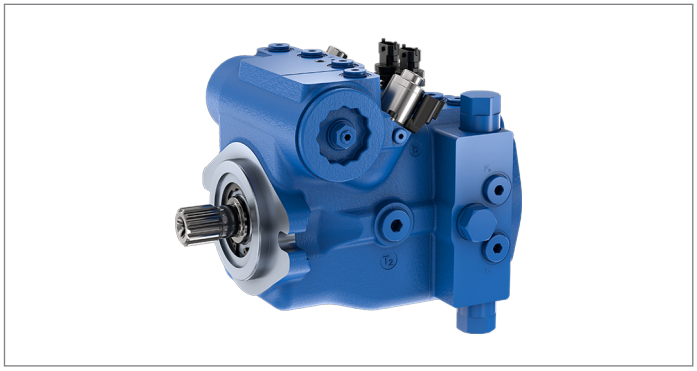
rexroth
A Bosch Company

Axial piston variable pump A10VG series 60



- Medium pressure pump for applications in a closed circuit up to 470 bar
- Size 45
- Nominal pressure 300 bar
- Maximum pressure 470 bar

Features

- High power density owing to a very high pressure level
- Flow direction changes when the swashplate is moved through the neutral position
- High total efficiency
- Swashplate design
- Compact design
- Integrated auxiliary pump for boost and pilot oil supply
- High-pressure relief valves with integrated boost function
- Boost-pressure relief valve
- Through drive for mounting of further pumps up to same size
- Sequence valve – option for higher safety level
- Optional: Version with attachable flushing valve
- Especially suitable for use in electronified travel drives thanks to integrated sensors
- Supports the cross-linking of motor and machine control with the travel drive.

Contents

Type code

01	02	03	04	05	06		07	08	09	10	11	12	13	14	15	16	17	18	19	20	21		22
A10V	**G**	**45**			**P**	**/**	**60**			**N**	**B2**											**–**	

Axial piston unit

01	Swashplate design, variable, nominal pressure 300 bar, maximum pressure 470 bar	**A10V**

Operating mode

02	Pump, closed circuit	**G**

Size (NG)

03	Geometric displacement, see "Technical data" on page 8	**045**	
		●	

Control device			On-board voltage	**045**	
04	Electronic control	direct-operated by two pressure reducing valves; prepared for BODAS Software, preferred variant	U = 12 V	●	**ETA**
			U = 24 V	●	**ETB**
		direct-operated by two pressure reducing valves; with manual override and spring return, prepared for BODAS Software, preferred variant	U = 12 V	○	**ETC**
			U = 24 V	○	**ETD**
	Electronic control	direct-operated by two pressure reducing valves	U = 12 V	●	**ET1**
			U = 24 V	●	**ET2**
		direct-operated by two pressure reducing valves; with manual override and spring return	U = 12 V	○	**ET3**
			U = 24 V	○	**ET4**

Additional function		**045**	
05	Without additional function	●	**0**
	Sequence valve (function normally closed)	●	**A**

Connector for pressure reducing valve and sequence valve[1]		**045**	
06	DEUTSCH molded connector, 2-pin, DT04-2P – without suppressor diode	●	**P**

Series

07	Series 6, index 0	**60**

Version of port and fastening threads		**045**	
08	Metric ports based on ISO 6149 with O-ring seal, metric fastening threads according to DIN 13	●	**M**
	Ports based on ISO 11926 with O-ring seal (ANSI), metric fastening threads according to DIN 13 at the working port and the through drive[2]	●	**D**

Direction of rotation			**045**	
09	Viewed on drive shaft	Clockwise	●	**R**
		Counter-clockwise	●	**L**

Sealing material		**045**	
10	NBR (nitrile rubber), shaft seal in FKM (fluorocarbon rubber)	●	**N**

Mounting flange			**045**	
11	SAE J744	101-2	●	**B2**

Drive shaft				**045**	
12	Splined shaft ANSI B92.1a–1976	1 in	15T 16/32DP	●	**S5**
		1 1/4 in	14T 12/24DP	●	**S7**

● = Available ○ = On request – = Not available = Preferred program

1) Connector specifications refers to control device. Connectors for other electric components may deviate.
2) Also applies to the version without through drive

01	02	03	04	05	06		07	08	09	10	11	12	13	14	15	16	17	18	19	20	21		22
A10V	**G**	**45**			**P**	**/**	**60**			**N**	**B2**											**–**	

Working port — 045

13	SAE working port **A** and **B**, same side left	Suction port **S** bottom	●	**1**
	SAE working port **A** and **B**, same side right	Suction port **S** bottom	●	**2**

Boost pump and rotary group configuration — 045

14	Standard rotary group	without integrated boost pump	●	**U**
		integrated boost pump (standard)	●	**F**
		integrated boost pump (large)	○	**B**

Through drive[3] — 045

15	Without through drive						●	**0000**
	Flange SAE J744			Hub for splined shaft[5]				
	Diameter	Mounting[4]	Code	Diameter		Code	045	
	82-2 (A)	⚷	A1	5/8 in	9T 16/32DP	S2	●	**A1S2**
				3/4 in	11T 16/32DP	S3	●	**A1S3**
		⚯	A2	5/8 in	9T 16/32DP	S2	●	**A2S2**
				3/4 in	11T 16/32DP	S3	●	**A2S3**
	101-2 (B)	⚷	B1	7/8 in	13T 16/32DP	S4	●	**B1S4**
				1 in	15T 16/32DP	S5	●	**B1S5**
		⚯	B2	7/8 in	13T 16/32DP	S4	●	**B2S4**
				1 in	15T 16/32DP	S5	●	**B2S5**

High-pressure relief valve — 045

16	High-pressure relief valve direct operated, fixed setting	without bypass	●	**A**
		with bypass	●	**C**

Boost-pressure relief valve — 045

17	Boost-pressure relief valve, fixed setting	●	**1**
	Locking set with nozzle	●	**7**
	Locking set without nozzle	●	**8**

Filtration boost circuit/ external boost pressure supply — 045

18	Filtration in the boost pump suction line	●	**S**
	Filtration in the boost pump pressure line Ports for external boost circuit filtration ($\mathbf{F}_e$ and $\mathbf{F}_a$)	●	**D**
	External boost pressure supply (on version without integrated boost pump)	●	**E**

Pressure sensor — 045

19	Without pressure sensor	●	**0**
	Pressure sensor at the measuring ports $\mathbf{M}_A$ and $\mathbf{M}_B$ (high pressure) – ratiometric[6]	●	**5**
	Pressure sensor at the measuring ports $\mathbf{M}_A$ and $\mathbf{M}_B$ (high pressure) – SENT[6]	●	**6**

3) Specifications for the version with integrated boost pump, please contact us for the version without boost pump
4) Mounting hole pattern viewed on through drive, control at top
5) Hub for splined shaft according to ANSI B92.1a-1976 (Splined shaft in accordance with SAE J744)
6) Type code, technical data, dimensions and safety instructions about the pressure sensor PR4 can be found in the relevant data sheet (95156). Observe the requirements for the electronics.

01	02	03	04	05	06		07	08	09	10	11	12	13	14	15	16	17	18	19	20	21		22
A10V	**G**	**45**			**P**	**/**	**60**			**N**	**B2**											**–**	

Swivel angle sensor

			045	
20	Without swivel angle sensor		●	**0**
	Electric swivel angle sensor PAL – ratiometric/PWM[7)]	Power supply 5 V DC	o	**H**
	Electric swivel angle sensor PAL – SENT/SENT[7)]	Power supply 5 V DC	o	**P**

Flushing valve

		045	
21	Without flushing valve	●	**0**
	Flushing valve mounted on working port A/B, SAE working port, metric mounting	o	**1**

Standard/special version

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

● = Available o = On request – = Not available = Preferred program

Notice

- Observe the project planning notes on page 35!
- In addition to the type code, please specify the relevant technical data when placing your order.
- Please note that not all type code combinations are available although the individual functions are marked as being available.

7) Type code, technical data, dimensions and safety instructions about the swivel angle sensors PAL can be found in the relevant data sheet 95161. Observe the requirements for the electronics.

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)
- 90225: Limited technical data for operation with water-free and water-containing fire-resistant hydraulic fluids (HFDR, HFDU, HFAE, HFAS, HFB, HFC)

Selection of hydraulic fluid

Bosch Rexroth evaluates hydraulic fluids on the basis of the Fluid Rating according to the technical data sheet 90235.
Hydraulic fluids with positive evaluation in the Fluid Rating are listed in the following data sheet:

- 90245: Bosch Rexroth Fluid Rating List for Rexroth hydraulic components (pumps and motors)

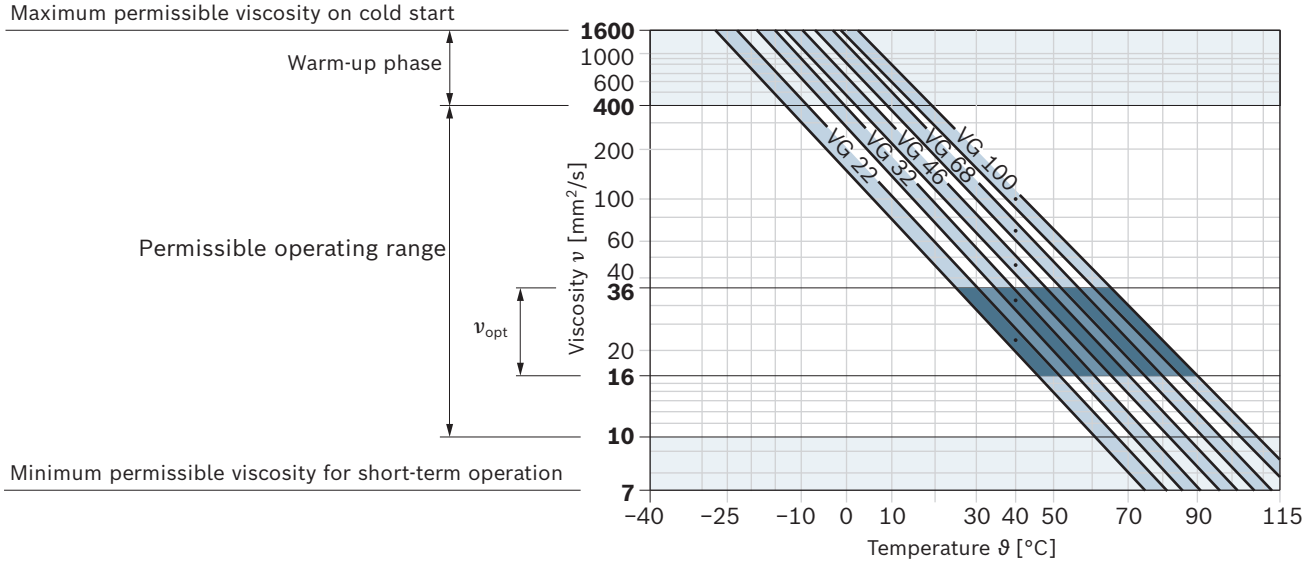
Selection of hydraulic fluid shall make sure that the operating viscosity in the operating temperature range is within the optimum range (v_{opt}; see selection diagram).

Viscosity and temperature of hydraulic fluids

	Viscosity	Shaft seal	Temperature[3]	Comment
Cold start	v_{max} ≤ 1600 mm²/s	NBR[2]	ϑ_{St} ≥ −40°C	t ≤ 3 min, without load (p ≤ 50 bar), n ≤ 1000 rpm
		FKM	ϑ_{St} ≥ −25°C	Permissible temperature difference between axial piston unit and hydraulic fluid in the system maximum 25 K
Warm-up phase	v = 1600 ... 400 mm²/s			t ≤ 15 min, p ≤ 0.7 × p_{nom} und n ≤ 0.5 × n_{nom}
Permissible operating range	v = 400 ... 10 mm²/s[1]	NBR[2]	ϑ ≤ +85 °C	Measured at port **T**
		FKM	ϑ ≤ +110°C	
	v_{opt} = 36 ... 16 mm²/s			Optimal operating viscosity and efficiency range
Short-term operation	v_{min} = 10 ... 7 mm²/s	NBR[2]	ϑ ≤ +85 °C	t ≤ 3 min, p ≤ 0.3 × p_{nom}, measured at port **T**
		FKM	ϑ ≤ +110 °C	

Notice: The maximum circuit temperature of +115°C must not be exceeded at the working ports **A** and **B** complying with the permissible viscosity.

▼ **Selection diagram**



1) This corresponds, e.g. on the 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 a hydraulic fluid viscosity of less than 10 mm²/s (e.g. due to high temperatures during short-term operation), a cleanliness level of at least 19/17/14 according to ISO 4406 is required.

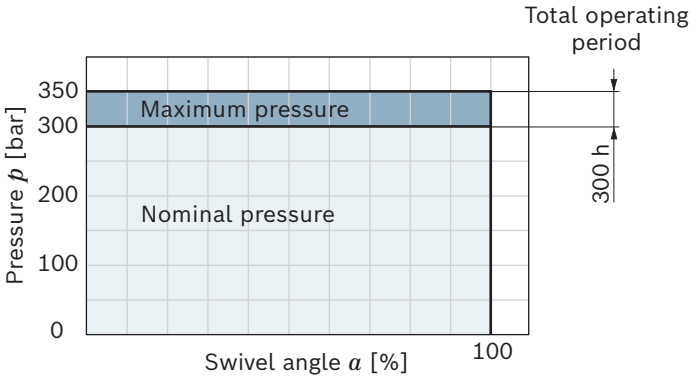
Examples of temperatures of hydraulic fluids at a viscosity of 10 mm²/s:

- 73 °C at HLP 32
- 85 °C at HLP 46

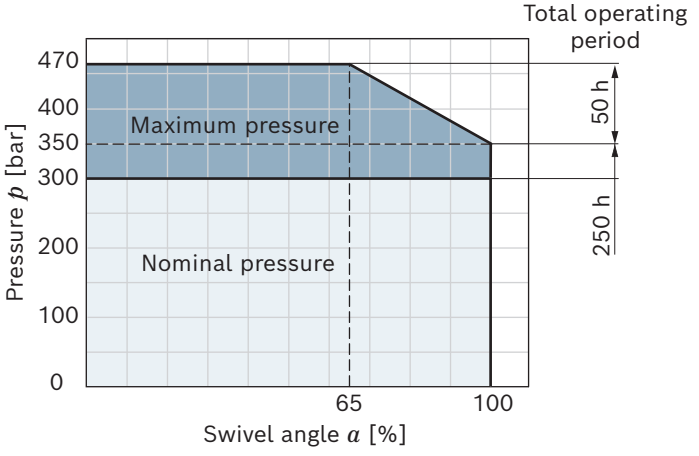
Working pressure range

Pressure at working port A or B		**Definition**
Nominal pressure p_{nom}	300 bar	The nominal pressure corresponds to the maximum design pressure.
Maximum pressure p_{max}	350 bar	The maximum pressure corresponds to the maximum working pressure within a single operating period. The sum of single operating periods must not exceed the total operating period. Within the total operating period of 300 h, a maximum pressure of 350 bar to 470 bar is permissible for a limited period of 50 h. With 470 bar, the axial piston unit may thereby only be swiveled out by a maximum of 65%, see characteristic curve "maximum pressure p_{max} up to 470 bar and total operating period" on page 7. Observe the information regarding "Project planning with a maximum pressure from 350 bar to 470 bar" on page 7.
Maximum single operating period	10 s	
Total operating period	300 h	
Swivel angle	100%	
Maximum pressure p_{max}	470 bar	
Maximum single operating period	10 s	
Total operating period	50 h	
Swivel angle	maximum 65%	
Minimum pressure (low-pressure side)	10 bar above case pressure	Minimum pressure on the low-pressure side (**A** or **B**) required to prevent damage to the axial piston unit.
Rate of pressure change $R_{A\ max}$	9000 bar/s	Maximum permissible speed of pressure build-up and reduction during a pressure change across the entire pressure range.
Boost pump		
Nominal pressure $p_{Sp\ nom}$	25 bar	
Maximum pressure $p_{Sp\ max}$	30 bar	
Pressure at suction port **S** (inlet)		
Continuous $p_{S\ min}$	≥0.8 bar absolute	$v \leq 30$ mm²/s
Short-term, at a cold start	≥0.5 bar absolute	$t < 3$ min
Maximum pressure $p_{S\ max}$	≤5 bar absolute	
Control pressure		
Required control pressure p_{St} at n = 1500 rpm	25 bar above case pressure	Required control pressure p_{St}, to ensure the function of the control. The required control pressure is dependent on the rotational speed and working pressure.
Case pressure at port T		
Continuous differential pressure $\Delta p_{T\ cont}$	2 bar	Maximum, averaged differential pressure at the shaft seal (housing to ambient pressure)
Maximum differential pressure $\Delta p_{T\ max}$	See the diagram	Permissible differential pressure at the shaft seal (case pressure to ambient pressure)
Pressure peaks $p_{T\ peak}$	10 bar	$t < 0.1$ s, maximum 1000 pressure peaks permissible

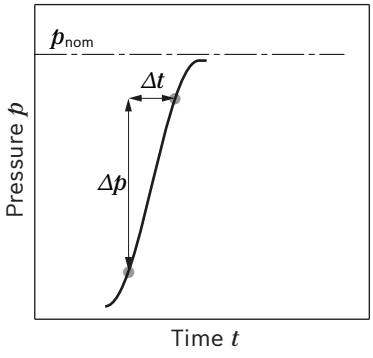
▼ **Maximum pressure p_{max} up to 350 bar and total operating period**



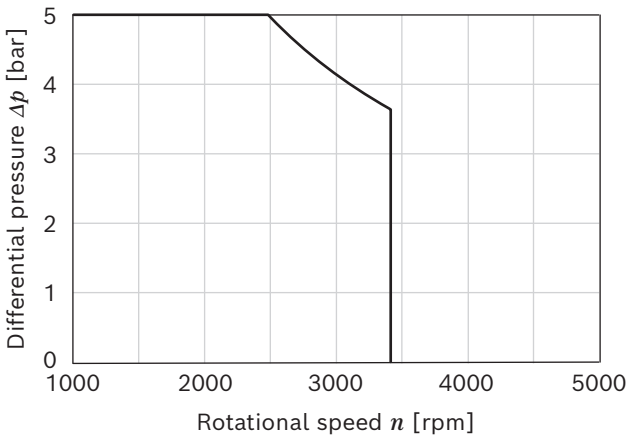
▼ **Maximum pressure p_{max} up to 470 bar and total operating period**



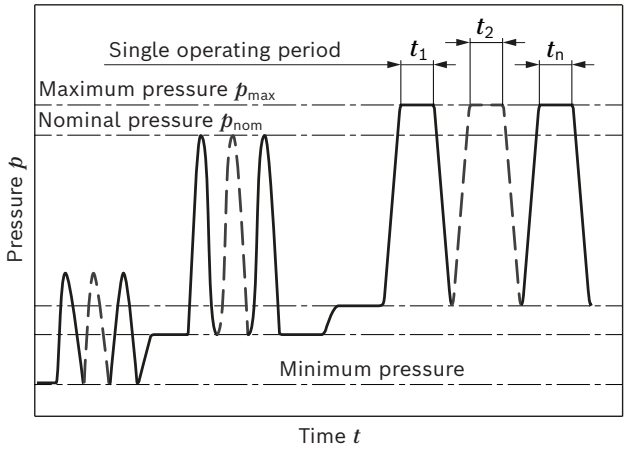
▼ **Rate of pressure change $R_{A\,max}$**



▼ **Maximum differential pressure at the shaft seal**



▼ **Pressure definition**



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

Notice

- Working pressure range applies 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 increasing frequency of pressure peaks and increasing mean differential pressure.
- The case pressure must be greater than the external pressure (ambient pressure) at the shaft seal.
- Project planning with a maximum pressure from 350 bar to 470 bar must be realized via your competent contact partner at Bosch Rexroth.

Technical data

Size			NG		45
Geometric displacement, per revolution					
	Variable pump		$V_{g\,max}$	cm^3	45
	Boost pump, standard (at p = 20 bar)		$V_{g\,Sp}$	cm^3	8.6
	Boost pump, large (at p = 20 bar)		$V_{g\,Sp}$	cm^3	11.6
Rotational speed[1]	Maximum at $V_{g\,max}$ and Δp = 0 bar		n_{nom}	rpm	3400
	At Δp ≥ 40 bar (t < 15 s)		$n_{max\,40}$	rpm	3600
	Minimum		n_{min}	rpm	500
Flow	At n_{nom} and $V_{g\,max}$		q_v	l/min	153
Power[2]	At n_{nom}, $V_{g\,max}$ and Δp = 300 bar		P	kW	76.5
Torque[2]	At $V_{g\,max}$ and	Δp = 300 bar	M	Nm	215
		Δp = 100 bar	M	Nm	71.6
Rotary stiffness of drive shaft		S5	c	kNm/rad	41.3
		S7	c	kNm/rad	57.7
Moment of inertia of the rotary group			J_{TW}	kgm^2	0.0033
Case volume			V	l	1.12
Weight (without through drive) approx.[4]			m	kg	34.3

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. Bosch Rexroth recommends testing the loads by means of experiment or calculation / simulation and comparison with the permissible values.

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

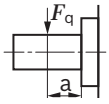
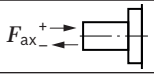
Key

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 ($\eta_t = \eta_v \times \eta_{hm}$)

1) The values are applicable:
   – for the optimum viscosity range from ν_{opt} = 36 to 16 mm^2/s
   – for hydraulic fluid based on mineral oils (for HF hydraulic fluids, observe the technical data in 90225)
2) Without boost pump
3) The data are valid for values between the minimum required and maximum permissible rotational speed.
   Valid for external excitation (e.g. diesel engine 2 to 8 times the rotary frequency; cardan shaft 2 times the rotary frequency).
   The limit value is only valid for a single pump.
   The load capacity of the connection parts must be considered.
4) Weight may vary by equipment.

Permissible radial and axial loading of the drive shaft

▼ **Splined shaft ANSI B92.1a**

Size		NG		45	45
Drive shaft			in	1	1 1/4
Maximum radial force at distance a (from shaft collar)		$F_{q\,max}$	N	4676	4191
		a	mm	19	24
Maximum axial force		$+F_{ax\,max}$	N	1700	1700
		$-F_{ax\,max}$	N	1060	1060

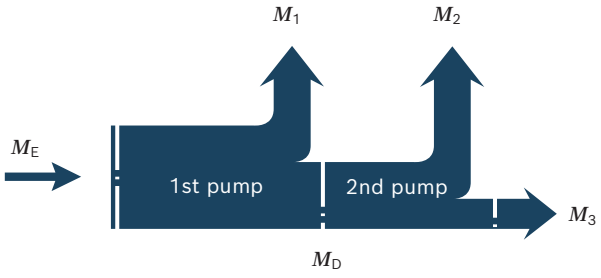
Notice

- The axial and radial loading generally influence the bearing service life.
- Special requirements apply in the case of belt drive and cardan shaft. Please contact us.

Permissible input and through-drive torques

Size			NG		45
Torque at $V_{g\,max}$ and Δp = 300 bar[1]			M	Nm	215
Maximum input torque on drive shaft[2]					
ANSI B92.1a–1976	**S5**	1 in	$M_{E\,max}$	Nm	414
	S7	1 1/4 in	$M_{E\,max}$	Nm	793
Maximum through-drive torque			$M_{D\,max}$	Nm	On request

▼ **Distribution of torques**



Torque at 1st pump	M_1		
Torque at 2nd pump	M_2		
Torque at 3rd pump	M_3		
Input torque	M_E	=	$M_1 + M_2 + M_3$
	M_E	<	$M_{E\,max}$
Through-drive torque	M_D	=	$M_2 + M_3$
	M_D	<	$M_{D\,max}$

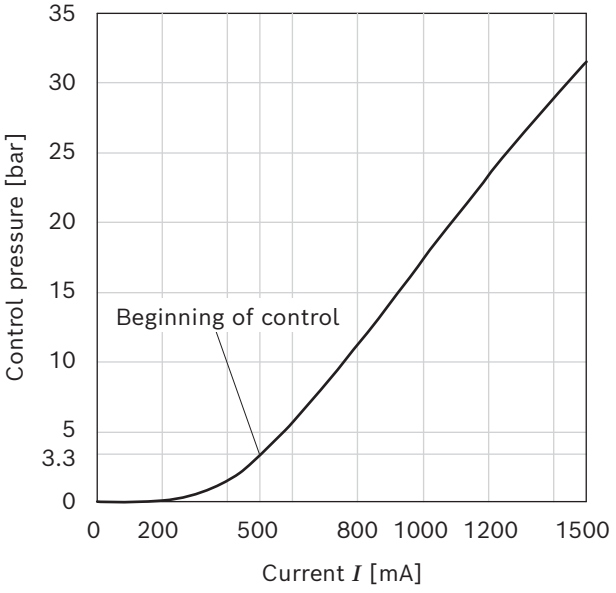
1) Efficiency not considered
2) For drive shafts free of radial force
3) Observe the maximum permissible input torque

ET – Electronic control, direct-operated

ETA/ETB – two pressure reducing valves; prepared for BODAS Software

The ETA/ETB control is optimized for electronic drives and is intended to be used together with BODAS Software. Here, all relevant configuration options have already been predefined and ensure an optimal interaction of pump and software thanks to the standardization. The pump function is largely determined by the software used.

The output flow of the pump is infinitely variable in the range between 0 and 100%. Depending on the preselected current I at solenoids **a** and **b** of the pressure reducing valves, the stroking cylinder of the pump is proportionally supplied with control pressure. The two control pressures $\mathbf{X}_1$ and $\mathbf{X}_2$ can be controlled independently. The pump displacement that arises at a certain control current is dependent on the rotational speed and working pressure of the pump. A different flow direction is associated with each pressure reducing valve.
Maximum permissible control pressure: 30 bar.

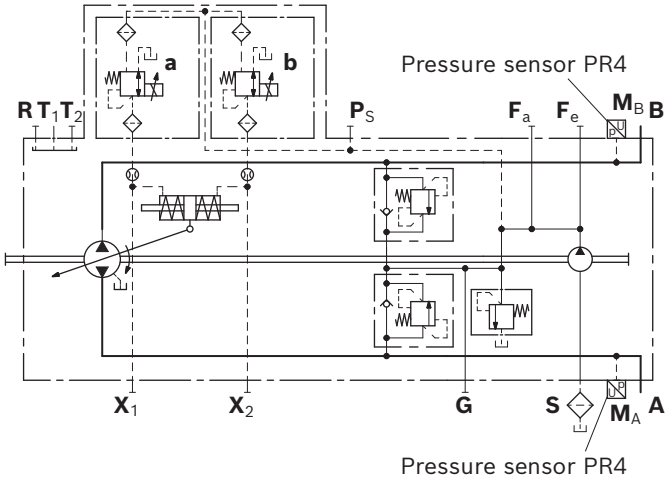


Technical data, pressure reducing valve	ETA	ETB
On-board voltage in the vehicle	12 V	24 V
Permissible voltage U	9.6 ... 28.8 V	
Current limit	1.5 A	
Nominal resistance (at 20°C)	3.3 Ω	
Dither		
Frequency	100 Hz	150 Hz
Minimum oscillation range[1)]	300 mA	
Recommended oscillation range	500 mA	
Duty cycle	100%	
Type of protection: see connector version page 27		

Notice

- All control-relevant data are already stored in the software.
- The pressure reducing valves in the ETA/ETB version have no manual override. Pressure reducing valves with manual override and spring return are available on request (version ETC/ETD).

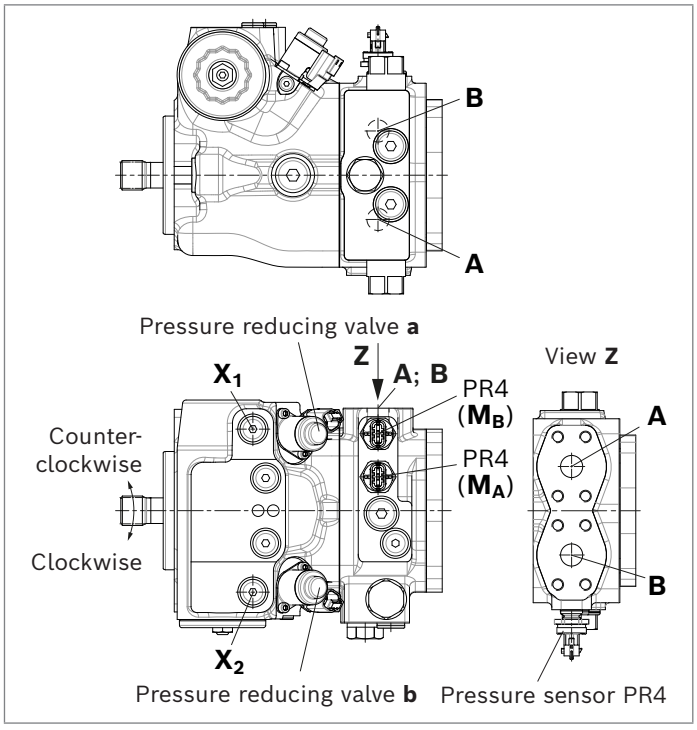
▼ **Circuit diagram**



1) Minimum required oscillation range of the control current $\Delta I_{p\text{-}p}$ (peak to peak) within the respective control range (start of control to end of control).

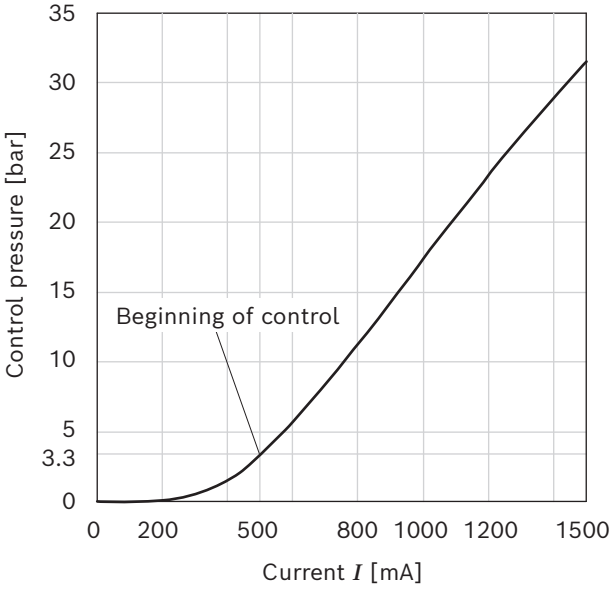
Correlation of direction of rotation, control and flow direction				
Direction of rotation	Clockwise		Counter-clockwise	
Actuation of pressure reducing valve	**a**	**b**	**a**	**b**
Control pressure	X_1	X_2	X_1	X_2
Flow direction	**A** to **B**	**B** to **A**	**B** to **A**	**A** to **B**
Working pressure	M_B	M_A	M_A	M_B

▼ **Position of ports (example)**



ET1/ ET2 – two pressure reducing valves

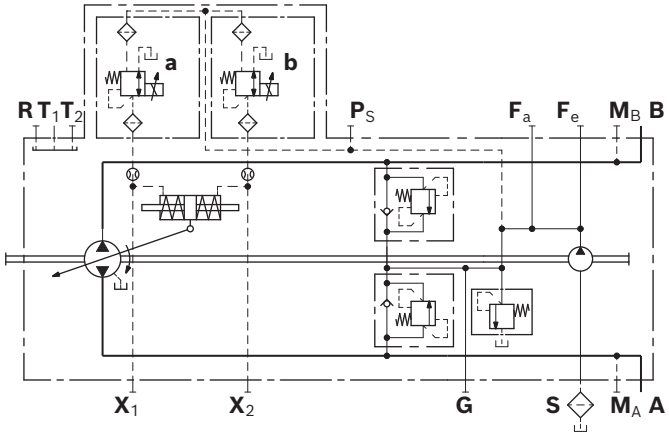
The output flow of the pump is infinitely variable in the range between 0 and 100%. Depending on the preselected current I at solenoids **a** and **b** of the pressure reducing valves, the stroking cylinder of the pump is proportionally supplied with control pressure. The two control pressures $\mathbf{X}_1$ and $\mathbf{X}_2$ can be controlled independently. The pump displacement that arises at a certain control current is dependent on the rotational speed and working pressure of the pump. A different flow direction is associated with each pressure reducing valve. Maximum permissible control pressure: 30 bar.



Technical data, pressure reducing valve	ET1	ET2
On-board voltage in the vehicle	12 V	24 V
Permissible voltage U	9.6 ... 28.8 V	
Current limit	1.5 A	
Nominal resistance (at 20°C)	3.3 Ω	
Dither		
Frequency	100 Hz	150 Hz
Minimum oscillation range[1)]	300 mA	
Recommended oscillation range	500 mA	
Duty cycle	100%	
Type of protection: see connector version page 27		

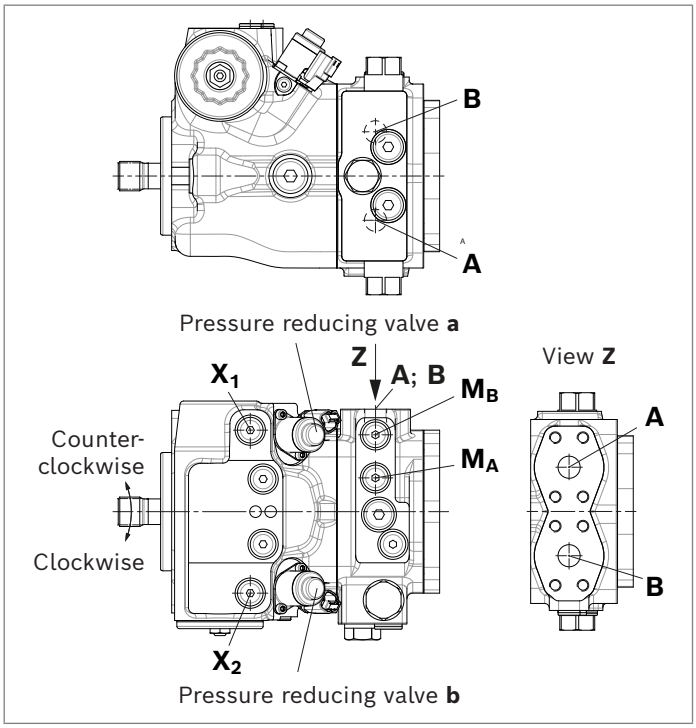
1) Minimum required oscillation range of the control current $\Delta I_{p\text{-}p}$ (peak to peak) within the respective control range (start of control to end of control).

▼ **Circuit diagram**



Correlation of direction of rotation, control and flow direction				
Direction of rotation	Clockwise		Counter-clockwise	
Actuation of pressure reducing valve	**a**	**b**	**a**	**b**
Control pressure	$\mathbf{X}_1$	$\mathbf{X}_2$	$\mathbf{X}_1$	$\mathbf{X}_2$
Flow direction	**A** to **B**	**B** to **A**	**B** to **A**	**A** to **B**
Working pressure	$\mathbf{M}_B$	$\mathbf{M}_A$	$\mathbf{M}_A$	$\mathbf{M}_B$

▼ **Position of ports (example)**



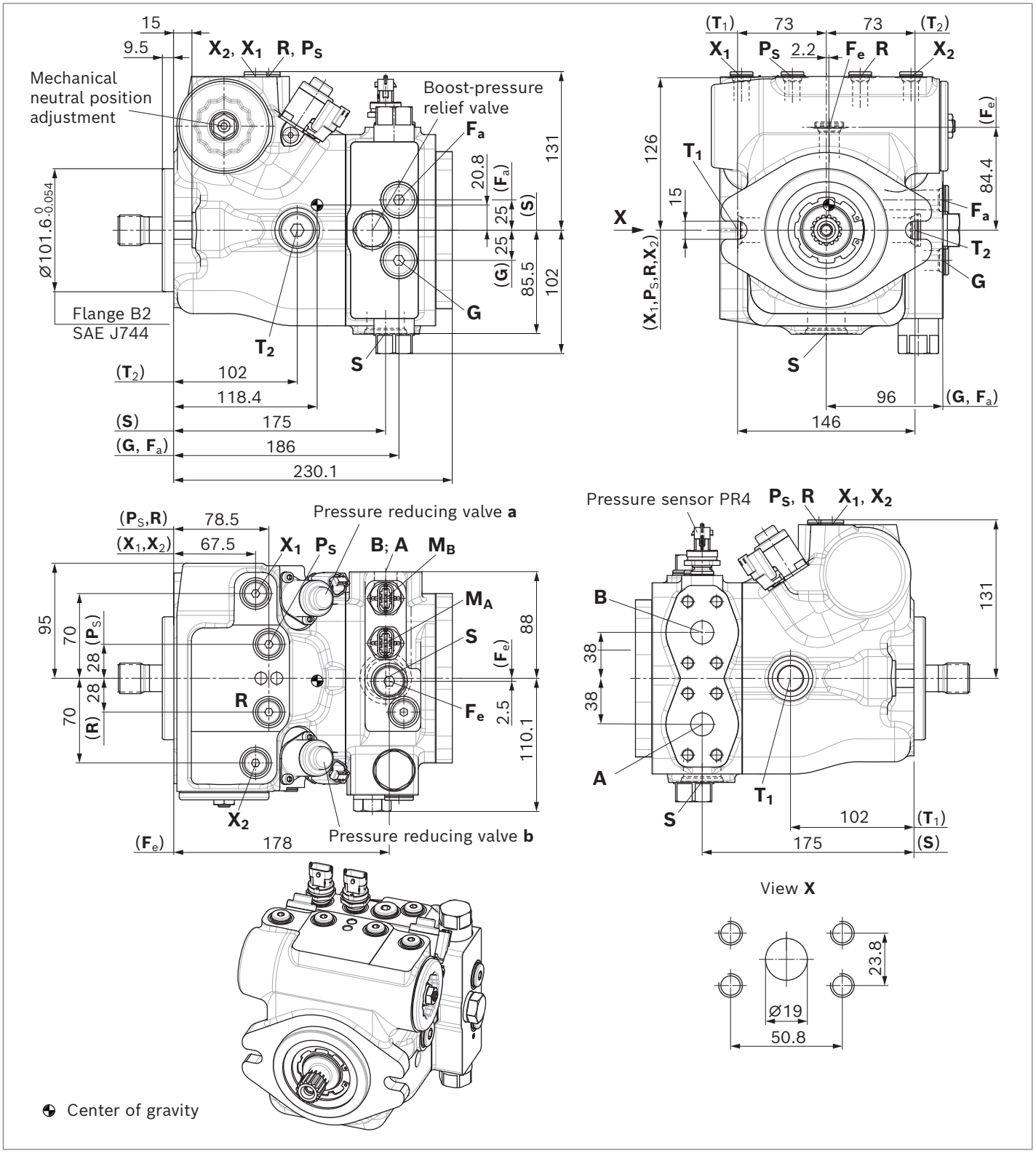
Notice

The pressure reducing valves in the ET1/ET2 version have no manual override. Pressure reducing valves with manual override and spring return are available on request (version ET3/ET4).

Dimensions, size 45

ETA/ETB – Electronic control, direct-operated, prepared for BODAS Software

Standard: working port **A** and **B** same side left, suction port **S** bottom (1)

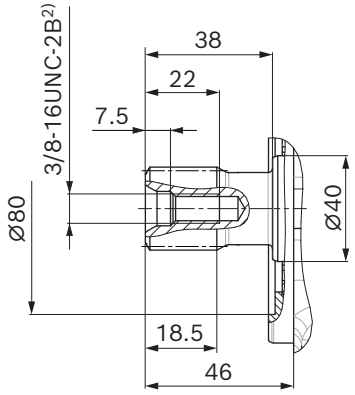


Notice

Option: Working port **A** and **B** same side right, suction port **S** bottom (2) installation drawing on request

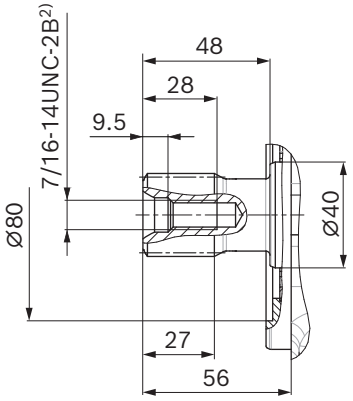
▼ **Splined shaft ANSI B92.1a**

S5 – 1 in 15T 16/32DP[1)]

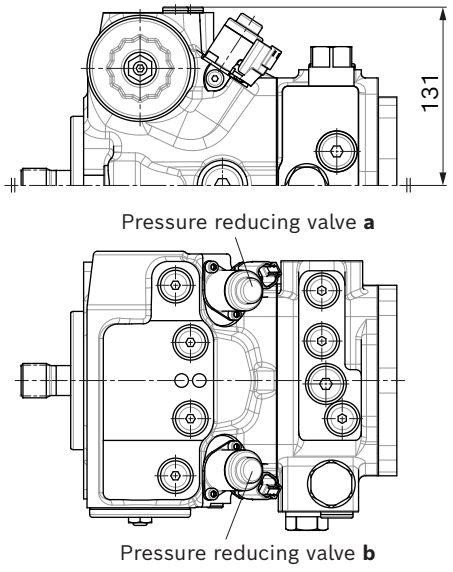


▼ **Splined shaft ANSI B92.1a**

S7 – 1 1/4 in 14T 12/24DP[1)]



▼ **ET1/ET2 – Electronic control, direct-operated**



1) Involute spline according to ANSI B92.1a, 30° pressure angle, flat root, side fit, tolerance class 5
2) Thread according to ASME B1.1

Ports version "M", metric		**Standard**	**Size**	p_{max} **[bar]**[3]	**State**[9]
A, B	Working port Fastening thread	ISO 6162-2[4] DIN 13	P19M M10 × 1.5; 18 deep	470	O
S	Suction port	ISO 6149	M33 × 2; 19 deep	5	O[5]
$\mathbf{T}_1$	Drain port	ISO 6149	M22 × 1.5; 15.5 deep	3	O[6]
$\mathbf{T}_2$	Drain port	ISO 6149	M22 × 1.5; 15.5 deep	3	X[6]
R	Air bleed port	ISO 6149	M14 × 1.5; 11.5 deep	3	X
$\mathbf{X}_1$, $\mathbf{X}_2$	Control pressure port	ISO 6149	M14 × 1.5; 11.5 deep	30	X
G	Boost pressure port inlet	ISO 6149	M18 × 1.5; 14.5 deep	30	X
$\mathbf{P}_S$	Pilot pressure port	ISO 6149	M14 × 1.5; 11.5 deep	30	X
$\mathbf{M}_A$, $\mathbf{M}_B$	Measuring port, pressure A, B	ISO 6149	M14 × 1.5; 11.5 deep	470	X[7]
$\mathbf{F}_a$	Boost pressure port inlet	ISO 6149	M18 × 1.5; 14.5 deep	30	X[8]
$\mathbf{F}_e$	Boost pressure port output	ISO 6149	M18 × 1.5; 14.5 deep	30	X[8]

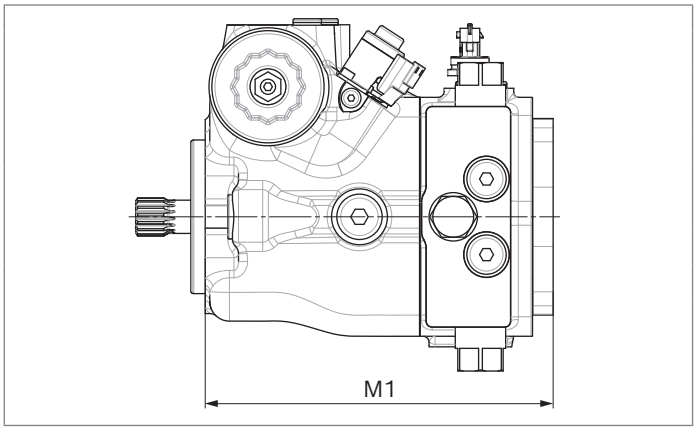
Ports version "D", ANSI, metric fastening thread		**Standard**	**Size**	p_{max} **[bar]**[3]	**State**[9]
A, B	Working port Fastening thread	ISO 6162-2[4] DIN 13	P19M M10 × 1.5; 18 deep	470	O
S	Suction port	ISO 11926	1 5/16 -14 UNF-2B; 20 deep	5	O[5]
$\mathbf{T}_1$	Drain port	ISO 11926	7/8 -14 UNF-2B; 17 deep	3	O[6]
$\mathbf{T}_2$	Drain port	ISO 11926	7/8 -14 UNF-2B; 17 deep	3	X[6]
R	Air bleed port	ISO 11926	9/16 -18 UNF-2B; 13 deep	3	X
$\mathbf{X}_1$, $\mathbf{X}_2$	Control pressure port	ISO 11926	9/16 -18 UNF-2B; 13 deep	30	X
G	Boost pressure port inlet	ISO 11926	3/4 -16 UNF-2B; 15 deep	30	X
$\mathbf{P}_S$	Pilot pressure port	ISO 11926	9/16 -18 UNF-2B; 13 deep	30	X
$\mathbf{M}_A$, $\mathbf{M}_B$	Measuring port, pressure A, B	ISO 11926	9/16 -18 UNF-2B; 13 deep	470	X[7]
$\mathbf{F}_a$	Boost pressure port inlet	ISO 11926	3/4 -16 UNF-2B; 15 deep	30	X[8]
$\mathbf{F}_e$	Boost pressure port output	ISO 11926	3/4 -16 UNF-2B; 15 deep	30	X[8]

3) Depending on the application, momentary pressure peaks can occur. Keep this in mind when selecting measuring devices and fittings.
4) Only dimensions according to ISO 6162-2, diameter in detail X is a deviation from the standard.
5) Plugged for external boost pressure supply.
6) Depending on installation position, $\mathbf{T}_1$ or $\mathbf{T}_2$ must be connected (see also installation instructions on page 32).
7) Pressure sensor mounted or $\mathbf{M}_A$, $\mathbf{M}_B$ plugged.
8) Must be connected for filtration in the pressure line.
9) O = Must be connected (plugged on delivery)
X = Plugged (in normal operation)

Dimensions, through-drive

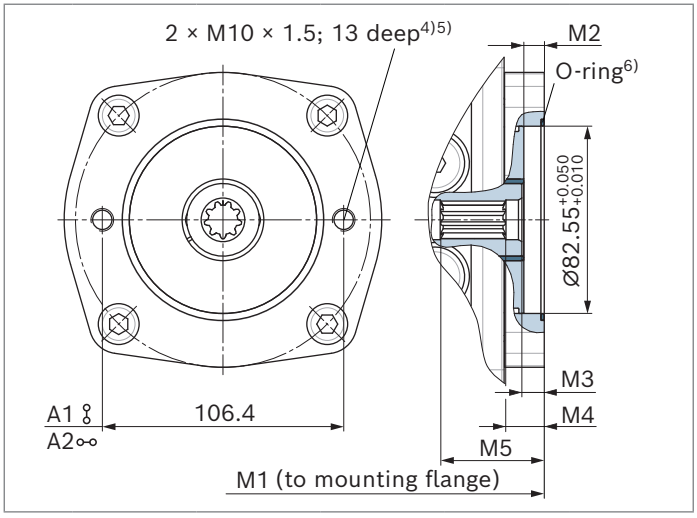
Flange SAE J744[1]			Hub for splined shaft[2]				
Diameter	**Mounting[3]**	**Code**	**Diameter**		**Code**	**45**	
Without through drive						●	**0000**
82-2 (A)	⚷	A1	5/8 in	9T 16/32DP	S2	●	**A1S2**
	⚯	A2	5/8 in	9T 16/32DP	S2	●	**A2S2**

▼ **Without through drive – without boost pump, with integrated boost pump – standard or with integrated boost pump – large**



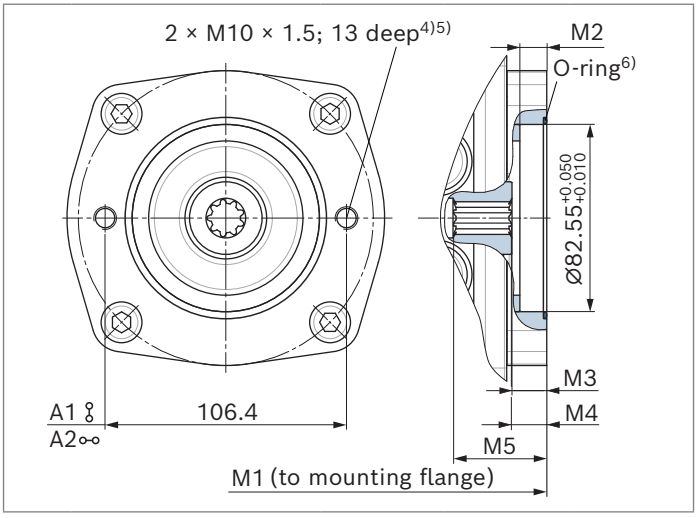
Without boost pump	
NG	**M1**
45	230.1
Integrated boost pump – standard	
NG	**M1**
45	230.1
Integrated boost pump – large	
NG	**M1**
45	234.1

▼ **A1S2, A2S2 (with boost pump)**
Flange SAE J744: 82-2 (A)
Hub for splined shaft 5/8 in 9T 16/32DP[2]



Integrated boost pump – standard					
NG	**M1**	**M2**	**M3**	**M4**	**M5**
45	234.1	9	9.9	17.1	45.6
Integrated boost pump – large					
NG	**M1**	**M2**	**M3**	**M4**	**M5**
45	238.1	9	9.9	17.1	49.6

▼ **A1S2, A2S2 (without boost pump)**
Flange SAE J744: 82-2 (A)
Hub for splined shaft 5/8 in 9T 16/32DP[2]

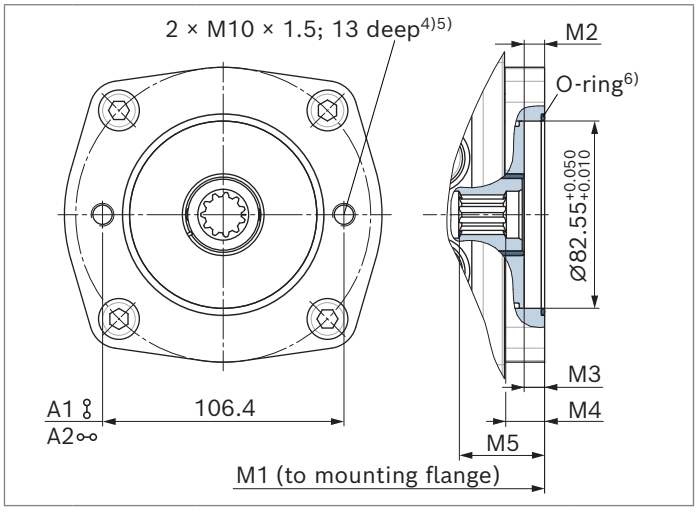


Without boost pump					
NG	**M1**	**M2**	**M3**	**M4**	**M5**
45	234.1	11.9	15.3	15.6	41

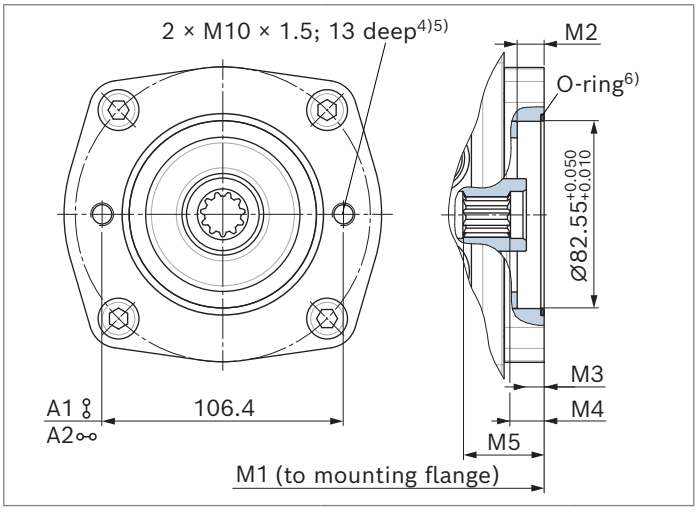
1) The through-drive flange is only supplied with a metric fastening thread.
2) Involute spline of the splined shaft in accordance with ANSI B92.1a, 30° pressure angle, flat root, side fit, tolerance class 5. Design for connecting overview according to SAE J744.
3) Mounting holes pattern viewed on through drive with control at top
4) Thread according to DIN 13
5) Design according to VDI 2230 with μ = 0.1 for screw quality 8.8 according to ISO 898-1
6) O-ring included in the scope of delivery

Flange SAE J744[1]			Hub for splined shaft[2]				
Diameter	**Mounting[3]**	**Code**	**Diameter**		**Code**	**45**	
82-2 (A)	⚷	A1	3/4 in	11T 16/32DP	S3	●	**A1S3**
	⚯	A2	3/4 in	11T 16/32DP	S3	●	**A2S3**

▼ **A1S3, A2S3 (with boost pump)**
Flange SAE J744: 82-2 (A)
Hub for splined shaft 3/4 in 11T 16/32DP[2]



▼ **A1S3, A2S3 (without boost pump)**
Flange SAE J744: 82-2 (A)
Hub for splined shaft 3/4 in 11T 16/32DP[2]



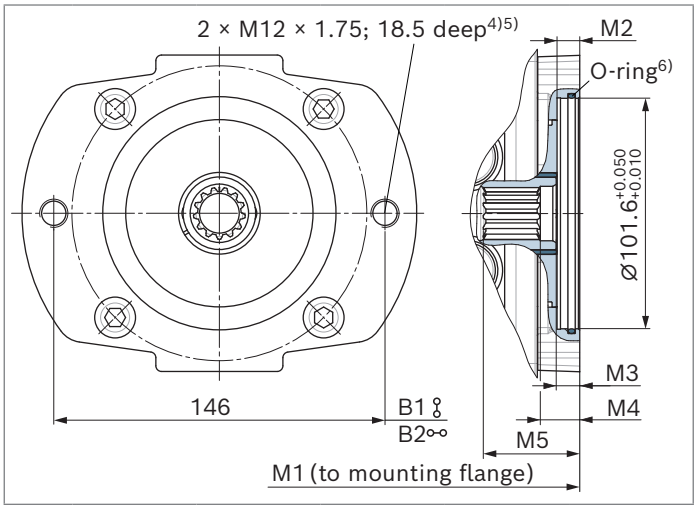
Integrated boost pump – standard					
NG	**M1**	**M2**	**M3**	**M4**	**M5**
45	234.1	9	9	17.2	37.6
Integrated boost pump – large					
NG	**M1**	**M2**	**M3**	**M4**	**M5**
45	238.1	9	9.4	17.7	38.1

Without boost pump					
NG	**M1**	**M2**	**M3**	**M4**	**M5**
45	234.1	11.9	7.8	15.1	35.5

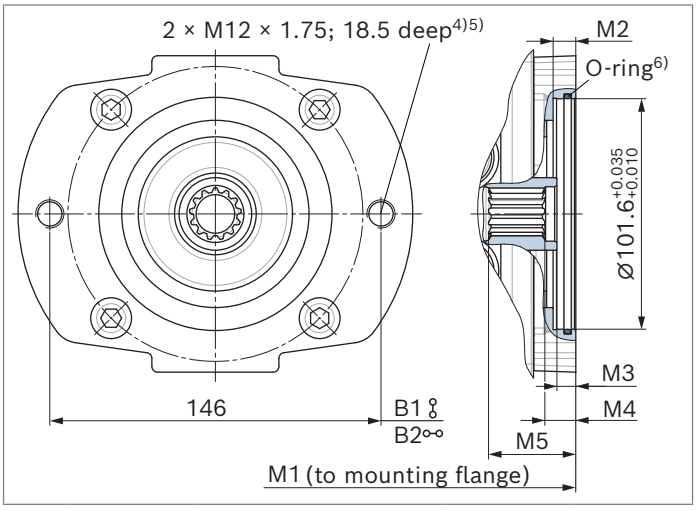
1) The through-drive flange is only supplied with a metric fastening thread.
2) Involute spline of the splined shaft in accordance with ANSI B92.1a, 30° pressure angle, flat root, side fit, tolerance class 5. Design for connecting overview according to SAE J744.
3) Mounting holes pattern viewed on through drive with control at top
4) Thread according to DIN 13
5) Design according to VDI 2230 with μ = 0.1 for screw quality 8.8 according to ISO 898-1
6) O-ring included in the scope of delivery

Flange SAE J744[1]			Hub for splined shaft[2]				
Diameter	**Mounting[3]**	**Code**	**Diameter**		**Code**	**45**	
101-2 (B)	⚷	B1	7/8 in	13T 16/32DP	S4	●	**B1S4**
	⚯	B2	7/8 in	13T 16/32DP	S4	●	**B2S4**

▼ **B1S4, B2S4 (with boost pump)**
Flange SAE J744: 101-2 (B)
Hub for splined shaft 7/8 in 13T 16/32DP[2]



▼ **B1S4, B2S4 (without boost pump)**
Flange SAE J744: 101-2 (B)
Hub for splined shaft 7/8 in 13T 16/32DP[2]



Integrated boost pump – standard					
NG	**M1**	**M2**	**M3**	**M4**	**M5**
45	235.1	10	10.4	17.7	42.5

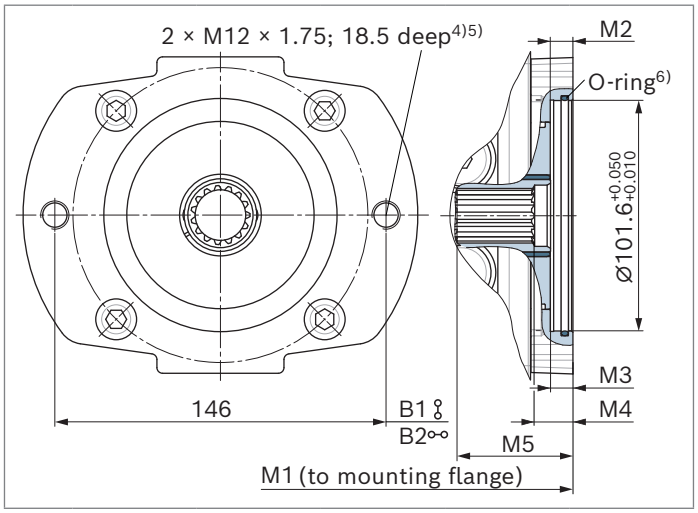
Integrated boost pump – large					
NG	**M1**	**M2**	**M3**	**M4**	**M5**
45	239.1	10	10.9	16.2	46.5

Without boost pump					
NG	**M1**	**M2**	**M3**	**M4**	**M5**
45	235.1	10	8.3	13.6	38.5

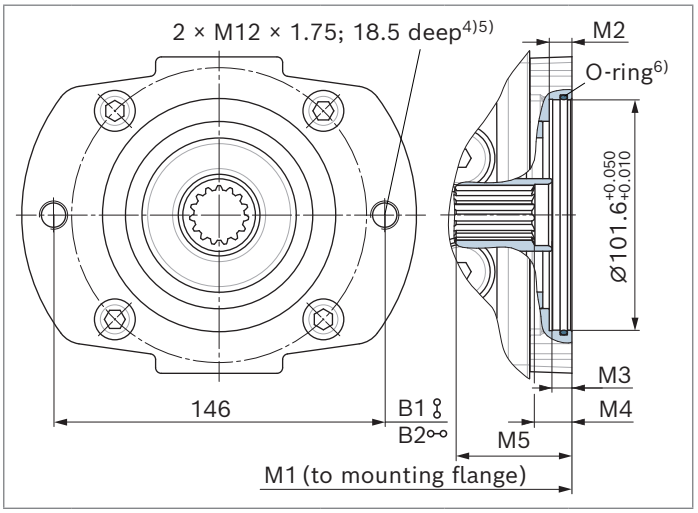
1) The through-drive flange is only supplied with a metric fastening thread.
2) Involute spline of the splined shaft in accordance with ANSI B92.1a, 30° pressure angle, flat root, side fit, tolerance class 5. Design for connecting overview according to SAE J744.
3) Mounting holes pattern viewed on through drive with control at top
4) Thread according to DIN 13
5) Design according to VDI 2230 with μ = 0.1 for screw quality 8.8 according to ISO 898-1
6) O-ring included in the scope of delivery

Flange SAE J744[1]			Hub for splined shaft[2]				
Diameter	**Mounting[3]**	**Code**	**Diameter**		**Code**	**45**	
101-2 (B)	⚷	B1	1 in	15T 16/32DP	S5	●	**B1S5**
	⚯	B2	1 in	15T 16/32DP	S5	●	**B2S5**

▼ **B1S5, B2S5 (with boost pump)**
Flange SAE J744: 101-2 (B)
Hub for splined shaft 1 in 15T 16/32DP[2]



▼ **B1S5, B2S5 (without boost pump)**
Flange SAE J744: 101-2 (B)
Hub for splined shaft 1 in 15T 16/32DP[2]



Integrated boost pump – standard					
NG	**M1**	**M2**	**M3**	**M4**	**M5**
45	235.1	10	9.9	17.1	51.1
Integrated boost pump – large					
NG	**M1**	**M2**	**M3**	**M4**	**M5**
45	239.1	10	10.9	16.6	55.1

Without boost pump					
NG	**M1**	**M2**	**M3**	**M4**	**M5**
45	235.1	10	8.8	16.6	51

1) The through-drive flange is only supplied with a metric fastening thread.
2) Involute spline of the splined shaft in accordance with ANSI B92.1a, 30° pressure angle, flat root, side fit, tolerance class 5. Design for connecting overview according to SAE J744.
3) Mounting holes pattern viewed on through drive with control at top
4) Thread according to DIN 13
5) Design according to VDI 2230 with μ = 0.1 for screw quality 8.8 according to ISO 898-1
6) O-ring included in the scope of delivery

Overview of mounting options

Through drive[1]			Mounting options – 2nd pump				
Flange	**Hub for splined shaft**	**Code**	**A10VG/60 NG (shaft)**	**A4VG/32 NG (shaft)**	**A10VG/10 NG (shaft)**	**External gear pump[2]**	
82-2 (A)	5/8 in	**A_S2**	–	–	–	AZPF, AZPS NG4 ... 28, AZPW NG5 ... 22	
101-2 (B)	7/8 in	**B_S4**	–	–	18 (S)	AZPN-11 NG20 ... 25, AZPG-22 NG28 ... 100	
	1 in	**B_S5**	45 (S5)	28 (S)	28, 45 (S)	–	

Through drive[1]				Mounting options – 2nd pump				
Flange	**Hub for splined shaft**	**Code**	**A10VO/60 NG (shaft)**	**A10V(S)O/31 NG (shaft)**	**A10VO/32 NG (shaft)**	**A10V(S)O/5x NG (shaft)**	**A11VO/1x NG (shaft)**	**A1VO/10 NG (shaft)**
82-2 (A)	5/8 in	**A_S2**	–	–	–	10, 18 (U)	–	–
101-2 (B)	7/8 in	**B_S4**	45 (S4)	28 (S) 45 (U)	45 (U)	28 (S) 45 (U)	–	35 (S4)
	1 in	**B_S5**	45 (S5)	45 (S)	45 (S)	45 (S) 60, 63, 72 (U)	40 (S)	35 (S5)

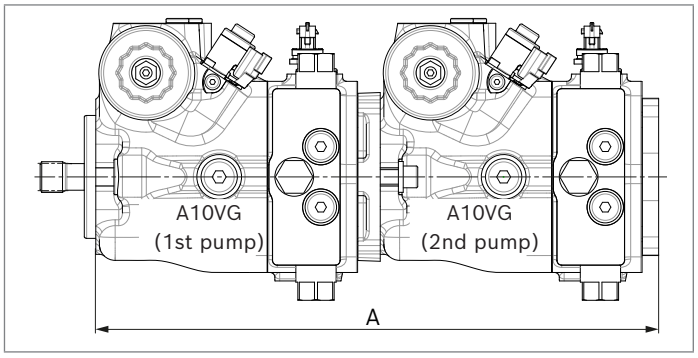
Notice
The mounting options listed only apply for drive shaft versions with undercut. Please contact us for drive shafts without undercut.

1) Availability of the individual sizes, see type code on page 3.
2) Bosch Rexroth recommends special versions of the gear pumps. Please contact us.

Combination pumps A10VG + A10VG

Total length A with integrated boost pump – standard

A10VG	**A10VG 2nd pump**[1)]
1st pump	**NG045**
NG045	465.2



By using combination pumps, it is possible to have independent circuits without the need for splitter gearboxes.
When ordering combination pumps the type designations for the 1st and the 2nd pump must be linked by a "**+**".

Order example:
A10VG045ETB0P/60MRNB2S71FB2S5A1S600-0 + A10VG045ETB0P/60MRNB2S51F0000A1S600-0
A tandem pump, with two pumps of equal size, is permissible without additional supports, assuming that the dynamic mass acceleration does not exceed maximum 10 *g* (= 98.1 m/s^2).
For combination pumps consisting of more than two pumps, the mounting flange must be rated for the permissible moment of inertia, please contact us.

Notice
- The combination pump type code is shown in shortened form in the order confirmation.
- The permissible through-drive torques are to be observed (see page 9).

1) 2nd pump without through drive

High-pressure relief valves

The two high-pressure relief valves protect the hydrostatic gear (pump and motor) from overloading. They limit the maximum pressure in the respective high-pressure line and serve simultaneously as boost valves.
The high-pressure relief valves are exclusively intended to protect the system from high-pressure peaks until the control dynamics of the pressure cut-off ensure the intended maximum working pressure.
An electronic pressure cut-off must be provided for permanent high-pressure limitation.
The hydrostatic gear must be designed in such a way that a longer response of the high-pressure relief valves (> 0.3 sec.) is prevented. The volume of 70 l/min must not be exceeded during the valve phase.

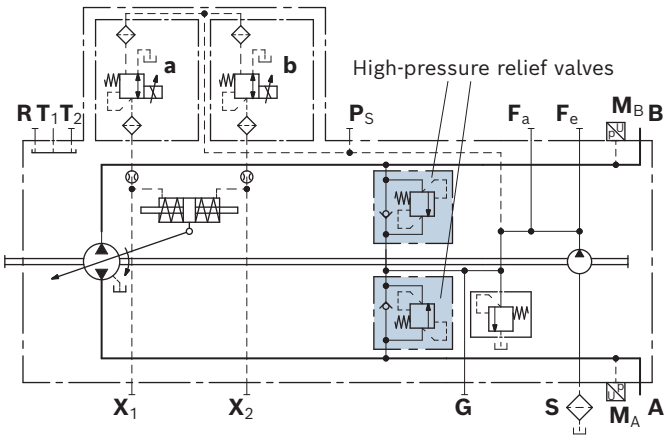
Setting ranges

High-pressure relief valve, direct operated	Differential pressure setting Δp_{HD}
Setting	320 bar
	400 bar
	420 bar
	440 bar

Settings on high-pressure relief valve A and B	
Differential pressure setting	Δp_{HD} = ... bar
Test pressure of the HD valve (at q_{V1}) ($p_{max} = \Delta p_{HD} + p_{Sp}$)	p_{max} = ... bar

The valve settings are set to be size-independent at a theoretical flow of approx. 70 l/min at $V_{g\,max}$ ($q_{v\,1}$). There may be deviations with other operating parameters.

▼ **Circuit diagram**

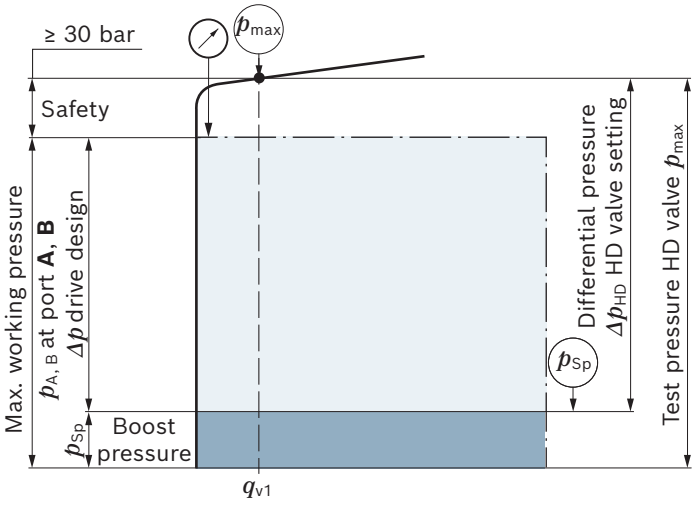


Example: Δp drive design = 290 bar ($p_{A,\,B} - p_{Sp}$)

Max. working pressure $p_{A,B}$	–	Boost pressure p_{Sp}	+	Safety	=	Differential pressure Δp_{HD}
315 bar	–	25 bar	+	30 bar	=	**320 bar**

▶ Test pressure of the HD valve (at q_{V1}):
p_{max} = 345 bar ($p_{max} = \Delta p_{HD} + p_{Sp}$)

▼ **Setting diagram**



Key	
HD valve	High-pressure relief valve
Test pressure HD valve p_{max}	The factory-set pressure value set at q_{V1}.
Differential pressure HD valve Δp_{HD}	Test pressure HD valve (abs.) minus the boost pressure setting
Maximum working pressure $p_{A,\,B}$	The total design of the hydrostatic drive is based on the maximum working pressure $p_{A,\,B}$. It is composed of the feed pressure setting and the Δp drive design.
Δp drive design	Differential pressure value determining the available torque at the hydraulic motor ($p_{A,\,B} - p_{Sp}$).
Boost pressure p_{Sp}	Boost pressure setting of the boost-pressure relief valve
Safety	Required distance between maximum working pressure (and/or pressure cut-off) and set pressure of the high-pressure relief valve to prevent constant response of the high-pressure relief valves at maximum working pressure.

Notice
Upon response of the high-pressure relief valve, the permissible temperature and viscosity must be complied with.

Option: Bypass function

A connection between the two high-pressure passages **A** and **B** can be established using the bypass function (e.g. for machine towing).

- **Towing speed**
  The maximum towing speed depends on the gear ratio in the vehicle and must be calculated by the vehicle manufacturer. The corresponding flow of q_v = 30 l/min may not be exceeded.
- **Towing distance**
  Only tow the vehicle out of the immediate danger zone.

For further information on the bypass function, see the operating instructions.

Notice
The bypass function is not illustrated in the circuit diagrams.

Boost-pressure relief valve

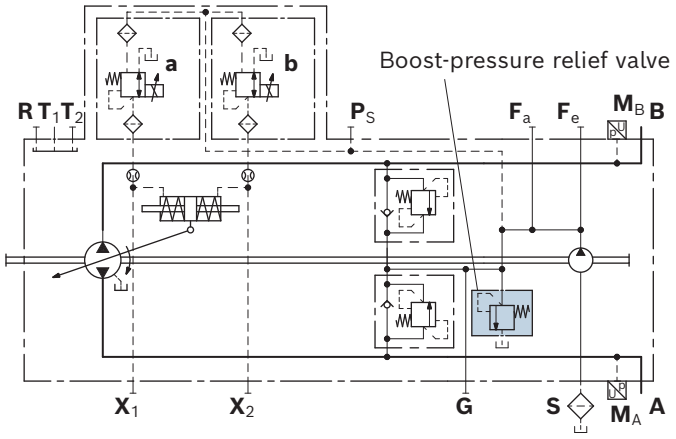
The boost-pressure relief valve is used to limit the boost pressure level. It limits the boost pressure depending on the case pressure.

Setting range

Boost-pressure relief valve	Differential pressure setting p_{St} ($p_{Sp} = \Delta p_{Sp} + p_T$)
Standard value	**25 bar**
Optional values	27 bar
	30 bar

The valve settings are performed at n = 1500 rpm.
There may be deviations in the set pressures with other operating parameters.

▼ **Circuit diagram**



Filtration in the boost pump suction line

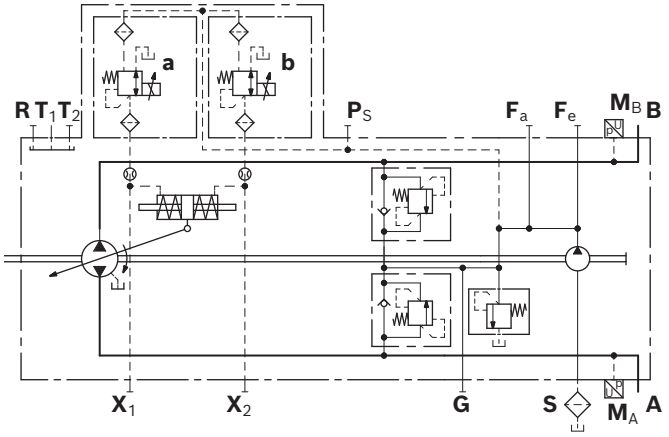
Version S

Filter version	Suction filter
Recommendation	With contamination indicator, with bypass
Recommended flow resistance at filter element	
At ν = 30 mm²/s, $n = n_{max}$	$\Delta p \leq 0.1$ bar
At ν = 1000 mm²/s, $n = n_{max}$	$\Delta p \leq 0.3$ bar
Pressure at suction port S	
Continuous $p_{S\ min}$ ($\nu \leq 30$ mm²/s)	≥ 0.8 bar absolute
Short-term, at a cold start (t < 3 min)	≥ 0.5 bar absolute
Maximum pressure $p_{S\ max}$	≤ 5 bar absolute

Use of version S is preferred.

The suction filter is not included in the scope of delivery.

▼ **Circuit diagram**



Filtration in the boost pump pressure line

Version D

Ports for external boost circuit filtration

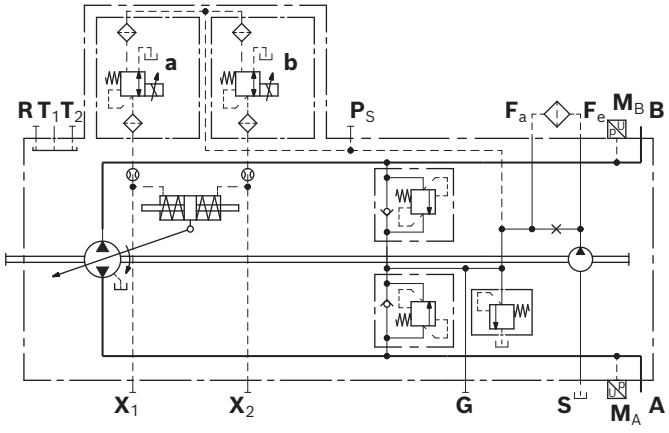
Ports	
Boost pressure inlet	Port **F**$_a$
Boost pressure output	Port **F**$_e$
Filter version	**Boost pressure filter**
Recommendation	With contamination indicator, with cold start valve
Filter arrangement	Separate in the pressure line (inline filter)

The boost pressure filter is not included in the scope of delivery.

Notice

- Filters with a bypass are **not recommended**. Please contact us for applications with a bypass.
- The pressure drop at the filter is viscosity- and contamination-dependent. Note the maximum permissible pressure of the boost pump in combination with the set feed pressure.

▼ **Circuit diagram**

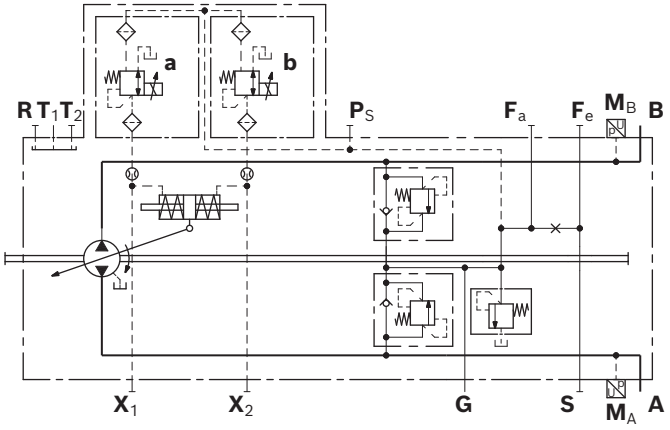


External boost pressure supply

Version E

This variant should be used in versions without integrated boost pump (**U**).
Port **S** is plugged.
The boost pressure supply comes from port **G**.
The filter should be installed separately on port **G** before the boost pressure supply.
To ensure functional reliability, maintain the required cleanliness level for the boost pressure fluid fed in at port **G** (see page 6).

▼ **Circuit diagram**

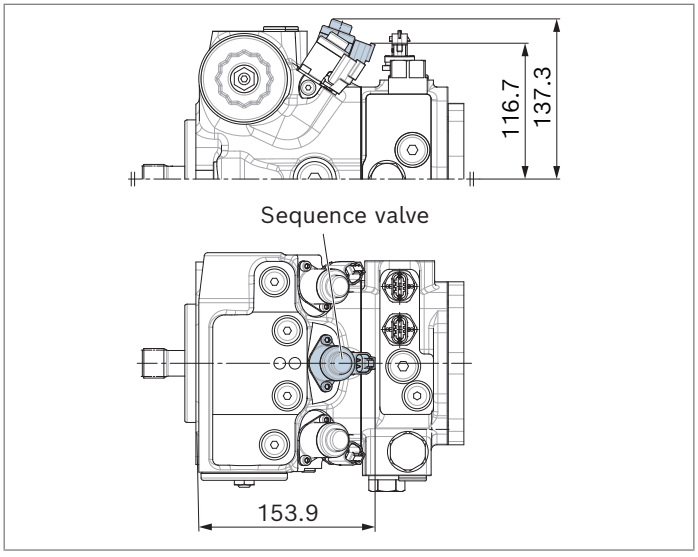


Sequence valve

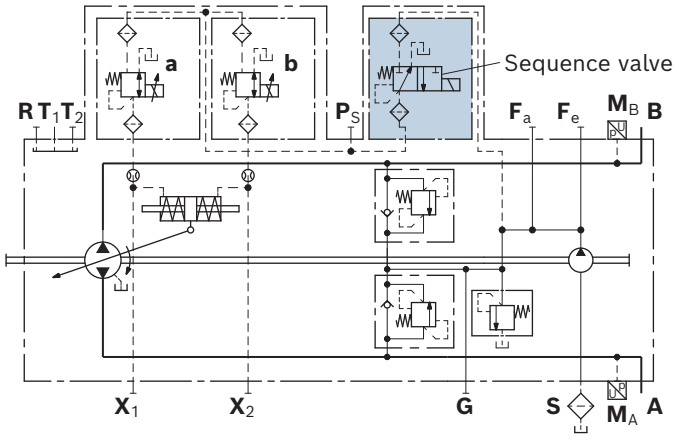
The sequence valve releases the connection between the boost pump and the control when the solenoid is energized. It interrupts the connection when the solenoid is de-energized. In addition, the sequence valve vents the stroking chambers to the reservoir when de-energized. This causes the springs in the stroking chambers to move the stroking piston towards the central position (neutral position). The reset function is influenced by the current working pressure and rotational speed.

Technical data, solenoid	Sequence valve	
Voltage	12 V (±20%)	24 V (±20%)
Control pressure interrupted	De-energized	De-energized
Control pressure not interrupted	Energized	Energized
Nominal resistance (at 20 °C)	12.0 Ω	46.0 Ω
Minimum active current required	0.47 A	0.245 A
Duty cycle	100%	100%
Connector	DEUTSCH DT04-2P-EP04	
Type of protection: see connector version page 27		

Dimensions



▼ **Circuit diagram**



Connector for pressure reducing valve and sequence valve

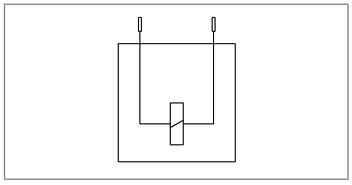
DEUTSCH DT04-2P-EP04

Molded, 2-pin

The following type of protection ensues with the installed mating connector:

- IP6K5 (ISO 20653)
- IP6K7 (ISO 20653) and
- IP6K9K (ISO 20653)

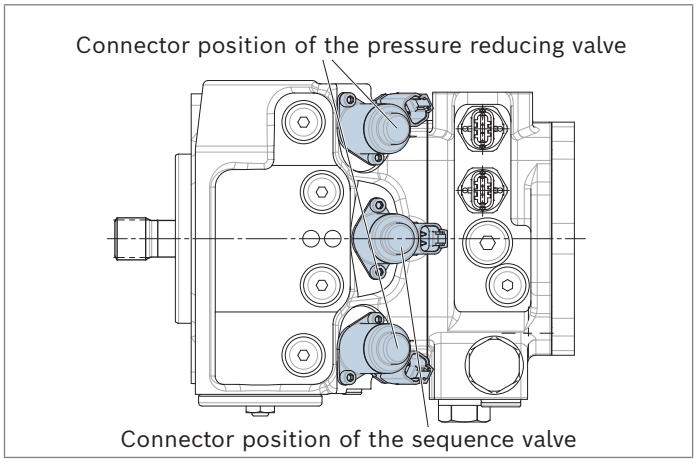
▼ **Switching symbol**



▼ **Mating connector DEUTSCH DT06-2S-EP04**

Consisting of	DT designation
1 housing	DT06-2S-EP04
1 wedge	W2S
2 sockets	0462-201-16141

The mating connector is not included in the scope of delivery. This can be supplied by Bosch Rexroth on request (material number R902601804).



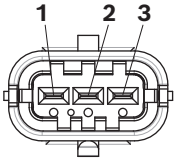
Pressure sensor

The pressure on the working ports **A** and **B** can be recorded using the mounted PR4 pressure sensors in $\mathbf{M}_A$ and $\mathbf{M}_B$. Type code, technical data, dimensions and safety instructions about the sensor can be found in the relevant data sheet 95156.

▼ **Permissible variants**

Pressure sensor PR4	
Measuring range	0 ... 600 bar
Mechanical connection	M14 × 1.5 according to ISO 6149-2
Electrical connection	Bosch Compact
Output signal	SENT according to SAE J2716 JAN 2010
	Option: 0.5 ... 4.5 V ratiometric (at 5±0 V supply voltage)

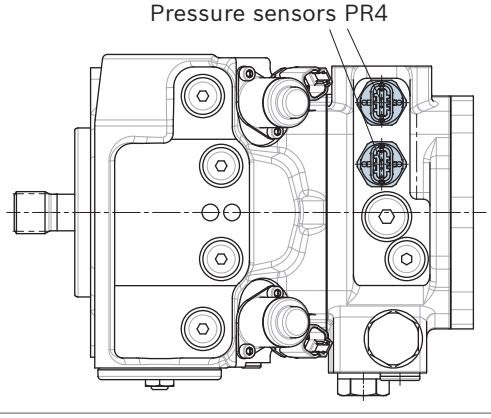
▼ **Pin assignment**



PIN	Connection	
1	Ground	GND
2	Sensor signal	
3	Supply voltage	U_s

Notice

- Only the variants of the pressure sensor PR4 listed in the above-mentioned table are approved for A10VG series 60.
- On delivery, the position of the pressure sensor connector position differs from that shown in the drawing.



Swivel angle sensor

The swivel angle sensor PAL is used for contactless detection of the swivel angle of axial piston units using a Hall effect-based sensor IC. The measured position is converted into electric signals by the redundant swivel angle sensor.
Type code, technical data, dimensions and safety instructions about the sensor can be found in the relevant data sheet 95161.

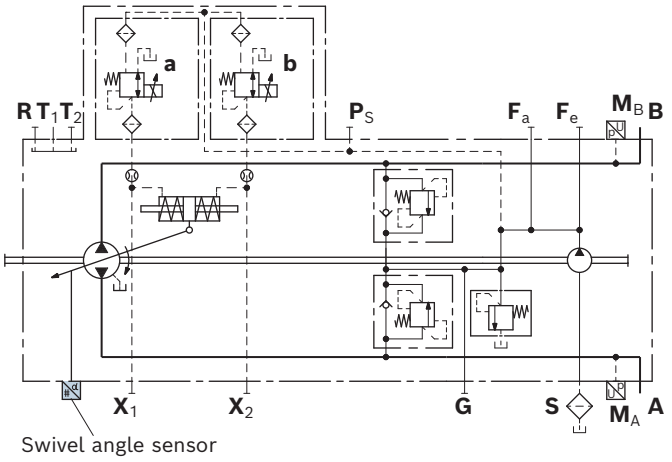
▼ Permissible variants

Swivel angle sensor PAL		Type
Output signal	Analog ratiometric/PWM	PAL 2 012L012 CM/10F
	SENT/SENT	PAL 2 012L012 SM/10F

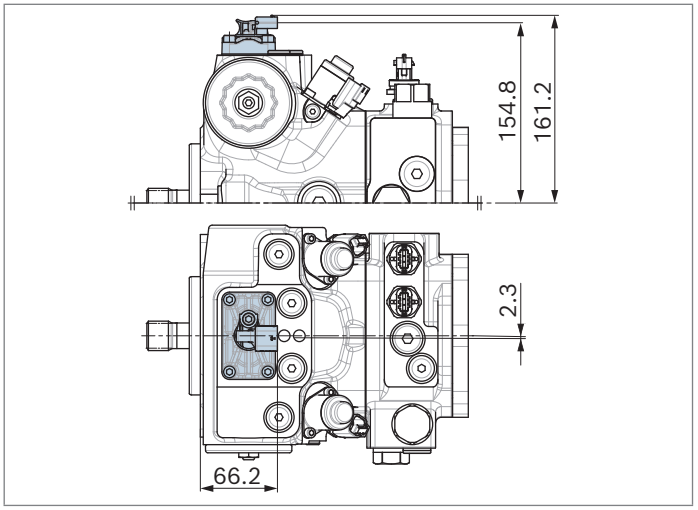
Characteristics			
Supply voltage U_{supply}	5±0.5 VDC		
Output signal 1	U_{min} ($V_{g\,max}$)	U_{mid} ($V_{g\,0}$)	U_{max} ($V_{g\,max}$)
Output signal 2	PWM_{min}	PWM_{mid}	PWM_{max}
Reverse polarity protection (48 h/60 sec)	−14 VDC/−18 VDC		
EMC resistance	Details on request		
Operating temperature range	-40 °C to +125 °C		
Housing material	Polyphenylene sulfide (PPS)		

Notice
Please contact us for further information on the application of the PAL swivel angle sensor.

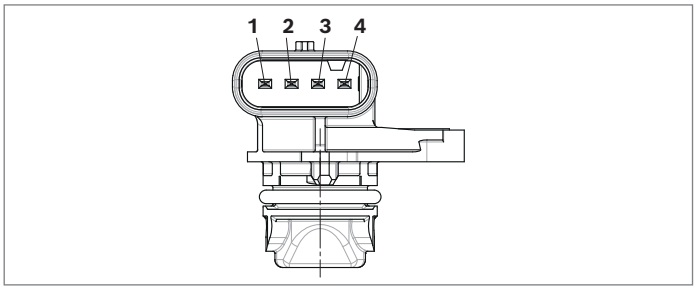
▼ SENT/SENT circuit diagram



Dimensions



▼ Pin assignment



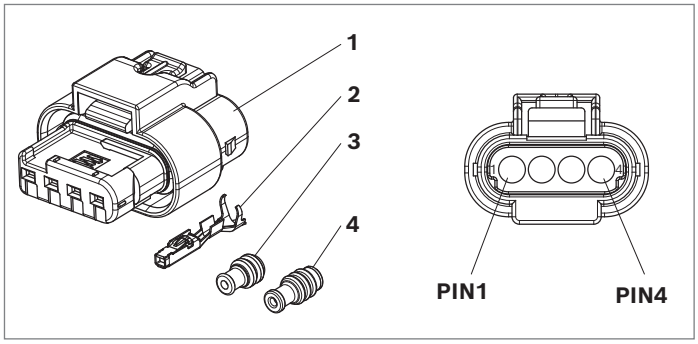
▼ Pin assignment analog ratiometric/PWM PAL 2 012L012 CM/10F

PIN	Connection	
1	Sensor signal 2	PWM
2	Supply voltage	U_{supply}
3	Ground	GND
4	Sensor signal 1	Analog (ratiometric)

▼ Pin assignment SENT/SENT PAL 2 012L012 SM/10F

PIN	Connection	
1	Sensor signal 2	SENT
2	Supply voltage	U_{supply}
3	Ground	GND
4	Sensor signal 1	SENT

Mating connector



Notice

- For the assembly, the tools prescribed by the connector manufacturer - MCON unpinning tool/unlocking tool and crimping pliers - are to be used (see TYCO Electronics drawing 1534326). To process the connector, refer to the user manual of the manufacturer TYCO Electronics (408-828).
- For possible mating connector alternatives, see data sheet 95161

▼ **Mating connector set (material number: R917012863)**

Pos.	Designation	Quantity	Order number	Manufacturer	Comment
1	4POS, MCON 1.2 CB REC 2p TL SEALED[1)]	1	1-1456426-5	TYCO Electronics	
2	MCON 1.2 CB REC SWS SN	4	1670146-1	TYCO Electronics	For cable cross-section (AWG) 20 or 0.5 mm² and 0.75 mm²
3	Single wire seal, rubber, red	4	2098582-1	TYCO Electronics	Accepted cable insulation diameter range: 1.35 ... 1.9 mm
4	Plug, blue	2	967056-1	TYCO Electronics	If the NTC thermistor is not connected, use blind plugs

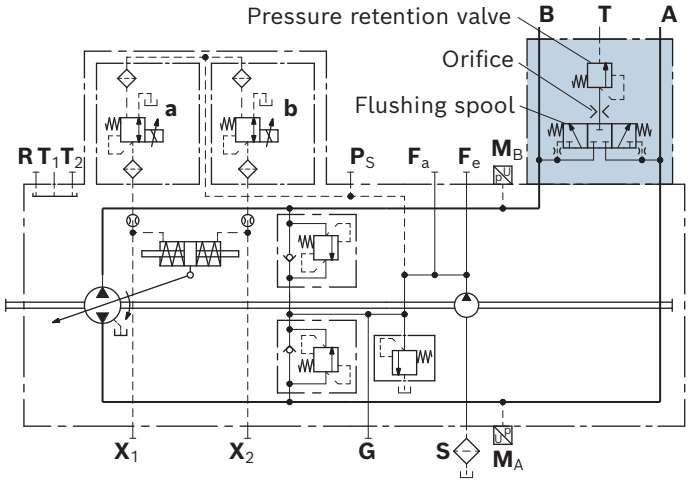
Flushing valve

The purpose of the flushing valve is to remove heat from the hydraulic circuit. The respective low-pressure side of the closed circuit is flushed out via the flushing spool from a pressure differential between A and B of 3 bar and a low pressure of 16 bar of hydraulic fluid.
It is necessary to replace both the flushing flow and the internal leakage of the axial piston units with a boost pressure supply. The boost pressure supply with filtered and cooled hydraulic fluid lowers the circuit temperature.
The flushing flow is determined by an orifice in the flushing valve. This depends on the orifice size, the pressure differential between the low pressure and the pressure in the drain line, as well as the viscosity. A pressure retention valve is also integrated in the flushing valve. As soon as the pressure level falls below the set retention pressure, e.g. due to excessive flushing flow, the pressure retention valve reduces the flushing flow and thus prevents impermissible pressure drops, e.g. due to excessively low rotational speeds. The valve is mounted to the port plate.

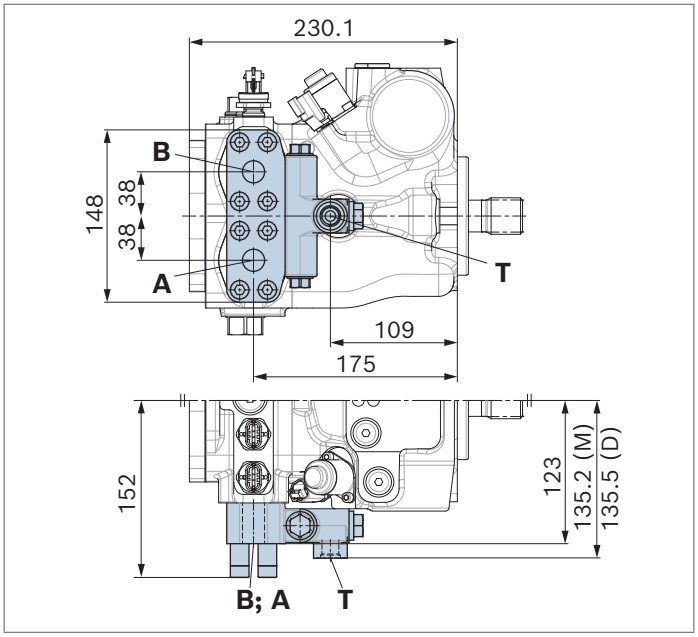
▼ Permissible variants

Flushing valve		
Sealing material	NBR (nitrile rubber)	
Orifices	Orifice ⌀	Theoretical flushing flow
	1.2 mm	3.2 l/min
	1.6 mm	5.5 l/min
	2.0 mm	8.8 l/min
	2.4 mm	12.5 l/min
	3.0 mm	20 l/min
Flushing side	A and B alternately, 3 to 5 bar switching pressure	
Flushing spool damping	Medium	
Retention pressure	16 bar	

▼ Circuit diagram



Dimensions



▼ Ports version "M", metric

Ports		Standard	Size
A, B	Working port	SAE J518	3/4 in
T	Drain port	ISO 6149	M14 × 1.5; 11.5 deep

▼ Ports version "D", ANSI

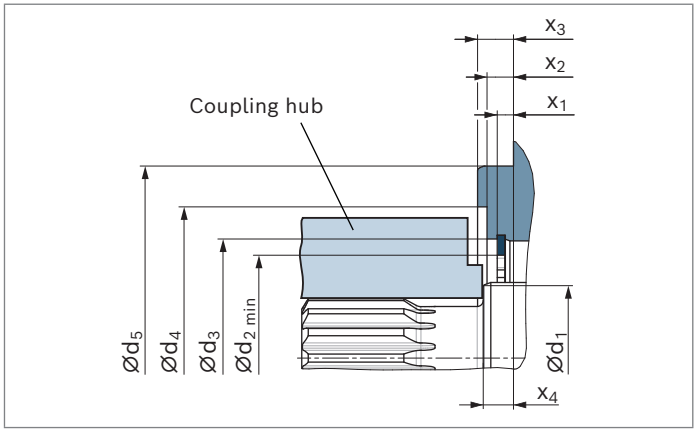
Ports		Standard	Size
A, B	Working port	SAE J518	3/4 in
T	Drain port	ISO 11926	9/16 in 18 UNF-2B; 13 deep

Notice
The T_1 port of the pump cannot be used in the version shown here. If the T_1 port is to be connected, the flushing valve must be installed rotated by 180°.

Installation dimensions for coupling assembly

To ensure that rotating components (coupling hub) and fixed components (housing, retaining ring) do not come into contact with each other, the installation conditions described here must be observed.
This depends on the pump size and the splined shaft.

SAE splined shaft (spline according to ANSI B92.1a)
Splined shaft **S5** or **S7**
The outer diameter of the coupling hub must be smaller than the inner diameter of the retaining ring (dimension d_3) in the area near the drive shaft collar (dimension $x_2 - x_4$).



NG	Ød$_1$	Ød$_{2\ min}$	Ød$_3$	Ød$_4$	Ød$_5$		x$_1$		x$_2$	x$_3$		x$_4$	
45	37.8	54.4	63±0.1	80	101.6	0 −0.054	4.3	+0.2 0	7	9.5	+0.9 −0.6	8	+0.9 −0.6

Installation instructions

General

The axial piston unit must be filled with hydraulic fluid and air bleed during commissioning and operation. This must also be observed during longer standstills, as the axial piston unit can empty itself via the hydraulic lines.
The leakage in the housing area must be directed to the reservoir via the highest drain port (**T_1**, **T_2**).
For combination pumps, the leakage must be drained off at each single pump.
If a shared drain line is used for several units, make sure that the respective case pressure in each unit 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 operating condition, particularly at cold start. If this is not possible, separate drain line has to be installed.
To prevent the transmission of structure-borne noise, use elastic elements to decouple all connecting lines from all vibration-capable components (e.g., reservoir, frame parts).
Under 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; it must not, however, be higher than $h_{S\ max}$ = 800 mm.
The suction pressure at port **S** must also not fall below the minimum value of 0.8 bar absolute during operation (cold start 0.5 bar absolute).
When designing the reservoir, ensure that there is adequate distance between the suction line and the drain line. We recommend using a baffle (baffle plate) between suction line and drain line. A baffle improves the air separation ability as it gives the hydraulic fluid more time for desorption. Apart from that, this prevents the heated return flow from being drawn directly back into the suction line. The suction port must be supplied with air-free, calmed and cooled hydraulic fluid.

Installation position

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

Notice

- For optimum function and dynamics of the axial piston unit, a complete filling of the two stroking chambers **X_1** and **X_2** with hydraulic fluid is required. By swiveling the swashplate several times during commissioning, this can usually be ensured. In case of unfavorable installation positions, air bleeding of the stroking chambers may take some time, so we recommend filling the stroking chambers via ports **X_1** and **X_2** before installation (e.g. for installation position 4 and 8).
- In certain installation positions, an influence on the adjustment or control can be expected. Gravity, dead weight and case pressure can cause minor characteristic shifts and changes in response time.

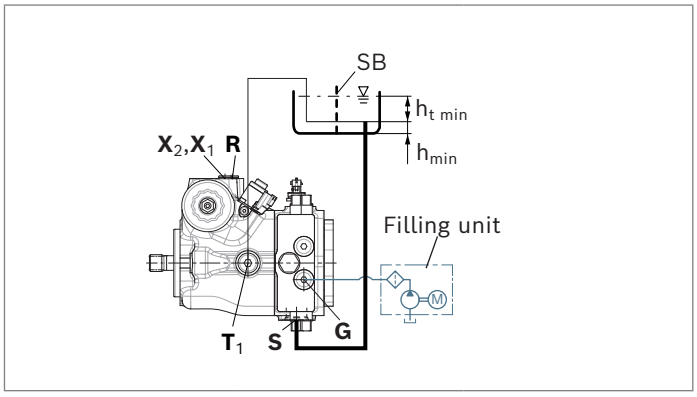
Key	
R	Air bleed port
S	Suction port
T_1, **T_2**	Drain port
X_1, **X_2**	Control pressure port
G	Boost pressure port inlet
SB	Baffle (baffle plate)
$h_{t\ min}$	Minimum required immersion depth (200 mm)
h_{min}	Minimum required distance to reservoir bottom (100 mm)
$h_{S\ max}$	Maximum permissible suction height (800 mm)

Below-reservoir installation (standard)

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

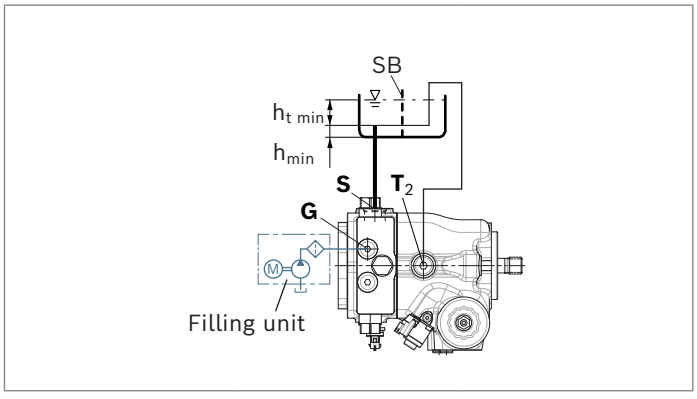
▼ Installation position 1

Air bleeding the housing	Air bleeding the stroking chamber	Filling
T_1, **R**	X_1, X_2	**G**[1], **S**, T_1, X_1, X_2



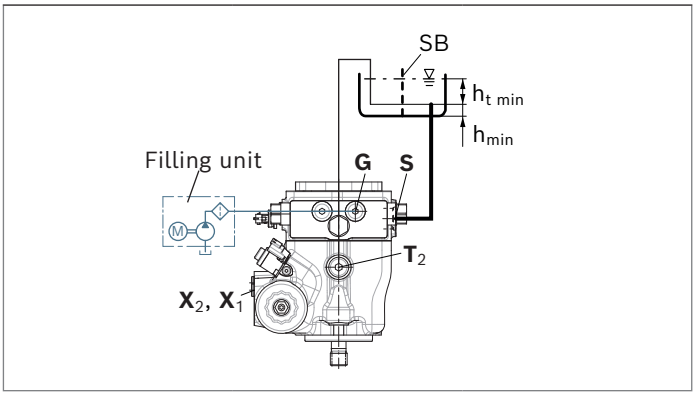
▼ Installation position 2

Air bleeding the housing	Air bleeding the stroking chamber	Filling
T_2	–	**G**[1], **S**, T_2



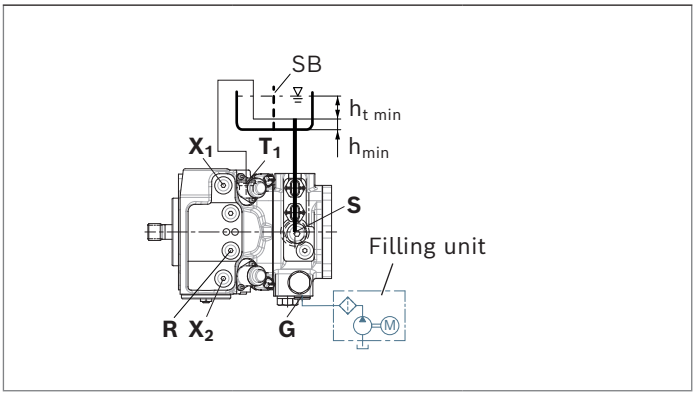
▼ Installation position 3

Air bleeding the housing	Air bleeding the stroking chamber	Filling
T_2	X_1, X_2	**G**[1], **S**, T_2, X_1, X_2



▼ Installation position 4[2]

Air bleeding the housing	Air bleeding the stroking chamber	Filling
T_1	X_1	**G**[1], **S**, T_1, X_1



1) Recommendation: Filling with filter/filling unit.
When filling without filter/filling unit, the pump must be filled at the highest drain port.

2) Port X_2 top only permissible upon request

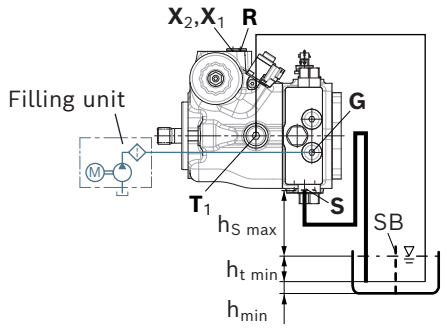
Above-reservoir installation

Above-reservoir installation means that the axial piston unit is installed above the minimum fluid level of the reservoir.

Observe the maximum permissible suction height $h_{S\ max}$ = 800 mm.

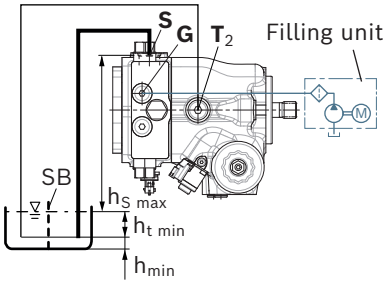
▼ Installation position 5

Air bleeding the housing	Air bleeding the stroking chamber	Filling
R	**X_1, X_2**	**G**[1], **S**, **T_1**, **X_1**, **X_2**



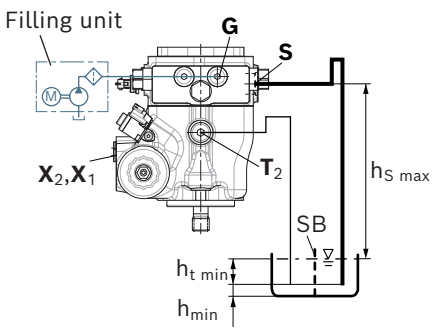
▼ Installation position 6

Air bleeding the housing	Air bleeding the stroking chamber	Filling
T_2	–	**G**[1], **S**, **T_2**



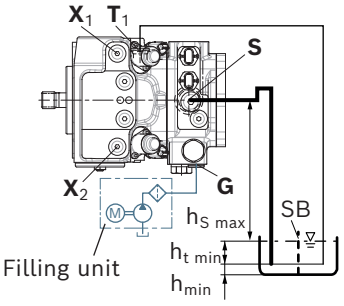
▼ Installation position 7

Air bleeding the housing	Air bleeding the stroking chamber	Filling
T_2	**X_1**, **X_2**	**G**[1], **S**, **T_2**, **X_1**, **X_2**



▼ Installation position 8[2]

Air bleeding the housing	Air bleeding the stroking chamber	Filling
T_1	**X_1**	**G**[1], **S**, **T_1**, **X_1**



1) Recommendation: Filling with filter/filling unit.
When filling without filter/filling unit, the pump must be filled at the highest drain port.

2) Port **X_2** top only permissible upon request

Project planning notes

- The pump is intended for use in a closed circuit.
- The project planning, installation and commissioning of the axial piston unit requires the involvement of skilled personnel.
- Before using the axial piston unit, please read the corresponding operating instructions 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 preservation protection for a maximum of 12 months. If longer preservation 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 the operating instructions.
- Not all configuration 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. Applying a direct voltage signal (DC) to solenoids does not create electromagnetic interference (EMI) nor is the solenoid affected by EMI. Electromagnetic interference (EMI) potential exists when operating and controlling a solenoid with a modulated direct voltage signal (e.g. PWM signal). Appropriate testing and measures should be taken by the machine manufacturer to ensure other components or operators (e.g. with pacemaker) are not affected by this potential.
- Pressure cut-off (hydraulic or electronic) is not a sufficient safeguard against pressure overload. Therefore, a pressure relief valve must be added to the hydraulic system (integrated into the pump or externally in the system). Observe the technical limits of the pressure relief valves here.
- With dynamic power flow (switch of pumps to operation as a motor) a maximum of 95% $V_{g\ max}$ is permissible. We recommend configuring the software accordingly.
- Please note that a hydraulic system is an oscillating system. This can lead, for example, to the stimulation the natural frequency within the hydraulic system during operation at constant rotational speed over a long period of time. The excitation frequency of the pump is 9 times the rotational speed frequency. This can be prevented, for example, with suitably designed hydraulic lines.
- Please note the information regarding the tightening torques of port threads and other screw connections in the operating instructions.
- The ports and fastening threads are designed for the p_{max} permissible pressures of the respective ports, see the connection tables. 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 service ports and function ports are only designed to accommodate hydraulic lines.

Safety instructions

- During and shortly after operation, there is a risk of burns on the axial piston unit and especially on the solenoids. Take the appropriate safety measures (e.g. by wearing protective clothing).
- Moving parts in control equipment (e.g. valve spools) can, under certain circumstances, get stuck in position as a result of contamination (e.g. contaminated hydraulic fluid, abrasion, or residual dirt from components). As a result, the hydraulic fluid flow and the build-up of torque in the axial piston unit can no longer respond correctly to the operator's specifications. Even the use of various filter elements (external or internal flow filtration) will not rule out a fault but merely reduce the risk. The machine/system manufacturer must test whether remedial measures are needed on the machine for the application concerned in order to bring the driven consumer into a safe position (e.g. safe stop) and ensure any measures are properly implemented.

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