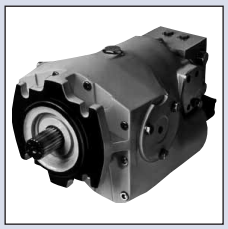
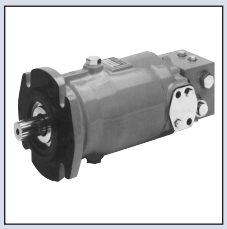
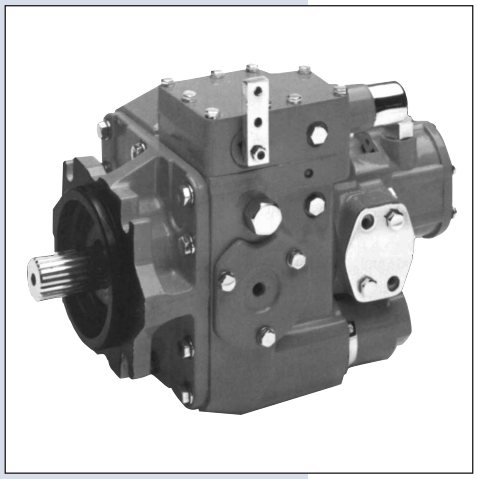
SAUER DANFOSS

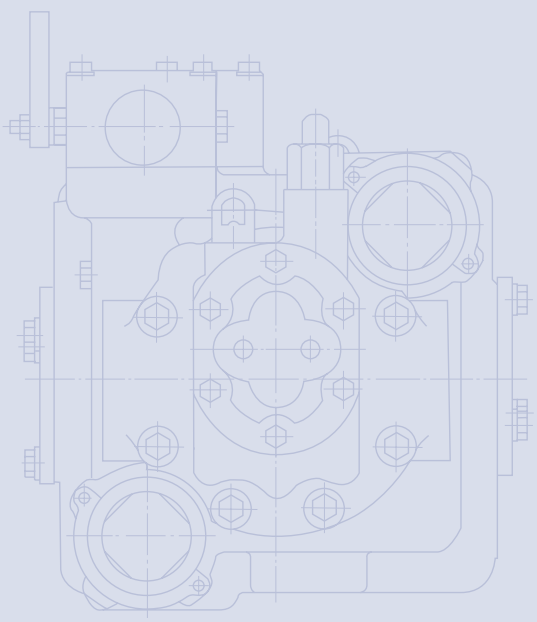
Series 20
Axial Piston Pumps

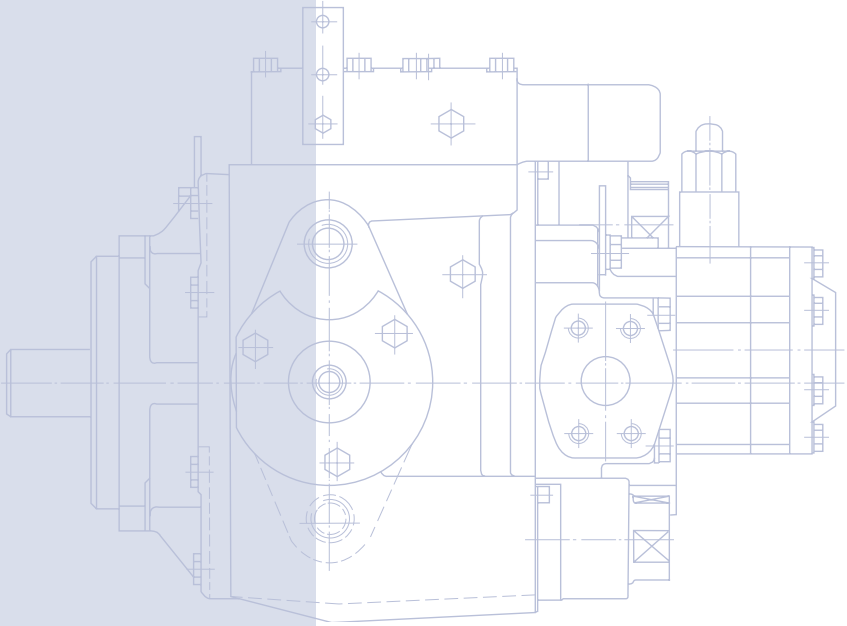
Technical Information











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

Front page: F000 234, F000 248, F000 150, F000 249

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Technical Information
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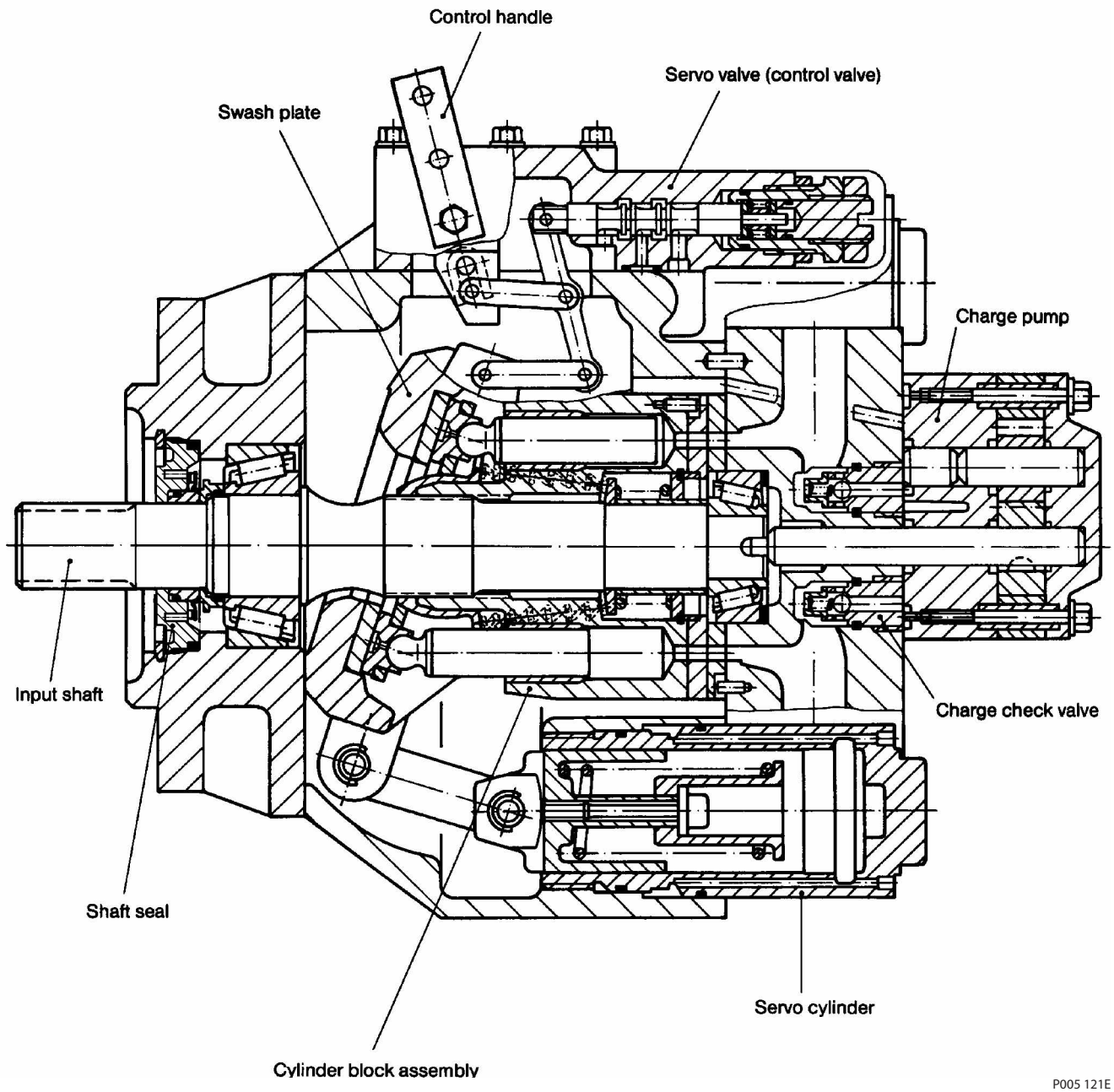
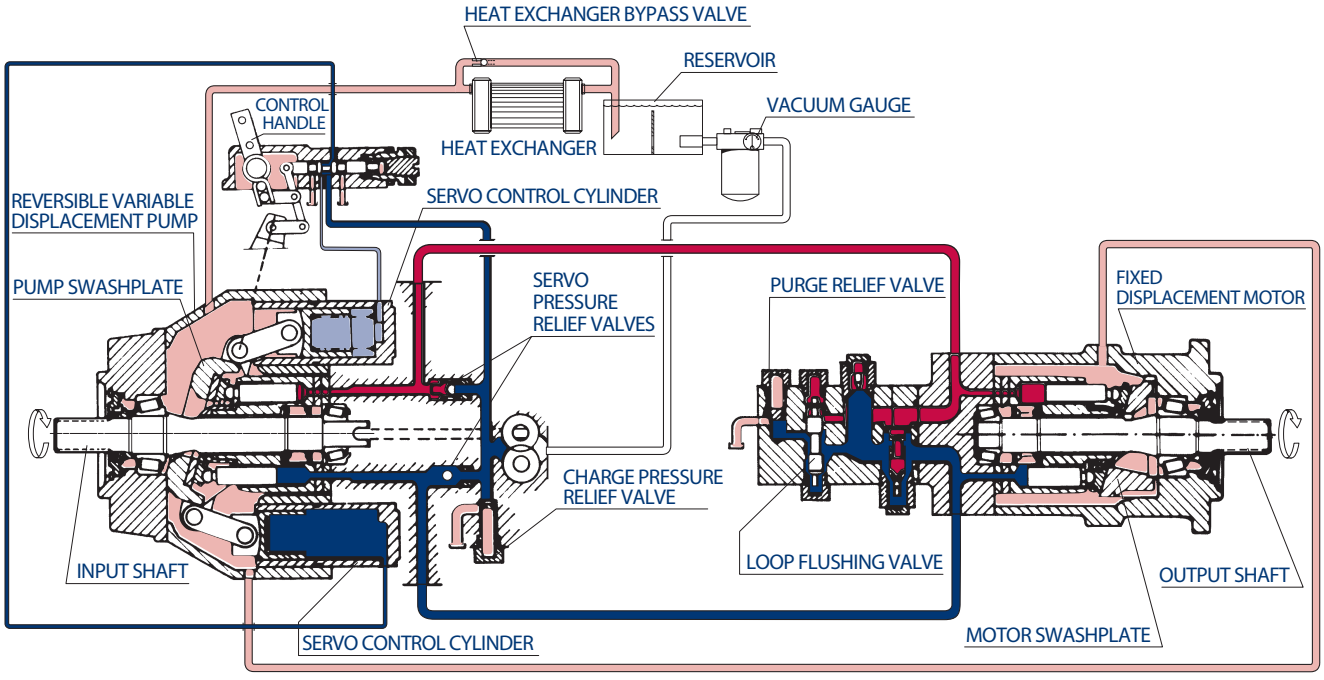
AXIAL PISTON VARIABLE DISPLACEMENT PUMP



P005 121E

PUMP AND MOTOR CIRCUIT DESCRIPTION



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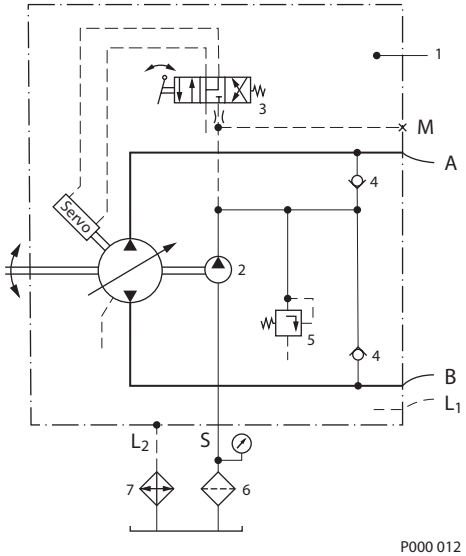
Above figure shows schematically the function of a hydrostatic transmission using an axial piston variable displacement pump and a fixed displacement motor.

PUMP CIRCUIT SCHEMATIC



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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.

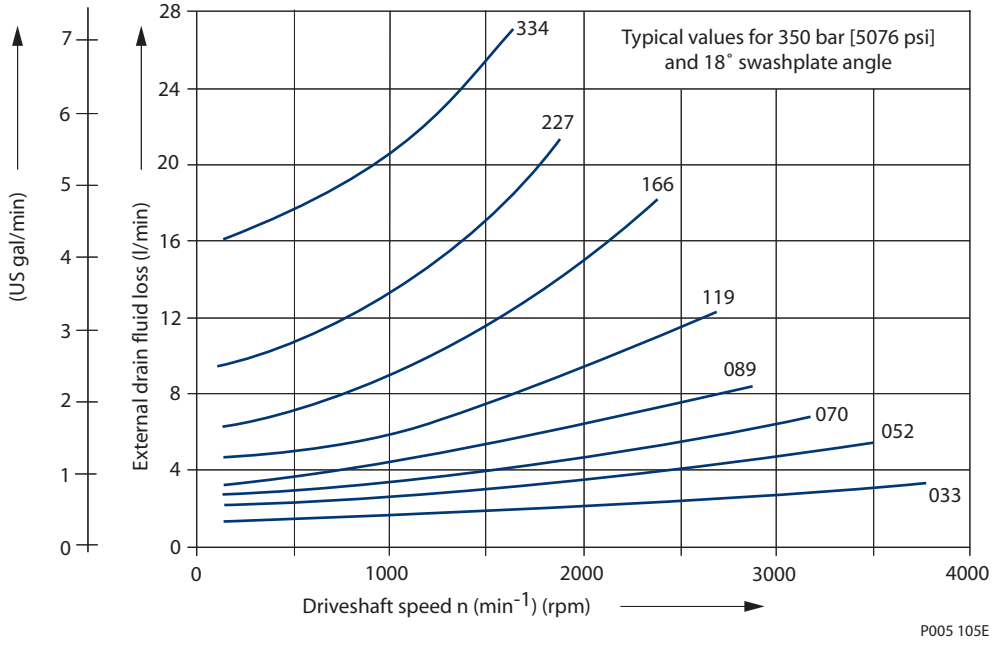
Type of mounting
SAE four bolt flanges.

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 fluid

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

Hydraulic fluid 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 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.*

HYDRAULIC PARAMETERS (continued)

Technical data									
		Dimension	Frame size						
			033	052	070	089	119	166	227	334
Max. displacement		cm^3 $[in^3]$	33.3 [2.03]	51.6 [3.15]	69.8 [4.26]	89.0 [5.43]	118.7 [7.24]	165.8 [10.12]	227.3 [13.87]	333.7 [20.36]
Charge pump displacement	options	cm^3 $[in^3]$	12.30 [0.75] 18.03 [1.10]		18.03 [1.10] 12.30 [0.75]		18.85 [1.15] 32.80 [2.00]	32.80 [2.00] 65.50 [4.00]		65.50 [4.00] –
Minimum speed		min^{-1} (rpm)	500							
Rated speed 1		min^{-1} (rpm)	3800	3500	3200	2900	2700	2400	2100	1900
Maximum swash plate angle		degree	±18							
Mass moment of inertia of rotating group		$kg\ m^2 \cdot 10^{-3}$	4.34	8.14	12.34	17.77	29.11	50.19	86.80	161.40
(without charge pump)		$[lbf\ ft^2 \cdot 10^{-3}]$	[103.0]	[193.2]	[292.8]	[421.7]	[690.8]	[1191.0]	[2059.8]	[3830.0]
Weight		kg [lb]	45 [99]	55 [121]	63 [139]	78 [172]	124 [273]	164 [362]	212 [467]	270 [595]

[1] for higher speeds contact your Sauer–Danfoss reprezentative

Determination of nominal pump size

Unit:	Metric system:		Inch system	
Pump output flow	$Q = \frac{V_g \cdot n \cdot \eta_v}{1000}$	l/min	$Q = \frac{V_g \cdot n \cdot \eta_v}{231}$	[gpm]
Input torque	$M = \frac{V_g \cdot \Delta p}{20 \cdot \pi \cdot \eta_m}$	Nm	$M = \frac{V_g \cdot \Delta p}{2 \cdot \pi \cdot \eta_m}$	[lbf•in]
Input power	$P = \frac{V_g \cdot n \cdot \Delta p}{600\,000 \cdot \eta_t}$	kW	$P = \frac{V_g \cdot n \cdot \Delta p}{396\,000 \cdot \eta_t}$	[hp]

Efficiency characteristic curves available on request.

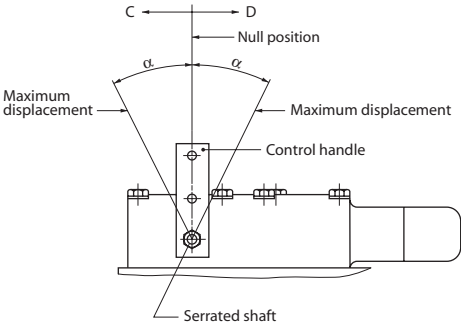
V_g	=	Pump displacement per revolution	cm^3	$[in^3]$
n	=	Pump speed	min^{-1}	(rpm)
Δp	=	Hydraulic pressure differential	bar	[psi]
η_v	=	Pump volumetric efficiency		
η_m	=	Pump mechanical efficiency		
η_t	=	Pump total efficiency		

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.

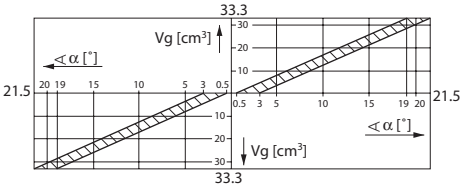
Pump flow direction

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

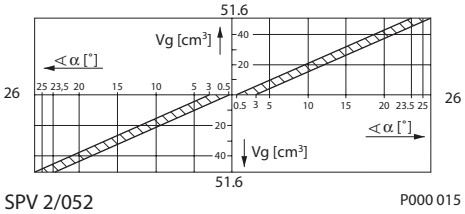


P000 013E

Pump rotation	Movement of control handle in direction	Pressure port OUT	Pressure port IN
Counter-clockwise (L)	C	B	A
	D	A	B
Clockwise (R)	C	A	B
	D	B	A



SPV 2/033 P000 014



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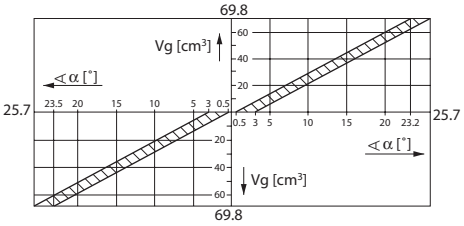

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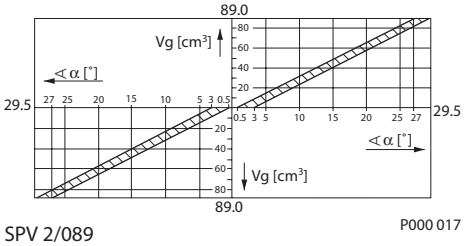
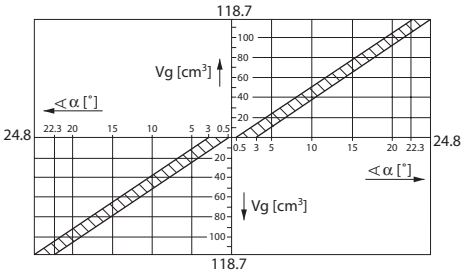


SPV 2/089 P000 017

SERVO DISPLACEMENT CONTROL (LINEAR RESPONSE) (continued)



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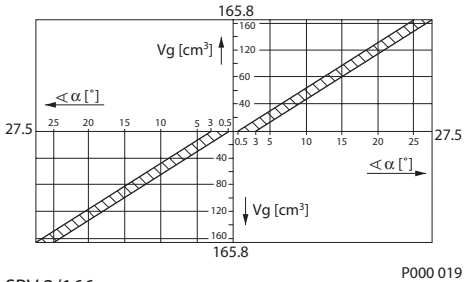

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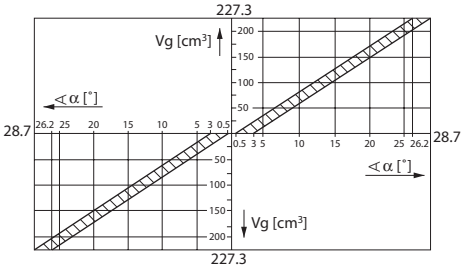

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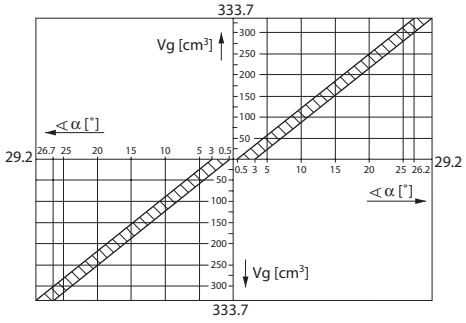


SPV 2/334 P000 021

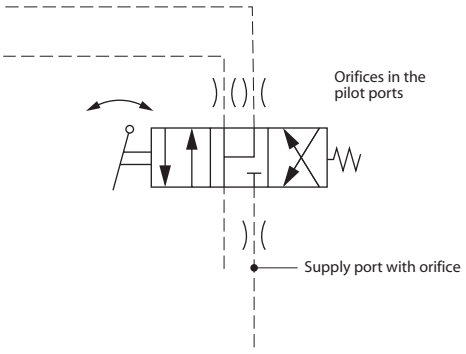
Reversing time

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 ∅ 0.66 in supply port
033	0.7	5.6
052	0.7	5.6
070	1.0	9.3
089	1.1	9.0
119	1.8	15.7
166	1.8	15.3
227	3.7	42.0
334	5.6	43.8

SERVO DISPLACEMENT CONTROL (LINEAR RESPONSE) (continued)

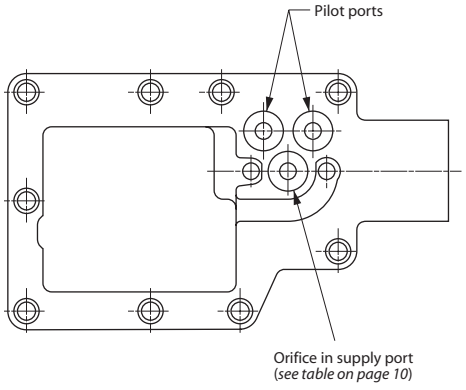


Schematic diagram of servo valve with alternative orifice positions

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]

Frame size	Minimum reset time (s)
033	
052	
070	3.0
089	
119	
166	4.2
227	
334	5.4



Servo valve counter bored recesses for orifice insert

Changing reversing and reset time

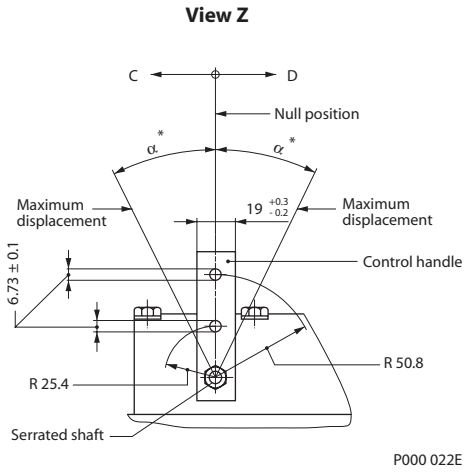
Inserting one orifice in each of the pilot ports can extend the reversing time. The reset time will also be extended.
Inserting an orifice in one of the pilot ports only can extend the reversing time in one flow direction. The reset time will be extended only for this flow direction.

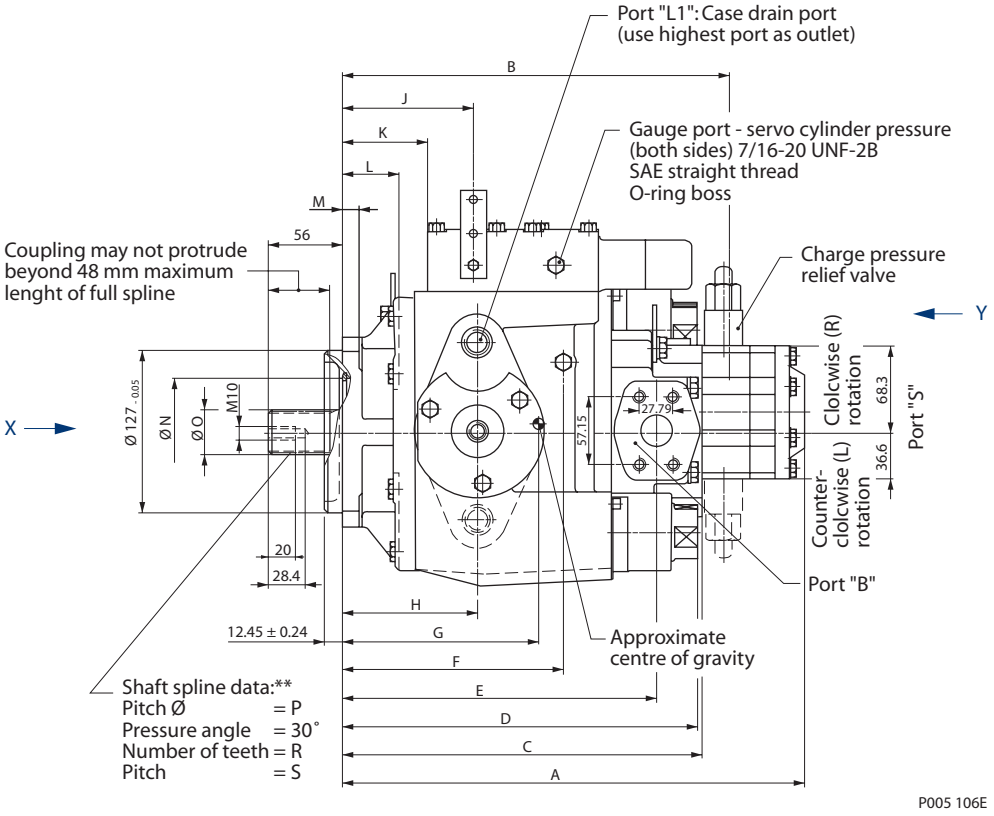
Dimensions – Frame Size 033, 052, 070 and 089 cm³

OUTLINE DRAWING, CONFIGURATION PS, DISPLACEMENT CONTROL VML 1

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

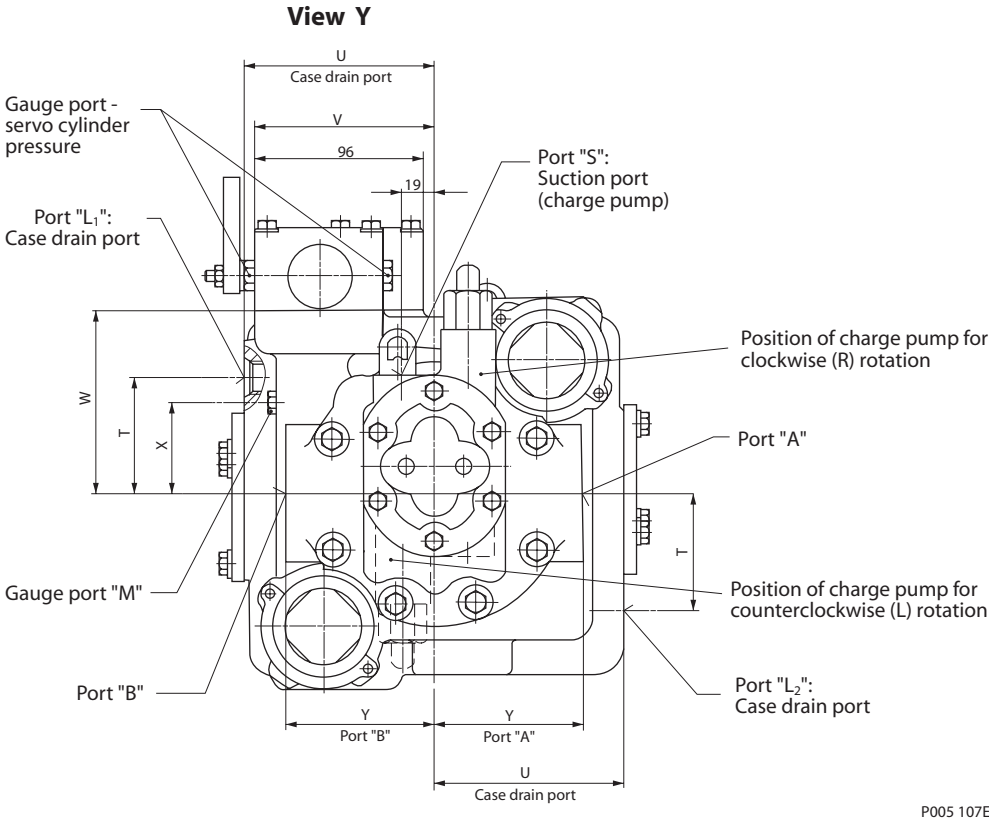
** Shaft spline data: spline shaft with involute spline, according to SAE handbook, 1963, class 1, fillet root side fit.





Dimensions – Frame Size 033, 052, 070 and 089 cm³

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



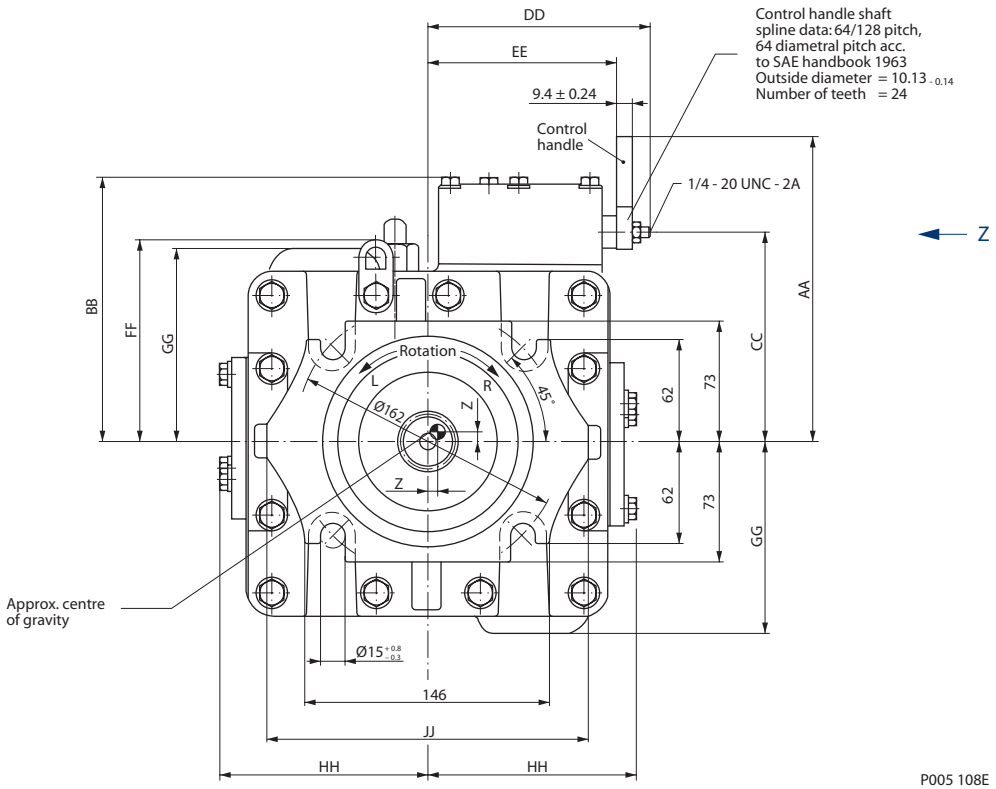
Max. torque for charge pump inlet port (7/8 -14 UNF - 2B) is 22 - 28 Nm [195 - 248 lbf•in].

Frame size	Port **A** and **B**	Port $\mathbf{L_1}$ and $\mathbf{L_2}$	Port **S**	Port **M**
033	SAE flange, size 1 SAE split flange boss 5000 psi 4 threads 3/8-16 UNC-2B 18 deep	7/8-14 UNF-2B SAE straight thread O-ring boss		7/16-20 UNF-2B SAE straight thread O-ring boss
052				
070				
089				

Dimensions – Frame Size 033, 052, 070 and 089 cm³

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

View X (for SPV 2/033 - 2/052 only)



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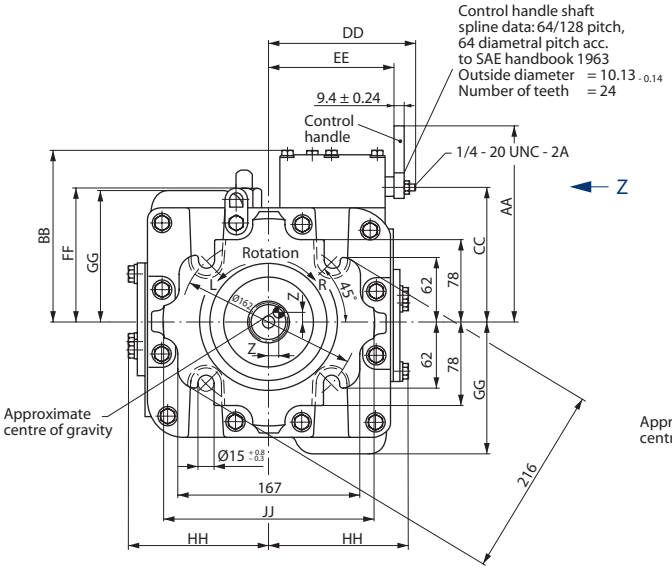
View X (for SPV 2/033 - 2/052 only)



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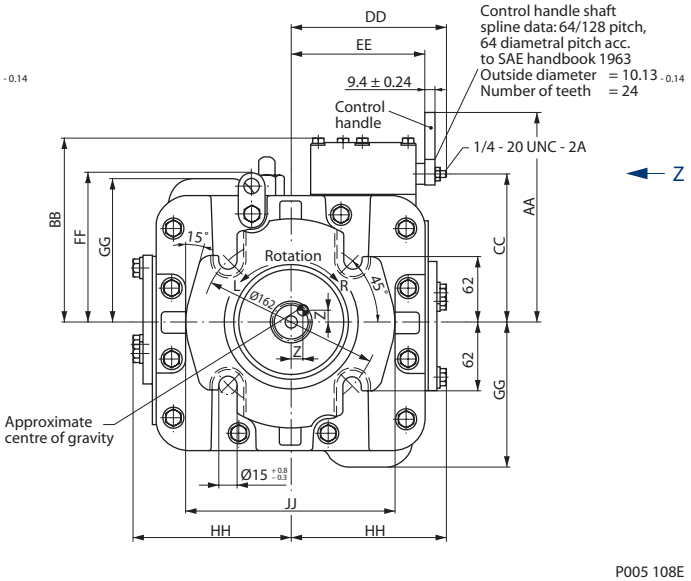

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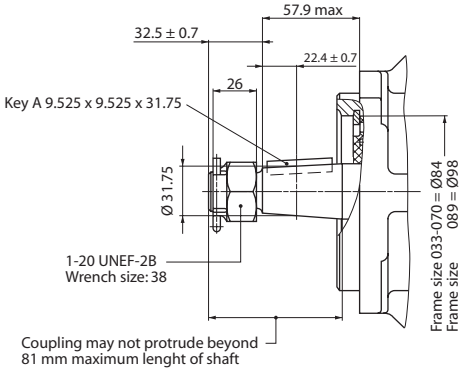
OUTLINE DRAWING, CONFIGURATION PS, DISPLACEMENT CONTROL VML 1 (Continued)

Dimensions												
Frame size	**B** mm [in]	**C** mm [in]	**D** mm [in]	**E** mm [in]	**F** mm [in]	**G** mm [in]	**H** mm [in]	**J** mm [in]	**K** mm [in]	**L** mm [in]	**M** mm [in]	**∅N** mm [in]
033	284 [11.181]	263 [10.354]	270 [10.630]	225 [8.858]	162 [6.378]	159 [6.260]	100 [3.937]	94 [3.701]	58 [2.283]	48 [1.890]	16 [0.630]	84 [3.307]
052	301 [11.850]	280 [11.024]	282 [11.102]	246 [9.685]	174 [6.850]	152 [5.984]	107 [4.213]	106 [4.173]	70 [2.756]	48 [1.890]	16 [0.630]	84 [3.307]
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	**T** mm [in]	**U** mm [in]	**V** mm [in]	**W** mm [in]	**X** mm [in]	**Y** mm [in]	**Z** mm [in]	**AA** mm [in]	**BB** mm [in]	**CC** mm [in]	**DD** mm [in]	**EE** mm [in]
033	62 [2.441]	95.7 [3.768]	92 [3.622]	95 [3.740]	51 [2.008]	81 [3.189]	3 [0.118]	174.9 [6.886]	150 [5.906]	115.9 [4.563]	120 [4.724]	100 [3.937]
052	68 [2.677]	108.7 [4.280]	102 [4.016]	108 [4.252]	53.2 [2.094]	85.8 [3.378]	6.35 [0.250]	187.6 [7.386]	162 [6.378]	128.6 [5.063]	131 [5.157]	110 [4.331]
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]	187.6 [7.386]	162 [6.378]	128.6 [5.063]	133 [5.236]	113 [4.449]
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]	198.6 [7.819]	173 [6.811]	139.6 [5.496]	144 [5.669]	123 [4.843]
Frame size	**FF** mm [in]	**GG** mm [in]	**HH** mm [in]	**JJ** mm [in]	**A**[1] mm [in] Charge pump cm³ [in³] 12 [0.732]	18 [1.098]	Shaft spline **∅O** mm [in]	**∅P** mm [in]	**R** mm [in]	**S**	Bore diameter for shaft coupling mm [in]	
033	117 [4.606]	113 [[4.449]	108 [4.252]	190 [7.480]	341 [13.425]	350 [13.780]	$34.50^{-0.17}_{-0.0067}$ [1.358]	33.338 [1.313]	21 [0.827]	16/32	$31.75^{+0.062}$ [$1.250^{+0.0024}$]	
052	122 [4.803]	116 [4.567]	124 [4.882]	191 [7.520]	358 [14.094]	367 [14.449]	$34.50^{-0.17}_{-0.0067}$ [1.358]	33.338 [1.313]	21 [0.827]	16/32	$31.75^{+0.062}$ [$1.250^{+0.0024}$]	
070	126 [4.961]	123 [4.843]	130 [5.118]	194 [7.638]	372 [14.646]	381 [15.000]	$34.50^{-0.17}_{-0.0067}$ [1.358]	33.338 [1.313]	21 [0.827]	16/32	$31.75^{+0.062}$ [$1.250^{+0.0024}$]	
089	140 [5.512]	134 [5.276]	148 [5.827]	194 [7.638]	358 [14.094]	394 [15.512]	$37.68^{-0.17}_{-0.0067}$ [1.483]	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 – Frame Size 033, 052, 070 and 089 cm³

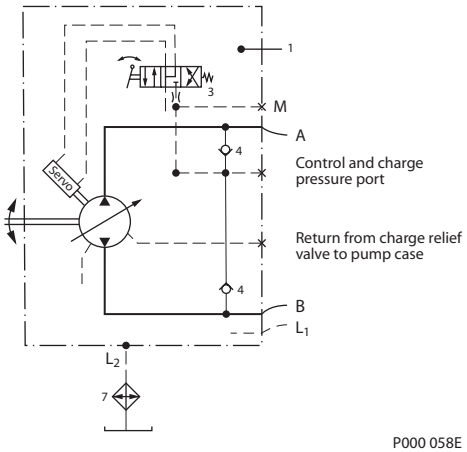
TAPERED SHAFT END



P000 006E

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

PUMP CONFIGURATION AA 010, DISPLACEMENT CONTROL VML 1



P000 058E

Designation:

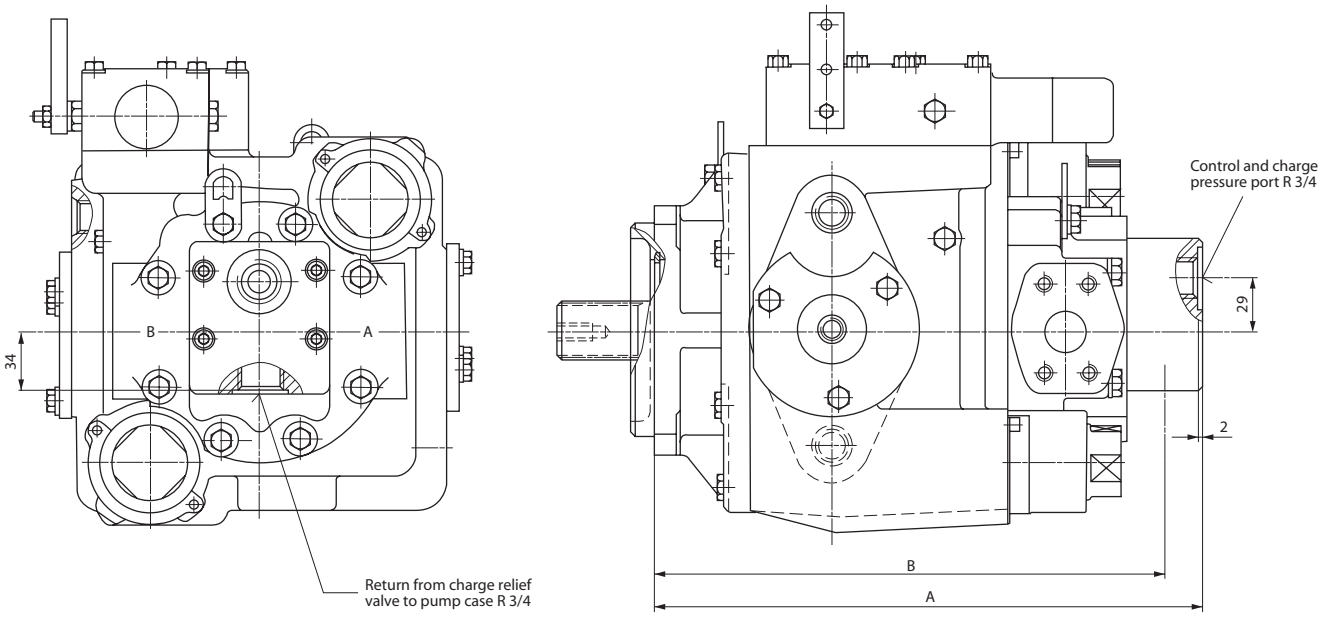
1	=	Variable Displacement pump
3	=	Servo control valve
4	=	Charge check valve
7	=	Heat exchanger

Ports:

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

Dimensions – Frame Size 033, 052, 070 and 089 cm³

PUMP CONFIGURATION AA 010, DISPLACEMENT CONTROL VML 1 (continued)



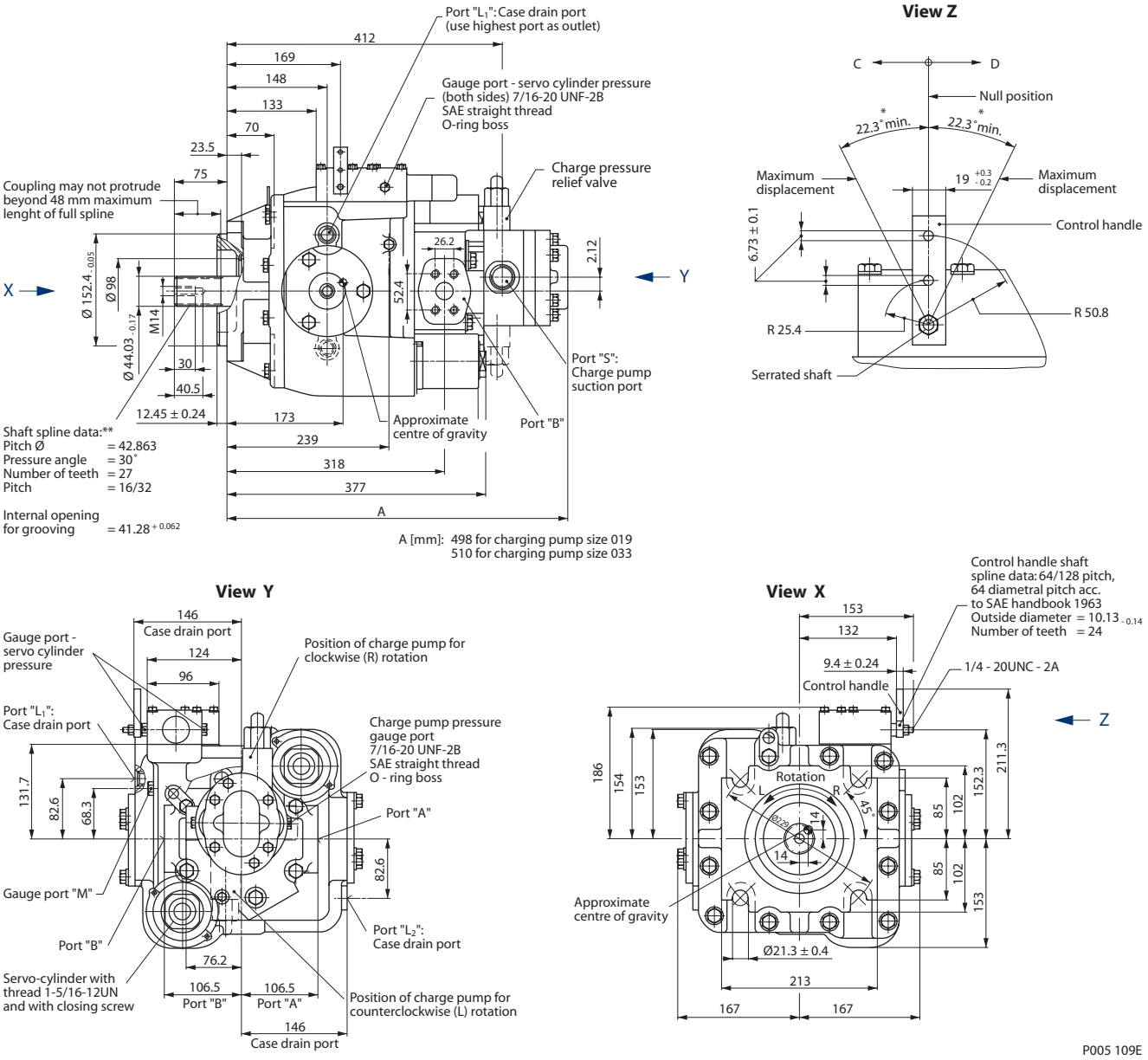
P000 009E

Dimensions			
Frame Size	A mm [in]	B mm [in]	Weight kg [lb]
033	308 [12.126]	285 [11.220]	46 [101]
052	324 [12.756]	301 [11.850]	56 [123]
070	339 [13.346]	316 [12.441]	63.5 [140]
089	352 [13.858]	329 [12.953]	78.5 [173]

Dimensions – Frame Size 119 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.



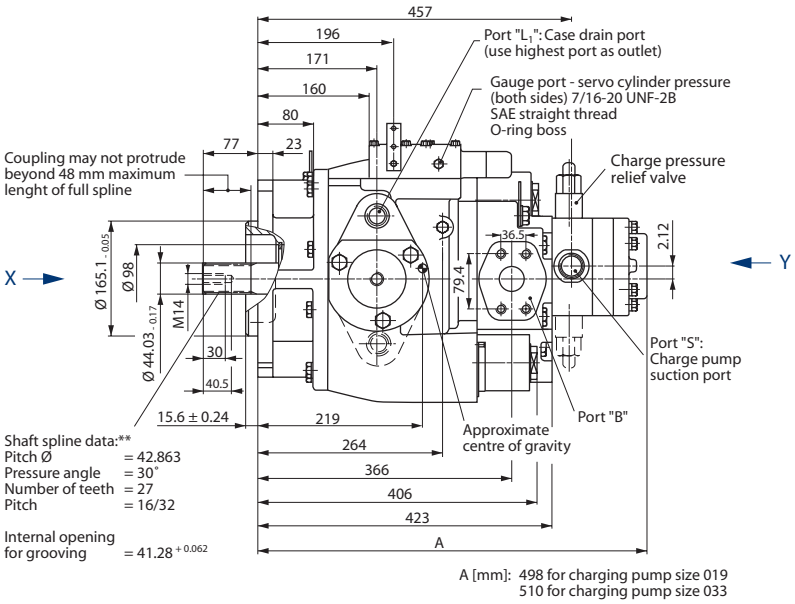
P005 109E

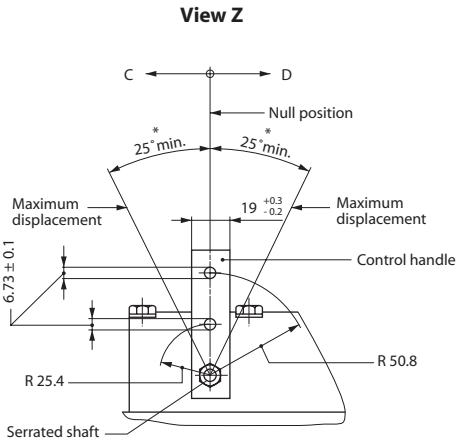
Frame size	Port **A** and **B**	Port L_1 and L_2	Port **S**	Port **M**
119	SAE flange, size 1 SAE split flange boss 5000 psi 4 threads 3/8-16 UNC-2B 18 deep	7/8-14 UNF-2B SAE straight thread O-ring boss	1 5/16-12 UNF-2B SAE straight thread O-ring boss	7/16-20 UNF-2B SAE straight thread O-ring boss

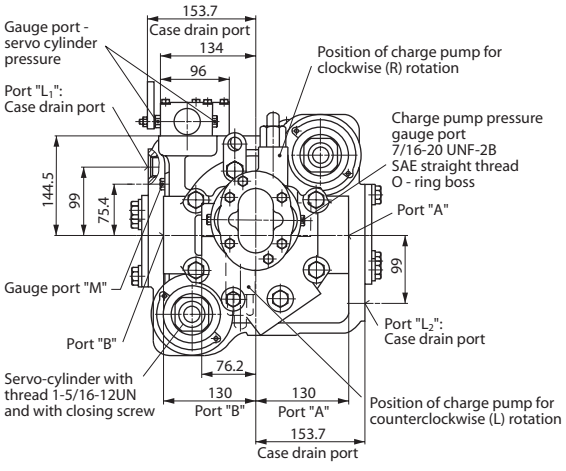
Dimensions – Frame Size 166 cm³

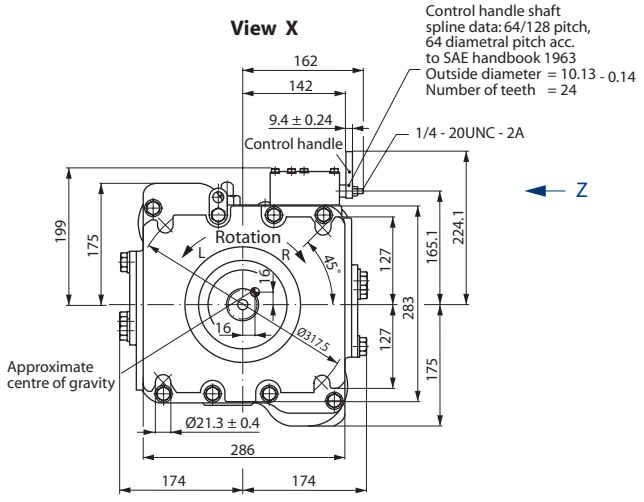
OUTLINE DRAWING, CONFIGURATION PS, DISPLACEMENT CONTROL VML 1

* 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.









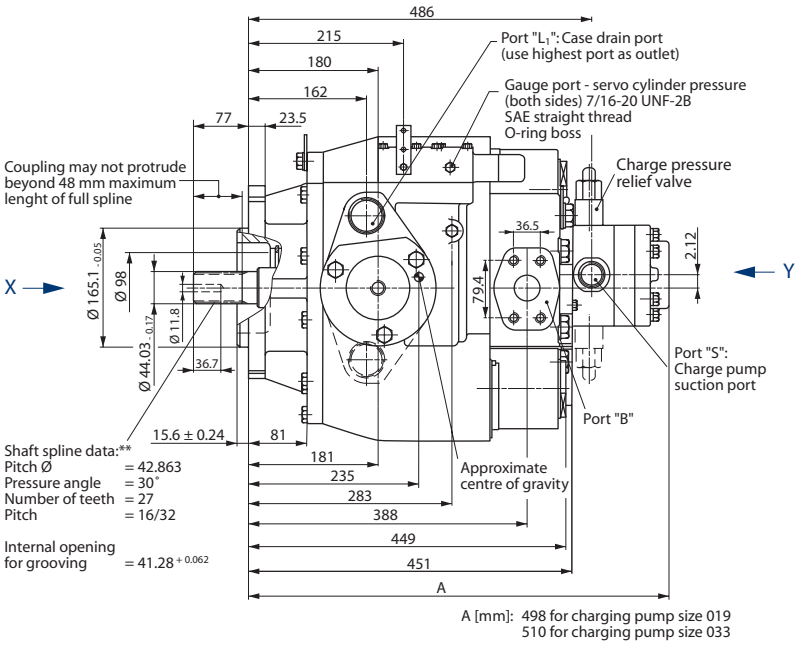
P005 110E

Frame size	Port **A** and **B**	Port L_1 and L_2	Port **S**	Port **M**
166	SAE flange, size 1 1/2 SAE split flange boss 6000 psi 4 threads 5/8-11 UNC-2B 35 deep	1 5/16-12 UNF-2B SAE straight thread O-ring boss	1 5/16-12 UNF-2B SAE straight thread O-ring boss	7/16-20 UNF-2B SAE straight thread O-ring boss

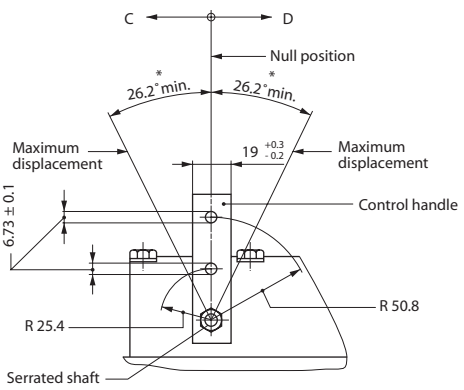
Dimensions – Frame Size 227 cm³

OUTLINE DRAWING, CONFIGURATION PS, DISPLACEMENT CONTROL VML 1

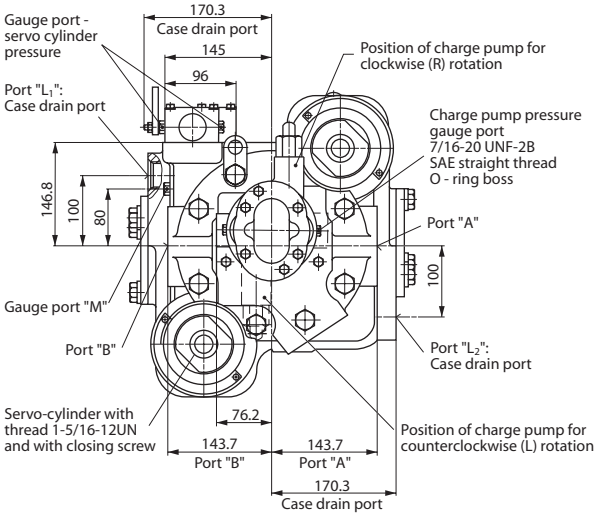
* Minimum and maximum angle α, (*see section servo displacement control*).
** Shaft spline data: spline shaft with involute spline, according to SAE handbook, 1963, class 1, fillet root side fit.



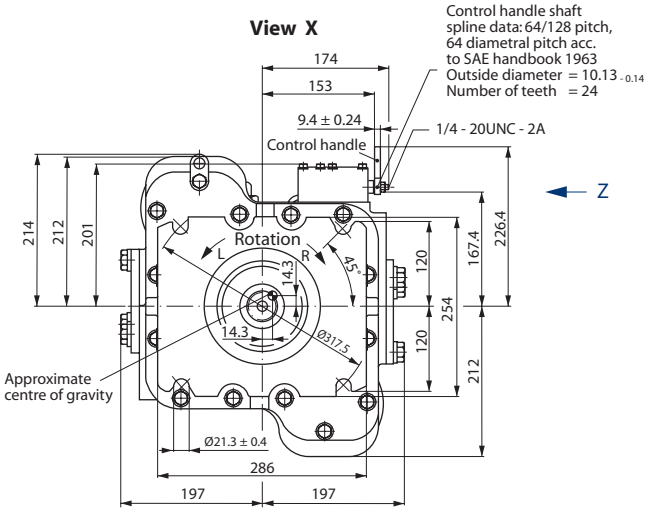
View Z



View Y



View X



P005 111E

Frame size	Port **A** and **B**	Port L_1 and L_2	Port **S**	Port **M**
227	SAE flange, size 1 1/2 SAE split flange boss 6000 psi 4 threads 5/8-14 UNC-2B 35 deep	1 7/8-12 UNF-2B SAE straight thread O-ring boss	1 5/16-12 UNF-2B SAE straight thread O-ring boss	7/16-20 UNF-2B SAE straight thread O-ring boss

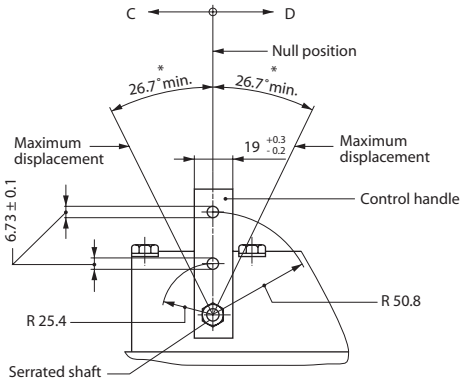
Dimensions – Frame Size 334 cm³

PUMP CONFIGURATION PS, DISPLACEMENT CONTROL VML 1

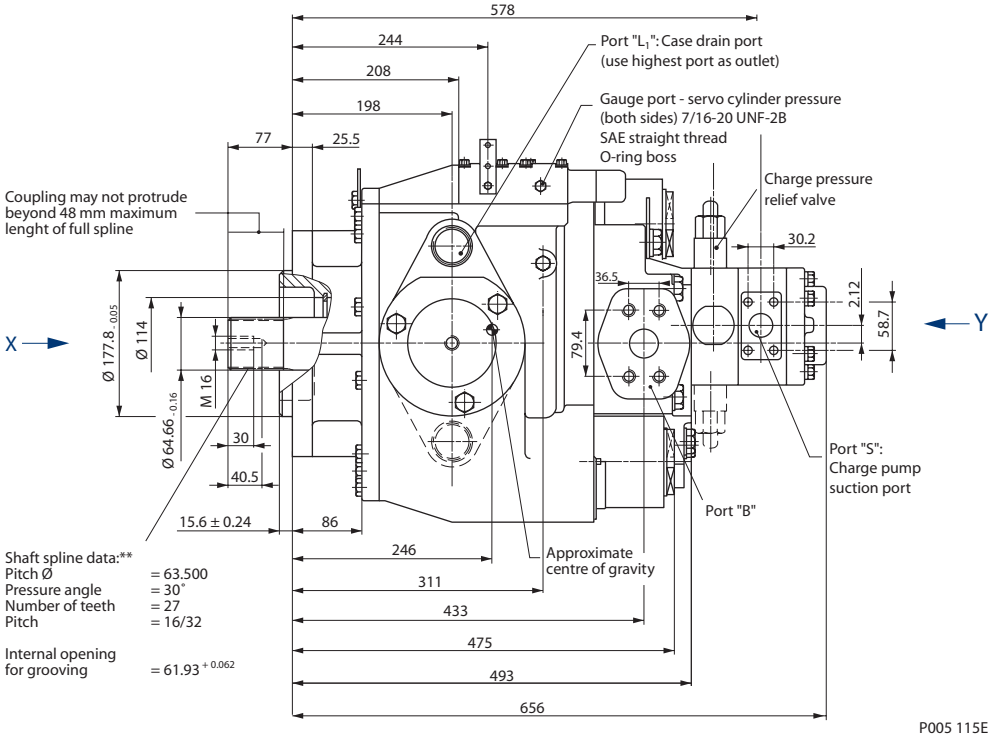
* Minimum and maximum angle α, (*see section servo displacement control*).

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

View Z



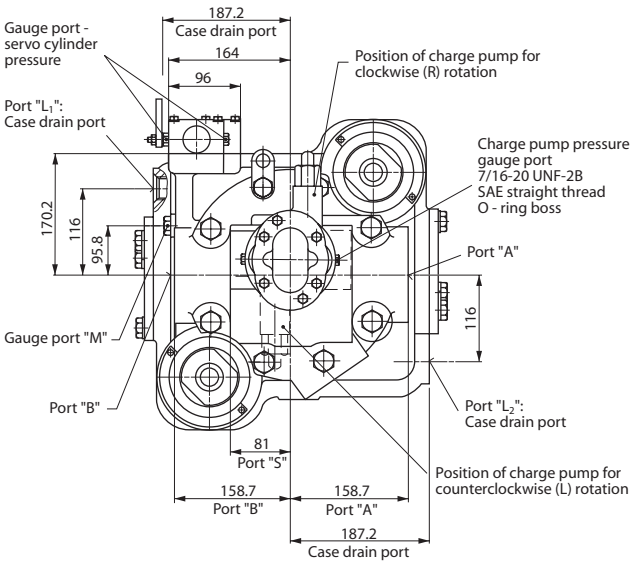
P000 026E



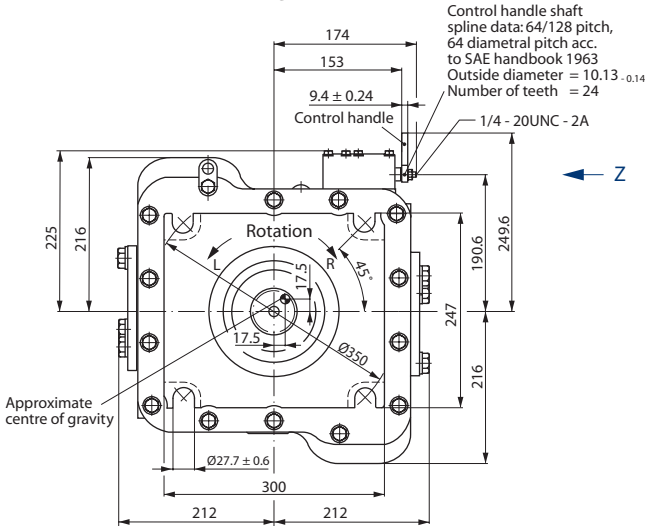
P005 115E

PUMP CONFIGURATION PS, DISPLACEMENT CONTROL VML 1 (continued)

View Y



View X

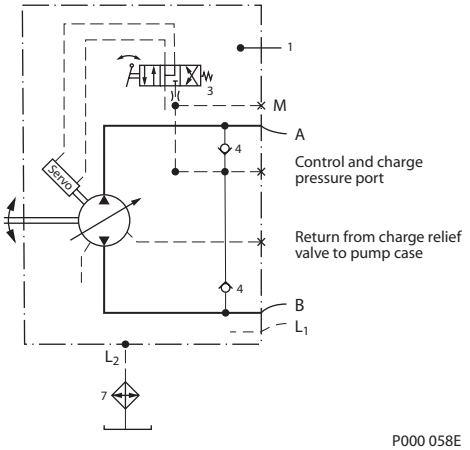


P005 111E

Frame size	Port **A** and **B**	Port L_1 and L_2	Port **S**	Port **M**
334	SAE flange, size 1 1/2 SAE split flange boss 6000 psi 4 threads 5/8-11 UNC-2B 35 deep	1 7/8-12 UNF-2B SAE straight thread O-ring boss	SAE flange, size 1 1/4 SAE split flange boss 3000 psi 4 threads 7/16-14 UNC-2B 28 deep	7/16-20 UNF-2B SAE straight thread O-ring boss

Dimensions – Frame Size 119, 166, 227, 334 cm³

PUMP CONFIGURATION AA 010, DISPLACEMENT CONTROL VML 1



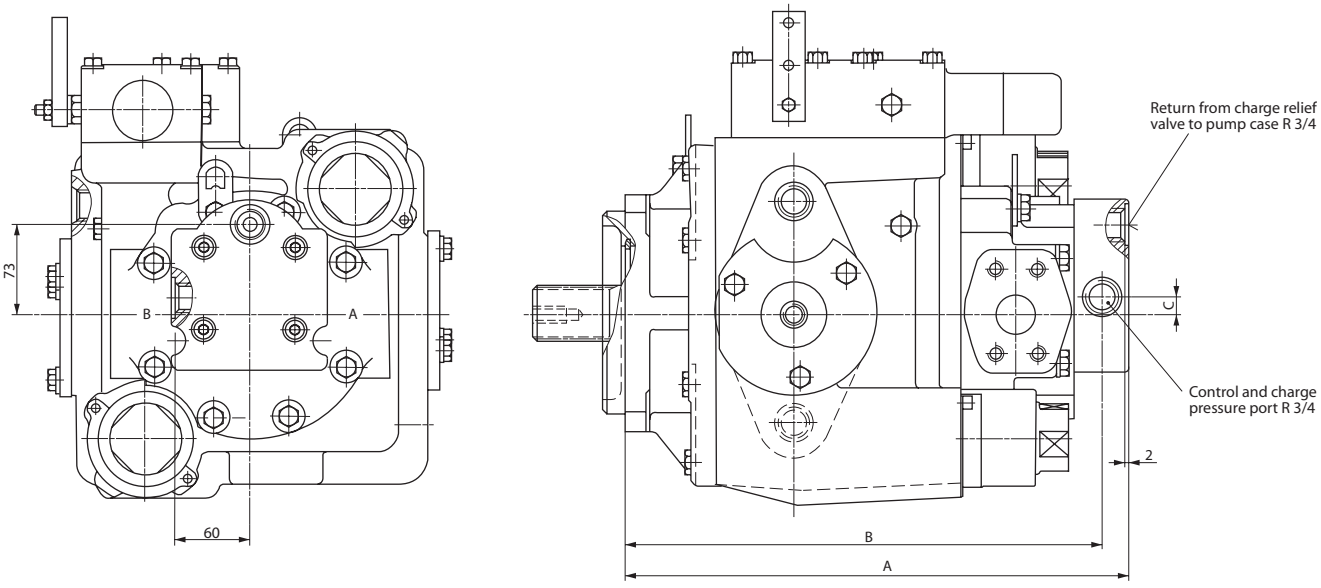
P000 058E

Designation:

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

Ports:

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



P000 010E

Dimensions				
Frame size	**A** mm [in]	**B** mm [in]	**C** mm [in]	Weight kg [lb]
119	422 [16.614]	401 [15.787]	14 [0.551]	128.5 [283]
166	476 [18.740]	450 [17.717]		160 [353]
227	504 [19.842]	478 [18.819]		208 [459]
334	546 [21.496]	520 [20.472]	21 [0.827]	264.5 [583]

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