

RE 91 455/04.00

replaces: 01.94

**Fixed Displacement Pump A4FO**

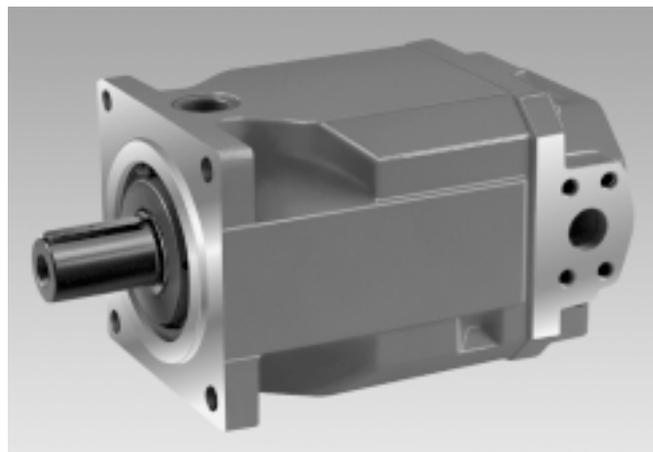
for open circuits

Sizes 16...500

Series 1, Series 3

Nominal pressure up to 400 bar

Peak pressure up to 450 bar



A4FO

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Features

- A4FO axial piston fixed displacement pumps of swashplate design are used for hydraulic drives in open loop circuits.
- Flow is proportional to the drive speed and to the displacement.
- Good suction characteristic
- Low noise level
- Long service life
- Pump combinations possible
- Through drive for mounting other pumps

– Further Informations:
Variable Pump A4VSO

RE 92 050



Ordering Code

Fluid / Design	16	22	28	40	71	125	250	500	
Mineral oil, HFD-Fluid	●	●	●	●	●	●	●	●	
HFA-, HFB-, HFC-Fluid	-	-	-	-	●	●	●	●	E-
High-Speed Design	-	-	-	-	-	-	●	●	H-

Axial piston unit

Fixed swashplate design	A4F
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Operation

Pump in open circuits	0
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Size

≙ Displacement V_g (cm ³)	16	22	28	40	71	125	250	500
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Series

	sizes 16...40, 125...500	3
	size 71	1

Index

	sizes 16...40	2
	sizes 71...500	0

Direction of rotation

viewed on shaft end	clockwise	R
	anti-clockwise	L

Seals

NBR (nitril-caoutchouc), shaft seal in FKM (fluor-caoutchouc)	sizes 16...40	N
	sizes 71...500	P
FKM (fluor-caoutchouc)	sizes 71...500	V

Shaft end

	16	22	28	40	71	125	250	500	
splined shaft SAE	●	●	●	-	-	-	-	-	S
splined shaft SAE	-	-	-	●	-	-	-	-	T
Splined shaft DIN 5480	-	-	-	-	●	●	●	●	Z
parallel shaft, with key DIN 6885	-	-	-	-	●	●	●	●	P

Mounting flange

	16	22	28	40	71	125	250	500	
SAE 2-hole	●	●	●	●	-	-	-	-	C
ISO 4-hole	-	-	-	-	●	●	●	-	B
ISO 8-hole	-	-	-	-	-	-	-	●	H

Service line connections

	sizes 16...40	sizes 71...500	
Pressure and suction port SAE at side (opposite side) (metric fixing screws)	●	-	12
Pressure and suction port SAE at side, rotated by 90° (metric fixing screws)	-	●	25
2nd pressure port B ₁ opposite B - when delivered plugged with a flange			

- = available
- = in preparation
- = not available

Ordering Code

	A4F	O	/			-							
Fluid													
Axial piston unit													
Operation													
Size													
Series													
Index													
Direction of rotation													
Seals													
Shaft end													
Mounting flange													
Service line connections													

Through Drive

16 22 28 40 71 125 250 500

flange	hub	for mounting	16	22	28	40	71	125	250	500	
–	–		●	●	●	–	●	●	●	●	N00
SAE A, 2-hole	SAE A	G2, A10VSO 10	●	●	●	●	–	–	–	–	K01
SAE B, 2-hole	SAE B	A4FO 16...28	–	●	●	–	–	–	–	–	K02
ISO 80, 2-hole	SAE A-B	A10VSO 18	–	–	–	–	○	●	●	○	KB2
ISO 100, 2-hole	SAE B	A10VSO 28	–	–	–	–	○	○	○	○	KB3
ISO 100, 2-hole	SAE B-B	A10VSO 45	–	–	–	–	○	○	○	○	KB4
ISO 125, 2-hole	SAE C	A10VSO 71	–	–	–	–	○	○	○	○	KB5
ISO 125, 2-hole	SAE C-C	A10VSO 100	–	–	–	–	–	○	○	○	KB6
ISO 180, 4-hole	SAE D	A10VSO 140	–	–	–	–	–	–	○	○	KB7
ISO 125, 4-hole	N32 (DIN 5480)	A4VS 40	–	–	–	–	○	○	●	○	K31
ISO 140, 4-hole	N40 (DIN 5480)	A4FO 71 / A4VS 71	–	–	–	–	●	●	●	○	K33
ISO 160, 4-hole	N50 (DIN 5480)	A4FO 125 / A4VS 125, 180	–	–	–	–	–	●	●	○	K34
ISO 224, 4-hole	N60 (DIN 5480)	A4FO 250 / A4VS 250	–	–	–	–	–	–	●	○	K35
ISO 315, 8-hole	N80 (DIN 5480)	A4FO 500 / A4VS 500	–	–	–	–	–	–	–	○	K43
with through drive shaft, without hub, without adapter flange, with cover plate			–	–	–	–	○	●	●	○	K99

Technical Data

Fluid

To review the application of A4FO pumps with the selected hydraulic fluid, detailed fluid compatibility and application data can be found in data sheets RE 90220 (mineral oil), RE 90221 (environmentally acceptable hydraulic fluids) and RE 90223 (fire resistant fluids, HF).

When using HF- or environmentally acceptable hydraulic fluids possible limitations for the technical data have to be taken into consideration. If necessary please consult our technical department (please indicate type of the hydraulic fluid used for your application on the order sheet).

Sizes 16...40 of fixed pump A4FO are not suitable for operation with HFA, HFB or HFC-fluids.

Operating viscosity range

In order to obtain optimum efficiency and service life, we recommend that the operating viscosity (at operating temperature) be selected from within the range:

$$v_{opt} = \text{operating viscosity } 16 \dots 36 \text{ mm}^2/\text{s}$$

referred to the tank temperature (open circuit).

Viscosity limits

The limiting values for viscosity are as follows:

Sizes 16...40

$v_{min} = 5 \text{ mm}^2/\text{s}$,
short term at a max. permissible temperature of $t_{max} = 115^\circ\text{C}$

$v_{max} = 1600$, short term on cold start ($t_{min} = -40^\circ\text{C}$)

Sizes 71...500

$v_{min} = 10 \text{ mm}^2/\text{s}$,
short term at a max. permissible leakage oil temp. of $t_{max} = 90^\circ\text{C}$

$v_{max} = 1000 \text{ mm}^2/\text{s}$, short term on cold start ($t_{min} = -25^\circ\text{C}$)

Please note that the max. fluid temperature is also not exceeded in certain areas (for instance bearing area).

At temperatures of -25°C up to -40°C special measures may be required for certain installation positions. Please contact us.

Notes on the selection of the hydraulic fluid

In order to select the correct fluid, it is necessary to know the operating temperature in the tank (open circuit) in relation to the ambient temperature.

The hydraulic fluid should be selected so that within the operating temperature range, the operating viscosity lies within the optimum range (v_{opt} ; see shaded section of the selection diagram). We recommend that the highest possible viscosity range should be chosen in each case.

Example: At an ambient temperature of $X^\circ\text{C}$ the operating temperature is 60°C . Within the operating viscosity range (v_{opt} ; shaded area), this corresponds to viscosity ranges VG 46 or VG 68. VG 68 should be selected.

Important: The leakage oil (case drain oil) temperature is influenced by pressure and pump speed and is always higher than the tank temperature. However, at no point in the circuit may the temperature exceed 115°C for sizes 16...40 or 90°C for sizes 71...500.

If it is not possible to comply with the above conditions because of extreme operating parameters or high ambient temperatures please consult us.

Filtration

The finer the filtration the better the achieved cleanliness level of the pressure fluid and the longer the life of the axial piston unit.

To ensure the functioning of the axial piston unit a minimum cleanliness level of

9 to NAS 1638

18/15 to ISO/DIS 4406 is necessary.

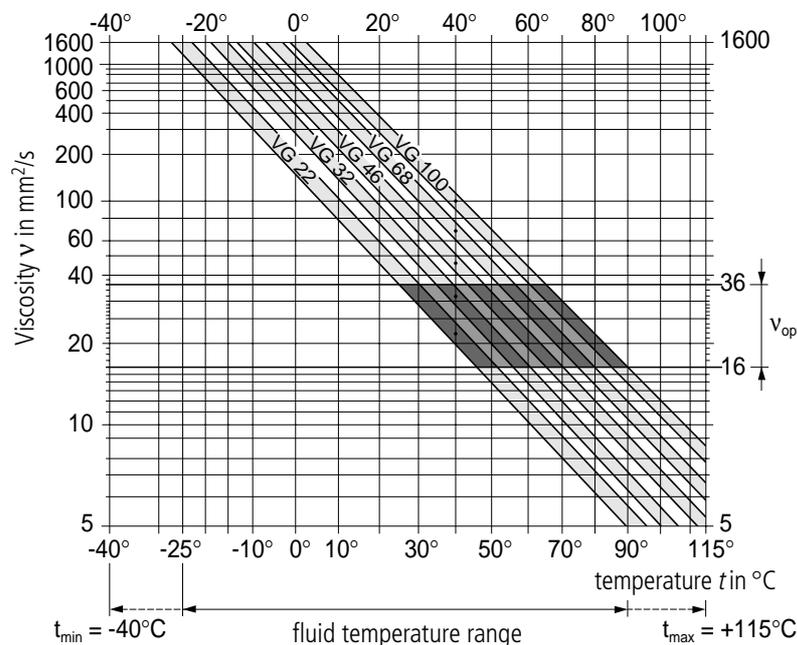
At very high temperatures of the hydraulic fluid (90°C to max. 115°C , not permissible for sizes 71...500) at least cleanliness level

8 to NAS 1638

17/14 to ISO/DIS 4406 is necessary.

If above mentioned grades cannot be maintained please consult us.

Selection diagram



Technical Data

valid for operation with mineral oils

Sizes 16...40

Working pressure range inlet

Absolut pressure at port S (suction port)

$P_{abs. min}$ _____ 0,8 bar

$P_{abs. max}$ _____ 2 bar

Working pressure range outlet

Maximum pressure at port A or B (pressure data to DIN 24312)

Nominal pressure p_N _____ 400 bar

Peak pressure p_{max} _____ 450 bar

Note:

When mounting further pumps at the through drive of the A4FO the max. input torque of the drive shaft has not to be exceeded (as to page 15). This may necessitate a limitation of the max. admissible pressure values.

Direction of flow

clockwise operation anti-clockwise operation

Sizes 16...40

S to B

S to A

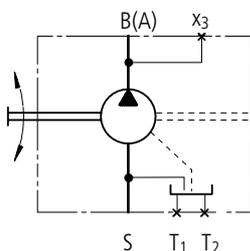
Symbol

A, B service line port

S suction port

T_1, T_2 drain port
(plugged)

x_3 gauge port



Case drain pressure

Perm. case drain pressure (housing pressure)

p_L _____ 2 bar abs.

The leakage oil chamber is connected to the suction chamber. A case drain line is therefore not necessary.

Sizes 71...500

Working pressure range inlet

Absolut pressure at port S (suction port)

$P_{abs. min}$ _____ 0,8 bar

$P_{abs. max}$ _____ 30 bar

Working pressure range outlet

Maximum pressure at port A or B (pressure data to DIN 24312)

Nominal pressure p_N _____ 350 bar

Peak pressure p_{max} _____ 400 bar

Flushing of the bearings (Sizes 125...500)

For informations about operating conditions, flushing quantities and notes on bearing flushing see data sheet RE 92 050 (A4VSO).

Direction of flow

clockwise operation anti-clockwise operation

Sizes 71...500

S to B

S to B

Symbol

B, B_1 service line port

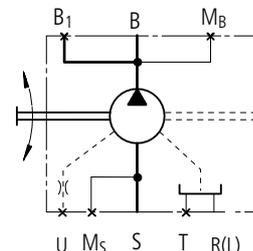
S suction port

T, R(L) drain port
(1 port plugged)

M_B gauge port working pressure

M_S gauge port suction pressure

U flushing port (sizes 125...500)



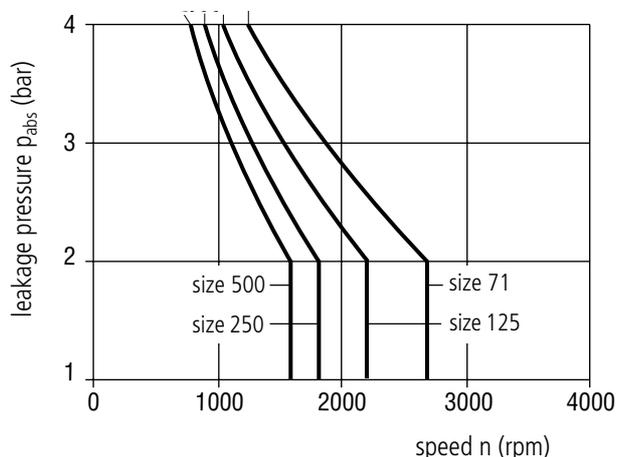
Leakage pressure

The max. permissible leakage pressure (housing pressure) is dependent on speed (see diagram). The pressure in the housing must be equal to or greater than the external pressure on the shaft sealing ring.

Max. leakage pressure (housing pressure)

p_L _____ 4 bar abs.

A case drain line to the tank is necessary.



Technical Data

Table of values (theoretical values, without considering η_{mh} and η_v ; values rounded)

Size		16	22	28	40	71	125	250/H*	500/H*
Displacement	V_g cm ³	16	22	28	40	71	125	250	500
Max. speed ¹⁾	n_{max} rpm	4000	3600	3000	2750	2200	1800	1500/1900	1320/1500
Max. permissible speed (speed limit) with increased inlet pressure	$n_{max perm.}$ rpm	4800	4500	3750	3400	2700	2200	1800/2100	1600/1800
Output flow at n_{max} ²⁾	q_{Vmax} L/min	62	77	81	107	152	218	364/461	640/728
Power at q_{Vmax} ; $\Delta p = 400$ bar	P_{max} kW	43	53	56	73	91 ³⁾	131 ³⁾	219/277 ³⁾	385/437 ³⁾
Max. torque at $\Delta p = 400$ bar	T_{max} Nm	102	140	178	254	395 ³⁾	696 ³⁾	1391 ³⁾	2783 ³⁾
Case volume	L	0,3	0,3	0,3	0,4	2,0	3,0	7,0	11,0
Moment of inertia, about drive axis	J kgm ²	0,0017	0,0017	0,0017	0,0030	0,0121	0,0300	0,0959	0,3325
Weight (approx.)	m kg	13,5	13,5	13,5	16,5	34	61	120	220

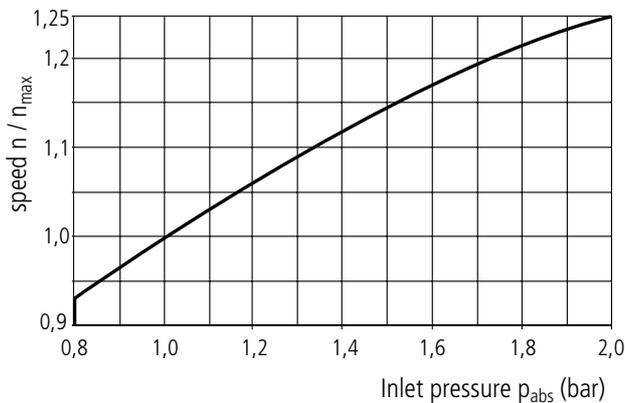
¹⁾ The values shown are valid for an absolute pressure (p_{abs}) of 1 bar at the suction inlet S and when operated on mineral oil.

²⁾ 3 % volumetric loss included

³⁾ $\Delta p = 350$ bar H*: High-speed-design

Maximum permissible speed (speed limit)

Maximum permissible speed with increased inlet pressure p_{abs} at suction port S (note: max. perm. speed $n_{max perm}$ (speed limit))



Calculation of size

Flow $q_v = \frac{V_g \cdot n \cdot \eta_v}{1000}$ in L/min

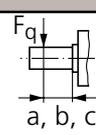
Torque $T = \frac{1,59 \cdot V_g \cdot \Delta p}{100 \cdot \eta_{mh}} = \frac{V_g \cdot \Delta p}{20 \cdot \pi \cdot \eta_{mh}}$ in Nm

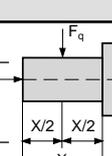
Power $P = \frac{T \cdot n}{9549} = \frac{2 \pi \cdot T \cdot n}{60000} = \frac{q_v \cdot \Delta p}{600 \cdot \eta_t}$ in kW

- V_g = displacement per revolution in cm³
- Δp = differential pressure in bar
- n = speed in rpm
- η_v = volumetric efficiency
- η_{mh} = mechanical-hydraulic efficiency
- η_t = overall efficiency

Input drive

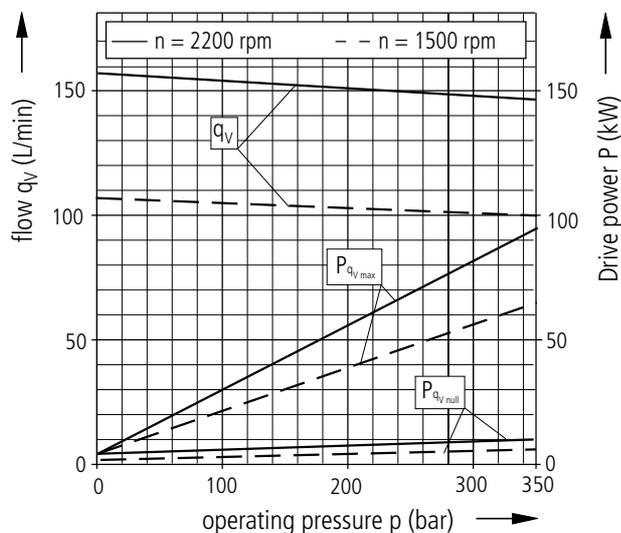
Permissible axial and radial force on drive shaft

Size		16	22	28	40
Distance of F_q (from shaft collar)	 a mm	17,5	17,5	17,5	17,5
	b mm	30	30	30	30
	c mm	42,5	42,5	42,5	42,5
max. permissible radial force at distance	a $F_{q max}$ N	2800	2500	2050	3600
	b $F_{q max}$ N	1600	1400	1150	2891
	c $F_{q max}$ N	1150	1000	830	2416
max. permissible axial force	 - $F_{ax max}$ N	1557	1557	1557	2120
	+ $F_{ax max}$ N	417	417	417	880

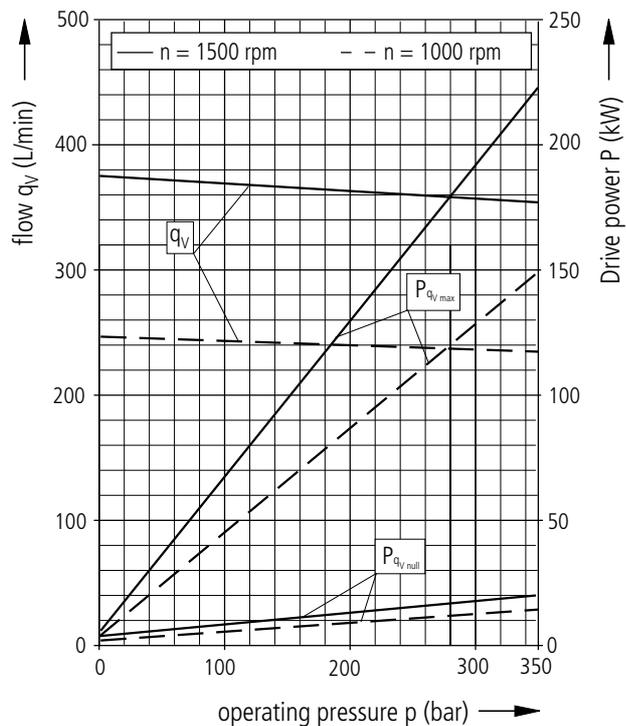
Size		71	125	250	500
Max. axial force at housing pressure p_{max} 1 bar abs.	 $\pm F_{ax max}$ N	1400	1900	3000	4000
Max. axial force at housing pressure p_{max} 4 bar abs.	+ $F_{ax max}$ N	810	1050	1850	2500
	- $F_{ax max}$ N	1990	2750	4150	5500
Max. shearing force	$F_{q max}$ N	1700	2500	4000	5000

Input Power and Flow

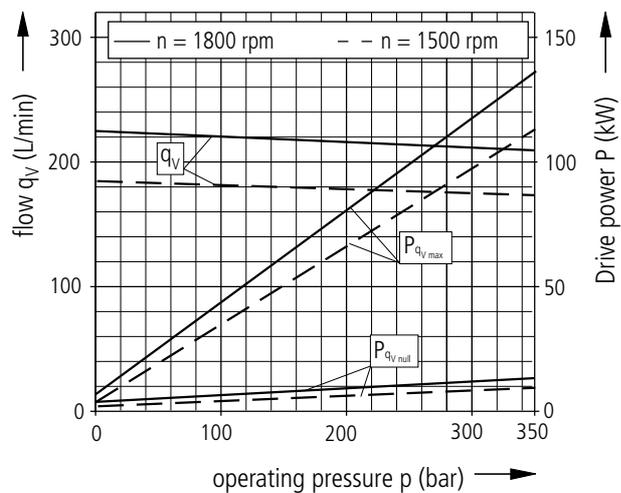
Size 71



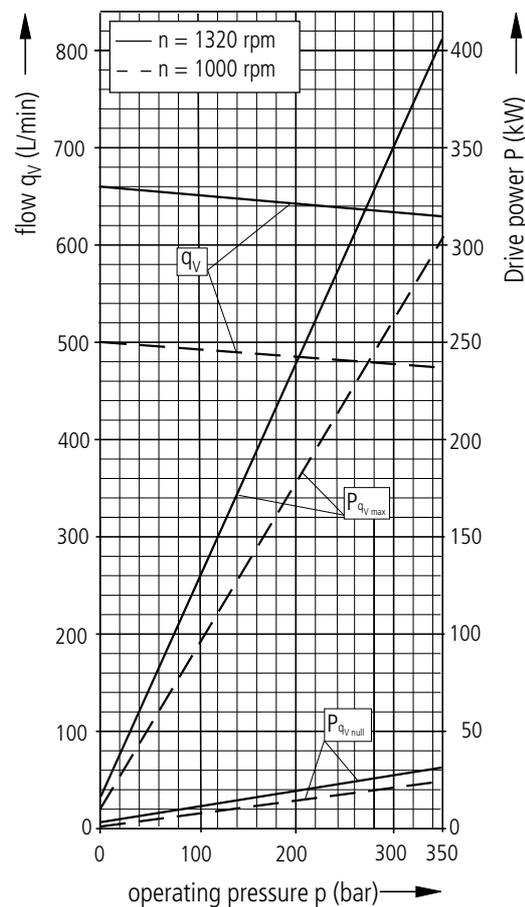
Size 250



Size 125



Size 500



Total efficiency:
$$\eta_t = \frac{q_v \cdot p}{P_{q_v, \max} \cdot 600}$$

Volumetric efficiency:
$$\eta_v = \frac{q_v}{q_{v, \text{theor}}}$$

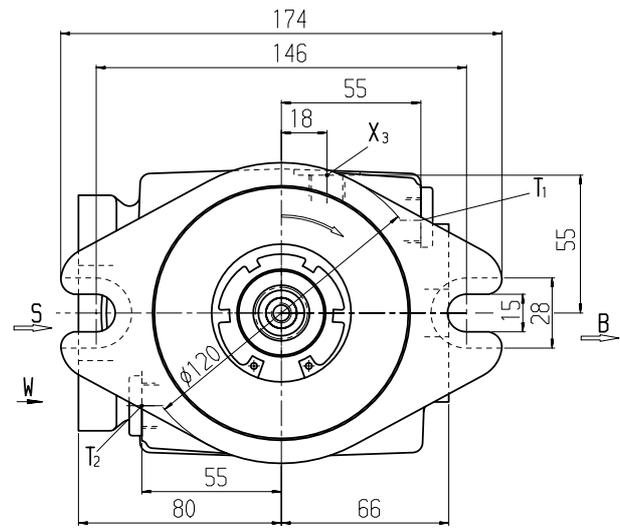
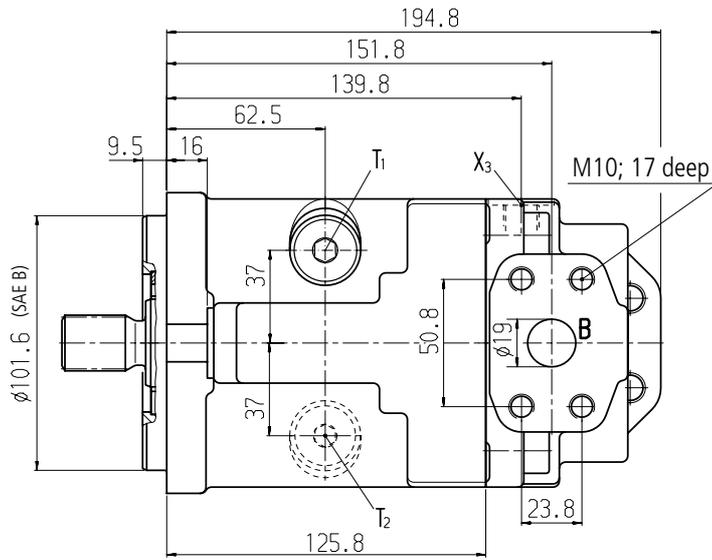
(Fluid: hydraulic oil ISO VG 46 DIN 51519, $t = 50^\circ\text{C}$)

Unit Dimensions, Sizes 16, 22, 28

Prior to finalising your design, please obtain a certified drawing.

Clockwise operation

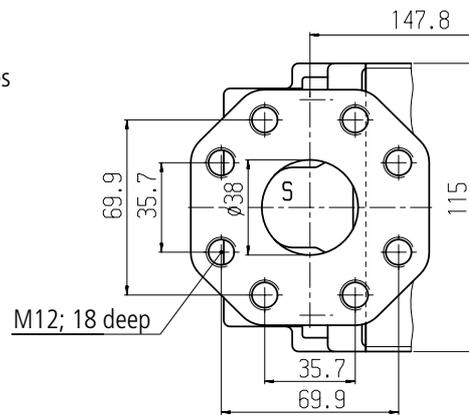
(port plate is rotated via 180° for anti-clockwise operation)



Connections

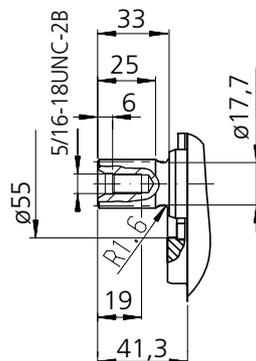
B (A)	Service line ports	SAE $\frac{3}{4}$ " 420 bar (6000 psi) high pressure series
S	Suction port	SAE $1\frac{1}{2}$ " 35 bar (500 psi) standard series
T_1, T_2	Case drain port, oil filling	M18x1,5; 12 deep
X_3	Gauge port	M14x1,5; 12 deep

View W



Shaft ends

S
Splined shaft SAE $\frac{7}{8}$ " (SAE B),
pressure angle 30°,
13 teeth, 16/32 Pitch,
flat root, side fit,
tolerance class 5
ANSI B92.1a-1976

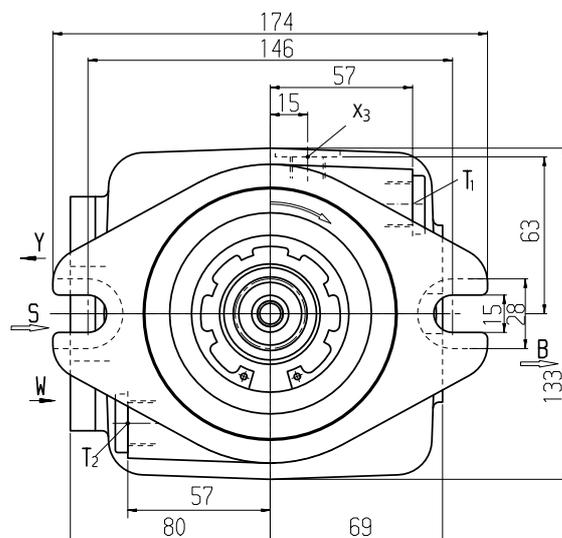
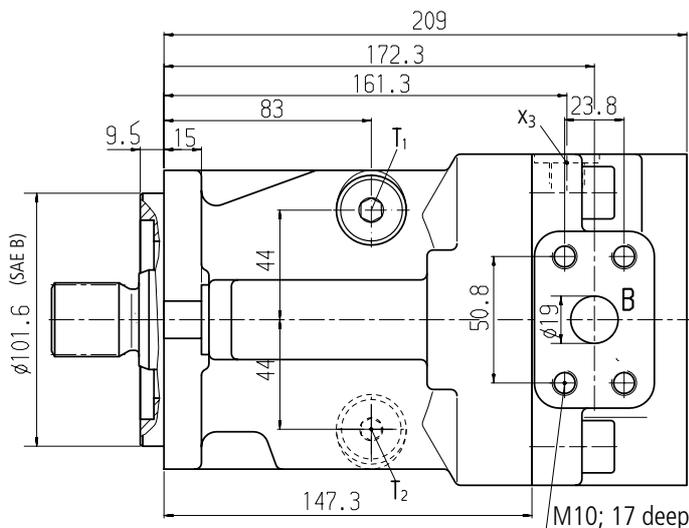


Unit Dimensions, Size 40

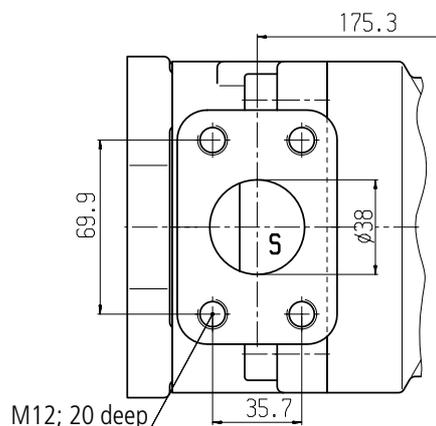
Prior to finalising your design, please obtain a certified drawing.

Clockwise operation

(port plate is rotated via 180° for anti-clockwise operation)



View W



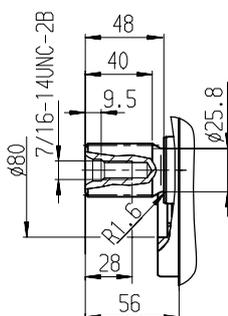
Connections

B (A)	Service line ports	SAE $\frac{3}{4}$ " 420 bar (6000 psi) high pressure series
S	Suction port	SAE $1\frac{1}{2}$ " 35 bar (500 psi) standard series
T ₁ , T ₂	Case drain port, oil filling	M18x1,5; 12 deep
X ₃	Gauge port	M14x1,5; 12 deep

Shaft ends

T

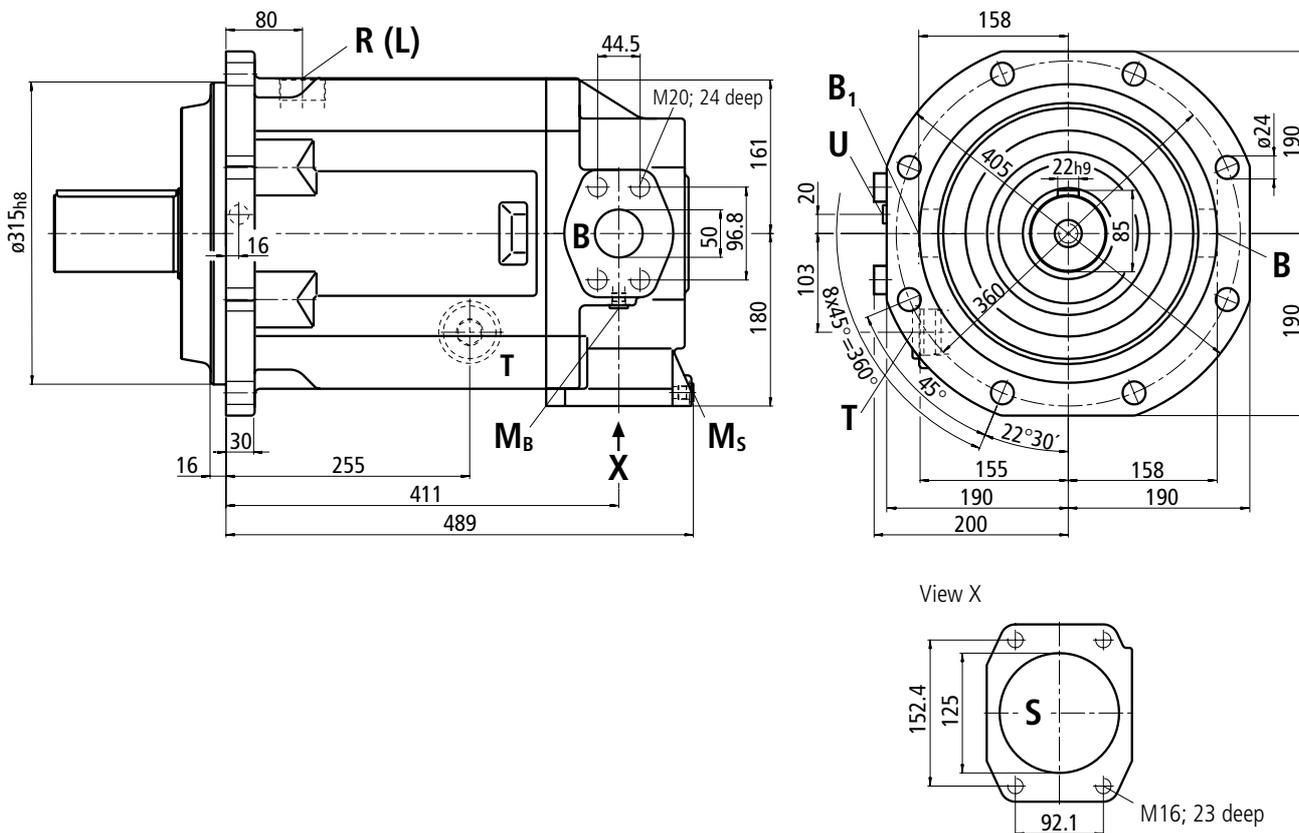
Splined shaft SAE $1\frac{1}{4}$ " (SAE C)
pressure angle 30°,
14 teeth, 12/24 Pitch
flat root side fit,
tolerance class 5
ANSI B92.1a-1976



Unit Dimensions, Size 500

Prior to finalising your design, please obtain a certified drawing.

Clockwise and anti-clockwise operation

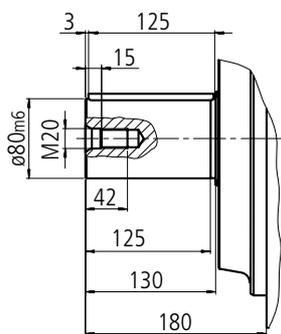


Connections

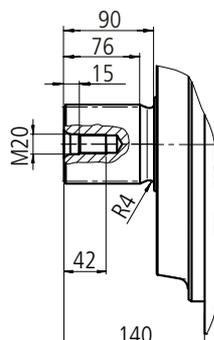
B	Service line port	SAE 2" (high pressure series)
B ₁	2nd service line port (plugged with a flange)	SAE 2" (high pressure series)
S	Suction port	SAE 5" (standard series)
R (L)	Case drain port, oil filling	M48x2
T	Oil drain (plugged)	M48x2
M _B	Gauge port operating pressure (plugged)	M18x1,5
M _S	Gauge port suction pressure (plugged)	M18x1,5
U	Flushing port (bearing flushing) (plugged)	M18x1,5

Shaft ends

P
Parallel shaft with key
AS 22x14x125
DIN 6885



Z
Splined shaft
W80x3x30x25x9g
DIN 5480

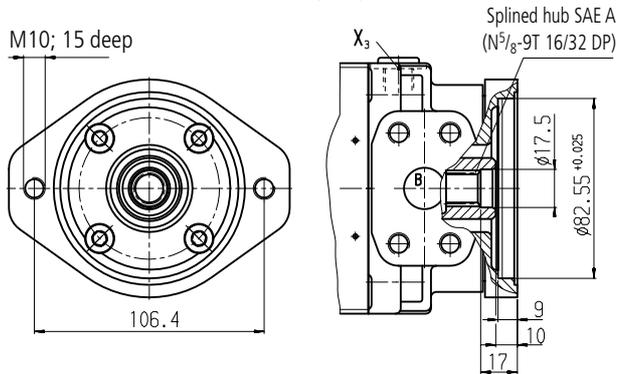


Unit Dimensions, Through Drives

Prior to finalising your design, please obtain a certified drawing.

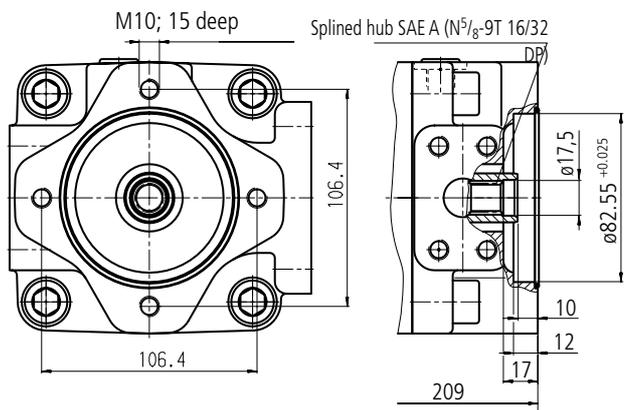
Through drive SAE A (K01)

Sizes 16, 22, 28



- suitable for connection of:
- gear pump G2 (RE 10030)
 - variable pump A10VSO10 (RE 92713)
 - variable pump A10VSO18 (RE 92712)

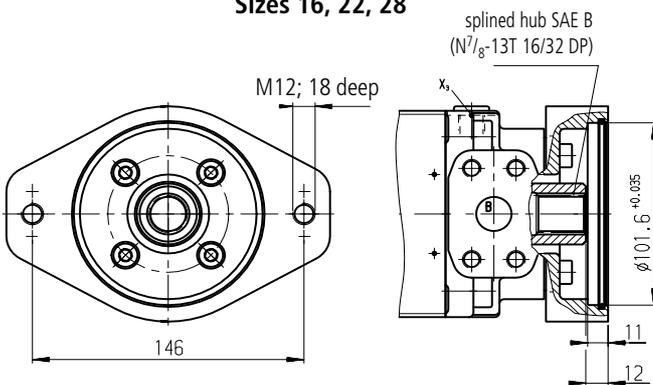
Size 40



- suitable for connection of:
- gear pump G2 (RE 10030)
 - variable pump A10VSO10 (RE 92713)
 - variable pump A10VSO18 (RE 92712)

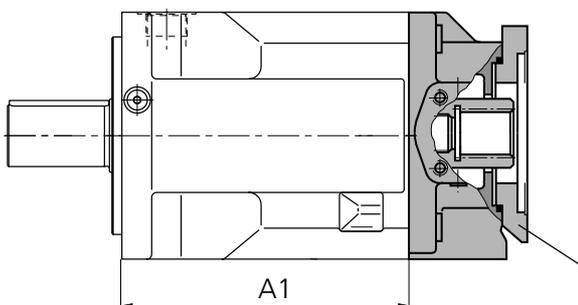
Through drive SAE B (K02)

Sizes 16, 22, 28



- suitable for connection of:
- fixed pump A4FO 16, 22, 28
 - gear pump G3 (RE 10039)
 - gear pump G4 (RE 10042)
 - variable pump A10VG18 (RE 92750)
 - variable pump A10VO28 (RE 92701/RE 92703)

Through drive sizes 71...500 (see RE 92050, A4VSO)



Size	71	125	250	500
A1	194	231	293	335

Through drive dimensions see RE 92050 (A4VSO)

Permissible Input and Through Drive Rotation Torques

Size			16	22	28	40
Corner torque (at $\Delta p = 400$ bar ¹⁾)	T_{\max}	Nm	102	140	178	254
Max. perm. through drive torque ²⁾)	$T_{D \text{ perm.}}$	Nm	192	192	192	314
Max. perm. input torque ³⁾)	shaft end S (SAE J744)	$T_{E \text{ perm.}}$	192 (SAE B, W7/8")	192 (SAE B, W7/8")	192 (SAE B, W7/8")	–
	shaft end T (SAE J744)	$T_{E \text{ perm.}}$	–	–	–	602 (SAE C, W1 1/4")
Size			71	125	250	500
Corner torque (at $\Delta p = 350$ bar ¹⁾)	T_{\max}	Nm	395	696	1391	2783
Max. perm. through drive torque ²⁾)	$T_{D \text{ perm.}}$	Nm	395	696	1391	2783
Max. perm. input torque ³⁾)	shaft end Z (DIN 5480)	$T_{E \text{ perm.}}$	790 (W40)	1392 (W50)	2782 (W60)	5566 (W80)
	shaft end P (keyed shaft, DIN 6885)	$T_{E \text{ perm.}}$	700 (AS12x8x68)	1392 (AS14x9x80)	2300 (AS18x11x100)	5200 (AS22x14x125)

¹⁾ efficiency not taken into consideration

²⁾ note: max. perm. input torque $T_{E \text{ perm.}}$ may not be exceeded

³⁾ drive shaft without side load

Code explanations

$T_{D \text{ perm.}}$ = max. permissible through drive torque

in Nm

$T_{E \text{ perm.}}$ = max. permissible input torque at the drive shaft

in Nm

T_1 = take off torque at 1st pump $= \frac{1,59 \cdot V_{g1} \cdot \Delta p_1}{100 \cdot \eta_{mh}}$ in Nm

T_2 = take off torque at 2nd pump $= \frac{1,59 \cdot V_{g2} \cdot \Delta p_2}{100 \cdot \eta_{mh}}$ in Nm

V_{g1} = pump displacement per rev. 1st pump in cm^3

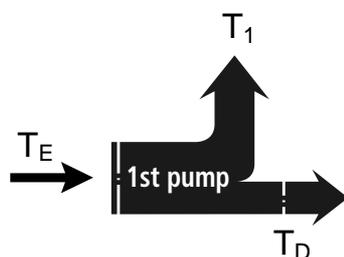
V_{g2} = pump displacement per rev. 2nd pump in cm^3

Δp_1 = differential pressure 1st pump in bar

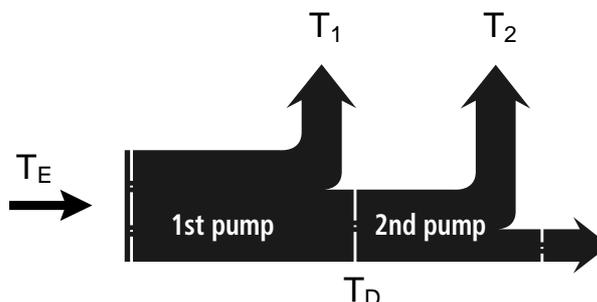
Δp_2 = differential pressure 2nd pump in bar

η_{mh} = mechanical-hydraulic efficiency

Single pump



Combination pump



Installation and Commissioning Guidelines, Sizes 16...40

General

At start-up and during operation the pump housing has imperatively to be filled up with hydraulic fluid (filling of the case chamber). Start-up has to be carried out at low speed and without load till the system is completely bled.

At a longer standstill the case may discharge via operating line. At new start-up a sufficient filling of the housing has to be granted.

The min. suction pressure at port S should not fall below 0,8 bar absolute.

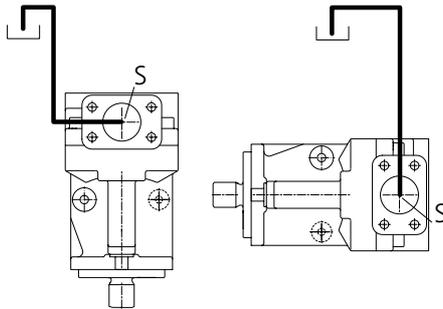
Installation position

Shaft horizontally resp. to the bottom. When mounting on top of the tank the installation position "shaft horizontally, suction port to the bottom" is not admissible!

Installation below tank level

Pumps below min. oil level in the tank (standard)

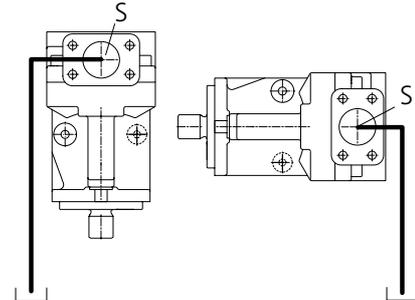
- Fill up axial piston pump before start-up via highest positioned case drain port
- Recommendation: Fill up suction lines
- Operate pump at low speed (igniton speed) till pump system is completely filled up
- Minimum immersion depth of the suction line or drain line in the tank: 200 mm (relative to the min. oil level in the tank).



Installation on top of tank level

Pump on top of min. oil level in the tank

- Actions as installation below tank level
- Installation positions "shaft to the top" and "shaft horizontally, suction port at bottom" are not admissible (at standstill the pump case is bleeding via suction line).
- note: - max. perm. suction pipe length $h_{max} = 800$ mm
- min. admissible pressure at port S (min. suction pressure)



Installation and Commissioning Guidelines, Sizes 71...500

see RE 92050 (A4VSO)

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