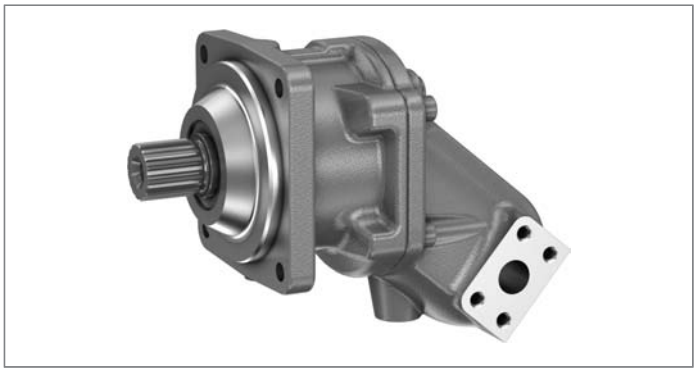
Axial piston fixed pump
A2FO Series 70

RE 91405
Edition: 05.2017



- Compact high-pressure pump with short installation length
- Sizes 45 ... 90
- Nominal pressure 400 bar
- Maximum pressure 450 bar
- Open circuit

Features

- For use in mobile and stationary applications
- Flow is proportional to drive speed and displacement
- Large variety of available nominal sizes allows exact adjustment
- High power density
- Compact dimensions
- High total efficiency
- Bent-axis design

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Type code

01	02	03	04		05	06	07	08	09	10	11	12		13
A2F	**O**	**M**		**/**	**70**	**N**		**V**					–	

Axial piston unit

01	Bent-axis design, fixed displacement	**A2F**

Operating mode

02	Pump, open circuit	**O**

Pressure range

03	Nominal pressure: 400 bar, maximum pressure: 450 bar	**M**

Size (NG)

04	Geometric displacement, see technical data on page 7	**045**	**056**	**063**	**080**	**090**	

Series

05	Series 7, Index 0	**70**

Version of port and fastening threads

06	Metric, DIN 3852 with profile seal (Europe, ROW)	**N**

Direction of rotation

07	Viewed on drive shaft	clockwise	**R**
		counter-clockwise	**L**

Sealing material

08	FKM (fluoroelastomer)	**V**

Mounting flange			**045**	**056**	**063**	**080**	**090**	
09	ISO 3019-2 metric	125-4	●	●	●	–	–	**M4**
		140-4	–	–	–	●	●	**N4**

Drive shaft			**045**	**056**	**063**	**080**	**090**	
10	Splined shaft DIN 5480	W30×2×14×9g	●	●	–	–	–	**Z6**
		W35×2×16×9g	–	●	●	●	–	**Z8**
		W40×2×18×9g	–	–	–	●	●	**Z9**
	Parallel keyed shaft DIN 6885	ø30	●	●	–	–	–	**P6**
		ø35	–	●	●	●	–	**P8**
		ø40	–	–	–	●	●	**P9**

Working port		**045**	**056**	**063**	**080**	**090**	
11	SAE working port **A**/**B** at side and SAE working port **S** at rear	●	●	●	●	●	**50**

Special version

12	Standard version	**0**

Standard/special version

13	Standard version	**0**
	Standard version with installation variants, e.g. **T** ports against standard open or closed	**Y**
	Special version	**S**

● = Available – = Not available

Notice

- ▶ Note the project planning notes on page 14.
- ▶ In addition to the type code, please specify the relevant technical data when placing your order.

Hydraulic fluid

The axial piston unit is designed for operation with HLP mineral oil according to DIN 51524.
Application instructions and requirements for hydraulic fluid selection, behavior during operation as well as disposal and environmental protection should be taken from the following data sheets before the start of project planning:

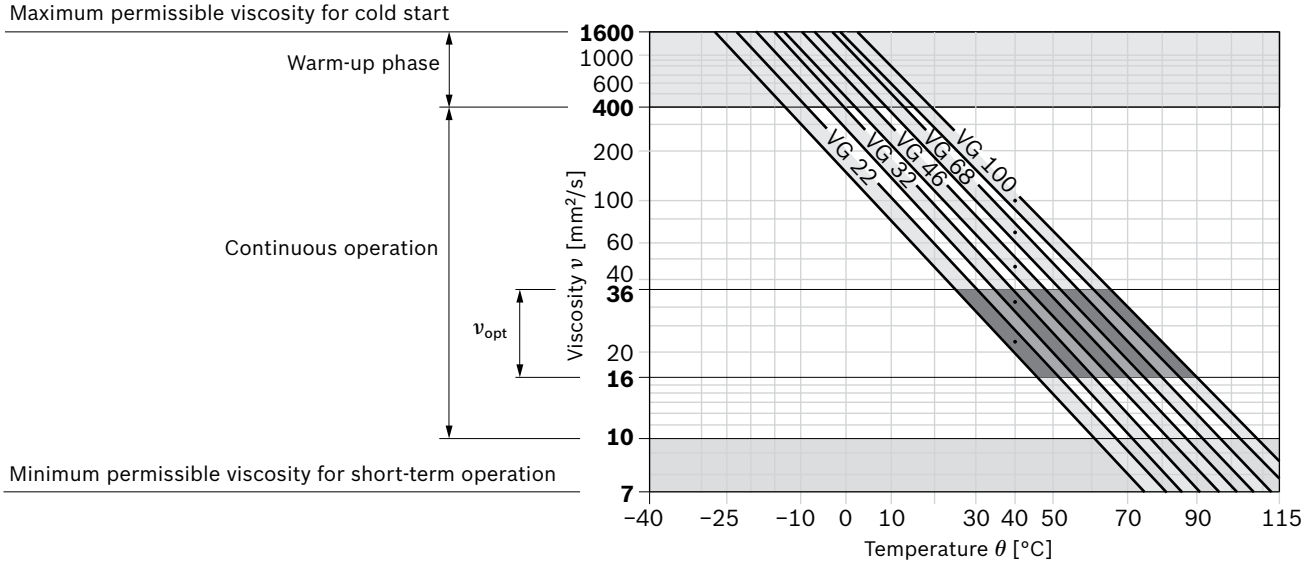
- 90220: Hydraulic fluids based on mineral oils and related hydrocarbons
- 90221: Environmentally acceptable hydraulic fluids
- 90222: Fire-resistant, water-free hydraulic fluids (HFDR/HFDU)
- 90223: Fire-resistant, water-containing hydraulic fluids (HFC/HFB/HFAE/HFAS)

Notes on selection of hydraulic fluid
The hydraulic fluid should be selected so that the operating viscosity in the operating temperature range is within the optimum range (v_{opt} see selection diagram).

Viscosity and temperature of hydraulic fluids

	Viscosity	Shaft seal	Temperature[3]	Comment
Cold start	v_{max} ≤ 1 600 mm²/s	NBR[2]	θ_{St} ≥ −40 °C	t ≤ 3 min, without load (p ≤ 50 bar), n ≤ 1 000 rpm Permissible temperature difference between the axial piston unit and hydraulic fluid in the system max. 25 K
		FKM	θ_{St} ≥ −25 °C	
Warm-up phase	v = 1 600 ... 400 mm²/s			t ≤ 15 min, p ≤ 0.7 × p_{nom} and n ≤ 0.5 × n_{nom}
Continuous operation	v = 400 ... 10 mm²/s[1]	NBR[2]	θ ≤ +78 °C	measured at port **T**
		FKM	θ ≤ +103 °C	
	v_{opt} = 36 ... 16 mm²/s			Range of optimum operating viscosity and efficiency
Short-term operation	v_{min} = 10 ... 7 mm²/s	NBR[2]	θ ≤ +78 °C	t ≤ 3 min, p ≤ 0.3 × p_{nom} , measured at port **T**
		FKM	θ ≤ +103 °C	

▼ **Selection diagram**



1) This corresponds, for example on VG 46, to a temperature range of +4 C° to +85 C° (see selection diagram)
2) Special version, please contact us
3) If the temperature at extreme operating parameters cannot be adhered to, please contact us.

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. A cleanliness level of at least 20/18/15 is to be maintained according to ISO 4406.

At very high hydraulic fluid temperatures (maximum 103 °C, measured at port **T**), a cleanliness level of at least 19/17/14 according to ISO 4406 is necessary.

Flow direction

Direction of rotation, viewed on drive shaft	
clockwise	counter-clockwise
S to **B**	**S** to **A**

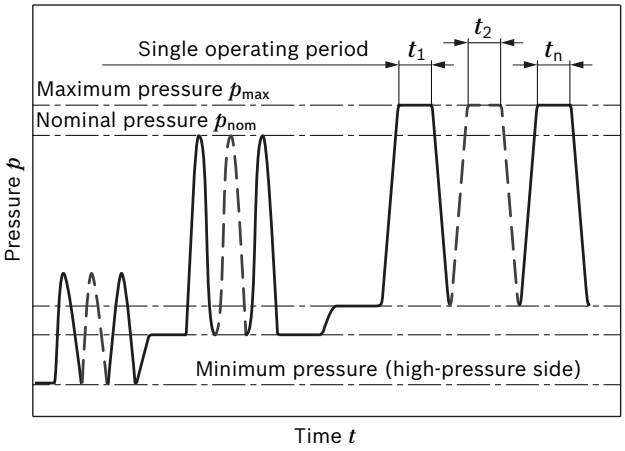
Working pressure range

Pressure at working port A or B		Definition
Nominal pressure p_{nom}	400 bar	The nominal pressure corresponds to the maximum design pressure.
Maximum pressure p_{max}	450 bar	The maximum pressure corresponds to the maximum working pressure within the single operating period. The sum of the single operating periods must not exceed the total operating period.
Single operating period	10 s	
Total operating period	300 h	
Minimum pressure (high-pressure side)	25 bar	Minimum pressure at the high-pressure side (**A** or **B**) which is required to prevent damage to the axial piston unit.
Rate of pressure change $R_{A\ max}$	16 000 bar/s	Maximum permissible speed of pressure build-up and reduction during a pressure change across the entire pressure range.
Pressure at suction port S (inlet)		
Minimum pressure $p_{S\ min}$	≥0.8 bar absolute	Minimum pressure at suction port **S** (inlet) which is required to prevent damage to the axial piston unit. The minimum pressure depends on the rotational speed and displacement of the axial piston unit (see diagram).
Maximum pressure $p_{S\ max}$	30 bar absolute	
Case pressure at port T		
Continuous differential pressure $\Delta p_{T\ cont}$	2 bar	Maximum averaged differential pressure at the shaft seal (case to ambient pressure)
Pressure peak $p_{T\ peak}$	10 bar	t < 0.1 s

Notice

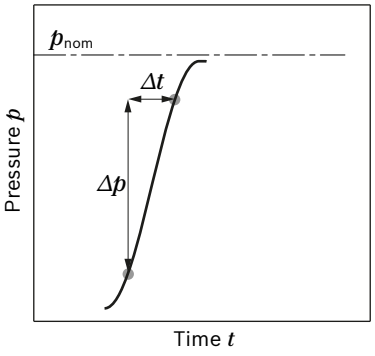
- Working pressure range valid when using hydraulic fluids based on mineral oils. Please contact us for values for other hydraulic fluids.
- In addition to the hydraulic fluid and the temperature, the service life of the shaft seal is influenced by the rotational speed of the axial piston unit and the case pressure.
- The service life of the shaft seal decreases with ncreasing frequency of pressure peaks and increasing mean differential pressure.
- The case pressure must be greater than the ambient pressure.

▼ **Pressure definition**



Total operating period = $t_1 + t_2 + ... + t_n$

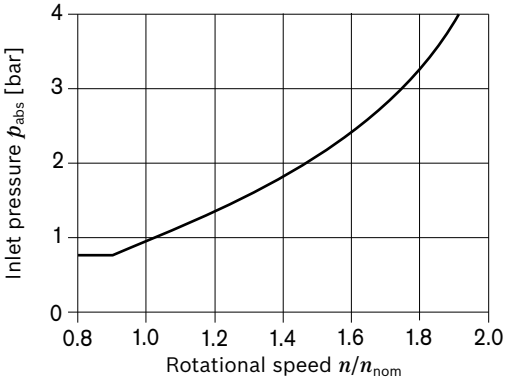
▼ **Rate of pressure change $R_{A\,max}$**



Technical data

Size	NG		45	56	63	80	90
Displacement, geometric, per revolution	V_g	cm³	44.9	56.6	63.0	79.8	90.5
Rotational speed maximum[1]	n_{nom}[2]	rpm	2 240	2 000	2 000	1 800	1 800
	n_{max}[3]	rpm	4 250	3 750	3 750	3 350	3 350
Flow	$q_{v\,max}$	l/min	191	212	236	267	303
Torque at Δp = 400 bar	T	Nm	286	360	401	508	576
Rotary stiffness	c_{min}	kNm/rad	4.52	6.83	8.09	8.96	9.69
Moment of inertia for rotary group	J_{TW}	kgm²	0.0032	0.0032	0.0032	0.0058	0.0054
Maximum angular acceleration	α	rad/s²	5 400	9 000	11 100	7 900	10 100
Case volume	V	l	0.6	0.6	0.6	0.65	0.65
Weight approx.	m	kg	17	17	17	23	23

▼ **Maximum speedw**



Determining the characteristics				
Flow	q_v	$= \frac{V_g \times n \times \eta_v}{1\,000}$		[l/min]
Torque	T	$= \frac{V_g \times \Delta p}{20 \times \pi \times \eta_{mh}}$		[Nm]
Power	P	$= \frac{2 \pi \times T \times n}{60\,000}$	$= \frac{q_v \times \Delta p}{600 \times \eta_t}$	[kW]

Key

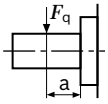
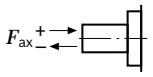
V_g	Displacement per revolution [cm³]
Δp	Differential pressure [bar]
n	Rotational speed [rpm]
η_v	Volumetric efficiency
η_{hm}	Hydraulic-mechanical efficiency
η_t	Total efficiency ($\eta_t = \eta_v \times \eta_{hm}$)

Notice

- Theoretical values, without efficiency and tolerances; values rounded
- Operation above the maximum values or below the minimum values may result in a loss of function, a reduced service life or in the destruction of the axial piston unit. Other permissible limit values, such as speed variation, reduced angular acceleration as a function of the frequency and the permissible angular acceleration at start (lower than the maximum angular acceleration) can be found in data sheet 90261.

1) The values are applicable:
   – for the optimum viscosity range ν_{opt} = 36 ... 16 mm²/s
   – with hydraulic fluid based on mineral oils
2) The values apply at absolute pressure p_{abs} = 1 bar at suction port **S**
3) Maximum speed (speed limit) with increased inlet pressure p_{abs} at suction port **S** (see diagram).

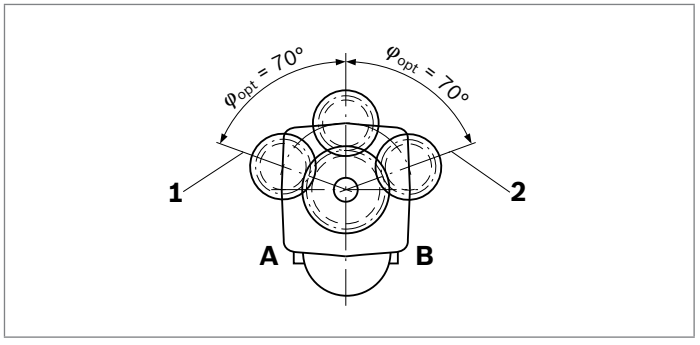
Permissible radial and axial forces of the drive shafts

Size		NG		45	56	56	63	80	80	90
Drive shaft	Type code			Z6/P6	Z6/P6	Z8/P8	Z8/P8	Z8/P8	Z9/P9	Z9/P9
	with splined shaft	ø	mm	30	30	35	35	35	40	40
	with keyed shaft	ø	mm	30	30	35	35	35	40	40
Maximum radial force at distance a (from shaft collar) 		$F_{q\,max}$	kN	7.6	9.5	8.1	9.2	11.6	10.2	11.5
		a	mm	18	18	18	18	20	20	20
Maximum torque at $F_{q\,max}$		$T_{q\,max}$	Nm	286	360	360	401	508	508	576
Maximum differential pressure at $F_{q\,max}$		$\Delta p_{q\,max}$	bar	400	400	400	400	400	400	400
Maximum axial force at standstill or pressure-free operation 		+ $F_{ax\,max}$	N	0	0	0	0	0	0	0
		− $F_{ax\,max}$	N	800	800	800	800	1 000	1 000	1 000
Permissible axial force per bar working pressure		+ $F_{ax\,perm}$/bar	N/bar	8.7	8.7	8.7	8.7	10.6	10.6	10.6

Effect of radial force F_q on bearing service life

By selecting a suitable direction of radial force F_q, the load on the bearings, caused by the internal rotary group forces can be reduced, thus optimizing the service life of the bearings. Recommended position of mating gear is dependent on direction of rotation. Examples:

▼ **Gear drive**



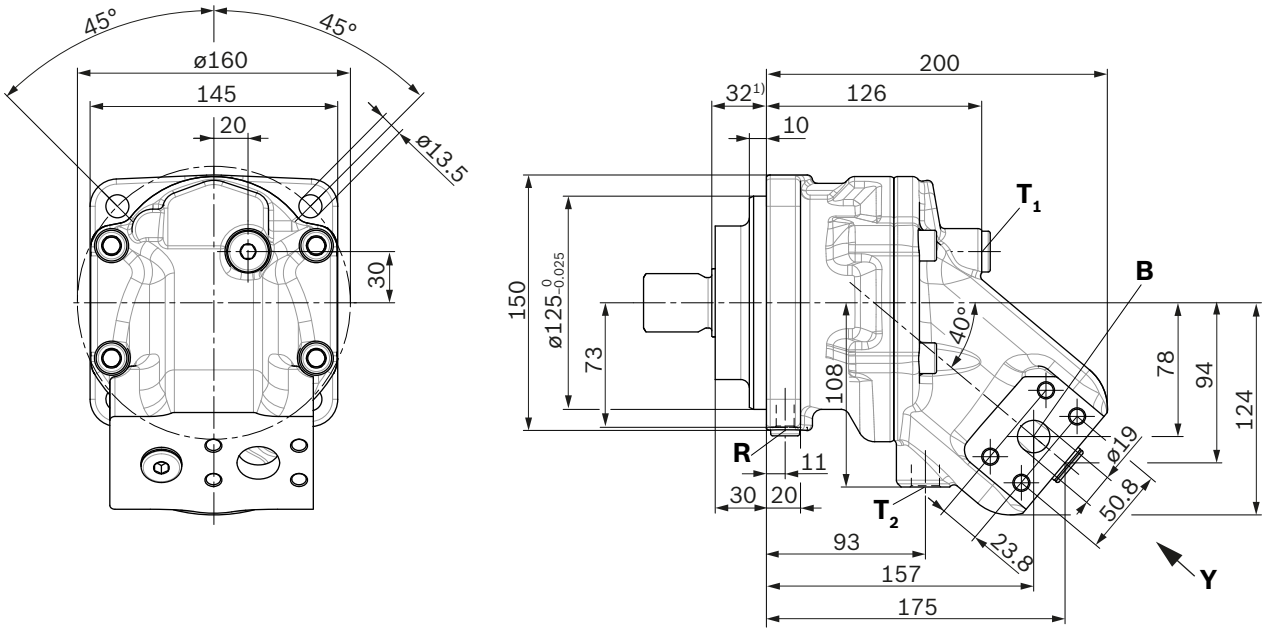
1 "Clockwise" rotation, pressure at port **B**
2 "Counter-clockwise" rotation, pressure at port **A**

Notice

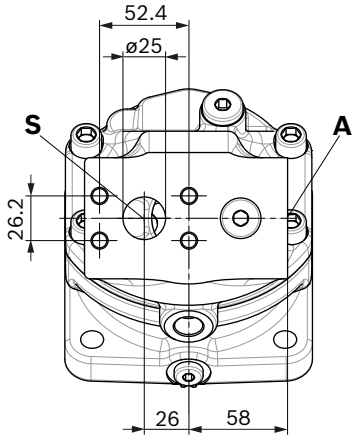
- The values given are maximum values and do not apply to continuous operation.
- The permissible axial force in direction $-F_{ax}$ is to be avoided as the service life of the bearing is reduced.
- Special requirements apply in the case of belt drives. Please contact us.

Dimensions for sizes 45, 56 and 63

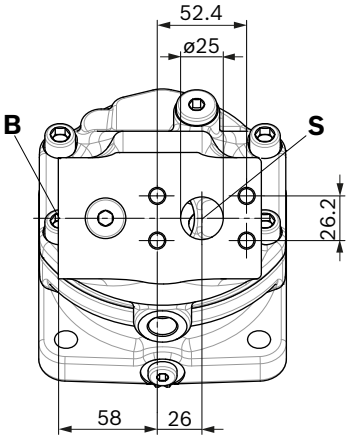
Clockwise rotation

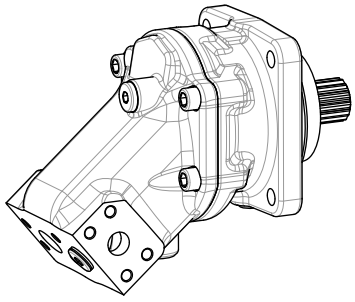


View **Y**
Counter-clockwise rotation



View **Y**
Clockwise rotation



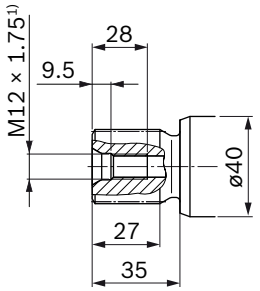


Ports		Standard	Size	p_{max} [bar][3]	State[6]
A, B	Working port Fastening thread	SAE J518[2] DIN 13	3/4 in M10 × 1.5; 17 deep	450	O
S	Suction port Fastening thread	SAE J518[2] DIN 13	1 in M10 × 1.5; 17 deep	30	O
T_1	Drain port	DIN 3852[5]	M18 × 1.5; 12 deep	3	X[4]
T_2	Drain port	DIN 3852[5]	M18 × 1.5; 12 deep	3	O[4]
R	Air bleed port	DIN 3852[5]	M12 × 1.5; 12 deep	3	X

1) To shaft collar
2) Only dimensions according to SAE J518, metric fastening thread is a deviation from the standard.
3) Depending on the application, momentary pressure peaks may occur. Keep this in mind when selecting measuring devices and fittings.
4) Depending on installation position, T_1 or T_2 must be connected (see also installation instructions on page 12).
5) The countersink can be deeper than as specified in the standard.
6) O = Must be connected (plugged on delivery)
X = Plugged (in normal operation)

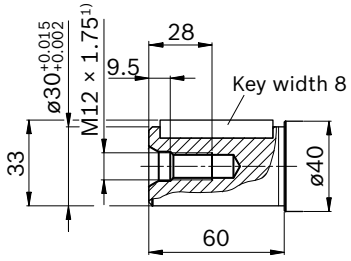
▼ **Splined shaft DIN 5480, sizes 45 and 56**

Z6 – W30×2×14×9g



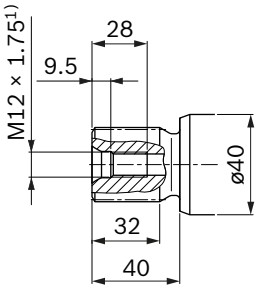
▼ **Parallel keyed shaft, DIN 6885, sizes 45 and 56**

P6 – AS8×7×50



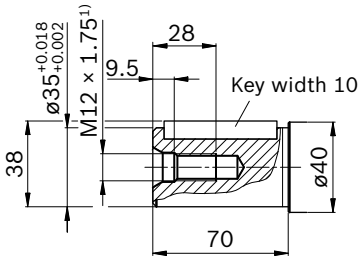
▼ **Splined shaft DIN 5480, sizes 56 and 63**

Z8 – W35×2×16×9g



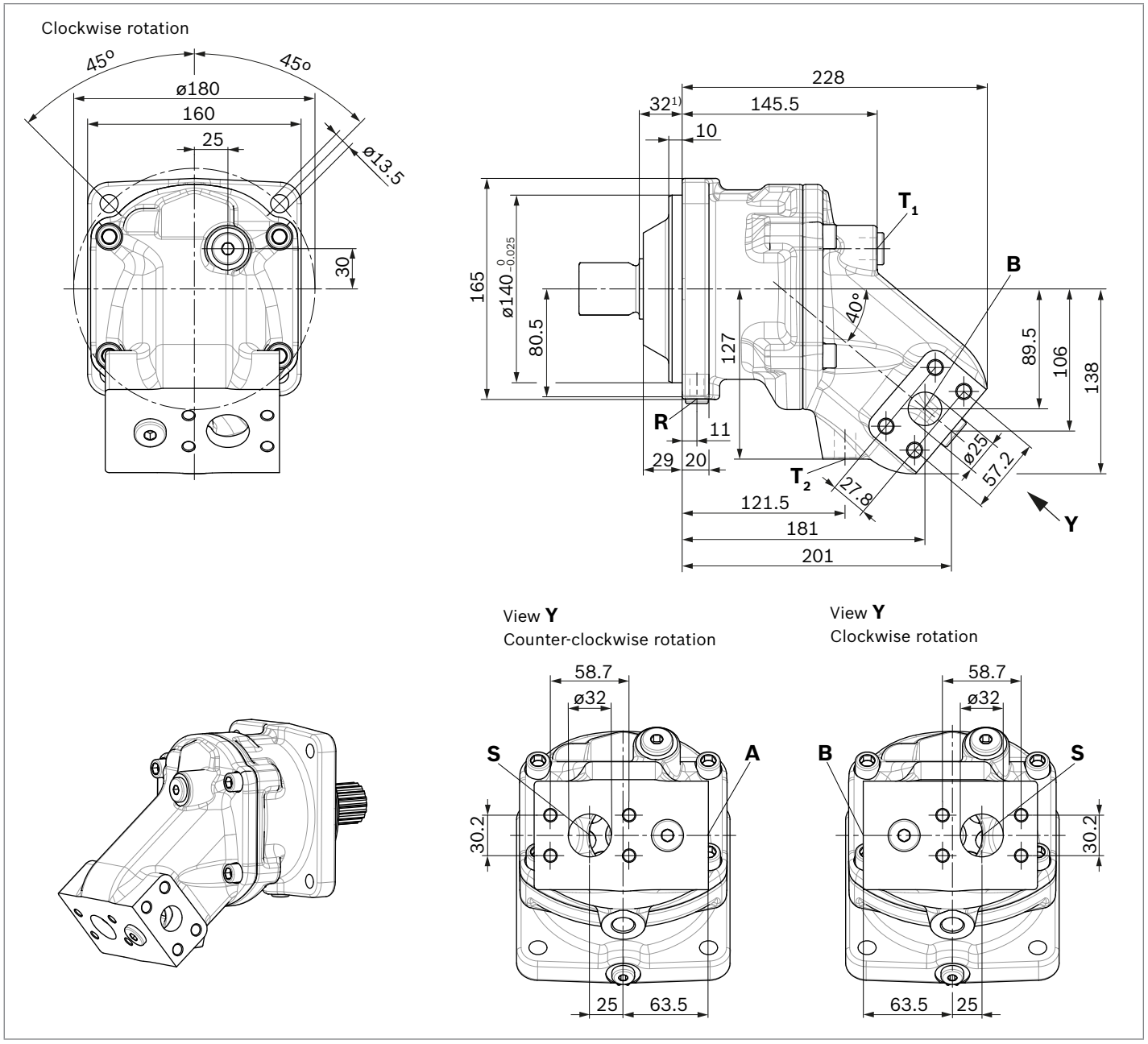
▼ **Parallel keyed shaft, DIN 6885, sizes 56 and 63**

P8 – AS10×8×56



1) Center bore according to DIN 332 (thread according to DIN 13)

Dimensions for sizes 80 and 90

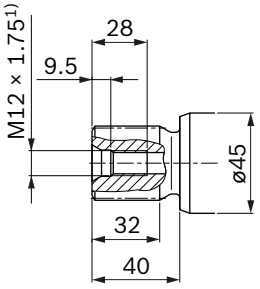


Ports		Standard	Size	p_{max} [bar][3]	State[6]
A, B	Working port Fastening thread	SAE J518[2] DIN 13	1 in M12 × 1.5; 17 deep	450	O
S	Suction port Fastening thread	SAE J518[2] DIN 13	1 1/4 in M10 × 1.5; 17 deep	30	O
$\mathbf{T}_1$	Drain port	DIN 3852[5]	M18 × 1.5; 12 deep	3	X[4]
$\mathbf{T}_2$	Drain port	DIN 3852[5]	M18 × 1.5; 12 deep	3	O[4]
R	Air bleed port	DIN 3852[5]	M12 × 1.5; 12 deep	3	X

1) To shaft collar
2) Only dimensions according to SAE J518, metric fastening thread is a deviation from the standard.
3) Depending on the application, momentary pressure peaks can occur. Keep this in mind when selecting measuring devices and fittings.
4) Depending on installation position, $\mathbf{T}_1$ or $\mathbf{T}_2$ must be connected (see also installation instructions on page 12).
5) The countersink can be deeper than as specified in the standard.
6) O = Must be connected (plugged on delivery)
X = Plugged (in normal operation)

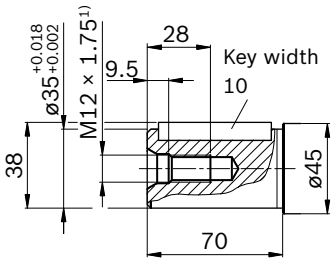
▼ **Splined shaft DIN 5480, size 80**

Z8 – W35×2×16×9g



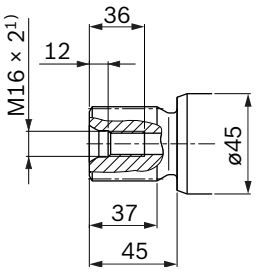
▼ **Parallel keyed shaft, DIN 6885, size 80**

P8 – AS10×8×56



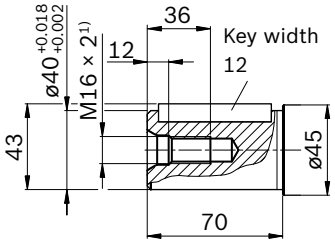
▼ **Splined shaft DIN 5480, sizes 80 and 90**

Z9 – W40×2×18×9g



▼ **Parallel keyed shaft, DIN 6885, sizes 80 and 90**

P9 – AS12×8×56



1) Center bore according to DIN 332 (thread according to DIN 13)

Installation instructions

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.
Particularly in the installation position “drive shaft upwards”, filling and air bleeding must be carried out completely as there is, for example, a danger of dry running.
The leakage in the housing area must be directed to the reservoir via the highest drain port (**T_1**, **T_2**).
If a shared drain line is used for several units, make sure that the respective case pressure is not exceeded. The shared drain line must be dimensioned to ensure that the maximum permissible case pressure of all connected units is not exceeded in any operational circumstances, particularly at cold start. If this is not possible, separate drain line must be laid, if necessary.
To achieve favorable noise values, decouple all connecting lines using elastic elements and avoid above-reservoir installation.
In all operating conditions, the suction line and drain line must flow into the reservoir below the minimum fluid level. The permissible suction height h_S results from the total pressure loss. However, it must not be higher than $h_{S\,max}$ = 800 mm. The minimum suction pressure at port S must also not fall below 0.8 bar absolute during operation or upon a cold start.
When designing the reservoir, ensure that there is adequate distance between the suction line and the drain line. This minimizes oil turbulence and carries out degassing, which prevents the heated hydraulic fluid from being sucked directly back in again.

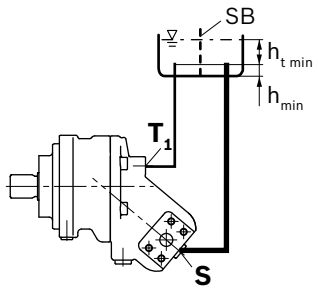
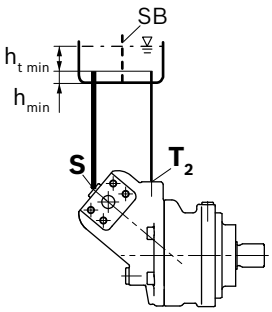
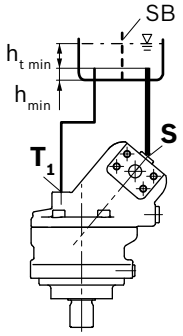
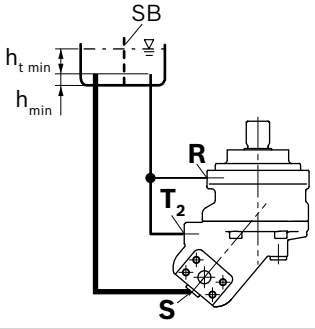
Key	
F	Filling/air bleeding
R	Air bleed port
S	Suction port
T_1, T_2	Drain port
SB	Baffle (baffle plate)
$h_{t\,min}$	Minimum required immersion depth (200 mm)
h_{min}	Minimum required distance to reservoir bottom (100 mm)
$h_{S\,max}$	Maximum permissible suction height (800 mm)

Installation position

See the following examples **1** ... **8**.
Further installation positions are available upon request.
Recommended installation position: **1** and **2**

Below-reservoir installation (standard)

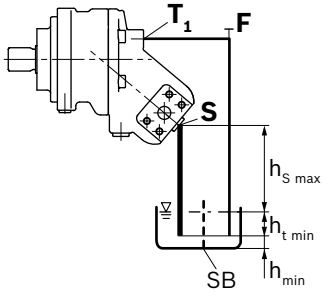
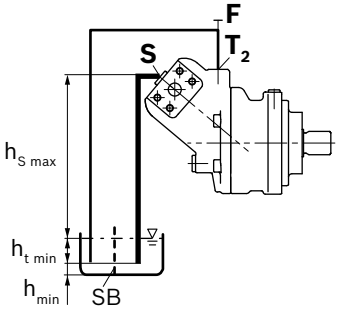
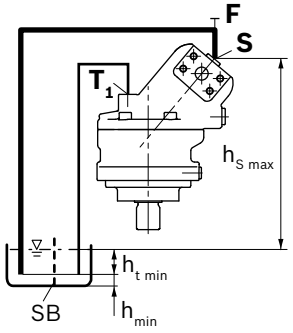
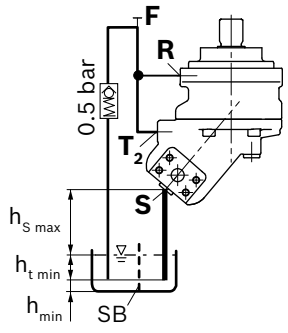
Below-reservoir installation means that the axial piston unit is installed outside of the reservoir and below the minimum fluid level of the reservoir.

Installation position	Air bleed	Filling
1 	–	**T_1**
2 	–	**T_2**
3 	–	**T_1**
4 	**R**	**T_2**

Above-reservoir installation

Above-reservoir installation means that the axial piston unit is installed above the minimum fluid level of the reservoir. Recommendation for installation position **8** (drive shaft upward):

A check valve in the drain line (cracking pressure 0.5 bar) can prevent the housing area from draining.

Installation position	Air bleed	Filling
5 	**F**	**T1 (F)**
6 	**F**	**T2 (F)**
7 	**F**	**T1 (F)**
8 	**R**	**T2 (F)**

Notice

Port **F** is part of the external piping and must be provided on the customer side to make filling and air bleeding easier.

Project planning notes

- The A2FO pump is designed to be used in open circuits.
- The project planning, installation and commissioning of the axial piston unit requires the involvement of qualified skilled personnel.
- Before using the axial piston unit, please read the corresponding instruction manual completely and thoroughly. If necessary, this can be requested from Bosch Rexroth.
- Before finalizing your design, please request a binding installation drawing.
- The specified data and notes contained herein must be observed.
- Depending on the operating conditions 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 periods apply under optimal storage conditions, details of which can be found in the data sheet 90312 or in the instruction manual.
- Not all versions of the product are approved for use in a safety function 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.
- Be sure to add a pressure relief valve to the hydraulic system.
- Please note the details regarding the tightening torques of port threads and other threaded joints in the instruction manual.
- 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 application conditions (pressure, flow, hydraulic fluid, temperature) with the necessary safety factors.
  - The working ports and function ports are only intended to accommodate hydraulic lines.

Safety instructions

- During and shortly after operation, there is a risk of burns on the axial piston unit. Take appropriate safety measures (e.g. by wearing protective clothing).

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