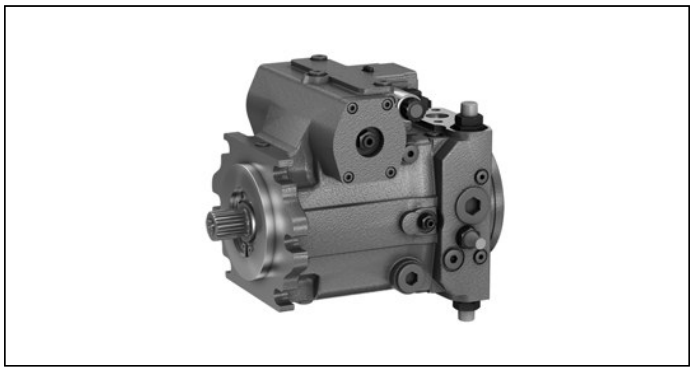
The Drive & Control Company

Rexroth
Bosch Group

Axial piston variable pump
AA4VG Series 32

Americas

RE-A 92003
Edition: 06.2018
Replaces: 04.2016



- High-pressure pump for applications in a closed circuit
- Size 28 to 125
- Nominal pressure 5800 psi (400 bar)
- Maximum pressure 6500 psi (450 bar)
- Closed circuit

Features

- Integrated auxiliary pump for boost and pilot oil supply
- Flow direction changes smoothly when the swashplate is moved through the neutral position
- High-pressure relief valves with integrated boost function
- With adjustable pressure cut-off as standard
- Boost-pressure relief valve
- Through drive for mounting of further pumps up to same nominal size
- Large variety of controls
- Swashplate design

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
AA4V	**G**			**D**					**/**	**32**		**–**	**N**										

Axial piston unit

01	Swashplate design, variable, nominal pressure 5800 psi (400 bar), maximum pressure 6500 psi (450 bar)	**AA4V**

Operating mode

02	Pump, closed circuit	**G**

Size (NG)

03	Geometric displacement, see “Technical data” on page 8	in³/rev.	**1.71**	**2.44**	**3.42**	**4.33**	**5.49**	**7.63**	
		cm³/rev.	**28**	**40**	**56**	**71**	**90**	**125**	

Control device			**28**	**40**	**56**	**71**	**90**	**125**	
04	Without control module		●	●	●	●	●	●	**NV**
	Proportional control, hydraulic	Pilot-pressure related p = 87 to 260 psi (6 to 18 bar)	○	○	●	●	●	●	**HD3**
		Mechanical servo	●	●	●	●	●	●	**HW**
	Proportional control, electric	U = 12 V	●	●	●	●	●	●	**EP3**
		U = 24 V	●	●	●	●	●	●	**EP4**
	Two-point control, electric	U = 12 V	●	●	●	●	●	●	**EZ1**
		U = 24 V	●	●	●	●	●	●	**EZ2**
	Automatic control, speed related	U = 12 V	●	●	●	●	●	●	**DA1**
		U = 24 V	●	●	●	●	●	●	**DA2**
	Hydraulic control, direct operated		○	○	●	●	●	●	**DG**
	Electric control, direct operated, two pressure reducing valves	U = 12 V	●	●	●	●	–	–	**ET5**
		U = 24 V	●	●	●	●	–	–	**ET6**

Pressure cut-off

05	Pressure cut-off (standard)	**D**

Neutral position switch

06	Without neutral position switch (without code)	●	
	Neutral position switch (for HW control only)	●	**L**

Mechanical stroke limiter

07	Without mechanical stroke limiter (without code)	●	
	Mechanical stroke limiter, externally adjustable	●	**M**

Stroking chamber pressure port		**28**	**40**	**56**	**71**	**90**	**125**	
08	Without stroking chamber pressure port **X**$_3$, **X**$_4$ (without code)	●	●	●	●	●	●	
	Stroking chamber pressure port **X**$_3$, **X**$_4$	○	○	●	●	●	●	**T**

DA control valve			**NV**	**HD**	**HW**	**DG**	**DA**	**EP**	**EZ**	
09	Without DA control valve		●	●	●	●	–	●	●	**1**
	DA control valve, fixed setting		–	●	●	●	●	●	–	**2**
	DA control valve, mechanically adjustable with position lever	direction of actuation, clockwise	–	●	●	●	●	●	–	**3R**
		direction of actuation, counter-clockwise	–	●	●	●	●	●	–	**3L**
	DA control valve, fixed setting, ports for pilot control device		–	○	○	–	○	○	–	**7**
	DA control valve, fixed setting and brake inch valve mounted, control with brake fluid	based on mineral oil	–	–	–	–	●	–	–	**8**

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

01	02	03	04	05	06	07	08	09		10	11		12	13	14	15	16	17	18	19	20	21	22
AA4V	**G**			**D**					**/**	**32**		**–**	**N**										

Series

10	Series 3, index 2	**32**

Direction of rotation

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

Sealing material

12	NBR (nitrile rubber), shaft seal in FKM (fluoroelastomer)	**N**

Drive shaft

			28	40	56	71	90	125	
13	Splined shaft ANSI B92.1a	for single pump	●	●	●	●	●	●	**S**
		for combination pump – 1st pump	–[1]	–[1]	●	●	–[1]	●	**T**
		only for combination pump – 2nd pump	–	●	–	–	●	–	**U**

Mounting flange

			28	40	56	71	90	125	
14	SAE J744	2-hole	●	●	●	–	–	–	**C**
		2+4-hole	–	–	–	●	●	●	**F**

Working port

			28	40	56	71	90	125	
15	SAE working port **A** and **B**, top and bottom	Suction port **S** bottom	–	●	●	●	●	●	**52**
	SAE working port **A** and **B**, top and bottom	Suction port **S** top	–	○	●	–	–	○	**53**
	SAE working port **A** and **B**, same side right[2]	Suction port **S** bottom	●	–	–	–	–	–	**60**
	SAE working port **A** and **B**, same side left[2]	Suction port **S** bottom	–	–	–	●	–	–	
	SAE working port **A** and **B**, same side right[2]	Suction port **S** top	–	–	–	–	–	○	**63**

Boost pump

16	Without integrated boost pump	without through drive	**N**
		with through drive	**K**
	Integrated boost pump	with and without through drive	**F**

Through drive[3]

			28	40	56	71	90	125	
17	Without through drive, versions N and F (no. 16) only		●	●	●	●	●	●	**00**
	Flange SAE J744[4]	Hub for splined shaft							
	82-2 (A)	5/8 in 9T 16/32DP[5]	●	●	●	●	●	●	**01**
	101-2 (B)	7/8 in 13T 16/32DP[5]	●	●	●	●	●	●	**02**
		1 in 15T 16/32DP[5]	●	●	●	●	●	●	**04**
	127-2 (C)[6]	1 1/4 in 14T 12/24DP[5]	–	–	●	●	●	●	**07**
	152-2/4 (D)	1 3/4 in 13T 8/16DP[5]	–	–	–	–	–	●	**69**

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

1) Standard for combination pump – 1st pump: Shaft S
2) Only possible without attachment filter
3) Specifications for version with integrated boost pump, please contact us for version without boost pump
4) 2 = 2-hole; 4 = 4-hole
5) Hub for splined shaft to ANSI B92.1a
6) NG90 to 125 with additional 4-hole-flange (127-4)

01	02	03	04	05	06	07	08	09		10	11		12	13	14	15	16	17	18	19	20	21	22
AA4V	**G**			**D**					**/**	**32**		–	**N**										

High-pressure relief valve		Setting range Δp		**28**	**40**	**56**	**71**	**90**	**125**	
18	High pressure relief valve, pilot operated	1450 to 6100 psi (100 to 420 bar)	with bypass	–	–	–	●	●	●	**1**
	High-pressure relief valve, direct operated, fixed setting	3600 to 6100 psi (250 to 420 bar)	without bypass	●	●	●	–	–	–	**3**
			with bypass	●	●	●	–	–	–	**5**
		1450 to 3600 bar (100 to 250 bar)	without bypass	●	●	●	–	–	–	**4**
			with bypass	●	●	●	–	–	–	**6**

Filtration boost circuit/external boost pressure supply		**28**	**40**	**56**	**71**	**90**	**125**	
19	Filtration in the boost pump suction line	●	●	●	●	●	●	**S**
	Filtration in the boost pump pressure line Ports for external boost circuit filtration (F_e and F_a)	●	●	●	●	●	●	**D**
	Mounted cold start valve and ports for external boost circuit filtration	–	●	●	–	–	–	**K**
	Attachment filter with cold start valve	–	●	●	●	●	●	**F**
	Attachment filter with cold start valve and visual contamination indicator	–	●	●	●	●	●	**P**
	Attachment filter with cold start valve and electric contamination indicator	–	●	●	●	●	●	**B**
	External boost pressure supply (version without integrated boost pump - N00, K...)	●	●	●	●	●	●	**E**

Swivel angle sensor		**28**	**40**	**56**	**71**	**90**	**125**	
20	Without swivel angle sensor (without code)	●	●	●	●	●	●	
	Electric swivel angle sensor[7)]	○	○	●	○	○	○	**R**

Connector for solenoids[8)]				
21	Without connector (without code), only for purely hydraulic control		●	
	DEUTSCH molded connector, 2-pin	without suppressor diode	●	**P**
		with suppressor diode (only for EZ and DA)	●	**Q**

Standard / special version			
22	Standard version	without code	
		combined with attachment part or attachment pump	**-K**
	Special version		**-S**
		combined with attachment part or attachment pump	**-SK**

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

Notice

- ▶ Note the project planning notes on page 68.
- ▶ In addition to the type code, please specify the relevant technical data when placing your order.

7) Please contact us if the swivel angle sensor is used for control
8) Connectors for other electric components may deviate

Hydraulic fluids

The AA4VG variable pump is designed for operation with HLP mineral oil according to DIN 51524.
Application instructions and requirements for hydraulic fluids 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: Axial piston units for operation with water-free and water-containing fire-resistant hydraulic fluids (HFDR, HFDU, HFAE, HFAS, HFB, HFC).

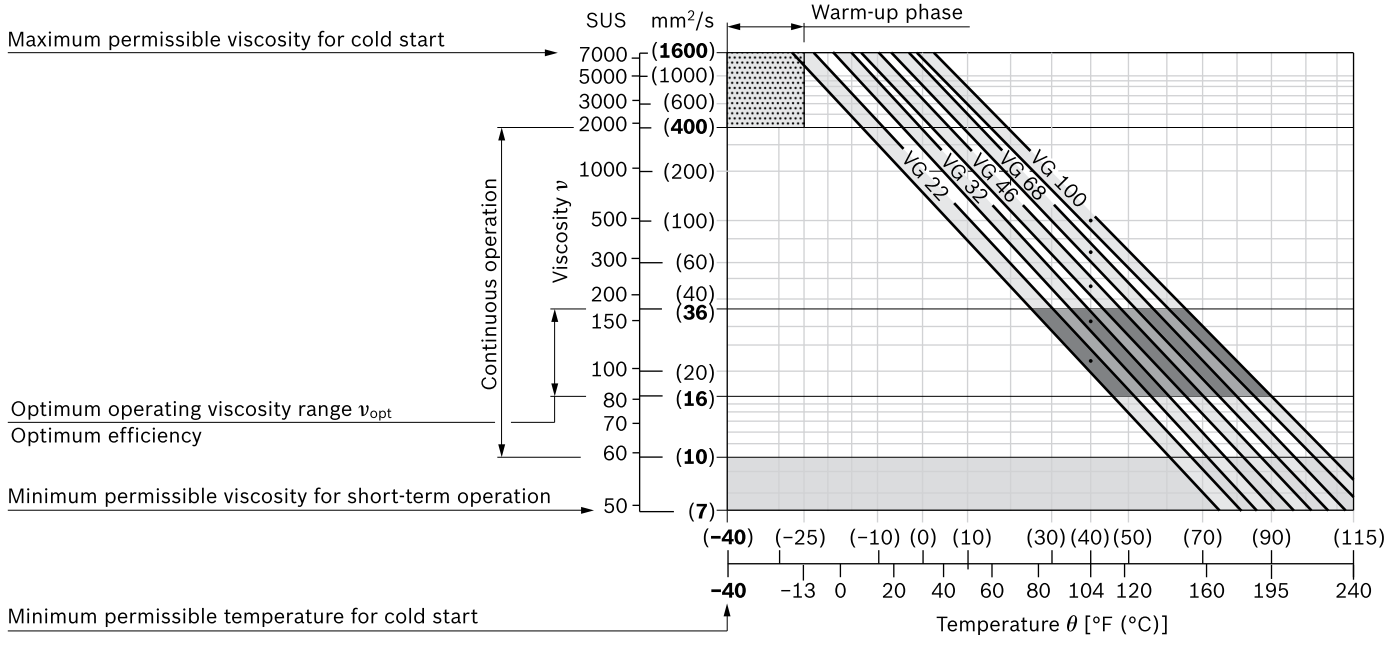
Notes on selection of hydraulic fluid
The hydraulic fluid should be selected such that the operating viscosity in the operating temperature range is within the optimum range (v_{opt} see selection diagram).

Notice
At no point of the component may the temperature be higher than 240 °F (115 °C). The temperature difference specified in the table is to be taken into account when determining the viscosity in the bearing.
Please contact us if the above conditions cannot be met due to extreme operating parameters.

Viscosity and temperature of hydraulic fluids

	Viscosity [SUS (mm²/s)**]**	**Temperature**	**Comment**
Cold start	v_{max} ≤ 7400 (1600)	θ_{St} ≥ −40 °F (−40 °C)	t ≤ 3 min, n ≤ 1000 rpm, without load p ≤ 725 psi (50 bar)
Permissible temperature difference		ΔT ≤ 45 °F (25 K)	between axial piston unit and hydraulic fluid in the system
Warm-up phase	v = 7400 to 1850 (1600 to 400)	θ = −40 °F to −13 °F (−40 °C to −25 °C)	at p ≤ 0.7 x p_{nom}, n ≤ 0.5 x n_{nom} and t ≤ 15 min
Continuous operation	v = 1850 to 60 (400 to 10)		this corresponds, for VG 46 for example, to a temperature range of +41 °F (5 °C) to + 185 °F (85 °C) (see selection diagram)
		θ = −13 °F to +230 °F (−25 °C to +110 °C)	measured at port **T** Observe the permissible temperature range of the shaft seal (ΔT = approx. 9 °F (5 K) between bearing/shaft seal and port **T**)
	v_{opt} = 170 to 82 (36 to 16)		Range of optimum operating viscosity and efficiency
Short-term operation	v_{min} ≥ 49 (7)		t < 3 min, p < 0.3 × p_{nom}

▼ **Selection diagram**



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.

Depending on the system and the application, for the AA4VG we recommend: Filter elements $\beta_{20} \geq 100$.

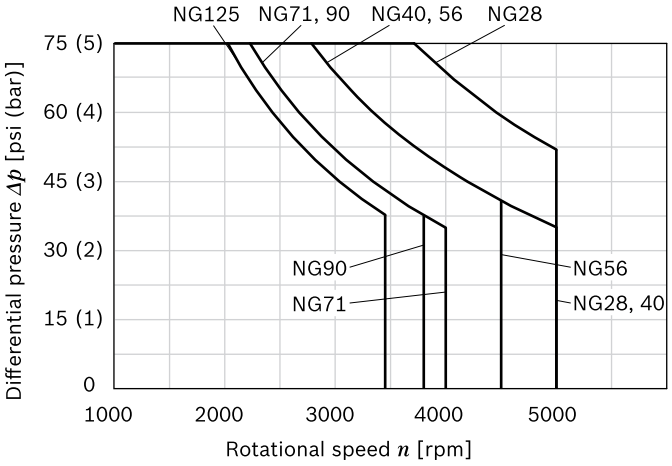
At very high hydraulic fluid temperatures (194 °F (90 °C) to maximum 230 °F (110 °C), measured at port **T**), a cleanliness level of at least 19/17/14 according to ISO 4406 is necessary.

Shaft seal

Permissible pressure loading

The service life of the shaft seal is influenced by the rotational speed of the axial piston unit and the leakage pressure in the housing (case pressure). Momentary (t < 0.1 s) pressure peaks of up to 145 psi (10 bar) are allowed. The service life of the shaft seal decreases with increasing frequency of pressure peaks and increasing mean differential pressure.

The case pressure must be higher than the ambient pressure.

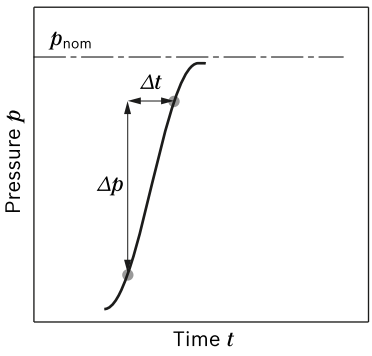


The FKM shaft seal ring may be used for leakage temperatures from −13 °F to +239 °F (−25 °C to +115 °C). For application cases below −13 °F (−25 °C), an NBR shaft seal is required (permissible temperature range: −40 °F to +194 °F (−40 °C to +90 °C)).

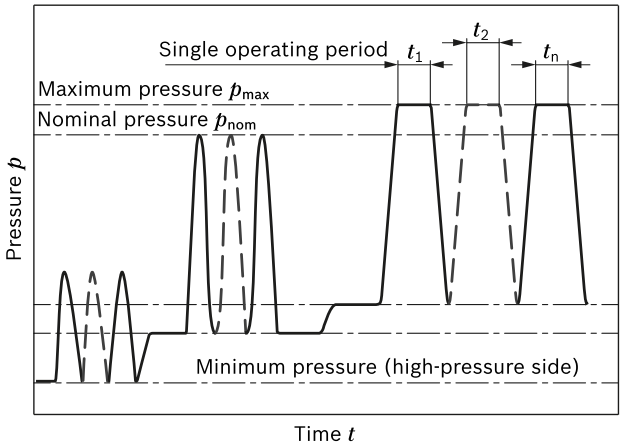
Working pressure range

Pressure at working port A or B		**Definition**
Nominal pressure p_{nom}	5800 psi (400 bar)	The nominal pressure corresponds to the maximum design pressure.
Maximum pressure p_{max}	6500 psi (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)	365 psi (25 bar)	Minimum pressure at the high-pressure side (**A** or **B**) which is required to prevent damage to the axial piston unit.
Minimum pressure (low-pressure side)	145 psi (10 bar) above case pressure	Minimum pressure at the low-pressure side (**A** or **B**) which is required to prevent damage to the axial piston unit.
Rate of pressure change $R_{A\,max}$	130000 psi/s (9000 bar/s)	Maximum permissible rate of pressure build-up and reduction during a pressure change across the entire pressure range.
Boost pump		
Nominal pressure $p_{Sp\,nom}$	365 psi (25 bar)	
Maximum pressure $p_{Sp\,max}$	580 psi (40 bar)	
Pressure at suction port **S** (inlet)		
Continuous $p_{S\,min}$ (v ≤ 140 SUS) (v ≤ 30 mm²/s)	≥ 12 psi absolute (≥ 0.8 bar absolute)	
Momentary, during cold start (t < 3 min)	≥ 7.5 psi (0.5 bar) absolute	
Maximum pressure $p_{S\,max}$	≤ 75 psi (5 bar) absolute	
Control pressure		
Minimum control pressure $p_{St\,min}$		To ensure the function of the control, a minimum control pressure $p_{St\,min}$ at n = 2000 rpm is necessary depending on the rotational speed and working pressure
Controls EP, HD, HW	290 psi (20 bar) above case pressure	
Controls DA, DG, EZ, ET	365 psi (25 bar) above case pressure	

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



▼ **Pressure definition**



Total operating period = $t_1 + t_2 + \ldots + t_n$

Notice

Working pressure range valid when using hydraulic fluids based on mineral oils. Please contact us for values for other hydraulic fluids.

Technical data

Size				NG	28	40	56	71	90	125
Displacement, geometric, per revolution			$V_{g\,max}$	in³	1.71	2.44	3.42	4.33	5.49	7.63
	variable pump			cm³	28	40	56	71	90	125
	boost pump (at p = 290 psi (20 bar))		$V_{g\,Sp}$	in³	0.37	0.52	0.71	1.20	1.20	1.73
				cm³	6.1	8.6	11.6	19.6	19.6	28.3
Rotational speed[1]	maximum at $V_{g\,max}$		n_{nom}	rpm	4250	4000	3600	3300	3050	2850
	limited, maximum[2]		n_{max1}	rpm	4500	4200	3900	3600	3300	3250
	intermittent, maximum[3]		n_{max2}	rpm	5000	5000	4500	4100	3800	3450
	minimum		n_{min}	rpm	500	500	500	500	500	500
Flow	at n_{nom} and $V_{g\,max}$		q_v	gpm	31.4	42.3	53.4	61.8	72.6	94
				l/min	119	160	202	234	275	356
Power[4]	at n_{nom}, $V_{g\,max}$ and	Δp = 5800 psi	P	hp	106	143	180	209	245	319
		Δp = 400 bar	P	kW	79	107	134	156	183	238
Torque[4]	at $V_{g\,max}$ and	Δp = 5800 psi	T	lb-ft	131	188	263	333	423	587
		Δp = 400 bar	T	Nm	178	255	357	452	573	796
		Δp = 1450 psi	T	lb-ft	33	47	66	83	105	147
		Δp = 100 bar	T	Nm	45	64	89	113	143	199
Rotary stiffness of drive shaft		S	c	lb-ft/rad	23159	50892	59595	72871	116609	161010
				kNm/rad	31.4	69	80.8	98.8	158.1	218.3
		T	c	lb-ft/rad	–	–	70068	89171	–	185939
				kNm/rad	–	–	95	120.9	–	252.1
		U	c	lb-ft/rad	–	37468	–	–	79362	–
				kNm/rad	–	50.8	–	–	107.6	–
Moment of inertia for rotary group			J_{TW}	lbs-ft²	0.0522	0.0902	0.1566	0.2302	0.3536	0.5505
				kgm²	0.0022	0.0038	0.0066	0.0097	0.0149	0.0232
Maximum angular acceleration[5]			α	rad/s²	38000	30000	24000	21000	18000	14000
Case volume			V	gal	0.24	0.29	0.40	0.34	0.40	0.55
				l	0.9	1.1	1.5	1.3	1.5	2.1
Weight (without through drive) approx.			m	lbs	64	68	84	110	132	176
				kg	29	31	38	50	60	80

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

Determining the operating characteristics

Flow $q_v = \frac{V_g \times n \times \eta_v}{231}$ [gpm] $\left(\frac{V_g \times n \times \eta_v}{1000}\right)$ [l/min]

Torque $T = \frac{V_g \times \Delta p}{24 \times \pi \times \eta_{hm}}$ [lb-ft] $\left(\frac{V_g \times \Delta p}{24 \times \pi \times \eta_{hm}}\right)$ [Nm]

Power $P = \frac{2 \pi \times T \times n}{33000} = \frac{q_v \times \Delta p}{1714 \times \eta_t}$ [HP] $\left(\frac{2 \pi \times T \times n}{60000} = \frac{q_v \times \Delta p \times \eta_t}{600}\right)$ [kW]

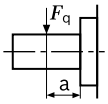
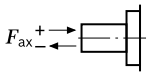
Key

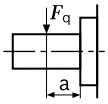
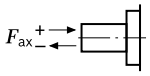
V_g	Displacement per revolution [in³ (cm³)]
Δp	Differential pressure [psi (bar)]
n	Rotational speed [rpm]
η_v	Volumetric efficiency
η_{mh}	Hydraulic-mechanical efficiency
η_t	Total efficiency ($\eta_t = \eta_v \times \eta_{mh}$)

1) The values are applicable:
   - for the optimum viscosity range from ν_{opt} = 170 to 82 SUS (36 to 16 mm²/s)
   - for hydraulic fluid based on mineral oils (for HF hydraulic fluids, observe the technical data in 90225)
2) Valid at half corner power (e.g. at $V_{g\,max}$ and $p_N/2$)
3) Valid at Δp = 1000 to 2200 psi (70 to 150 bar) or Δp < 4350 psi (300 bar) and t < 0.1 s
4) Without boost pump
5) 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 rotary frequency, cardan shaft twice the rotary frequency).
   The limit value is only valid for a single pump.
   The load capacity of the connecting parts must be considered.

Permissible radial and axial forces on the drive shaft

▼ **Splined shaft ANSI B92.1a**

Size	**NG**		**28**	**40**	**40**	**56**	**56**	**71**
Drive shaft		in	1	1	1 1/4	1 1/4	1 3/8	1 1/4
Maximum radial force at distance a (from shaft collar) 	$F_{q\,max}$	lbf	671	958	766	1073	975	1360
		N	2983	4261	3409	4772	4338	6050
	a	in	0.75	0.75	0.94	0.94	0.94	0.94
		mm	19	19	24	24	24	24
Maximum axial force 	$+F_{ax\,max}$	lbf	350	477	477	654	654	954
		N	1557	2120	2120	2910	2910	4242
	$-F_{ax\,max}$	lbf	94	198	198	355	355	620
		N	417	880	880	1490	1490	2758

Size	**NG**		**71**	**90**	**90**	**125**	**125**
Drive shaft		in	1 3/8	1 1/4	1 3/4	1 3/4	2
Maximum radial force at distance a (from shaft collar) 	$F_{q\,max}$	lbf	1236	1724	1232	1711	1497
		N	5500	7670	5478	7609	6658
	a	in	0.94	0.94	1.32	1.32	1.57
		mm	24	24	33.5	33.5	40
Maximum axial force 	$+F_{ax\,max}$	lbf	954	973	973	1361	1361
		N	4242	4330	4330	6053	6053
	$-F_{ax\,max}$	lbf	620	600	600	797	797
		N	2758	2670	2670	3547	3547

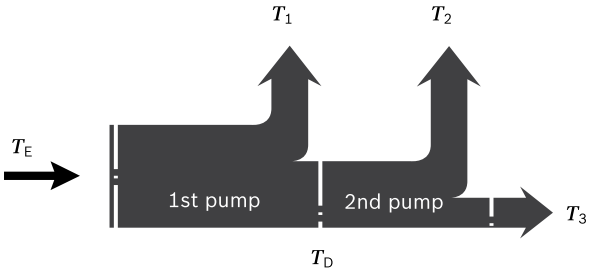
Notice

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

Permissible input and through-drive torques

Size			NG		28	40	56	71	90	125
Torque at $V_{g\,max}$ and	Δp = 5800 psi[1]		T	lb-ft	131	188	263	333	423	587
	Δp = 400 bar[1]		T	Nm	178	255	357	452	573	796
Maximum input torque at drive shaft[2] ANSI B92.1a (SAE J744)		S	$T_{E\,max}$	lb-ft	232	444	444	444	1210	1210
				Nm	314	602	602	602	1640	1640
				in	1	1 1/4	1 1/4	1 1/4	1 3/4	1 3/4
		T	$T_{E\,max}$	lb-ft	–	–	715	715	–	1969
				Nm	–	–	970	970	–	2670
				in	–	–	1 3/8	1 3/8	–	2
		U[3]	$T_{E\,max}$	lb-ft	–	232	–	–	444	–
				Nm	–	314	–	–	602	–
				in	–	1	–	–	1 1/4	–
Maximum through-drive torque[4]			$T_{D\,max}$	lb-ft	170	232	384	487	606	819
				Nm	231	314	521	660	822	1110

Distribution of torques

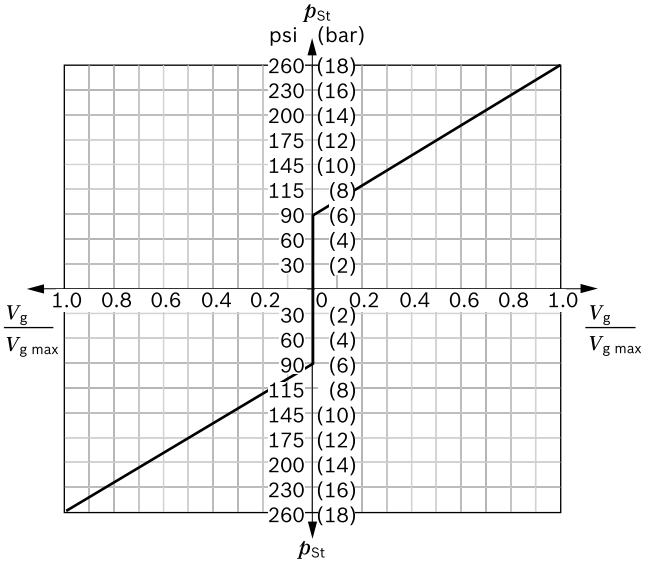


Torque at 1st pump	T_1		
Torque at 2nd pump	T_2		
Torque at 3rd pump	T_3		
Input torque	T_E	=	$T_1 + T_2 + T_3$
	T_E	<	$T_{E\,max}$
Through-drive torque	T_D	=	$T_2 + T_3$
	T_D	<	$T_{D\,max}$

1) Efficiency not considered
2) For drive shafts free of radial force
3) Shaft “U” is only permitted as drive shaft on the 2nd pump on a combination pump of the same size.
4) Note maximum input torque for shaft S!

HD – Proportional control, hydraulic, pilot-pressure related

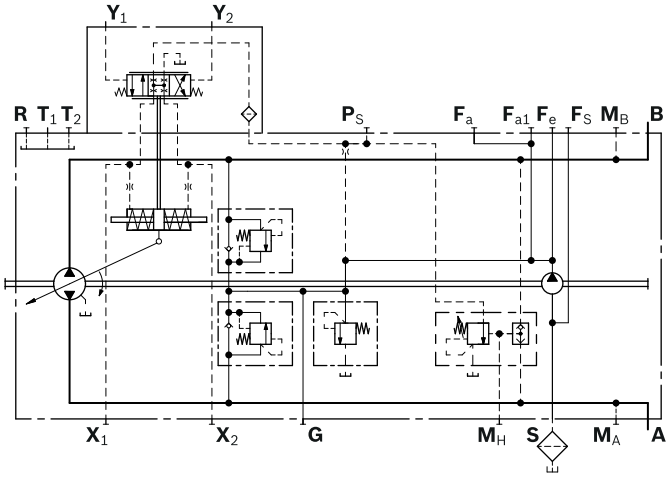
The output flow of the pump is infinitely variable between 0 and 100%, proportional to the difference in pilot pressure applied to the two pilot pressure ports (**Y**$_1$ and **Y**$_2$).
The pilot signal, coming from an external source, is a pressure signal. Flow is negligible, as the pilot signal acts only on the control spool of the control valve.
This control spool then directs control oil into and out of the stroking cylinder to adjust pump displacement as required.
A feedback lever connected to the stroking piston maintains the pump flow for any given pilot signal within the control range.
If the pump is also equipped with a DA control valve (see page 19), automotive operation is possible for travel drives.



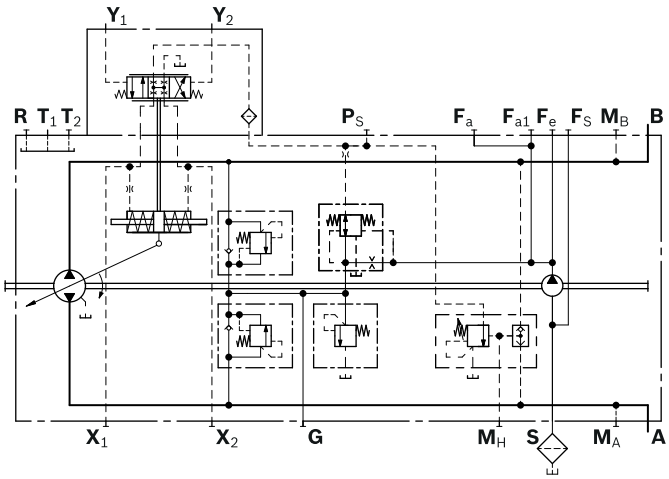
- V_g = Displacement at p_{St}
  $V_{g\,max}$ = Displacement at p_{St} = 260 psi (18 bar)
- Pilot signal p_{St} = 87 to 260 psi (6 to 18 bar)
  (at port **Y**$_1$, **Y**$_2$)
- Start of control at 87 psi (6 bar)
- End of control at 260 psi (18 bar)
  (maximum displacement $V_{g\,max}$)

Notice
In the neutral position, the HD control module must be vented to reservoir via the external pilot control device.

▼ **Standard version**[1)]

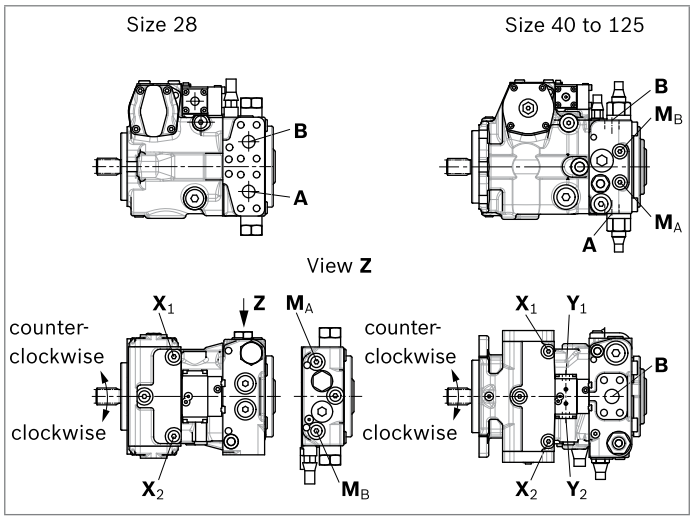


▼ **Version with DA control valve**[1)]



1) Size 28 without port **F**$_{a1}$ and **F**$_S$

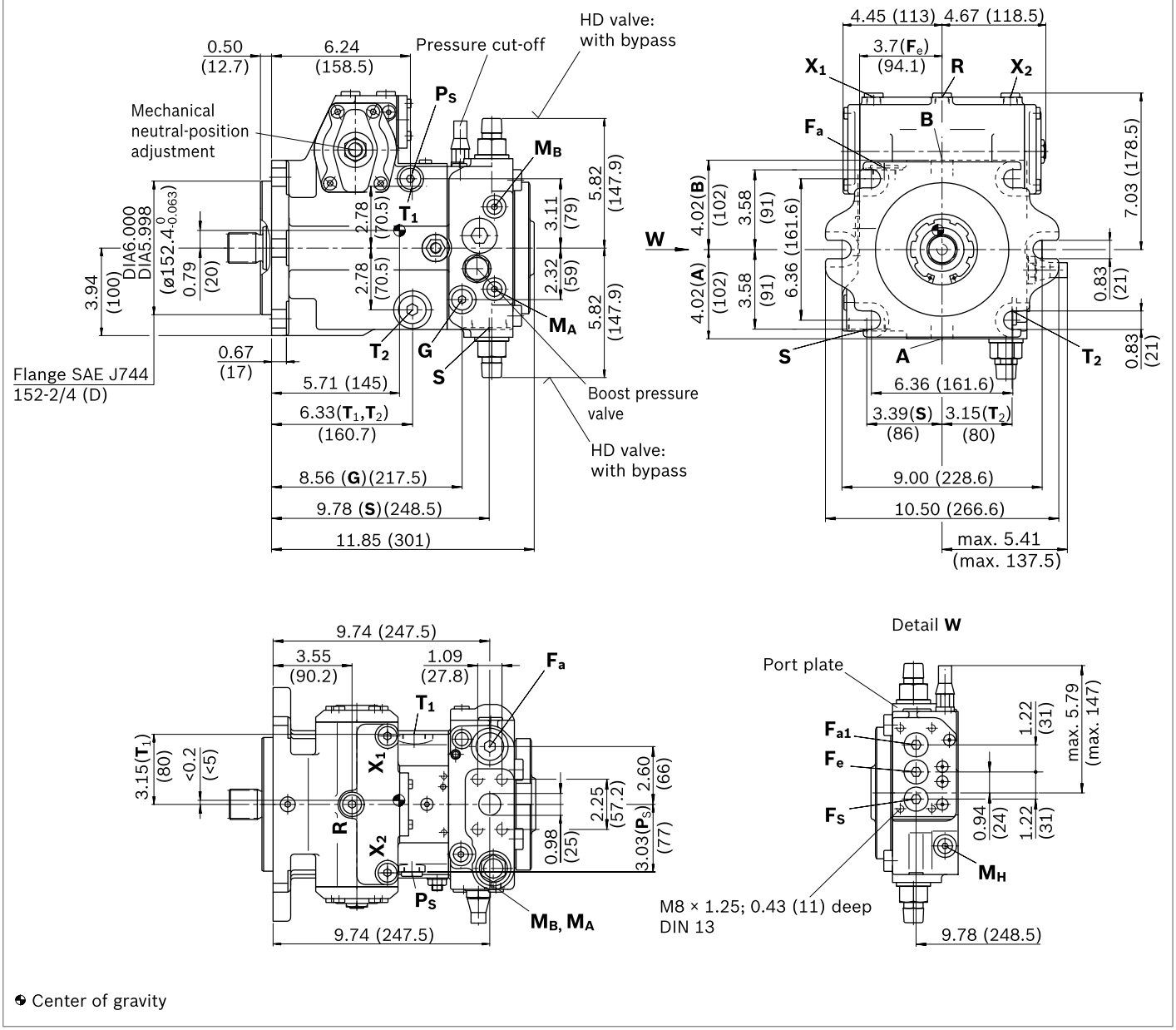
Correlation of direction of rotation, control and flow direction								
Direction of rotation	clockwise				counter-clockwise			
Size	28 to 56		71 to 125		28 to 56		71 to 125	
Pilot signal	Y_1	Y_2	Y_1	Y_2	Y_1	Y_2	Y_1	Y_2
Control pressure	X_1	X_2	X_1	X_2	X_1	X_2	X_1	X_2
Flow direction	**A** to **B**	**B** to **A**	**B** to **A**	**A** to **B**	**B** to **A**	**A** to **B**	**A** to **B**	**B** to **A**
Working pressure	M_B	M_A	M_A	M_B	M_A	M_B	M_B	M_A



Dimensions, size 90

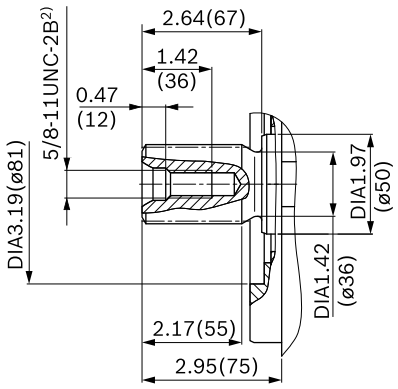
NV – Version without control module

Standard: SAE working port **A** and **B** top and bottom, suction port **S** bottom (52)



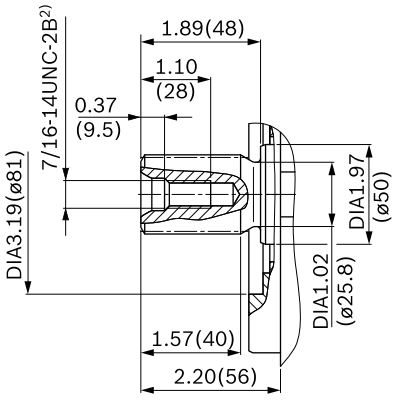
▼ **Splined shaft ANSI B92.1a**

S – 1 3/4 in 13T 8/16DP[1)]



▼ **Splined shaft ANSI B92.1a**

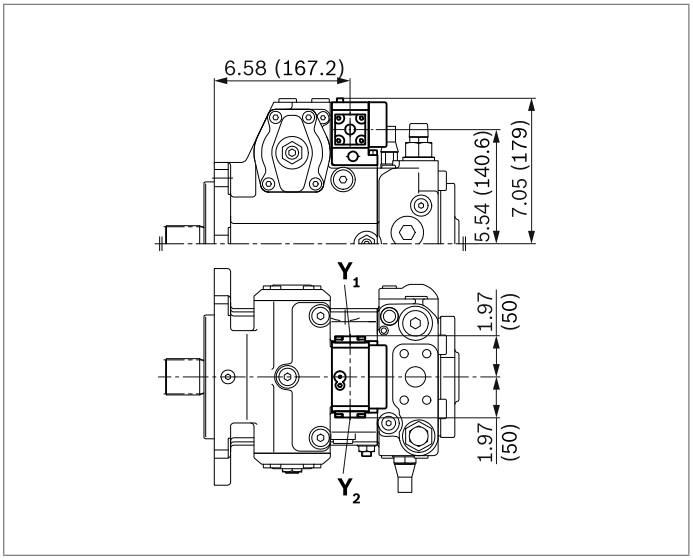
U – 1 1/4 in 14T 12/24DP[1)]



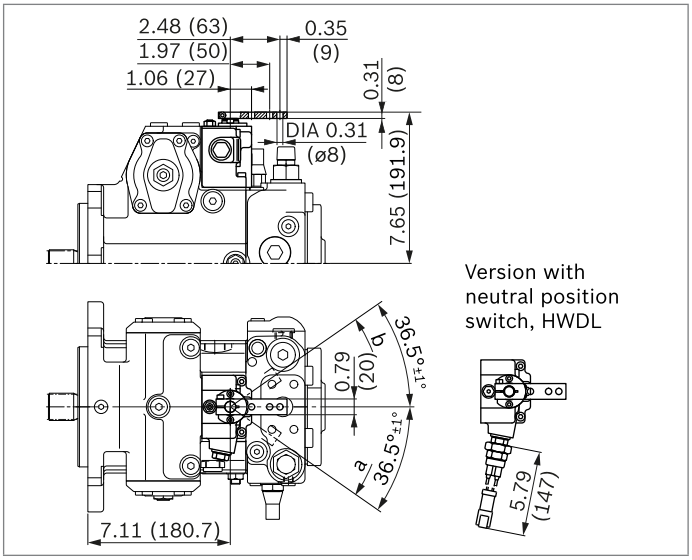
Ports		Standard	Size	p_{max} [psi (bar)][3)]	State[9)]
A, B	Working port Fastening thread	SAEJ518[4)] ASME B1.1	1 in 7/16 in -14 UNC-2B; 0.67 (17) deep	6500 (450)	O
S	Suction port	ISO 11926[7)]	1 5/8 in -12 UN-2B; 0.79 (20) deep	75 (5)	O[5)]
T_1	Drain port	ISO 11926[7)]	1 1/16 in -12 UN-2B; 0.79 (20) deep	45 (3)	O[6)]
T_2	Drain port	ISO 11926[7)]	1 1/16 in -12 UN-2B; 0.79 (20) deep	45 (3)	X[6)]
R	Air bleed port	ISO 11926[7)]	9/16 in -18 UNF-2B; 0.51 (13) deep	45 (3)	X
X_1, X_2	Control pressure port (upstream of orifice)	ISO 11926[7)]	9/16 in -18 UNF-2B; 0.51 (13) deep	580 (40)	X
X_1, X_2	Control pressure port (upstream of orifice, DG only)	ISO 11926[7)]	9/16 in -18 UNF-2B; 0.51 (13) deep	580 (40)	O
X_3, X_4[8)]	Stroking chamber pressure port	ISO 11926[7)]	7/16 in -20 UNF-2B; 0.47 (12) deep	580 (40)	X
G	Boost pressure port inlet	ISO 11926[7)]	3/4 in -16 UNF-2B; 0.59 (15) deep	580 (40)	X
P_S	Pilot pressure port	ISO 11926[7)]	9/16 in -18 UNF-2B; 0.51 (13) deep	580 (40)	X
M_A, M_B	Measuring port pressure A, B	ISO 11926[7)]	7/16 in -20 UNF-2B; 0.47 (12) deep	6500 (450)	X
M_H	Measuring port, high pressure	ISO 11926[7)]	7/16 in -20 UNF-2B; 0.47 (12) deep	6500 (450)	X
F_a	Boost pressure port inlet	ISO 11926[7)]	1 1/16 in -12 UN-2B; 0.79 (20) deep	580 (40)	X
F_{a1}	Boost pressure port inlet (attachment filter)	DIN 3852[7)]	M22 x 1.5; 0.55 (14) deep	580 (40)	X
F_e	Boost pressure port outlet	DIN 3852[7)]	M22 x 1.5; 0.55 (14) deep	580 (40)	X
F_S	Line from filter to suction port (cold start)	DIN 3852[7)]	M22 x 1.5; 0.55 (14) deep	580 (40)	X
Y_1, Y_2	Pilot pressure port (pilot signal HD only)	ISO 11926[7)]	9/16 in -18 UNF-2B; 0.51 (13) deep	580 (40)	O
Z	Pilot pressure port (inch signal DA..8 only)	DIN 3852[7)]	M10 x 1; 0.31 (8) deep	580 (40)	X

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
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 SAE J518, metric fastening thread is a deviation from the standard.
5) Plugged for external boost pressure supply.
6) Depending on installation position, **T_1** or **T_2** must be connected (see also installation instructions on page 65).
7) The countersink can be deeper than as specified in the standard.
8) Optional, see page 55
9) O = Must be connected (plugged when delivered)
X = Plugged (in normal operation)

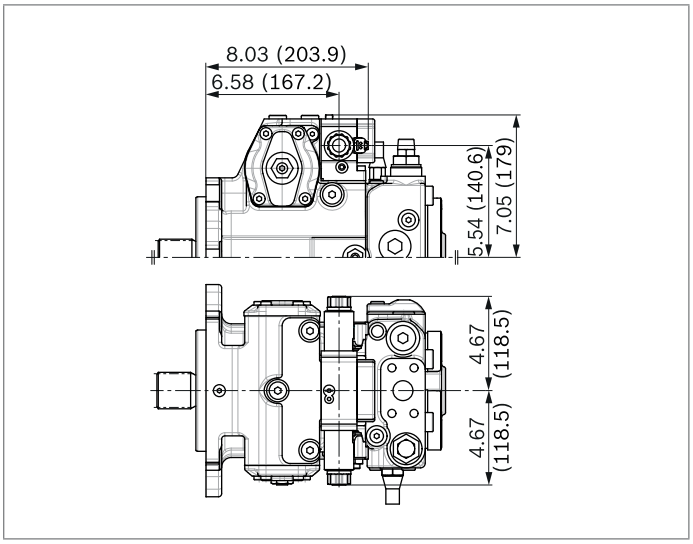
▼ **HD** – Proportional control, hydraulic, pilot-pressure related



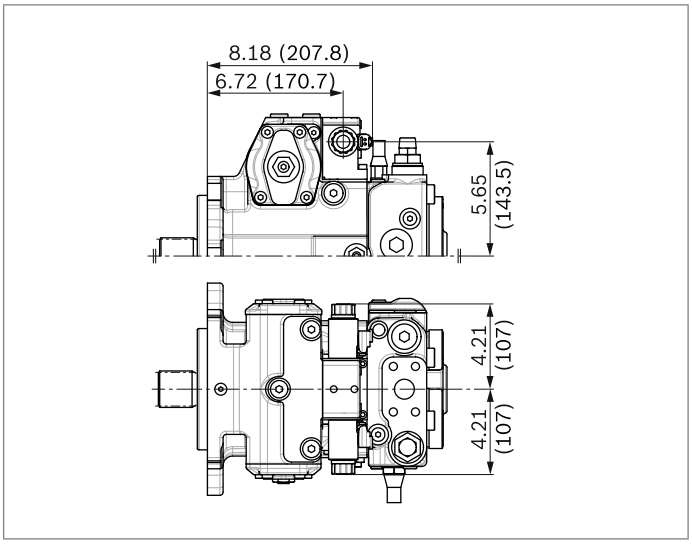
▼ **HW** – Proportional control, hydraulic, mechanical servo



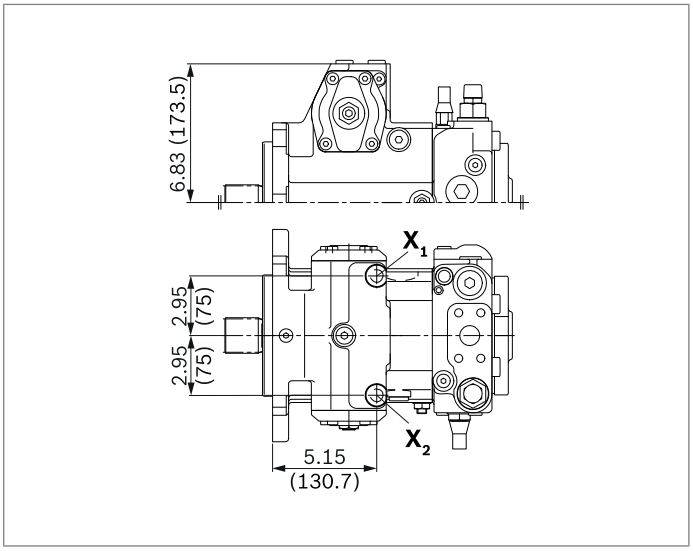
▼ **EP** – Proportional control, electric



▼ **EZ** – Two-point control, electric

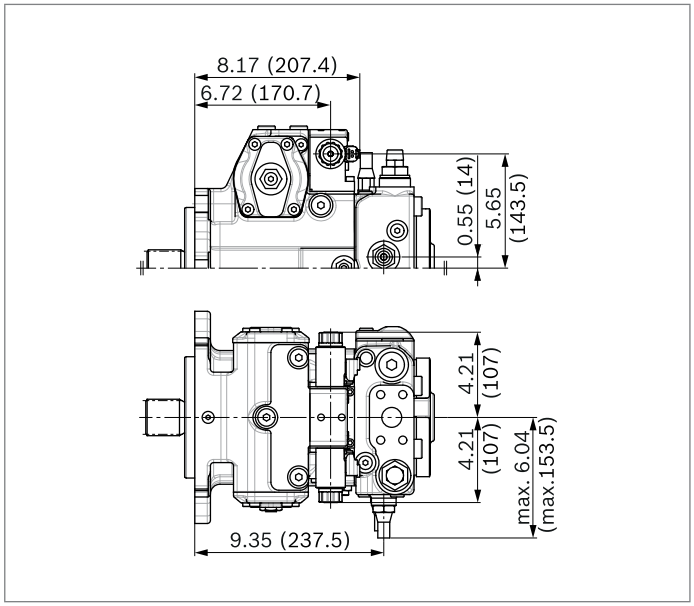


▼ **DG** – Hydraulic control, direct operated

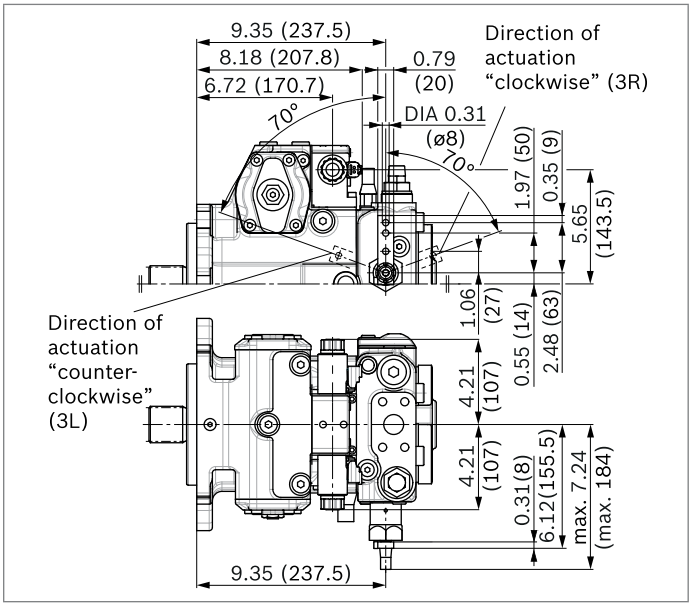


DA control valve

▼ **DA..2** – Fixed setting



▼ **DA..3** – Mechanically adjustable with position lever



▼ **DA..8** – Fixed setting and inch valve mounted