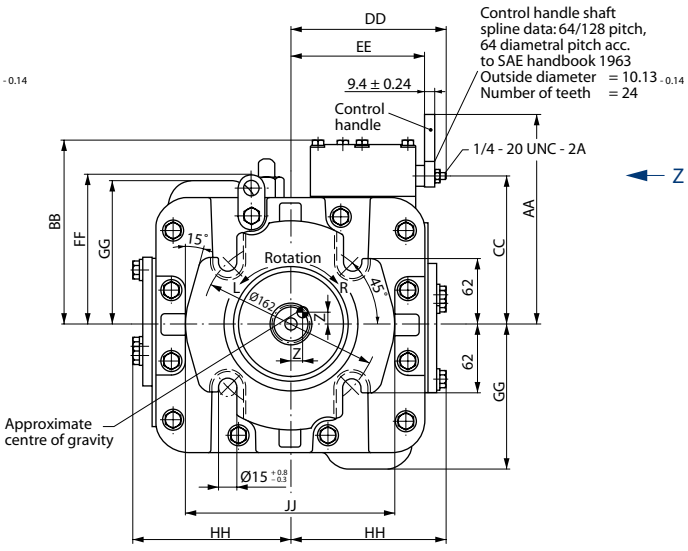
Dimensions – Frame Size 070 and 089 cm³

Configuration PS, displacement control VML 1 (continued)

View X (for SPV 2/070 only)



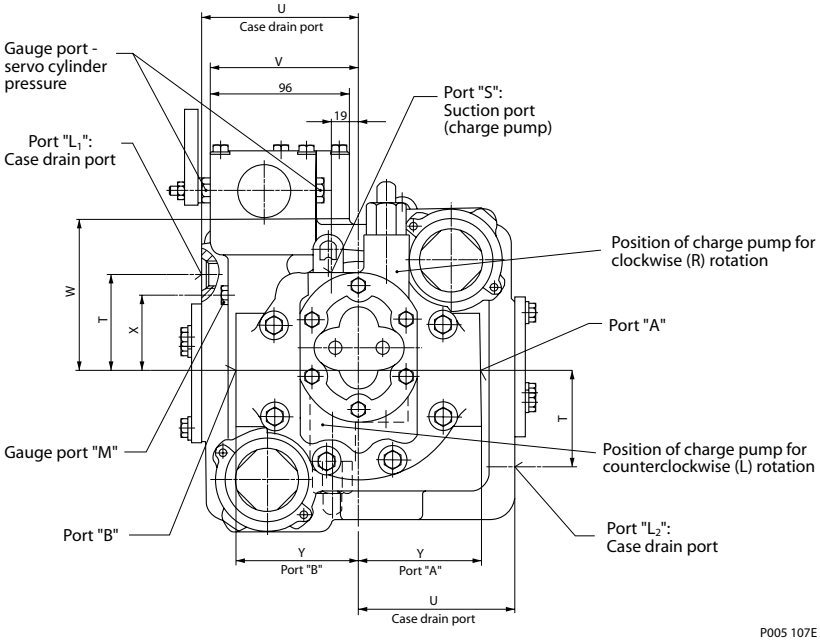
View X (for SPV 2/089 only)



P005 108E

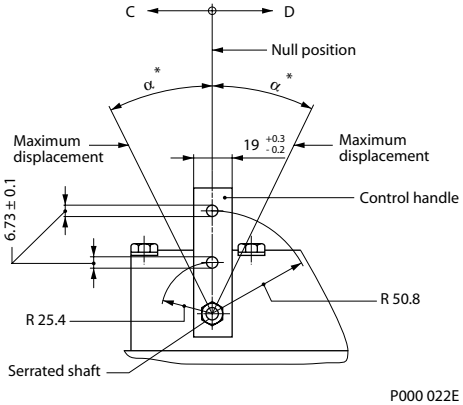
Frame size	AA	BB	CC	DD	EE	FF	GG	HH	JJ
070	187.6 [7.386]	162 [6.378]	128.6 [5.063]	133 [5.236]	113 [4.449]	126 [4.961]	123 [4.843]	130 [5.118]	194 [7.638]
089	198.6 [7.819]	173 [6.811]	139.6 [5.496]	144 [5.669]	123 [4.843]	140 [5.512]	134 [5.276]	148 [5.827]	194 [7.638]

View Y



P005 107E

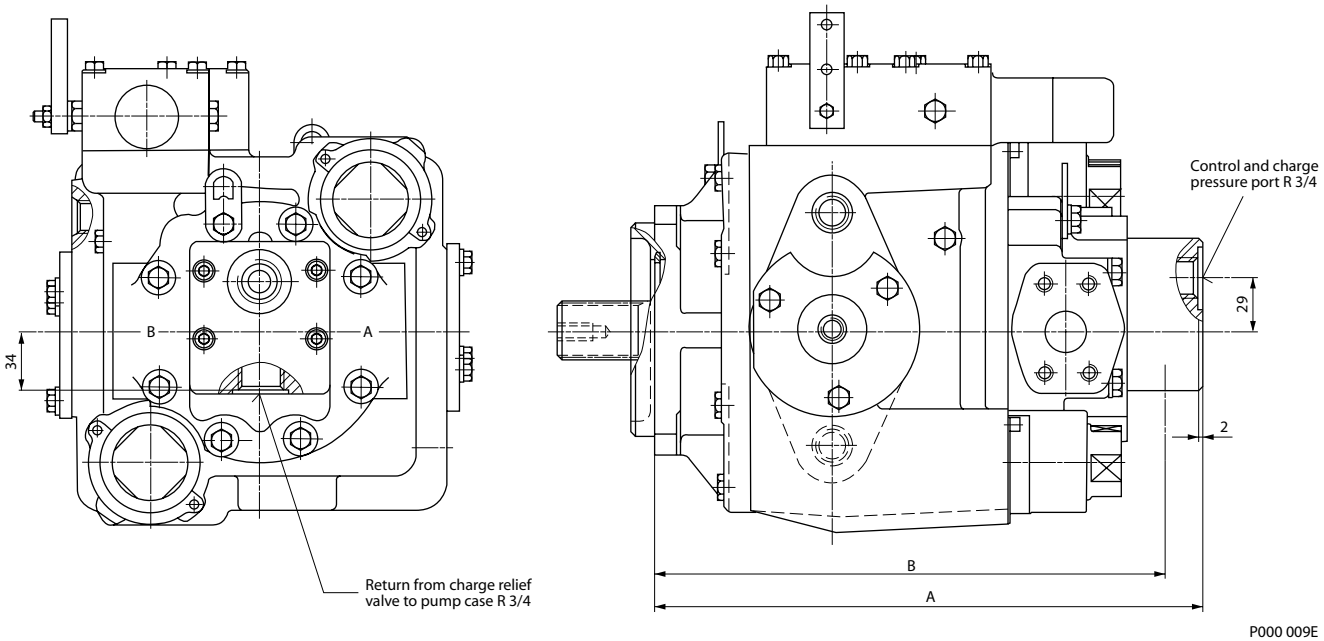
View Z



P000 022E

Dimensions – Frame Size 070 and 089 cm³

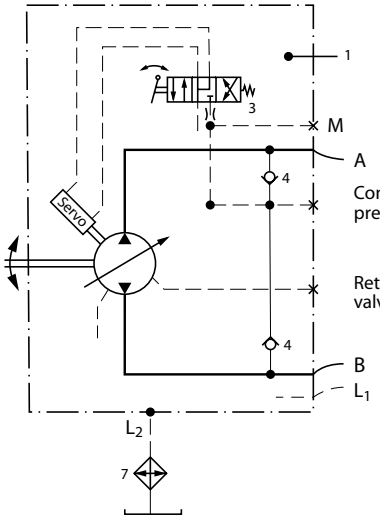
Configuration AA 010, displacement control VML 1



Dimensions - mm [in]

Frame Size	A	B	Weight kg [lb]
070	339 [13.346]	316 [12.441]	63.5 [140]
089	352 [13.858]	329 [12.953]	78.5 [173]

Circuit schematic

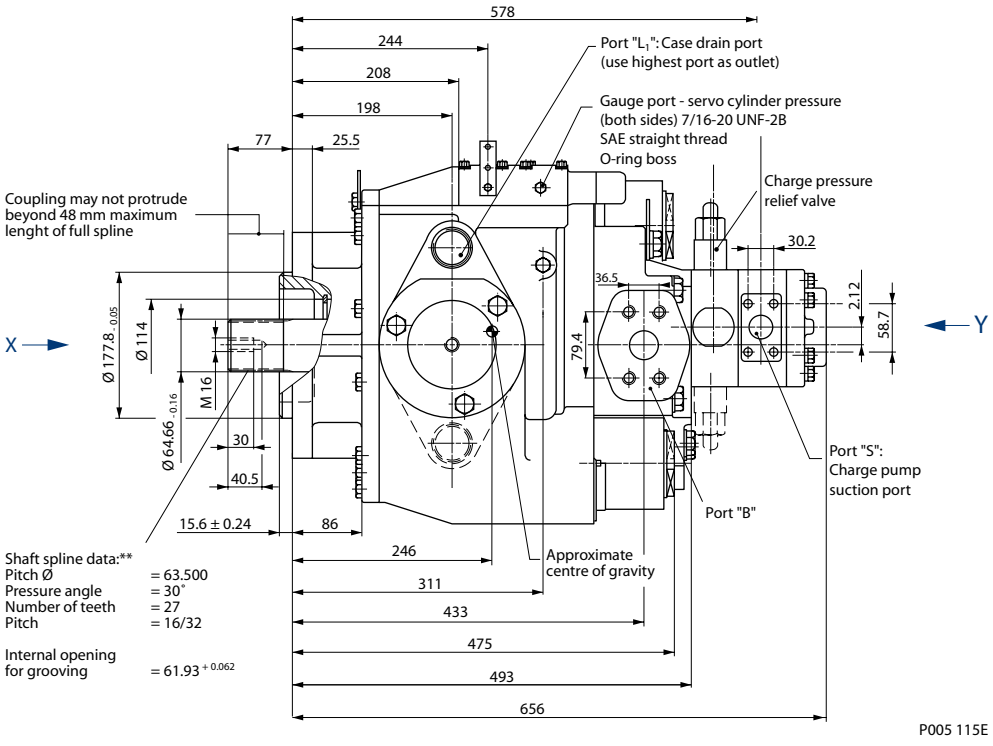


Designation:
1 = Variable Displacement pump
3 = Servo control valve
4 = Charge check valve
7 = Heat exchanger

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

Dimensions – Frame Size 334 cm³

Configuration PS, displacement control VML 1

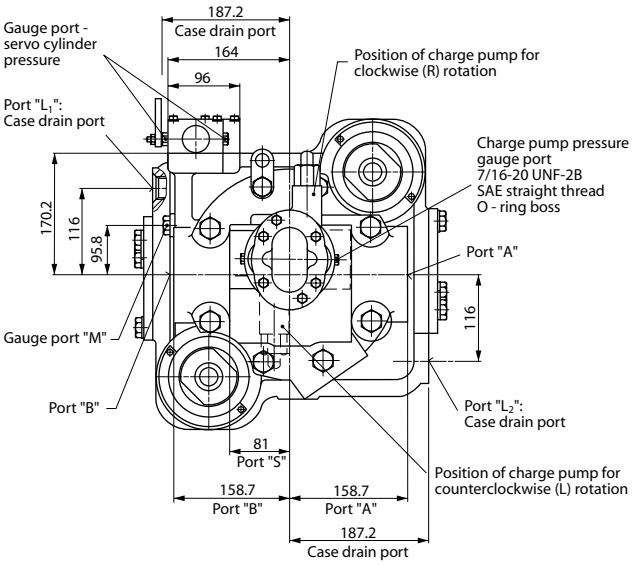


* Minimum and maximum angle α, (see section *servo displacement control*).
** Shaft spline data: spline shaft with involute spline, according to SAE handbook, 1963, class 1, fillet root side fit.

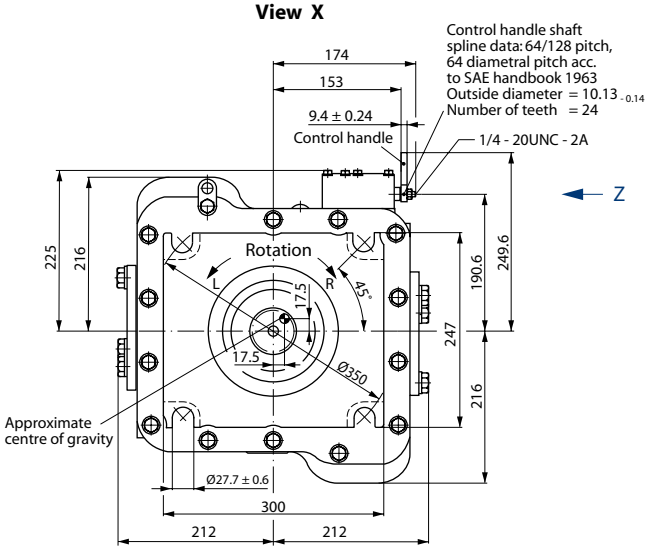
Dimensions – Frame Size 334 cm³

Configuration PS, displacement control VML 1 (continued)

View Y

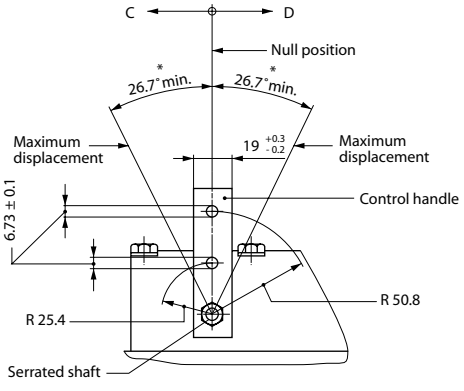


View X



P005 111E

View Z

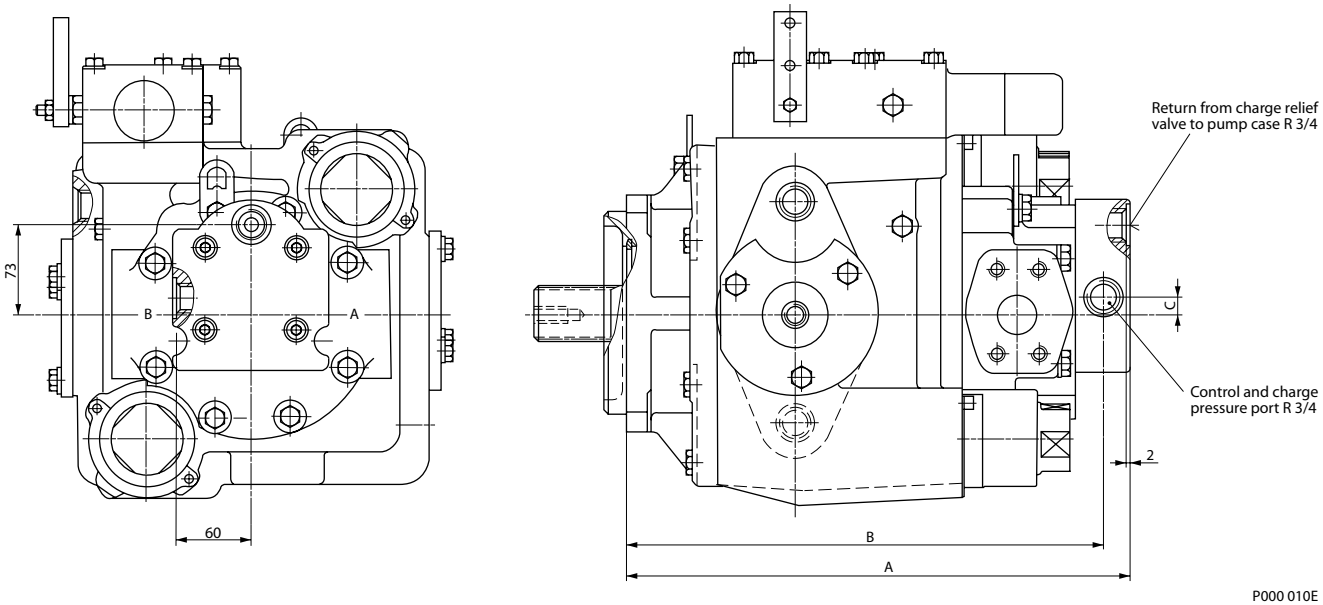


P000 026E

Port A and B: SAE flange, size 1 1/2 SAE split flange boss, 6000 psi, 4 threads, 5/8-11 UNC-2B, 35 deep
Port L1, L2: 1 7/8-12 UNF-2B, SAE straight thread, O-ring boss
Port S: SAE flange, 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

Dimensions – Frame Size 334 cm³

Configuration AA 010, displacement control VML 1

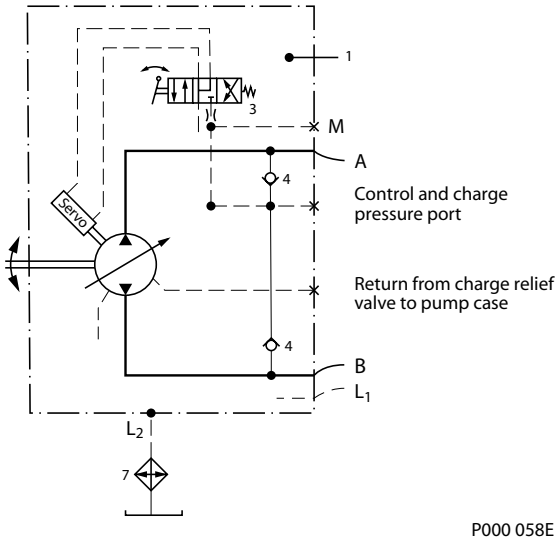


P000 010E

Dimensions - mm [in]

Frame size	A	B	C	Weight kg [lb]
334	546 [21.496]	520 [20.472]	21 [0.827]	264.5 [583]

Circuit schematic



P000 058E

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

SAUER DANFOSS

Products we offer:

- Bent Axis Motors
- Closed Circuit Axial Piston Pumps and Motors
- Displays
- Electrohydraulic Power Steering
- Electrohydraulics
- Hydraulic Power Steering
- Integrated Systems
- Joysticks and Control Handles
- Microcontrollers and Software
- Open Circuit Axial Piston Pumps
- Orbital Motors
- PLUS+1™ GUIDE
- Proportional Valves
- Sensors
- Steering
- Transit Mixer Drives

Members of the Sauer-Danfoss Group:

Comatrol
www.comatrol.com

Schwarzmüller-Inverter
www.schwarzmueller-inverter.com

Turolla
www.turollaocg.com

Hydro-Gear
www.hydro-gear.com

Sauer-Danfoss-Daikin
www.sauer-danfoss-daikin.com

L1003621 • Rev AB • Jan 2011

Sauer-Danfoss is a global manufacturer and supplier of high-quality hydraulic and electronic components. We specialize in providing state-of-the-art technology and solutions that excel in the harsh operating conditions of the mobile off-highway market. Building on our extensive applications expertise, we work closely with our customers to ensure exceptional performance for a broad range of off-highway vehicles.

We help OEMs around the world speed up system development, reduce costs and bring vehicles to market faster.
Sauer-Danfoss – Your Strongest Partner in Mobile Hydraulics.

Go to www.sauer-danfoss.com for further product information.

Wherever off-highway vehicles are at work, so is Sauer-Danfoss.

We offer expert worldwide support for our customers, ensuring the best possible solutions for outstanding performance. And with an extensive network of Global Service Partners, we also provide comprehensive global service for all of our components.

Please contact the Sauer-Danfoss representative nearest you.

Local address:

Sauer-Danfoss (US) Company
2800 East 13th Street
Ames, IA 50010, USA
Phone: +1 515 239 6000
Fax: +1 515 239 6618

Sauer-Danfoss ApS
DK-6430 Nordborg, Denmark
Phone: +45 7488 4444
Fax: +45 7488 4400

Sauer-Danfoss GmbH & Co. OHG
Postfach 2460, D-24531 Neumünster
Krokamp 35, D-24539 Neumünster, Germany
Phone: +49 4321 871 0
Fax: +49 4321 871 122

Sauer-Danfoss-Daikin LTD.
Shin-Osaka TERASAKI 3rd Bldg. 6F
1-5-28 Nishimiyahara, Yodogawa-ku
Osaka 532-0004, Japan
Phone: +81 6 6395 6066
Fax: +81 6 6395 8585

www.sauer-danfoss.com