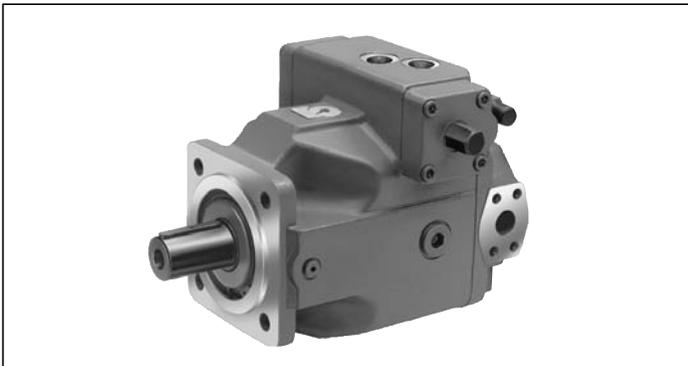


Axial piston variable pump A4VSO Series 10, 11 and 30 for HFC hydraulic fluids

RE 92053

Issue: 10.2015

Replaces: 08.2015



- ▶ Sizes 71 to 355
- ▶ Nominal pressure 350 bar
- ▶ Maximum pressure 400 bar
- ▶ Open circuit

Features

- ▶ Variable pump with axial piston rotary group in swash-plate design for hydrostatic drives in open circuit.
- ▶ Flow is proportional to the drive speed and displacement.
- ▶ The flow can be infinitely varied by adjusting the swash-plate angle.
- ▶ Particularly suitable for operation with HFC hydraulic fluids
- ▶ Version for operation without external bearing flushing possible.
- ▶ With selected HFC hydraulic fluids, the same pressures and rotational speed as for operation with mineral oil
- ▶ Excellent suction performance
- ▶ Low noise level
- ▶ Long service life
- ▶ Favorable power/weight ratio
- ▶ Axial and radial load capacity of drive shaft
- ▶ Modular assembly
- ▶ Short control times
- ▶ Through drive and pump combinations possible
- ▶ Swivel angle indicator
- ▶ Freely variable installation position

Contents

Ordering code	2
Hydraulic fluid	3
Bearing flushing	4
Technical data	5
Installation instructions	6
Project planning notes	8
Safety instructions	8

Ordering code

01	02	03	04	05	06	07	08	09	10	11	12
A4VS	O		/			-	F				

Axial piston unit

01	Variable swashplate design, nominal pressure 350 bar, maximum pressure 400 bar	A4VS
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Operating mode

02	Pump, open circuit	O
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Size (NG)

03	Geometric displacement, see "Technical data" on page 5	71	125	180	250	355
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Control device

See data sheet for additional information

04	Pressure controller	92060	●	●	●	●	●	DR..
	Pressure controller with parallel operation		●	●	●	●	●	DP..
	Flow controller		●	●	●	●	●	FR..
	Pressure and flow controller		●	●	●	●	●	DFR.
	Power controller with hyperbolic characteristic curve	92064	●	●	●	●	●	LR..¹⁾
	Electric motor control	92072	●	●	●	●	●	EM..
	Hydraulic control, volume dependent	92076	●	●	●	●	●	HM..
	Hydraulic control with servo/ proportional valve		●	●	●	●	●	HS..¹⁾
	Electronic control		●	●	●	●	●	EO..¹⁾
	Hydraulic control, pilot-pressure related	92080	●	●	●	●	●	HD..¹⁾
	Electro-hydraulic control system DFE1	92088	●	●	●	●	●	DFE.¹⁾
	System solution SYHDFE	30035						

Series

05	Series 1, index 0	●	-	-	-	-	10²⁾
	Series 1, index 1	●	-	-	-	-	11²⁾
	Series 3, index 0	-	●	●	●	●	30

Direction of rotation

06	Viewed on drive shaft	clockwise	R
		counter-clockwise	L

Sealing material and hydraulic fluid

07	NBR nitrile rubber, PTFE Teflon shaft seal, special version for HFC hydraulic fluids Bearing flushing required (U port)	●	●	●	●	●	F
	NBR nitrile rubber, PTFE Teflon shaft seal, special version for HFC hydraulic fluids Operation without external bearing flushing	○	○	○	●	○	F2

Further details on the basic unit for positions 08 to 12 can be found in data sheet 92050

● = Available ○ = On request - = Not available

1) Please observe the notes and restrictions in the individual data sheets regarding controls for operation with HFC hydraulic fluids.
2) Version with HD controls only in series 11.

Hydraulic fluid

Prior to project planning, please refer to the detailed information in our data sheet RE 90223 (HF hydraulic fluids) concerning the choice of hydraulic fluids and application conditions. Compared with mineral-oil-based pressure media, HFC fluids show other, partly unfavorable properties. Please observe the following notes when project planning, operating, and maintaining systems with HFC hydraulic fluids. The following HFC fluids, with a water content of approx. 35 to 55% in weight, are approved without any restrictions for speed and pressure in comparison with operation on mineral oil based fluids.

- ▶ Fuchs Hydrotherm 46M
- ▶ Petrofer Ultrasafe 620
- ▶ Fuchs Renosafe 500
- ▶ Houghton Houghto Safe 620
- ▶ Union Carbide HP 5046

The use of HFC hydraulic fluids is only possible if their properties and values comply with ISO 12922. For HFC hydraulic fluids other than those named above, the limitations regarding the technical data according to data sheet 90223 must be observed, where appropriate. Please contact us if the unit is to be operated with rolling oils or HFA hydraulic fluids or other low-viscosity operating fluids. In addition, the notes on filtration, intrinsic viscosity, and temperature range must be observed. Operation with mineral oil is basically possible without restriction (please observe the information of F/F2 bearing flushing on page 4).

Operating viscosity range selection diagram and explanation regarding the selection of hydraulic fluid
see data sheet 92050

Limit of viscosity range

For threshold operating conditions the following values apply:

- $n_{\min} = 10 \text{ mm}^2/\text{s}$
momentary ($t < 1 \text{ min}$),
 $t_{\max} < +50 \text{ }^\circ\text{C}$
- $n_{\max} = 1,000 \text{ mm}^2/\text{s}$
only for start-up (cold start, an operating viscosity of less than $100 \text{ mm}^2/\text{s}$ should be achieved within 15 min)
 $t_{\min} > -10 \text{ }^\circ\text{C}$

Temperature range		
t_{\min}	\geq	$-10 \text{ }^\circ\text{C}$
t_{\max}	\leq	$+50 \text{ }^\circ\text{C}$
t_{opt}	$=$	$+40 \text{ }^\circ\text{C}$

Higher temperatures are not permissible since they can lead to high water losses.

Compliance with the intrinsic velocity and temperature range means HFC hydraulic fluids can also be operated at low temperatures.

Note: The leakage temperature, which is influenced by pressure and rotational speed, is always higher than the reservoir temperature.

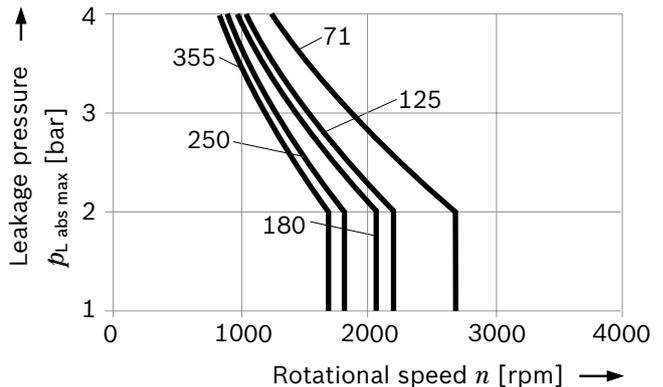
The temperature may not be higher than $+50 \text{ }^\circ\text{C}$ at any point in the system.

Filtration of the hydraulic fluid

Finer filtration improves the cleanliness level of the hydraulic fluid, which increases the service life of the axial piston unit. In order to guarantee the functional reliability of the axial piston unit it is necessary to carry out a gravimetric evaluation of the hydraulic fluid to determine the particle contamination and the cleanliness level according to ISO 4406. A cleanliness level of at least 20/18/15 must be maintained.

Leakage pressure

The permissible leakage pressure (case pressure) depends on the rotational speed (see diagram).



Maximum leakage pressure (case pressure)	
$p_{L \text{ abs max}}$	4 bar absolute

These data are guideline figures; a restriction may be necessary under certain operating conditions.

For further details see data sheet 92050

Bearing flushing

External bearing flushing is mandatory for the version “F” (type code position 07).

The variant “F2” (type code position 07) is without external bearing flushing. Certain installation conditions must therefore be taken into account. Please consult us if operation with external bearing flushing is required. Bearing flushing is realized at port “U” in the area of the front flange of the variable pump. The flushing fluid flows through the front bearing and is discharged together with the leakage.

The following important values can be found in the table below

- ▶ Minimum required flushing flow $q_{Sp\ min}$ in port **U**
- ▶ Maximum permissible pressure p_{max} in port **U**
- ▶ Reference flow $q_{Sp\ bez}$ to check the attainment of the minimum required flushing flow (see example)

NG	71	125	180	250	355
$q_{Sp\ min}$ l/min	1.0	1.0	1.5	2.0	3.0
p_{max} bar	5.0	5.0	5.0	5.0	5.0
$q_{Sp\ bez}$ l/min	2.0	3.5	5.0	6.5	10.0

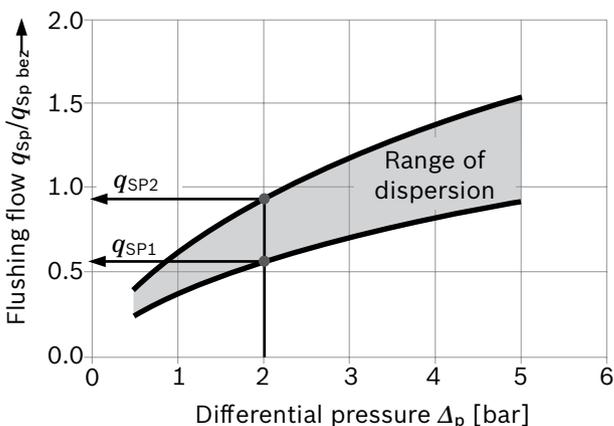
Note

For variant “F”, i.e. operation with external bearing flushing, ensure that the throttle screw located in port **U**, is screwed fully in.

Note for the setting and control:

The flushing flow depends on the pressure difference between port **U** and housing ($\Delta p = p_U - p_{hous}$). This correlation is illustrated in the following diagram independent of size.

Flushing flow at port U



Example A4VSO 250.../30...F...		
Case pressure	p_{hous}	1 bar
Pressure in port U	p_U	3 bar
	Δp	2 bar
Reference flow	$q_{Sp\ bez}$	6.5 l/min
Flushing flow (delimitation of flow range)	$q_{Sp\ 1} = 0.56 \times q_{Sp\ bez}$	= 3.6 l/min
	$q_{Sp\ 2} = 0.94 \times q_{Sp\ bez}$	= 6.1 l/min
required minimum flow	$q_{Sp\ min}$	2 l/min

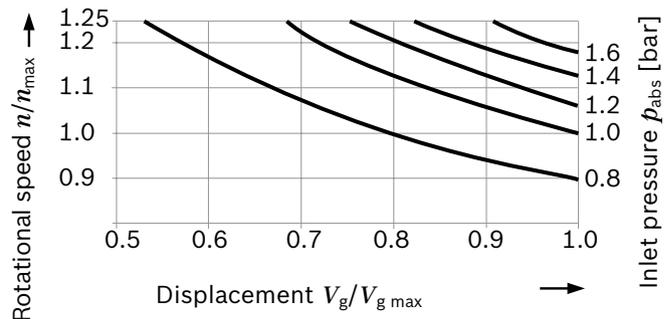
Check the values using a control measurement.

Working pressure range

Pressure at port S (inlet)	
$p_{abs\ min}$	0.8 bar absolute
$p_{abs\ max}$	30 bar absolute
Pressure at the service line port B	
Nominal pressure p_{nom}	350 bar absolute
Maximum pressure p_{max}	400 bar absolute

Almost all HF fluids have a higher density than mineral oil. It is essential that the suction pressure $p_{abs\ min}$ at the pump inlet does not fall below the minimum permissible pressure. All measures, which could obstruct the suction performance must be avoided (eg. no suction filter).

Determining the inlet pressure p_{abs} at the suction opening **S** or reducing displacement in the case of a speed increase



The inlet pressure is the static supply pressure or the minimum dynamic value e.g. in the case of pre-charge pressure.

Note

For the maximum permissible rotational speed n_{max} , see “Technical data” on page 5.

The technical data on the working pressure range for the outlet can be found in data sheet “92050”.

Technical data

Size		NG	71	125	180	250	355	
Displacement, geometric, per revolution		$V_{g \max}$	cm ³	71	125	180	250	355
Maximum rotational speed ¹⁾²⁾	at $V_{g \max}$	n_{nom}	rpm	2.00	1800	1800	1500	1500
	at $V_g \leq V_{g \max}$	n_{max}	rpm	2700	2200	2100	1800	1700
Minimum rotational speed		n_{min}	rpm	800	800	800	800	800
Flow	at n_{nom} and $V_{g \max}$	q_v	l/min	156	225	324	375	533
	at $n_E = 1500$ rpm	$q_{E \max}$	l/min	107	186	270	375	533
Power	at n_{nom} , $V_{g \max}$ and $\Delta p = 350$ bar	P	kW	91	131	189	219	311
	at $n_E = 1500$ rpm	$P_{E \max}$	kW	62	109	158	219	311
Torque	at $V_{g \max}$ and $\Delta p = 350$ bar	T	Nm	395	696	1002	1391	1976
	at $V_{g \max}$ and $\Delta p = 100$ bar	T	Nm	113	199	286	398	564
Rotary stiffness of drive shaft	P	c	kNm/rad	146	260	328	527	800
	Z	c	kNm/rad	146	263	332	543	770
Moment of inertia for rotary group		J_{TW}	kgm ²	0.0121	0.03	0.055	0.0959	0.19
Maximum angular acceleration ⁵⁾		α	rad/s ²	11000	8000	6800	4800	3600
Case volume		V	l	2.5	5	4	10	8
Weight (with pressure controller) approx.		m	kg	53	88	102	184	207

Determining the operating characteristics

Flow	$q_v = \frac{V_g \times n \times \eta_v}{1000}$	[l/min]
Torque	$T = \frac{V_g \times \Delta p}{20 \times \pi \times \eta_{hm}}$	[Nm]
Power	$P = \frac{2 \pi \times T \times n}{60000} = \frac{q_v \times \Delta p}{600 \times \eta_t}$	[kW]

Key

V_g	Displacement per revolution [cm ³]
Δp	Differential pressure [bar]
n	Rotational speed [rpm]
η_v	Volumetric efficiency
η_{hm}	Hydraulic mechanical efficiency
η_t	Total efficiency ($\eta_t = \eta_v \times \eta_{hm}$)

Note

- Theoretical values, without efficiency and tolerances; values rounded
- Exceeding the maximum or falling below the minimum permissible values can lead to a loss of function, a reduction in operational service life or total destruction of the axial piston unit. Bosch Rexroth recommend testing the loads by means of experiment or calculation / simulation and comparison with the permissible values.

1) The values apply:

- For the optimum viscosity range from $\nu_{\text{opt}} = 36$ to 16 mm²/s
- For hydraulic fluid based on mineral oils
- For a pressure $p_{\text{suction}} \geq 1$ bar absolute at suction port **S**.

2) The data are valid for values between the minimum required and maximum permissible rotational speed. Apply to external excitation (e.g. diesel engine 2- to 8-fold rotary frequency, cardan shaft 2-fold rotary frequency). The limit value only applies to a single pump. The load capacity of the connecting parts must be considered.

Installation instructions

General review of the elements

A check needs to be made as to whether each component intended for the circuit is suitable for the hydraulic fluid that is to be used. At the same time, it needs to be ensured that the sealing and hose materials or their linings as well as coats of paint are compatible with the hydraulic fluid.

Reservoir

HF hydraulic fluids have a poor air and dirt separative capacity. The separating capacity can be improved by a longer dwell time in the reservoir (using a larger reservoir than in the case of mineral oil) and by inclined baffles with perforations and sieves (calms the liquid).

The low temperature limits require controlled cooling of the hydraulic fluid. A larger reservoir surface can support this. Evaporation losses may be considerably reduced by using a tank breather.

General

The axial piston unit must be filled with hydraulic fluid and air bled during commissioning and operation. This must also be observed following a longer standstill as the axial piston unit may empty via the hydraulic lines.

The case drain fluid in the housing area must be directed to the reservoir via the highest reservoir port (**T**, **R(L)**). For combinations of multiple units, the case drain fluid must be drained off at each pump. If a shared drain line is used for this purpose, make sure that the case pressure in each pump is not exceeded. In the event of pressure differences at the reservoir ports of the units, the shared drain line must be changed so that the minimum permissible case pressure of all connected units is not exceeded in any situation. If this is not possible, separate drain lines must be installed if necessary. To achieve favorable noise values, decouple all connecting lines using elastic elements and avoid above-reservoir installation.

During operation, the suction and drain lines must flow into the reservoir below the minimum fluid level. The minimum suction pressure at port **S** must also not fall below 1 bar absolute during operation and during cold start.

When designing the reservoir, ensure that there is sufficient distance between the suction line and the drain line. This prevents the heated, return flow from being drawn directly back into the suction line.

Note

In certain installation positions, an influence on the control characteristic can be expected. Gravity, dead weight and case pressure can cause minor shifts in characteristics and changes in response time.

To prevent air pockets forming in the front bearing area, port **U** for bearing flushing is basically to be arranged so that it is positioned laterally or vertically upward.

See the following examples **1** to **4**.

Installation position “F”

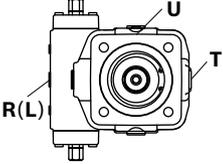
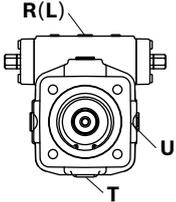
For A4VSO units with version “**F**” (type code position 07), bearing flushing is a basic requirement. For permitted installation positions, see data sheet 92050.

Installation position “F2”

(operation without external bearing flushing)

The following positions for the **U** port must be utilised for the version “**F2**” as shown below.

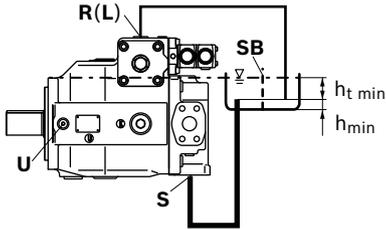
Additional installation positions are possible on request.

Position U port	Air bleeding	Filling
	U	U
	R(L)	R(L)

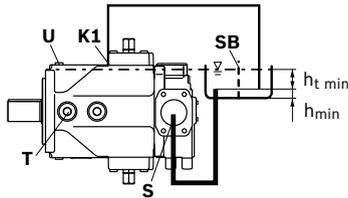
Below-reservoir installation (standard)

Below-reservoir installation is when the axial piston unit is installed outside of the reservoir below the minimum fluid level. The upper edge of the axial piston unit's mounting flange must always be below the hydraulic fluid level.

Installation position	Air bleeding	Filling
1	R(L)	R(L)



2	K1	K1
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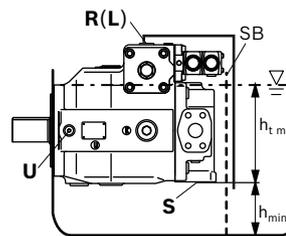
Inside-reservoir installation

Inside-reservoir installation is when the axial piston unit is installed in the reservoir below the minimum fluid level. The axial piston unit is completely below the hydraulic fluid.

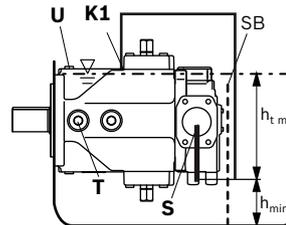
At a minimum hydraulic fluid level, the upper edge of the axial piston unit's mounting flange must not be below the hydraulic fluid level.

Axial piston units with electric components (e.g. electric controls, sensors) must not be installed in a reservoir below the fluid level.

Installation position	Air bleeding	Filling
3	Via the highest port R(L)	Via the port R(L)



4	Via the highest port K1	Via the port K1
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Key	
R(L)	Filling / air bleeding
K1	Filling / air bleeding
S	Suction port
T	Reservoir port
U	Bearing flushing port
SB	Baffle (baffle plate)
$h_{t \text{ min}}$	Minimum required immersion depth (200 mm)
h_{min}	Minimum required distance to reservoir bottom (100 mm)

Project planning notes

- ▶ The A4VSO variable pump is designed to be used in an open circuit.
- ▶ The project planning, installation and commissioning of the axial piston unit require the involvement of qualified skilled personnel.
- ▶ Before using the axial piston unit, please read the corresponding instruction manual completely and thoroughly. If necessary, request it from Bosch Rexroth.
- ▶ Before finalizing your design, request a binding installation drawing.
- ▶ The specified data and notes must be observed.
- ▶ Depending on the operating state of the axial piston unit (working pressure, fluid temperature), the characteristic curve may shift.
- ▶ Preservation: Our axial piston units are supplied as standard with preservative protection for a maximum of 12 months. If longer preservative protection is required (maximum 24 months), please specify this in plain text when placing your order. The preservation times apply under optimal storage conditions, details of these conditions can be found in the data sheet 90312 or the instruction manual.
- ▶ Not all variants of the product are approved for use in safety functions according to ISO 13849. Please consult the responsible contact person at Bosch Rexroth if you require reliability parameters (e.g. $MTTF_d$) for functional safety.
- ▶ Depending on the type of control used, electromagnetic effects can be produced when using solenoids. When a direct current is applied, solenoids do not cause electromagnetic interference nor is their operation impaired by electromagnetic interference. Other behavior can result when a modulated direct current (e.g. PWM signal) is applied. Potential electromagnetic interference for persons (e.g. persons with a pacemaker) and other components must be tested by the machine manufacturer.
- ▶ Pressure controllers are not safeguards against pressure overload. A pressure relief valve is to be provided in the hydraulic system.
- ▶ Working ports:
 - The ports and fastening threads are designed for the specified maximum pressure. The machine or system manufacturer must ensure that the connecting elements and lines correspond to the specified operating conditions (pressure, flow, hydraulic fluid, temperature) with the necessary safety factors.
 - The working ports and function ports can only be used to accommodate hydraulic lines.

Safety instructions

- ▶ During and shortly after operation, there is a risk of burning on the axial piston unit and especially on the solenoids. Take appropriate safety measures (e.g. by wearing protective clothing).
- ▶ Moving parts in control and regulation systems (e.g. valve spools) may in certain circumstances become stuck in an undefined position due to contamination (e.g. contaminated hydraulic fluid, abrasion or residual dirt from components). As a result, the hydraulic fluid flow or build-up of torque of the axial piston unit will no longer respond correctly to the operator's commands. Even the use of different filter cartridges (external or internal inlet filter) will not rule out a fault but merely reduce the risk. The machine/system manufacturer must check whether additional measures are required on the machine for the application in question in order to bring the driven consumer to a safe position (e.g. safe stop) and ensure these measures are properly put into practice.