

Axial piston variable motor  
A6VM Series 63

Europe

**RE-E 91604**

Edition: 05.2016

Replaces: 06.2012



- ▶ All-purpose high pressure motor
- ▶ Sizes 28:
  - Nominal pressure 400 bar
  - Maximum pressure 450 bar
- ▶ Sizes 250 to 1000:
  - Nominal pressure 350 bar
  - Maximum pressure 400 bar
- ▶ Open and closed circuits

**Features**

- ▶ Robust motor with long service life
- ▶ Approved for very high rotational speeds
- ▶ High control range (can be swiveled to zero)
- ▶ High torque
- ▶ Variety of controls
- ▶ Optionally with flushing and boost-pressure valve mounted
- ▶ Optionally with integrated or mounted counterbalance valve
- ▶ Bent-axis design

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## Type code

01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	
	<b>A6V</b>		<b>M</b>					<b>/</b>	<b>63</b>	<b>W</b>		<b>-</b>	<b>V</b>						<b>-</b>	

### Hydraulic fluid

01	Mineral oil and HFD. HFD for sizes 250 to 1000 only in conjunction with long-life bearings "L" (without code)	
	HFB, HFC hydraulic fluid	Sizes 28 (without code)
		Sizes 250 to 1000 (only in conjunction with long-life bearings "L")
		<b>E</b>

### Axial piston unit

02	Bent-axis design, variable	<b>A6V</b>
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### Drive shaft bearing

		250	355	500	1000	
03	Standard bearings (without code)	●	●	●	-	
	Long-life bearings	●	●	●	●	<b>L</b>

### Operating mode

04	Motor (plug-in motor A6VE, see data sheet 91606)	<b>M</b>
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### Size (NG)

05	Geometric displacement, see page 8	<b>28</b>	<b>250</b>	<b>355</b>	<b>500</b>	<b>1000</b>
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### Control device<sup>1)</sup>

06	Proportional control, hydraulic	$\Delta p_{St} = 10 \text{ bar}$	●	●	●	●	●	<b>HD1</b>	
		$\Delta p_{St} = 25 \text{ bar}$	●	●	●	●	●	<b>HD2</b>	
		$\Delta p_{St} = 35 \text{ bar}$	-	●	●	●	●	<b>HD3</b>	
	Proportional control, electric	$U = 12 \text{ V}$	●	●	●	●	●	<b>EP1</b>	
		$U = 24 \text{ V}$	●	●	●	●	●	<b>EP2</b>	
	Two-point control, hydraulic		-	●	●	●	●	<b>HZ</b>	
			●	-	-	-	-	<b>HZ1</b>	
			-	-	-	-	-	<b>HZ3</b>	
	Two-point control, electric	$U = 12 \text{ V}$	●	●	●	●	●	<b>EZ1</b>	
		$U = 24 \text{ V}$	●	●	●	●	●	<b>EZ2</b>	
		$U = 12 \text{ V}$	-	-	-	-	-	<b>EZ3</b>	
		$U = 24 \text{ V}$	-	-	-	-	-	<b>EZ4</b>	
	Automatic control, high-pressure related	With minimum pressure increase $\Delta p \leq \text{approx. } 10 \text{ bar}$	●	●	●	●	●	<b>HA1</b>	
		With pressure increase $\Delta p = 100 \text{ bar}$	●	●	●	●	●	<b>HA2</b>	
	Automatic control, speed related	$p_{St}/p_{HD} = 3/100$ Hydraulic travel direction valve	-	●	●	●	○	<b>DA</b>	
		$p_{St}/p_{HD} = 5/100$ Hydraulic travel direction valve	●	-	-	-	-	<b>DA1</b>	
		Electric travel direction valve + electric $V_{g \max}$ circuit	$U = 12 \text{ V}$	●	-	-	-	-	<b>DA2</b>
			$U = 24 \text{ V}$	●	-	-	-	-	<b>DA3</b>
		$p_{St}/p_{HD} = 8/100$ Hydraulic travel direction valve		●	-	-	-	-	<b>DA4</b>
		Electric travel direction valve + electric $V_{g \max}$ circuit	$U = 12 \text{ V}$	●	-	-	-	-	<b>DA5</b>
	$U = 24 \text{ V}$	●	-	-	-	-	<b>DA6</b>		

### Pressure control/override (only for HD, EP)

		28	250	355	500	1000	
07	Without pressure control/override	●	●	●	●	●	
	Pressure control	fixed setting	●	●	●	●	<b>D</b>
		Hydraulic override, two-point	●	2)	2)	2)	2)
	Hydraulic remote control, proportional	-	●	●	●	●	<b>G</b>

● = Available    ○ = On request    - = Not available

1) Specify response time damping when ordering (size 28)

2) 2nd pressure setting fitted as standard with version D (sizes 250 to 1000)

01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	
	<b>A6V</b>		<b>M</b>					/	<b>63</b>	<b>W</b>		-	<b>V</b>						-	

Overrides for the HA1 and HA2 controls		28	250	355	500	1000		
08	Without override (without code)	●	●	●	●	●		
	Hydraulic override, remote control, proportional	●	●	●	●	●	<b>T</b>	
	Remote control electric override, two-point	$U = 12\text{ V}$	●	-	-	-	-	<b>U1</b>
		$U = 24\text{ V}$	●	-	-	-	-	<b>U2</b>
	Electric override + travel direction valve, electric	$U = 12\text{ V}$	●	-	-	-	-	<b>R1</b>
$U = 24\text{ V}$		●	-	-	-	-	<b>R2</b>	

**Series**

09	Series 6, index 3	<b>63</b>
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**Direction of rotation**

10	Viewed on drive shaft, bidirectional	<b>W</b>
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**Setting ranges for displacement<sup>3)</sup>**

		28	250	355	500	1000	
11	$V_{g\ min} = 0\text{ to }0.7\ V_{g\ max}$	●	-	-	-	-	
	$V_{g\ min} = 0\text{ to }0.4\ V_{g\ max}$ $V_{g\ max} = V_{g\ max}\text{ to }0.8\ V_{g\ max}$	-	●	●	●	●	<b>1</b>
	$V_{g\ min} > 0.4\ V_{g\ max}\text{ to }0.8\ V_{g\ max}$ $V_{g\ max} = V_{g\ max}\text{ to }0.8\ V_{g\ max}$	-	●	●	●	●	<b>2</b>

**Sealing material**

12	FKM (fluoroelastomer)	<b>V</b>
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**Drive shaft**

		28	250	355	500	1000	
13	Splined shaft DIN 5480	●	-	-	-	-	<b>A</b>
		●	●	●	●	●	<b>Z</b>
	Parallel keyed shaft DIN 6885	-	●	●	●	●	<b>P</b>

**Mounting flange**

		28	250	355	500	1000		
14	ISO 3019-2	4-hole	●	●	-	-	-	<b>B</b>
		8-hole	-	-	●	●	●	<b>H</b>

**Port plate for working line<sup>4)</sup>**

		28	250	355	500	1000			
15	SAE working ports <b>A</b> and <b>B</b> at rear	<b>01</b>	0	●	●	●	●	●	<b>010</b>
			7	●	●	●	●	●	<b>017</b>
	SAE working ports <b>A</b> and <b>B</b> lateral, opposite	<b>02</b>	0	●	●	●	●	●	<b>020</b>
			7	●	●	●	●	●	<b>027</b>
	SAE working ports <b>A</b> and <b>B</b> lateral, opposite + rear	<b>15</b>	0	-	●	●	●	●	<b>150</b>
	Port plate with 1-stage pressure relief valves for mounting a counterbalance valve <sup>5)</sup>	<b>38</b>	0	-	● <sup>6)</sup>	-	-	-	<b>380</b>
8			-	● <sup>6)</sup>	-	-	-	<b>388</b>	

**Valve** (see page 48)

Without valve	<b>0</b>
Flushing and boost-pressure valve, mounted	<b>7</b>
Counterbalance valve mounted <sup>7)</sup>	<b>8</b>

● = Available    ○ = On request    - = Not available

3) Please specify exact settings for  $V_{g\ min}$  and  $V_{g\ max}$  in plain text when ordering:  $V_{g\ min} = \dots\text{ cm}^3$ ,  $V_{g\ max} = \dots\text{ cm}^3$

4) Fastening thread, metric

5) Only possible in combination with HD, EP and HA control.

6) Counterbalance valve MHB32, please contact us.

4 **A6VM Series 63** | Axial piston variable motor  
Type code

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	<b>A6V</b>		<b>M</b>					<b>/</b>	<b>63</b>	<b>W</b>		<b>-</b>	<b>V</b>						<b>-</b>	

<b>Speed sensor</b> (see page 51)		<b>28</b>	<b>250</b>	<b>355</b>	<b>500</b>	<b>1000<sup>8)</sup></b>	
16	Without speed sensor (without code)	●	●	●	●	●	<b>0</b>
	Prepared for HDD speed sensor	▲	●	●	●	-	<b>F</b>
	HDD speed sensor mounted <sup>9)</sup>	▲	●	●	●	-	<b>H</b>
	Prepared for DSM/DSA speed sensor	●	-	-	-	-	<b>U</b>
	DSM/DSA speed sensor mounted <sup>9)</sup>	●	-	-	-	-	<b>V</b>

<b>Swivel angle sensor</b> (see page 50)		<b>28</b>	<b>250</b>	<b>355</b>	<b>500</b>	<b>1000</b>	
17	Without swivel angle sensor	●	●	●	●	-	
	Optical swivel angle sensor	-	●	●	●	●	<b>V</b>
	Electric swivel angle sensor	-	●	●	●	●	<b>E</b>

<b>Connector for solenoids</b> (see page 47)		<b>28</b>	<b>250 to 1000</b>	
18	Without connector (without solenoid, with hydraulic control only) (sizes 250 to 1000)	●	-	<b>0</b>
		-	●	
	DEUTSCH molded connector, 2-pin – without suppressor diode	●	-	<b>P</b>
	HIRSCHMANN connector – without suppressor diode	-	●	

<b>Beginning of control</b>		<b>28</b>	<b>250</b>	<b>355</b>	<b>500</b>	<b>1000</b>	
19	At $V_{g\ min}$ (standard for HA)	●	●	●	●	●	<b>A</b>
	At $V_{g\ max}$ (standard for HD, HZ, EP, EZ, DA)	●	●	●	●	●	<b>B</b>

<b>Standard / special version</b>		
20	Standard version	
	Standard version with installation variants, e.g. <b>T</b> ports open and closed contrary to standard	<b>-Y</b>
	Special version	<b>-S</b>

● = Available    ○ = On request    ▲ = Not for new projects    - = Not available

**Notice**

- ▶ Note the project planning notes on page 54.
- ▶ In addition to the type code, please specify the relevant technical data when placing your order.

7) Please contact us.  
8) Specify type code separately for sensor in accordance with data sheet 95132 – DSM or 95133 – DSA, 95135 – HDD and observe the requirements for the electronics.

## Hydraulic fluids

The A6VM variable motor 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)
- ▶ 990223: Fire-resistant, water-containing hydraulic fluids (HFC, HFB)
- ▶ 90225: Axial piston units for operation with water-free and water-containing fire-resistant hydraulic fluids (HFDR, HFDU, HFB, HFC).

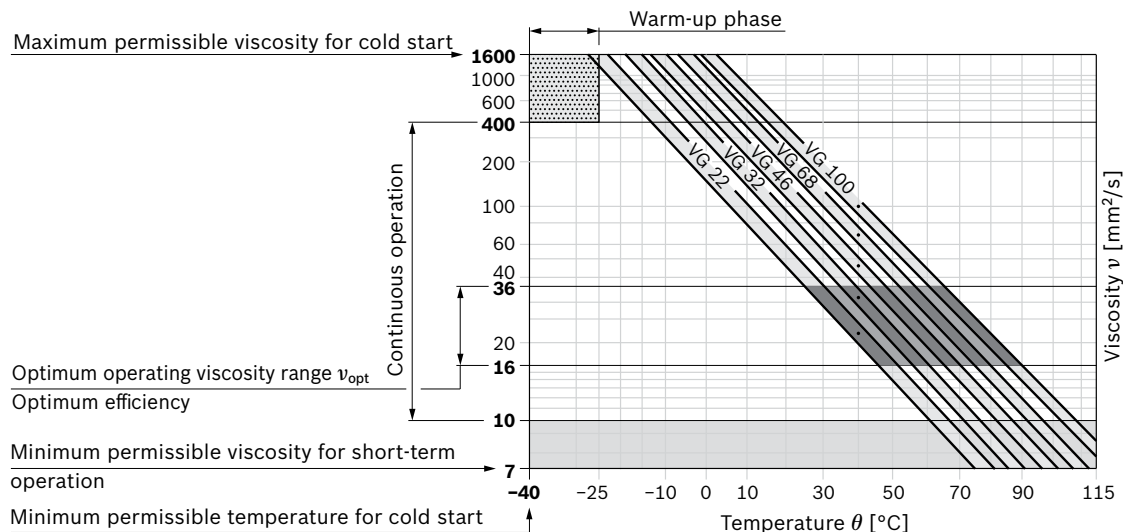
The variable motor A6VM is not suitable for operation with HFA fluids. If operating with HFB-, HFC- and HFD or environmentally acceptable hydraulic fluids, the limitations regarding technical data or other seals must be observed.

### Viscosity and temperature of hydraulic fluids

	Viscosity	Temperature	Comment
Cold start <sup>1)</sup>	$v_{\max} \leq 1600 \text{ mm}^2/\text{s}$	$\theta_{\text{St}} \geq -40 \text{ }^\circ\text{C}$	$t \leq 3 \text{ min}$ , $n \leq 1000 \text{ rpm}$ , without load $p \leq 50 \text{ bar}$
	Permissible temperature difference	$\Delta T \leq 25 \text{ K}$	between axial piston unit and hydraulic fluid in the system
Warm-up phase	$v = 1600 \text{ to } 400 \text{ mm}^2/\text{s}$	$\theta = -40 \text{ }^\circ\text{C to } -25 \text{ }^\circ\text{C}$	at $p \leq 0.7 \times p_{\text{nom}}$ , $n \leq 0.5 \times n_{\text{nom}}$ and $t \leq 15 \text{ min}$
Continuous operation	$v = 400 \text{ to } 10 \text{ mm}^2/\text{s}$		This corresponds, for example on the VG 46, to a temperature range of $+5 \text{ }^\circ\text{C to } +85 \text{ }^\circ\text{C}$ (see selection diagram)
		$\theta = -25 \text{ }^\circ\text{C to } +103 \text{ }^\circ\text{C}$	Note the permissible temperature range of the shaft seal measured at port <b>T</b> ( $\Delta T = \text{approx. } 12 \text{ K}$ between the bearing/shaft seal and port <b>T</b> )
	$v_{\text{opt}} = 36 \text{ to } 16 \text{ mm}^2/\text{s}$		Range of optimum operating viscosity and efficiency
Short-term operation	$v_{\min} \geq 7 \text{ mm}^2/\text{s}$		$t < 3 \text{ min}$ , $p < 0.3 \times p_{\text{nom}}$

1) For application cases below  $-25 \text{ }^\circ\text{C}$ , an NBR shaft seal is required (permissible temperature range  $-40 \text{ }^\circ\text{C to } +90 \text{ }^\circ\text{C}$ ).

### ▼ Selection diagram



### 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 ( $v_{\text{opt}}$  see selection diagram).

### Notice

At no point of the component may the temperature be higher than  $115 \text{ }^\circ\text{C}$ . The temperature difference specified in the table is to be taken into account when determining the viscosity in the bearing.

If the above conditions cannot be maintained due to extreme operating parameters, we recommend the use of a flushing and boost-pressure valve (see page 48).

### Filtration of the hydraulic fluid

Finer filtration improves the cleanliness level of the hydraulic fluid, which increases the service life of the axial piston unit. A cleanliness level of at least 20/18/15 is to be maintained according to ISO 4406.

At very high hydraulic fluid temperatures (90 °C to maximum 103 °C, measured at port **T**), a cleanliness level of at least 19/17/14 according to ISO 4406 is necessary.

### Effect of case pressure on beginning of control

An increase in case pressure affects the beginning of control of the variable motor when using the following control options:

- ▶ HD, HA.T3: increase
- ▶ HD, EP, HA, HA.T (Sizes 250 to 1000): increase
- ▶ DA: decrease

With the following settings, an increase in case pressure will have no effect on the beginning of control:

HA.R and HA.U, EP, HA

The factory settings for the beginning of control are made at  $p_{abs} = 2$  bar (size 28) and  $p_{abs} = 1$  bar (sizes 250 to 1000) case pressure.

### Flow direction

Direction of rotation, viewed on drive shaft	
clockwise	counter-clockwise
<b>A to B</b>	<b>B to A</b>

### Bearing

#### Long-life bearing, NG250-1000

For long service life and use with HF hydraulic fluids. Identical external dimensions as motor with standard bearings. Subsequent conversion to long-life bearings is possible.

### Flushing

#### Flushing flow (recommended)

Size	250	355	500	1000
$q_{v\ flush}$ [l/min]	10	16	16	16

To reduce the leakage temperature, external case flushing is possible via port **U** or internally via a flushing valve.

### Shaft seal

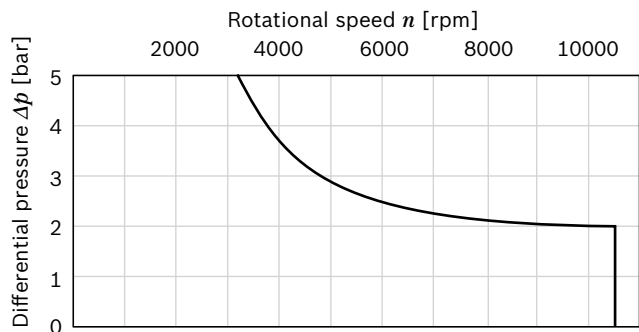
#### Permissible pressure loading

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 10 bar are allowed. Case pressures of a continuous 2 bar maximum are permitted to be able to utilize the entire speed range. Higher case pressures are permissible at lower rotational speeds (see diagram).

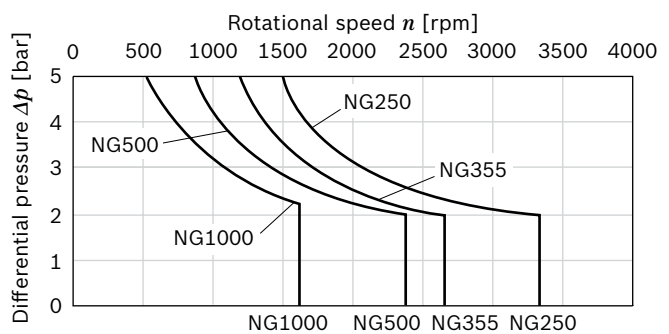
The service life of the shaft seal decreases with increasing frequency of pressure peaks and increasing mean differential pressure.

The case pressure must be equal to or higher than the ambient pressure.

#### ▼ Size 28



#### ▼ Sizes 250 to 1000

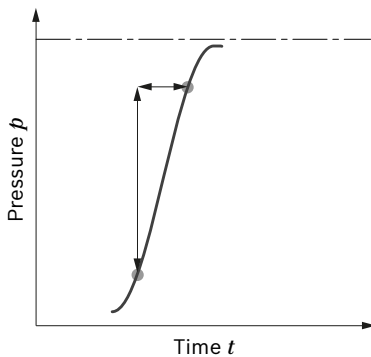


The FKM shaft seal ring may be used for leakage temperatures from -25 °C to +115 °C. For application cases below -25 °C, an NBR shaft seal is required (permissible temperature range: -40 °C to +90 °C).

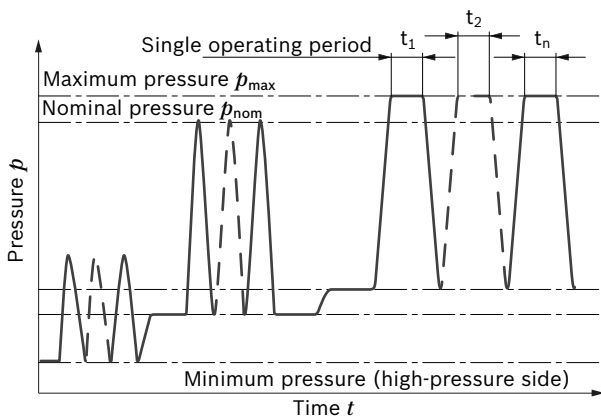
### Working pressure range

Pressure at working port A or B		Definition
Nominal pressure $p_{nom}$	NG28	400 bar
	NG250 to 1000	350 bar
Maximum pressure $p_{max}$	NG28	450 bar
	NG250 to 1000	400 bar
Single operating period		10 s
Total operating period		300 h
Minimum pressure (high-pressure side)		25 bar
Minimum pressure – operation as a pump (inlet)		See diagram below
Summation pressure $p_{Su}$ (pressure A + pressure B)		700 bar
Rate of pressure change $R_{A\ max}$		Maximum permissible rate of pressure build-up and reduction during a pressure change across the entire pressure range.
with built-in pressure relief valve		
without pressure relief valve		16000 bar/s

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

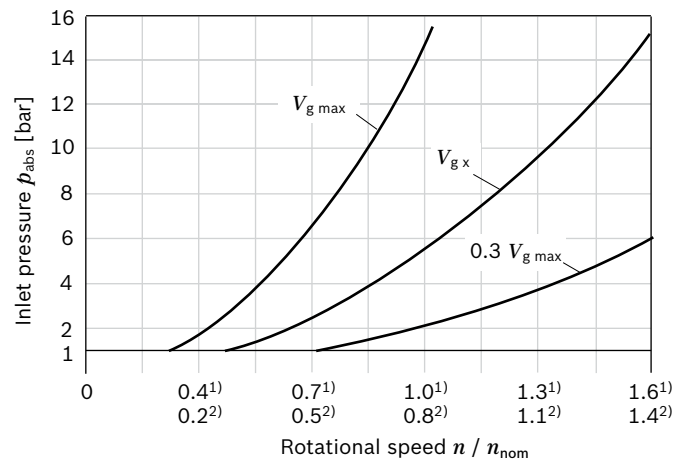


▼ Pressure definition



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

▼ Minimum pressure – operation as a pump (inlet)



This diagram is only valid for the optimum viscosity range of  $\nu_{opt} = 36$  to  $16\text{ mm}^2/\text{s}$ .

If the above mentioned conditions cannot be ensured please contact us.

**Notice**

Working pressure range valid when using hydraulic fluids based on mineral oils. Values for other hydraulic fluids, please contact us.

1) For size 28

2) For sizes 250 to 1000

## Technical data

Size		NG	28	250	355	500	1000	
Geometric displacement, per revolution <sup>1)</sup>		$V_{g \max}$	cm <sup>3</sup>	28.1	250	355	500	1000
		$V_{g \min}$	cm <sup>3</sup>	0	0	0	0	0
		$V_{g x}$	cm <sup>3</sup>	18	205	300	417	1000
Maximum rotational speed <sup>2)</sup> (while adhering to the maximum permissible inlet flow)	at $V_{g \max}$	$n_{\text{nom}}$	rpm	5550	2700	2240	2000	1600
	at $V_g < V_{g x}$ (see diagram on page 8)	$n_{\text{max}}$	rpm	8750	3300	2650	2400	1600
	where $V_{g 0}$	$n_{\text{max}}$	rpm	10450	3300	2650	2400	1600
Inlet flow <sup>3)</sup>	at $n_{\text{nom}}$ and $V_{g \max}$	$q_{v \max}$	l/min	156	675	795	1000	1600
Torque	at $V_{g \max}$ and $\Delta p = 400$ bar	$T$	Nm	179	-	-	-	-
	at $V_{g \max}$ and $\Delta p = 350$ bar	$T$	Nm	157	1391	1978	2785	5571
Rotary stiffness	$V_{g \max}$ to $V_g/2$	$c_{\text{min}}$	kNm/rad	6	60	75	115	281
	$V_g/2$ to 0 (interpolated)	$c_{\text{min}}$	kNm/rad	18	181	262	391	820
Moment of inertia for rotary group		$J_{\text{TW}}$	kgm <sup>2</sup>	0.0014	0.061	0.102	0.178	0.55
Maximum angular acceleration		$\alpha$	rad/s <sup>2</sup>	47000	10000	8300	5500	4000
Case volume		$V$	l	0.5	3.00	5.0	7.0	16.0
Weight approx.		$m$	kg	16	100	170	210	430

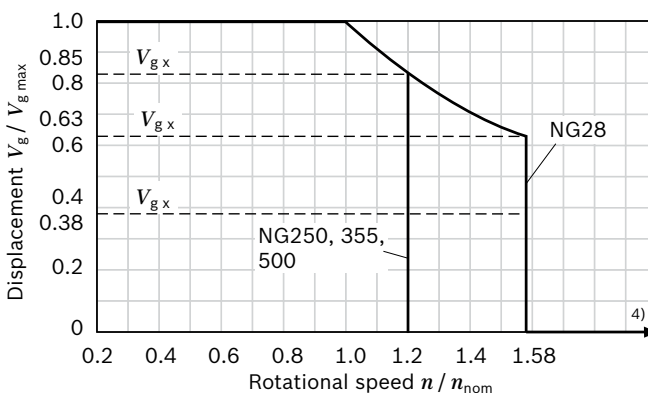
### Speed range

The minimum rotational speed  $n_{\text{min}}$  is not restricted. Please consult us regarding applications requiring uniformity of the rotatory motion at low speeds.

#### Notice

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

### Permissible displacement in relation to rotational speed



#### Determining the operating characteristics

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

#### Key

$V_g$	Displacement per revolution [cm <sup>3</sup> ]
$\Delta p$	Differential pressure [bar]
$n$	Rotational speed [rpm]
$\eta_v$	Volumetric efficiency
$\eta_{\text{hm}}$	Hydraulic-mechanical efficiency
$\eta_t$	Total efficiency ( $\eta_t = \eta_v \times \eta_{\text{hm}}$ )

1) The minimum and maximum displacement can be steplessly adjusted, see type code on page 3. (standard setting for sizes 250 to 1000 if ordering code is missing:

$$V_{g \min} = 0.2 \times V_{g \max}, V_{g \max} = V_{g \max}.$$


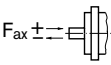
2) The values are applicable:

- for the optimum viscosity range from  $\nu_{\text{opt}} = 36$  to  $16$  mm<sup>2</sup>/s
- with hydraulic fluid based on mineral oils

3) Torque without radial force, with radial force, see page 9.

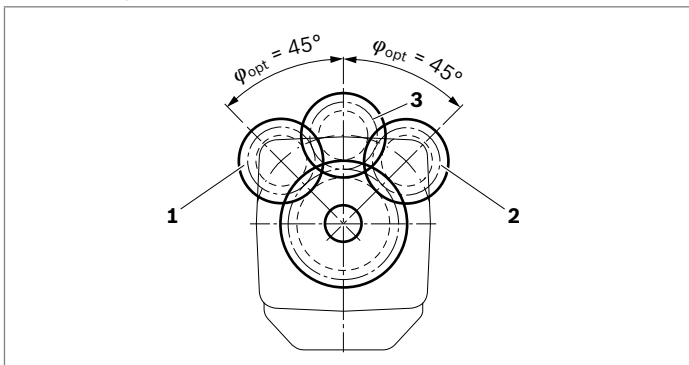
4) Values in this range on request

**Permissible radial and axial forces of the drive shafts**

Size	NG	28	28	250	250	355	355	500	500	1000	1000		
Drive shaft	Code		A	Z	Z	P	Z	P	Z	P	Z	P	
	Splined shaft		W30	W25	W50	–	W60	–	W70	–	W90	–	
	Keyed shaft	∅	mm	–	–	–	50	–	60	–	70	–	90
Maximum radial force at distance a (from shaft collar)		$F_{q \max}$	N	4838	6436	1200 <sup>1)</sup>	1200 <sup>1)</sup>	1500 <sup>1)</sup>	1500 <sup>1)</sup>	1900 <sup>1)</sup>	1900 <sup>1)</sup>	2600 <sup>1)</sup>	2600 <sup>1)</sup>
		a	mm	17.5	14.0	41.0	41.0	52.5	52.5	52.5	52.5	67.5	67.5
Maximum torque at $F_{q \max}$	$T_{q \max}$	Nm	179	179	2)	2)	2)	2)	2)	2)	2)	2)	
Maximum differential pressure at $V_{g \max}$ and $F_{q \max}$	$\Delta p_{q \max}$	bar	400	400	2)	2)	2)	2)	2)	2)	2)	2)	
Maximum axial force at standstill or depressurized operation		$+ F_{ax \max}$	N	0	0	0	0	0	0	0	0	0	
		$- F_{ax \max}$	N	315	315	1200	1200	1500	1500	1900	1900	2600	2600
Permissible axial force per bar working pressure	$+ F_{ax \text{ perm/bar}}$	N/bar	4.6	4.6	2)	2)	2)	2)	2)	2)	2)	2)	

**Effect of radial force  $F_q$  on the service life of bearings**

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

**▼ Toothed gear output drive**


**1** “Counter-clockwise” rotation. Pressure at port **B**

**2** “Clockwise” rotation, pressure at port **A**

**3** Bidirectional direction of rotation

**Notice**

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

1) When at standstill or when axial piston unit working in depressurized conditions. Higher forces are permissible under pressure, please contact us.  
 2) Please contact us.

## HD – Proportional control, hydraulic

The proportional hydraulic control provides infinite adjustment of the displacement. The control is proportional to the pilot pressure at port **X**.

### HD1, HD2, HD3

- ▶ Beginning of control at  $V_{g \max}$  (maximum torque, minimum rotational speed at minimum pilot pressure).
- ▶ End of control at  $V_{g \min}$  (minimum torque, maximum permissible rotational speed, at maximum pilot pressure).

### Notice

- ▶ Maximum permissible pilot pressure:  $p_{St} = 100$  bar
- ▶ The control oil is internally taken out of the high pressure side of the motor (**A** or **B**). For reliable control, a working pressure of at least 30 bar is necessary in **A** (**B**). If a control operation is performed at a working pressure < 30 bar, an auxiliary pressure of at least 30 bar must be applied at port **G** using an external check valve. For lower pressures, please contact us. Please note that at port **G** up to 450 bar (size 28) or 400 bar (sizes 250 to 1000) can occur.
- ▶ Specify the desired beginning of control in plain text when ordering, e.g.: beginning of control at 10 bar.
- ▶ The beginning of control and the HD-characteristic curve are influenced by case pressure. An increase in the case pressure causes an increase in the beginning of control (see page 7) and thus a parallel displacement of the characteristic curve.
- ▶ A leakage flow of maximum 0.3 l/min can occur at port **X** due to internal leakage (working pressure > pilot pressure). The control is to be suitably configured to avoid an independent build-up of pilot pressure.

### Response time damping

The response time damping impacts the pivot behavior of the motor and consequently the machine response speed.

#### Standard for size 28

HD1, HD2 without damping.

HD.D, HD.E with throttle pin on both sides, symmetrical (see table)

#### Option for size 28

HD1, HD2, with throttle pin on both sides, symmetrical (see table)

#### ▼ Throttle pin overview

Size	28	55	80	107	140	160	200
Groove size [mm]	0.3	0.45	0.45	0.55	0.55	0.55	0.65

#### Standard for sizes 250 to 1000

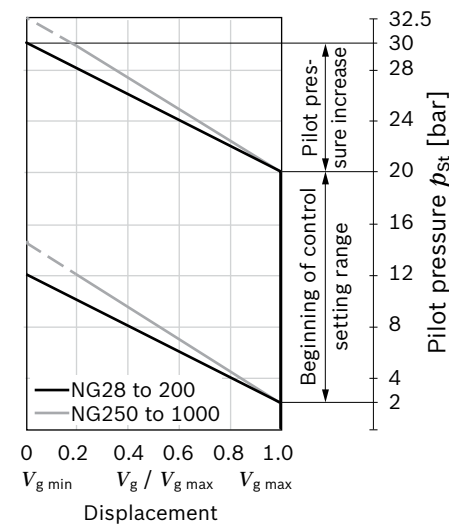
HD1, HD2 and HD3 with orifice ( $\varnothing 1.2$  mm)

HD.D, HD.E, HP.G with adjustable response time limiting valve with orifice ( $\varnothing 1.2$  mm)

#### HD1, pilot pressure increase $\Delta p_{St} = 10$ bar

A pilot pressure increase of 10 bar at port **X** will cause a reduction in displacement from  $V_{g \max}$  to 0 cm<sup>3</sup> (size 28) or from  $V_{g \max}$  to 0.2  $V_{g \max}$  (sizes 250 to 1000).  
Beginning of control, setting range 2 to 20 bar  
Standard setting: beginning of control at 3 bar (end of control at 13 bar)

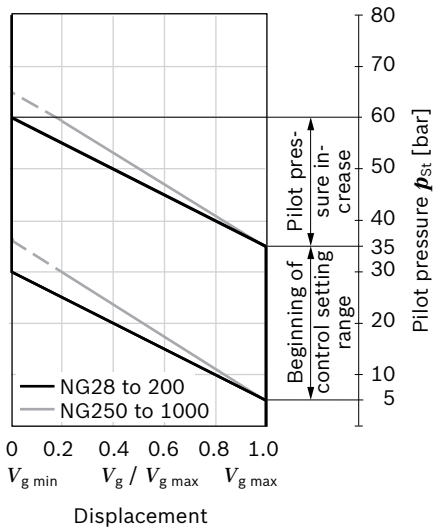
#### ▼ Characteristic curve



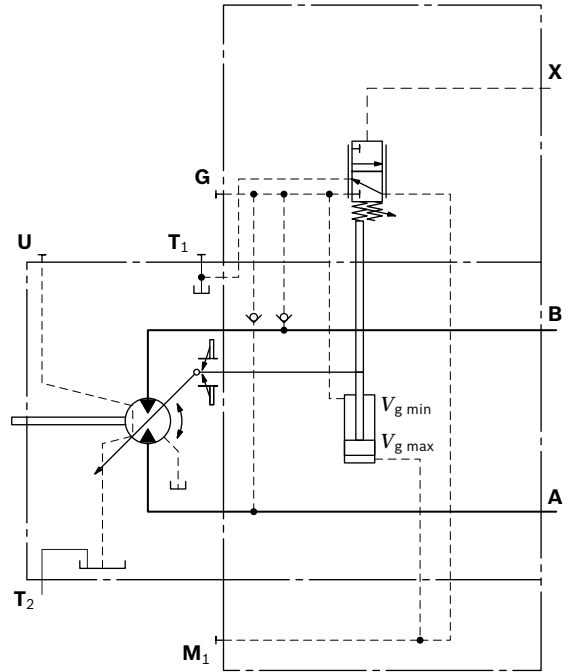
**HD2, pilot pressure increase  $\Delta p_{St} = 25$  bar**

A pilot pressure increase of 25 bar at port **X** results in a reduction in displacement from  $V_{g\ max}$  to  $0\ cm^3$  (size 28) or from  $V_{g\ max}$  to  $0.2\ V_{g\ max}$  (sizes 250 to 1000).  
 Beginning of control, setting range 5 to 35 bar  
 Standard setting: beginning of control at 10 bar (end of control at 35 bar)

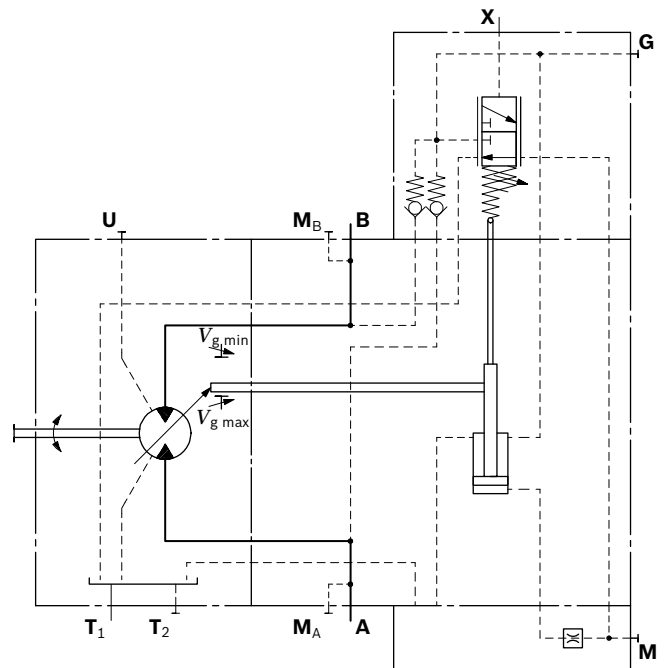
▼ **Characteristic curve**



▼ **Circuit diagram HD1, HD2, size 28**



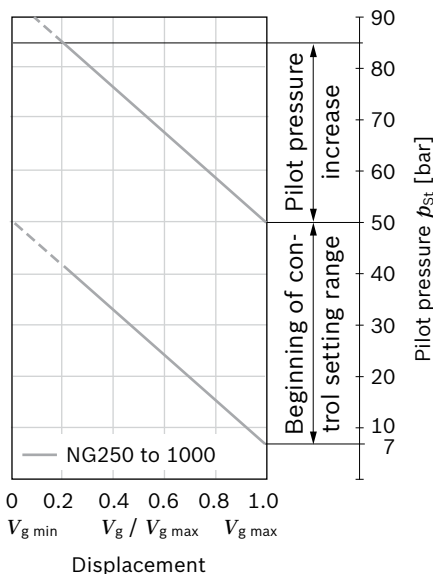
▼ **Circuit diagram HD1, HD2, HD3, sizes 250 to 1000**



**HD3, pilot pressure increase  $\Delta p_{St} = 35$  bar**

(sizes 250 to 1000)  
 A pilot pressure increase of 35 bar at port **X** results in a reduction in displacement from  $V_{g\ max}$  to  $0.2\ V_{g\ max}$ .  
 Beginning of control, setting range 7 to 50 bar  
 Standard setting: beginning of control at 10 bar (end of control at 45 bar)

▼ **Characteristic curve**



**HD.D Pressure control, fixed setting**

The pressure control overrides the HD control function. If the load torque or a reduction in motor swivel angle causes the system pressure to reach the setpoint value of the pressure control, the motor will swivel towards a larger angle. The increase in displacement and the resulting reduction in pressure cause the control deviation to decrease. With the increase in displacement the motor develops more torque, while the pressure remains constant.

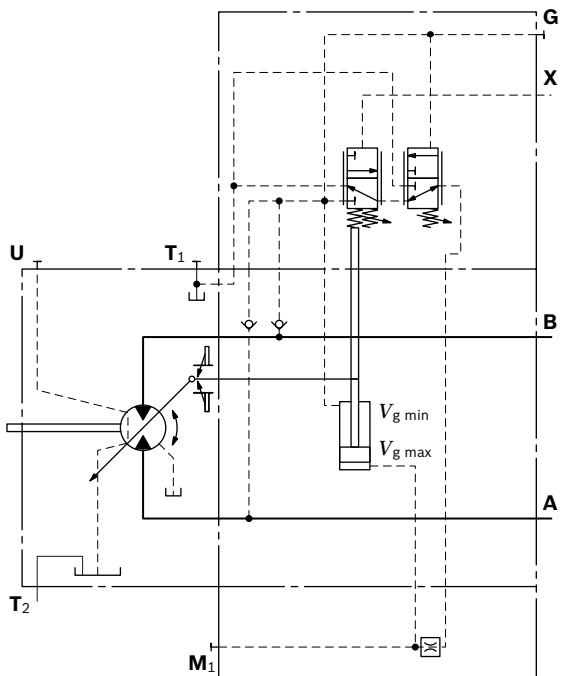
Size 28:

Setting range of the pressure control valve 80 to 400 bar

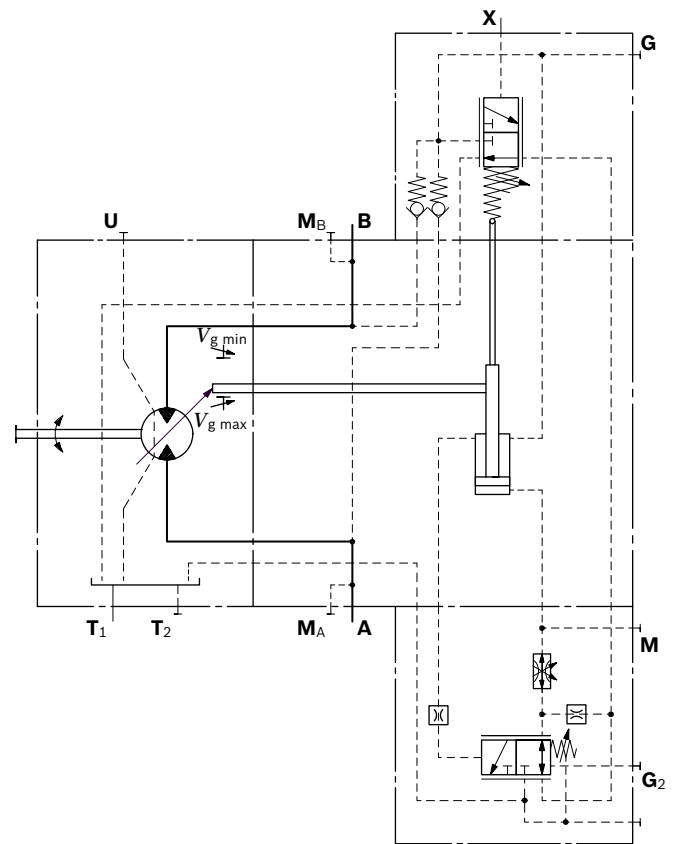
Sizes 250 to 1000:

Setting range of the pressure control valve 80 to 350 bar

▼ **Circuit diagram HD.D, size 28**



▼ **Circuit diagram HD.D, sizes 250 to 1000**



**HD.E pressure control, hydraulic override, two-point, size 28**

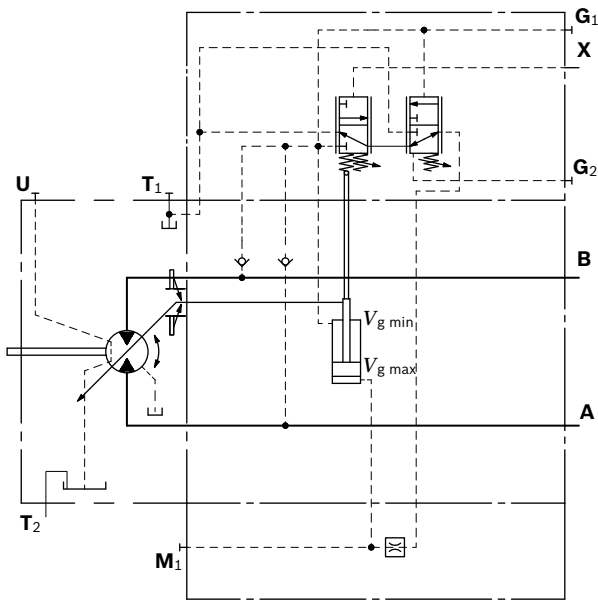
The pressure control setting can be overridden by applying an external pilot pressure at port **G<sub>2</sub>**, realizing a 2nd pressure setting.

Necessary pilot pressure at port **G<sub>2</sub>**:

$$p_{St} = 20 \text{ to } 50 \text{ bar}$$

When ordering, please specify the 2nd pressure setting in plain text.

▼ **Circuit diagram HD.E**



**Sizes 250 to 1000 (HD.D)**

Pressure control with 2nd pressure setting for HD.D provided as standard (see page 12).

The pressure control setting can be overridden by applying an external pilot pressure at port **G<sub>2</sub>**, realizing a 2nd pressure setting.

Necessary pilot pressure at port **G<sub>2</sub>**:

$$p_{St} \geq 130 \text{ bar}$$

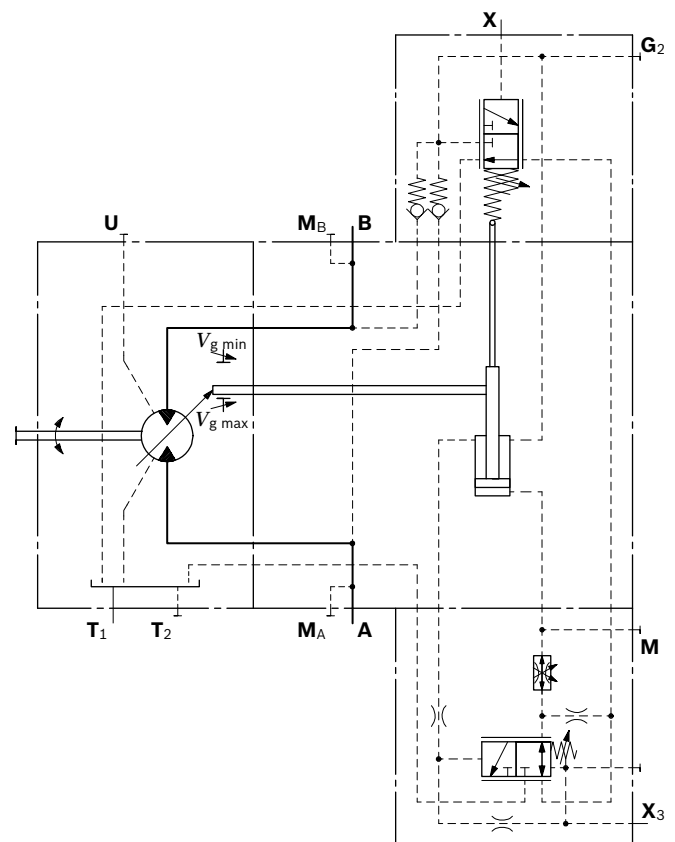
When ordering, please specify the 2nd pressure setting in plain text.

**HD.G pressure control, remote controlled, sizes 250 to 1000**

When the pressure command value is reached, the remote controlled pressure control continually regulates the motor to maximum displacement  $V_{g \max}$ . A pressure relief valve (not included in the scope of delivery), which is located separately from the motor and which is connected to port **X<sub>3</sub>**, assumes the task of controlling the internal pressure cut-off valve. So long as the pressure command value has not been reached, pressure is evenly applied to the valve from both sides in addition to the spring force, and the valve remains closed. The pressure command value is between 80 bar and 350 bar. When the pressure command value is reached at the separate pressure-relief valve, this will open, relieving the pressure on the spring side to the reservoir. The internal control valve switches and the motor swivels to maximum displacement  $V_{g \max}$ .

The differential pressure at the DRG control valve is set as standard to 25 bar. As a separate pressure relief valve, we recommend: DBD 6 (hydraulic) as per data sheet 25402; maximum line length should not exceed 2 m.

▼ **Circuit diagram HD.G**



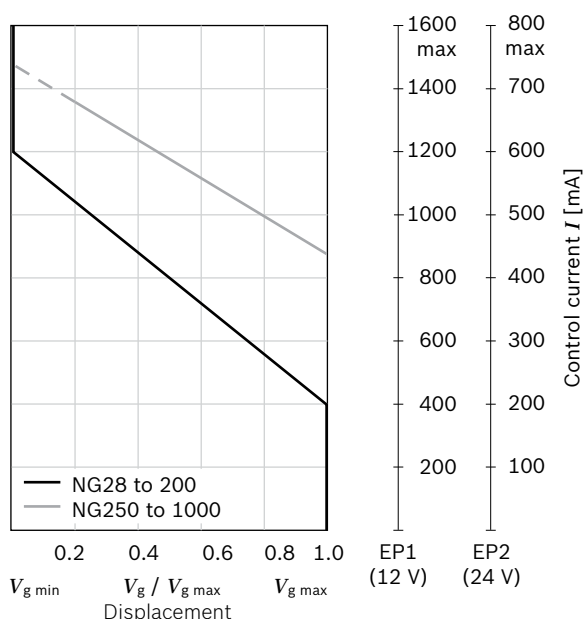
## EP – Proportional control, electric

The electric control with proportional solenoid (size 28) or proportional valve (sizes 250 to 1000) enable the displacement to be steplessly adjusted. Control is proportional to the electric control current applied to the solenoid.

Sizes 250 to 1000 require an external pilot oil supply at port **P** with a pressure of  $p_{\min} = 30 \text{ bar}$  ( $p_{\max} = 100 \text{ bar}$ ).

- ▶ Beginning of control at  $V_{g \max}$  (maximum torque, minimum rotational speed at minimum control current)
- ▶ End of control at  $V_{g \min}$  (minimum torque, maximum permissible rotational speed at maximum control current)

### ▼ Characteristic curve



### Notice

- ▶ The control oil is internally taken out of the high pressure side of the motor (**A** or **B**). For reliable control, a working pressure of at least 30 bar is necessary in **A** (**B**). If a control operation is performed at a working pressure < 30 bar, an auxiliary pressure of at least 30 bar must be applied at port **G** using an external check valve. For lower pressures at port **G**, please contact us. Please note that at port **G** up to 450 bar (size 28) or 400 bar (sizes 250 to 1000) can occur.
- ▶ The following only needs to be noted for sizes 250 to 1000:
  - The beginning of control and the **EP** characteristic curve are influenced by the case pressure. An increase in the case pressure causes an increase in the beginning of control (see page 6) and thus a parallel displacement of the characteristic curve.

### Response time damping

The response time damping impacts the pivot behavior of the motor and consequently the machine response speed.

#### Standard for size 28

EP1, EP2 without damping.

EP.D, EP.E with throttle pin on both sides, symmetrical (see table)

#### Option for size 28

EP1, EP2, with throttle pin on both sides, symmetrical (see table)

### ▼ Throttle pin overview

Size	28
Groove size [mm]	0.3

#### Standard for sizes 250 to 1000

EP1, EP2 with orifice ( $\varnothing 1.2 \text{ mm}$ )

EP.D, EP.E, EP.G with adjustable response time limiting valve

Technical data, solenoid, size 28	EP1	EP2
Voltage	12 V ( $\pm 20\%$ )	24 V ( $\pm 20\%$ )
Control current		
Beginning of control	400 mA	200 mA
End of control	1200 mA	600 mA
Current limit	1.54 A	0.77 A
Nominal resistance (at 20 °C)	5.5 $\Omega$	22.7 $\Omega$
Dither		
Frequency	100 Hz	100 Hz
minimum oscillation range <sup>1)</sup>	240 mA	120 mA
Duty cycle	100%	100%
Type of protection: see connector version page 47		

Various BODAS controllers with application software and amplifiers are available for controlling the proportional solenoids.

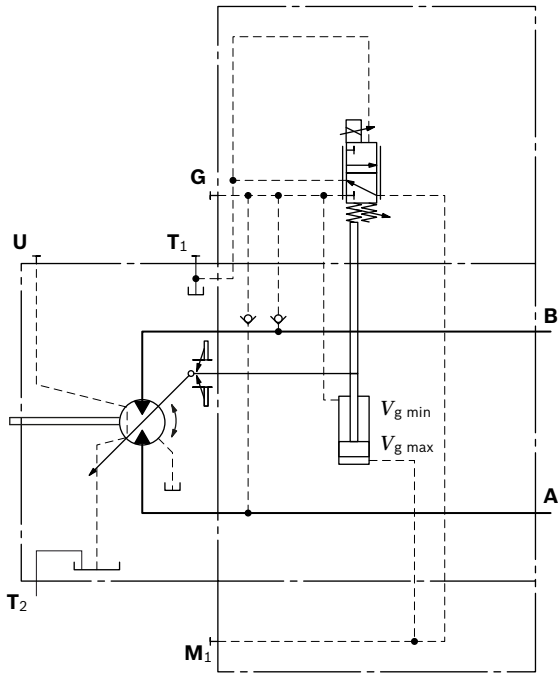
Further information can also be found on the internet at [www.boschrexroth.de/mobilelektronik](http://www.boschrexroth.de/mobilelektronik).

Technical data, proportional valve, sizes 250 to 1000	EP1	EP2
Voltage	12 V ( $\pm 20\%$ )	24 V ( $\pm 20\%$ )
Control current		
Start of control at $V_{g \max}$	900 mA <sup>1)</sup>	450 mA <sup>1)</sup>
End of control at $V_{g \min}$	approx. 1360 mA	approx. 680 mA
Current limit	2.2 A	1.0 A
Nominal resistance (at 20 °C)	2.4 $\Omega$	12 $\Omega$
Duty cycle	100%	100%
Type of protection: see connector version page 47		

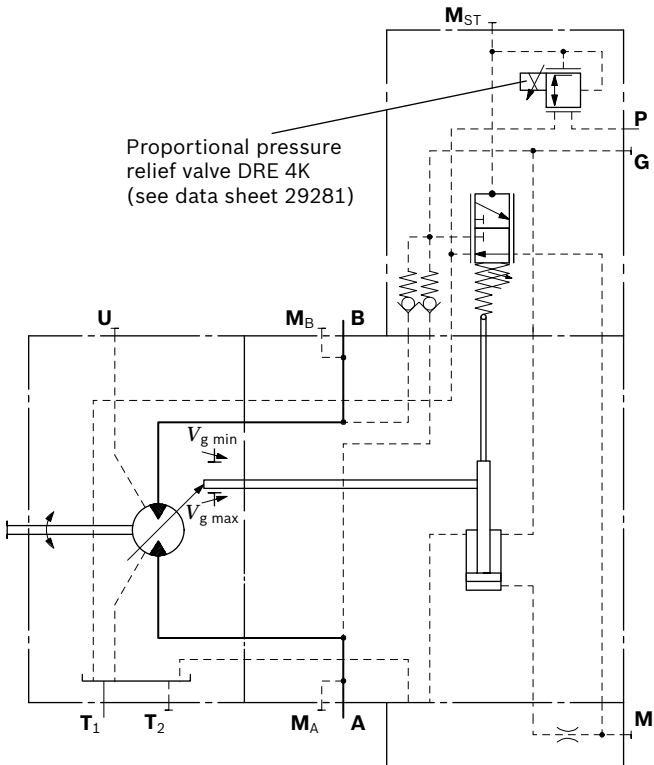
See also proportional pressure reducing valve DRE 4K (data sheet 29281 – proportional pressure reducing valve)

1) Setting

▼ Circuit diagram EP1, EP2, size 28



▼ Circuit diagram EP1, EP2, sizes 250 to 1000



**EP.D pressure control, fixed setting**

The pressure control overrides the EP control function. If the load torque or a reduction in motor swivel angle causes the system pressure to reach the setpoint value of the pressure control, the motor will swivel towards a larger angle.

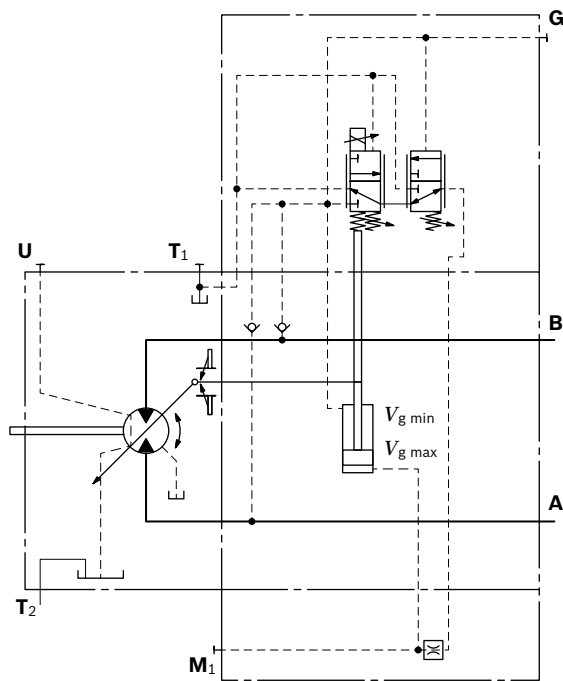
The increase in displacement and the resulting reduction in pressure cause the control deviation to decrease. With the increase in displacement the motor develops more torque, while the pressure remains constant.

size 28:

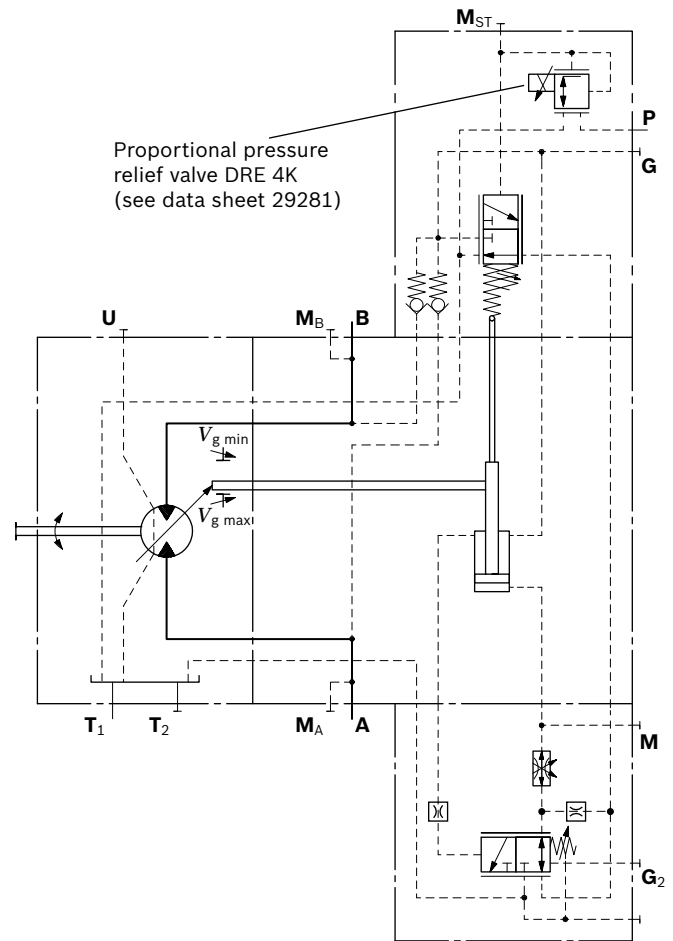
Setting range of the pressure control valve 80 to 400 bar  
 sizes 250 to 1000:

Setting range of the pressure control valve 80 to 350 bar

▼ **Circuit diagram EP.D, size 28**



▼ **Circuit diagram EP.D, sizes 250 to 1000**



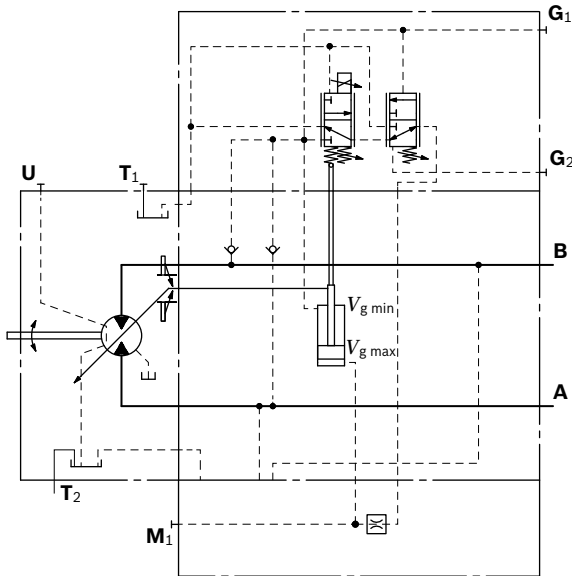
Proportional pressure relief valve DRE 4K (see data sheet 29281)

**EP.E pressure control, hydraulic override, two-point, size 28**

The pressure control setting can be overridden by applying an external pilot pressure at port **G<sub>2</sub>**, realizing a 2nd pressure setting realized. Necessary pilot pressure at port **G<sub>2</sub>**:  $p_{St} = 20$  to 50 bar

When ordering, please specify the 2nd pressure setting in plain text.

▼ **Circuit diagram EP.E**



**Sizes 250 to 1000 (EP.D)**

Pressure control with 2nd pressure setting for EP.D provided as standard (see page 16).

The pressure control setting can be overridden by applying an external pilot pressure at port **G<sub>2</sub>**, realizing a 2nd pressure setting.

Necessary pilot pressure at port **G<sub>2</sub>**:

$p_{St} \geq 100$  bar

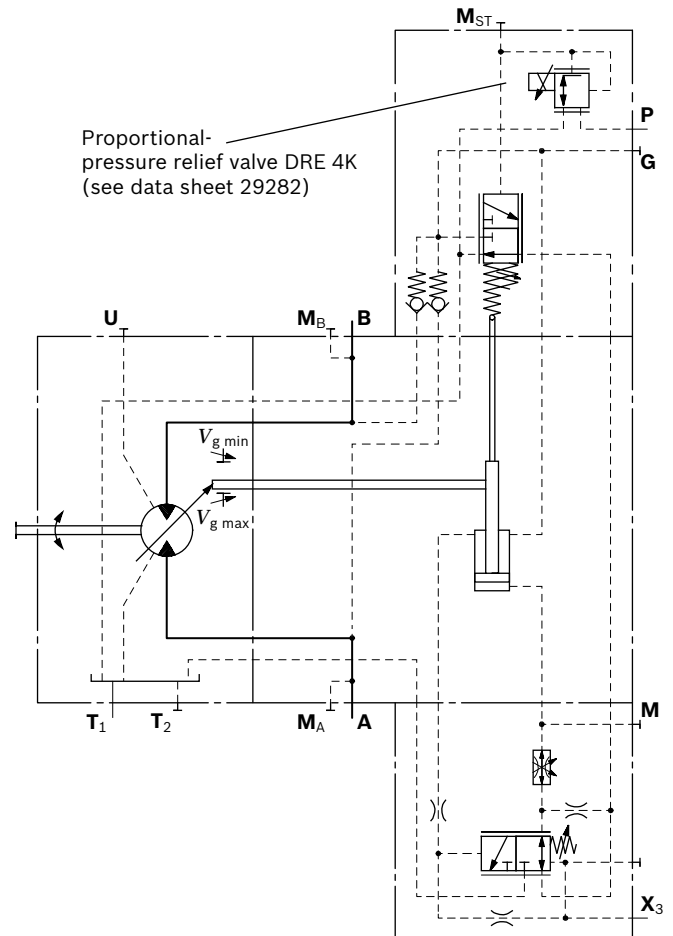
When ordering, please specify the 2nd pressure setting in plain text.

**EP.G pressure control, remote controlled, sizes 250 to 1000**

When the pressure command value is reached, the remote controlled pressure control continually regulates the motor to maximum displacement  $V_{g \max}$ . A pressure relief valve (not included in the scope of delivery), which is located separately from the motor and which is connected to port **X<sub>3</sub>**, assumes the task of controlling the internal pressure cut-off valve. So long as the pressure command value has not been reached, pressure is evenly applied to the valve from both sides in addition to the spring force, and the valve remains closed. The pressure command value is between 80 bar and 350 bar. When the pressure command value is reached at the separate pressure-relief valve, this will open, relieving the pressure on the spring side to the reservoir. The internal control valve switches and the motor swivels to maximum displacement  $V_{g \max}$ .

The differential pressure at the DRG control valve is set as standard to 25 bar. As a separate pressure relief valve, we recommend: DBD 6 (hydraulic) as per data sheet 25402; maximum line length should not exceed 2 m.

▼ **Circuit diagram EP.G**

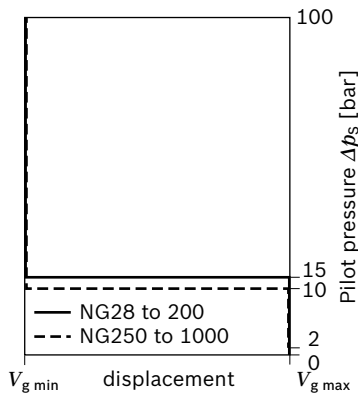


## HZ – Two-point control, hydraulic

The two-point hydraulic control allows the displacement to be set to either  $V_{g\ min}$  or  $V_{g\ max}$  by switching the pilot pressure at port **X** on or off.

- ▶ Position at  $V_{g\ max}$  (without pilot pressure, maximum torque, minimum rotational speed)
- ▶ Position at  $V_{g\ min}$  (with pilot pressure > 15 bar for size 28 and 10 bar for sizes 250 to 1000 switched on, minimum torque, maximum permissible rotational speed)

### ▼ Characteristic curve



### Notice

- ▶ Maximum permissible pilot pressure: 100 bar
- ▶ The control oil is internally taken out of the high pressure side of the motor (**A** or **B**). For reliable control, a working pressure of at least 30 bar is necessary in **A** (**B**). If a control operation is performed at a working pressure < 30 bar, an auxiliary pressure of at least 30 bar must be applied at port **G** using an external check valve. For lower pressures, please contact us. Please note that at port **G** up to 450 bar (size 28) or 400 bar (sizes 250 to 1000) can occur.
- ▶ A leakage flow of maximum 0.3 l/min can occur at port **X** due to internal leakage (working pressure > pilot pressure). The control is to be suitably configured to avoid an independent build-up of pilot pressure.

### Response time damping

The response time damping impacts the pivot behavior of the motor and consequently the machine response speed.

### Standard for sizes 28, 140 to 200

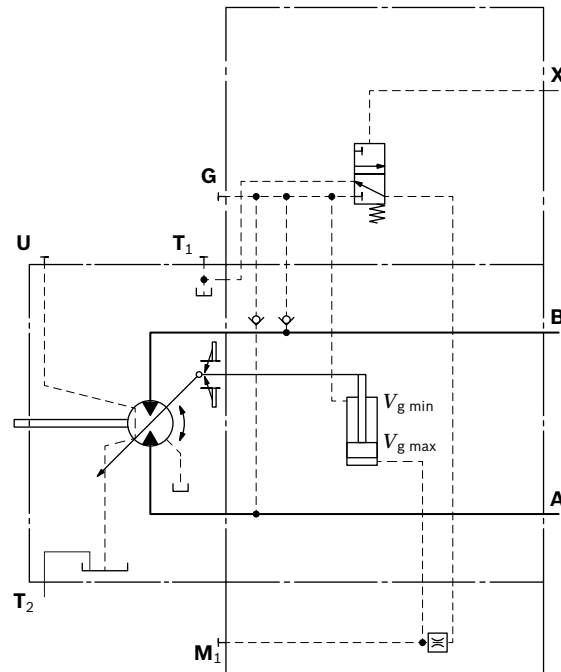
HZ1 with throttle pin on both sides, symmetrical (see table)

### ▼ Throttle pin overview

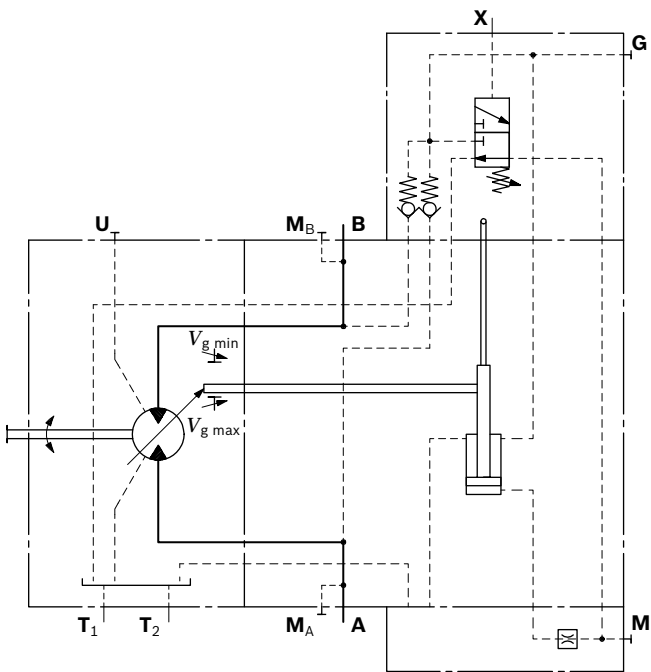
<b>Size</b>	<b>28</b>
Groove size [mm]	0.30

### Standard for sizes 250 to 1000 with orifice (ø1.2 mm)

### ▼ Circuit diagram HZ1, size 28



▼ **Circuit diagram HZ, sizes 250 to 1000**



## EZ – Two-point control, electric

The two-point electric control allows the displacement to be set to either  $V_{g \min}$  or  $V_{g \max}$  by switching the electric current on or off to a switching solenoid (size 28) or to an on/off valve (sizes 250 to 1000).

### Notice

The control oil is internally taken out of the high pressure side of the motor (**A** or **B**). For reliable control, a working pressure of at least 30 bar is necessary in **A** (**B**). If a control operation is performed at a working pressure < 30 bar, an auxiliary pressure of at least 30 bar must be applied at port **G** using an external check valve. For lower pressures, please contact us.

Please note that at port **G** up to 450 bar (size 28) or 400 bar (sizes 250 to 1000) can occur.

### Response time damping

The response time damping impacts the pivot behavior of the motor and consequently the machine response speed.

### Standard for sizes 28

EZ1, EZ2 with throttle pin on both sides, symmetrical (see table)

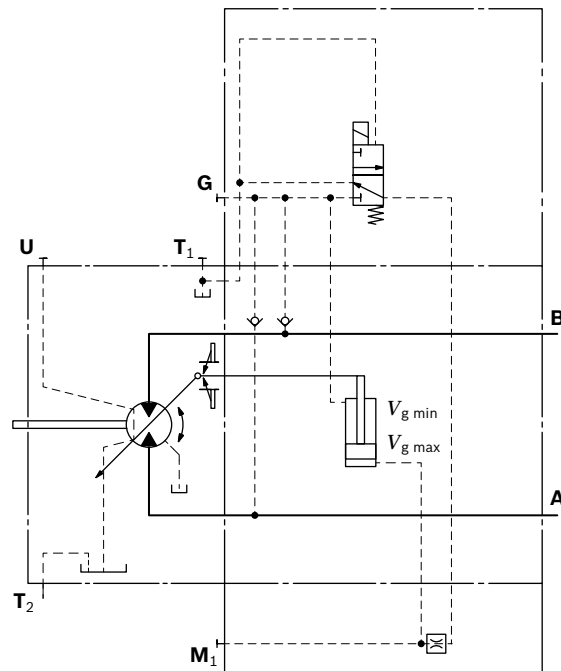
### ▼ Throttle pin overview

Size	28	55	80	107	140	160	200
Groove size [mm]	0.30	0.30	0.30	0.30	0.55	0.55	0.65

Standard for sizes 250 to 1000 with orifice ( $\varnothing 1.2$  mm)

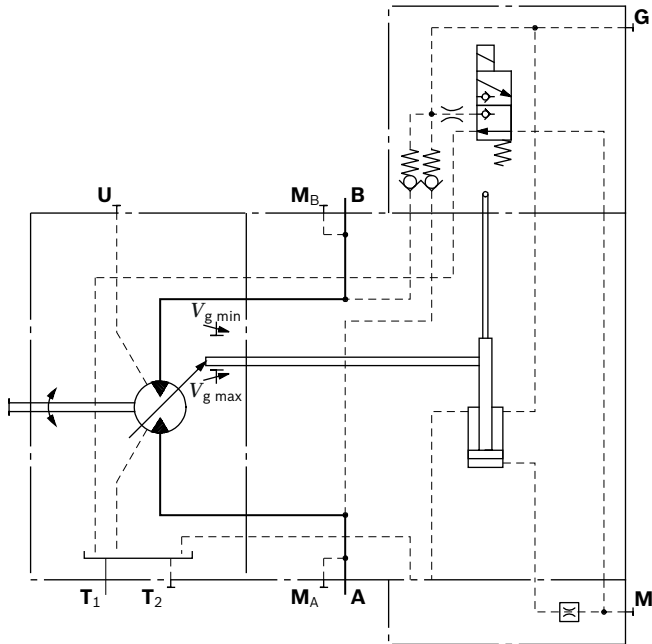
Technical data, solenoid with $\varnothing 37$ , sizes 28	EZ1	EZ2
Voltage	12 V ( $\pm 20\%$ )	24 V ( $\pm 20\%$ )
Position $V_{g \max}$	de-energized	de-energized
Position $V_{g \min}$	energized	energized
Nominal resistance (at 20 °C)	5.5 $\Omega$	21.7 $\Omega$
Nominal power	26.2 W	26.5 W
Minimum active current required	1.32 A	0.67 A
Duty cycle	100%	100%
Type of protection: see connector version page 47		

### ▼ Circuit diagram EZ1, EZ2, size 28



Technical data, on/off valve, sizes 250 to 1000	EZ1	EZ2
Voltage	12 V ( $\pm 20\%$ )	24 V ( $\pm 20\%$ )
Position $V_{g \max}$	de-energized	de-energized
Position $V_{g \min}$	energized	energized
Nominal resistance (at 20 °C)	6 $\Omega$	23 $\Omega$
Nominal power	26 W	26 W
Minimum active current required	2 A	1.04 A
Duty cycle	100%	100%
Type of protection: see connector version page 47		

▼ **Circuit diagram EZ1, EZ2, sizes 250 to 1000**



## HA – Automatic high-pressure related control

The automatic high-pressure related control adjusts the displacement automatically depending on the working pressure.

The displacement of the A6VM motor with HA control is  $V_{g \min}$  (maximum rotational speed and minimum torque). The control device measures internally the working pressure at **A** or **B** (no control line required) and upon reaching the set beginning of control, the controller swivels the motor with increasing pressure from  $V_{g \min}$  to  $V_{g \max}$ . The displacement is modulated between  $V_{g \min}$  and  $V_{g \max}$  depending on the load.

### HA1, HA2

- ▶ Beginning of control at  $V_{g \min}$  (minimum torque, maximum rotational speed)
- ▶ End of control at  $V_{g \max}$  (maximum torque, minimum rotational speed)

### Notice

- ▶ For safety reasons, winch drives are not permissible with beginning of control at  $V_{g \min}$  (standard for HA).
- ▶ The control oil is internally taken out of the high pressure side of the motor (**A** or **B**). For reliable control, a working pressure of at least 30 bar is necessary in **A** (**B**). If a control operation is performed at a working pressure < 30 bar, an auxiliary pressure of at least 30 bar must be applied at port **G** using an external check valve. For lower pressures, please contact us. Please note that at port **G** up to Please note that at port **G** up to 450 bar (size 28) or 400 bar (sizes 250 to 1000) can occur.
- ▶ The beginning of control and the HA characteristic curve are influenced by the case pressure. An increase in the case pressure causes an increase in the beginning of control (see page 6) and thus a parallel displacement of the characteristic curve. Only for HA1T (size 28) and for HA1, HA2 and HA.T (sizes 250 to 1000).
- ▶ A leakage flow of maximum 0.3 l/min occurs at port X (working pressure > pilot pressure). To avoid a build-up of pilot pressure, pressure must to be relieved from port X to the reservoir. **Only for HA.T control.**

### Response time damping

The response time damping impacts the pivot behavior of the motor and consequently the machine response speed.

### Standard for size 28

HA with throttle pin on one side, throttle from  $V_{g \min}$  to  $V_{g \max}$ . (see table)

#### ▼ Throttle pin overview

Size	28
Groove size [mm]	0.3

**Standard for sizes 250 to 1000** with orifice ( $\varnothing 1.2$  mm)

**HA1 with minimum pressure increase, positive control**

A working pressure increase of  $\Delta p \leq$  approx. 10 bar results in an increase in displacement from  $V_{g \min}$  to  $V_{g \max}$ .

Size 28:

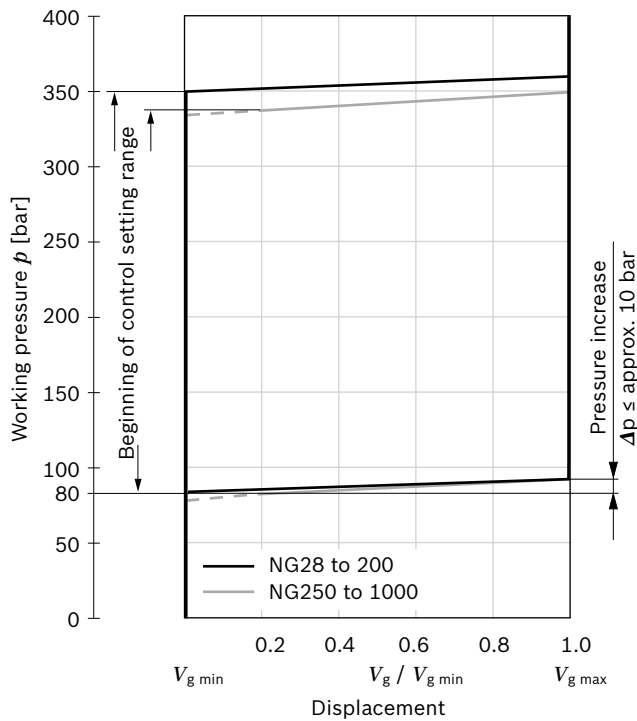
Setting range of the pressure control valve 80 to 350 bar

Sizes 250 to 1000:

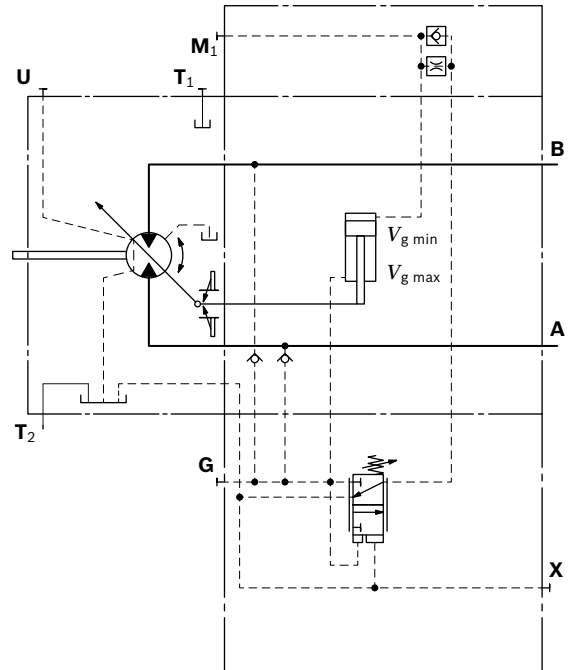
Setting range of the pressure control valve 80 to 340 bar

Please state the desired beginning of control in plain text when ordering, e.g.: beginning of control at 300 bar.

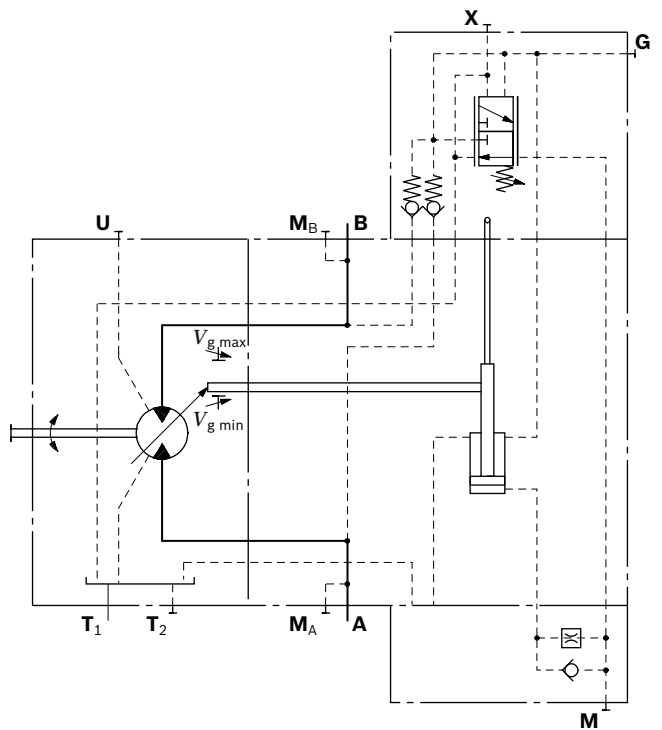
▼ **Characteristic curve HA1**



▼ **Circuit diagram HA1, size 28**



▼ **Circuit diagram HA1, sizes 250 to 1000**



**HA2 with pressure increase, positive control**

A working pressure increase of  $\Delta p \leq$  approx. 100 bar results in an increase in displacement from  $V_{g \min}$  to  $V_{g \max}$ .

Size 28:

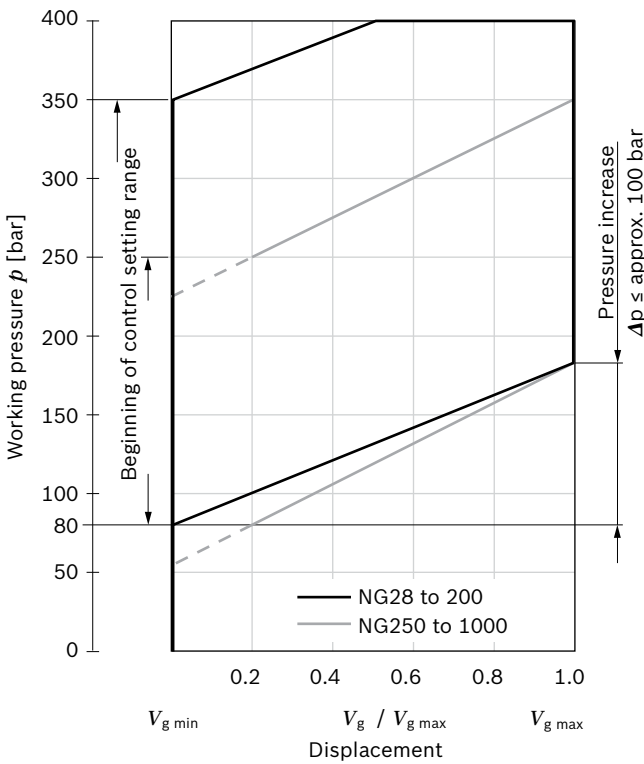
Setting range of the pressure control valve 80 to 350 bar

Sizes 250 to 1000:

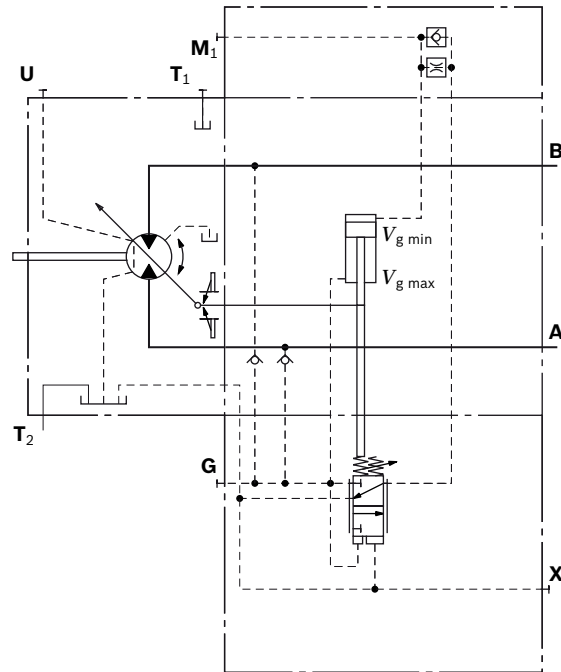
Setting range of the pressure control valve 80 to 250 bar

Please state the desired beginning of control in plain text when ordering, e.g.: beginning of control at 200 bar.

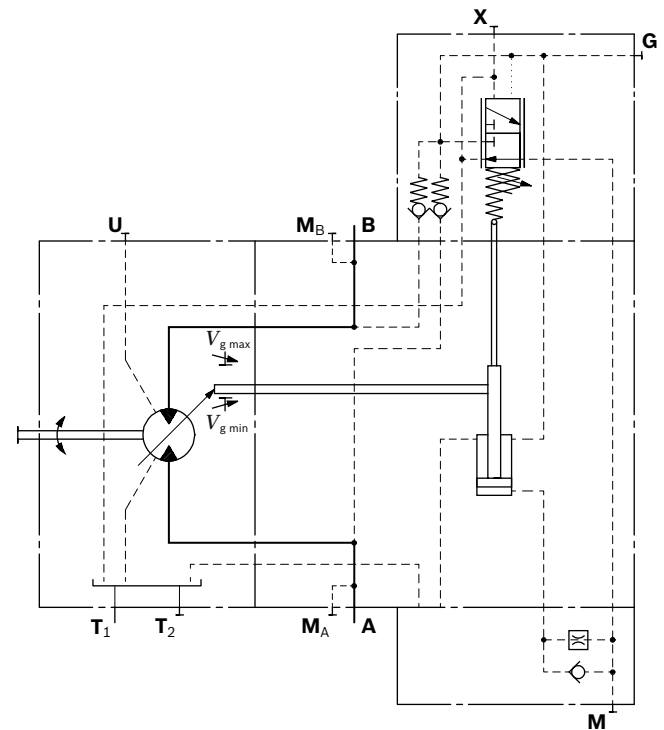
**Characteristic curve HA2**



**Circuit diagram HA2, size 28**



**Circuit diagram HA2, sizes 250 to 1000**



**HA.T Hydraulic override, remote control, proportional**

With the HA.T3 control, the beginning of control can be influenced by applying a pilot pressure to port **X**.

For every 1 bar of pilot pressure, the beginning of control is reduced by 17 bar (size 28) or 9 bar (sizes 250 to 1000).

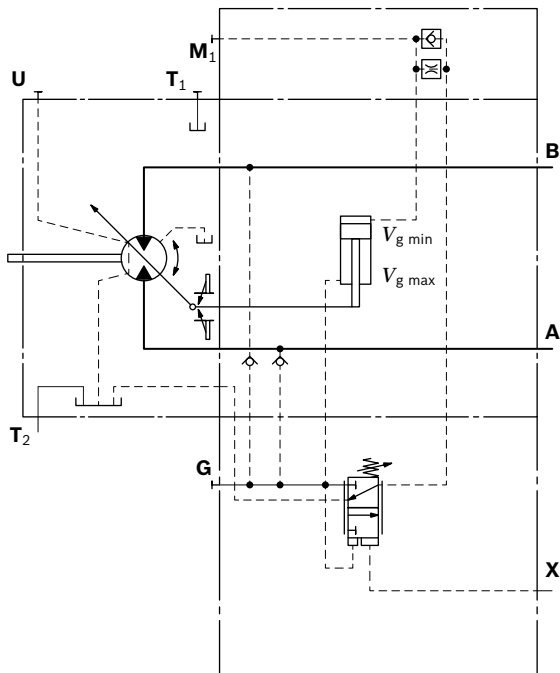
Example (size 28):

Settings for the beginning of control	300 bar	300 bar
Pilot pressure at port <b>X</b>	0 bar	10 bar
Beginning of control at	300 bar	130 bar

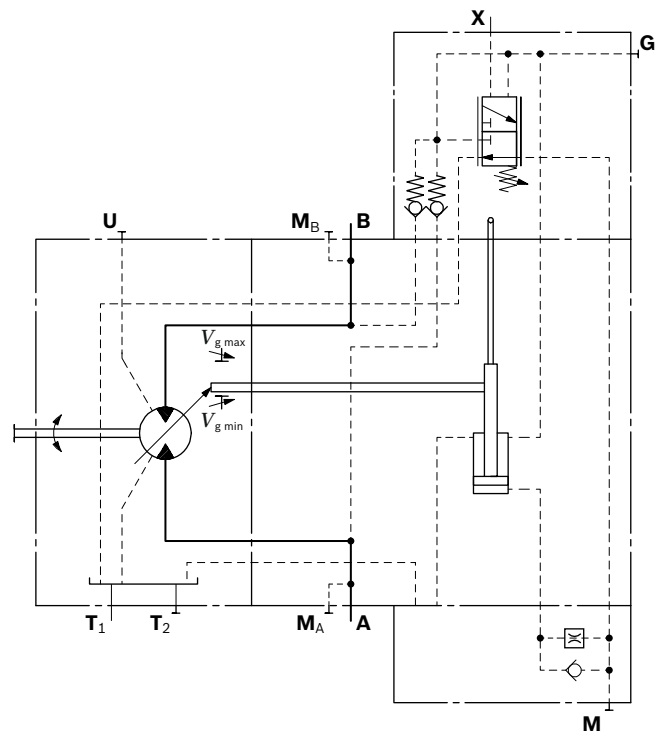
**Notice**

Maximum permissible pilot pressure 100 bar.

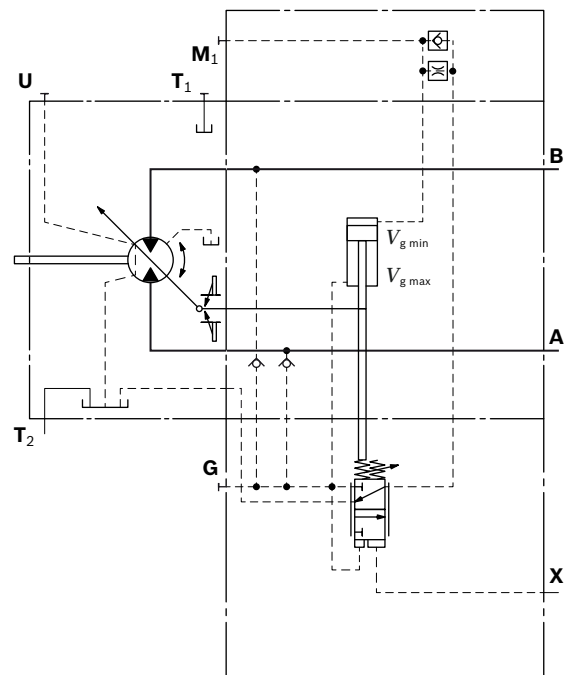
▼ **Circuit diagram HA1T, size 28**



▼ **Circuit diagram HA1T, sizes 250 to 1000**



▼ **Circuit diagram HA2T, size 28**



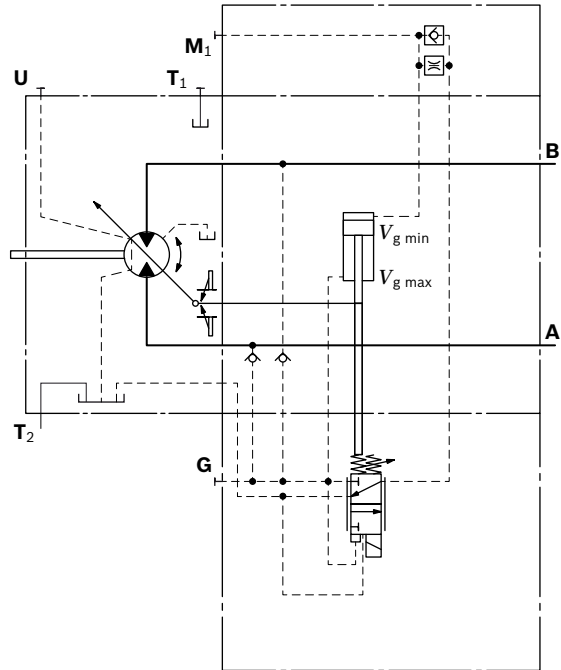
**HA.U1, HA.U2 electric override, two-point, size 28**

With the HA.U1 or HA.U2 control, the beginning of control can be overridden by an electric signal to a switching solenoid. When the override solenoid is energized, the variable motor swivels to maximum swivel angle, without intermediate position.

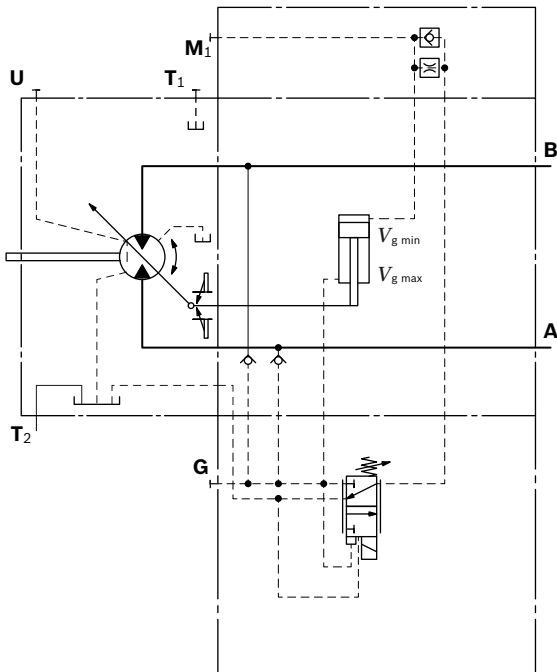
The beginning of control can be set between 80 and 300 bar (specify required setting in plain text when ordering).

Technical data, solenoid with Ø45	U1	U2
Voltage	12 V ( $\pm 20\%$ )	24 V ( $\pm 20\%$ )
No override	de-energized	de-energized
Position $V_{g \max}$	energized	energized
Nominal resistance (at 20 °C)	4.8 $\Omega$	19.2 $\Omega$
Nominal power	30 W	30 W
Minimum active current required	1.5 A	0.75 A
Duty cycle	100%	100%
Type of protection: see connector version page 47		

▼ **Circuit diagram HA2.U1, HA2.U2**



▼ **Circuit diagram HA1.U1, HA1.U2**



**HA.R1, HA.R2 electric override, travel direction valve electric, size 28**

With the HA.R1 or HA.R2 control, the beginning of control can be overridden by an electric signal to switching solenoid **b**. When the override solenoid is energized, the variable motor swivels to maximum swivel angle, without intermediate position.

The travel direction valve ensures that the preselected pressure side of the hydraulic motor (**A** or **B**) is always connected to the HA control, and thus determines the swivel angle, even if the high-pressure side changes (e.g. -travel drive during a downhill operation). This thereby prevents undesired swiveling of the variable motor to a larger displacement (jerky deceleration and/or braking characteristics).

Depending on the direction of rotation (direction of travel), the travel direction valve is actuated through the compression spring or the switching solenoid **a** (see page 30).

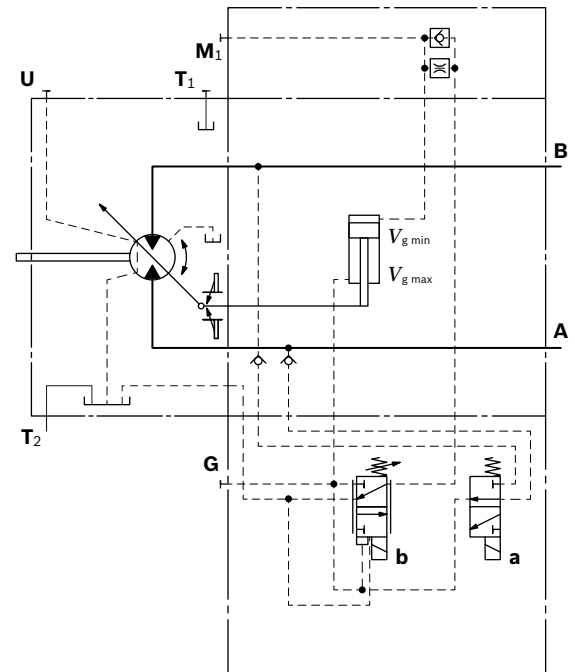
**Electric override**

Technical data, solenoid <b>b</b> with $\varnothing 45$	R1	R2
Voltage	12 V ( $\pm 20\%$ )	24 V ( $\pm 20\%$ )
No override	de-energized	de-energized
Position $V_{g \max}$	energized	energized
Nominal resistance (at 20 °C)	4.8 $\Omega$	19.2 $\Omega$
Nominal power	30 W	30 W
Minimum active current required	1.5 A	0.75 A
Duty cycle	100%	100%
Type of protection: see connector version page 47		

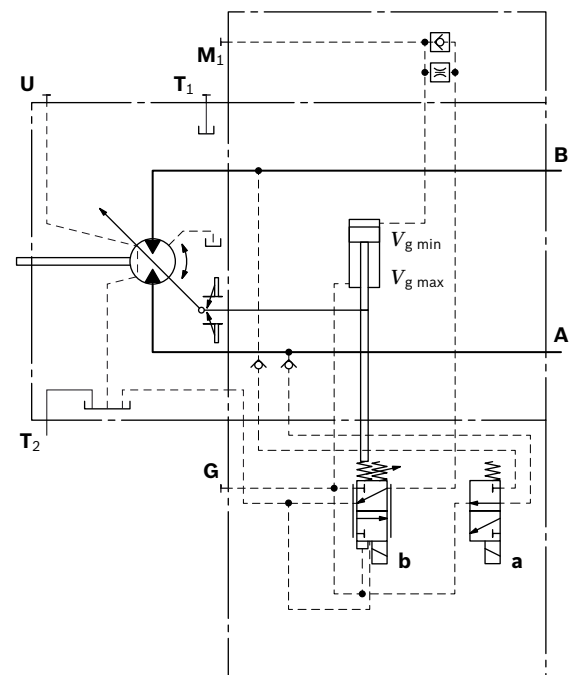
**Travel direction valve, electric**

Technical data, solenoid <b>a</b> with $\varnothing 37$	R1	R2
Voltage	12 V ( $\pm 20\%$ )	24 V ( $\pm 20\%$ )
Direction of rotation	Working pressure in	
counter-clockwise <b>B</b>	energized	energized
clockwise <b>A</b>	de-energized	de-energized
Nominal resistance (at 20 °C)	5.5 $\Omega$	21.7 $\Omega$
Nominal power	26.2 W	26.5 W
Minimum active current required	1.32 A	0.67 A
Duty cycle	100%	100%
Type of protection: see connector version page 47		

▼ Circuit diagram HA1.R1, HA1.R2



▼ Circuit diagram HA2.R1, HA2.R2



## DA – Automatic control, speed related

The variable motor A6VM with automatic speed-related control is intended for use in hydrostatic travel drives in combination with the variable pump A4VG with DA control. A drive speed-related pilot pressure signal is generated by the A4VG variable pump, and that signal, together with the working pressure, regulates the swivel angle of the hydraulic motor.

Increasing drive speed, i.e. increasing pilot pressure, causes the motor to swivel to a smaller displacement (lower torque, higher rotational speed), depending on the working pressure.

If the working pressure exceeds the pressure command value of the controller, the variable motor swivels to a larger displacement (higher torque, lower rotational speed).

► Pressure ratio  $p_{st}/p_{HD} = 3/100, 5/100, 8/100$

DA control is only suitable for certain types of travel drive systems and requires review of the engine and vehicle parameters to ensure that the motor is used correctly and that machine operation is safe and efficient. We recommend that all DA applications be reviewed by a Bosch Rexroth application engineer.

Our Sales department will provide you detailed information.

### Notice

The beginning of control and the DA characteristic curve are influenced by case pressure. An increase in the case pressure causes a decrease / reduction in the beginning of control (see page 6) and thus a parallel displacement of the characteristic curve.

### Response time damping

The response time damping impacts the pivot behavior of the motor and consequently the machine response speed.

### Standard for size 28

DA with throttle pin on one side, throttle from  $V_{g \min}$  to  $V_{g \max}$  (see table)

#### ▼ Throttle pin overview

Size	28
Groove size [mm]	0.30

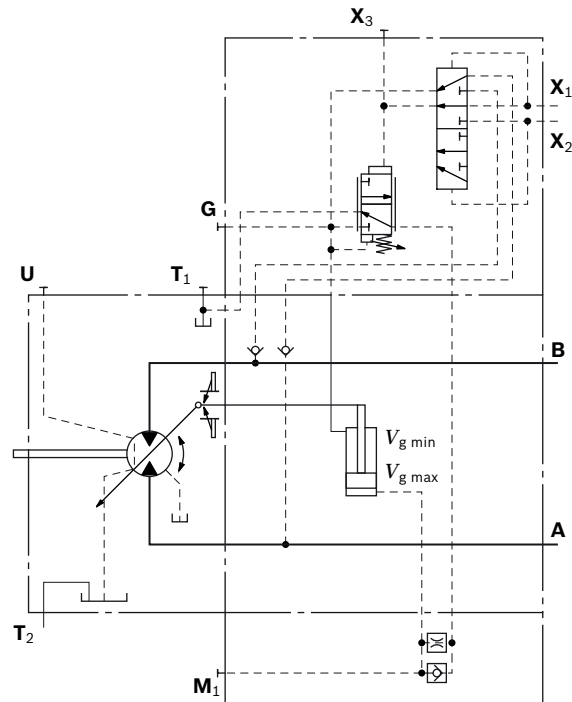
**Standard for sizes 250 to 1000** with orifice ( $\varnothing 1.2$  mm)

### DA, DA1, DA4 hydraulic travel direction valve,

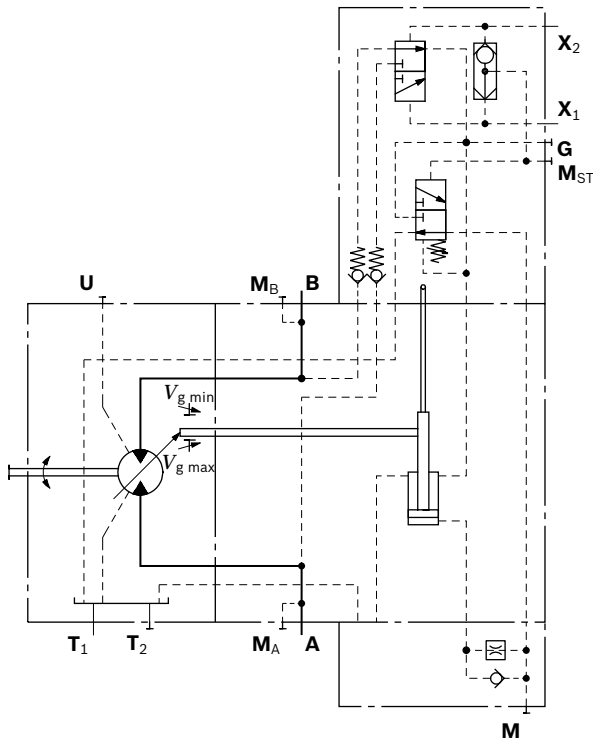
Dependent on the direction of rotation (travel direction), the travel direction valve is switched by using pilot pressures  $X_1$  or  $X_2$ . The maximum permissible pilot pressure for sizes 250 to 1000 is  $p_{st} = 25$  bar. Momentary ( $t < 0.1$  s) pressure peaks of up to 40 bar are permitted.

Direction of rotation	Working pressure in	Pilot pressure in
clockwise	<b>A</b>	<b>X<sub>1</sub></b>
counter-clockwise	<b>B</b>	<b>X<sub>2</sub></b>

#### ▼ Circuit diagram DA1, DA4, size 28



▼ **Circuit diagram DA, sizes 250 to 1000**



**DA2, DA3, DA5, DA6 electric travel direction valve + electric  $V_{g \max}$ -circuit, size 28**

Depending on the direction of rotation (direction of travel), the travel direction valve is actuated through the compression spring or the switching solenoid **a**.

When switching solenoid **b** is energized, the control can be overridden and the motor can be swiveled to maximum displacement (high torque, lower rotational speed) (electric  $V_{g \max}$ -circuit).

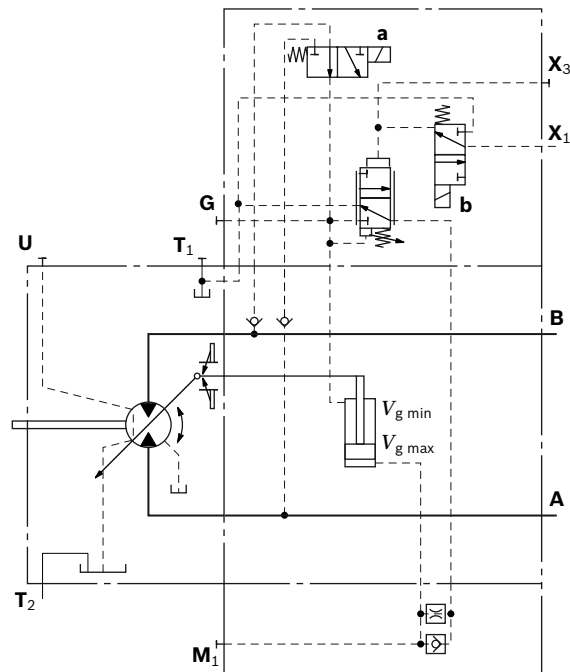
**Travel direction valve, electric**

Technical data, solenoid a with $\varnothing 37$	DA2, DA5	DA3, DA6
Voltage	12 V ( $\pm 20\%$ )	24 V ( $\pm 20\%$ )
Direction of rotation	Working pressure in	
counter-clockwise <b>B</b>	de-energized	de-energized
clockwise <b>A</b>	energized	energized
Nominal resistance (at 20 °C)	5.5 $\Omega$	21.7 $\Omega$
Nominal power	26.2 W	26.5 W
Minimum active current required	1.32 A	0.67 A
Duty cycle	100%	100%
Type of protection: see connector version page 47		

**Electric override**

Technical data, solenoid b with $\varnothing 37$	DA2, DA5	DA3, DA6
Voltage	12 V ( $\pm 20\%$ )	24 V ( $\pm 20\%$ )
No override	de-energized	de-energized
Position $V_{g \max}$	energized	energized
Nominal resistance (at 20 °C)	5.5 $\Omega$	21.7 $\Omega$
Nominal power	26.2 W	26.5 W
Minimum active current required	1.32 A	0.67 A
Duty cycle	100%	100%
Type of protection: see connector version page 47		

▼ **Circuit diagram DA2, DA3, DA5, DA6, size 28**



## Electric travel direction valve (for DA, HA.R)

Application in travel drives in closed circuits. The travel direction valve of the motor is actuated by an electric signal that also switches the swivel direction of the travel drive pump (e.g. A4VG with DA control valve).

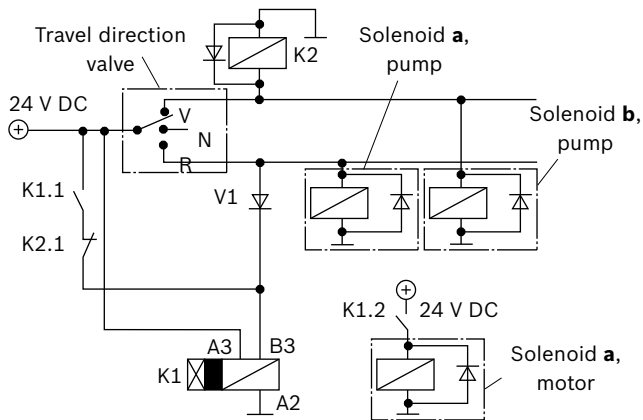
If the pump in the closed circuit is switched to the neutral position or into reverse, the vehicle may experience jerky deceleration or braking, depending on the vehicle weight and current travel speed.

When the travel direction valve, which must be logically coordinated with the pump control, of the pump (e.g. 4/3-way directional valve of the DA-control) is switched to

- ▶ the neutral position,
  - the electrical circuitry causes the previous signal on the travel direction valve on the motor to be retained.
- ▶ Reversing,
  - the electrical circuitry causes the travel direction valve of the motor to switch to the other travel direction following a time delay (approx. 0.8 s) with respect to the pump.

As a result, jerky deceleration or braking is prevented in both cases.

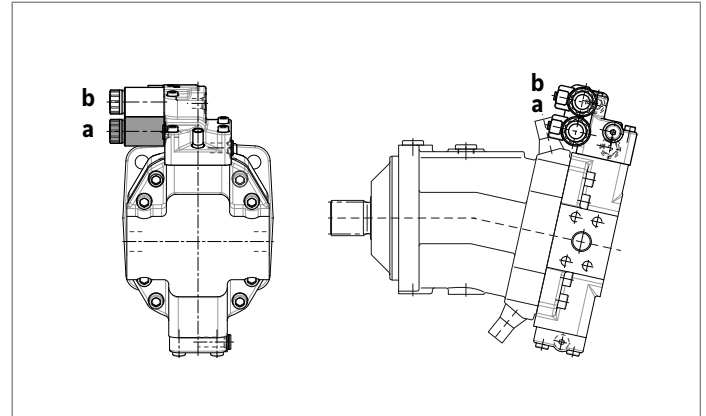
### ▼ Circuit diagram, electric travel direction valve



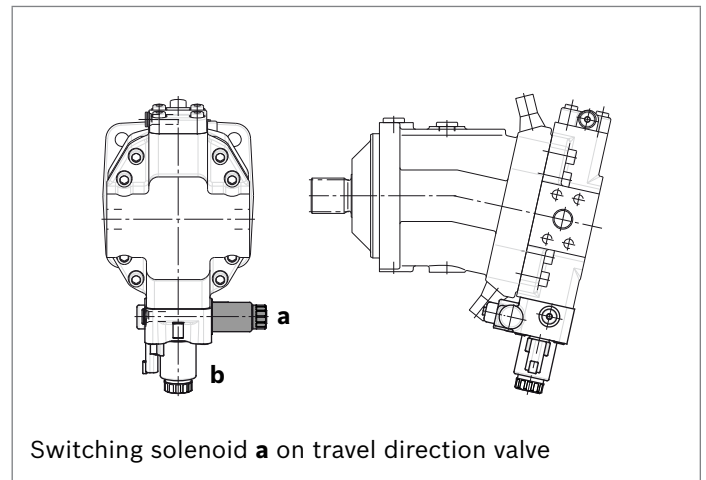
### Notice

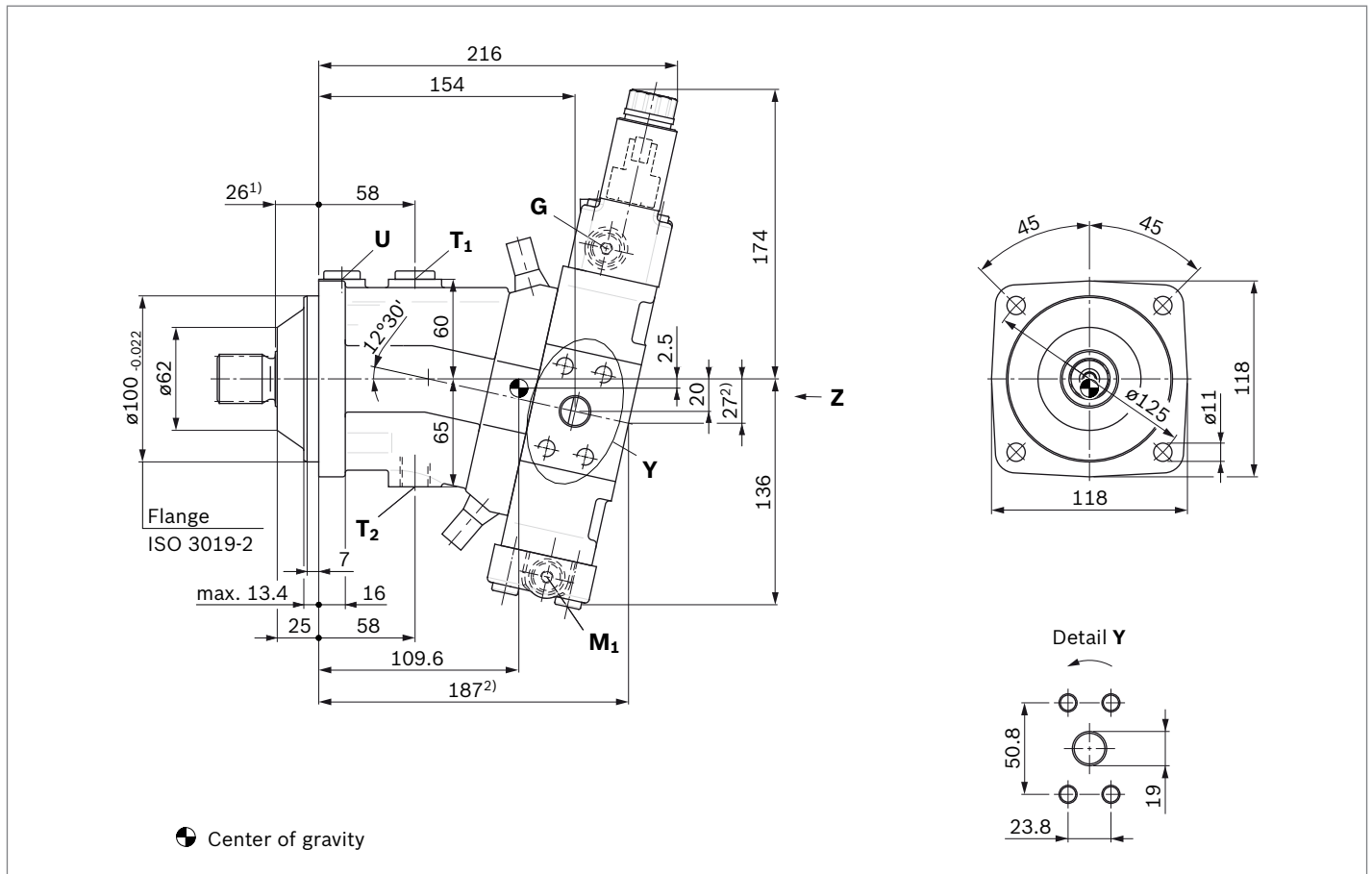
The shown diodes and relays are not included in the scope of delivery of the motor.

### ▼ Control, DA2, DA3, DA5, DA6



### ▼ Control, HA1R., HA2R.



**Dimensions, sizes 28****EP1, EP2 – Proportional control, electric**Port plate 2 – SAE working ports **A** and **B** lateral, opposing

Ports	Standard	Size <sup>3)</sup>	$p_{\max}$ [bar] <sup>4)</sup>	State <sup>8)</sup>
<b>A, B</b>	Working port Fastening thread	SAE J518 <sup>5)</sup> DIN 13	3/4 in M10 × 1.5; 17 deep	450 O
<b>T<sub>1</sub></b>	Drain port	DIN 3852 <sup>7)</sup>	M18 × 1.5; 12 deep	3 X <sup>6)</sup>
<b>T<sub>2</sub></b>	Drain port	DIN 3852 <sup>7)</sup>	M18 × 1.5; 12 deep	3 O <sup>6)</sup>
<b>G</b>	Synchronous control	DIN 3852 <sup>7)</sup>	M14 × 1.5; 12 deep	450 X
<b>G<sub>2</sub></b>	2nd pressure setting (HD.E, EP.E)	DIN 3852 <sup>7)</sup>	M14 × 1.5; 12 deep	100 X
<b>U</b>	Bearing flushing	DIN 3852 <sup>7)</sup>	M16 × 1.5; 12 deep	3 X
<b>X</b>	Pilot signal (HD, HZ, HA1T/HA2T)	DIN 3852 <sup>7)</sup>	M14 × 1.5; 12 deep	100 O
<b>X</b>	Pilot signal (HA1, HA2)	DIN 3852 <sup>7)</sup>	M14 × 1.5; 12 deep	3 X
<b>X<sub>1</sub>, X<sub>2</sub></b>	Pilot signal (DA1, DA4)	DIN 2353-CL	8B-ST	40 O
<b>X<sub>1</sub></b>	Pilot signal (DA2, DA3, DA5, DA6)	DIN 3852 <sup>7)</sup>	M14 × 1.5; 12 deep	40 O
<b>X<sub>3</sub></b>	Pilot signal (DA2, DA3, DA5, DA6)	DIN 3852 <sup>7)</sup>	M14 × 1.5; 12 deep	40 X
<b>M<sub>1</sub></b>	Stroking chamber measurement	DIN 3852 <sup>7)</sup>	M14 × 1.5; 12 deep	450 X

1) To shaft collar

2) Port plate 1 – SAE working ports **A** and **B** at rear

3) For notes on tightening torques, see the instruction manual

4) Depending on the application, momentary pressure peaks can occur. Keep this in mind when selecting measuring devices and fittings.

5) Only dimensions according to SAE J518, metric fastening thread is a deviation from the standard

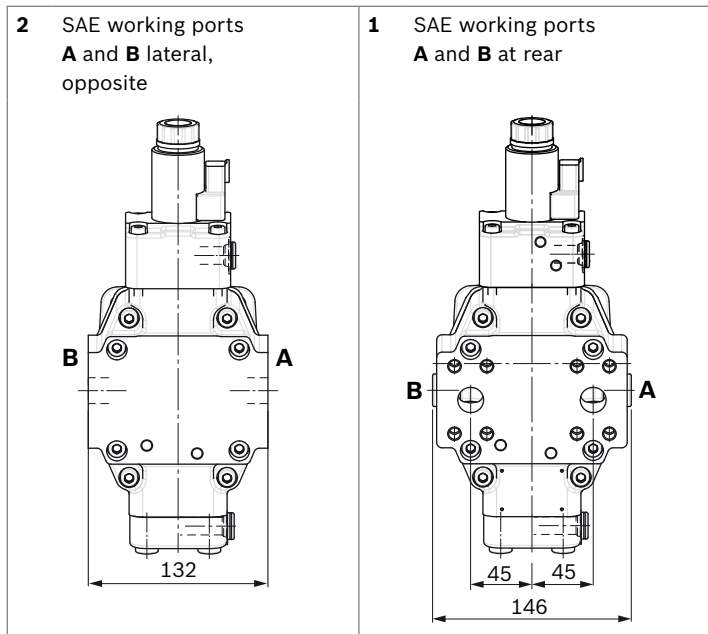
6) Depending on installation position, **T<sub>1</sub>** or **T<sub>2</sub>** must be connected (see also installation instructions on page 52).

7) The countersink can be deeper than as specified in the standard.

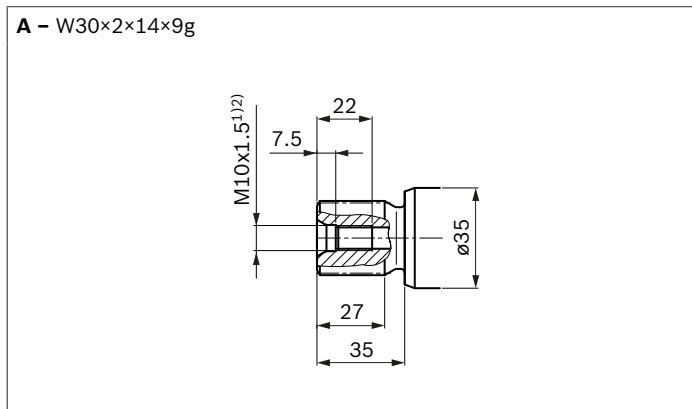
8) O = Must be connected (plugged when delivered)

X = Plugged (in normal operation)

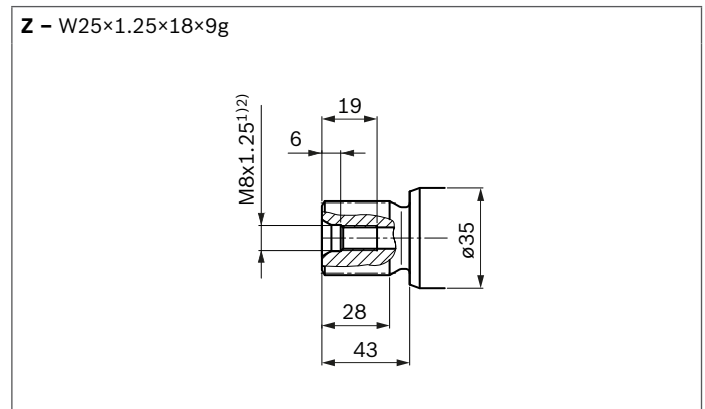
▼ **Location of the working ports on the port plates (view Z)**



▼ **Splined shaft DIN 5480**

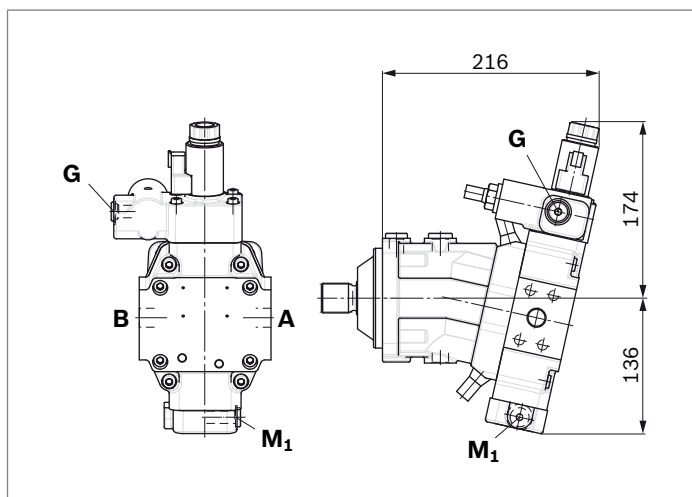


▼ **Splined shaft DIN 5480**

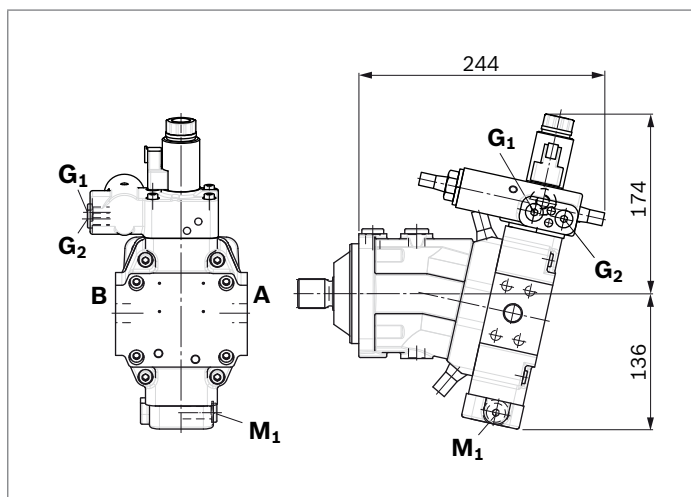


1) For notes on tightening torques, see the instruction manual  
 2) Center bore according to DIN 332 (thread according to DIN 13)

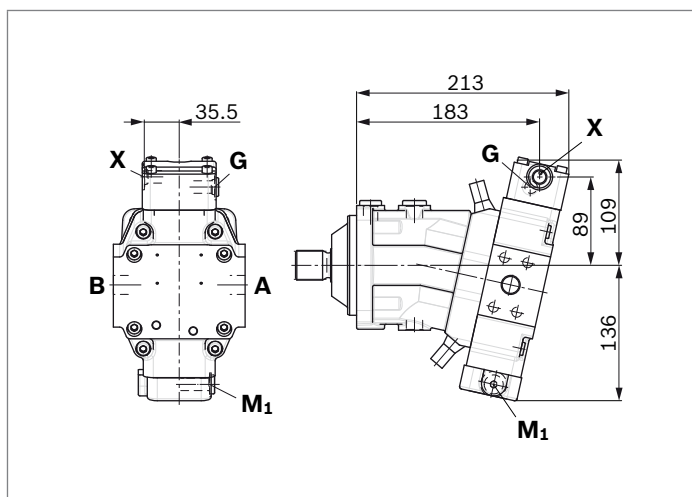
▼ **EP.D** – Proportional control, electric,  
 with pressure control fixed setting



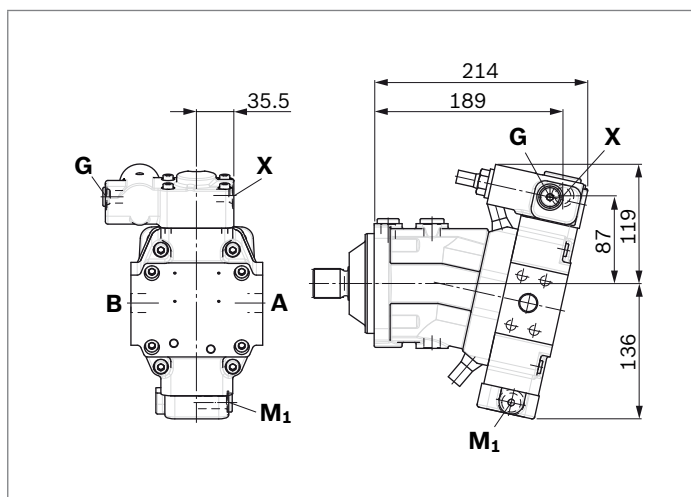
▼ **EP.E** – Proportional control, electric,  
 with pressure control hydraulic override, two-point



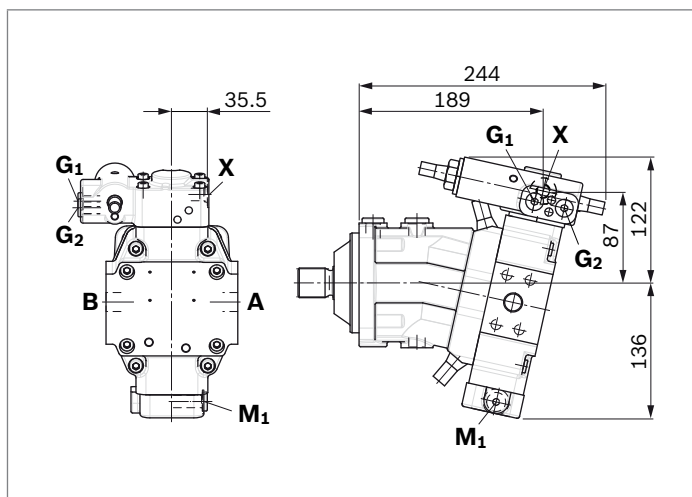
▼ **HD1, HD2** – Proportional control, hydraulic



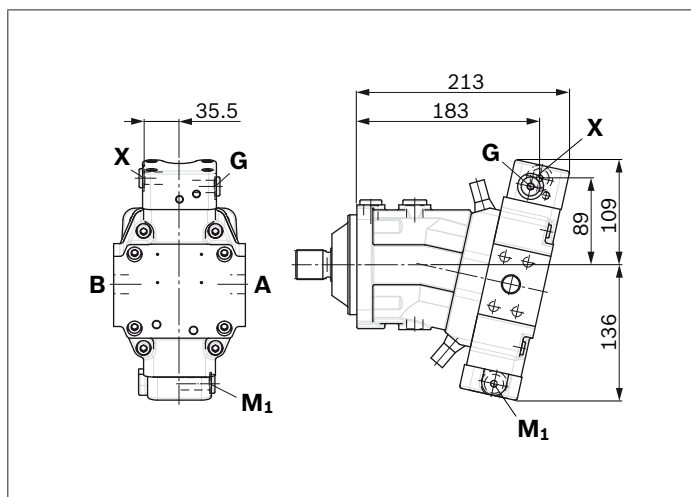
▼ **HD.D** – Proportional control, hydraulic,  
 with pressure control fixed setting



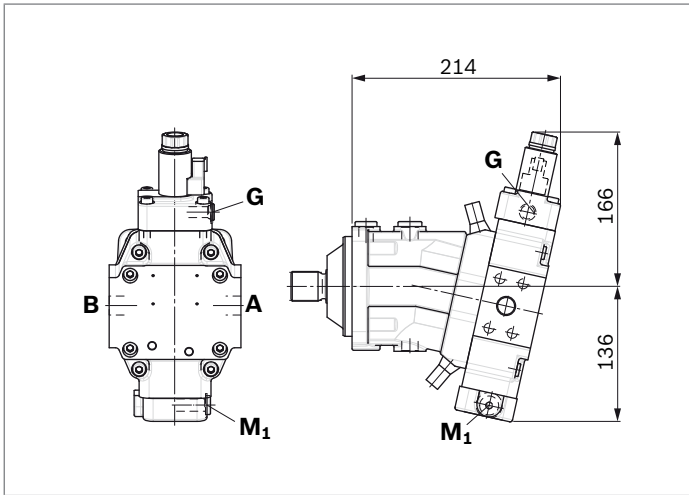
▼ **HD.E** – Proportional control, hydraulic,  
 with pressure control hydraulic override, two-point



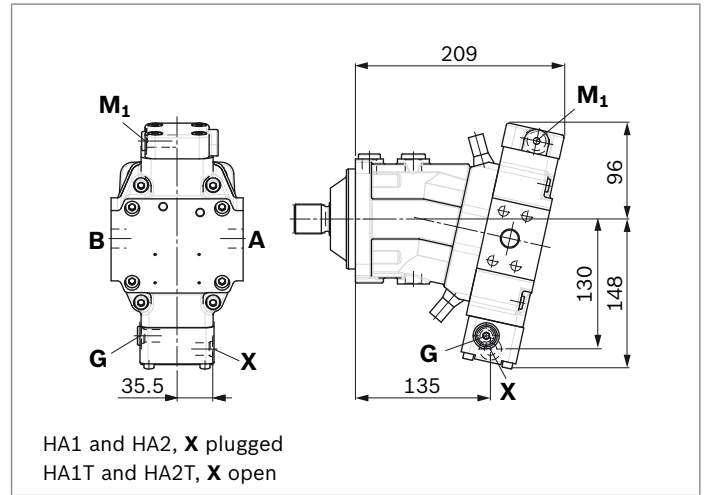
▼ **HZ1** – Two-point control, hydraulic



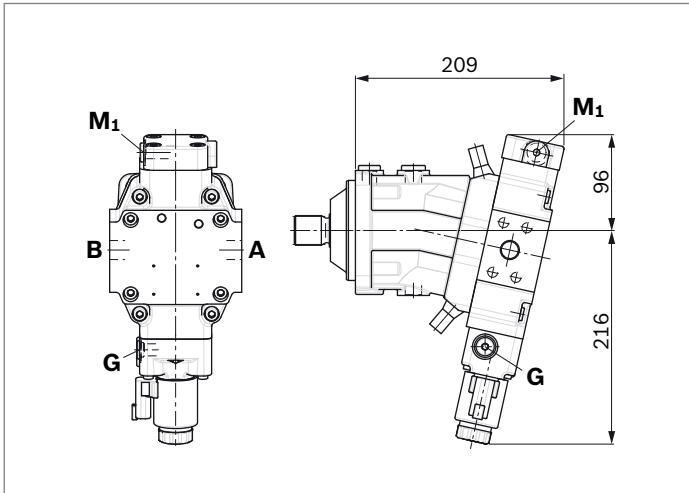
▼ **EZ1, EZ2** – Two-point control, electric



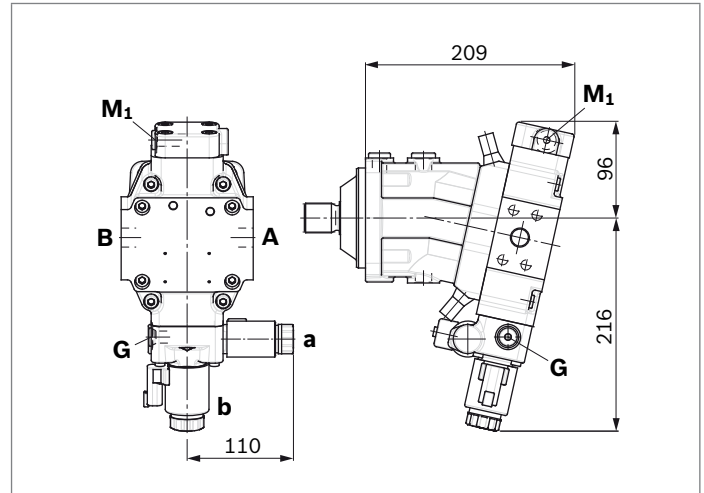
▼ **HA1, HA2 / HA1T, HA2T** – Automatic high-pressure related control, with override, hydraulic remote control, proportional



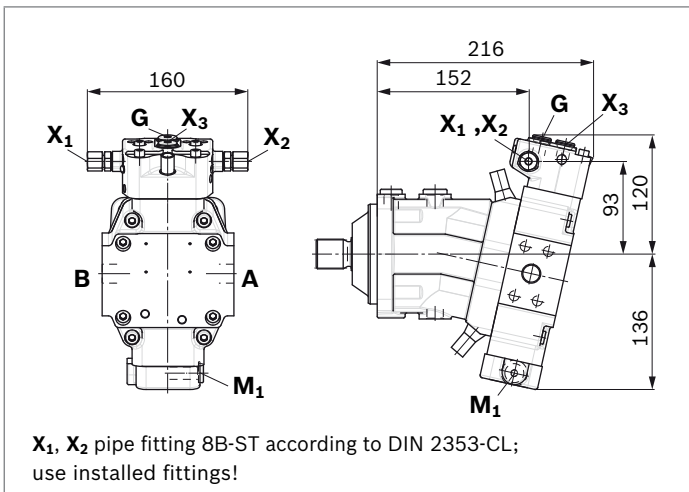
▼ **HA1U1, HA2U2** – Automatic high-pressure related control, with electric override, two-point



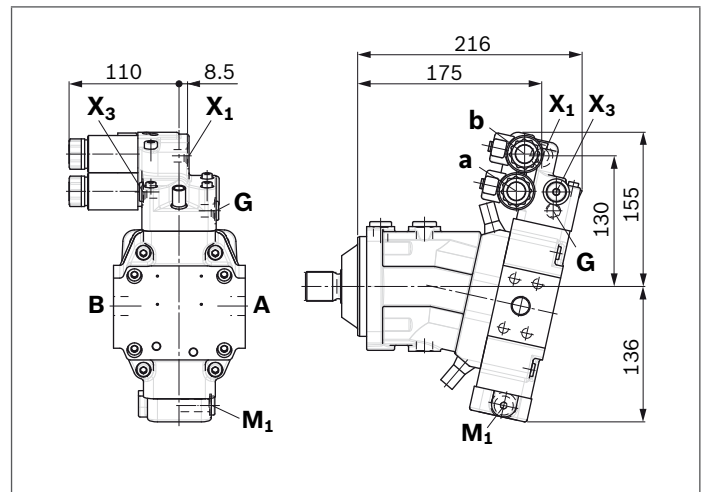
▼ **HA1R1, HA2R2** – Automatic high-pressure related control, with electric override and electric travel direction valve

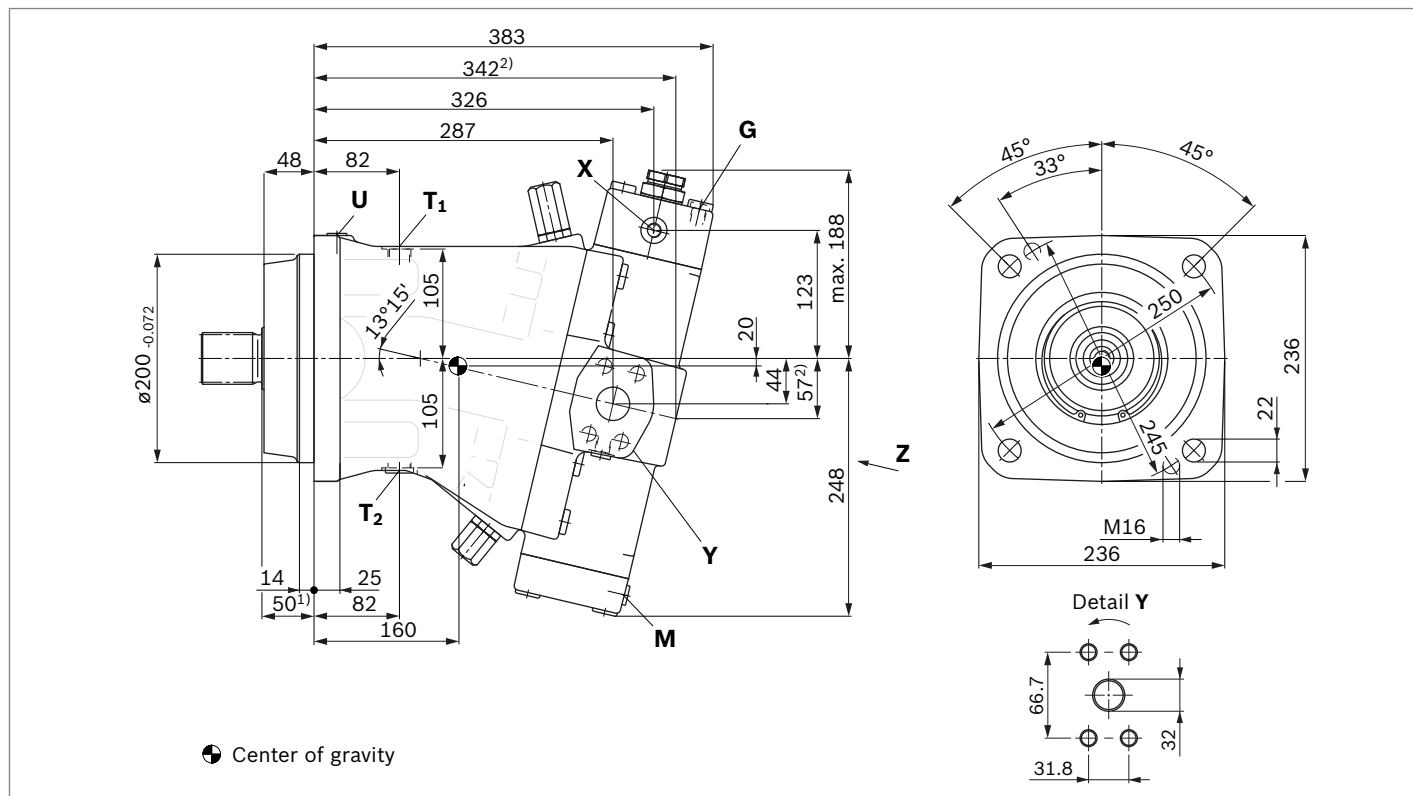


▼ **DA1, DA4** – Automatic speed related control, with hydraulic travel direction valve



▼ **DA2, DA3, DA5, DA6** – Automatic speed related control, with electric travel direction valve and electric V<sub>g max</sub>-circuit



**Dimensions, sizes 250****HD1, HD2 – Proportional control, hydraulic****HZ – Two-point control, hydraulic**Port plate 2 – SAE working ports **A** and **B** lateral, opposing

Ports		Standard	Size <sup>3)</sup>	$p_{max}$ [bar] <sup>4)</sup>	State <sup>8)</sup>
<b>A, B</b>	Working port Fastening thread A/B	SAE J518 <sup>5)</sup> DIN 13	1 1/4 in M14 × 2; 19 deep	400	O
<b>A<sub>1</sub>, B<sub>1</sub></b>	Additional working port for plate 15 fastening thread A <sub>1</sub> /B <sub>1</sub>	SAE J518 <sup>5)</sup> DIN 13	1 1/4 in M14 × 2; 19 deep	400	O
<b>T<sub>1</sub></b>	Drain port	DIN 3852 <sup>7)</sup>	M22 × 1.5; 14 deep	3	X <sup>6)</sup>
<b>T<sub>2</sub></b>	Drain port	DIN 3852 <sup>7)</sup>	M22 × 1.5; 14 deep	3	O <sup>6)</sup>
<b>G</b>	Synchronous control	DIN 3852 <sup>7)</sup>	M14 × 1.5; 12 deep	400	X
<b>G<sub>2</sub></b>	2nd pressure setting (HD.D, EP.D)	DIN 3852 <sup>7)</sup>	M14 × 1.5; 12 deep	400	X
<b>P</b>	Pilot oil supply (EP)	DIN 3852 <sup>7)</sup>	M14 × 1.5; 12 deep	100	O
<b>U</b>	Bearing flushing	DIN 3852 <sup>7)</sup>	M14 × 1.5; 12 deep	3	X
<b>X</b>	Pilot signal (HD, HZ, HA1T/HA2T)	DIN 3852 <sup>7)</sup>	M14 × 1.5; 12 deep	100	O
<b>X</b>	Pilot signal (HA1, HA2)	DIN 3852 <sup>7)</sup>	M14 × 1.5; 12 deep	3	X
<b>X<sub>1</sub>, X<sub>2</sub></b>	Pilot signal (DA)	DIN 2353-CL	8B-ST	40	O
<b>X<sub>3</sub></b>	Pilot signal (HD.G, EP.G)	DIN 3852 <sup>7)</sup>	M14 × 1.5; 12 deep	400	O
<b>M</b>	Stroking chamber measurement	DIN 3852 <sup>7)</sup>	M14 × 1.5; 12 deep	400	X
<b>M<sub>A</sub>, M<sub>B</sub></b>	Pressure measurement A/B	DIN 3852 <sup>7)</sup>	M14 × 1.5; 12 deep	400	X
<b>M<sub>St</sub></b>	Pilot pressure measurement	DIN 3852 <sup>7)</sup>	M14 × 1.5; 12 deep	400	X

1) To shaft collar

2) Port plate 1/15 – SAE working ports **A** and **B** at rear

3) For notes on tightening torques, see the instruction manual

4) Depending on the application, momentary pressure peaks can occur. Keep this in mind when selecting measuring devices and fittings.

5) Only dimensions according to SAE J518, metric fastening thread is a deviation from the standard

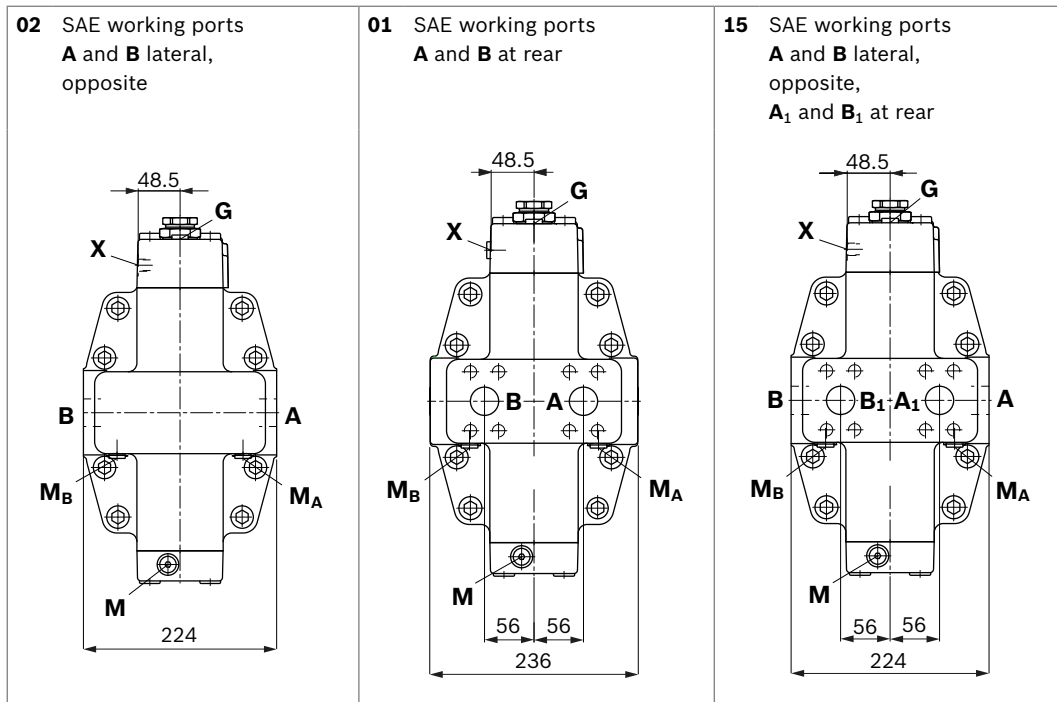
6) Depending on installation position, **T<sub>1</sub>** or **T<sub>2</sub>** must be connected (see also installation instructions on page 52).

7) The countersink can be deeper than as specified in the standard.

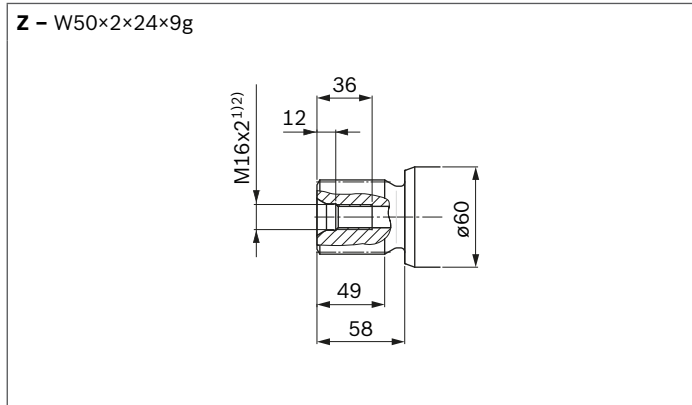
8) O = Must be connected (plugged when delivered)

X = Plugged (in normal operation)

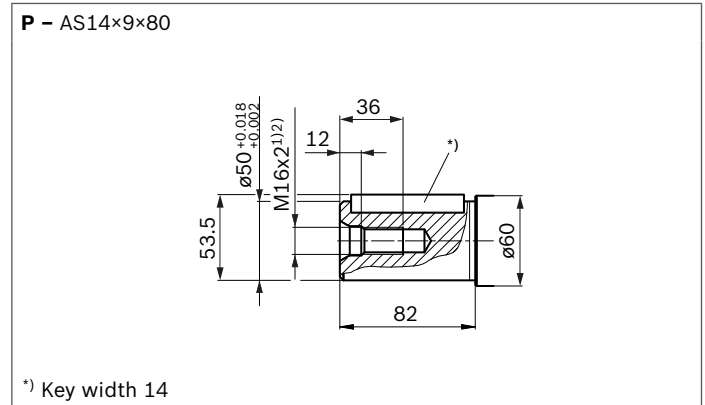
▼ Location of the working ports on the port plates (view Z)



▼ Splined shaft DIN 5480

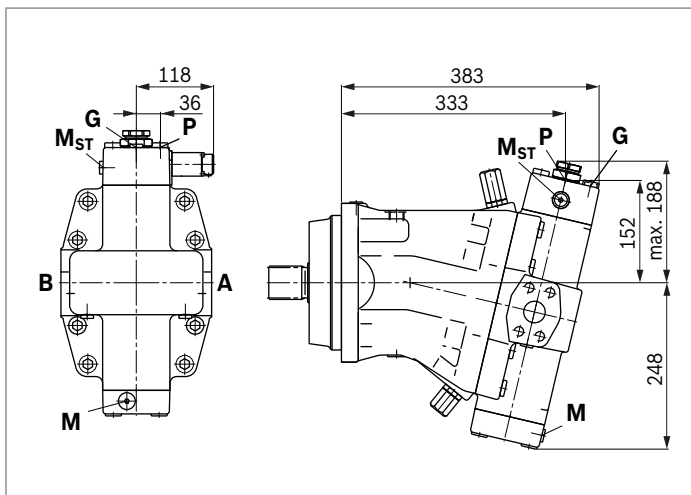


▼ Cyl. Keyed shaft, DIN 6885

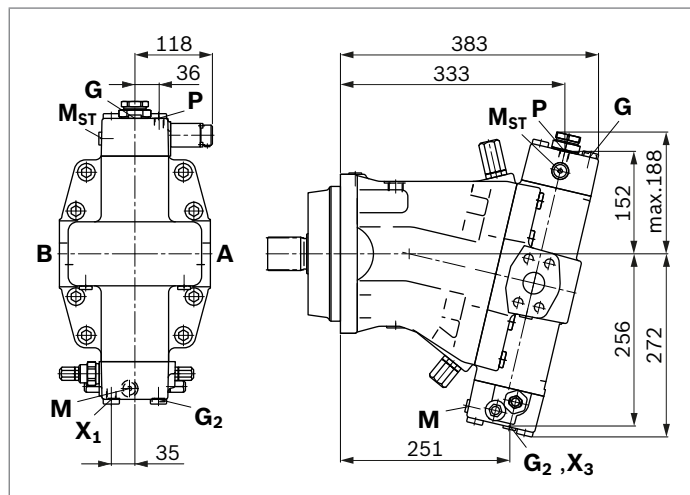


1) For notes on tightening torques, see the instruction manual  
2) Center bore according to DIN 332 (thread according to DIN 13)

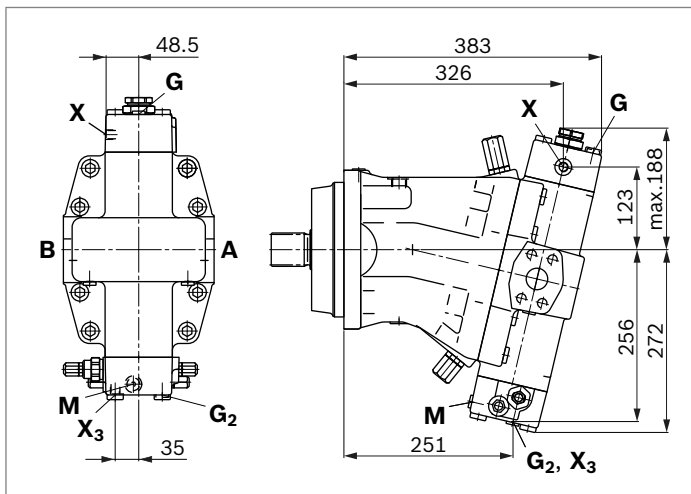
▼ **EP1, EP2** – Proportional control, electric



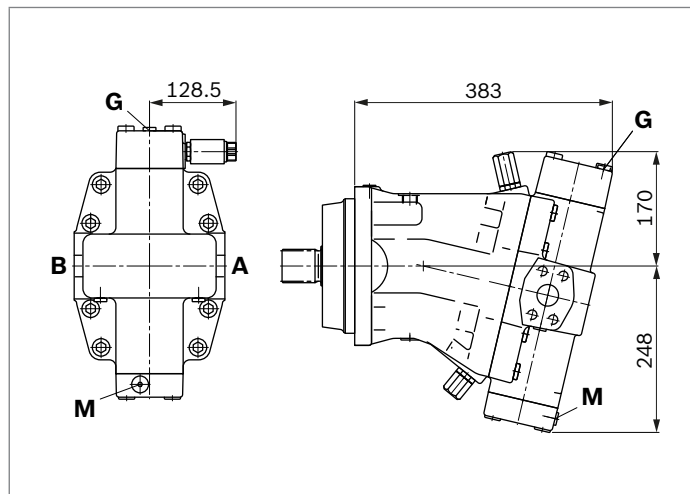
▼ **EP.D, EP.G** – Proportional control electric, with pressure control fixed setting; remote controlled (EP.G)



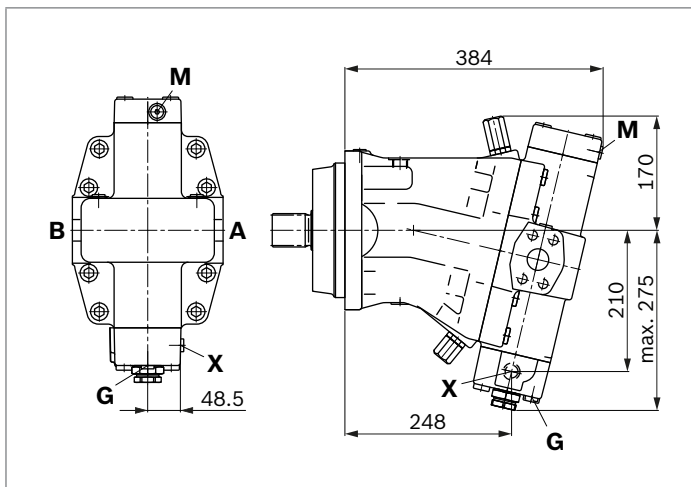
▼ **HD.D, HD.G** – Proportional control hydraulic with pressure control fixed setting; remote controlled (HD.G)



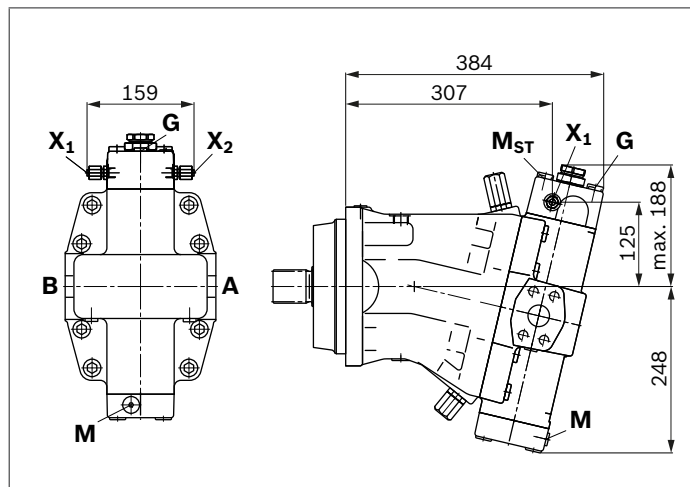
▼ **EZ1, EZ2** – Two-point control, electric



▼ **HA1, HA2 / HA1T, HA2T** – Automatic high-pressure related control, with override hydraulic remote control, proportional



▼ **DA** – Automatic speed related control, with hydraulic travel direction valve

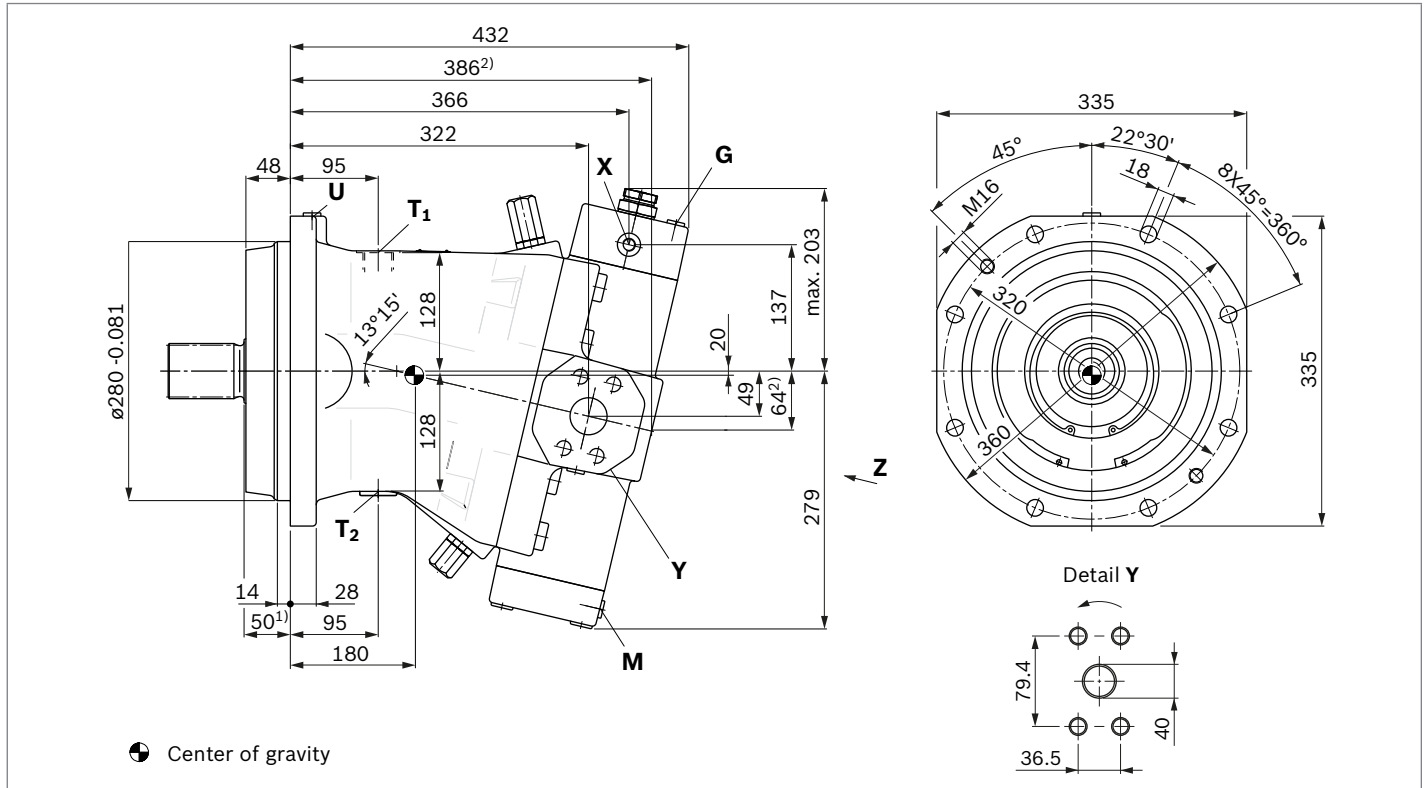


## Dimensions, sizes 355

**HD1, HD2 – Proportional control, hydraulic**

**HZ – Two-point control, hydraulic**

Port plate 2 – SAE working ports **A** and **B** lateral, opposite



Ports	Standard	Size <sup>3)</sup>	$p_{max}$ [bar] <sup>4)</sup>	State <sup>5)</sup>
<b>A, B</b>	Working port Fastening thread A/B	SAE J518 <sup>5)</sup> DIN 13	1 1/2 in M16 × 2; 24 deep	400 O
<b>A<sub>1</sub>, B<sub>1</sub></b>	Additional working port for plate 15 fastening thread A <sub>1</sub> /B <sub>1</sub>	SAE J518 <sup>5)</sup> DIN 13	1 1/2 in M16 × 2; 24 deep	400 O
<b>T<sub>1</sub></b>	Drain port	DIN 3852 <sup>7)</sup>	M33 × 2; 18 deep	3 X <sup>6)</sup>
<b>T<sub>2</sub></b>	Drain port	DIN 3852 <sup>7)</sup>	M33 × 2; 18 deep	3 O <sup>6)</sup>
<b>G</b>	Synchronous control	DIN 3852 <sup>7)</sup>	M14 × 1.5; 12 deep	400 X
<b>G<sub>2</sub></b>	2nd pressure setting (HD.D, EP.D)	DIN 3852 <sup>7)</sup>	M14 × 1.5; 12 deep	400 X
<b>P</b>	Pilot oil supply (EP)	DIN 3852 <sup>7)</sup>	M14 × 1.5; 12 deep	100 O
<b>U</b>	Bearing flushing	DIN 3852 <sup>7)</sup>	M14 × 1.5; 12 deep	3 X
<b>X</b>	Pilot signal (HD, HZ, HA1T/HA2T)	DIN 3852 <sup>7)</sup>	M14 × 1.5; 12 deep	100 O
<b>X</b>	Pilot signal (HA1, HA2)	DIN 3852 <sup>7)</sup>	M14 × 1.5; 12 deep	3 X
<b>X<sub>1</sub>, X<sub>2</sub></b>	Pilot signal (DA)	DIN 2353-CL	8B-ST	40 O
<b>X<sub>3</sub></b>	Pilot signal (HD.G, EP.G)	DIN 3852 <sup>7)</sup>	M14 × 1.5; 12 deep	400 O
<b>M</b>	Stroking chamber measurement	DIN 3852 <sup>7)</sup>	M14 × 1.5; 12 deep	400 X
<b>M<sub>A</sub>, M<sub>B</sub></b>	Pressure measurement A/B	DIN 3852 <sup>7)</sup>	M14 × 1.5; 12 deep	400 X
<b>M<sub>ST</sub></b>	Pilot pressure measurement	DIN 3852 <sup>7)</sup>	M14 × 1.5; 12 deep	400 X

1) To shaft collar

2) Port plate 1/15 – SAE working ports **A** and **B**

3) For notes on tightening torques, see the instruction manual

4) Depending on the application, momentary pressure peaks can occur.  
Keep this in mind when selecting measuring devices and fittings.

5) Only dimensions according to SAE J518, metric fastening thread is a deviation from the standard

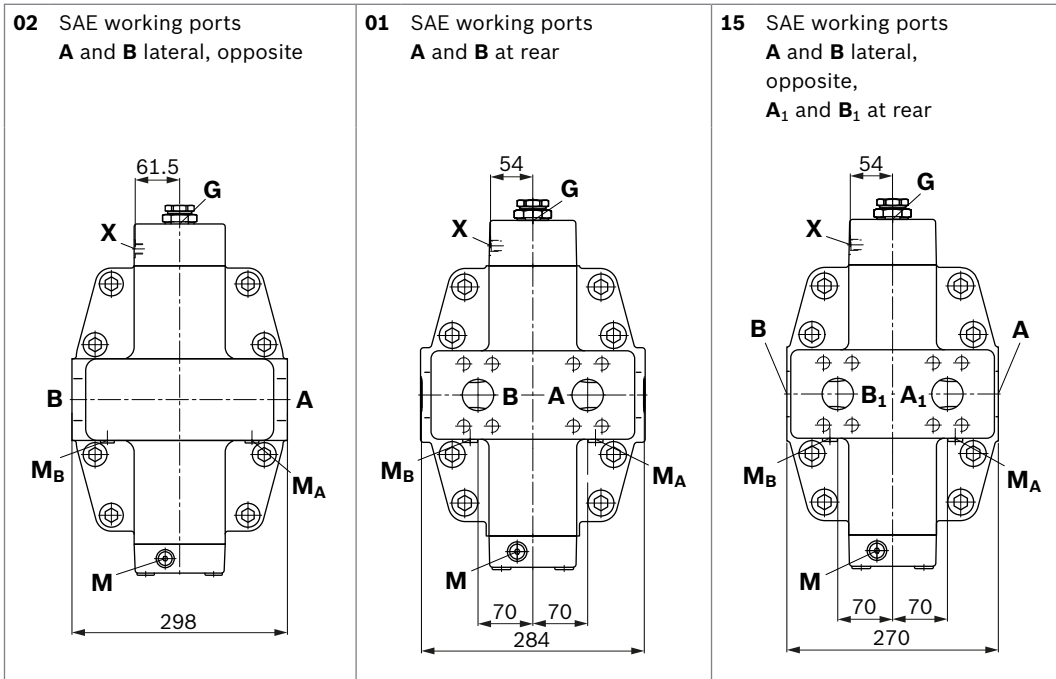
6) Depending on installation position, **T<sub>1</sub>** or **T<sub>2</sub>** must be connected (see also installation instructions on page 52).

7) The countersink can be deeper than as specified in the standard.

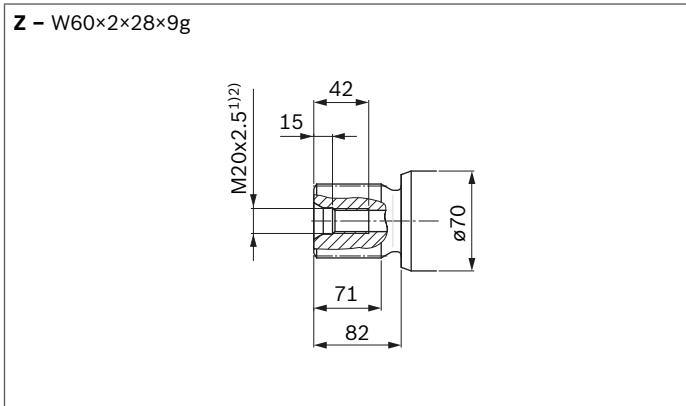
8) O = Must be connected (plugged when delivered)

X = Plugged (in normal operation)

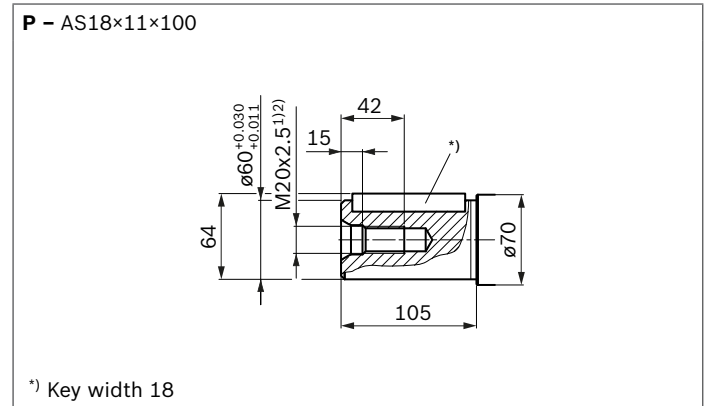
▼ **Location of the working ports on the port plates (view Z)**



▼ **Splined shaft DIN 5480**

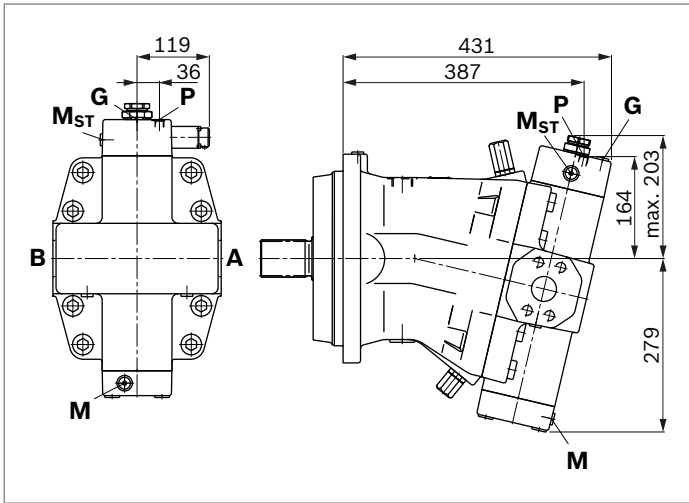


▼ **Cyl. Keyed shaft, DIN 6885**

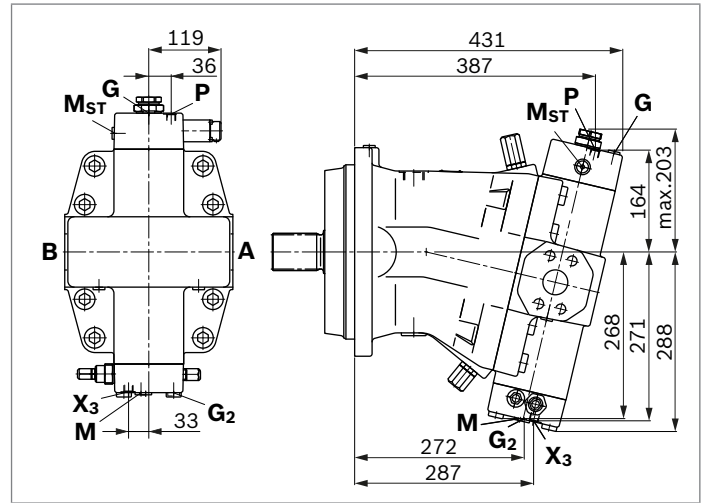


1) For notes on tightening torques, see the instruction manual  
 2) Center bore according to DIN 332 (thread according to DIN 13)

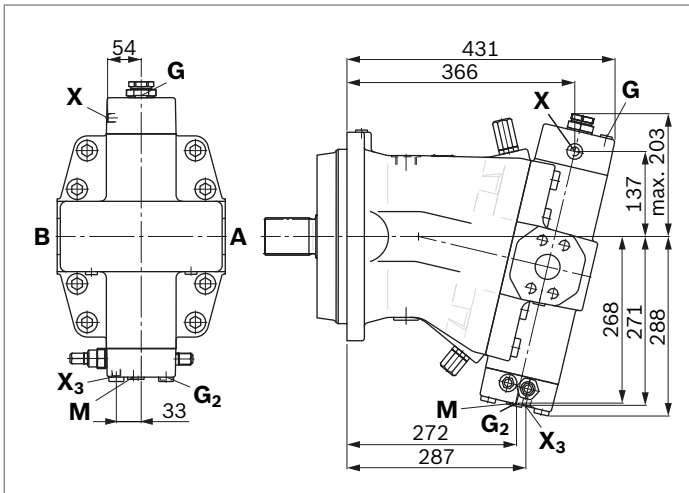
▼ **EP1, EP2** – Proportional control, electric



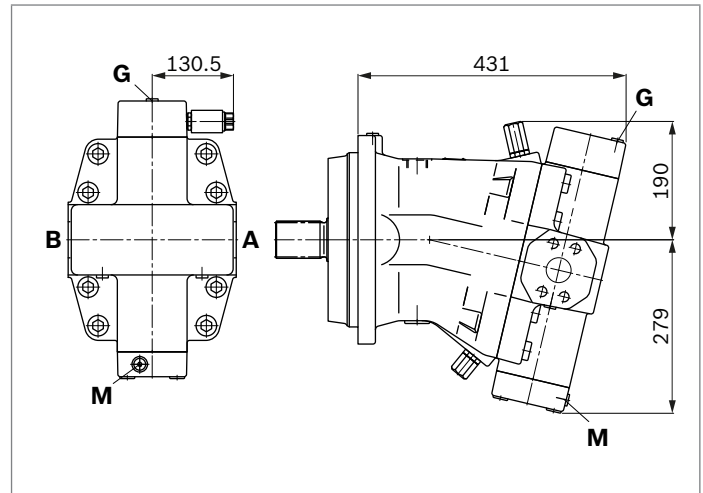
▼ **EP.D, EP.G** – Proportional control electric, with pressure control fixed setting; remote controlled (EP.G)



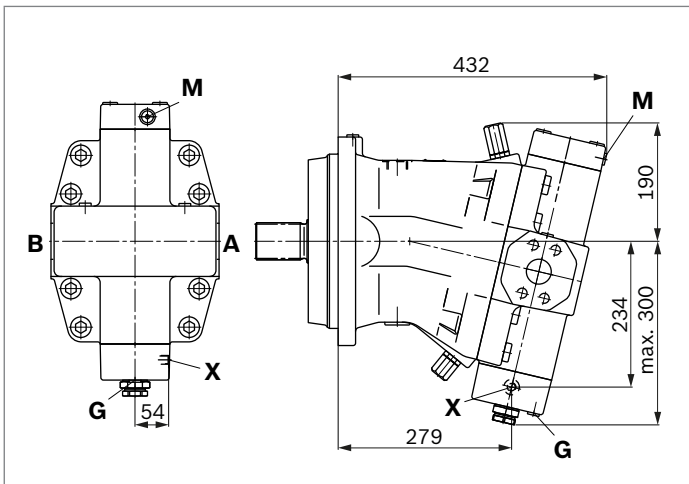
▼ **HD.D, HD.G** – Proportional control hydraulic with pressure control fixed setting; remote controlled (HD.G)



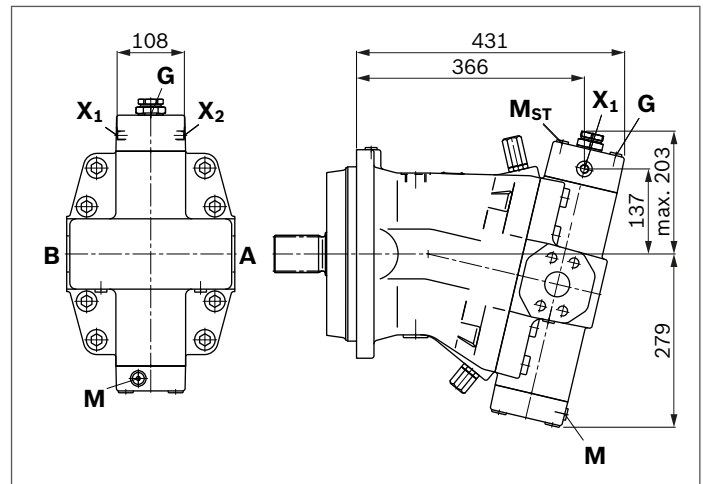
▼ **EZ1, EZ2** – Two-point control, electric

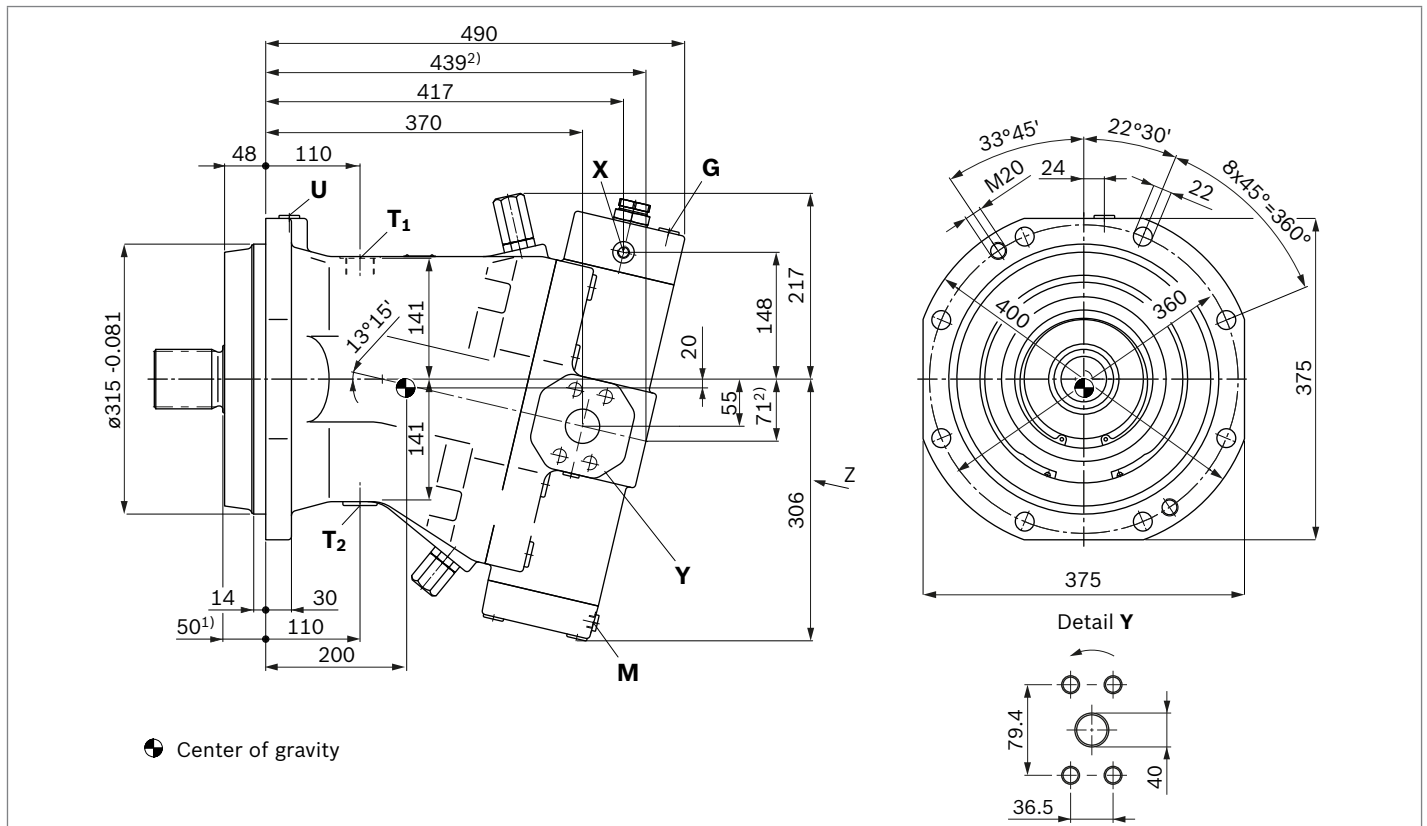


▼ **HA1, HA2 / HA1T, HA2T** – Automatic high-pressure related control, with override hydraulic remote control, proportional



▼ **DA** – Automatic speed related control, with hydraulic travel direction valve



**Dimensions, sizes 500****HD1, HD2 – Proportional control, hydraulic****HZ – Two-point control, hydraulic**Port plate 2 – SAE working ports **A** and **B** lateral, opposite

Ports		Standard	Size <sup>3)</sup>	$p_{\max}$ [bar] <sup>4)</sup>	State <sup>8)</sup>
<b>A, B</b>	Working port Fastening thread A/B	SAE J518 <sup>5)</sup> DIN 13	1 1/2 in M16 × 2; 24 deep	400	O
<b>A<sub>1</sub>, B<sub>1</sub></b>	Additional working port for plate 15 fastening thread A <sub>1</sub> /B <sub>1</sub>	SAE J518 <sup>5)</sup> DIN 13	1 1/2 in M16 × 2; 24 deep	400	O
<b>T<sub>1</sub></b>	Drain port	DIN 3852 <sup>7)</sup>	M33 × 2; 18 deep	3	X <sup>6)</sup>
<b>T<sub>2</sub></b>	Drain port	DIN 3852 <sup>7)</sup>	M33 × 2; 18 deep	3	O <sup>6)</sup>
<b>G</b>	Synchronous control	DIN 3852 <sup>7)</sup>	M18 × 1.5; 12 deep	400	X
<b>G<sub>2</sub></b>	2nd pressure setting (HD.D, EP.D)	DIN 3852 <sup>7)</sup>	M18 × 1.5; 12 deep	400	X
<b>P</b>	Pilot oil supply (EP)	DIN 3852 <sup>7)</sup>	M14 × 1.5; 12 deep	100	O
<b>U</b>	Bearing flushing	DIN 3852 <sup>7)</sup>	M18 × 1.5; 12 deep	3	X
<b>X</b>	Pilot signal (HD, HZ, HA1T/HA2T)	DIN 3852 <sup>7)</sup>	M14 × 1.5; 12 deep	100	O
<b>X</b>	Pilot signal (HA1, HA2)	DIN 3852 <sup>7)</sup>	M14 × 1.5; 12 deep	3	X
<b>X<sub>1</sub>, X<sub>2</sub></b>	Pilot signal (DA)	DIN 2353-CL	8B-ST	40	O
<b>X<sub>3</sub></b>	Pilot signal (HD.G, EP.G)	DIN 3852 <sup>7)</sup>	M14 × 1.5; 12 deep	400	O
<b>M</b>	Stroking chamber measurement	DIN 3852 <sup>7)</sup>	M14 × 1.5; 12 deep	400	X
<b>M<sub>A</sub>, M<sub>B</sub></b>	Pressure measurement A/B	DIN 3852 <sup>7)</sup>	M14 × 1.5; 12 deep	400	X
<b>M<sub>St</sub></b>	Pilot pressure measurement	DIN 3852 <sup>7)</sup>	M14 × 1.5; 12 deep	400	X

1) To shaft collar

2) Port plate 1/15 – SAE working ports **A** and **B** at rear

3) For notes on tightening torques, see the instruction manual

4) Depending on the application, momentary pressure peaks can occur.

Keep this in mind when selecting measuring devices and fittings.

5) Only dimensions according to SAE J518, metric fastening thread is a deviation from the standard

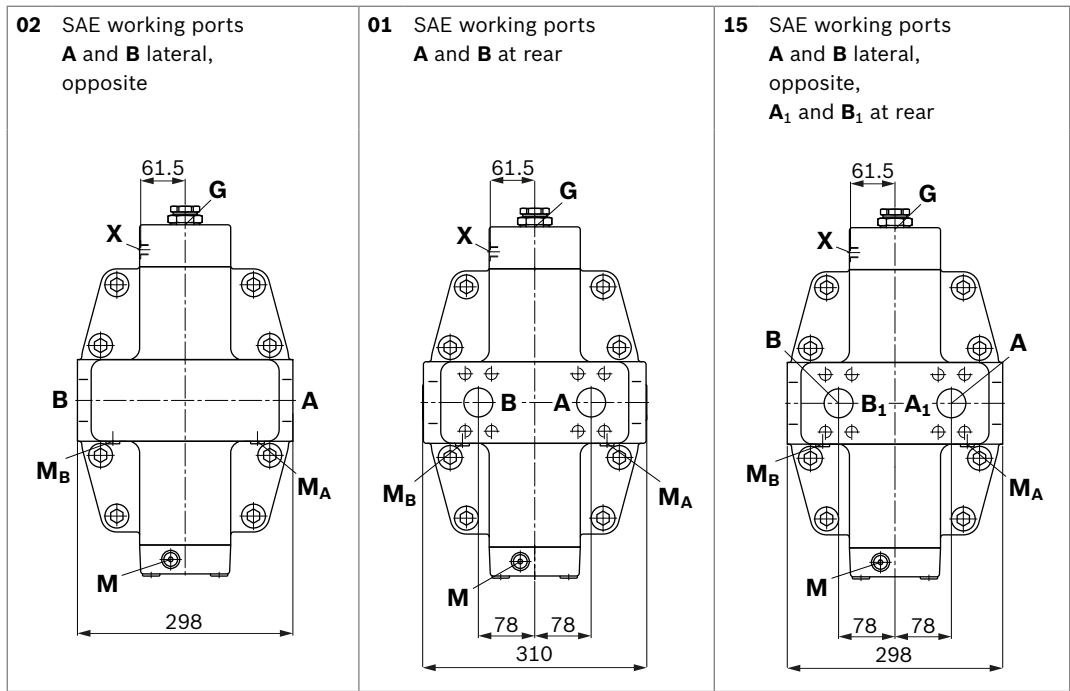
6) Depending on installation position, **T<sub>1</sub>** or **T<sub>2</sub>** must be connected (see also installation instructions on page 52).

7) The countersink can be deeper than as specified in the standard.

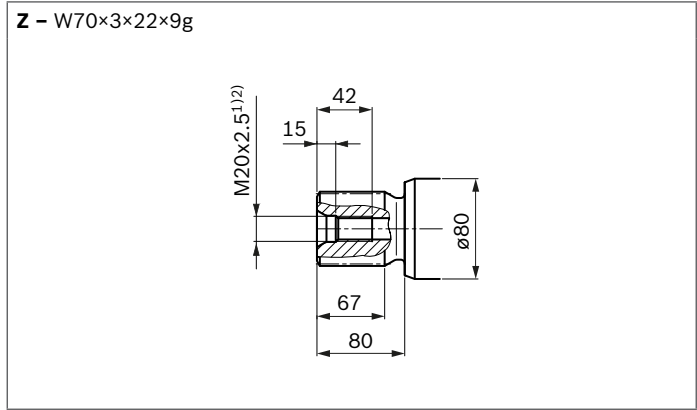
8) O = Must be connected (plugged when delivered)

X = Plugged (in normal operation)

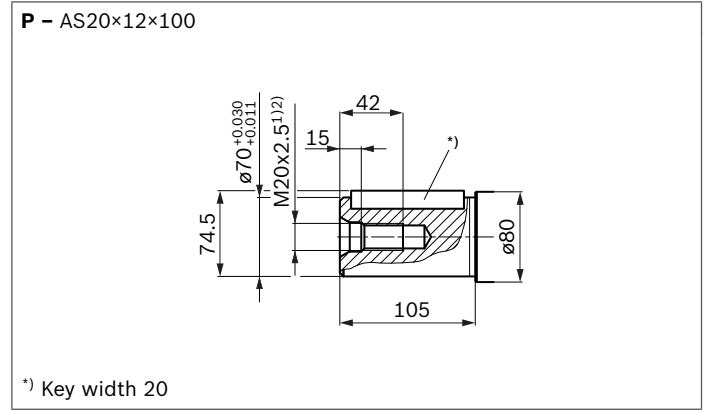
▼ **Location of the working ports on the port plates (view Z)**



▼ **Splined shaft DIN 5480**

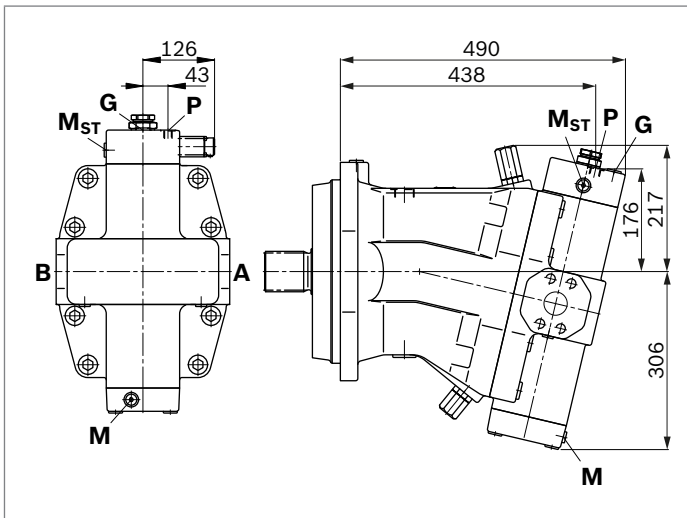


▼ **Cyl. Keyed shaft, DIN 6885**

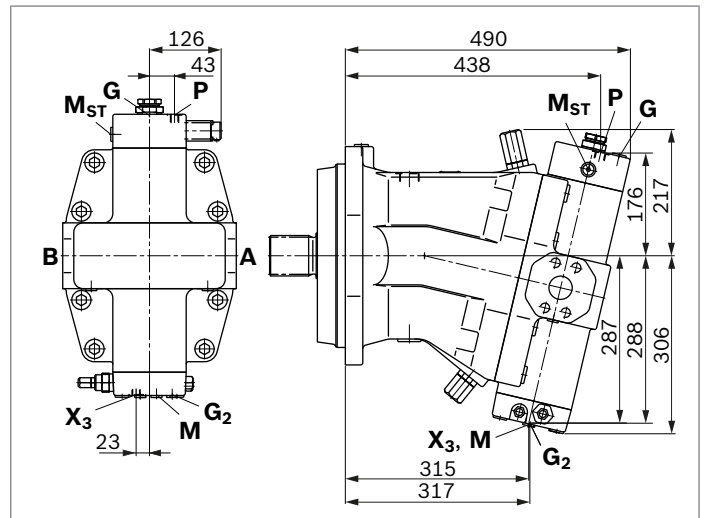


1) For notes on tightening torques, see the instruction manual  
2) Center bore according to DIN 332 (thread according to DIN 13)

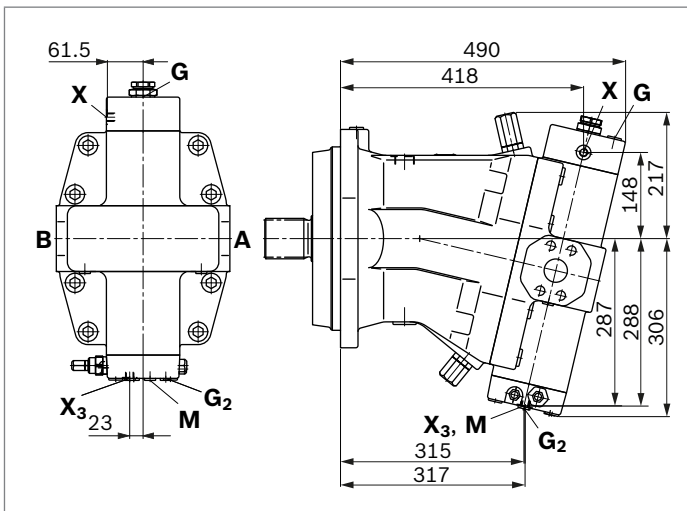
▼ **EP1, EP2** – Proportional control, electric



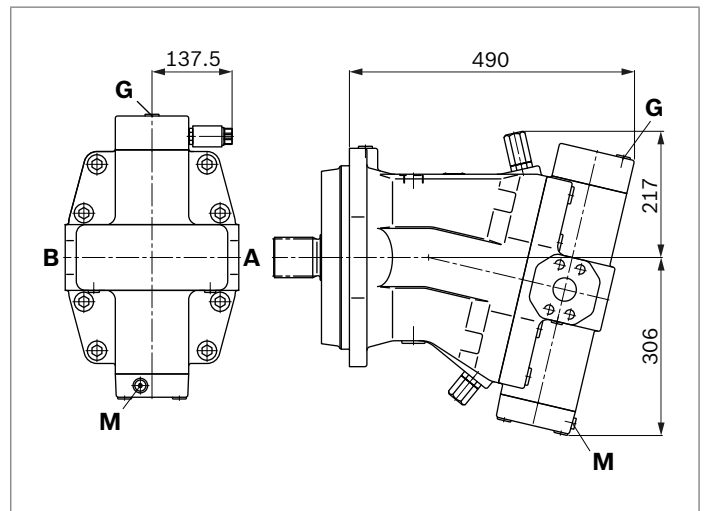
▼ **EP.D, EP.G** – Proportional control electric, with pressure control fixed setting; remote controlled (EP.G)



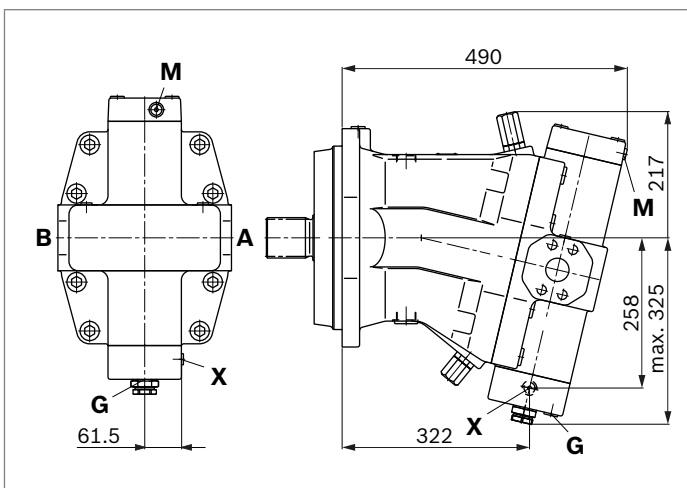
▼ **HD.D, HD.G** – Proportional control hydraulic with pressure control fixed setting; remote controlled (HD.G)



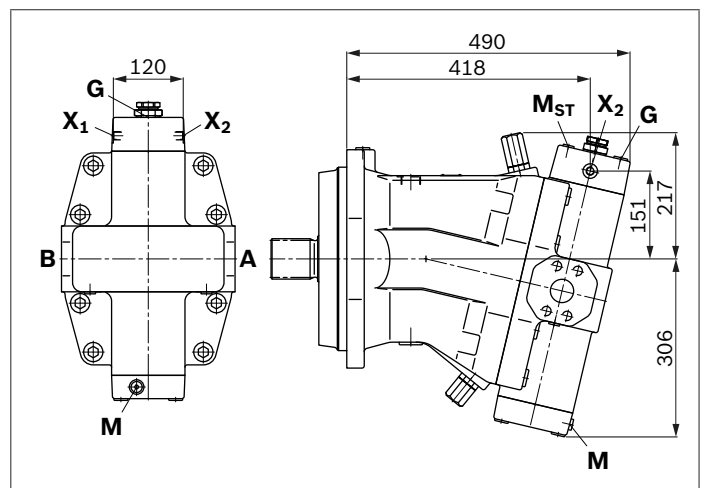
▼ **EZ1, EZ2** – Two-point control, electric



▼ **HA1, HA2 / HA1T, HA2T** – Automatic high-pressure related control, with override, hydraulic remote control, proportional



▼ **DA** – Automatic speed related control, with hydraulic travel direction valve

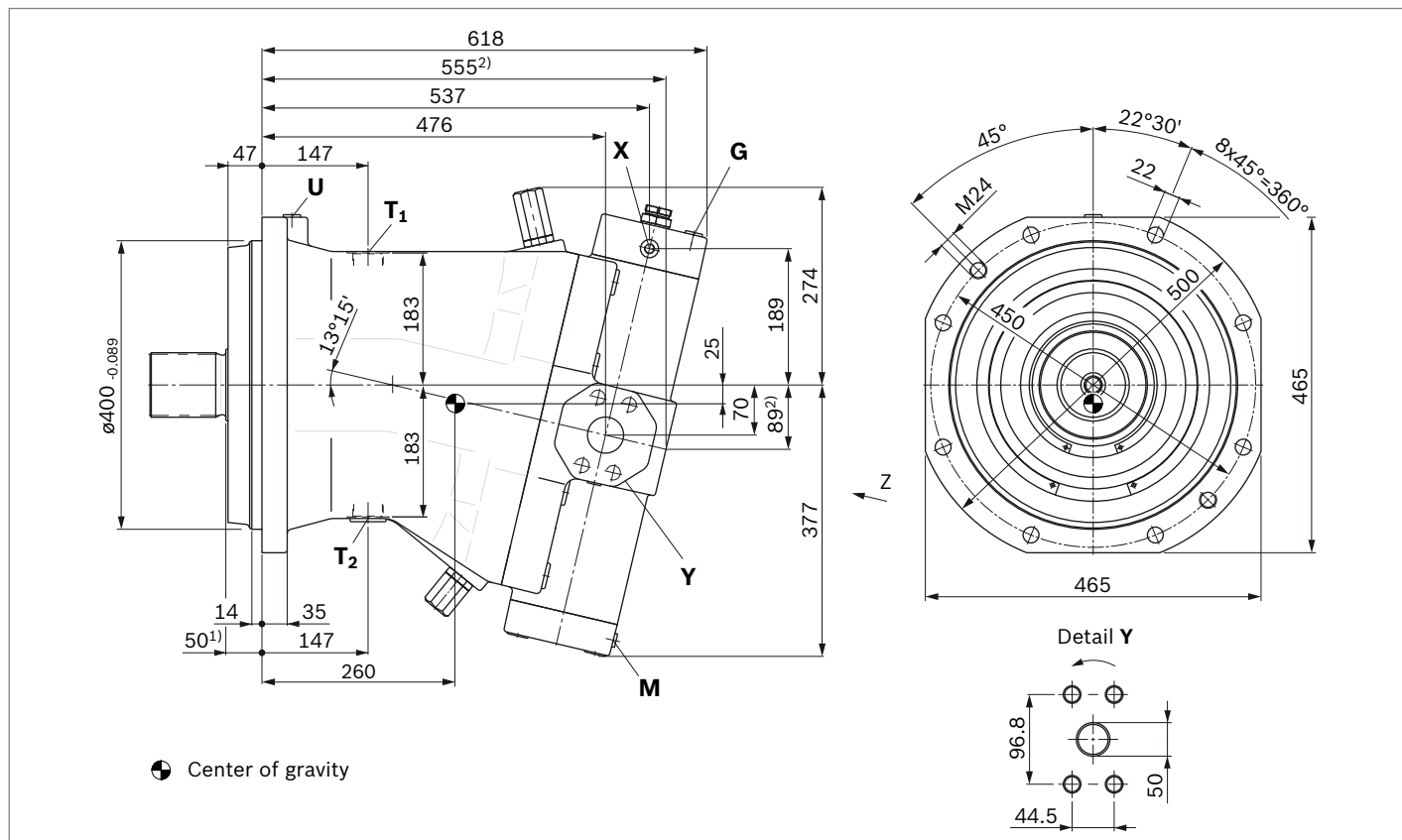


## Dimensions, sizes 1000

**HD1, HD2 – Proportional control, hydraulic**

**HZ – Two-point control, hydraulic**

Port plate 2 – SAE working ports **A** and **B** lateral, opposite



Ports	Standard	Size <sup>3)</sup>	$p_{max}$ [bar] <sup>4)</sup>	State <sup>8)</sup>
<b>A, B</b>	Working port Fastening thread A/B	SAE J518 <sup>5)</sup> DIN 13	2 in M20 × 2.5; 24 deep	400 O
<b>A<sub>1</sub>, B<sub>1</sub></b>	Additional working port for plate 15 fastening thread A <sub>1</sub> /B <sub>1</sub>	SAE J518 <sup>5)</sup> DIN 13	2 in M20 × 2.5; 24 deep	400 O
<b>T<sub>1</sub></b>	Drain port	DIN 3852 <sup>7)</sup>	M42 × 2; 20 deep	3 X <sup>6)</sup>
<b>T<sub>2</sub></b>	Drain port	DIN 3852 <sup>7)</sup>	M42 × 2; 20 deep	3 O <sup>6)</sup>
<b>G</b>	Synchronous control	DIN 3852 <sup>7)</sup>	M18 × 1.5; 12 deep	400 X
<b>G<sub>2</sub></b>	2nd pressure setting (HD.E, EP.E)	DIN 3852 <sup>7)</sup>	M18 × 1.5; 12 deep	400 X
<b>P</b>	Pilot oil supply (EP)	DIN 3852 <sup>7)</sup>	M14 × 1.5; 12 deep	100 O
<b>U</b>	Bearing flushing	DIN 3852 <sup>7)</sup>	M18 × 1.5; 12 deep	3 X
<b>X</b>	Pilot signal (HD, HZ, HA1T/HA2T)	DIN 3852 <sup>7)</sup>	M14 × 1.5; 12 deep	100 O
<b>X</b>	Pilot signal (HA1, HA2)	DIN 3852 <sup>7)</sup>	M14 × 1.5; 12 deep	3 X
<b>X<sub>3</sub></b>	Pilot signal (HD.G, EP.G)	DIN 3852 <sup>7)</sup>	M14 × 1.5; 12 deep	400 O
<b>M</b>	Stroking chamber measurement	DIN 3852 <sup>7)</sup>	M14 × 1.5; 12 deep	400 X
<b>M<sub>A</sub>, M<sub>B</sub></b>	Pressure measurement A/B	DIN 3852 <sup>7)</sup>	M14 × 1.5; 12 deep	400 X
<b>M<sub>St</sub></b>	Pilot pressure measurement	DIN 3852 <sup>7)</sup>	M14 × 1.5; 12 deep	400 X

1) To shaft collar

2) Port plate 1/15 – SAE working ports **A** and **B** at rear

3) For notes on tightening torques, see the instruction manual

4) Depending on the application, momentary pressure peaks can occur.  
Keep this in mind when selecting measuring devices and fittings.

5) Only dimensions according to SAE J518, metric fastening thread is a deviation from the standard

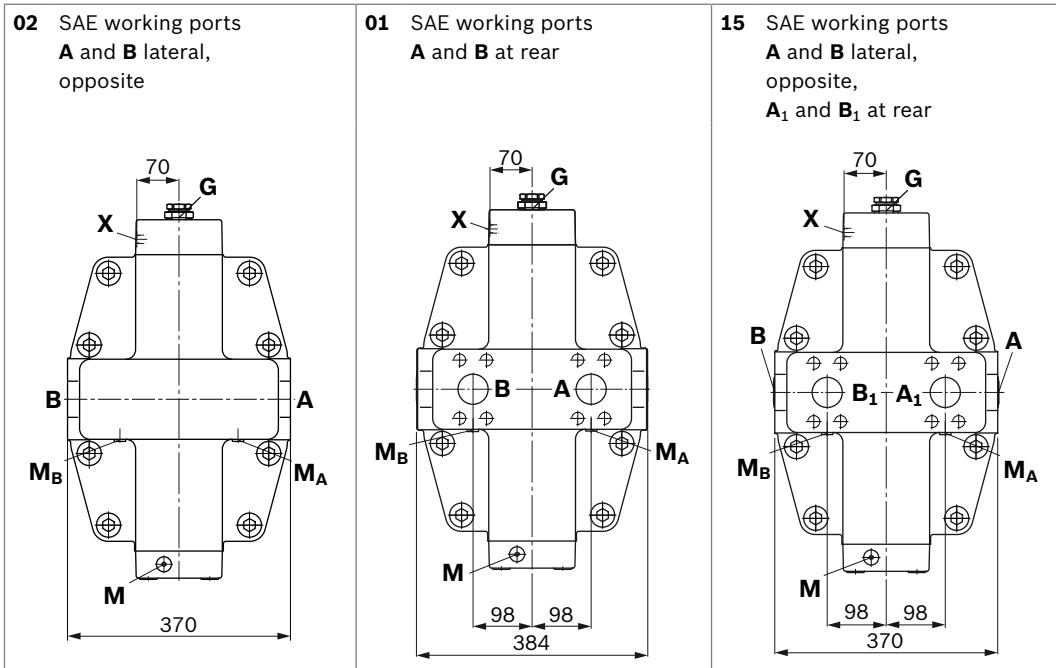
6) Depending on installation position, **T<sub>1</sub>** or **T<sub>2</sub>** must be connected (see also installation instructions on page 52).

7) The countersink can be deeper than as specified in the standard.

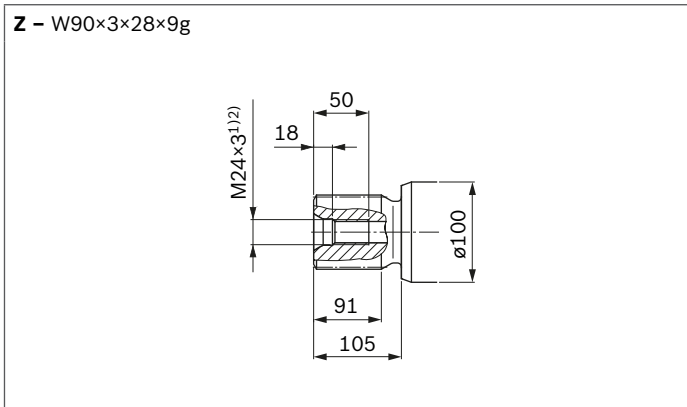
8) O = Must be connected (plugged when delivered)

X = Plugged (in normal operation)

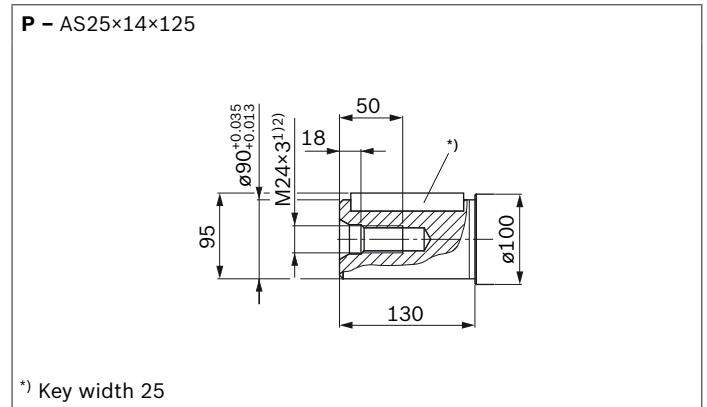
▼ Location of the working ports on the port plates (view Z)



▼ Splined shaft DIN 5480

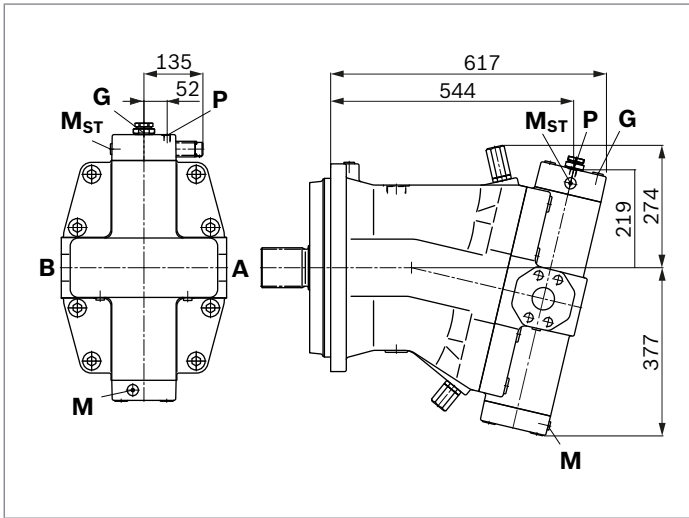


▼ Cyl. Keyed shaft, DIN 6885

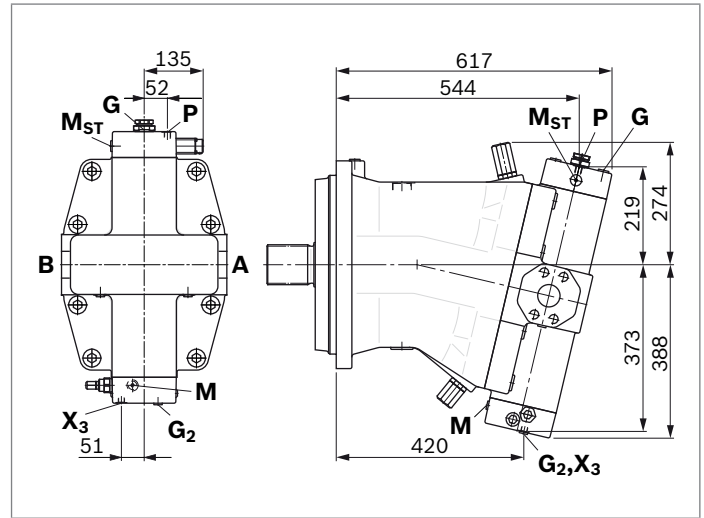


1) For notes on tightening torques, see the instruction manual  
 2) Center bore according to DIN 332 (thread according to DIN 13)

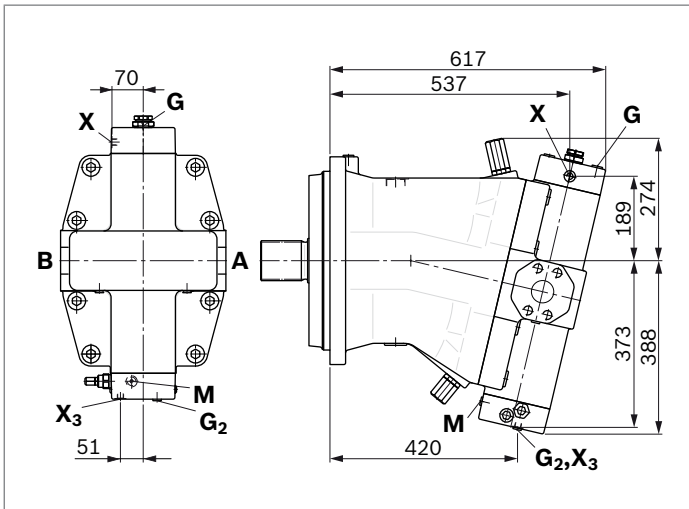
▼ **EP1, EP2** – Proportional control, electric



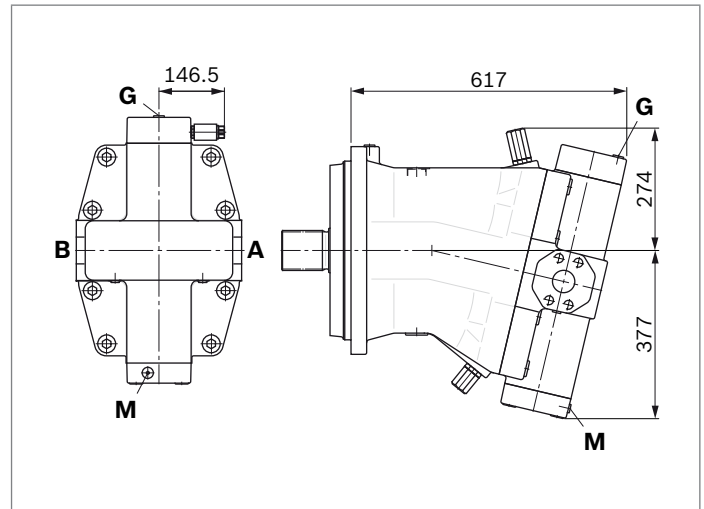
▼ **EP.D, EP.G** – Proportional control electric, with pressure control fixed setting; remote controlled (EP.G)



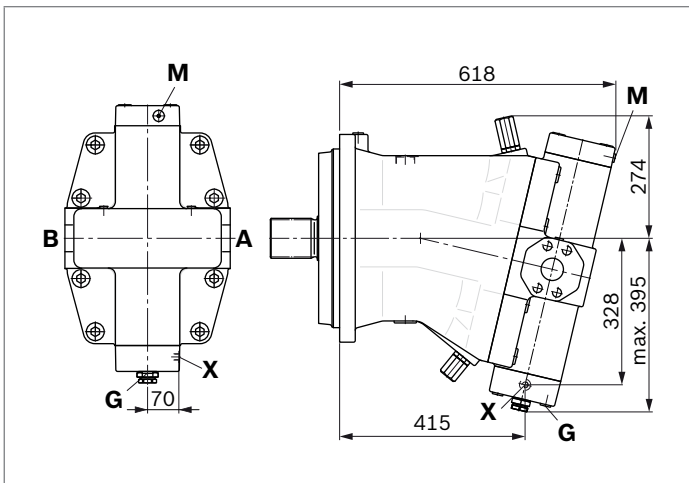
▼ **HD.D, HD.G** – Proportional control hydraulic with pressure control fixed setting; remote controlled (HD.G)



▼ **EZ1, EZ2** – Two-point control, electric



▼ **HA1, HA2 / HA1T, HA2T** – Automatic high-pressure related control, with override hydraulic remote control, proportional



## Connector for solenoids

### DEUTSCH DT04-2P-EP04

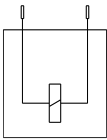
#### Size 28

Molded connector, 2-pin, without bidirectional suppressor diode

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

- ▶ IP67 (DIN/EN 60529) and
- ▶ IP69K (DIN 40050-9)

#### ▼ 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).

#### Notice

- ▶ If necessary, you can change the position of the connector by turning the solenoid.
- ▶ The procedure is defined in the instruction manual.

### HIRSCHMANN DIN EN 175 301-803-A/ISO 4400

#### Sizes 250 to 1000

Without bidirectional suppressor diode

Type of protection:

- ▶ IP65 (DIN/EN 60529)

The seal ring in the cable fitting is suitable for lines of diameter 4.5 mm to 10 mm.

The mating connector is included in the scope of delivery.

## Flushing and boost-pressure valve

The flushing and boost-pressure valve is used to remove heat from the hydraulic circuit.

In a closed circuit, it is used for flushing the case and safeguarding the minimum boost pressure.

Hydraulic fluid is directed from the respective low pressure side into the motor housing. This is then fed into the reservoir, together with the leakage. In the closed circuit, the removed hydraulic fluid must be replaced by cooled hydraulic fluid supplied by the boost pump.

The valve is mounted on the port plate or integrated (depending on the control type and size).

### Cracking pressure of pressure retaining valve

(observe when setting the primary valve)

- ▶ sizes 28, 250 to 1000, fixed setting 16 bar

### Switching pressure of flushing spool $\Delta p$

- ▶ size 28,  $8 \pm 1$  bar
- ▶ sizes 250 to 1000,  $17.5 \pm 1.5$  bar

### Flushing flow $q_v$

Orifices can be used to adjust the flushing flows as required. The following parameters are based on:

$$\Delta p_{ND} = p_{ND} - p_G = 25 \text{ bar and } v = 10 \text{ mm}^2/\text{s}$$

( $p_{ND}$  = low pressure,  $p_G$  = case pressure)

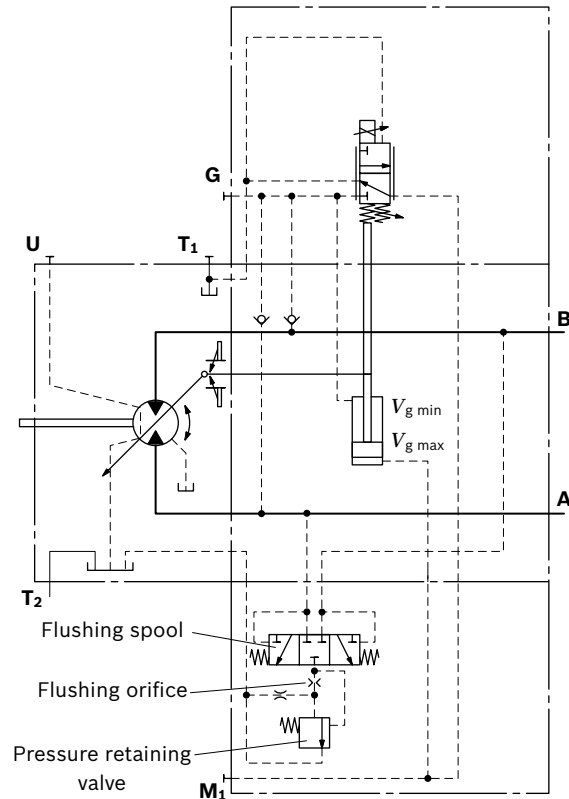
### Flushing valve for size 28

Material number of orifice	$\varnothing$ [mm]	$q_v$ [l/min]
R909651766	1.2	3.5
R909419695	1.4	5

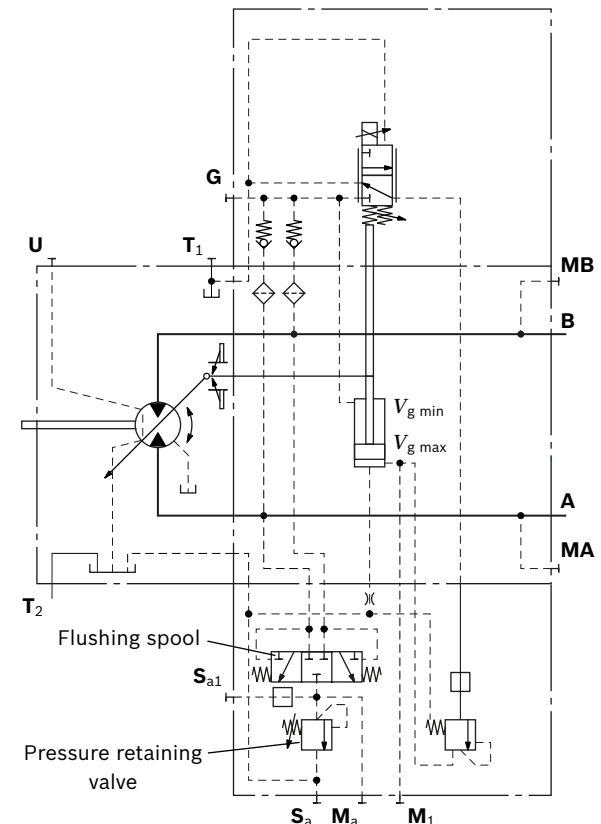
### Flushing valve for sizes 250 to 1000

Material number of orifice	$\varnothing$ [mm]	$q_v$ [l/min]
R909419697	2.0	10
R910928643	2.8	16

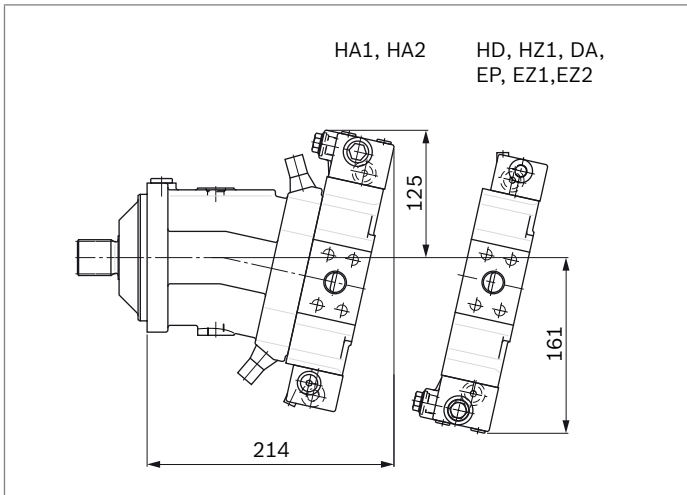
### ▼ Circuit diagram EP, size 28



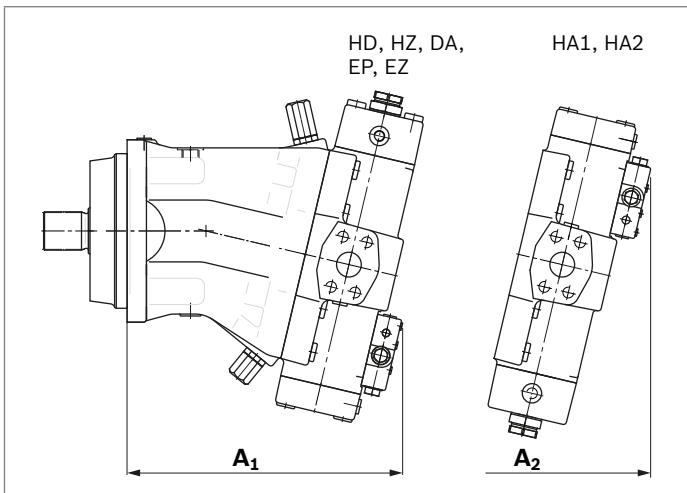
### ▼ Circuit diagram EP, sizes 250 to 1000



▼ **Dimensions, size 28**



▼ **Dimensions, sizes 250 to 1000**



NG	A1	A2
250	357	402
355	397	446
500	440	504
1000	552	629

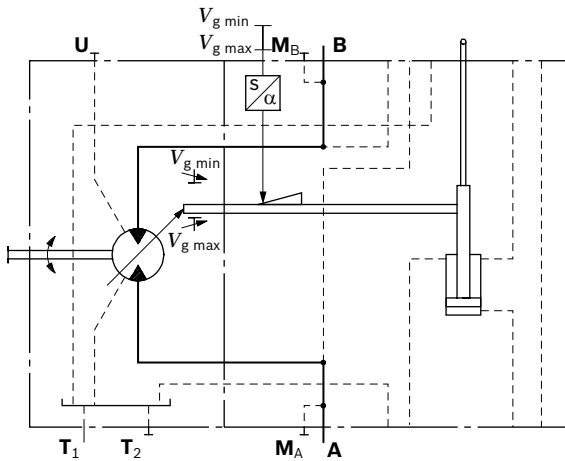
## Swivel angle indicator

### Optical (V)

The swivel position is indicated by a pin on the side of the port plate. The length of pin protruding depends on the position of the lens plate.

If the pin is flush with the port plate, the motor is at the beginning of control. At maximum swivel, the pin length is 8 mm (visible after removing the cap nut).

#### ▼ Example: Beginning of control at $V_{g \max}$



### Electric (E)

The motor position is detected by an inductive position transducer. This converts the travel of the control device into an electric signal.

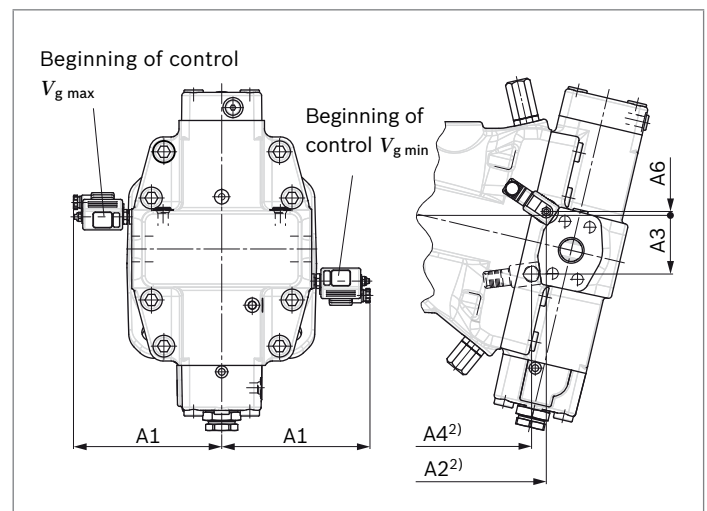
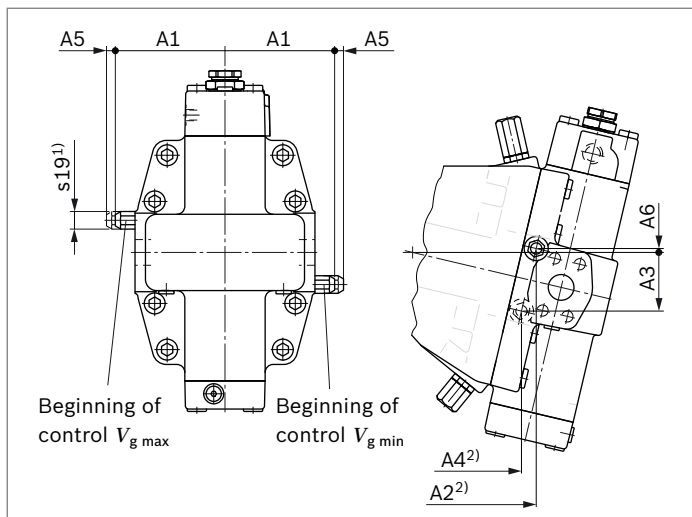
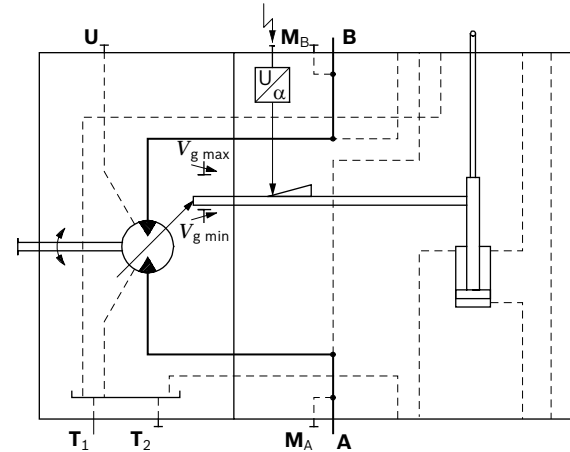
This signal is used to forward the swivel position to an electric control unit.

Inductive position transducer

Type of protection:

- ▶ IP65 (DIN/EN 60529)

#### ▼ Example: Beginning of control at $V_{g \max}$



NG	A1	A2 <sup>2)</sup>	A3	A4	A5 <sup>3)</sup>	A6
250	136.5	256	73	238	11	5
355	159.5	288	84	266	11	8
500	172.5	331	89	309	11	3
1000	208.5	430	114	402	11	3

NG	A1	A2 <sup>2)</sup>	A3	A4	A6
250	185	256	73	238	5
355	208	288	84	266	8
500	221	331	89	309	3
1000	257	430	114	402	3

1) Width across flats

2) Dimension to mounting flange

3) Required clearance for removal of cap nut

## Speed sensor

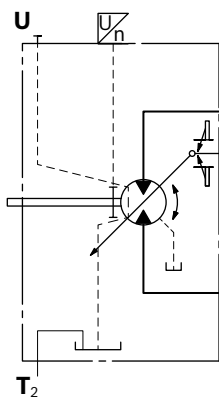
Version A6VM...U ("prepared for speed sensor", i.e. without sensor) is equipped with a spline on the rotary group. A signal proportional to motor rotational speed can be generated with the DSA/DSM or HDD speed sensor mounted. The DSA/DSM sensor registers the rotational speed and direction of rotation.

Type code, technical data, dimensions and parameters for the connector, plus safety instructions about the sensor can be found in the relevant data sheet 95132 – DSM, 95133 – DSA or 95135 – HDD.

The sensor is mounted on the port provided for this purpose with a mounting bolt. On deliveries without sensor, the port is plugged with a pressure-resistant cover. We recommend ordering the A6VM variable motor complete with mounted sensor.

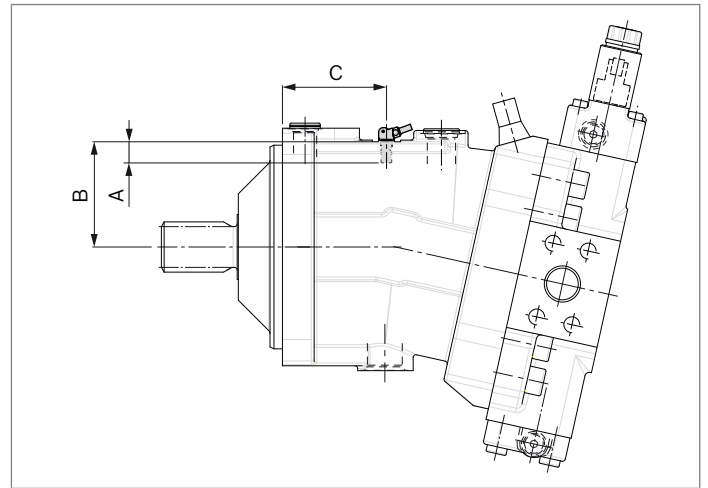
### ▼ Circuit diagram

Size 28

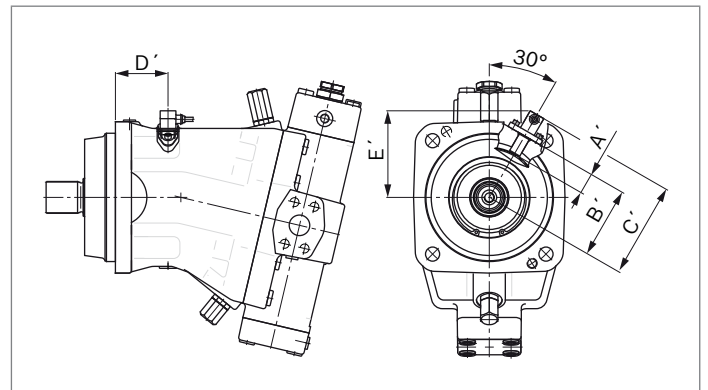


### ▼ Dimensions

Version "V" with DSA sensor or DSM sensor (size 28)



Version "H" with HDD sensor (sizes 250 to 500)



NG			28	250	355	500
Number of teeth			40	78	78	90
DSA	A	Insertion depth (tolerance -0.25)	18.4	1)	1)	1)
	B	Contact surface	61	1)	1)	1)
	C		57.2	1)	1)	1)
HDD	A'	Insertion depth (tolerance ±0.1)	–	32.5	32.5	32.5
	B'	Contact surface	–	110.5	122.5	132.5
	C'		–	149	161	171
	D'		–	82	93	113
	E'		–	135	145	154

1) On request

## Installation instructions

### General

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

Particularly in the installation position “drive shaft upwards”, filling and air bleeding must be carried out completely as there is, for example, a danger of dry running. The leakage in the housing area must be directed to the reservoir via the highest drain port (**T<sub>1</sub>**, **T<sub>2</sub>**).

For combinations of multiple units, make sure that the respective case pressure in each unit is not exceeded. In the event of pressure differences at the drain ports of the units, the shared drain line must be changed so that the maximum permissible case pressure of all connected units is not exceeded at any operational conditions. If this is not possible, separate drain lines must be laid.

To achieve favorable noise values, decouple all connecting lines using elastic elements and avoid above-reservoir installation.

In all operating conditions, the drain line must flow into the reservoir below the minimum fluid level.

### Notice

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

Key	
<b>F</b>	Filling / air bleeding
<b>U</b>	Bearing flushing / air bleed port
<b>T<sub>1</sub>, T<sub>2</sub></b>	Drain port
$h_{t\ min}$	Minimum required immersion depth (200 mm)
$h_{min}$	Minimum required distance to reservoir bottom (100 mm)

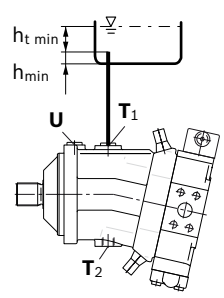
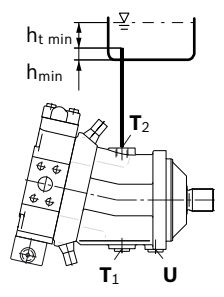
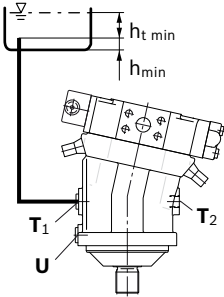
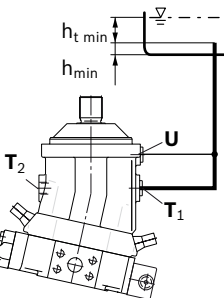
### Installation position

See the following examples **1** to **8**.

Further installation positions are available upon request.  
Recommended installation position: **1** and **2**

### Below-reservoir installation (standard)

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

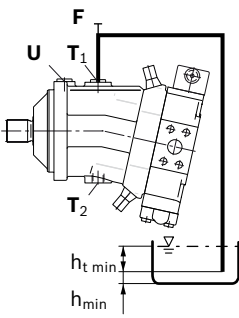
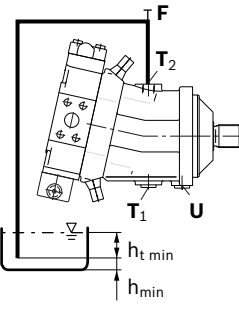
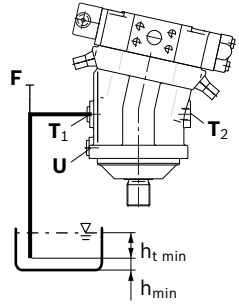
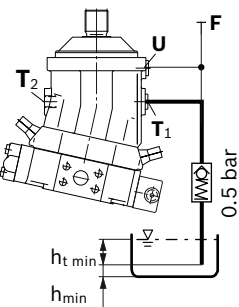
Installation position	Air bleed	Filling
<p><b>1</b></p> 		<b>T<sub>1</sub></b>
<p><b>2</b></p> 		<b>T<sub>2</sub></b>
<p><b>3</b></p> 		<b>T<sub>1</sub></b>
<p><b>4</b></p> 	<b>U</b>	<b>T<sub>1</sub></b>

**Above-reservoir installation**

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

Recommendation for installation position 8 (drive shaft upward):

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

Installation position	Air bleed	Filling
<p><b>5</b></p> 	<b>U (F)</b>	<b>T<sub>1</sub> (F)</b>
<p><b>6</b></p> 	<b>F</b>	<b>T<sub>2</sub> (F)</b>
<p><b>7</b></p> 	<b>F</b>	<b>T<sub>1</sub> (F)</b>
<p><b>8</b></p> 	<b>U</b>	<b>T<sub>1</sub> (F)</b>

**Notice**

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

## Project planning notes

- ▶ The motor A6VM is designed to be used in open and closed circuits.
- ▶ The project planning, installation and commissioning of the axial piston unit requires the involvement of qualified skilled personnel.
- ▶ Before using the axial piston unit, please read the corresponding instruction manual completely and thoroughly. If necessary, these 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.
- ▶ For safety reasons, controls with beginning of control at  $V_{g \min}$  (e.g., HA) are not permissible for winch drives (e.g. anchor winches)!
- ▶ Depending on the operating conditions of the axial piston unit (working pressure, fluid temperature), the characteristic curve may shift.
- ▶ Preservation: Our axial piston units are supplied as standard with preservative protection for a maximum of 12 months. If longer preservative protection is required (maximum 24 months), please specify this in plain text when placing your order. The preservation periods apply under optimal storage conditions, details of which can be found in the data sheet 90312 or the instruction manual.
- ▶ Not all variants of the product are approved for use in safety functions according to ISO 13849. Please consult the responsible contact person at Bosch Rexroth if you require reliability parameters (e.g.  $MTTF_d$ ) for functional safety.
- ▶ Depending on the type of control used, electromagnetic effects can be produced when using solenoids. When a direct current is applied, solenoids do not cause electromagnetic interference nor is their operation impaired by electromagnetic interference.  
Other behavior can result when a modulated direct current (e.g. PWM signal) is applied. Potential electromagnetic interference for persons (e.g. persons with a pacemaker) and other components must be tested by the machine manufacturer.
- ▶ Please note the details regarding the tightening torques of port threads and other threaded joints in the instruction manual.
- ▶ Working ports:
  - The ports and fastening threads are designed for the specified maximum pressure. The machine or system manufacturer must ensure that the connecting elements and lines correspond to the specified application conditions (pressure, flow, hydraulic fluid, temperature) with the necessary safety factors.
  - The working ports and function ports are only intended to accommodate hydraulic lines.

## Safety instructions

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

- ▶ Moving parts in control equipment (e.g. valve spools) can, under certain circumstances get blocked in position as a result of contamination (e.g. impure 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 filter) will not rule out a fault but merely reduce the risk.

The machine/system manufacturer must check whether additional measures are required on the machine for the relevant application in order to bring the driven consumer into a safe position (e.g. safe stop) and ensure any measures are properly implemented.

- ▶ Moving parts in high-pressure relief valves may in certain circumstances become stuck in an undefined position due to contamination (e.g. contaminated hydraulic fluid). This can result in restriction or loss of the load holding function in lifting winches.

The machine/system manufacturer must check whether additional measures are required on the machine for the relevant application in order to keep the load in a safe position and ensure they are properly implemented.

- ▶ When using the axial piston motor in winch drives, make certain that the technical limit values are not exceeded under all operating conditions. If the axial piston motor is extremely overloaded (e.g., if the maximum permissible rotational speeds are exceeded during weighing of the anchor while the ship is in motion), the rotary group may be damaged and, in the worst case, the axial piston motor may burst. The machine manufacturer / system manufacturer is to undertake additional measures, up to and including encapsulation.

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# Axial piston variable motor

## A6VM series 65

**RE 91607**

Edition: 06.2016

Replaces: 06.2014



- ▶ All-purpose high pressure motor
- ▶ Sizes 55 to 200
- ▶ Nominal pressure 400 bar
- ▶ Maximum pressure 450 bar
- ▶ Open and closed circuits

**Features**

- ▶ Robust motor with long service life
- ▶ Approved for very high rotational speeds
- ▶ High control range (can be swiveled to zero)
- ▶ High torque
- ▶ Variety of controls
- ▶ Optionally with flushing and boost-pressure valve mounted
- ▶ Optionally with mounted high-pressure counterbalance valve
- ▶ Bent-axis design

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## Ordering code

01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	
<b>A6V</b>	<b>M</b>						<b>0</b>			<b>/</b>	<b>65</b>	<b>M</b>	<b>W</b>	<b>V</b>	<b>0</b>					<b>-</b>	

### Axial piston unit

01	Bent-axis design, variable, nominal pressure 400 bar, maximum pressure 450 bar	<b>A6V</b>
----	--	------------

### Operating mode

02	Motor	<b>M</b>
----	-------	----------

### Size (NG)

03	Geometric displacement, see technical data on page 9	<b>055</b>	<b>080</b>	<b>107</b>	<b>140</b>	<b>160</b>	<b>200</b>
----	--	------------	------------	------------	------------	------------	------------

### Control device

				<b>055</b>	<b>080</b>	<b>107</b>	<b>140</b>	<b>160</b>	<b>200</b>	
04	Proportional control hydraulic	positive control	$\Delta p_{St} = 10 \text{ bar}$	●	●	●	●	●	●	<b>HP1</b>
			$\Delta p_{St} = 25 \text{ bar}$	●	●	●	●	●	●	<b>HP2</b>
		negative control	$\Delta p_{St} = 10 \text{ bar}$	●	●	●	●	●	●	<b>HP5</b>
			$\Delta p_{St} = 25 \text{ bar}$	●	●	●	●	●	●	<b>HP6</b>
	Proportional control electrical	positive control	$U = 12 \text{ V DC}$	●	●	●	●	●	●	<b>EP1</b>
			$U = 24 \text{ V DC}$	●	●	●	●	●	●	<b>EP2</b>
		negative control	$U = 12 \text{ V DC}$	●	●	●	●	●	●	<b>EP5</b>
			$U = 24 \text{ V DC}$	●	●	●	●	●	●	<b>EP6</b>
	Two-point control hydraulic	negative control		-	-	-	●	●	●	<b>HZ5</b>
				●	●	●	-	-	-	<b>HZ7</b>
	Two-point control electrical	negative control	$U = 12 \text{ V DC}$	-	-	-	●	●	●	<b>EZ5</b>
			$U = 24 \text{ V DC}$	-	-	-	●	●	●	<b>EZ6</b>
$U = 12 \text{ V DC}$			●	●	●	-	-	-	<b>EZ7</b>	
$U = 24 \text{ V DC}$			●	●	●	-	-	-	<b>EZ8</b>	
Automatic control high-pressure related, Positive control	with minimum pressure increase	$\Delta p \leq \text{approx. } 10 \text{ bar}$	●	●	●	●	●	●	<b>HA1</b>	
	with pressure increase	$\Delta p = 100 \text{ bar}$	●	●	●	●	●	●	<b>HA2</b>	
Automatic control speed related, negative control $p_{St} / p_{HD} = 5/100$	hydr. travel direction valve			●	●	●	●	●	●	<b>DA0</b>
	electric travel direction valve + electric $V_{g \text{ max}}$ circuit	$U = 12 \text{ V DC}$	●	●	●	●	●	●	●	<b>DA1</b>
		$U = 24 \text{ V DC}$	●	●	●	●	●	●	●	<b>DA2</b>

### Pressure control/override

				<b>055</b>	<b>080</b>	<b>107</b>	<b>140</b>	<b>160</b>	<b>200</b>		
05	Without pressure control/override			●	●	●	●	●	●	<b>00</b>	
	Pressure control fixed setting, only for HP5, HP6, EP5 and EP6			●	●	●	●	●	●	<b>D1</b>	
	Override of controls HA1 and HA2	hydraulic remote control, proportional			●	●	●	●	●	●	<b>T3</b>
		electric, two-point	$U = 12 \text{ V DC}$	●	●	●	●	●	●	●	<b>U1</b>
			$U = 24 \text{ V DC}$	●	●	●	●	●	●	●	<b>U2</b>
		electric and travel direction valve, electric	$U = 12 \text{ V DC}$	●	●	●	●	●	●	●	<b>R1</b>
			$U = 24 \text{ V DC}$	●	●	●	●	●	●	●	<b>R2</b>

### Connector for solenoids<sup>1)</sup> (see page 62)

06	Without connector (without solenoid, only for hydraulic control)	<b>0</b>
	DEUTSCH - molded connector, 2-pin, without suppressor diode	<b>P</b>

● = Available    ○ = On request    - = Not available

1) Connectors for other electric components can deviate.

01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	
<b>A6V</b>	<b>M</b>						<b>0</b>			<b>/</b>	<b>65</b>	<b>M</b>	<b>W</b>	<b>V</b>	<b>0</b>					-	

<b>Neutral position switch</b>										<b>055</b>	<b>080</b>	<b>107</b>	<b>140</b>	<b>160</b>	<b>200</b>	
07	Without additional function									●	●	●	●	●	●	<b>0</b>
	Neutral position switch									-	●	●	●	●	●	<b>N</b>

<b>Additional function</b>										
08	Without additional function									<b>0</b>

<b>Response time damping</b> (for selection, see control)										
09	Without damping (standard with HP and EP)									<b>0</b>
	Damping									
	HP, EP, HP5,6D. and EP5,6D., HZ, EZ, HA with counterbalance valve BVD/BVE									<b>1</b>
	One-sided in inlet to large stroking chamber (HA)									<b>4</b>
	One-sided in outlet from large stroking chamber (DA)									<b>7</b>

<b>Setting range for displacement<sup>2)</sup></b>										
10	$V_{g \max}$ -setting screw	$V_{g \min}$ -setting screw	<b>055</b>	<b>080</b>	<b>107</b>	<b>140</b>	<b>160</b>	<b>200</b>		
	Without setting screw									
		short (0-adjustable)	●	●	●	●	●	●	●	<b>A</b>
		medium	●	●	●	●	●	●	●	<b>B</b>
		long	●	●	●	●	●	●	●	<b>C</b>
		extra long	-	-	●	●	●	●	●	<b>D</b>
	Short									
		short (0-adjustable)	●	●	●	●	●	●	●	<b>E</b>
		medium	●	●	●	●	●	●	●	<b>F</b>
		long	●	●	●	●	●	●	●	<b>G</b>
		extra long	-	-	●	●	●	●	●	<b>H</b>
	Medium									
		short (0-adjustable)	●	●	●	●	●	●	●	<b>J</b>
		medium	●	●	●	●	●	●	●	<b>K</b>
		long	●	●	●	●	●	●	●	<b>L</b>
		extra long	-	-	●	●	●	●	●	<b>M</b>

<b>Series</b>										
11	Series 6, index 5									<b>65</b>

<b>Configuration of ports and fastening threads</b>										
12	Metric, port threads with O-ring sealing according to ISO 6149									<b>M</b>

<b>Direction of rotation</b>										
13	Viewed on drive shaft, bidirectional									<b>W</b>

<b>Sealing material</b>										
14	FKM (fluoroelastomer)									<b>V</b>

<b>Drive shaft bearing</b>										
15	Standard bearing									<b>0</b>

<b>Mounting flange</b>										<b>055</b>	<b>080</b>	<b>107</b>	<b>140</b>	<b>160</b>	<b>200</b>	
16	ISO 3019-2		125-4	●	-	-	-	-	-	-	<b>M4</b>					
			140-4	-	●	-	-	-	-	-	<b>N4</b>					
			160-4	-	-	●	-	-	-	-	<b>P4</b>					
			180-4	-	-	-	●	●	-	-	<b>R4</b>					
			200-4	-	-	-	-	-	-	●	<b>S4</b>					

● = Available    ○ = On request    - = Not available

<sup>2)</sup> The settings for the setting screws can be found in the table (see pages 70 and 71).

4 **A6VM series 65** | Axial piston variable motor  
Ordering code

01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	
<b>A6V</b>	<b>M</b>						<b>0</b>			<b>/</b>	<b>65</b>	<b>M</b>	<b>W</b>	<b>V</b>	<b>0</b>					<b>-</b>	

<b>Drive shaft</b>			<b>055</b>	<b>080</b>	<b>107</b>	<b>140</b>	<b>160</b>	<b>200</b>	
17	Splined shaft ANSI B92.1a	1 1/4 in 14T 12/24 DP	●	●	-	-	-	-	<b>S7</b>
		1 3/4 in 13T 8/16 DP	-	-	●	●	●	-	<b>T1</b>
		2 in 15T 8/16 DP	-	-	-	-	-	●	<b>T2</b>
Splined shaft DIN 5480	W30x2x14x9g	●	-	-	-	-	-	-	<b>Z6</b>
	W35x2x16x9g	●	●	-	-	-	-	-	<b>Z8</b>
	W40x2x18x9g	-	●	●	-	-	-	-	<b>Z9</b>
	W45x2x21x9g	-	-	●	●	●	-	-	<b>A1</b>
	W50x2x24x9g	-	-	-	-	●	●	-	<b>A2</b>

<b>Working port</b>			<b>055</b>	<b>080</b>	<b>107</b>	<b>140</b>	<b>160</b>	<b>200</b>	
18	SAE working ports <b>A</b> and <b>B</b> at rear		●	●	●	●	●	●	<b>1</b>
	SAE working ports <b>A</b> and <b>B</b> at side, opposite		●	●	●	●	●	●	<b>2</b>
	Port plate with 1-stage pressure limitation valves for mounting a counterbalance valve <sup>3)</sup>	BVD20	●	●	●	-	-	-	<b>7</b>
		BVD25, BVE25	-	-	●	●	●	●	<b>8</b>

<b>Valve</b> (see pages 64 to 68)			<b>055</b>	<b>080</b>	<b>107</b>	<b>140</b>	<b>160</b>	<b>200</b>		
19	Without valve		●	●	●	●	●	●	<b>0</b>	
	With counterbalance valve BVD/BVE mounted <sup>4)</sup>		●	●	●	●	●	●	<b>W</b>	
	With flushing and boost pressure valve, mounted		<b>Flushing flow <math>q_v</math> [l/min]</b>							
	Flushing on both sides									
	Flushing flow at:									
	$\Delta p = p_{ND} - p_G = 25 \text{ bar}$ and $v = 10 \text{ mm}^2/\text{s}$									
	$(p_{ND} = \text{low pressure, } p_G = \text{case pressure})$									
	Only possible with port plates 1 and 2									
	3.5		●	●	●	-	-	-	-	<b>A</b>
	5		●	●	●	-	-	-	-	<b>B</b>
	8		●	●	●	●	●	●	●	<b>C</b>
	10		●	●	●	●	●	●	●	<b>D</b>
	14		●	●	●	-	-	-	-	<b>F</b>
	17		-	-	-	●	●	●	●	<b>G</b>
20		-	-	● <sup>5)</sup>	●	●	●	●	<b>H</b>	
25		-	-	● <sup>5)</sup>	●	●	●	●	<b>J</b>	
30		-	-	● <sup>5)</sup>	●	●	●	●	<b>K</b>	
35		-	-	-	●	●	●	●	<b>L</b>	
40		-	-	-	●	●	●	●	<b>M</b>	

● = Available    ○ = On request    - = Not available

3) Only possible in combination with HP, EP and HA control. Note the restrictions described on page 66.

4) State ordering code for counterbalance valve separately in accordance with data sheet 95522 – BVD or 95525 – BVE. Note the restrictions described on page 66.

5) Not for E27, E28 and HZ7.

01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	
<b>A6V</b>	<b>M</b>					<b>0</b>	<b>0</b>			<b>/</b>	<b>65</b>	<b>M</b>	<b>W</b>	<b>V</b>	<b>0</b>					<b>-</b>	

**Speed sensor** (see page 69)

		055	080	107	140	160	200	
20	Without speed sensor	●	●	●	●	●	●	<b>0</b>
	Prepared with speed sensor DSM/DSA	●	●	●	●	●	●	<b>U</b>
	With speed sensor DSM/DSA mounted <sup>6)</sup>	●	●	●	●	●	●	<b>V</b>

**Standard / special version**

21	Standard version	<b>0</b>
	Standard version with installation variants, e.g. <b>T</b> ports against standard open and closed	<b>Y</b>
	Special version	<b>S</b>

● = Available    ○ = On request    - = Not available

**Notice**  
▶ Note the project planning notes on page 74.

<sup>6)</sup> State ordering code for sensor separately in accordance with data sheet 95132 – DSM or 95133 – DSA and note the requirements relating to the electronics.

## Hydraulic fluids

The variable motor A6VM is designed for operation with mineral oil HLP 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)
- ▶ 90223: Fire-resistant, water-containing hydraulic fluids (HFC, HFB)
- ▶ 90225: Axial piston units for operation with water-free and water-containing fire-resistant hydraulic fluids (HFDR, HFDU, HFB, HFC).

The variable motor A6VM is not suitable for operation with HFA fluids. If operating with HFB-, HFC- and HFD or environmentally acceptable hydraulic fluids, the limitations regarding technical data or other seals must be observed.

### 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).

#### Note

At no point of the component may the temperature be higher than 115 °C. The temperature difference specified in the table is to be taken into account when determining the viscosity in the bearing.

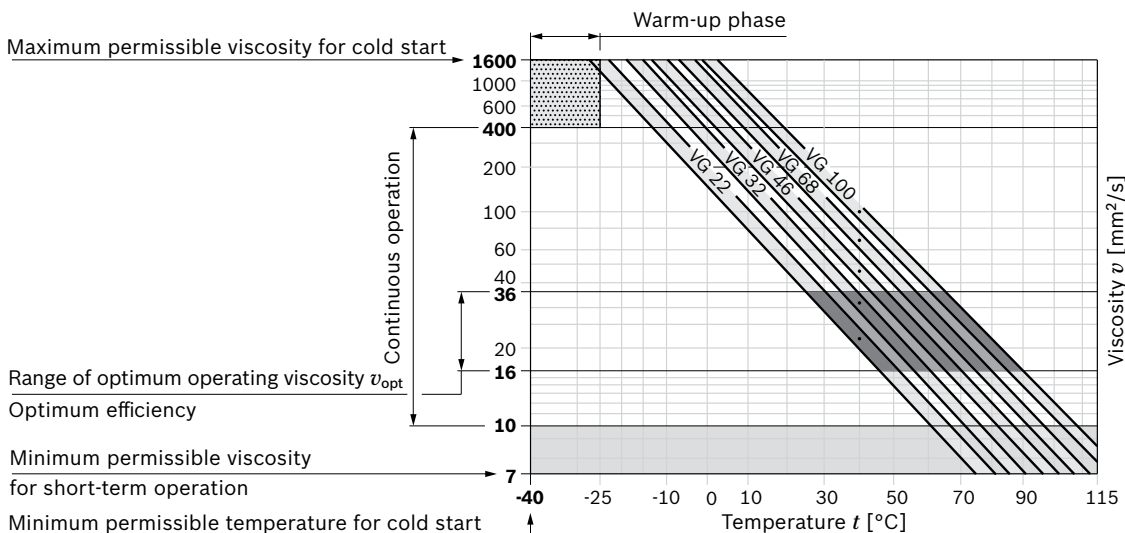
If the above conditions cannot be maintained due to extreme operating parameters, we recommend the use of a flushing and boost-pressure valve (see page 64).

### Viscosity and temperature of hydraulic fluids

	Viscosity	Temperature	Comment
Cold start <sup>1)</sup>	$v_{min} \geq 1600 \text{ mm}^2/\text{s}$	$\theta_{St} \geq -40 \text{ }^\circ\text{C}$	$t \leq 3 \text{ min}$ , $n \leq 1000 \text{ rpm}$ , without load $p \leq 50 \text{ bar}$
Permissible temperature difference		$\Delta T \leq 25 \text{ K}$	between axial piston unit and hydraulic fluid in the system
Warm-up phase	$v = 1600 \text{ to } 400 \text{ mm}^2/\text{s}$	$\theta = -40 \text{ }^\circ\text{C to } -25 \text{ }^\circ\text{C}$	at $p \leq 0.7 \times p_{nom}$ , $n \leq 0.5 \times n_{nom}$ and $t \leq 15 \text{ min}$
Continuous operation	$v = 400 \text{ to } 10 \text{ mm}^2/\text{s}$		This corresponds, for example on the VG 46, to a temperature range of +5 °C to +85 °C (see selection diagram)
		$\theta = -25 \text{ }^\circ\text{C to } +103 \text{ }^\circ\text{C}$	measured at port <b>T</b> Note the permissible temperature range of the shaft seal ( $\Delta T = \text{approx. } 12 \text{ K}$ between the bearing/shaft seal and port <b>T</b> )
	$v_{opt} = 36 \text{ to } 16 \text{ mm}^2/\text{s}$		Range of optimum operating viscosity and efficiency
Short-term operation	$v_{min} \geq 7 \text{ mm}^2/\text{s}$		$t < 3 \text{ min}$ , $p < 0.3 \times p_{nom}$

1) For application cases below -25 °C, an NBR shaft seal is required (permissible temperature range -40 °C to +90 °C).

#### ▼ 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.

At very high hydraulic fluid temperatures (90 °C to maximum 103 °C, measured at port **T**), a cleanliness level of at least 19/17/14 according to ISO 4406 is necessary.

**Influence of case pressure on beginning of control**

An increase in case pressure affects the beginning of control of the variable motor when using the following control options:

- ▶ HP, HA.T3: increase
- ▶ DA: decrease

With the following settings, an increase in case pressure will have no effect on the beginning of control:

HA.R and HA.U, EP, HA

The factory setting of the beginning of control is made at  $p_{abs} = 2$  bar case pressure.

**Flow direction**

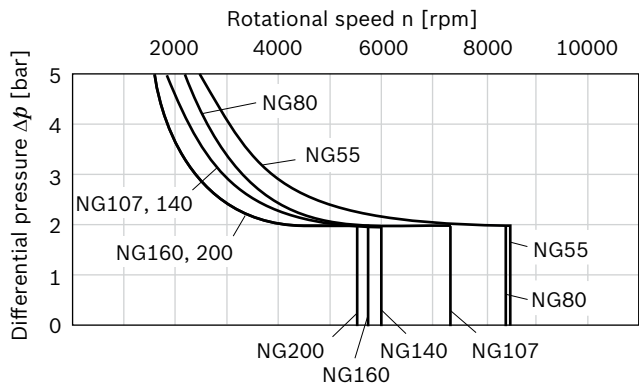
Direction of rotation, viewed on drive shaft	
cw	ccw
<b>A to B</b>	<b>B to A</b>

**Shaft seal**

**Permissible pressure loading**

The service life of the shaft seal will be influenced by the speed of the axial piston unit and the leakage pressure in the housing (case pressure). Momentary pressure spikes ( $t < 0.1$  s) of up to 10 bar are permitted. Case pressures of a continuous 2 bar maximum are permitted to be able to utilize the entire speed range. Higher case pressures are permissible at lower rotational speeds (see diagram). The service life of the shaft seal decreases with increasing frequency of pressure spikes and increasing mean differential pressure.

The case pressure must be equal to or higher than the ambient pressure.

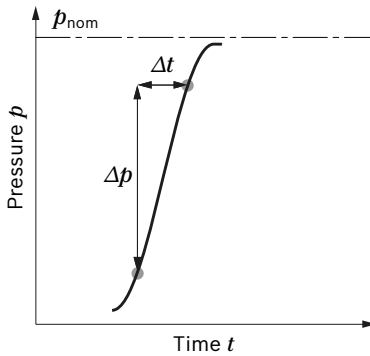


The FKM shaft seal may be used for leakage temperatures from -25 °C to +115 °C. For application cases below -25 °C, an NBR shaft seal is required (permissible temperature range: -40 °C to +90 °C).

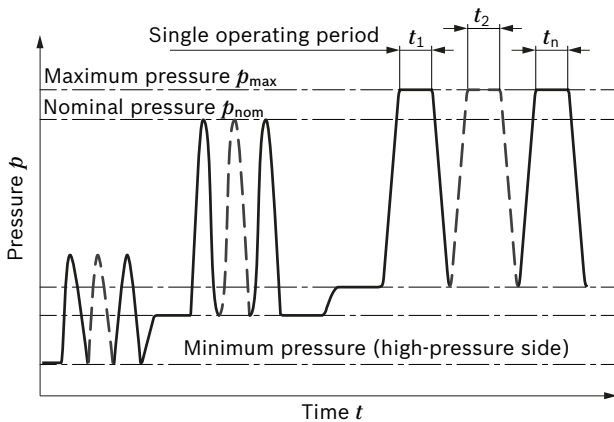
## Operating pressure range

Pressure at service line port A or B		Definition
Nominal pressure $p_{nom}$	400 bar	The nominal pressure corresponds to the maximum design pressure.
Maximum pressure $p_{max}$	450 bar	The maximum pressure corresponds to the maximum operating pressure within the single operating period. The sum of the single operating periods must not exceed the total operating period.
Single operating period	10 s	
Total operating period	300 h	
Minimum pressure (high-pressure side)	25 bar absolute	Minimum pressure at the high-pressure side ( <b>A</b> or <b>B</b> ) which is required in order to prevent damage to the axial piston unit.
Minimum pressure – pump operating mode (inlet)	See the diagram below	To prevent damage to the axial piston motor in pump operating mode (change of high-pressure side with unchanged direction of rotation, e.g. when braking), a minimum pressure must be guaranteed at the service line port (inlet). This minimum pressure is dependent on the speed and displacement of the axial piston unit (see characteristic curve)
Summation pressure $p_{Su}$ (pressure <b>A</b> + pressure <b>B</b> )	700 bar	The summation pressure is the sum of the pressures at both service line ports ( <b>A</b> and <b>B</b> )
Rate of pressure change $R_{A\ max}$		Maximum permissible rate of pressure build-up and reduction during a pressure change over the entire pressure range.
With integrated pressure-relief valve	9000 bar/s	
Without pressure-relief valve	16000 bar/s	

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

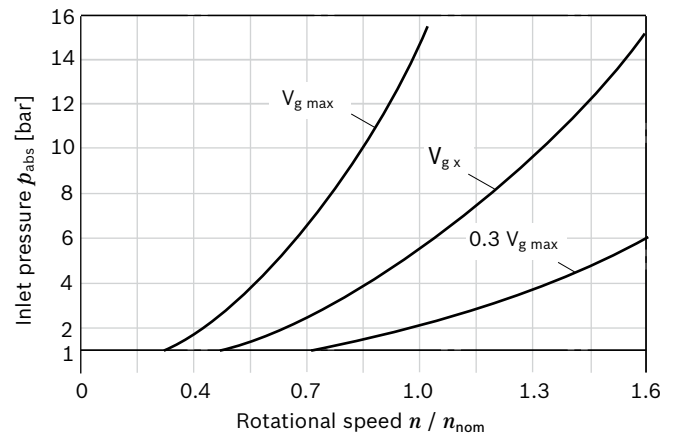


### ▼ Pressure definition



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

### ▼ Minimum pressure – pump operating mode (inlet)



This diagram is valid only for the optimum viscosity range from  $v_{opt} = 36$  to  $16\text{ mm}^2/\text{s}$ .

Please contact us if these conditions cannot be satisfied.

#### Notice

Operating pressure range valid when using hydraulic fluids based on mineral oils. Values for other hydraulic fluids, please contact us.

## Technical data

Size		NG	55	80	107	140	160	200	
Displacement geometric, per revolution		$V_{g \max}$	cm <sup>3</sup>	54.8	80	107	140	160	200
		$V_{g \min}$	cm <sup>3</sup>	0	0	0	0	0	0
		$V_{g x}$	cm <sup>3</sup>	35	51	68	88	61	76
Maximum speed <sup>1)</sup> (complying with the maximum permissible inlet flow)	at $V_{g \max}$	$n_{\text{nom}}$	rpm	4450	3900	3550	3250	3100	2900
	at $V_g < V_{g x}$ (see diagram)	$n_{\text{max}}$	rpm	7000	6150	5600	5150	4900	4600
	at $V_{g 0}$	$n_{\text{max}}$	rpm	8350	7350	6300	5750	5500	5100
Inlet flow <sup>2)</sup>	at $n_{\text{nom}}$ and $V_{g \max}$	$q_{v \max}$	l/min	244	312	380	455	496	580
Torque <sup>3)</sup>	at $V_{g \max}$ and $\Delta p = 400$ bar	$T$	Nm	349	509	681	891	1019	1273
Rotary stiffness	$V_{g \max}$ to $V_g/2$	$c_{\text{min}}$	kNm/rad	10	16	21	34	35	44
	$V_g/2$ to 0 (interpolated)	$c_{\text{min}}$	kNm/rad	32	48	65	93	105	130
Moment of inertia for rotary group		$J_{TW}$	kgm <sup>2</sup>	0.0042	0.008	0.0127	0.0207	0.0253	0.0353
Maximum angular acceleration		$\alpha$	rad/s <sup>2</sup>	31500	24000	19000	11000	11000	11000
Case volume		$V$	l	0.75	1.2	1.5	1.8	2.4	2.7
Weight, approx.		$m$	kg	28	36	46	61	62	78

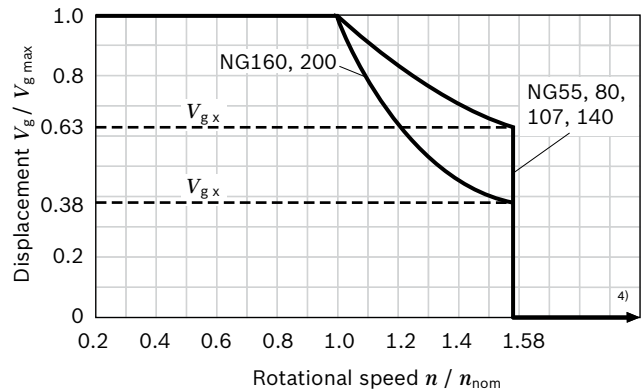
### Speed range

The minimum rotational speed  $n_{\text{min}}$  is not limited. For applications with requirements on the evenness of the rotation at low rotational speeds, please contact us.

#### Notice

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

### Permissible displacement in relation to speed



#### Determining the operating characteristics


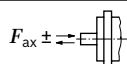
Inlet flow	$q_v = \frac{V_g \times n}{1000 \times \eta_v}$	[l/min]
Rotational speed	$n = \frac{q_v \times 1000 \times \eta_v}{V_g}$	[rpm]
Torque	$T = \frac{V_g \times \Delta p \times \eta_{mh}}{20 \times \pi}$	[Nm]
Power	$P = \frac{2 \pi \times T \times n}{60000} = \frac{q_v \times \Delta p \times \eta_t}{600}$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


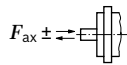
#### Key

$V_g$	=	Displacement per revolution [cm <sup>3</sup> ]
$\Delta p$	=	Differential pressure [bar]
$n$	=	Rotational speed [rpm]
$\eta_v$	=	Volumetric efficiency
$\eta_{mh}$	=	Mechanical-hydraulic efficiency
$\eta_t$	=	Total efficiency ( $\eta_t = \eta_v \cdot \eta_{mh}$ )

- The values are valid:
  - for the optimum viscosity range from  $\nu_{\text{opt}} = 36$  to  $16$  mm<sup>2</sup>/s
  - with hydraulic fluid based on mineral oils
- Observe limitation of input flow due to counterbalance valve (see page 66).
- Torque without radial force, With radial force see page 10.
- Values in this range on request

**Permissible radial and axial forces of the drive shafts**

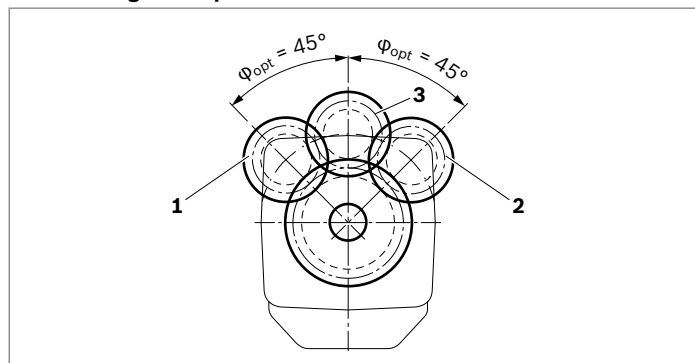
Size	NG		55	80	107	140	160	200	
Drive shaft		in	1 1/4	1 1/4	1 3/4	1 3/4	1 3/4	2	
Maximum radial force at distance a (from shaft collar)		$F_{q \max}$	N	7811	7559	12256	16036	14488	20047
		a	mm	24.0	24.0	33.5	33.5	33.5	33.5
Maximum torque at $F_{q \max}$	$T_{q \max}$	Nm	310	300	681	891	920	1273	
Maximum differential pressure at $V_{g \max}$ and $F_{q \max}$	$\Delta p_{q \max}$	bar	315	236	400	400	361	400	
Maximum axial force at standstill or depressurized operation		$+ F_{ax \max}$	N	0	0	0	0	0	0
		$- F_{ax \max}$	N	500	710	900	1030	1120	1250
Permissible axial force per bar operating pressure	$+ F_{ax \text{ zul}/\text{bar}}$	N/bar	7.5	9.6	11.3	13.3	15.1	17.0	

Size	NG		55	55	80	80	107	107	140	160	160	200	
Drive shaft	$\varnothing$	mm	W30	W35	W35	W40	W40	W45	W45	W45	W50	W50	
Maximum radial force at distance a (from shaft collar)		$F_{q \max}$	N	7581	8069	10867	10283	13758	12215	15982	18278	16435	20532
		a	mm	17.5	20.0	20.0	22.5	22.5	25.0	25.0	25.0	27.5	27.5
Maximum torque at $F_{q \max}$	$T_{q \max}$	Nm	281	349	470	509	681	681	891	1019	1019	1273	
Maximum differential pressure at $V_{g \max}$ and $F_{q \max}$	$\Delta p_{q \max}$	bar	322	400	369	400	400	400	400	400	400	400	
Maximum axial force at standstill or depressurized operation		$+ F_{ax \max}$	N	0	0	0	0	0	0	0	0	0	
		$- F_{ax \max}$	N	500	500	710	710	900	900	1030	1120	1120	1250
Permissible axial force per bar operating pressure	$+ F_{ax \text{ zul}/\text{bar}}$	N/bar	7.5	7.5	9.6	9.6	11.3	11.3	13.3	15.1	15.1	17.0	

**Effect of radial force  $F_q$  on the service life of bearings**

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

▼ **Toothed gear output drive**



- 1 Direction of rotation “counter-clockwise”, pressure at port **A**
- 2 Direction of rotation “clockwise”, pressure at port **B**
- 3 Alternating direction of rotation

**Notice**

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

## HP – Proportional hydraulic control

The proportional hydraulic control provides infinite adjustment of the displacement. Control is proportional to the pilot pressure applied to port **X**.

### HP1, HP2 positive control

- ▶ Beginning of control at  $V_{g \min}$  (minimum torque, maximum permissible speed at minimum pilot pressure)
- ▶ End of control at  $V_{g \max}$  (maximum torque, minimum speed at maximum pilot pressure)

### HP5, HP6 negative control

- ▶ Beginning of control at  $V_{g \max}$  (maximum torque, minimum speed at minimum pilot pressure)
- ▶ End of control at  $V_{g \min}$  (minimum torque, maximum permissible speed at maximum pilot pressure)

### Notice

- ▶ Maximum permissible pilot pressure:  $p_{St} = 100$  bar
- ▶ The control oil is internally taken out of the high pressure side of the motor (**A** or **B**). For reliable control, a working pressure of at least 30 bar is required in **A** (**B**). If a control operation is performed at a working pressure < 30 bar, an auxiliary pressure of at least 30 bar must be applied at port **G** using an external check valve. For lower pressures, please contact us. Bear in mind that pressures up to 450 bar can occur at port **G**.
- ▶ Specify the desired beginning of control in plain text when ordering, e.g.: beginning of control at 10 bar.
- ▶ The beginning of control and the HP characteristic curve are influenced by the case pressure. An increase in case pressure causes an increase in the beginning of control (see page 7) and thus a parallel shift of the characteristic.
- ▶ A leakage flow of maximum 0.3 l/min can occur at port **X** due to internal leakage (working pressure > pilot pressure). The control is to be suitably configured to avoid an independent build-up of pilot pressure.

### Response time damping

The response time damping impacts the swivel behavior of the motor and consequently the machine response speed.

### Standard for sizes 55 to 200

HP without damping.

HP.D with throttle pin on both sides, symmetrical (see table)

### Optional for sizes 55 to 200

HP with throttle pin on both sides, symmetrical (see table)

#### ▼ Throttle pin overview

Size	55	80	107	140	160	200
Groove size [mm]	0.45	0.45	0.55	0.55	0.55	0.65

### HP1, HP5 pilot pressure increase $\Delta p_{St} = 10$ bar

#### HP1 positive control

A pilot pressure increase of 10 bar at port **X** results in an increase in displacement from  $V_{g \min}$  to  $V_{g \max}$ .

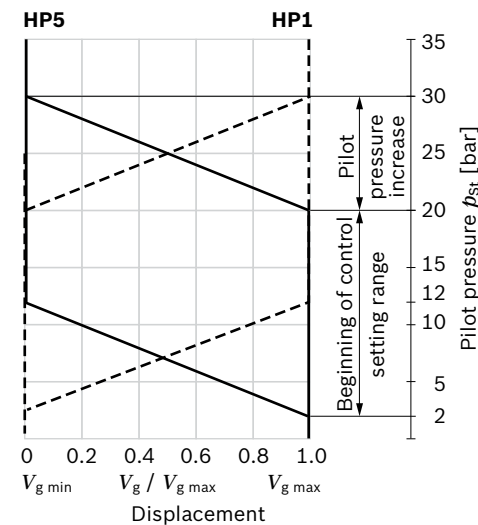
#### HP5 negative control

A pilot pressure increase of 10 bar at port **X** results in a decrease in displacement from  $V_{g \max}$  to  $V_{g \min}$ .

Beginning of control, setting range 2 to 20 bar

Standard setting: beginning of control at 3 bar (end of control at 13 bar)

#### ▼ Characteristic curve



**HP2, HP6 pilot pressure increase  $\Delta p_{St} = 25$  bar**

**HP2 positive control**

A pilot pressure increase of 25 bar at port **X** results in an increase in displacement from  $V_{g\ min}$  to  $V_{g\ max}$ .

**HP6 negative control**

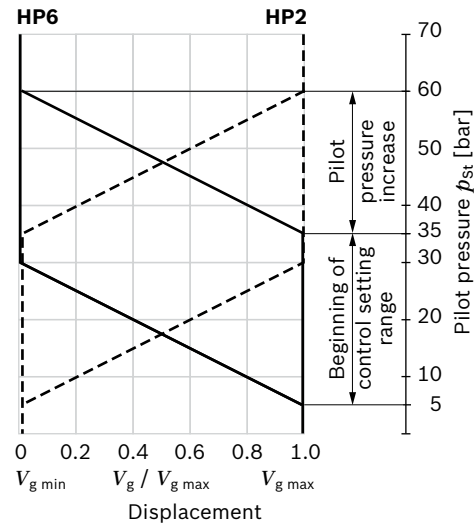
A pilot pressure increase of 25 bar at port **X** results in a decrease in displacement from  $V_{g\ max}$  to  $V_{g\ min}$ .

Beginning of control, setting range 5 to 35 bar

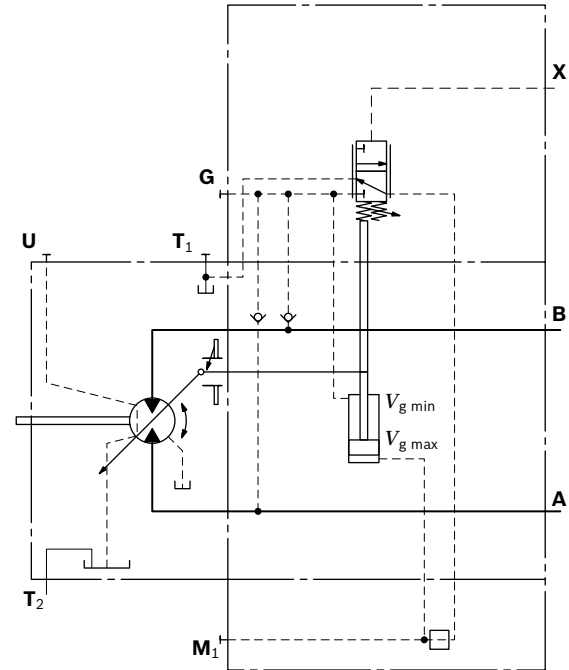
Standard setting:

beginning of control at 10 bar (end of control at 35 bar)

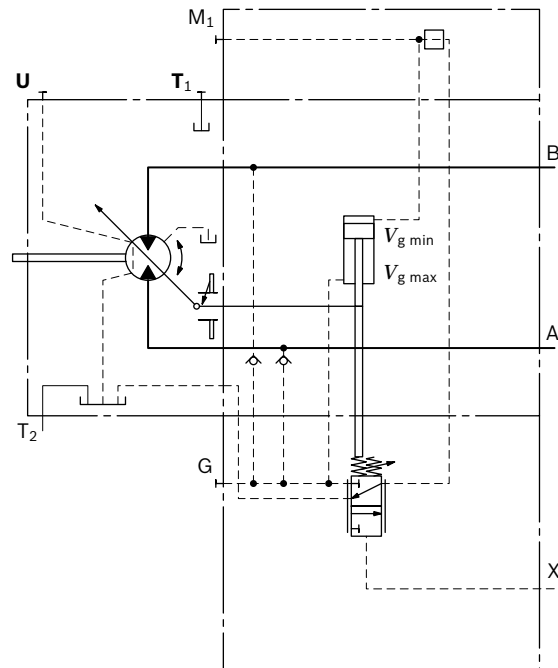
▼ **Characteristic curve**



▼ **Circuit diagram HP5, HP6 (negative control)**



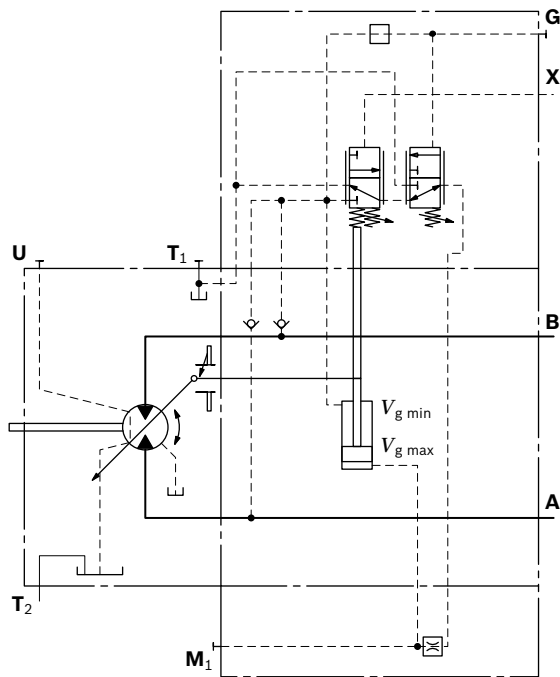
▼ **Circuit diagram HP1, HP2 (positive control)**



**HP5D1, HP6D1 Pressure control, fixed setting**

The pressure control overrides the HP control function.  
 If the load torque or a reduction in motor swivel angle causes the system pressure to reach the setpoint value of the pressure control, the motor will swivel towards a larger displacement.  
 The increase in the displacement and the resulting reduction in pressure cause the control deviation to decrease.  
 With the increase in displacement the motor develops more torque, while the pressure remains constant.  
 Setting range of the pressure control valve 80 to 400 bar

▼ **Circuit diagram HP5D1, HP6D1 (negative control)**



## EP – Proportional electric control

The proportional electric control, type EP, provides infinite adjustment of the displacement, proportional to the control current applied to the solenoid.

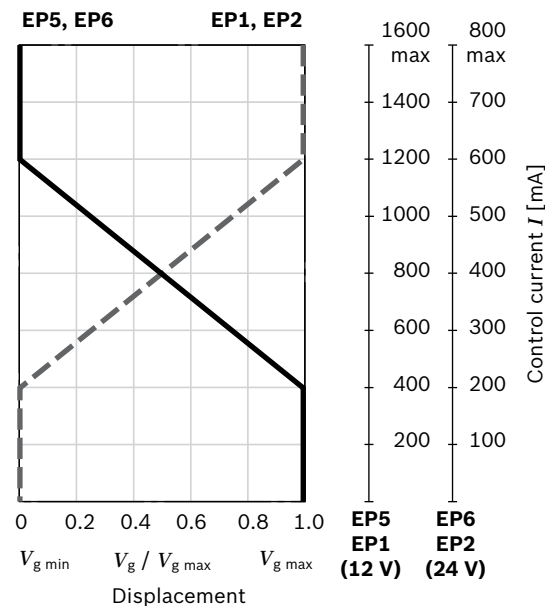
### EP1, EP2 positive control

- ▶ Beginning of control at  $V_{g \min}$  (minimum torque, maximum permissible speed at minimum control current)
- ▶ End of control at  $V_{g \max}$  (maximum torque, minimum speed at maximum control current)

### EP5, EP6 negative control

- ▶ Beginning of control at  $V_{g \max}$  (maximum torque, minimum speed at minimum control current)
- ▶ End of control at  $V_{g \min}$  (minimum torque, maximum permissible speed at maximum control current)

### ▼ Characteristic curve



### Notice

The control oil is internally taken from the high pressure side of the motor (**A** or **B**). For reliable control, an operating pressure of at least 30 bar is required in **A** (**B**). If a control operation is performed at an operating pressure < 30 bar, an auxiliary pressure of at least 30 bar must be applied at port **G** via an external check valve. For lower pressures, please contact us.

Please note that pressures up to 450 bar can occur at port **G**.

### Response time damping

The response time damping impacts the swivel behavior of the motor and consequently the machine response speed.

### Standard for sizes 55 to 200

EP without damping.

EP.D with throttle pin on both sides, symmetrical (see table)

### Optional for sizes 55 to 200

EP with throttle pin on both sides, symmetrical (see table)

### ▼ Throttle pin overview

Size	55	80	107	160	200
Groove size [mm]	0.45	0.45	0.55	0.55	0.65

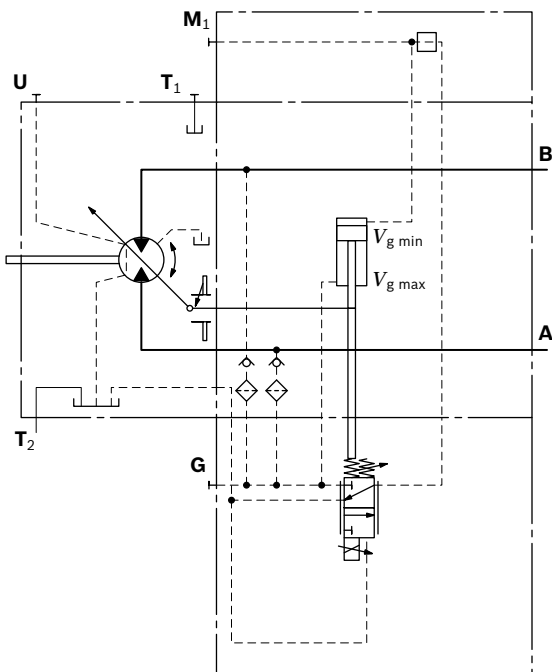
Technical data, solenoid	EP1, EP5	EP2, EP6
Voltage	12 V ( $\pm 20\%$ )	24 V ( $\pm 20\%$ )
Control current		
Beginning of control	400 mA	200 mA
End of control	1200 mA	600 mA
Current limit	1.54 A	0.77 A
Nominal resistance (at 20 °C)	5.5 $\Omega$	22.7 $\Omega$
Dither		
Frequency	100 Hz	100 Hz
Minimum oscillation range <sup>1)</sup>	240 mA	120 mA
Duty cycle	100%	100%
Type of protection: see connector version on page 62		

Various BODAS controllers with application software and amplifiers are available for controlling the proportional solenoids.

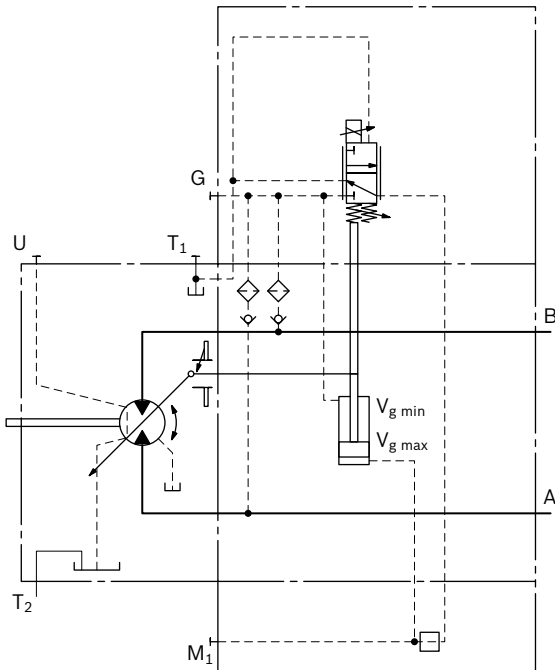
Further information can also be found on the internet at [www.boschrexroth.com/mobile-electronics](http://www.boschrexroth.com/mobile-electronics).

<sup>1)</sup> Minimum required oscillation range of the control current  $\Delta I_{p,p}$  (peak to peak) within the respective control range (start of control to end of control)

▼ **Circuit diagram EP1, EP2 (positive control)**



▼ **Circuit diagram EP5, EP6 (negativ control)**



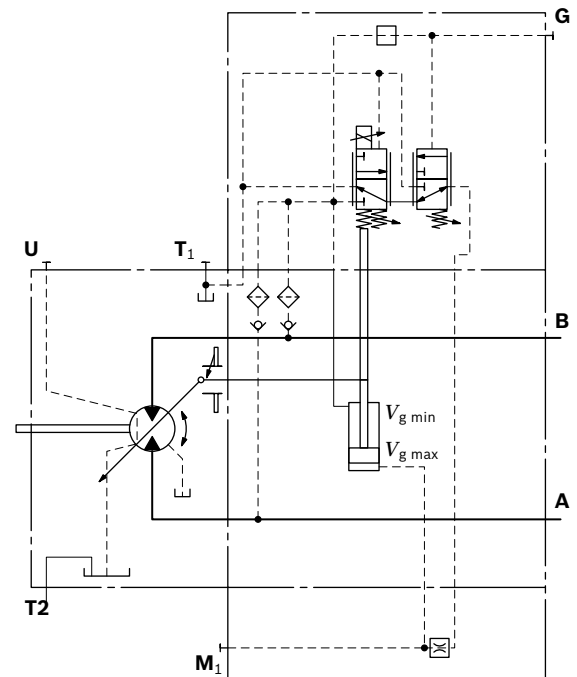
▼ **EP5D1, EP6D1 Pressure control, fixed setting**

The pressure control overrides the EP control function. If the load torque or a reduction in motor swivel angle causes the system pressure to reach the setpoint value of the pressure control, the motor will swivel towards a larger displacement.

The increase in the displacement and the resulting reduction in pressure cause the control deviation to decrease. With the increase in displacement the motor develops more torque, while the pressure remains constant.

Setting range of the pressure control valve 80 to 400 bar

▼ **Circuit diagram EP5D1, EP6D1 (negativ control)**



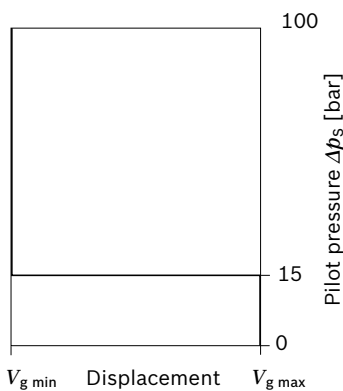
## HZ – Two-point hydraulic control

The two-point hydraulic control allows the displacement to be set to either  $V_{g\ min}$  or  $V_{g\ max}$  by switching the pilot pressure at port **X** on or off.

### HZ5, HZ7 negative control

- ▶ Position at  $V_{g\ max}$  (without pilot pressure, maximum torque, minimum speed)
- ▶ Position at  $V_{g\ min}$  (with pilot pressure > 15 bar activated, minimum torque, maximum permissible speed)

#### ▼ Characteristic curve HZ5, HZ7



#### Notice

- ▶ Maximum permissible pilot pressure: 100 bar
- ▶ The control oil is internally taken out of the high pressure side of the motor (**A** or **B**). For reliable control, an operating pressure of at least 30 bar is required in **A** (**B**). If a control operation is performed at an operating pressure < 30 bar, an auxiliary pressure of at least 30 bar must be applied at port **G** via an external check valve. For lower pressures, please contact us. Please note that pressures up to 450 bar can occur at port **G**.
- ▶ At port **X** a leakage flow of maximum 0.3 l/min occurs (working pressure > pilot pressure). To avoid a build-up of pilot pressure, pressure is to be relieved from port **X** to the reservoir.

### Response time damping

The response time damping impacts the swivel behavior of the motor and consequently the machine response speed.

#### Standard for sizes 140 to 200

HZ5 with throttle pin on both sides, symmetrical (see table)

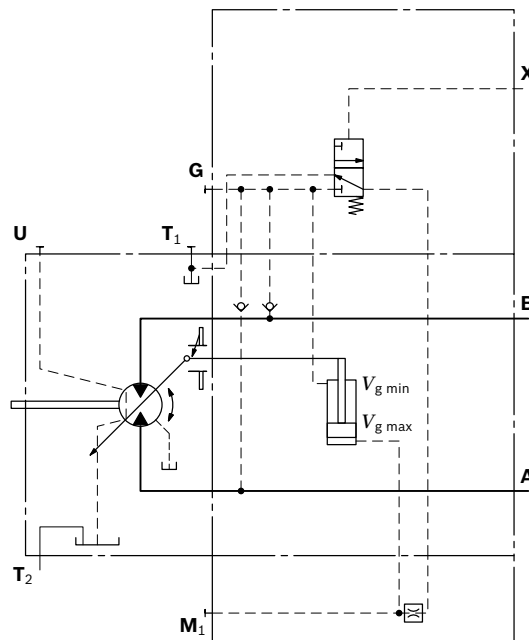
#### Standard for sizes 55 to 107

HZ7 (synchronous piston) with throttle pin on both sides, symmetrical (see table)

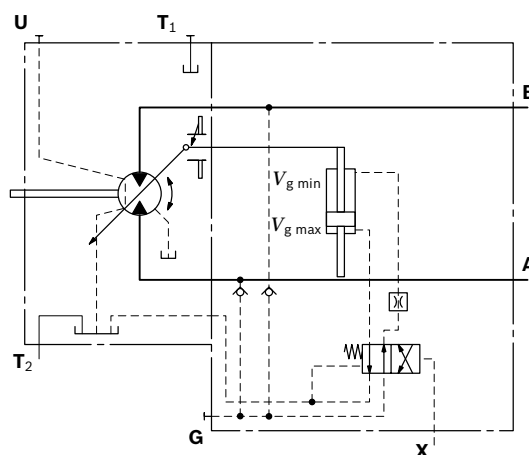
#### ▼ Throttle pin overview

Size	55	80	107	140	160	200
Groove size [mm]	0.30	0.30	0.30	0.55	0.55	0.65

#### ▼ Circuit diagram HZ5 (negative control) sizes 140 and 200



#### ▼ Circuit diagram HZ7 (negative Kennung) Nenngröße 55 bis 107



## EZ – Two-point electric control

The two-point electric control allows the displacement to be set to either  $V_{g \min}$  or  $V_{g \max}$  by switching the electric current to a switching solenoid on or off.

### Notice

The control oil is internally taken out of the high pressure side of the motor (**A** or **B**). For reliable control, an operating pressure of at least 30 bar is required in **A** (**B**). If a control operation is performed at an operating pressure < 30 bar, an auxiliary pressure of at least 30 bar must be applied at port **G** via an external check valve. For lower pressures, please contact us.

Please note that pressures up to 450 bar can occur at port **G**.

### Response time damping

The response time damping impacts the swivel behavior of the motor and consequently the machine response speed.

### Standard for sizes 140 to 200

EZ5, EZ6 with throttle pin on both sides, symmetrical (see table)

### Standard for sizes 55 to 107

EZ7, EZ8 (synchronous piston) with throttle pin on both sides, symmetrical (see table)

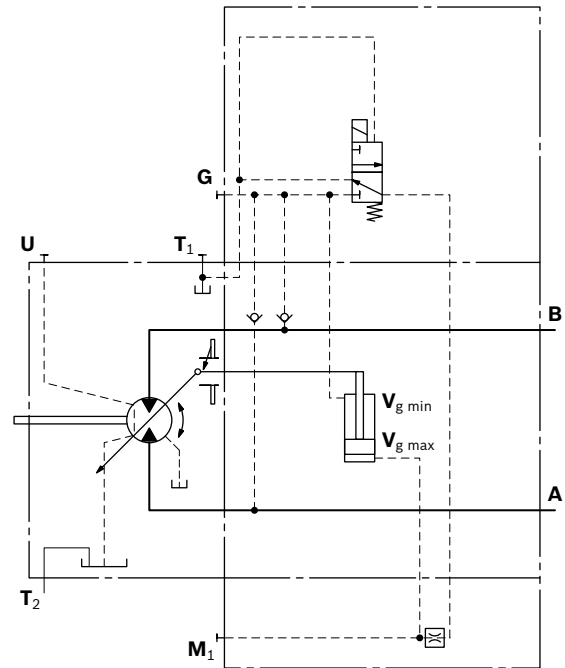
### ▼ Throttle pin overview

Size	55	80	107	140	160	200
Groove size [mm]	0.30	0.30	0.30	0.55	0.55	0.65

### Sizes 140 to 200

Technical data, solenoid with $\varnothing 37$	EZ5	EZ6
Voltage	12 V ( $\pm 20\%$ )	24 V ( $\pm 20\%$ )
Position $V_{g \max}$	de-energized	de-energized
Position $V_{g \min}$	energized	energized
Nominal resistance (at 20 °C)	5.5 $\Omega$	21.7 $\Omega$
Nominal power	26.2 W	26.5 W
Minimum required active current	1.32 A	0.67 A
Duty cycle	100%	100%
Type of protection: see connector version on page 62		

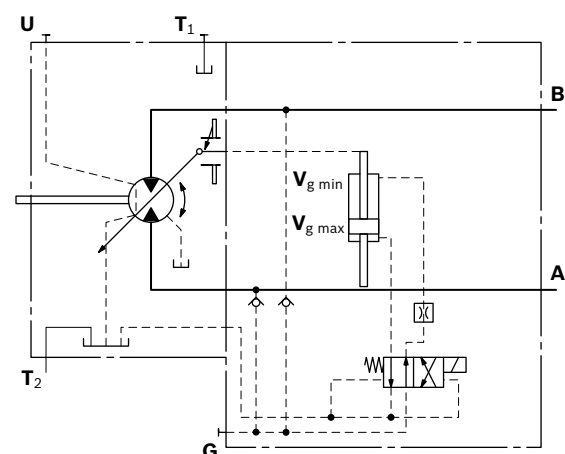
### ▼ Circuit diagram EZ5, EZ6 (negative control)



### Sizes 55 to 107

Technical data, solenoid with $\varnothing 45$	EZ7	EZ8
Voltage	12 V ( $\pm 20\%$ )	24 V ( $\pm 20\%$ )
Position $V_{g \max}$	de-energized	de-energized
Position $V_{g \min}$	energized	energized
Nominal resistance (at 20 °C)	4.8 $\Omega$	19.2 $\Omega$
Nominal power	30 W	30 W
Minimum required active current	1.5 A	0.75 A
Duty cycle	100%	100%
Type of protection: see connector version on page 62		

### ▼ Circuit diagram EZ7, EZ8 (negative control)



## HA – Automatic high-pressure related control

The automatic high-pressure related control adjusts the displacement automatically depending on the operating pressure.

The displacement of the A6VM motor with HA control is  $V_{g \min}$  (maximum speed and minimum torque). The control device measures internally the operating pressure at **A** or **B** (no control line required) and upon reaching the set beginning of control, the controller swivels the motor from  $V_{g \min}$  to  $V_{g \max}$  with increase of operating pressure. The displacement is modulated between  $V_{g \min}$  and  $V_{g \max}$ , thereby depending on load conditions.

### HA1, HA2 positive control

- ▶ Beginning of control at  $V_{g \min}$  (minimum torque, maximum speed)
- ▶ End of control at  $V_{g \max}$  (maximum torque, minimum speed)

### Notice

- ▶ For safety reasons, winch drives are not permissible with beginning of control at  $V_{g \min}$  (standard for HA).
- ▶ The control oil is internally taken from the high pressure side of the motor (**A** or **B**). For reliable control, an operating pressure of at least 30 bar is required in **A** (**B**). If a control operation is performed at an operating pressure < 30 bar, an auxiliary pressure of at least 30 bar must be applied at port **G** via an external check valve. For lower pressures, please contact us.  
Please note that pressures up to 450 bar can occur at port **G**.
- ▶ The beginning of control and the HA.T3 characteristic curve are influenced by case pressure. An increase in case pressure causes an increase in the beginning of control (see page 7) and thus a parallel shift of the characteristic.
- ▶ At port **X** a leakage flow of maximum 0.3 l/min occurs (working pressure > pilot pressure). To avoid a build-up of pilot pressure, pressure is to be relieved from port **X** to the reservoir. **Only with HA.T control**

### Response time damping

The response time damping impacts the swivel behavior of the motor and consequently the machine response speed.

#### Standard for sizes 55 to 200

HA1,2 with one-sided throttle pin, throttling occurs from  $V_{g \min}$  to  $V_{g \max}$ . (see table)  
 HA3 and HA3T3 with BVI and throttle pin on both sides, 0.30, symmetrical

#### ▼ Throttle pin overview

Size	55	80	107	140	160	200
Groove size [mm]	0.45	0.45	0.55	0.55	0.55	0.65

#### Standard for sizes 55 to 200

HA with BVD or BVE counterbalance valve, with throttle screw (see table)

#### ▼ Throttle screw

Size	55	80	107	140	160	200
Diameter [mm]	0.80	0.80	0.80	0.80	0.80	0.80

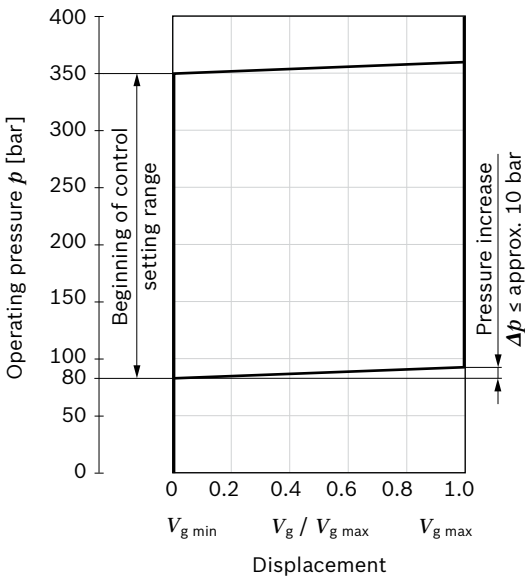
**HA1 with minimum pressure increase, positive control**

An operating pressure increase of  $\Delta p \leq$  approx. 10 bar results in an increase in displacement from  $V_{g \min}$  towards  $V_{g \max}$ .

Beginning of control, setting range 80 to 350 bar

Please state the desired beginning of control in plain text when ordering, e.g.: beginning of control at 300 bar.

▼ **Characteristic curve HA1**



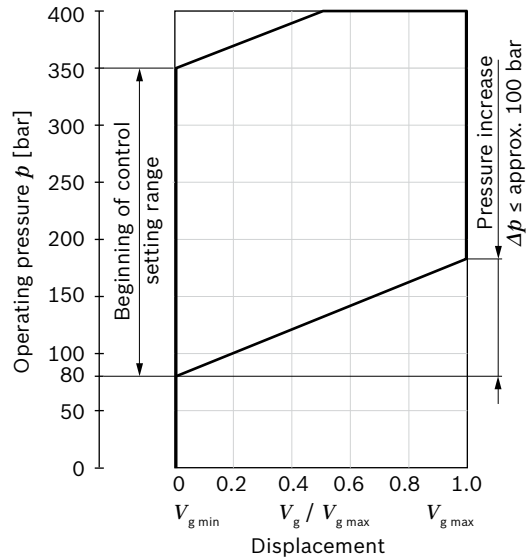
**HA2 with pressure increase, positive control**

An operating pressure increase of  $\Delta p$  approx. 100 bar results in an increase in displacement from  $V_{g \min}$  to  $V_{g \max}$ .

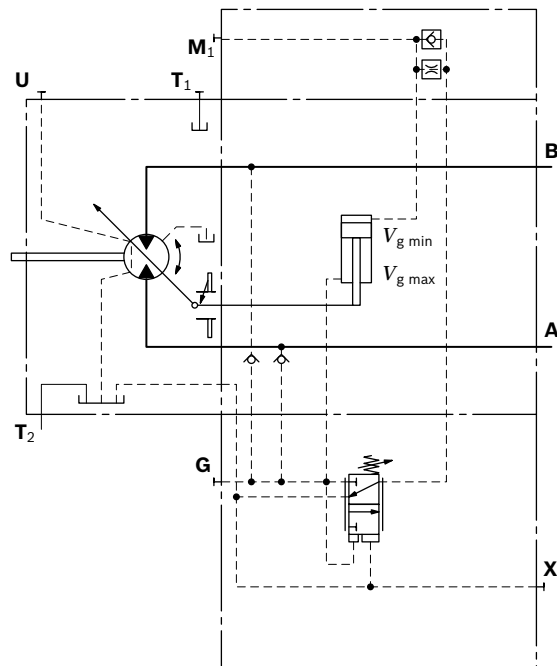
Beginning of control, setting range 80 to 350 bar

Please state the desired beginning of control in plain text when ordering, e.g.: beginning of control at 200 bar.

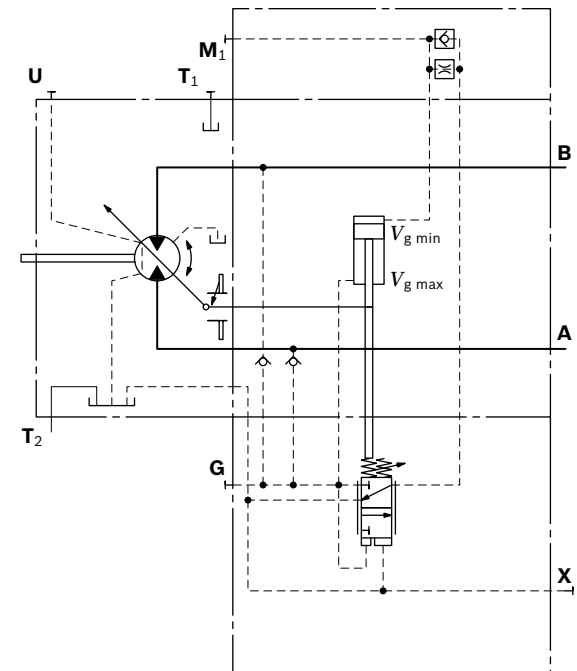
▼ **Characteristic curve HA2**



▼ **Circuit diagram HA1**



▼ **Circuit diagram HA2**



**HA.T3 override, hydraulic, remote controlled, proportional**

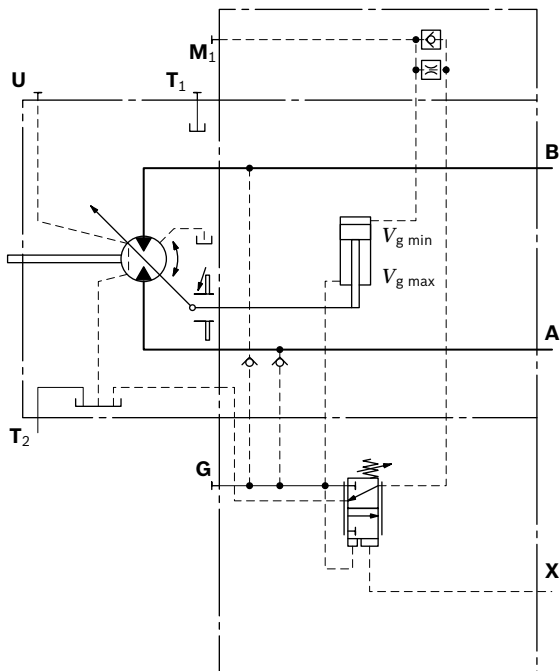
With the HA.T3 control, the beginning of control can be influenced by applying a pilot pressure to port **X**.  
 For every 1 bar of pilot pressure increase, the beginning of control is reduced by 17 bar.

Beginning of control setting	300 bar	300 bar
Pilot pressure at port <b>X</b>	0 bar	10 bar
Beginning of control at	300 bar	130 bar

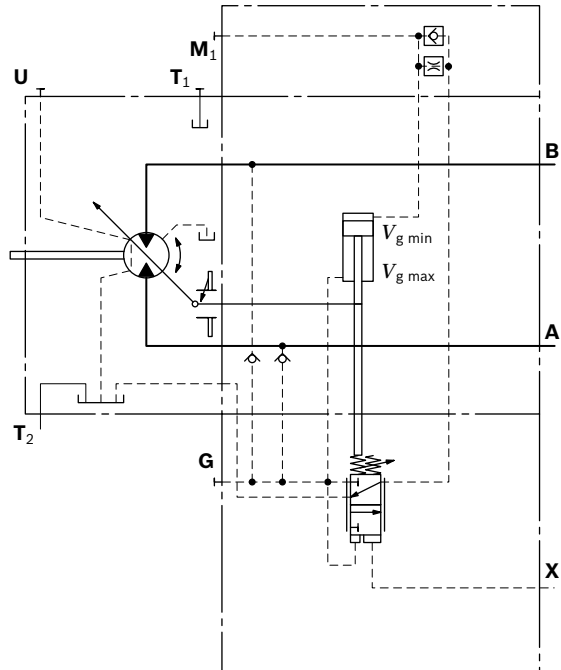
**Notice**

Maximum permissible pilot pressure 100 bar.

▼ **Circuit diagram HA1T3**



▼ **Circuit diagram HA2T3**



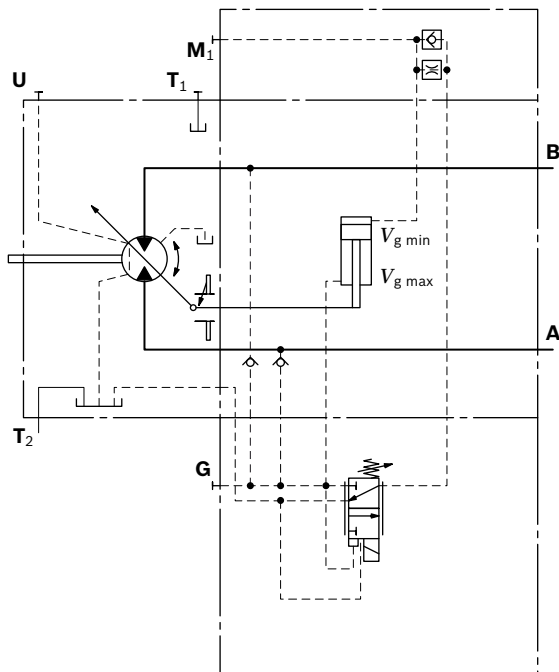
**HA.U1, HA.U2 electric override, two-point**

With the HA.U1 or HA.U2 control, the beginning of control can be overridden by an electric signal to a switching solenoid. When the override solenoid is energized, the variable motor swivels to maximum swivel angle, without intermediate position.

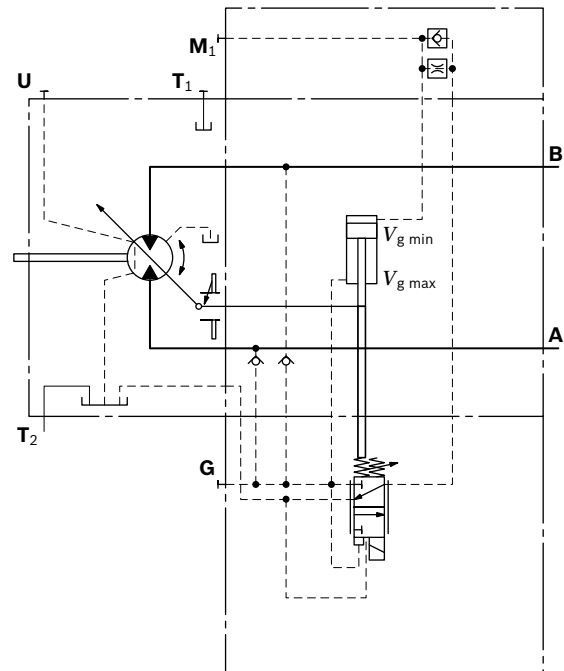
The beginning of control can be set between 80 and 300 bar (specify required setting in plain text when ordering).

Technical data, solenoid with $\varnothing 45$	U1	U2
Voltage	12 V ( $\pm 20\%$ )	24 V ( $\pm 20\%$ )
No override	de-energized	de-energized
Position $V_{g \max}$	energized	energized
Nominal resistance (at 20 °C)	4.8 $\Omega$	19.2 $\Omega$
Nominal power	30 W	30 W
Minimum required active current	1.5 A	0.75 A
Duty cycle	100%	100%
Type of protection: see connector version on page 62		

▼ **Circuit diagram HA1U1, HA1U2**



▼ **Circuit diagram HA2U1, HA2U2**



**HA.R1, HA.R2 electric override, electric travel direction valve**

With the HA.R1 or HA.R2 control, the beginning of control can be overridden by an electric signal to switching solenoid **b**. When the override solenoid is energized, the variable motor swivels to maximum swivel angle, without intermediate position.

The travel direction valve ensures that the preselected pressure side of the hydraulic motor (**A** or **B**) is always connected to the HA control, and thus determines the swivel angle, even if the high-pressure side changes (e.g. -travel drive during a downhill operation). This thereby prevents undesired jerky deceleration and/or braking characteristics.

The travel direction valve (see page 25) is either pressure spring or switched by energizing switching solenoid **a**, depending on the direction of rotation (travel direction).

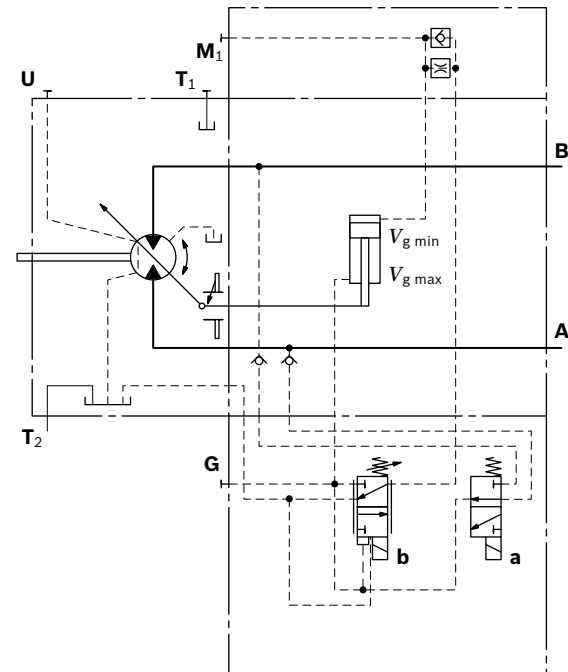
**Electric override**

Technical data, solenoid <b>b</b> with ø45	R1	R2
Voltage	12 V (±20%)	24 V (±20%)
No override	de-energized	de-energized
Position $V_{g \max}$	energized	energized
Nominal resistance (at 20 °C)	4.8 Ω	19.2 Ω
Nominal power	30 W	30 W
Minimum required active current	1.5 A	0.75 A
Duty cycle	100%	100%
Type of protection: see connector version on page 62		

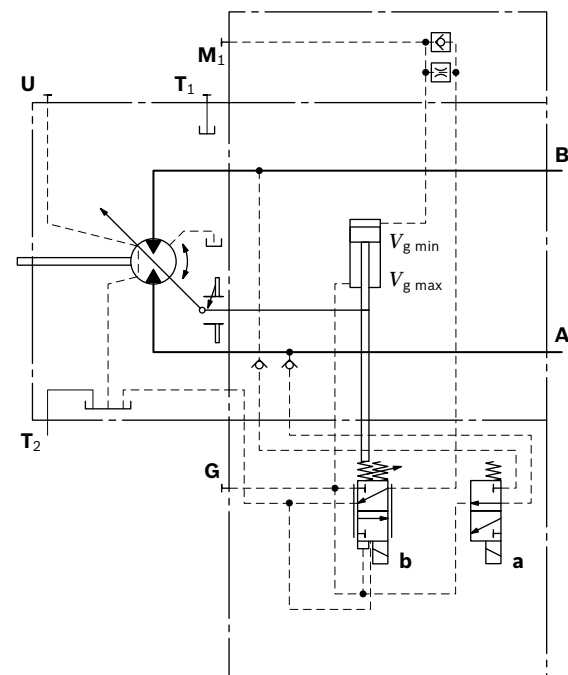
**Travel direction valve, electric**

Technical data, solenoid <b>a</b> with ø37		R1	R2
Voltage		12 V (±20%)	24 V (±20%)
Direction of rotation	Operating pressure in		
	ccw	<b>B</b>	energized
cw	<b>A</b>	de-energized	de-energized
Nominal resistance (at 20 °C)		5.5 Ω	21.7 Ω
Nominal power		26.2 W	26.5 W
Minimum required active current		1.32 A	0.67 A
Duty cycle		100%	100%
Type of protection: see connector version on page 62			

▼ **Circuit diagram HA1R1, HA1R2**



▼ **Circuit diagram HA2R1, HA2R2**



## DA – Automatic speed-related control

The variable motor A6VM with automatic speed-related control, type DA, is intended for use in hydrostatic travel drives in combination with the variable pump A4VG with DA control.

A drive-speed-related pilot pressure signal is generated by the A4VG variable pump, and that signal, together with the operating pressure, regulates the swivel angle of the hydraulic motor.

Increasing pump speed, i.e. increasing pilot pressure, causes the motor to swivel to a smaller displacement (lower torque, higher speed), depending on the operating pressure.

If the operating pressure exceeds the pressure setpoint set on the controller, the variable motor swivels to a larger displacement (higher torque, lower speed).

- ▶ Pressure ratio  $p_{St}/p_{HD} = 5/100$

DA closed loop control is only suitable for certain types of drive systems and requires review of the engine and vehicle parameters to ensure that the motor is used correctly and that machine operation is safe and efficient. We recommend that all DA applications be reviewed by a Bosch Rexroth application engineer.

Detailed information is available from our sales organization.

### Notice

The beginning of control and the DA characteristic curve are influenced by case pressure. An increase in case pressure causes a decrease in the beginning of control (see page 7) and thus a parallel shift of the characteristic.

### Response time damping

The response time damping impacts the swivel behavior of the motor and consequently the machine response speed.

### Standard for sizes 55 to 200

DA with throttle pin on one side, throttling occurs from  $V_{g \min}$  to  $V_{g \max}$  (see table).

#### ▼ Throttle pin overview

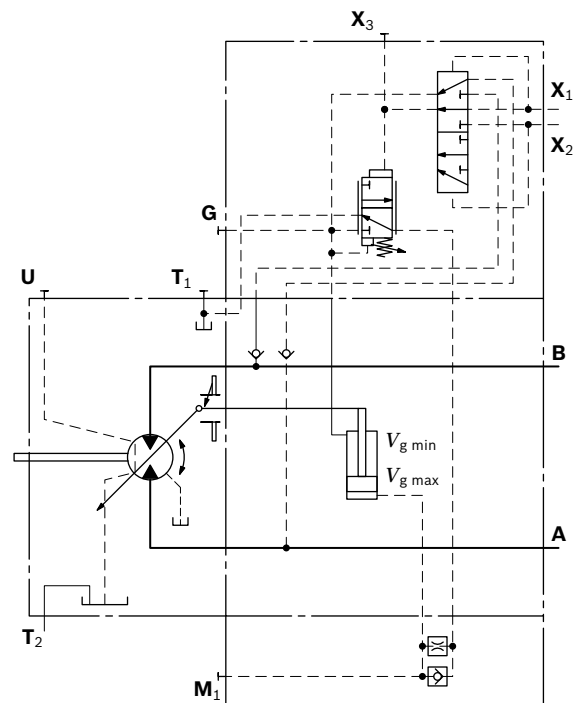
Size	55	80	107	140	160	200
Groove size [mm]	0.45	0.45	0.55	0.55	0.55	0.65

### DA0 hydraulic travel direction valve, negative control

Depending on the direction of rotation (travel direction), the travel direction valve is switched by using pilot pressures connections  $X_1$  or  $X_2$ .

Direction of rotation	Operating pressure in	Pilot pressure in
cw	<b>A</b>	<b>X<sub>1</sub></b>
ccw	<b>B</b>	<b>X<sub>2</sub></b>

#### ▼ Circuit diagram DA0



**DA1, DA2 electric travel direction valve + electric  $V_{g \max}$  circuit, negative control**

Depending on the direction of rotation (direction of travel), the travel direction valve is actuated through the compression spring or the switching solenoid **a**.

When switching solenoid **b** is energized, the control can be overridden and the motor can be swiveled to maximum displacement (high torque, lower rotational speed) (electric  $V_{g \max}$ -circuit).

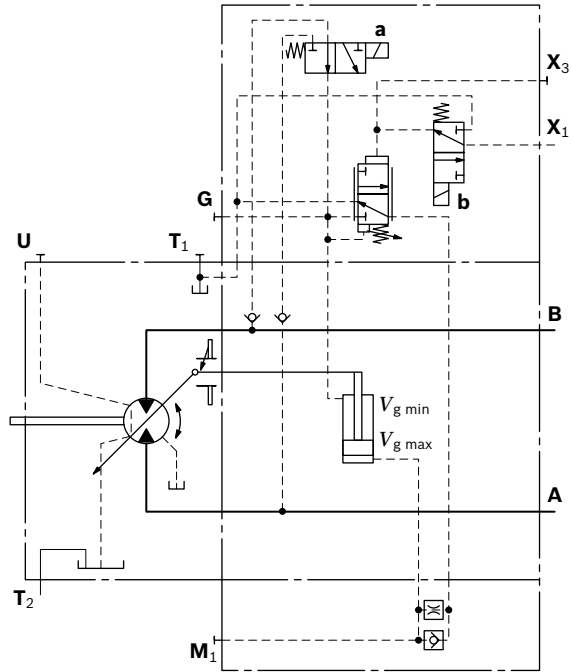
**Travel direction valve, electric**

Technical data, solenoid a with $\varnothing 37$		DA1	DA2
Voltage		12 V ( $\pm 20\%$ )	24 V ( $\pm 20\%$ )
Direction of rotation	Operating pressure in		
ccw	<b>B</b>	de-energized	de-energized
cw	<b>A</b>	energized	energized
Nominal resistance (at 20 °C)		5.5 $\Omega$	21.7 $\Omega$
Nominal power		26.2 W	26.5 W
Minimum required active current		1.32 A	0.67 A
Duty cycle		100%	100%
Type of protection: see connector version on page 62			

**Electric override**

Technical data, solenoid b with $\varnothing 37$		DA1	DA2
Voltage		12 V ( $\pm 20\%$ )	24 V ( $\pm 20\%$ )
No override		de-energized	de-energized
Position $V_{g \max}$		energized	energized
Nominal resistance (at 20 °C)		5.5 $\Omega$	21.7 $\Omega$
Nominal power		26.2 W	26.5 W
Minimum required active current		1.32 A	0.67 A
Duty cycle		100%	100%
Type of protection: see connector version on page 62			

▼ **Circuit diagram DA1, DA2**



## Electric travel direction valve (for DA, HA.R)

Application in travel drives in closed circuits. The travel direction valve of the motor is actuated by an electric signal that also switches the swivel direction of the travel drive pump (e.g. A4VG with DA control valve).

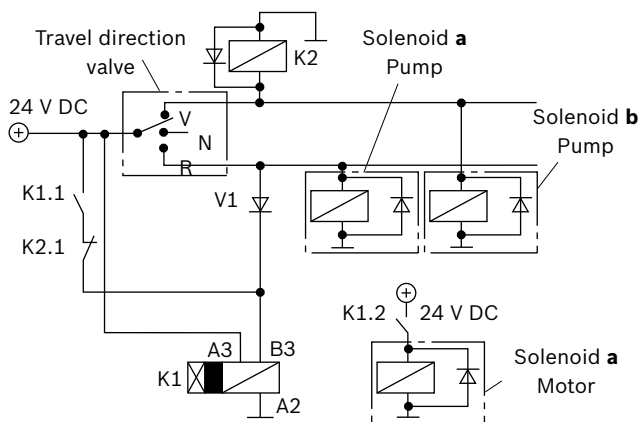
If the pump in the closed circuit is switched to the neutral position or into reverse, the vehicle may experience jerky deceleration or braking, depending on the vehicle weight and current travel speed.

When the travel direction valve, which must be logically coordinated with the pump control, of the pump (e.g. 4/3-way directional valve of the DA-control) is switched to neutral position,

- ▶ the neutral position, the electrical circuitry causes the previous signal on the travel direction valve on the motor to be retained.
- ▶ Reversing, the electrical circuitry causes the travel direction valve of the motor to switch to the other travel direction following a time delay (approx. 0.8 s) with respect to the pump.

As a result, jerky deceleration or braking is prevented in both cases. Circuit diagram, electric travel direction valve

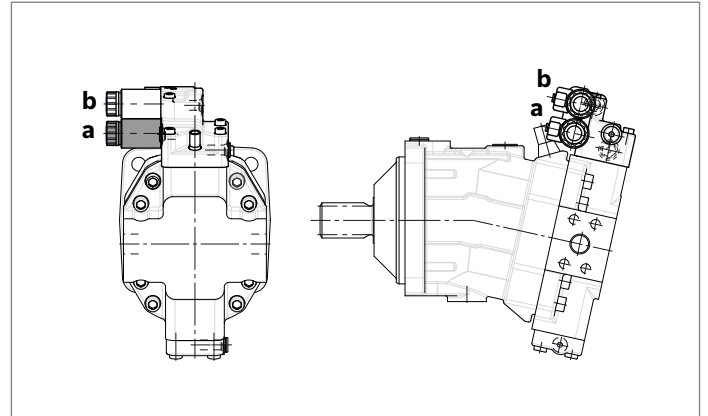
### ▼ Circuit diagram, electric travel direction valve



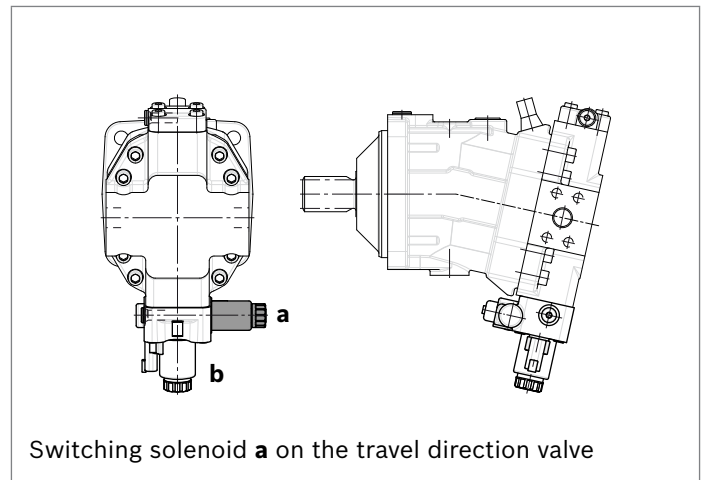
### Notice

The shown diodes and relays are not included in the scope of delivery of the motor.

### ▼ Control DA1, DA



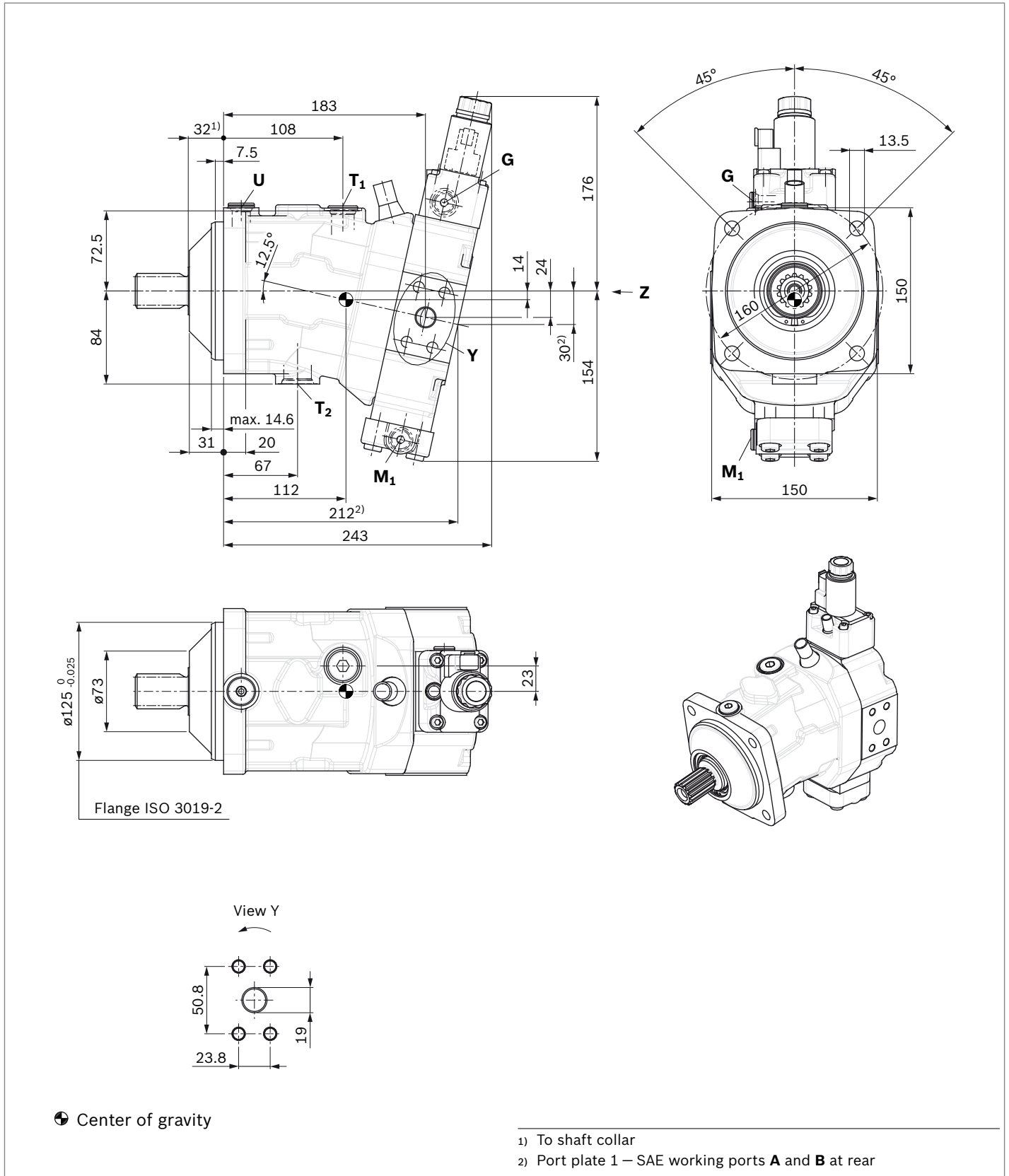
### ▼ Control HA1R., HA2R.



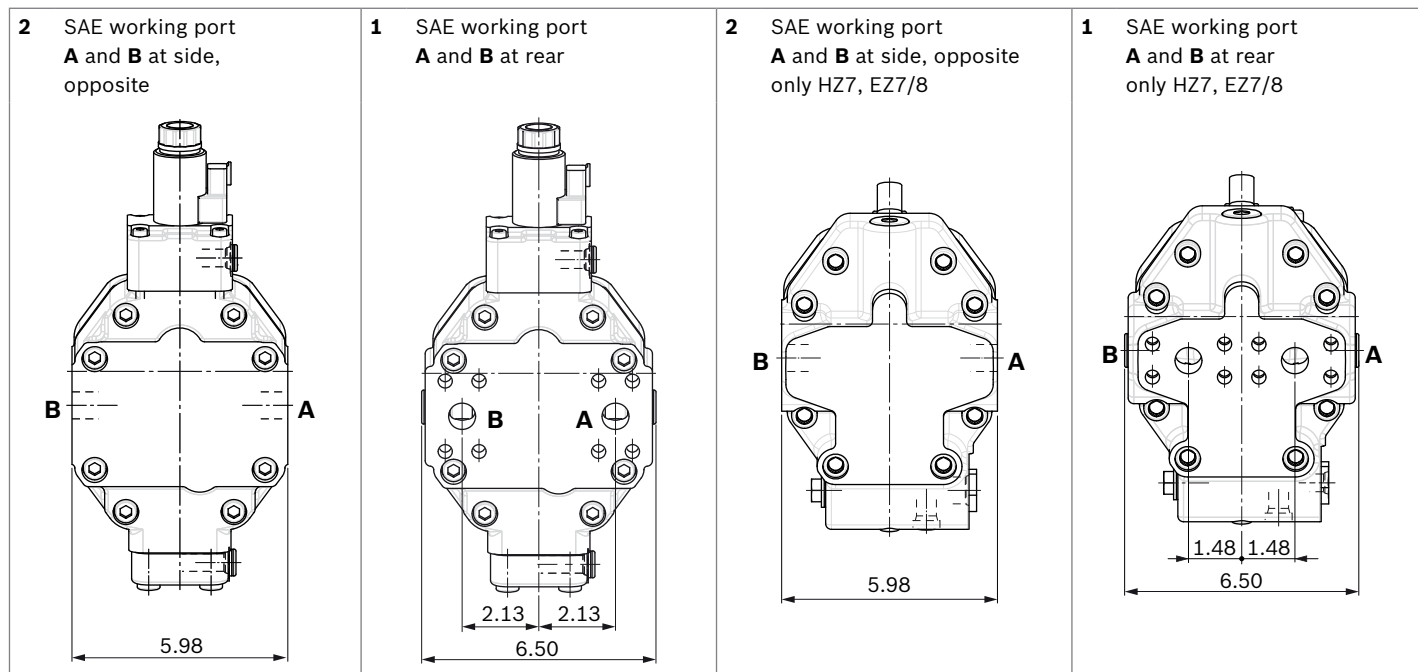
**Dimensions size 55**

**EP5, EP6 – Proportional electric control, negative control**

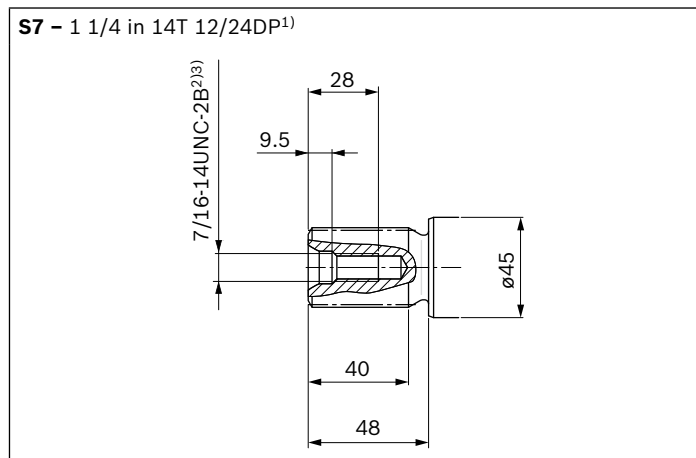
Port plate 2 – SAE working ports **A** and **B** at side, opposite



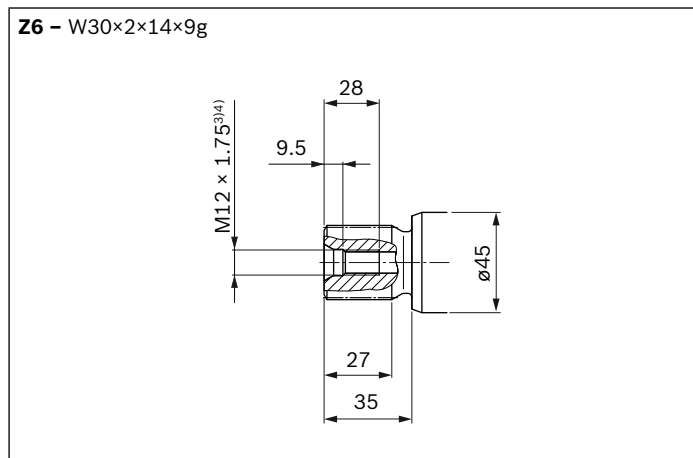
▼ Location of the service line ports on the port plates (view Z)



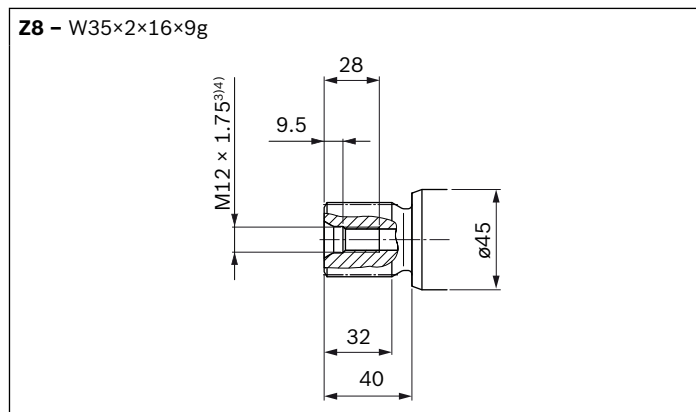
▼ Splined shaft SAE J744



▼ Splined shaft DIN 5480



▼ Splined shaft DIN 5480



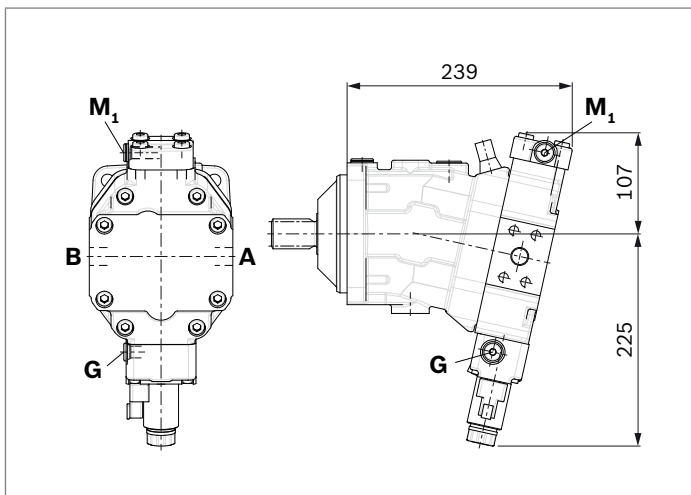
1) Involute spline acc. to ANSI B92.1a, 30° pressure angle, flat root, side fit, tolerance class 5  
 2) Thread according to ASME B1.1  
 3) For notes on tightening torques, see instruction manual  
 4) Center bore according to DIN 332 (thread according to DIN 13)

Ports		Standard	Size <sup>1)</sup>	$p_{max}$ [bar] <sup>2)</sup>	Status <sup>6)</sup>
<b>A, B</b>	Working port Fastening thread A/B	SAE J518 <sup>3)</sup> DIN 13	3/4 in M10 × 1.5; 17 deep	450	O
<b>T<sub>1</sub></b>	Drain port	ISO 6149 <sup>5)</sup>	M22 × 1.5; 15.5 deep	3	X <sup>4)</sup>
<b>T<sub>2</sub></b>	Drain port	ISO 6149 <sup>5)</sup>	M27 × 2; 19 deep	3	O <sup>4)</sup>
<b>G</b>	Synchronous control	ISO 6149 <sup>5)</sup>	M14 × 1.5; 11.5 deep	450	X
<b>U</b>	Bearing flushing	ISO 6149 <sup>5)</sup>	M18 × 1.5; 14.5 deep	3	X
<b>X</b>	Pilot signal (HP, HZ, HA1T/HA2T)	ISO 6149 <sup>5)</sup>	M14 × 1.5; 11.5 deep	100	O
<b>X</b>	Pilot signal (HA1, HA2)	ISO 6149 <sup>5)</sup>	M14 × 1.5; 11.5 deep	3	X
<b>X<sub>1</sub>, X<sub>2</sub></b>	Pilot signal (DA0)	ISO 8434-1	SDSC-L8×M12-F	40	O
<b>X<sub>1</sub></b>	Pilot signal (DA1, DA2)	ISO 6149 <sup>5)</sup>	M14 × 1.5; 11.5 deep	40	O
<b>X<sub>3</sub></b>	Pilot signal (DA1, DA2)	ISO 6149 <sup>5)</sup>	M14 × 1.5; 11.5 deep	40	X
<b>M<sub>1</sub></b>	Stroking chamber measurement	ISO 6149 <sup>5)</sup>	M14 × 1.5; 11.5 deep	450	X

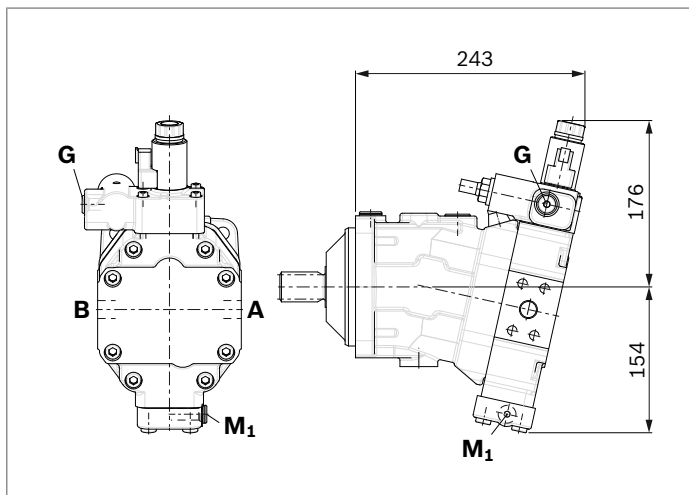
1) For notes on tightening torques, see instruction manual  
 2) Depending on the application, momentary pressure peaks can occur. Keep this in mind when selecting measuring devices and fittings.  
 3) Only dimensions according to SAE J518, metric fastening thread is a deviation from standard.

4) Depending on installation position, **T<sub>1</sub>** or **T<sub>2</sub>** must be connected (see also installation instructions on page 72).  
 5) The countersink can be deeper than as specified in the standard.  
 6) O = Must be connected (plugged on delivery)  
 X = Plugged (in normal operation)

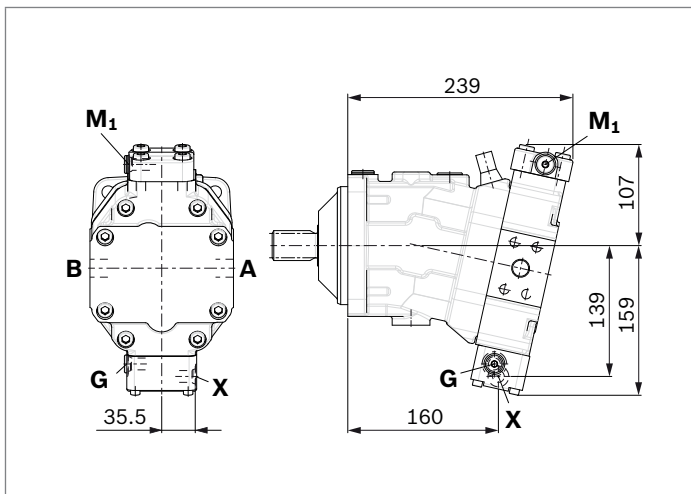
▼ **EP1, EP2** – Electric proportional control, positive control



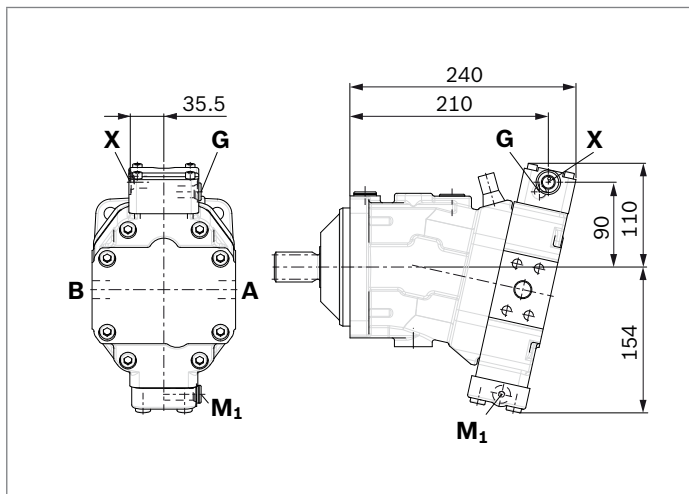
▼ **EP5D1, EP6D1** – Electric proportional control, negative control, with pressure control, fixed



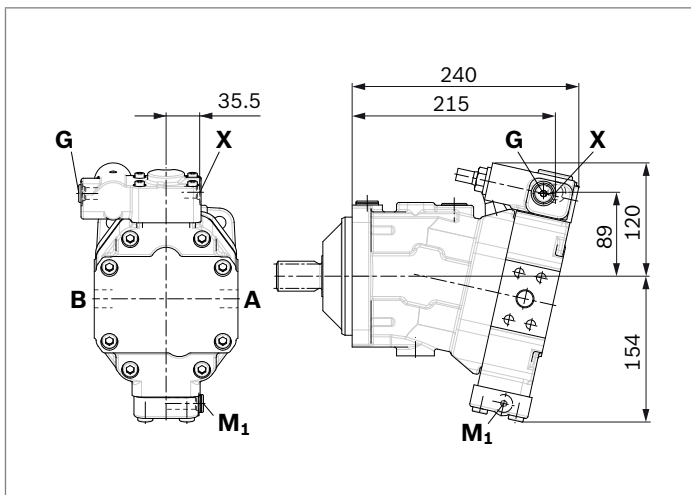
▼ **HP1, HP2** – Hydraulic proportional control, positive control



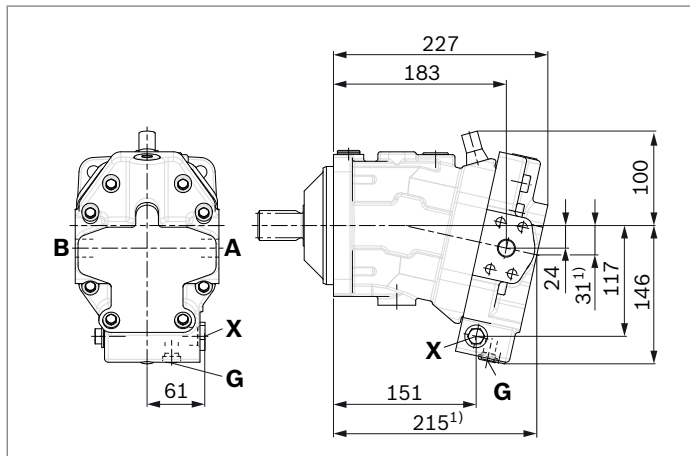
▼ **HP5, HP6** – Hydraulic proportional control, negative control



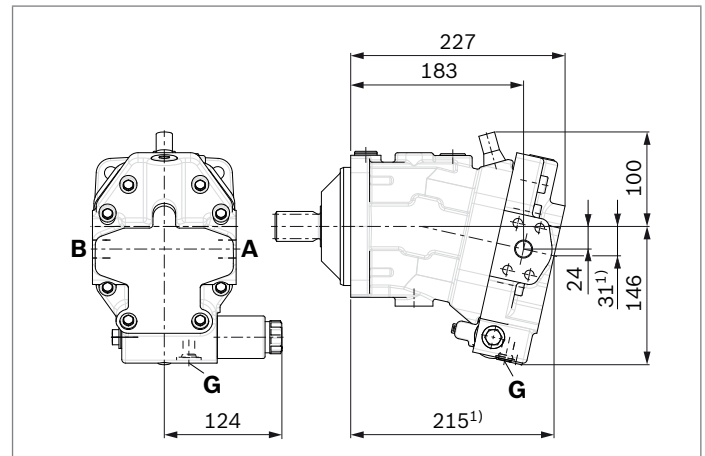
▼ **HP5D1, HP6D1** – Hydraulic proportional control, negative control, with pressure control, fixed



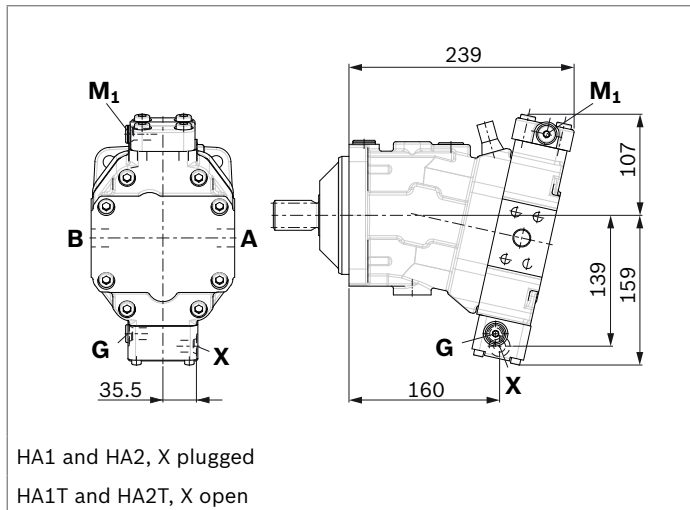
▼ **HZ7** – Hydraulic two-point control,  
negative control



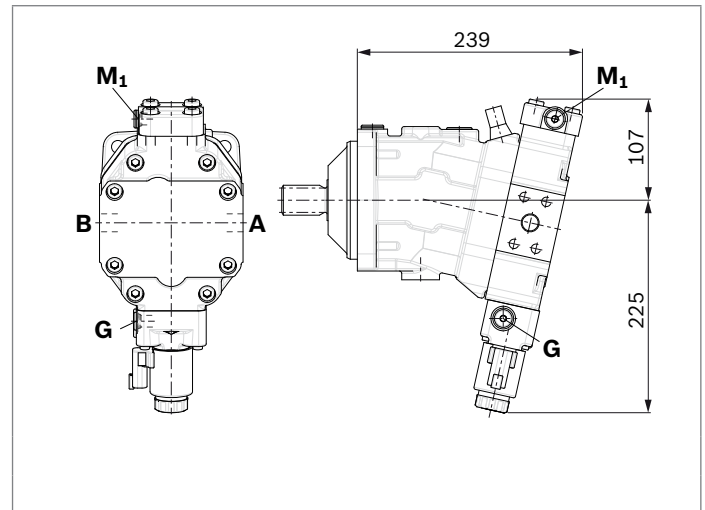
▼ **EZ7, EZ8** – Electric two-point control,  
negative control



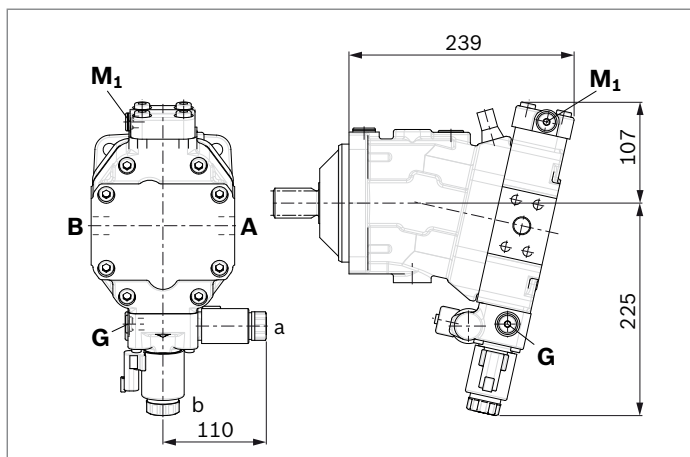
▼ **HA1, HA2 / HA1T3, HA2T3** – Automatic high-pressure-related  
control, positive control, with override hydraulic remote controlled,  
proportional



▼ **HA1U1, HA2U2** – Automatic high-pressure-related control,  
positive control, with override, electric, two-point



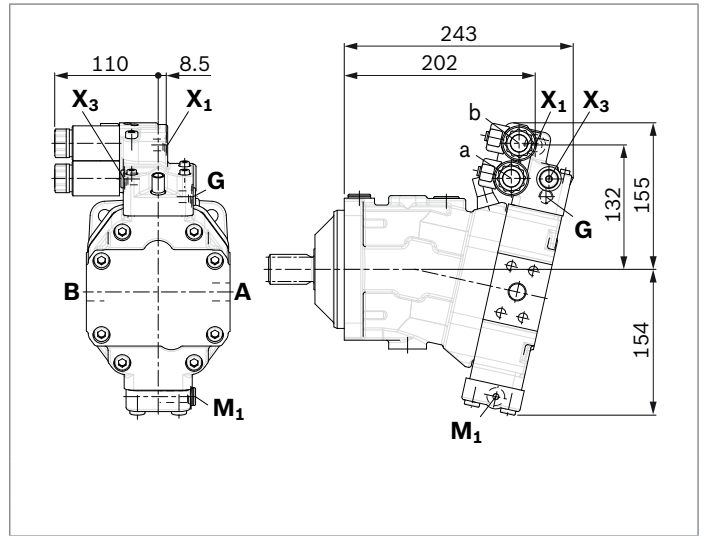
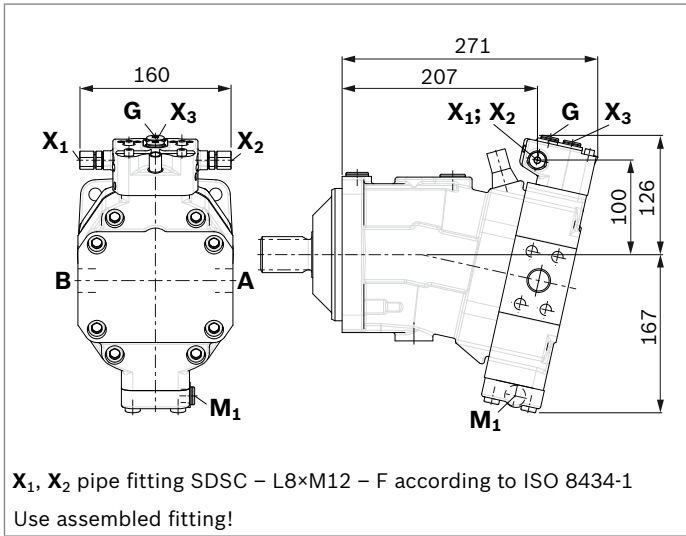
▼ **HA1R1, HA2R2** – Automatic high-pressure-related control,  
positive control, with override, electric and travel direction  
valve, electric



1) Port plate 1 – SAE working ports **A** and **B** at rear

▼ **DA0** – Automatic speed-related control, negative control, with hydraulic travel direction valve

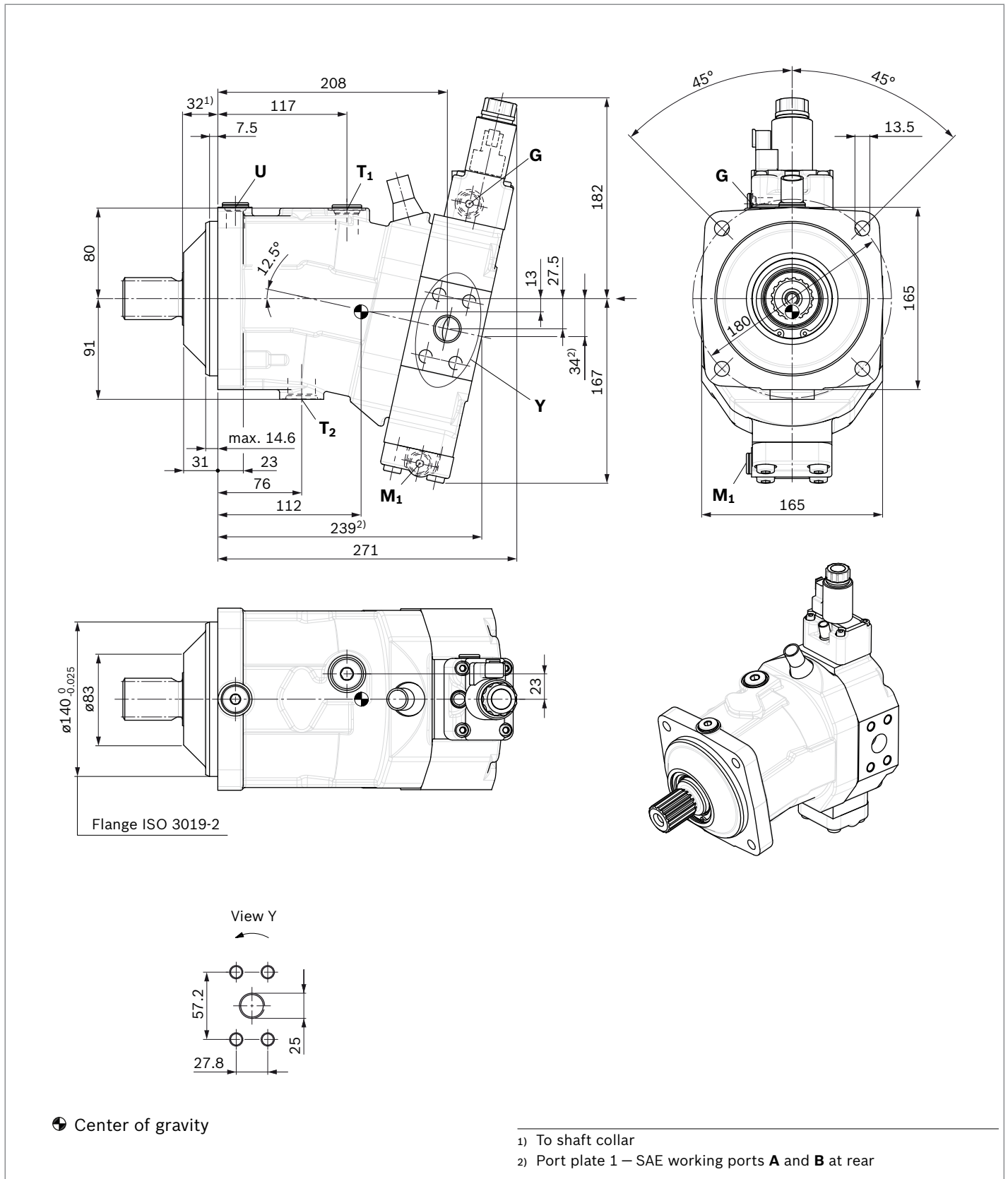
▼ **DA1, DA2** – Automatic speed-related control, negative control, with electric travel direction valve and electric  $V_{g\max}$  circuit



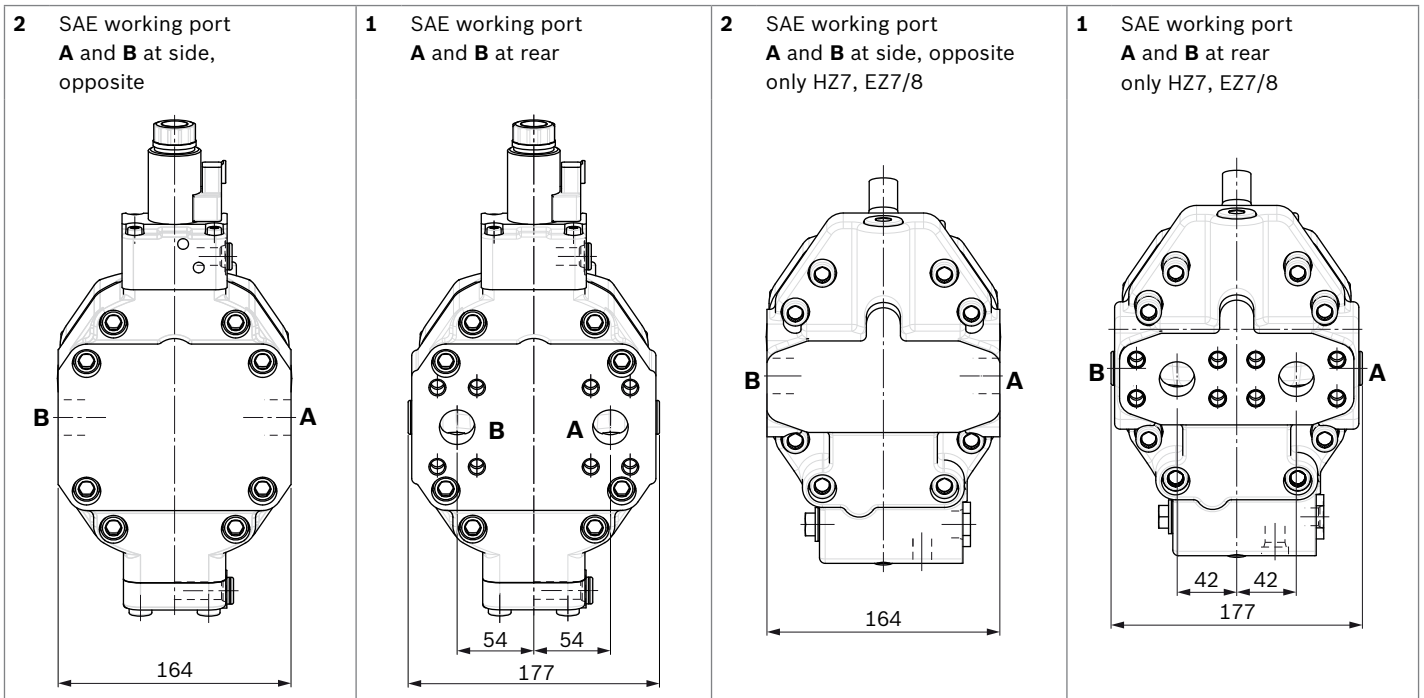
**Dimensions size 80**

**EP5, EP6 – Proportional electric control, negative control**

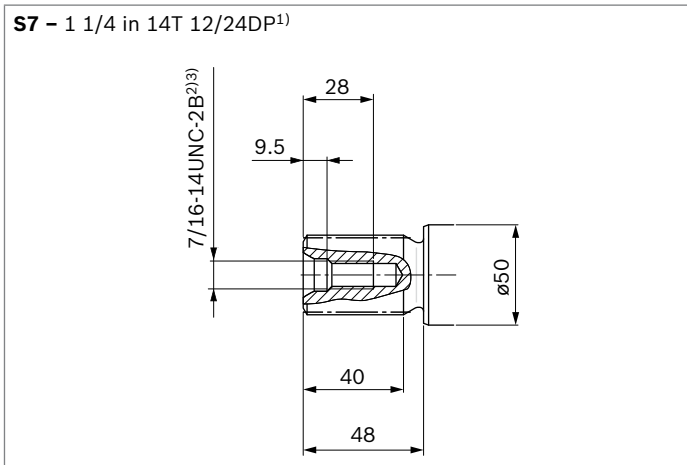
Port plate 2 – SAE working ports **A** and **B** at side, opposite



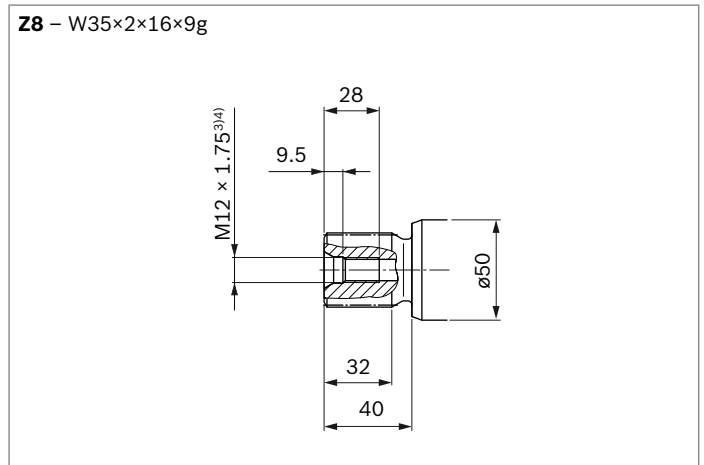
▼ Location of the service line ports on the port plates (view Z)



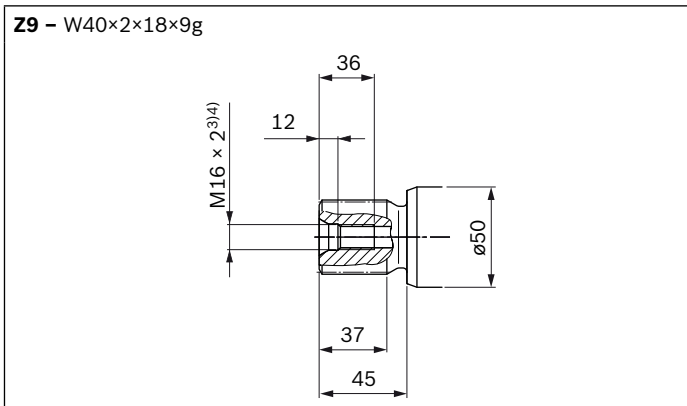
▼ Splined shaft SAE J744



▼ Splined shaft DIN 5480



▼ Splined shaft DIN 5480



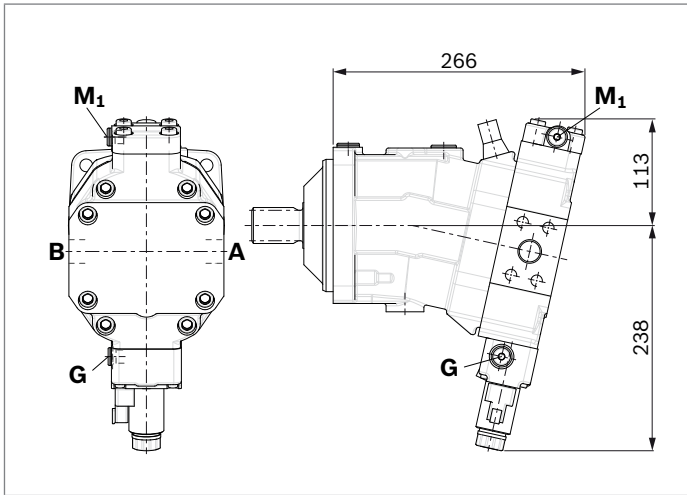
1) Involute spline acc. to ANSI B92.1a, 30° pressure angle, flat root, side fit, tolerance class 5  
2) Thread according to ASME B1.1  
3) For notes on tightening torques, see instruction manual  
4) Center bore according to DIN 332 (thread according to DIN 13)

Ports		Standard	Size <sup>1)</sup>	$p_{max}$ [bar] <sup>2)</sup>	Status <sup>6)</sup>
<b>A, B</b>	Working port	SAE J518 <sup>3)</sup>	1 in	450	O
	Fastening thread A/B	DIN 13	M12 × 1.75; 17 deep		
<b>T<sub>1</sub></b>	Drain port	ISO 6149 <sup>5)</sup>	M22 × 1.5; 15.5 deep	3	X <sup>4)</sup>
<b>T<sub>2</sub></b>	Drain port	ISO 6149 <sup>5)</sup>	M27 × 2; 19 deep	3	O <sup>4)</sup>
<b>G</b>	Synchronous control	ISO 6149 <sup>5)</sup>	M14 × 1.5; 11.5 deep	450	X
<b>U</b>	Bearing flushing	ISO 6149 <sup>5)</sup>	M18 × 1.5; 14.5 deep	3	X
<b>X</b>	Pilot signal (HP, HZ, HA1T/HA2T)	ISO 6149 <sup>5)</sup>	M14 × 1.5; 11.5 deep	100	O
<b>X</b>	Pilot signal (HA1, HA2)	ISO 6149 <sup>5)</sup>	M14 × 1.5; 11.5 deep	3	X
<b>X<sub>1</sub>, X<sub>2</sub></b>	Pilot signal (DA0)	ISO 8434-1	SDSC-L8×M12-F	40	O
<b>X<sub>1</sub></b>	Pilot signal (DA1, DA2)	ISO 6149 <sup>5)</sup>	M14 × 1.5; 11.5 deep	40	O
<b>X<sub>3</sub></b>	Pilot signal (DA1, DA2)	ISO 6149 <sup>5)</sup>	M14 × 1.5; 11.5 deep	40	X
<b>M<sub>1</sub></b>	Stroking chamber measurement	ISO 6149 <sup>5)</sup>	M14 × 1.5; 11.5 deep	450	X

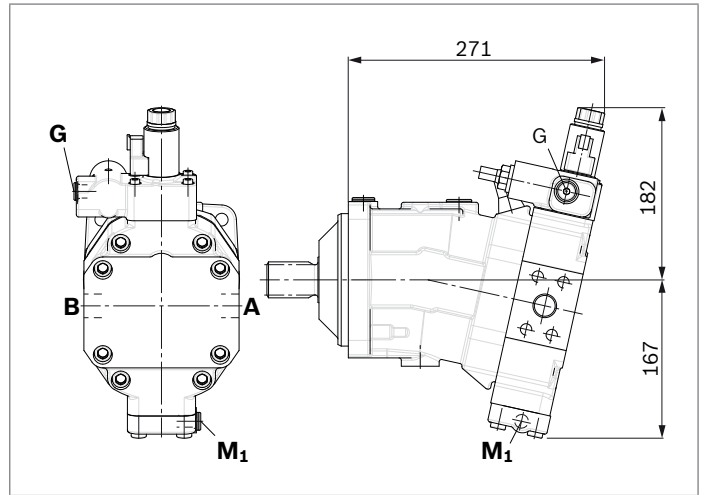
1) For notes on tightening torques, see instruction manual  
 2) Depending on the application, momentary pressure peaks can occur. Keep this in mind when selecting measuring devices and fittings.  
 3) Only dimensions according to SAE J518, metric fastening thread is a deviation from standard.

4) Depending on installation position, **T<sub>1</sub>** or **T<sub>2</sub>** must be connected (see also installation instructions on page 72).  
 5) The countersink can be deeper than as specified in the standard.  
 6) O = Must be connected (plugged on delivery)  
 X = Plugged (in normal operation)

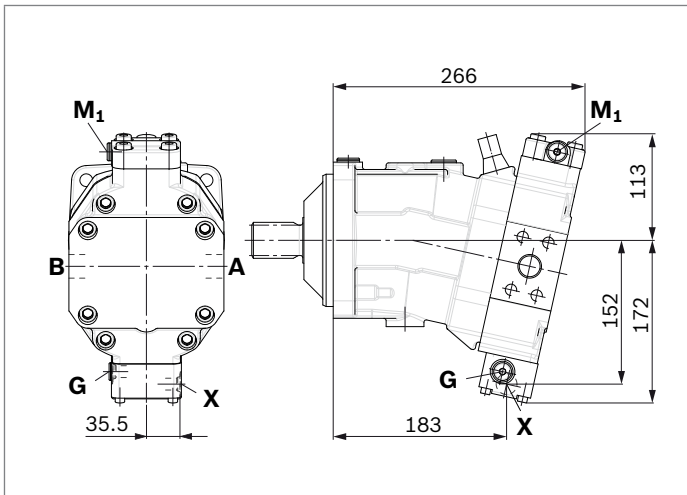
▼ **EP1, EP2** – Electric proportional control, positive control



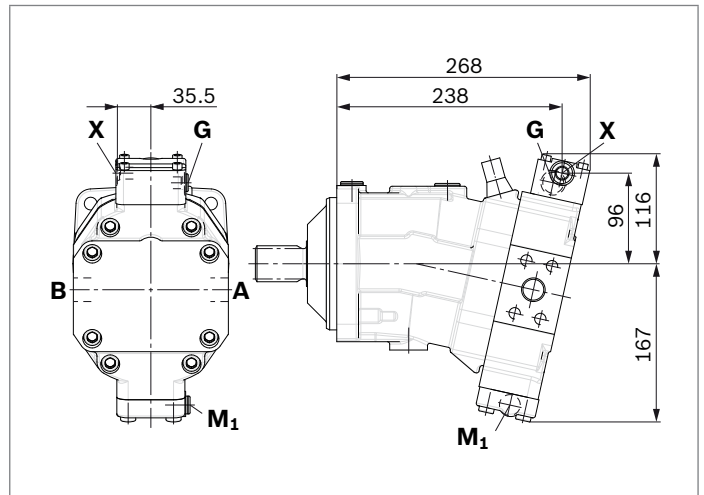
▼ **EP5D1, EP6D1** – Electric proportional control, negative control, with pressure control, fixed



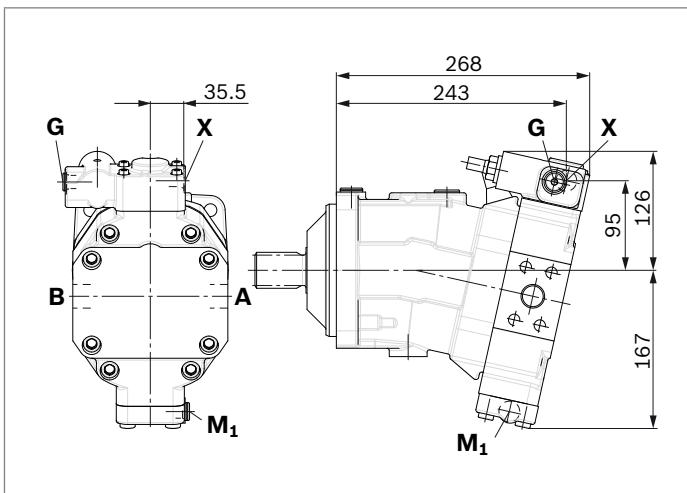
▼ **HP1, HP2** – Hydraulic proportional control, positive control



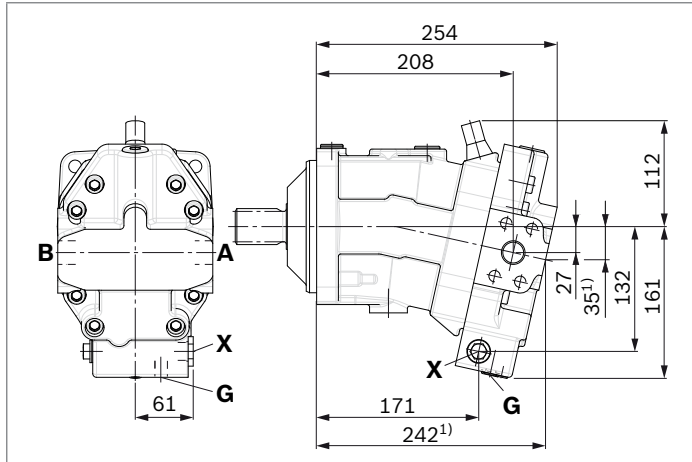
▼ **HP5, HP6** – Hydraulic proportional control, negative control



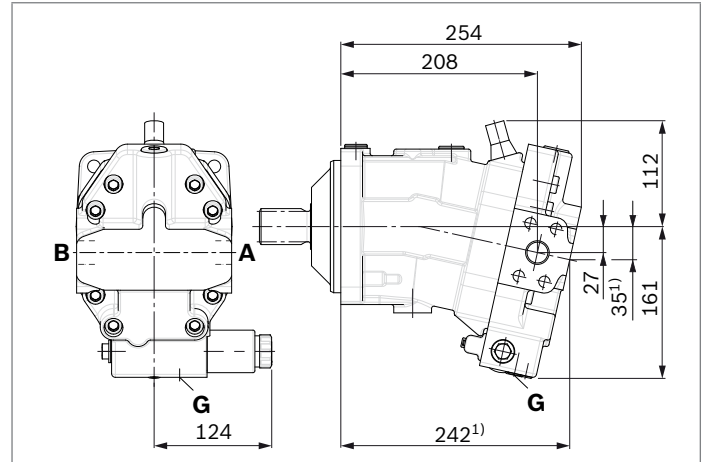
▼ **HP5D1, HP6D1** – Hydraulic proportional control, negative control, with pressure control, fixed



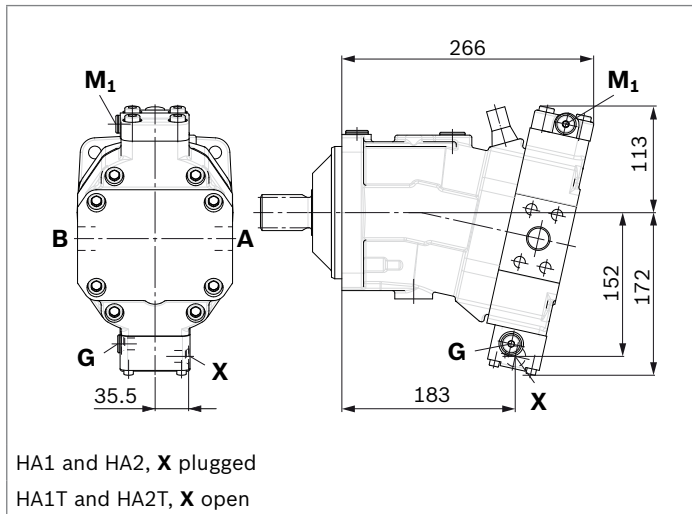
▼ **HZ7** – Hydraulic two-point control, negative control



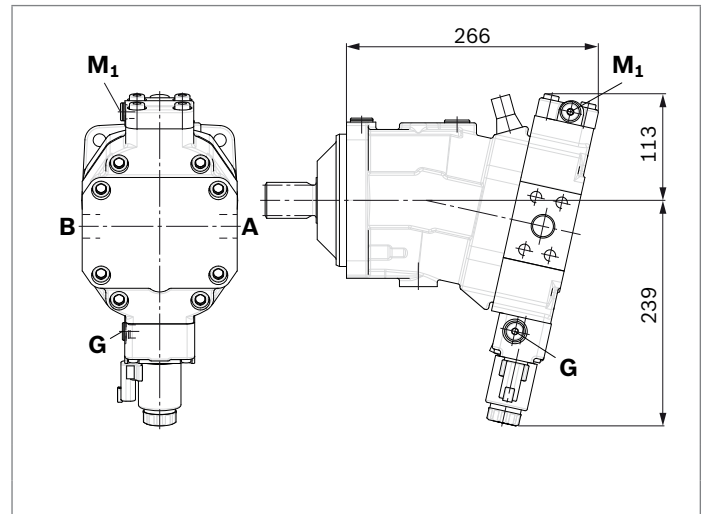
▼ **EZ7, EZ8** – Electric two-point control, negative control



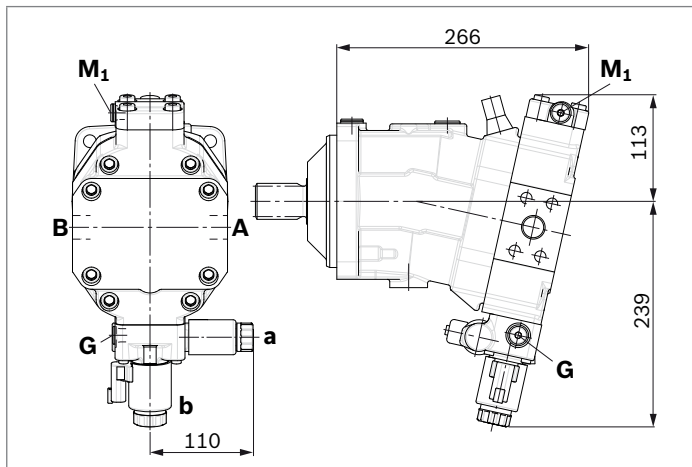
▼ **HA1, HA2 / HA1T3, HA2T3** – Automatic high-pressure-related control, positive control, with override hydraulic remote controlled, proportional



▼ **HA1U1, HA2U2** – Automatic high-pressure-related control, positive control, with override, electric, two-point



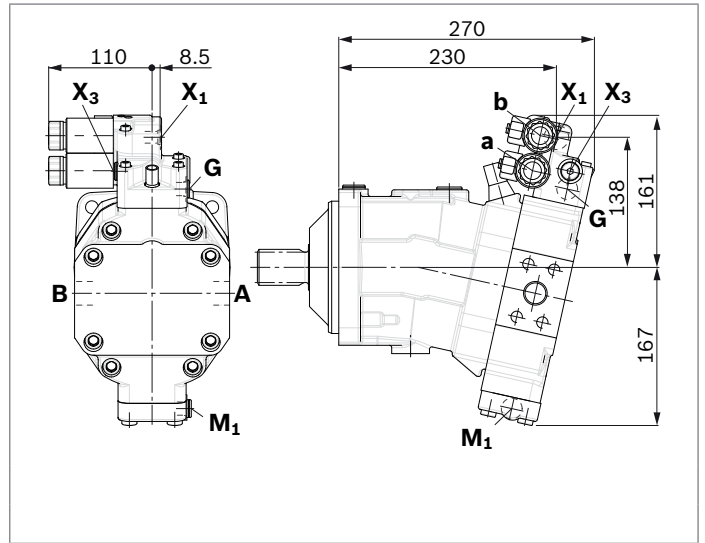
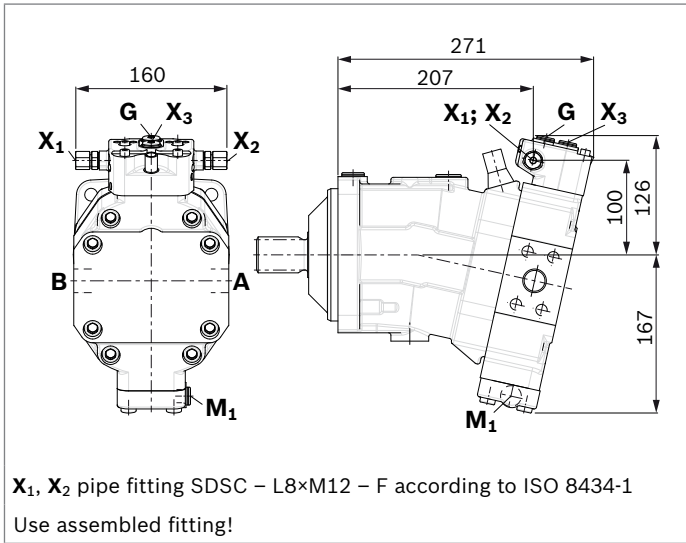
▼ **HA1R1, HA2R2** – Automatic high-pressure-related control, positive control, with override, electric and travel direction valve, electric



1) Port plate 1 – SAE working ports **A** and **B** at rear

▼ **DA0** – Automatic speed-related control, negative control, with hydraulic travel direction valve

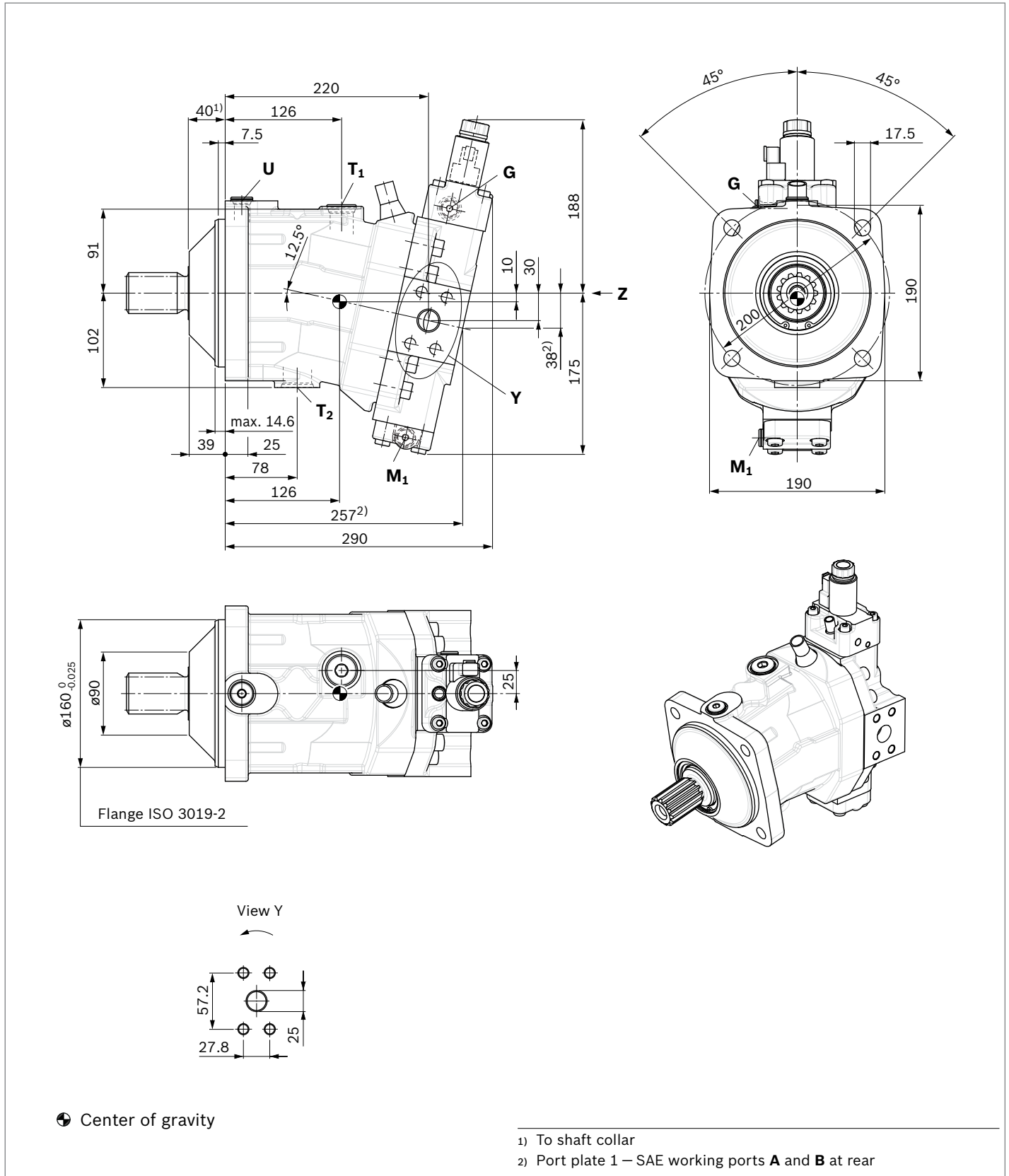
▼ **DA1, DA2** – Automatic speed-related control, negative control, with electric travel direction valve and electric  $V_{g\max}$  circuit



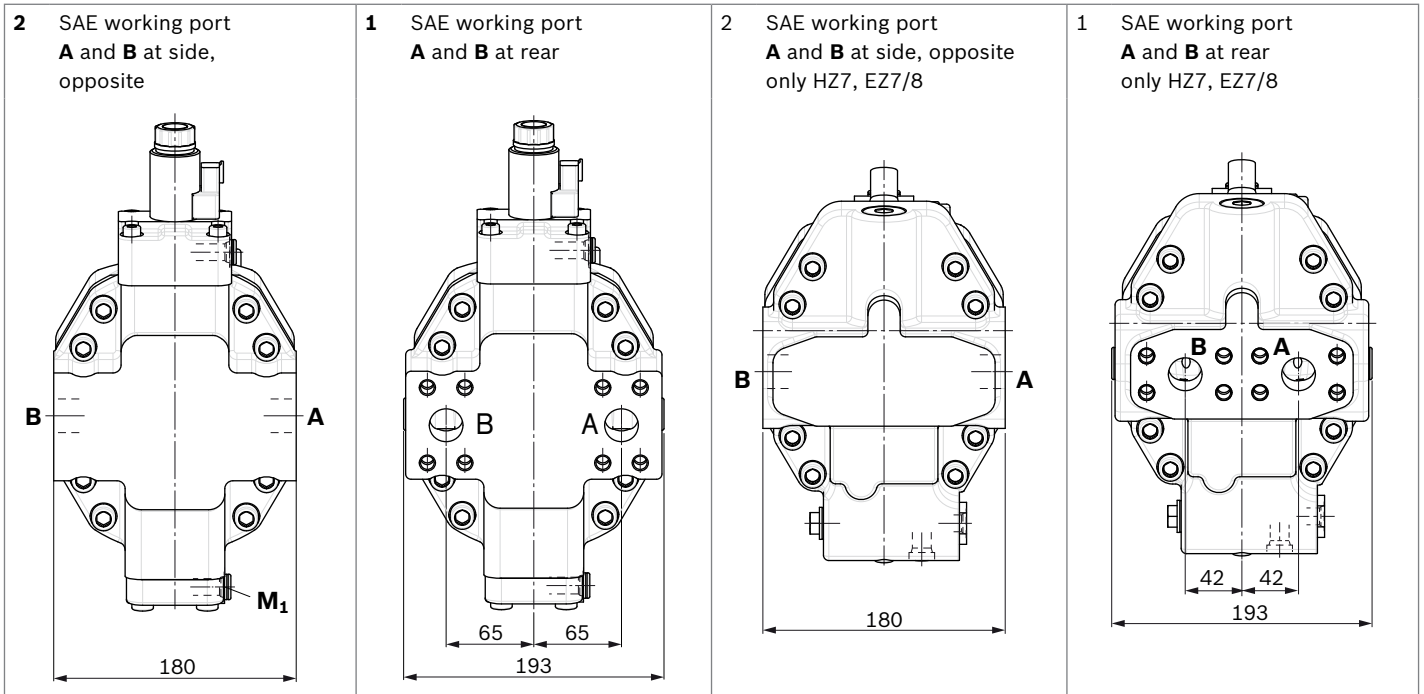
**Dimensions size 107**

**EP5, EP6 – Proportional electric control, negative control**

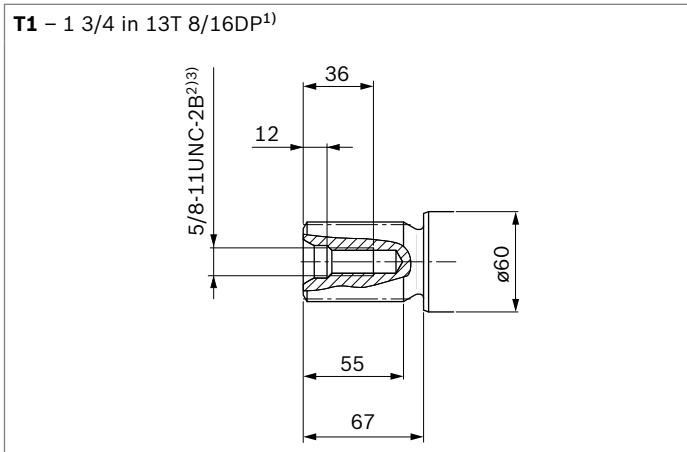
Port plate 2 – SAE working ports **A** and **B** at side, opposite



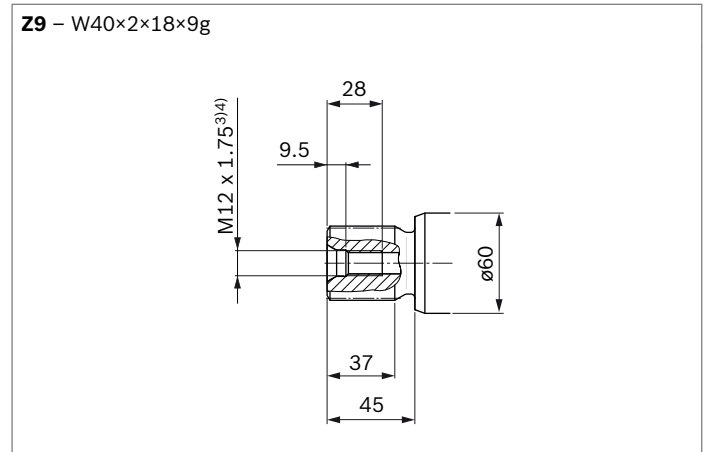
▼ **Location of the service line ports on the port plates (view Z)**



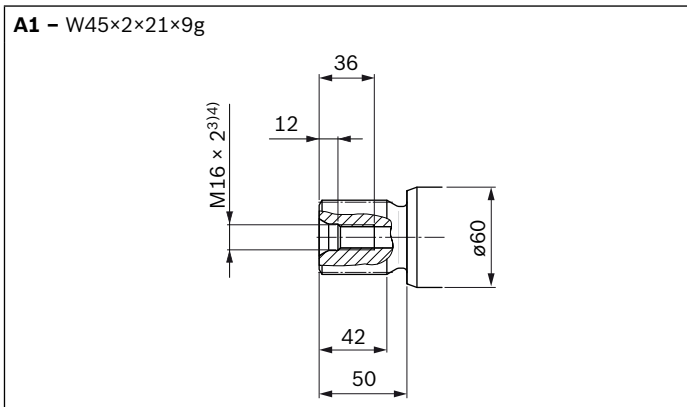
▼ **Splined shaft SAE J744**



▼ **Splined shaft DIN 5480**



▼ **Splined shaft DIN 5480**



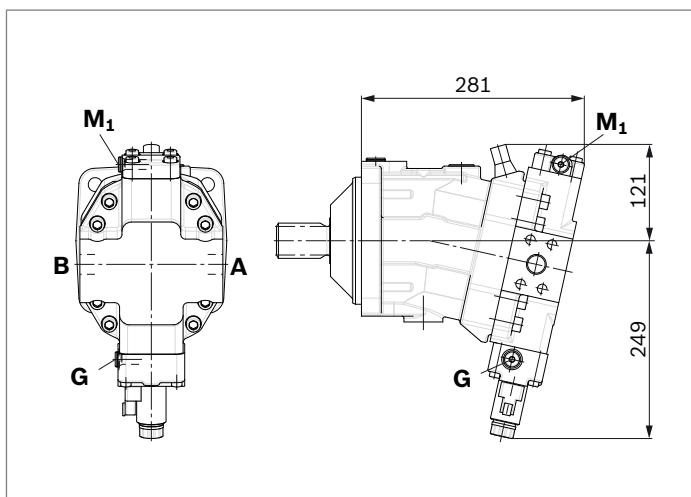
1) Involute spline acc. to ANSI B92.1a, 30° pressure angle, flat root, side fit, tolerance class 5  
 2) Thread according to ASME B1.1  
 3) For notes on tightening torques, see instruction manual  
 4) Center bore according to DIN 332 (thread according to DIN 13)

Ports		Standard	Size <sup>1)</sup>	$p_{\max}$ [bar] <sup>2)</sup>	Status <sup>6)</sup>
<b>A, B</b>	Working port	SAE J518 <sup>3)</sup>	1 in	450	O
	Fastening thread A/B	DIN 13	M12 × 1.75; 17 deep		
<b>T<sub>1</sub></b>	Drain port	ISO 6149 <sup>5)</sup>	M27 × 2; 19 deep	3	X <sup>4)</sup>
<b>T<sub>2</sub></b>	Drain port	ISO 6149 <sup>5)</sup>	M33 × 2; 19 deep	3	O <sup>4)</sup>
<b>G</b>	Synchronous control	ISO 6149 <sup>5)</sup>	M14 × 1.5; 11.5 deep	450	X
<b>U</b>	Bearing flushing	ISO 6149 <sup>5)</sup>	M18 × 1.5; 14.5 deep	3	X
<b>X</b>	Pilot signal (HP, HZ, HA1T/HA2T)	ISO 6149 <sup>5)</sup>	M14 × 1.5; 11.5 deep	100	O
<b>X</b>	Pilot signal (HA1, HA2)	ISO 6149 <sup>5)</sup>	M14 × 1.5; 11.5 deep	3	X
<b>X<sub>1</sub>, X<sub>2</sub></b>	Pilot signal (DA0)	ISO 8434-1	SDSC-L8×M12-F	40	O
<b>X<sub>1</sub></b>	Pilot signal (DA1, DA2)	ISO 6149 <sup>5)</sup>	M14 × 1.5; 11.5 deep	40	O
<b>X<sub>3</sub></b>	Pilot signal (DA1, DA2)	ISO 6149 <sup>5)</sup>	M14 × 1.5; 11.5 deep	40	X
<b>M<sub>1</sub></b>	Stroking chamber measurement	ISO 6149 <sup>5)</sup>	M14 × 1.5; 11.5 deep	450	X

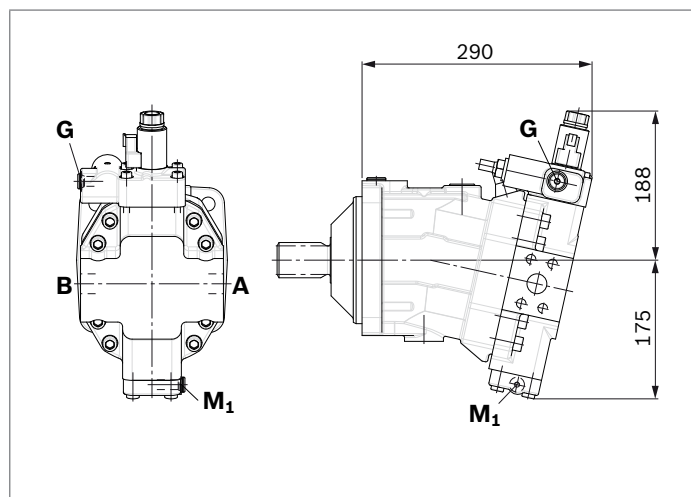
1) For notes on tightening torques, see instruction manual  
 2) Depending on the application, momentary pressure peaks can occur. Keep this in mind when selecting measuring devices and fittings.  
 3) Only dimensions according to SAE J518, metric fastening thread is a deviation from standard.

4) Depending on installation position, **T<sub>1</sub>** or **T<sub>2</sub>** must be connected (see also installation instructions on page 72).  
 5) The countersink can be deeper than as specified in the standard.  
 6) O = Must be connected (plugged on delivery)  
 X = Plugged (in normal operation)

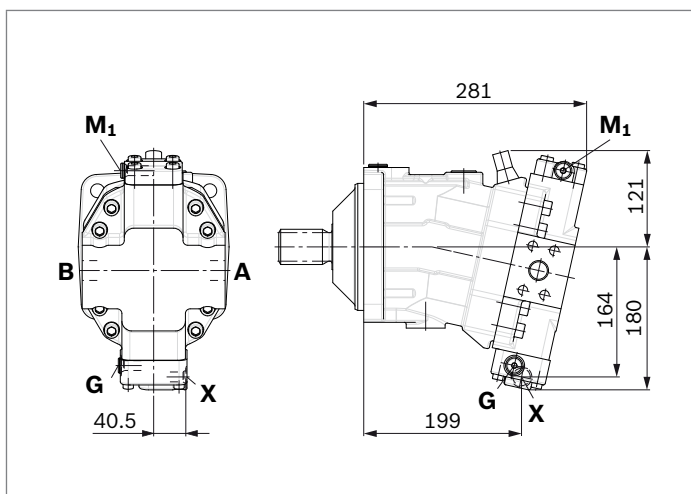
▼ **EP1, EP2** – Electric proportional control, positive control



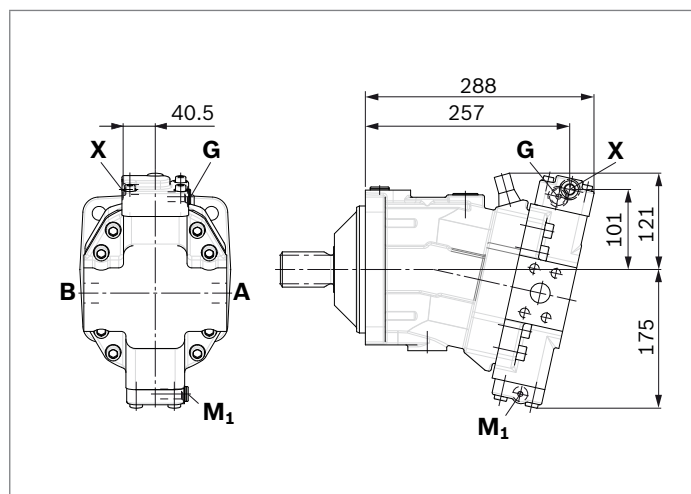
▼ **EP5D1, EP6D1** – Electric proportional control, negative control, with pressure control, fixed



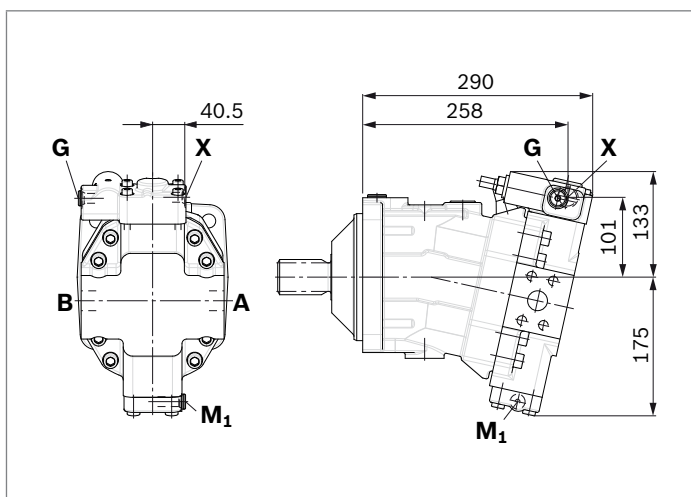
▼ **HP1, HP2** – Hydraulic proportional control, positive control



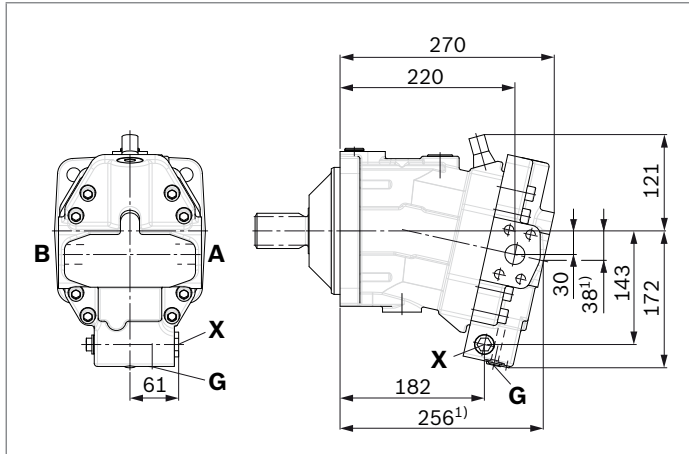
▼ **HP5, HP6** – Hydraulic proportional control, negative control



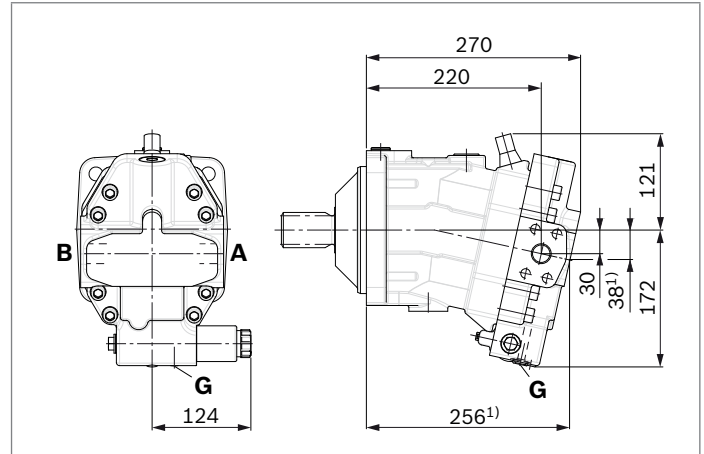
▼ **HP5D1, HP6D1** – Hydraulic proportional control, negative control, with pressure control, fixed



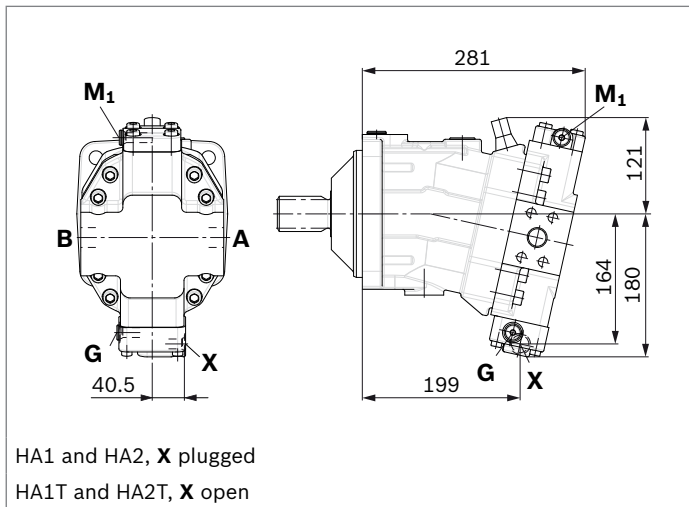
▼ **HZ7** – Hydraulic two-point control, negative control



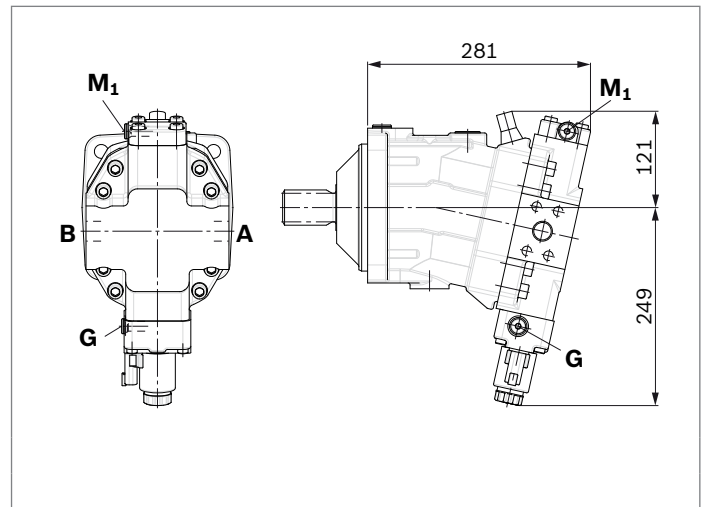
▼ **EZ7, EZ8** – Electric two-point control, negative control



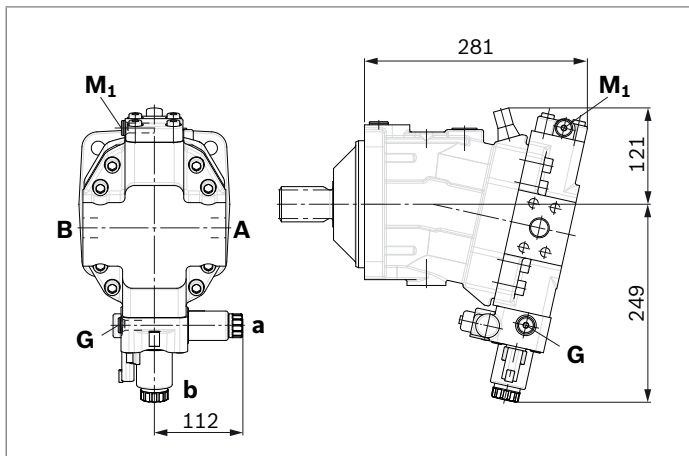
▼ **HA1, HA2 / HA1T3, HA2T3** – Automatic high-pressure-related control, positive control, with override hydraulic remote controlled, proportional



▼ **HA1U1, HA2U2** – Automatic high-pressure-related control, positive control, with override, electric, two-point



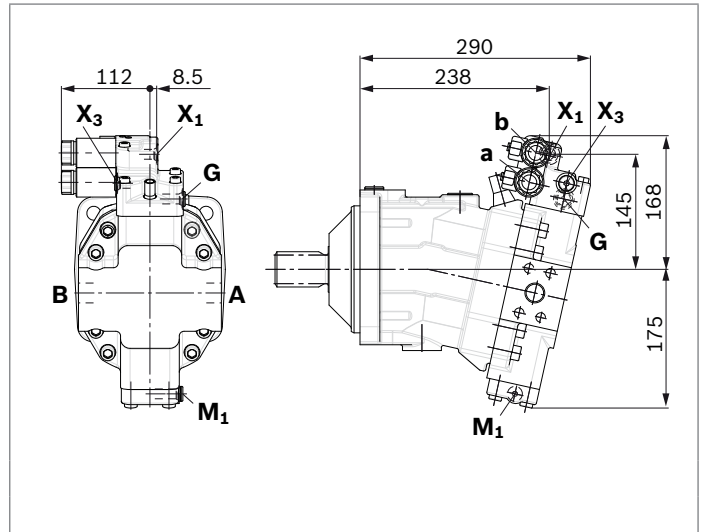
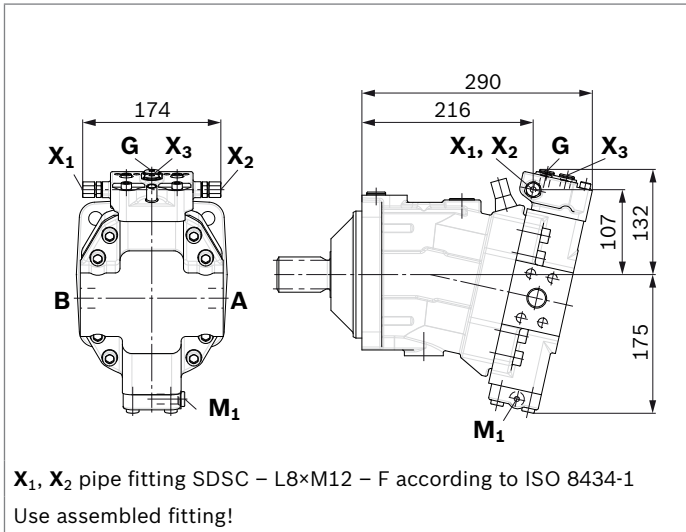
▼ **HA1R1, HA2R2** – Automatic high-pressure-related control, positive control, with override, electric and travel direction valve, electric



1) Port plate 1 – SAE working ports **A** and **B** at rear

▼ **DA0** – Automatic speed-related control, negative control, with hydraulic travel direction valve

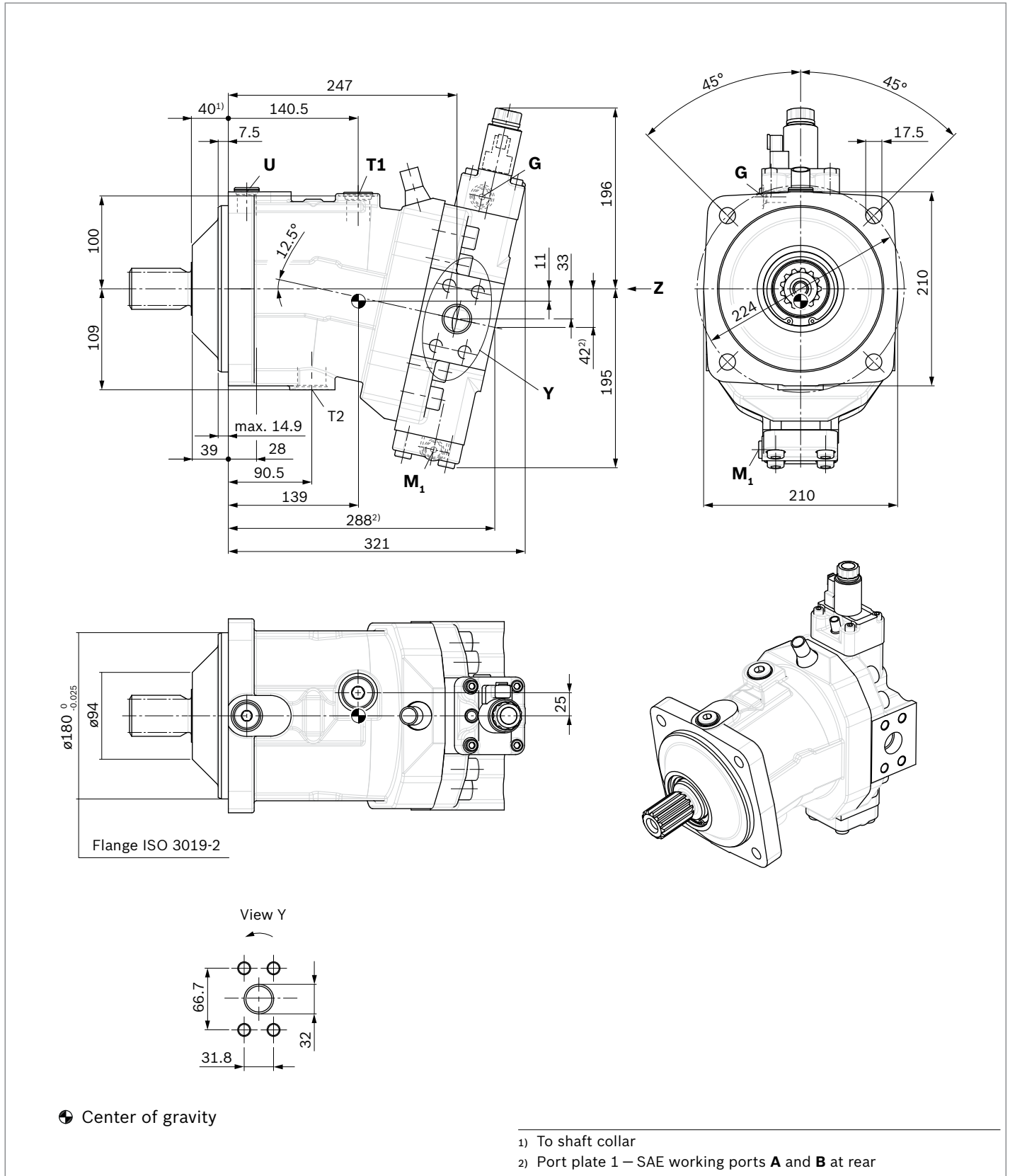
▼ **DA1, DA2** – Automatic speed-related control, negative control, with electric travel direction valve and electric  $V_{g\max}$  circuit



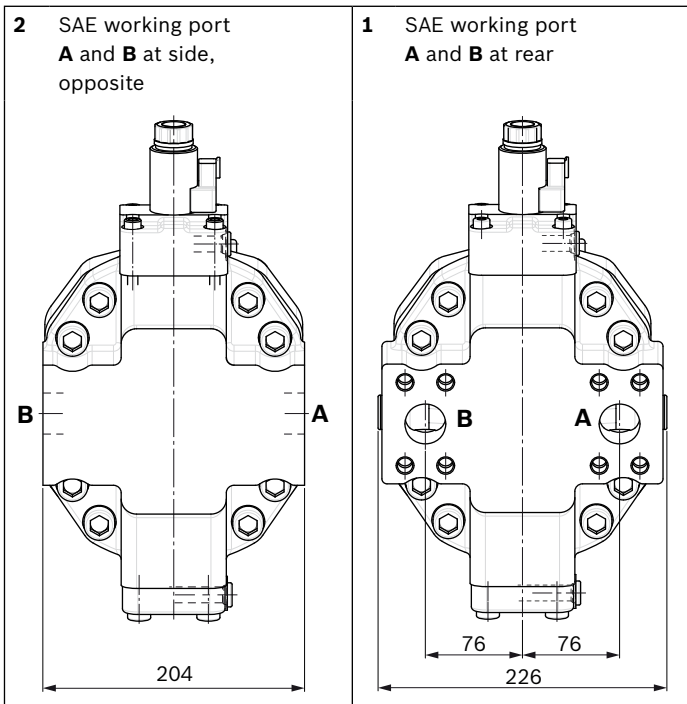
## Dimensions size 140

### EP5, EP6 – Proportional electric control, negative control

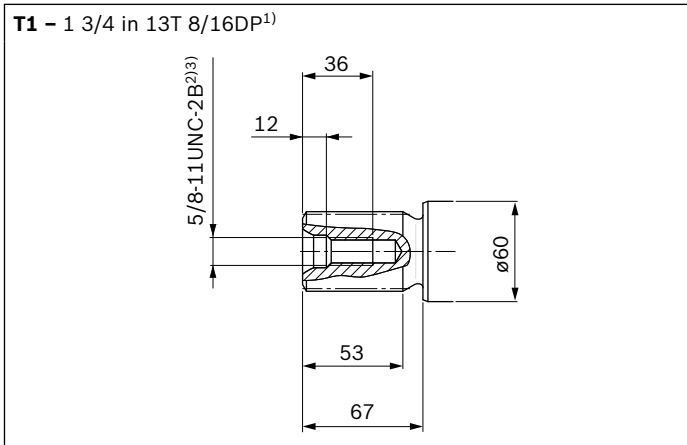
Port plate 2 – SAE working ports A and B at side, opposite



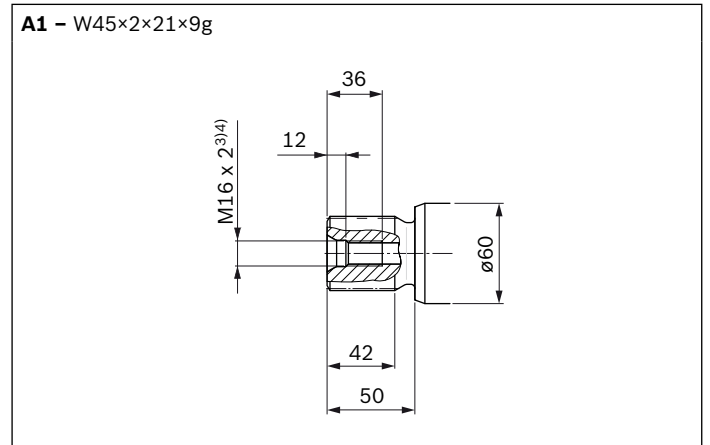
▼ **Location of the service line ports on the port plates (view Z)**



▼ **Splined shaft SAE J744**



▼ **Splined shaft DIN 5480**



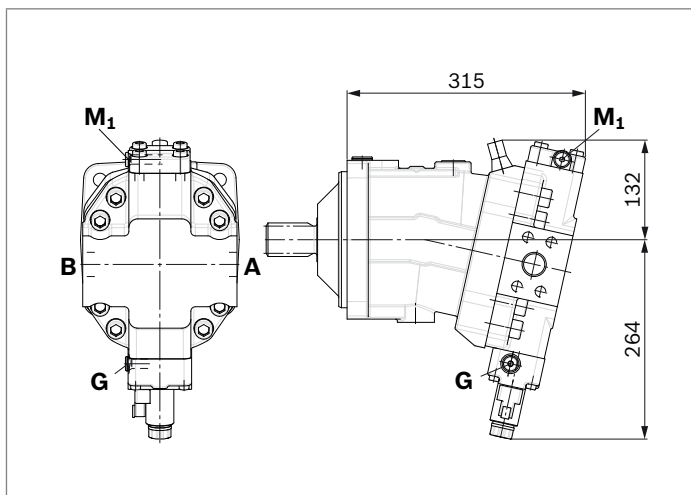
1) Involute spline acc. to ANSI B92.1a, 30° pressure angle, flat root, side fit, tolerance class 5  
 2) Thread according to ASME B1.1  
 3) For notes on tightening torques, see instruction manual  
 4) Center bore according to DIN 332 (thread according to DIN 13)

Ports		Standard	Size <sup>1)</sup>	$p_{\max}$ [bar] <sup>2)</sup>	Status <sup>6)</sup>
<b>A, B</b>	Working port	SAE J518 <sup>3)</sup>	1 1/4 in	450	O
	Fastening thread A/B	DIN 13	M14 × 2; 19 deep		
<b>T<sub>1</sub></b>	Drain port	ISO 6149 <sup>5)</sup>	M27 × 2; 19 deep	3	X <sup>4)</sup>
<b>T<sub>2</sub></b>	Drain port	ISO 6149 <sup>5)</sup>	M33 × 2; 19 deep	3	O <sup>4)</sup>
<b>G</b>	Synchronous control	ISO 6149 <sup>5)</sup>	M14 × 1.5; 11.5 deep	450	X
<b>U</b>	Bearing flushing	ISO 6149 <sup>5)</sup>	M22 × 1.5; 15.5 deep	3	X
<b>X</b>	Pilot signal (HP, HZ, HA1T/HA2T)	ISO 6149 <sup>5)</sup>	M14 × 1.5; 11.5 deep	100	O
<b>X</b>	Pilot signal (HA1, HA2)	ISO 6149 <sup>5)</sup>	M14 × 1.5; 11.5 deep	3	X
<b>X<sub>1</sub>, X<sub>2</sub></b>	Pilot signal (DA0)	ISO 8434-1	SDSC-L8×M12-F	40	O
<b>X<sub>1</sub></b>	Pilot signal (DA1, DA2)	ISO 6149 <sup>5)</sup>	M14 × 1.5; 11.5 deep	40	O
<b>X<sub>3</sub></b>	Pilot signal (DA1, DA2)	ISO 6149 <sup>5)</sup>	M14 × 1.5; 11.5 deep	40	X
<b>M<sub>1</sub></b>	Stroking chamber measurement	ISO 6149 <sup>5)</sup>	M14 × 1.5; 11.5 deep	450	X

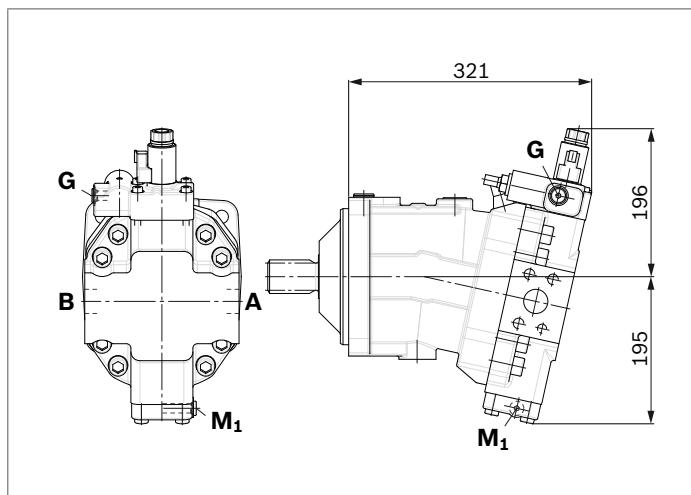
1) For notes on tightening torques, see instruction manual  
 2) Depending on the application, momentary pressure peaks can occur. Keep this in mind when selecting measuring devices and fittings.  
 3) Only dimensions according to SAE J518, metric fastening thread is a deviation from standard.

4) Depending on installation position, **T<sub>1</sub>** or **T<sub>2</sub>** must be connected (see also installation instructions on page 72).  
 5) The countersink can be deeper than as specified in the standard.  
 6) O = Must be connected (plugged on delivery)  
 X = Plugged (in normal operation)

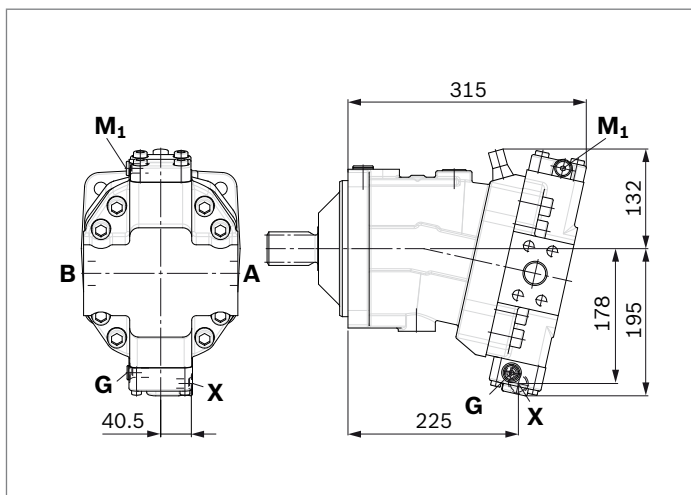
▼ **EP1, EP2** – Electric proportional control, positive control



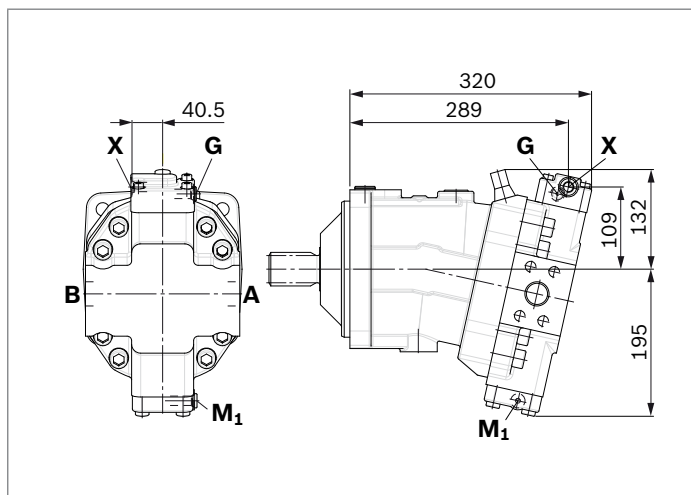
▼ **EP5D1, EP6D1** – Electric proportional control, negative control, with pressure control, fixed



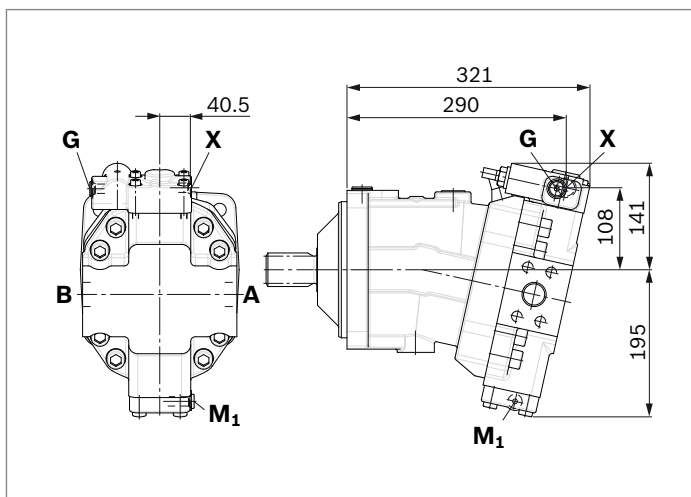
▼ **HP1, HP2** – Hydraulic proportional control, positive control



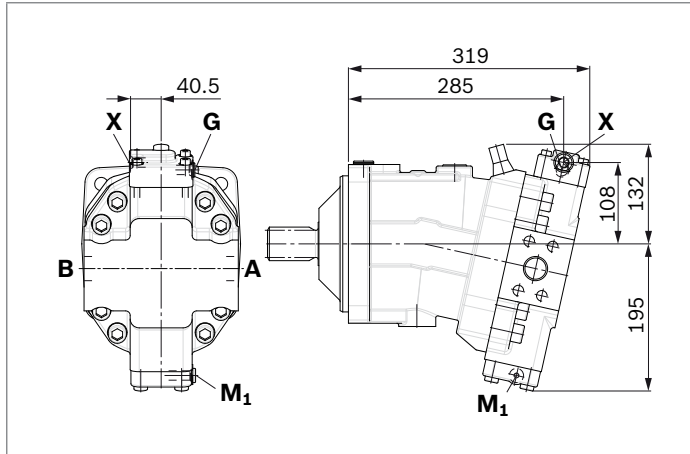
▼ **HP5, HP6** – Hydraulic proportional control, negative control



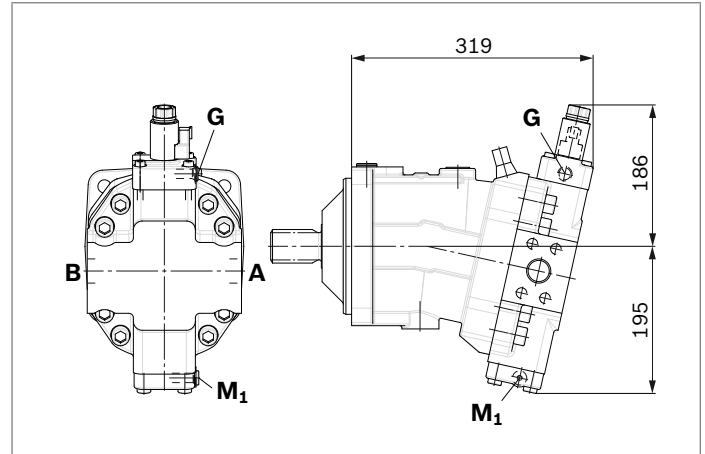
▼ **HP5D1, HP6D1** – Hydraulic proportional control, negative control, with pressure control, fixed



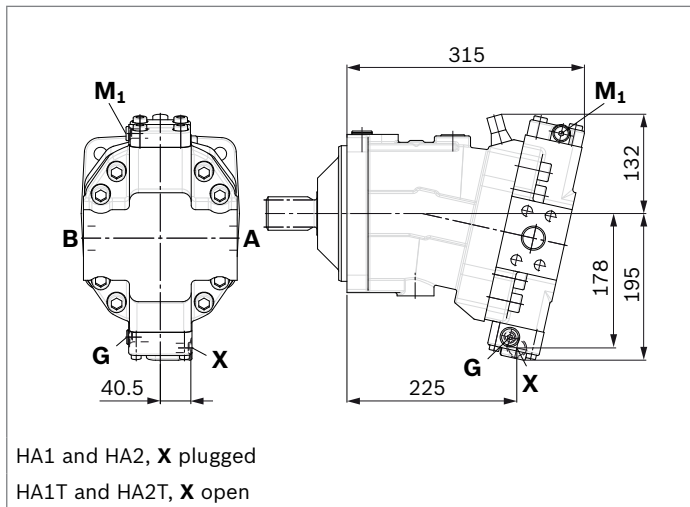
▼ **HZ5** – Hydraulic two-point control, negative control



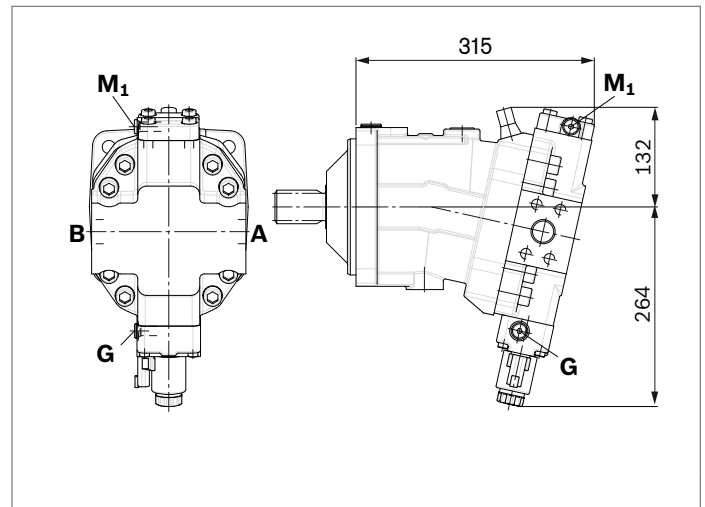
▼ **EZ5, EZ6** – Electric two-point control, negative control



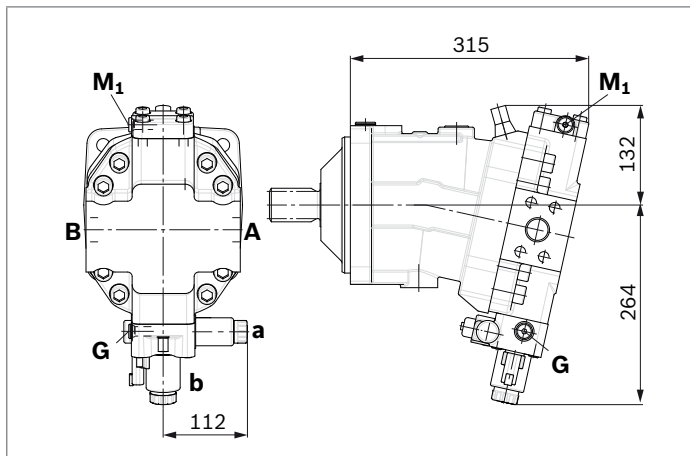
▼ **HA1, HA2 / HA1T3, HA2T3** – Automatic high-pressure-related control, positive control, with override hydraulic remote controlled, proportional



▼ **HA1U1, HA2U2** – Automatic high-pressure-related control, positive control, with override, electric, two-point

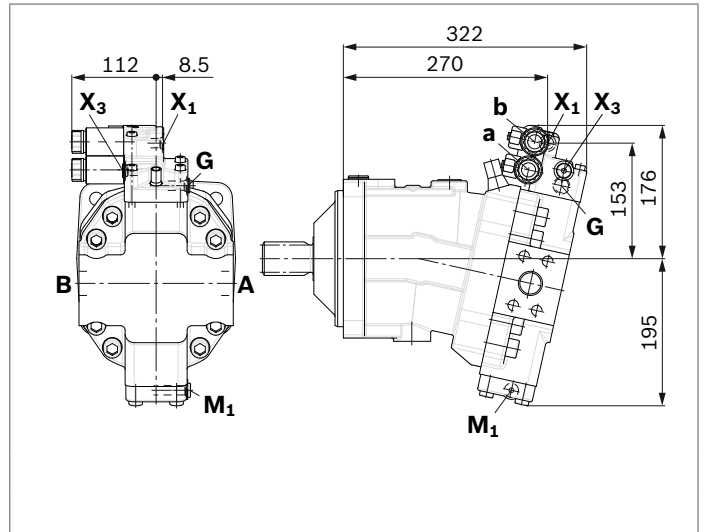
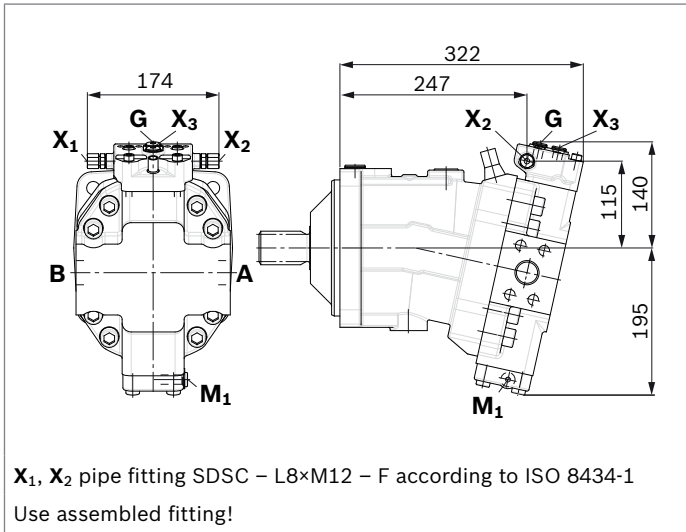


▼ **HA1R1, HA2R2** – Automatic high-pressure-related control, positive control, with override, electric and travel direction valve, electric



▼ **DA0** – Automatic speed-related control, negative control, with hydraulic travel direction valve

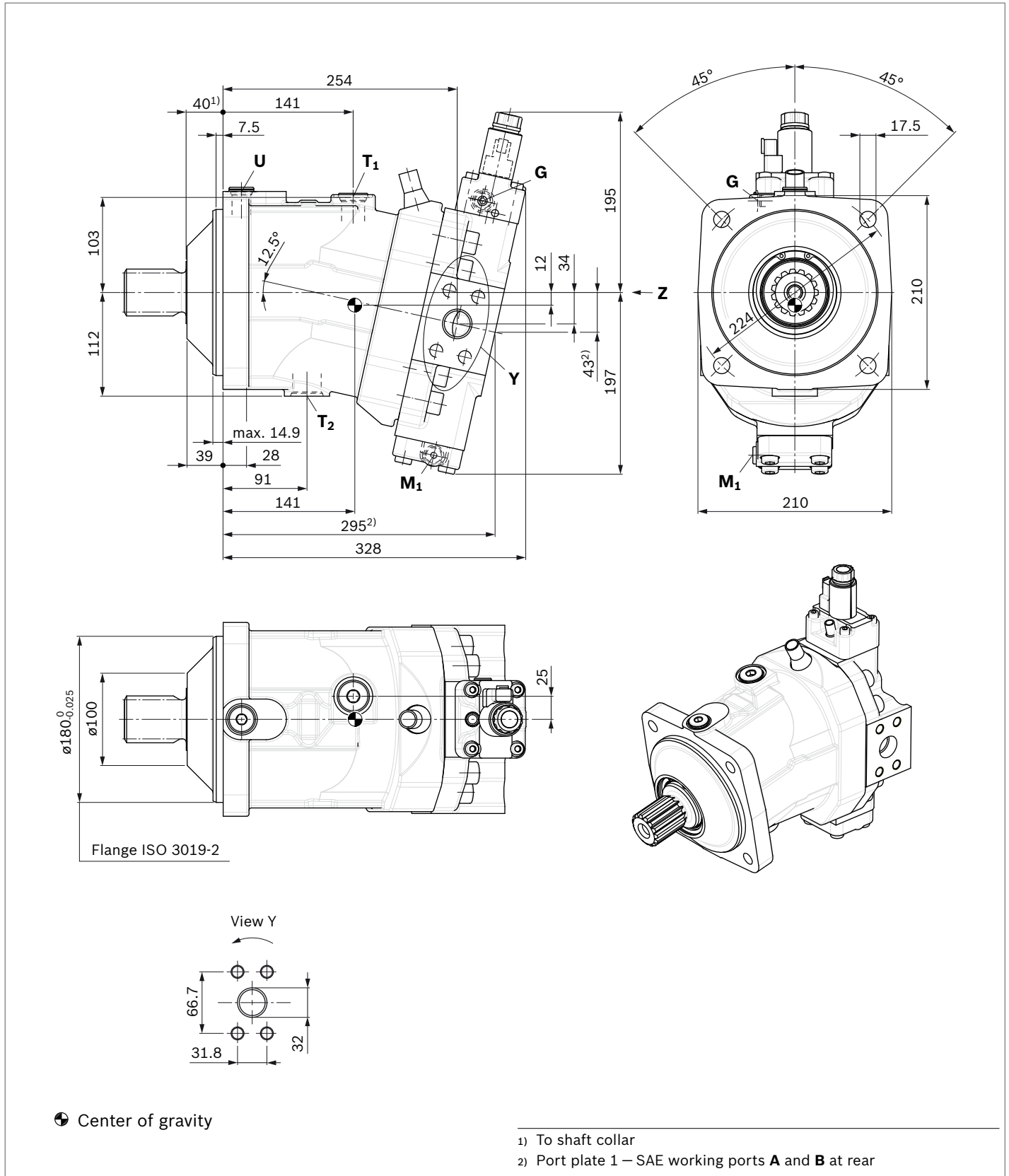
▼ **DA1, DA2** – Automatic speed-related control, negative control, with electric travel direction valve and electric  $V_{g\max}$  circuit



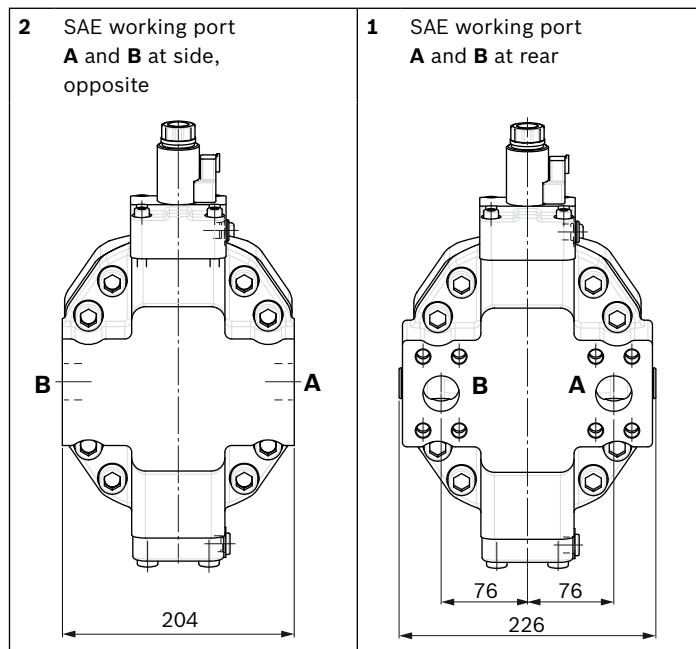
**Dimensions size 160**

**EP5, EP6 – Proportional electric control, negative control**

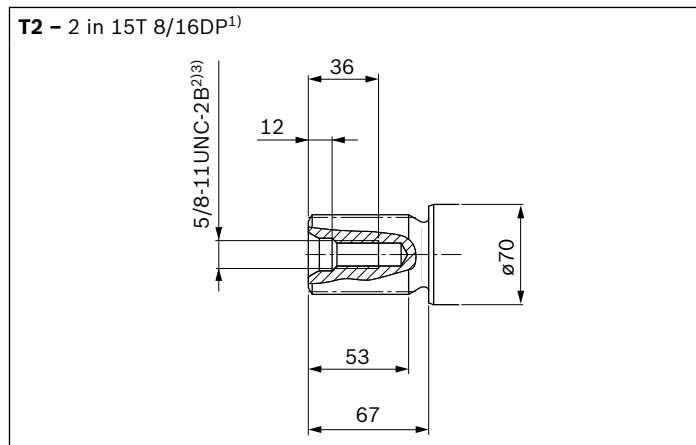
Port plate 2 – SAE working ports **A** and **B** at side, opposite



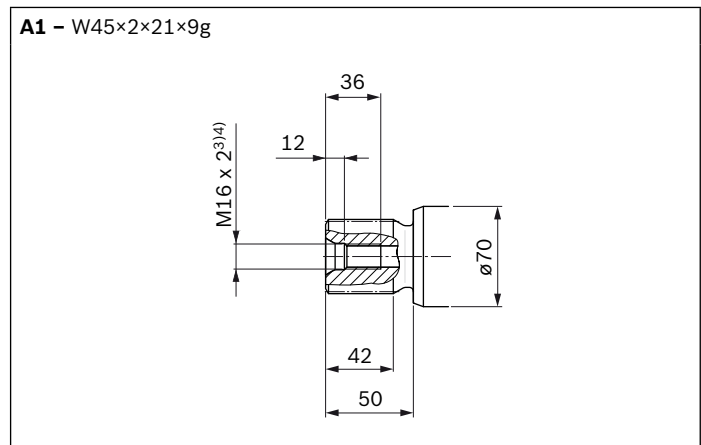
▼ **Location of the service line ports on the port plates (view Z)**



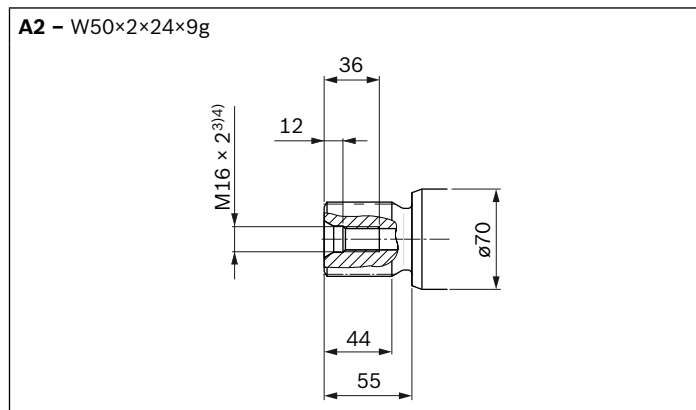
▼ **Splined shaft SAE J744**



▼ **Splined shaft DIN 5480**



▼ **Splined shaft DIN 5480**



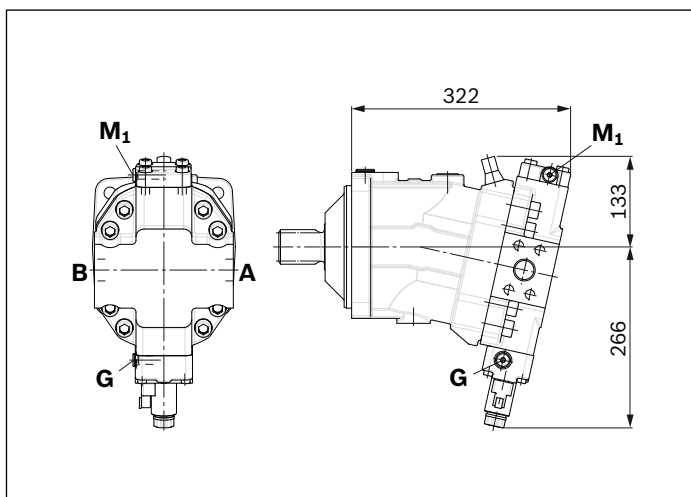
1) Involute spline acc. to ANSI B92.1a, 30° pressure angle, flat root, side fit, tolerance class 5  
 2) Thread according to ASME B1.1  
 3) For notes on tightening torques, see instruction manual  
 4) Center bore according to DIN 332 (thread according to DIN 13)

Ports		Standard	Size <sup>1)</sup>	$p_{\max}$ [bar] <sup>2)</sup>	Status <sup>6)</sup>
<b>A, B</b>	Working port	SAE J518 <sup>3)</sup>	1 1/4 in	450	O
	Fastening thread A/B	DIN 13	M14 × 2; 19 deep		
<b>T<sub>1</sub></b>	Drain port	ISO 6149 <sup>5)</sup>	M27 × 2; 19 deep	3	X <sup>4)</sup>
<b>T<sub>2</sub></b>	Drain port	ISO 6149 <sup>5)</sup>	M33 × 2; 19 deep	3	O <sup>4)</sup>
<b>G</b>	Synchronous control	ISO 6149 <sup>5)</sup>	M14 × 1.5; 11.5 deep	450	X
<b>U</b>	Bearing flushing	ISO 6149 <sup>5)</sup>	M22 × 1.5; 15.5 deep	3	X
<b>X</b>	Pilot signal (HP, HZ, HA1T/HA2T)	ISO 6149 <sup>5)</sup>	M14 × 1.5; 11.5 deep	100	O
<b>X</b>	Pilot signal (HA1, HA2)	ISO 6149 <sup>5)</sup>	M14 × 1.5; 11.5 deep	3	X
<b>X<sub>1</sub>, X<sub>2</sub></b>	Pilot signal (DA0)	ISO 8434-1	SDSC-L8×M12-F	40	O
<b>X<sub>1</sub></b>	Pilot signal (DA1, DA2)	ISO 6149 <sup>5)</sup>	M14 × 1.5; 11.5 deep	40	O
<b>X<sub>3</sub></b>	Pilot signal (DA1, DA2)	ISO 6149 <sup>5)</sup>	M14 × 1.5; 11.5 deep	40	X
<b>M<sub>1</sub></b>	Stroking chamber measurement	ISO 6149 <sup>5)</sup>	M14 × 1.5; 11.5 deep	450	X

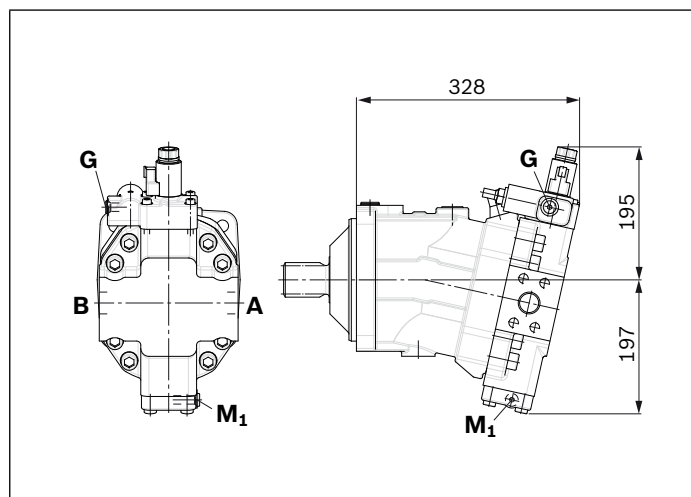
1) For notes on tightening torques, see instruction manual  
 2) Depending on the application, momentary pressure peaks can occur. Keep this in mind when selecting measuring devices and fittings.  
 3) Only dimensions according to SAE J518, metric fastening thread is a deviation from standard.

4) Depending on installation position, **T<sub>1</sub>** or **T<sub>2</sub>** must be connected (see also installation instructions on page 72).  
 5) The countersink can be deeper than as specified in the standard.  
 6) O = Must be connected (plugged on delivery)  
 X = Plugged (in normal operation)

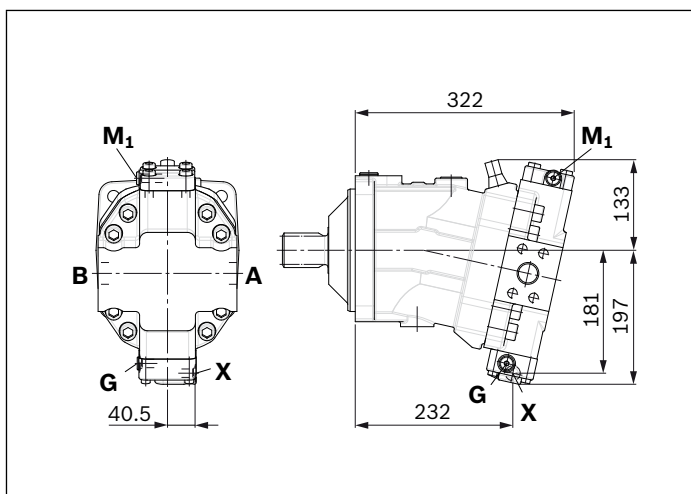
▼ **EP1, EP2** – Electric proportional control, positive control



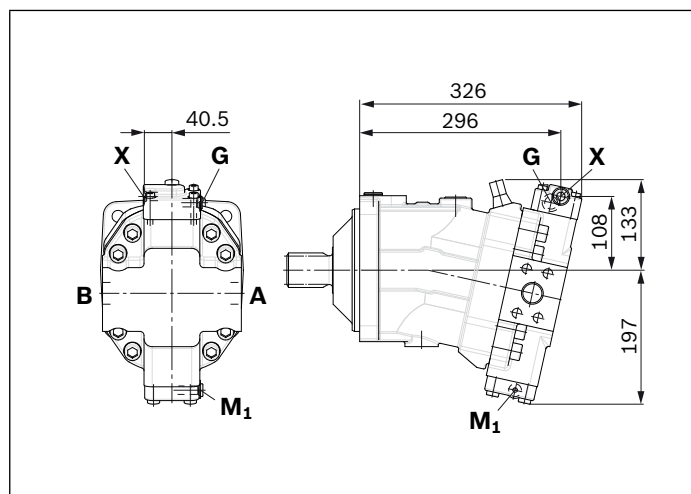
▼ **EP5D1, EP6D1** – Electric proportional control, negative control, with pressure control, fixed



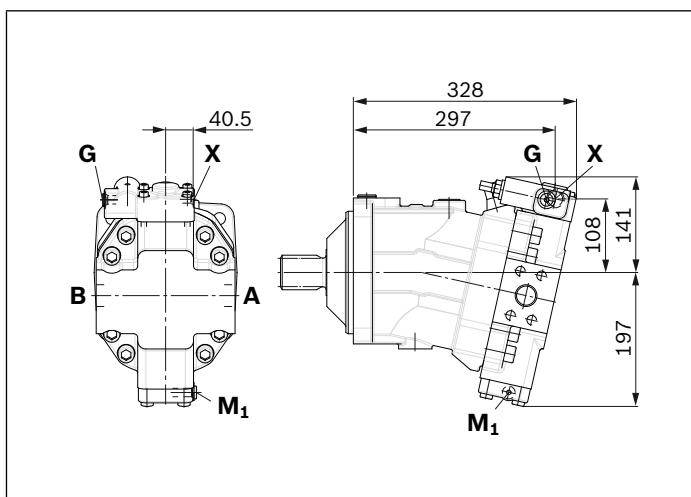
▼ **HP1, HP2** – Hydraulic proportional control, positive control



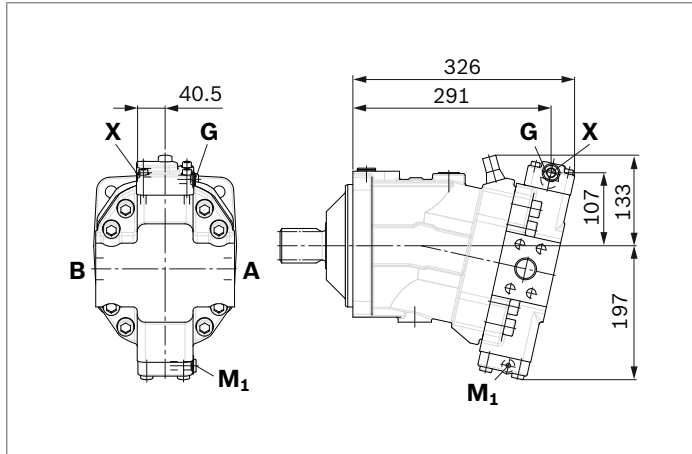
▼ **HP5, HP6** – Hydraulic proportional control, negative control



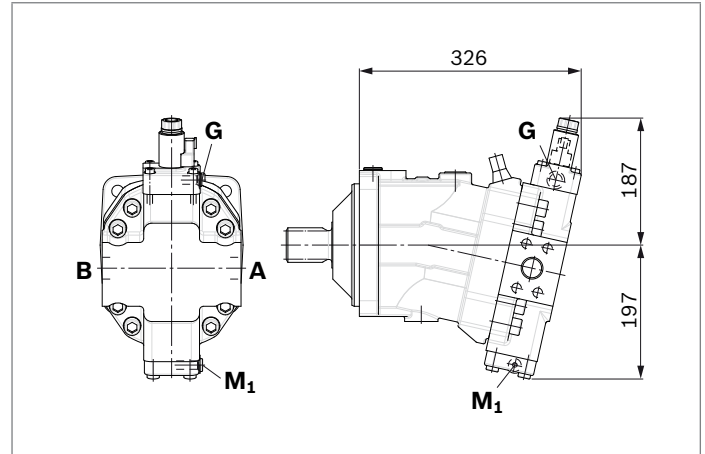
▼ **HP5D1, HP6D1** – Hydraulic proportional control, negative control, with pressure control, fixed



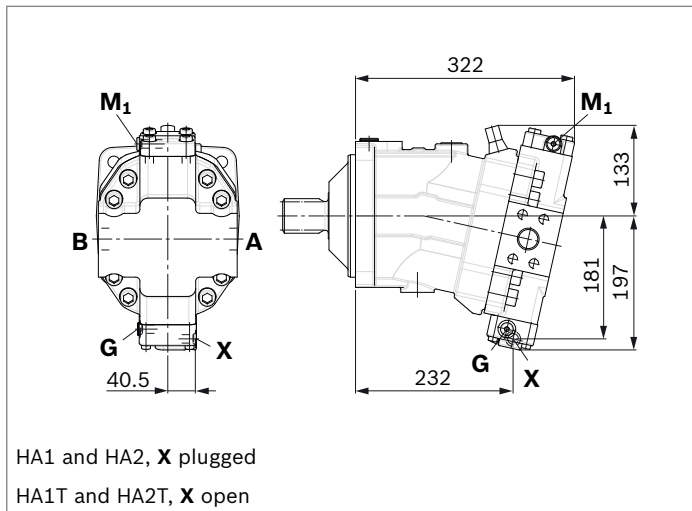
▼ **HZ5** – Hydraulic two-point control, negative control



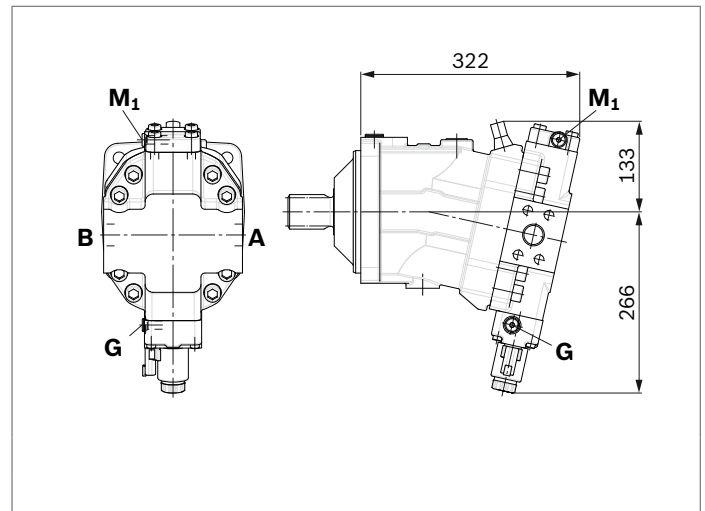
▼ **EZ5, EZ6** – Electric two-point control, negative control



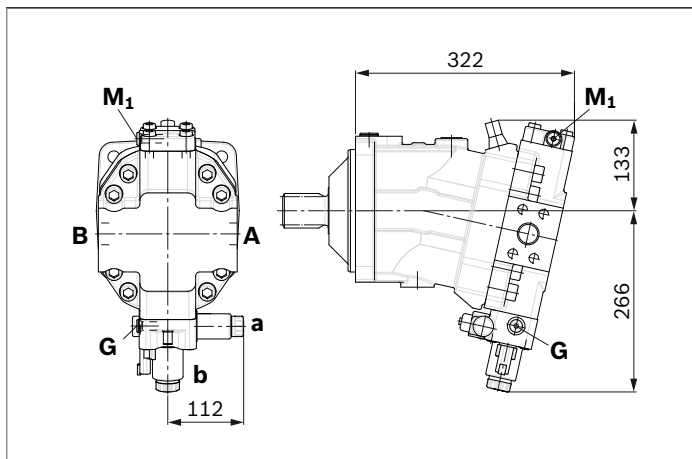
▼ **HA1, HA2 / HA1T3, HA2T3** – Automatic high-pressure-related control, positive control, with override hydraulic remote controlled, proportional



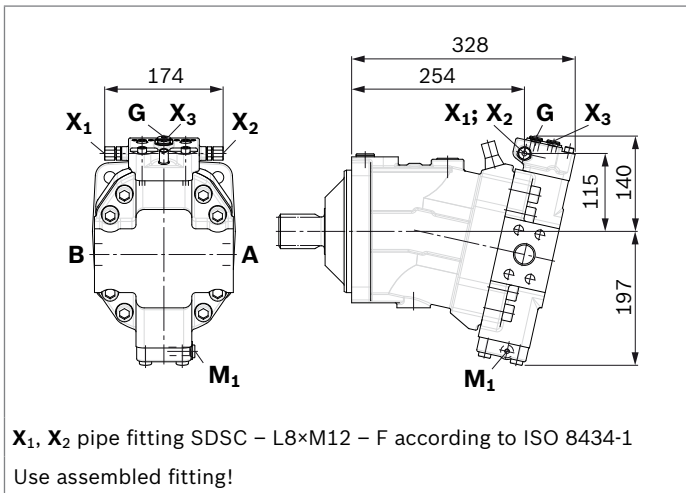
▼ **HA1U1, HA2U2** – Automatic high-pressure-related control, positive control, with override, electric, two-point



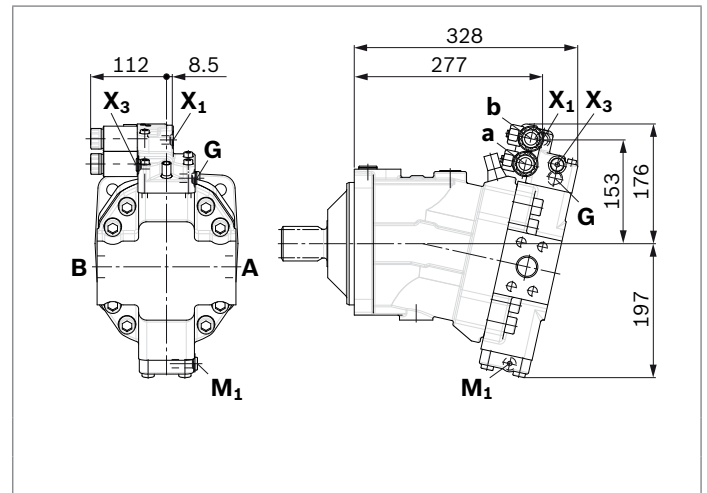
▼ **HA1R1, HA2R2** – Automatic high-pressure-related control, positive control, with override, electric and travel direction valve, electric



▼ **DA0** – Automatic speed-related control, negative control, with hydraulic travel direction valve



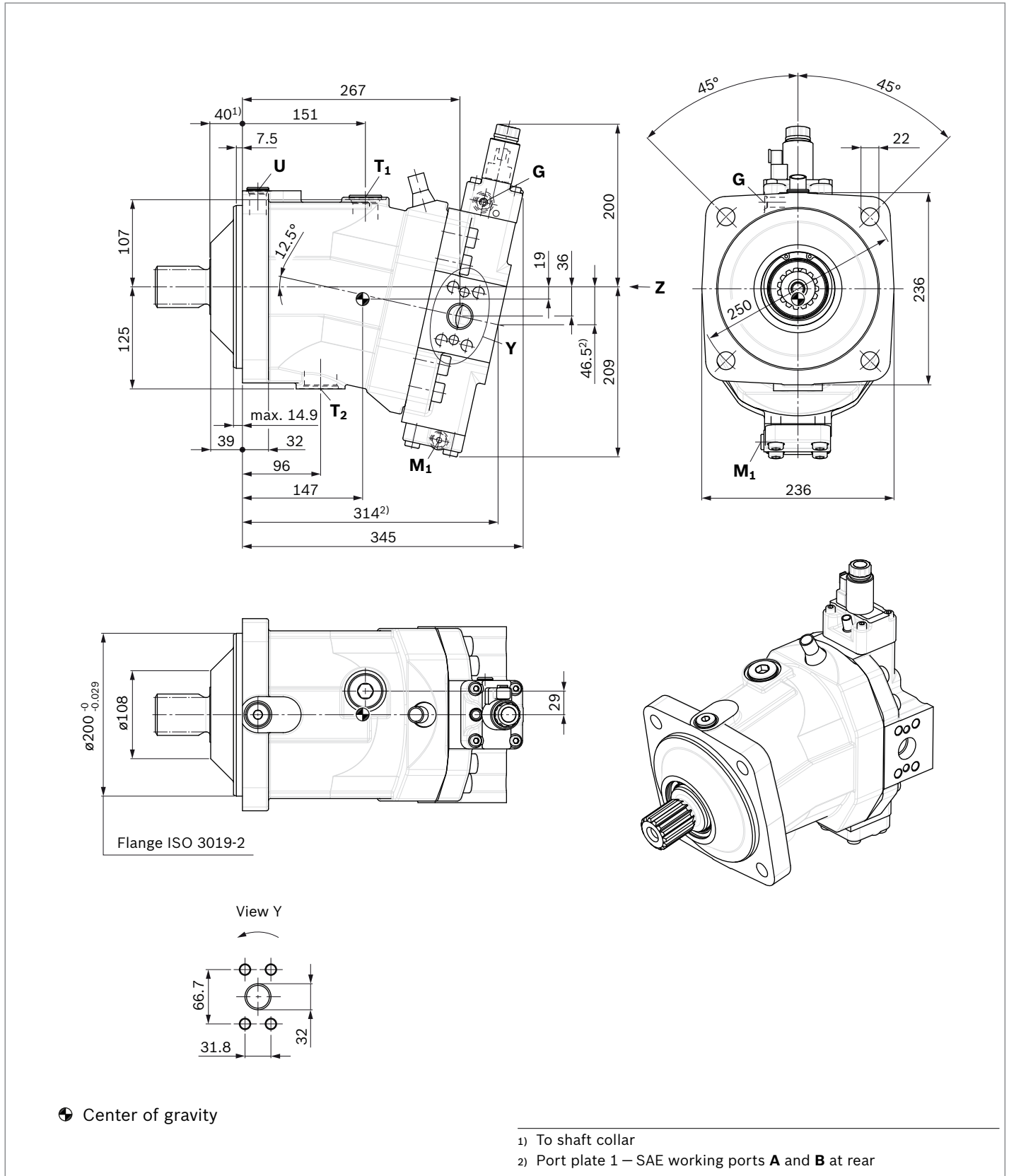
▼ **DA1, DA2** – Automatic speed-related control, negative control, with electric travel direction valve and electric  $V_{g\ max}$  circuit



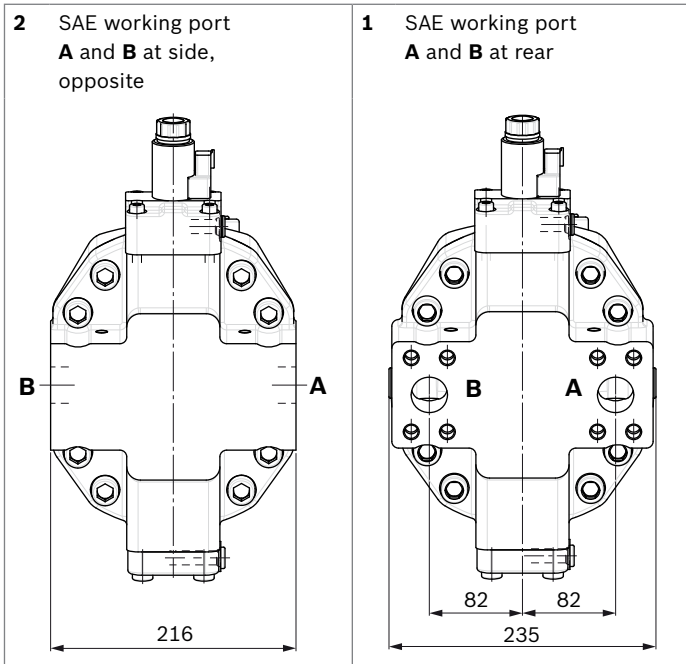
**Dimensions size 200**

**EP5, EP6 – Proportional electric control, negative control**

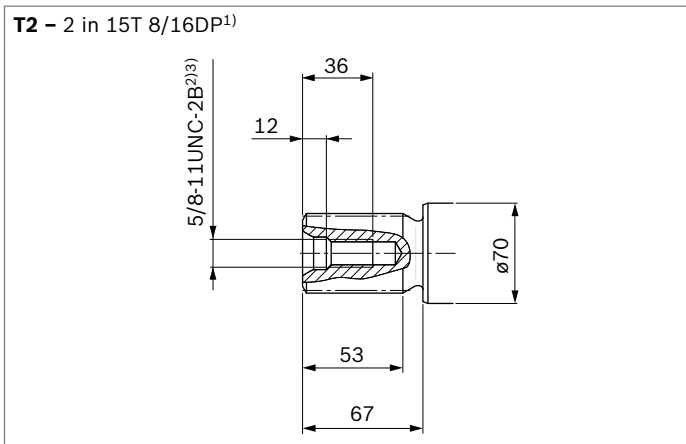
Port plate 2 – SAE working ports **A** and **B** at side, opposite



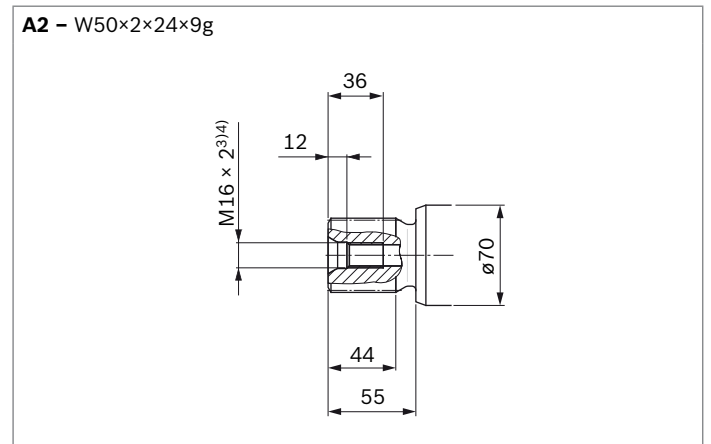
▼ **Location of the service line ports on the port plates (view Z)**



▼ **Splined shaft SAE J744**



▼ **Splined shaft DIN 5480**



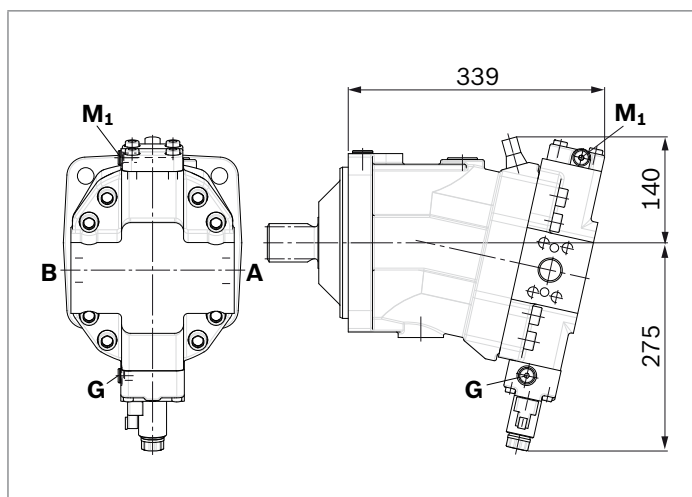
1) Involute spline acc. to ANSI B92.1a, 30° pressure angle, flat root, side fit, tolerance class 5  
 2) Thread according to ASME B1.1  
 3) For notes on tightening torques, see instruction manual  
 4) Center bore according to DIN 332 (thread according to DIN 13)

Ports		Standard	Size <sup>1)</sup>	$p_{max}$ [bar] <sup>2)</sup>	Status <sup>6)</sup>
<b>A, B</b>	Working port	SAE J518 <sup>3)</sup>	1 1/4 in	450	O
	Fastening thread A/B	DIN 13	M14 × 2; 19 deep		
<b>T<sub>1</sub></b>	Drain port	ISO 6149 <sup>5)</sup>	M33 × 2; 19 deep	3	X <sup>4)</sup>
<b>T<sub>2</sub></b>	Drain port	ISO 6149 <sup>5)</sup>	M42 × 2; 19.5 deep	3	O <sup>4)</sup>
<b>G</b>	Synchronous control	ISO 6149 <sup>5)</sup>	M14 × 1.5; 11.5 deep	450	X
<b>U</b>	Bearing flushing	ISO 6149 <sup>5)</sup>	M22 × 1.5; 15.5 deep	3	X
<b>X</b>	Pilot signal (HP, HZ, HA1T/HA2T)	ISO 6149 <sup>5)</sup>	M14 × 1.5; 11.5 deep	100	O
<b>X</b>	Pilot signal (HA1, HA2)	ISO 6149 <sup>5)</sup>	M14 × 1.5; 11.5 deep	3	X
<b>X<sub>1</sub>, X<sub>2</sub></b>	Pilot signal (DA0)	ISO 8434-1	SDSC-L8×M12-F	40	O
<b>X<sub>1</sub></b>	Pilot signal (DA1, DA2)	ISO 6149 <sup>5)</sup>	M14 × 1.5; 11.5 deep	40	O
<b>X<sub>3</sub></b>	Pilot signal (DA1, DA2)	ISO 6149 <sup>5)</sup>	M14 × 1.5; 11.5 deep	40	X
<b>M<sub>1</sub></b>	Stroking chamber measurement	ISO 6149 <sup>5)</sup>	M14 × 1.5; 11.5 deep	450	X

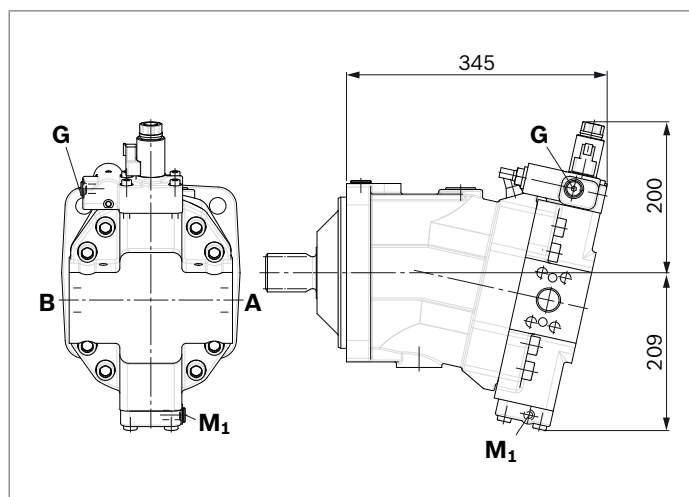
1) For notes on tightening torques, see instruction manual  
 2) Depending on the application, momentary pressure peaks can occur. Keep this in mind when selecting measuring devices and fittings.  
 3) Only dimensions according to SAE J518, metric fastening thread is a deviation from standard.

4) Depending on installation position, **T<sub>1</sub>** or **T<sub>2</sub>** must be connected (see also installation instructions on page 72).  
 5) The countersink can be deeper than as specified in the standard.  
 6) O = Must be connected (plugged on delivery)  
 X = Plugged (in normal operation)

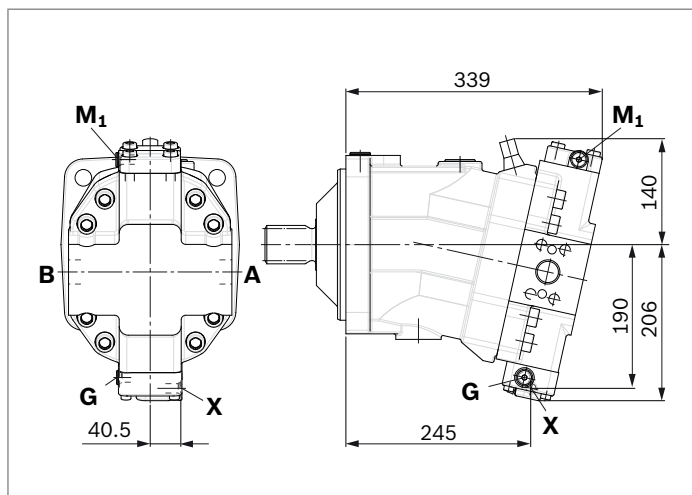
▼ **EP1, EP2** – Electric proportional control, positive control



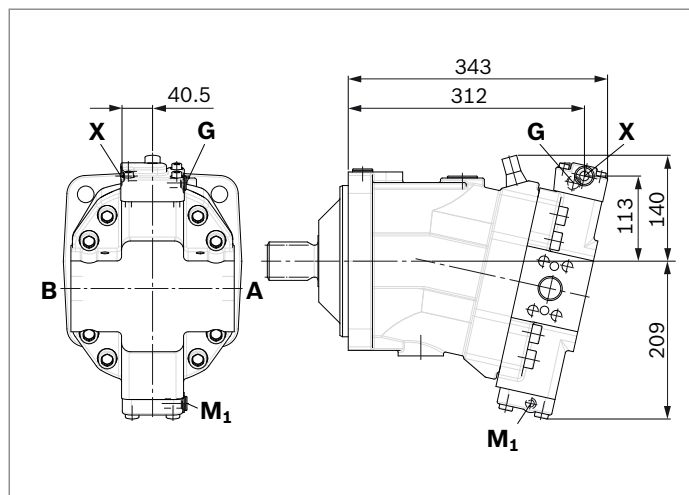
▼ **EP5D1, EP6D1** – Electric proportional control, negative control, with pressure control, fixed



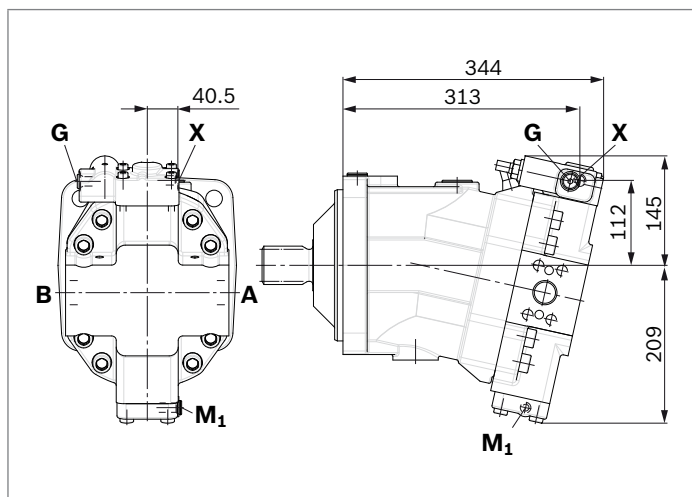
▼ **HP1, HP2** – Hydraulic proportional control, positive control



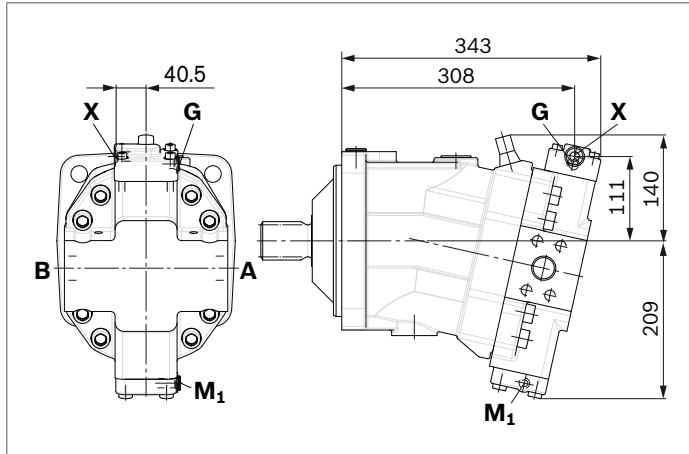
▼ **HP5, HP6** – Hydraulic proportional control, negative control



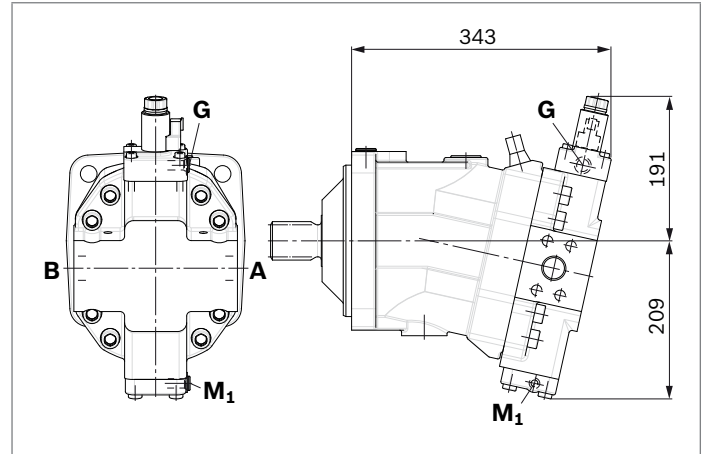
▼ **HP5D1, HP6D1** – Hydraulic proportional control, negative control, with pressure control, fixed



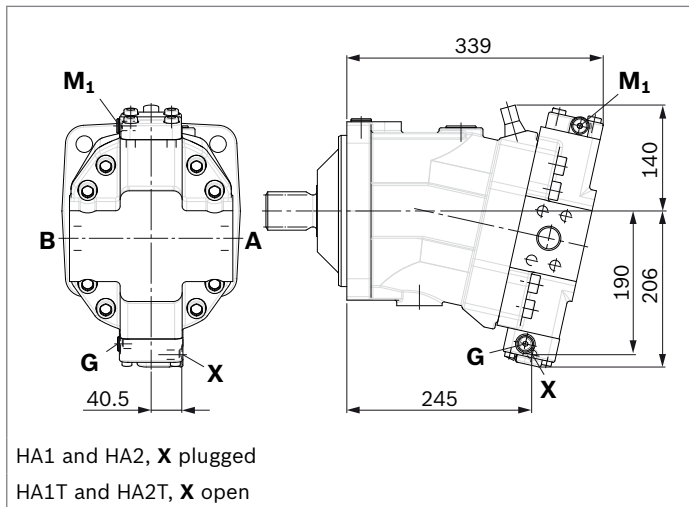
▼ **HZ5** – Hydraulic two-point control, negative control



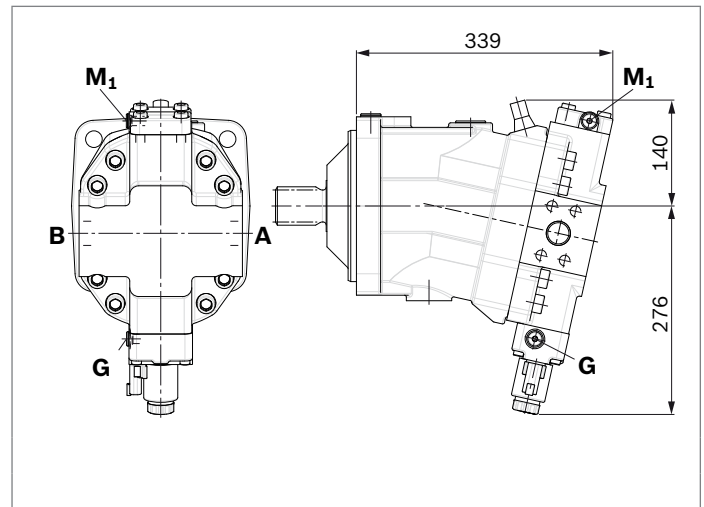
▼ **EZ5, EZ6** – Electric two-point control, negative control



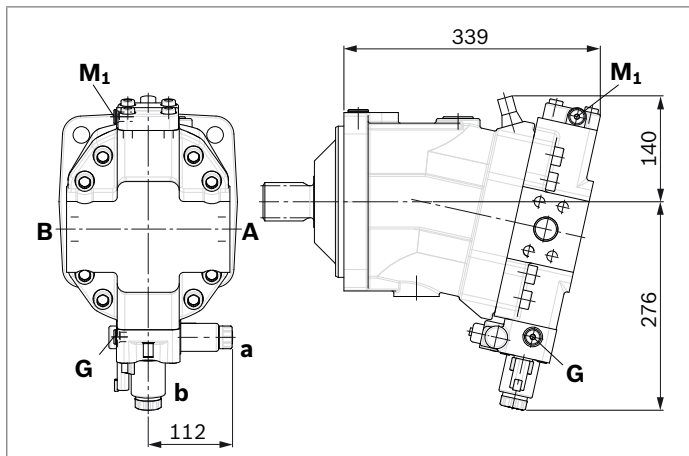
▼ **HA1, HA2 / HA1T3, HA2T3** – Automatic high-pressure-related control, positive control, with override hydraulic remote controlled, proportional



▼ **HA1U1, HA2U2** – Automatic high-pressure-related control, positive control, with override, electric, two-point

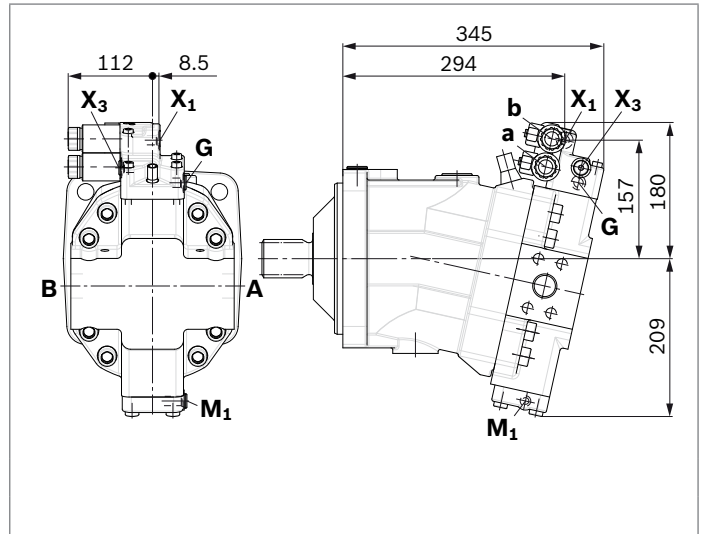
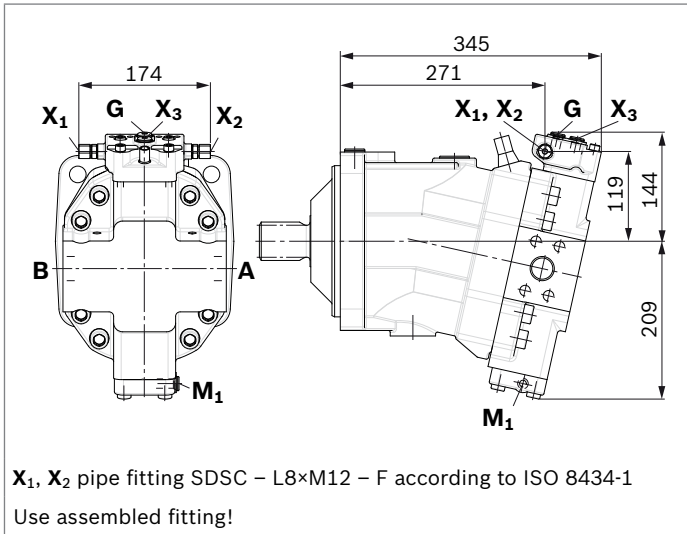


▼ **HA1R1, HA2R2** – Automatic high-pressure-related control, positive control, with override, electric and travel direction valve, electric



▼ **DA0** – Automatic speed-related control, negative control, with hydraulic travel direction valve

▼ **DA1, DA2** – Automatic speed-related control, negative control, with electric travel direction valve and electric  $V_{g\ max}$  circuit



## Connector for solenoids

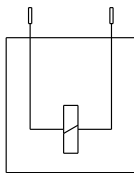
### DEUTSCH DT04-2P-EP04

Molded connector, 2-pin, without bidirectional suppressor diode

There is the following type of protection with mounted mating connector:

- ▶ IP67 (DIN/EN 60529) and
- ▶ IP69K (DIN 40050-9)

#### ▼ 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).

#### Notice

- ▶ If necessary, you can change the position of the connector by turning the solenoid.
- ▶ The procedure is defined in the instruction manual.

## Neutral position switch

The neutral position switch NLS electronically detects the neutral position of the A6VM, thereby ensuring the torque freedom of the motor. The use of the NLS in a transmission control provides a faster switching cycle in the drive. In addition, the switch reliability is improved and thereby the service life of the drive is increased. Type code, technical data, dimensions and parameters for the connector, plus safety instructions about the sensor can be found in the relevant data sheet 95152 – NLS.

### Technical data

Type	NLS	
Recommended operating voltage	5 V	
Maximum voltage	not actuated	32 V
	actuated	11.5 V
Minimum permissible current	0 mA	
Maximum permissible current	10 mA	
Maximum switching cycle number	1 million	
Contact type	normally open contact (open in unactuated state)	
Type of protection (with mating connector plugged)	IP67/IP69K	
Temperature range of sensor (medium and ambient temperature) <sup>1)</sup>	-40 °C ... 125 °C	
Temperature range of thread seal ring FKM <sup>1)</sup>	-15 °C ... 125 °C	
Pressure resistance	nominal	3 bar
	maximum (momentary peaks)	10 bar <sup>2)</sup>

### Notice

The minimum swivel angle is dependent on the  $V_{g \text{ min-Stop}}$

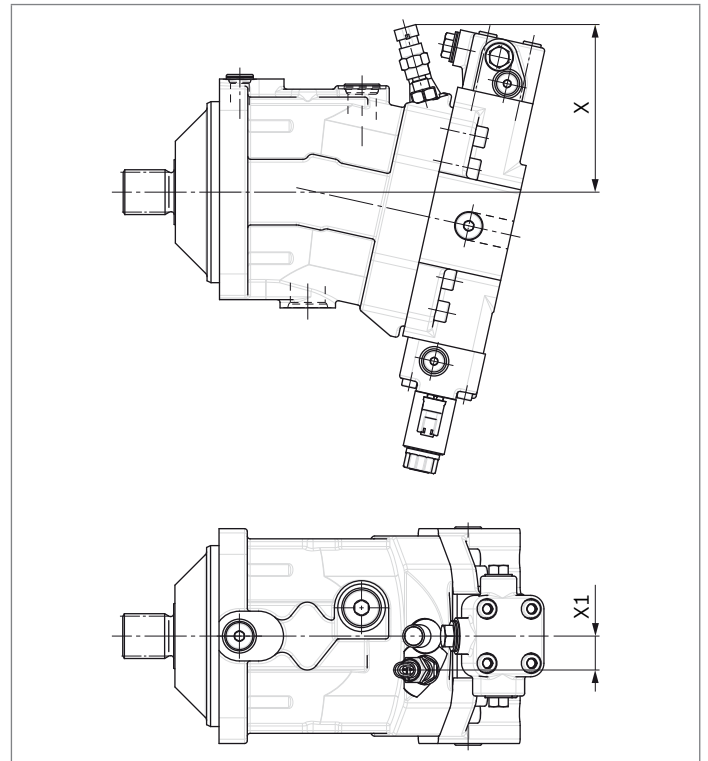
### ▼ Mating Connector

Consisting of	Material number
1 housing	282080
1 socket contact	282403-1

The mating connector is not included in the scope of delivery. This mating connector can be ordered from AMP.

### ▼ Dimensions

Version "N" with neutral position switch mounted



Size	Adjustable angle		X [mm]		X1 [mm]
	min.	max.	at min angle	at max angle	
80	0°	2°	144.7	141.4	28.0
107	0°	4°	148.1	140.4	30.0
140	0°	1°	153.1	150.9	30.0
160	0°	0°		153.1	30.0
200	0°	0°		159.1	30.0

- 1) Observe the permissible temperature range of the axial piston motor.
- 2) Observe the permissible viscosity range of the axial piston motor. At oil viscosities >1800 mm<sup>2</sup>/s, the switch may be unintentionally actuated by case pressure peaks of > 10 bar.

## Flushing and boost pressure valve

The flushing and boost pressure valve is used to remove heat from the hydraulic circuit.

In a closed circuit, it is used for flushing the case and safeguarding the minimum boost pressure.

Hydraulic fluid is directed from the respective low pressure side into the motor housing. This is then fed into the reservoir, together with the leakage. The hydraulic fluid, removed out of the closed circuit must be replaced by cooled hydraulic fluid from the boost pump.

The valve is mounted onto the port plate or integrated (depending on the control type and size).

### Cracking pressure of pressure retaining valve

(observe when adjusting the primary valve)

- Sizes 55 to 200, fixed setting 16 bar

### Switching pressure of flushing spool $\Delta p$

- Sizes 55 to 107 (small flushing valve)  $8 \pm 1$  bar
- Sizes 107 to 200 (medium and large flushing valve)  $17.5 \pm 1.5$  bar

### Flushing flow $q_v$

Orifices can be used to adjust the flushing flows as required. The following information is based on:

$$\Delta p_{ND} = p_{ND} - p_G = 25 \text{ bar and } v = 10 \text{ mm}^2/\text{s}$$

( $p_{ND}$  = low pressure,  $p_G$  = case pressure)

### Small flushing valve for sizes 55 to 107

Material number of orifice	$\varnothing$ [mm]	$q_v$ [l/min]	Code
R909651766	1.2	3.5	A
R909419695	1.4	5	B
R909419696	1.8	8	C
R909419697	2.0	10	D
R909444361	2.4	14	F

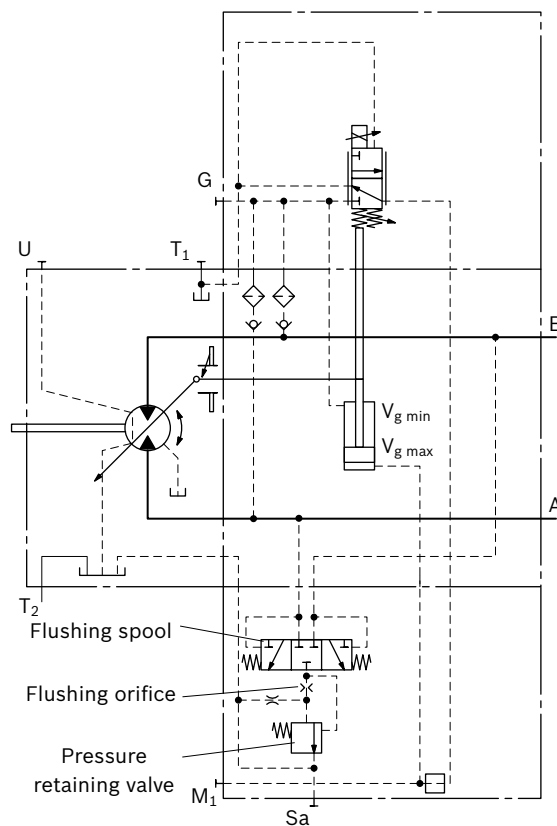
### Medium flushing valve for size 107

Material number of orifice	$\varnothing$ [mm]	$q_v$ [l/min]	Code
R909431310	2.8	18	I
R909435172	3.5	27	K
R909449967	5.0	31	L

### Large flushing valve for sizes 140 to 200

Material number of orifice	$\varnothing$ [mm]	$q_v$ [l/min]	Code
R909449998	1.8	8	C
R909431308	2.0	10	D
R909431309	2.5	15	G
R909431310	2.8	18	I
R902138235	3.1	21	J
R909435172	3.5	27	K
R909436622	4.0	31	L
R909449967	5.0	37	M

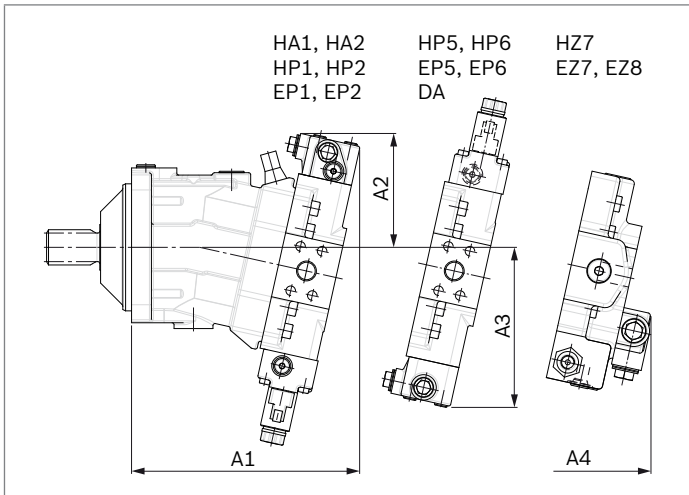
### ▼ Schematic EP



### Notice

- Port **S<sub>a</sub>** only for sizes 140 to 200
- For a flushing flow of 35 l/min, it is recommended that port **S<sub>a</sub>** be connected in order to prevent an increase in case pressure. An increased case pressure reduces the flushing flow.

▼ **Dimensions of sizes 55 to 107 (small flushing valve)**



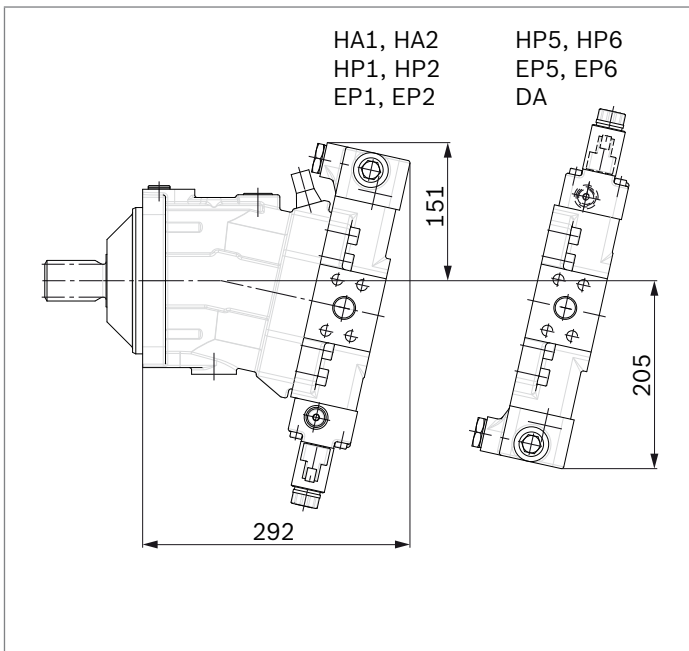
HA1, HA2  
HP1, HP2  
EP1, EP2

HP5, HP6  
EP5, EP6  
DA

HZ7  
EZ7, EZ8

NG	A1	A2	A3	A4
55	245	137	183	236
80	273	142	194	254
107	287	143	202	269

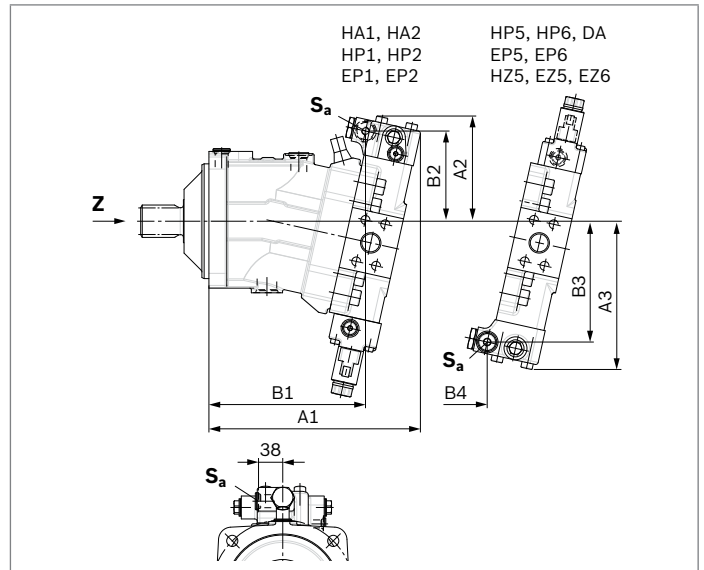
▼ **Dimensions for sizes 140 to 200 (large flushing valve)**



HA1, HA2  
HP1, HP2  
EP1, EP2

HP5, HP6  
EP5, EP6  
DA

▼ **Dimensions of size 107 (medium flushing valve)**



HA1, HA2  
HP1, HP2  
EP1, EP2

HP5, HP6, DA  
EP5, EP6  
HZ5, EZ5, EZ6

NG	A1	B1	A2	B2	A3	B3	B4	Sa <sup>1)</sup>
140	325	239	165	142	230	187	166	M22 × 1.5; 15.5 deep
160	332	246	165	142	233	190	172	M22 × 1.5; 15.5 deep
200	349	263	172	148	244	201	185	M22 × 1.5; 15.5 tief

1) ISO 6149, ports plugged (in normal operation)  
For notes on tightening torques, see instruction manual.  
The spot face may be deeper than that specified in the standard.

## Counterbalance valve BVD and BVE

### Function

Counterbalance valves for travel drives and winches operations are designed to reduce the danger of overspeeding and cavitation of axial piston motors in open circuits.

Cavitation occurs if, during braking, when driving downhill or during the load-lowering process, the motor speed is greater than it should be for the given inlet flow and thus the supply pressure collapses.

If the supply pressure falls below the level specified for the relevant counterbalance valve, the counterbalance valve piston moves into the closed position. The cross-sectional area of the counterbalance valve return duct is then reduced, creating a bottleneck in the return flow of the hydraulic fluid. The pressure increases and brakes the motor until the rotational speed of the motor is again as it should be for the given inlet flow.

### Notice

- ▶ BBVD available for sizes 55 to 200 and BVE available for sizes 107 to 200.
- ▶ The counterbalance valve must be ordered additionally. We recommend ordering the counterbalance valve and the motor as a set.  
Ordering example: A6VM080HA1T30004A/65MWW0N4S 97W0-0 + BVD20F27S/41B-V03K16D0400S12

- ▶ For safety reasons, controls with beginning of control at  $V_{g \min}$  (e.g. HA) are not permissible for winch drives!
- ▶ Counterbalance valves must be optimized during prototype commissioning to prevent unacceptable operating conditions and compliance with the specification must be verified.
- ▶ The counterbalance valve does not replace the mechanical service brake and holding brake.
- ▶ Observe the detailed notes on the counterbalance valve in data sheet 95522 – BVD and in data sheet 95525 – BVE!
- ▶ For the design of the brake release valve, we require the following data for the mechanical holding brake:
  - the cracking pressure
  - the volume of the counterbalance spool between minimum travel (brake closed) and maximum stroke (brake released with 21 bar)
  - the required closing time for a warm device (oil viscosity approx. 15 mm<sup>2</sup>/s)

### Permissible inlet flow or pressure when using DBV and BVD/BVE

Motor NG	Without valve		Limited values when using DBV and BVD/BVE				BVD <sup>2)</sup> /BVE <sup>3)</sup>			
	$p_{nom}/p_{max}$ [bar]	$q_{V \max}$ [l/min]	NG	$p_{nom}/p_{max}$ [bar]	$q_V$ [l/min]	Code	NG	$p_{nom}/p_{max}$ [bar]	$q_V$ [l/min]	Code
55	400/450	244	22	350/420	240	7	20 (BVD)	350/420	220	7W
80		312								
107		380								
107		380								
140		455								
160		496								
200		580	On request							

### Mounting of the counterbalance valve

When delivered, the counterbalance valve is fastened to the motor with two tacking screws (transport lock). The tacking screws may not be removed while mounting the working lines! If the counterbalance valve and motor are delivered separately, the counterbalance valve must first be fastened to the motor port plate using the provided tacking screws.

The counterbalance valve is finally mounted to the motor by fitting the SAE flange.

The screws to be used and the instructions for mounting can be found in the instruction manual.

1) Pressure-relief valve  
2) Counterbalance valve, double-acting  
3) Counterbalance valve, one-sided

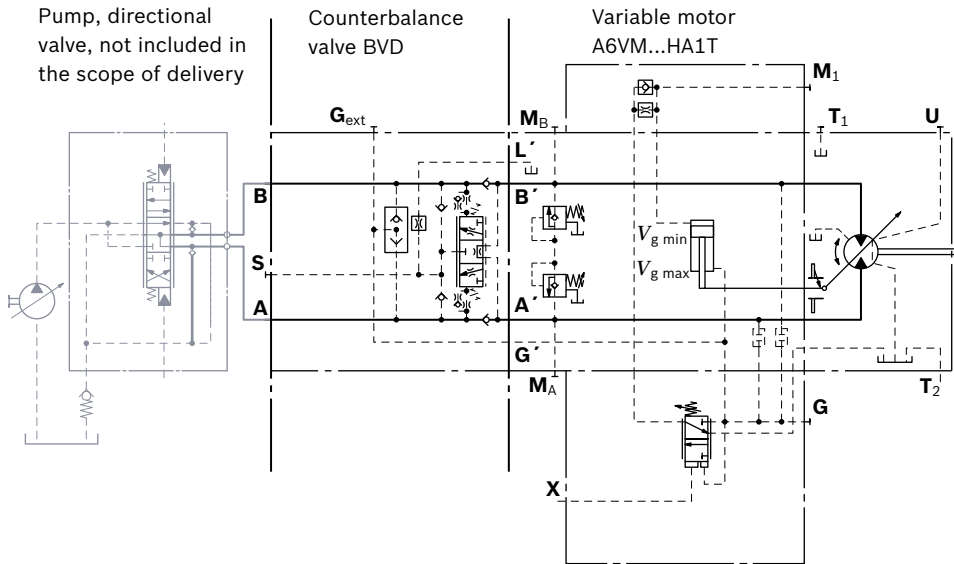
**Counterbalance valve for travel drive BVD...F**

Application option

- ▶ Travel drive for wheeled excavators (BVD and BVE)

▼ **Example circuit diagram for travel drive on wheeled excavators**

A6VM080HA1T30004A/65MWW0N4S97W0-0 + BVD20F27S/41B-V03K16D0400S12



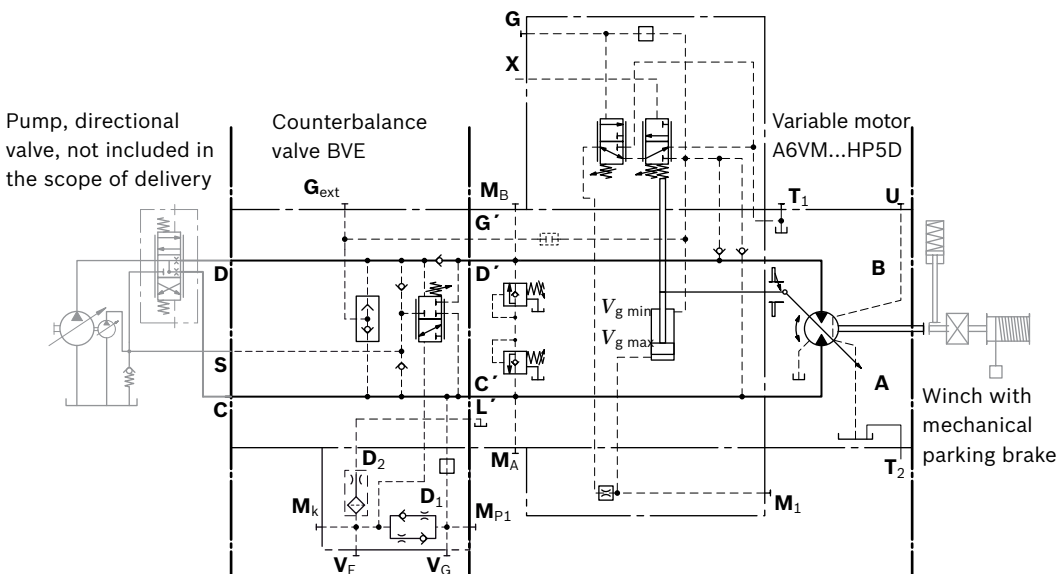
**Counterbalance valve for winches and track drives BVD...W and BVE**

Application option

- ▶ Winch drives in cranes (BVD and BVE)
- ▶ Track drive in excavator crawlers (BVD)

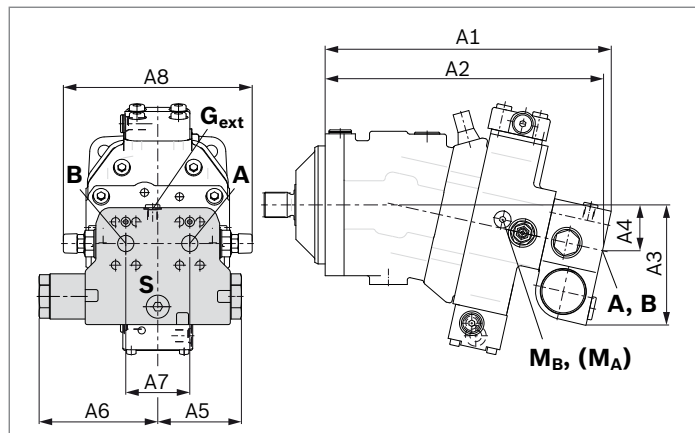
▼ **Example circuit diagram for winch drive in cranes**

A6VM080HP5D10001A/65MWW0N4S97W0-0 + BVE25W38S/51ND-V100K00D4599T30S00-0

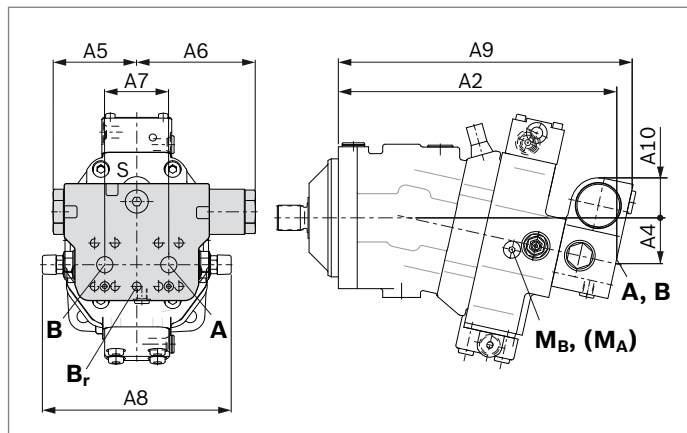


**Dimensions**

▼ **A6VM...HA, HP1, HP2 and EP1, EP2**



▼ **A6VM...HP5, HP6 and EP5, EP6<sup>1)</sup>**



A6VM NG...plate	Counterbalance valve Type	Ports A, B	Dimensions									
			A1	A2	A3	A4	A5	A6	A7	A8	A9	A10
55...7	BVD20...17	3/4 in	311	302	143	50	98	139	75	222	326	50
80...7	BVD20...27	1 in	340	331	148	55	98	139	75	222	355	46
107...7	BVD20...28	1 in	362	353	152	59	98	139	84	234	377	41
107...8	BVD25...38	1 1/4 in	380	370	165	63	120.5	175	84	238	395	56
140...8	BVD25...38	1 1/4 in	411	401	168	67	120.5	175	84	238	426	53
160...8	BVD25...38	1 1/4 in	417	407	170	68	120.5	175	84	238	432	51
200...8	BVD25...38	1 1/4 in	448	438	176	74	120.5	175	84	299	463	46
107...8	BVE25...38	1 1/4 in	380	370	171	63	137	214	84	238	397	63
140...8	BVE25...38	1 1/4 in	411	401	175	67	137	214	84	238	423	59
160...8	BVE25...38	1 1/4 in	417	407	176	68	137	214	84	238	432	59
200...8	BVE25...38	1 1/4 in	448	438	182	74	137	214	84	299	463	52

Ports	Version	A6VM plate	Standard	Size <sup>2)</sup>	P <sub>max</sub> [bar] <sup>3)</sup>	Status <sup>5)</sup>	
A, B	Working port		SAE J518	see table above	420	O	
S	Infeed	BVD20	DIN 3852 <sup>4)</sup>	M22 × 1.5; 14 deep	30	X	
		BVD25, BVE25	DIN 3852 <sup>4)</sup>	M27 × 2; 16 deep	30	X	
B <sub>r</sub>	Brake release, reduced high pressure	L	7	DIN 3852 <sup>4)</sup>	M12 × 1.5; 12.5 deep	30	O
			8	DIN 3852 <sup>4)</sup>	M12 × 1.5; 12 deep	30	O
G <sub>ext</sub>	Brake release, high pressure	S		DIN 3852 <sup>4)</sup>	M12 × 1.5; 12.5 deep	420	X
M <sub>A</sub> , M <sub>B</sub>	Pressure measurement <b>A and B</b>			ISO 6149 <sup>4)</sup>	M18 × 1.5; 14.5 deep	420	X

1) At the mounting version for the controls HP5, HP6 and EP5, EP6, the cast-in port designations **A** and **B** on the BVD counterbalance valve do not correspond with the port designation of the A6VM motor..  
The designation of the ports on the installation drawing of the motor is binding!

2) For notes on tightening torques, see instruction manual

3) Depending on the application, momentary pressure peaks can occur. Keep this in mind when selecting measuring devices and fittings.

4) The countersink can be deeper than as specified in the standard.

5) O = Must be connected (plugged on delivery)  
X = Plugged (in normal operation)

## Speed sensor

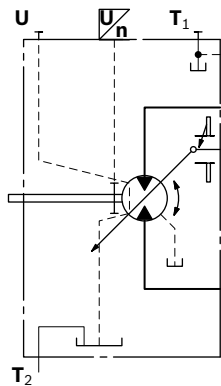
Version A6VM...U ("prepared for speed sensor", i.e. without sensor) is equipped with a spline on the rotary group. A signal proportional to motor speed can be generated with the fitted DSA/DSM speed sensor. The DSA/DSM sensor registers the speed and direction of rotation.

Ordering code, technical data, dimensions and details on the connector, plus safety instructions about the sensor can be found in the relevant data sheet (95132 – DSM, 95133 – DSA).

The sensor is mounted on the port provided for this purpose with a mounting bolt. On deliveries without sensor, the port is plugged with a pressure-resistant cover.

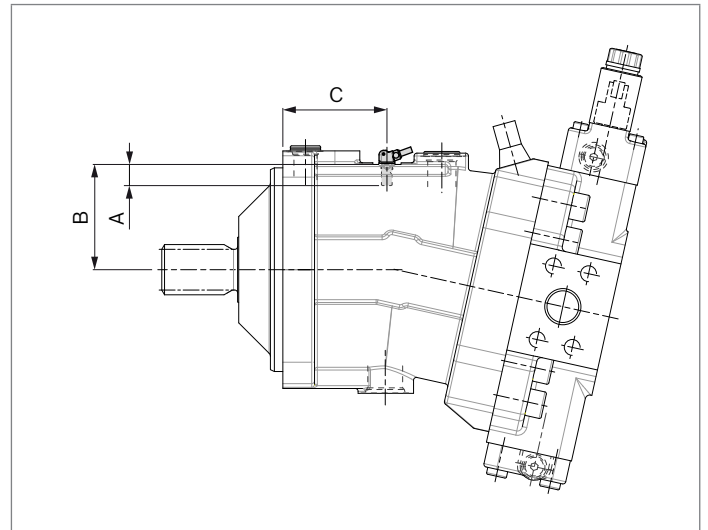
We recommend ordering the A6VM variable motor complete with mounted sensor.

### ▼ Circuit diagram EP



### ▼ Dimensions

"V" design with mounted speed sensor



Size	55	80	107	140	160	200
Number of teeth	54	58	67	72	75	80
A Insertion depth (tolerance -0.25)	18.4	18.4	18.4	18.4	18.4	18.4
B Contact surface	75	79	88	93	96	101
C	66.2	75.2	77.2	91.2	91.7	95.2

## Setting range for displacement

	55				80				107			
	$V_{g \max}$ (cm <sup>3</sup> /rev)		$V_{g \min}$ (cm <sup>3</sup> /rev)		$V_{g \max}$ (cm <sup>3</sup> /rev)		$V_{g \min}$ (cm <sup>3</sup> /rev)		$V_{g \max}$ (cm <sup>3</sup> /rev)		$V_{g \min}$ (cm <sup>3</sup> /rev)	
	from	to	from	to	from	to	from	to	from	to	from	to
<b>A</b>	54.8	54.8	0.0	13.3	80.0	80.0	0.0	9.0	107.0	107.0	0.0	22.2
	without screw		M10 × 60 R909154690		ohne Schraube		M12 × 60 R909083530		without screw		M12 × 70 R909085976	
<b>B</b>	54.8	54.8	> 13.3	27	80.0	80.0	> 9.0	26.0	107.0	107.0	> 22.2	43.8
	without screw		M10 × 70 R909153779		ohne Schraube		M12 × 70 R909085976		without screw		M12 × 80 R909153075	
<b>C</b>	54.8	54.8	> 27.0	38.0	80.0	80.0	> 26.0	44.0	107.0	107.0	> 43.8	65.5
	without screw		M10 × 80 R909154058		ohne Schraube		M12 × 80 R909153075		without screw		M12 × 90 R909154041	
<b>D</b>	x		x		80.0	80.0	> 44.0	56.0	107.0	107.0	> 65.5	75.0
					ohne Schraube		M12 × 90 R909154041		without screw		M12 × 100 R909153975	
<b>E</b>	< 54.8	42.0	0.0	13.3	< 80.0	72.0	0.0	9.0	< 107.0	86.0	0.0	22.2
	M10 × 60 R909154690		M10 × 60 R909154690		M12 × 60 R909083530		M12 × 60 R909083530		M12 × 70 R909085976		M12 × 70 R909085976	
<b>F</b>	< 54.8	42.0	> 13.3	27.0	< 80.0	72.0	> 9.0	26.0	< 107.0	86.0	> 22.2	43.8
	M10 × 60 R909154690		M10 × 70 R909153779		M12 × 60 R909083530		M12 × 70 R909085976		M12 × 70 R909085976		M12 × 80 R909153075	
<b>G</b>	< 54.8	42.0	> 27.0	38.0	< 80.0	72.0	> 26.0	44.0	< 107.0	86.0	> 43.8	65.5
	M10 × 60 R909154690		M10 × 80 R909154058		M12 × 60 R909083530		M12 × 80 R909153075		M12 × 70 R909085976		M12 × 90 R909154041	
<b>H</b>	x		x		< 80.0	72.0	> 44.0	56.0	< 107.0	86.0	> 65.5	75.0
					M12 × 60 R909083530		M12 × 90 R909154041		M12 × 70 R909085976		M12 × 100 R909153975	
<b>J</b>	< 42.0	29.0	0.0	13.3	< 72.0	55.0	0.0	9.0	< 86.0	64.0	0.0	22.2
	M10 × 70 R909153779		M10 × 60 R909154690		M12 × 70 R909085976		M12 × 60 R909083530		M12 × 80 R909153075		M12 × 70 R909085976	
<b>K</b>	< 42.0	29.0	> 13.3	27.0	< 72.0	55.0	> 9.0	26.0	< 86.0	64.0	> 22.2	43.8
	M10 × 70 R909153779		M10 × 70 R909153779		M12 × 70 R909085976		M12 × 70 R909085976		M12 × 80 R909153075		M12 × 80 R909153075	
<b>L</b>	< 42.0	29.0	> 27.0	38.0	< 72.0	55.0	> 26.0	44.0	< 86.0	64.0	> 43.8	65.5
	M10 × 70 R909153779		M10 × 80 R909154058		M12 × 70 R909085976		M12 × 80 R909153075		M12 × 80 R909153075		M12 × 90 R909154041	
<b>M</b>	x		x		< 72.0	55.0	> 44.0	56.0	< 86.0	64.0	> 65.5	75.0
					M12 × 70 R909085976		M12 × 90 R909154041		M12 × 80 R909153075		M12 × 100 R909153975	

Specify exact settings for  $V_{g \min}$  and  $V_{g \max}$  in plain text when ordering:

▶  $V_{g \min} = \dots \text{ cm}^3, V_{g \max} = \dots \text{ cm}^3$

Theoretical, maximum setting:

▶ for  $V_{g \min} = 0.7 \times V_{g \max}$

▶ for  $V_{g \max} = 0.3 \times V_{g \max}$

Settings that are not listed in the table may lead to damage.

Please contact us.

	140				160				200			
	$V_{g \max}$ (cm <sup>3</sup> /rev)		$V_{g \min}$ (cm <sup>3</sup> /rev)		$V_{g \max}$ (cm <sup>3</sup> /rev)		$V_{g \min}$ (cm <sup>3</sup> /rev)		$V_{g \max}$ (cm <sup>3</sup> /rev)		$V_{g \min}$ (cm <sup>3</sup> /rev)	
	from	to	from	to	from	to	from	to	from	to	from	to
<b>A</b>	140.0	140.0	0.0	38.0	160.0	160.0	0.0	32.6	200.0	200.0	0.0	39.0
	without screw		M12 × 80 R909153075		without screw		M12 × 80 R909153075		without screw		M12 × 80 R909153075	
<b>B</b>	140.0	140.0	> 38.0	63.5	160.0	160.0	> 32.6	59.2	200.0	200.0	> 39.0	72.0
	without screw		M12 × 90 R909154041		without screw		M12 × 90 R909154041		without screw		M12 × 90 R909154041	
<b>C</b>	140.0	140.0	> 63.5	89.0	160.0	160.0	> 59.2	89.0	200.0	200.0	> 72.0	105.0
	without screw		M12 × 100 R909153975		without screw		M12 × 100 R909153975		without screw		M12 × 100 R909153975	
<b>D</b>	140.0	140.0	> 89.0	98.0	160.0	160.0	> 89.0	112.0	200.0	200.0	> 105.0	140.0
	without screw		M12 × 110 R909154212		without screw		M12 × 110 R909154212		without screw		M12 × 110 R909154212	
<b>E</b>	< 140.0	105.0	0.0	38.0	< 160.0	129.0	0.0	32.6	< 200.0	164.0	0.0	39.0
	M12 × 80 R909153075		M12 × 80 R909153075		M12 × 80 R909153075		M12 × 80 R909153075		M12 × 80 R909153075		M12 × 80 R909153075	
<b>F</b>	< 140.0	105.0	> 38.0	63.5	< 160.0	129.0	> 32.6	59.2	< 200.0	164.0	> 39.0	72.0
	M12 × 80 R909153075		M12 × 90 R909154041		M12 × 80 R909153075		M12 × 90 R909154041		M12 × 80 R909153075		M12 × 90 R909154041	
<b>G</b>	< 140.0	105.0	> 63.5	89.0	< 160.0	129.0	> 59.2	89.0	< 200.0	164.0	> 72.0	105.0
	M12 × 80 R909153075		M12 × 100 R909153975		M12 × 80 R909153075		M12 × 100 R909153975		M12 × 80 R909153075		M12 × 100 R909153975	
<b>H</b>	< 140.0	105.0	> 89.0	98.0	< 160.0	129.0	> 89.0	112.0	< 200.0	164.0	> 105.0	140.0
	M12 × 80 R909153075		M12 × 110 R909154212		M12 × 80 R909153075		M12 × 110 R909154212		M12 × 80 R909153075		M12 × 110 R909154212	
<b>J</b>	< 105.0	80.0	0.0	38.0	< 129.0	100.0	0.0	32.6	< 164.0	130.5	0.0	39.0
	M12 × 90 R909154041		M12 × 80 R909153075		M12 × 90 R909154041		M12 × 80 R909153075		M12 × 90 R909154041		M12 × 80 R909153075	
<b>K</b>	< 105.0	80.0	> 38.0	63.5	< 129.0	100.0	> 32.6	59.2	< 164.0	130.5	> 39.0	72.0
	M12 × 90 R909154041		M12 × 90 R909154041		M12 × 90 R909154041		M12 × 90 R909154041		M12 × 90 R909154041		M12 × 90 R909154041	
<b>L</b>	< 105.0	80.0	> 63.5	89.0	< 129.0	100.0	> 59.2	89.0	< 164.0	130.5	> 72.0	105.0
	M12 × 90 R909154041		M12 × 100 R909153975		M12 × 90 R909154041		M12 × 100 R909153975		M12 × 90 R909154041		M12 × 100 R909153975	
<b>M</b>	< 105.0	80.0	> 89.0	98.0	< 129.0	100.0	> 89.0	112.0	< 164.0	130.5	> 105.0	140.0
	M12 × 90 R909154041		M12 × 110 R909154212		M12 × 90 R909154041		M12 × 110 R909154212		M12 × 90 R909154041		M12 × 110 R909154212	

Specify exact settings for  $V_{g \min}$  and  $V_{g \max}$  in plain text when ordering:

▶  $V_{g \min} = \dots \text{ cm}^3$ ,  $V_{g \max} = \dots \text{ cm}^3$

Theoretical, maximum setting:

▶ for  $V_{g \min} = 0.7 \times V_{g \max}$

▶ for  $V_{g \max} = 0.3 \times V_{g \max}$

Settings that are not listed in the table may lead to damage.

Please contact us.

## Installation instructions

### General

During commissioning and operation, the axial piston unit must be filled with hydraulic fluid and air bled. This must also be observed following a relatively long standstill as the fluid from the axial piston unit may drain back to the reservoir via the hydraulic lines.

Particularly in the installation position “drive shaft upwards” filling and air bleeding must be carried out completely as there is, for example, a danger of dry running.

The leakage in the motor housing must be directed to the reservoir via the highest available drain port (**T<sub>1</sub>**, **T<sub>2</sub>**).

For combinations of multiple units, make sure that the respective case pressure in each unit is not exceeded. In the event of pressure differences at the drain ports of the units, the shared drain line must be changed so that the maximum permissible case pressure of all connected units is not exceeded at any operational conditions. If this is not possible, separate drain lines must be laid.

To achieve favorable noise values, decouple all connecting lines using elastic elements and avoid above-reservoir installation.

In all operating conditions, the drain line must flow into the reservoir below the minimum fluid level.

### Notice

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

Key	
<b>F</b>	Filling / air bleeding
<b>U</b>	Bearing flushing / air bleed port
<b>T<sub>1</sub>, T<sub>2</sub></b>	Drain port
<b>h<sub>t min</sub></b>	Minimum required immersion depth (200 mm)
<b>h<sub>min</sub></b>	Minimum required spacing to reservoir bottom (100 mm)

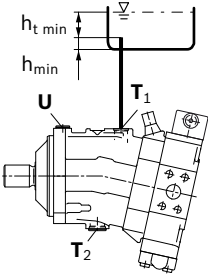
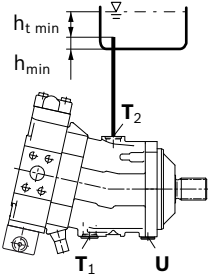
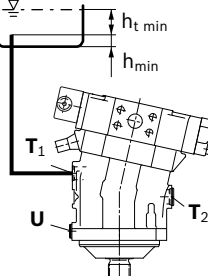
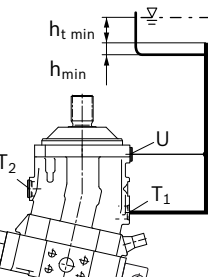
### Installation position

See examples **1** to **8** below.

Additional installation positions are available upon request.  
Recommended installation position: **1** and **2**

### Below-reservoir installation (standard)

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

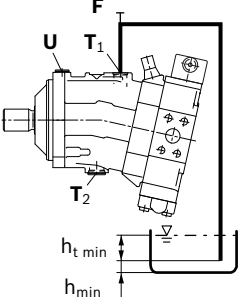
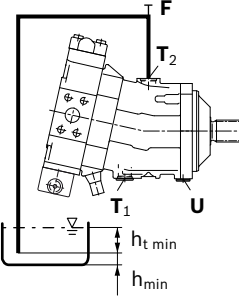
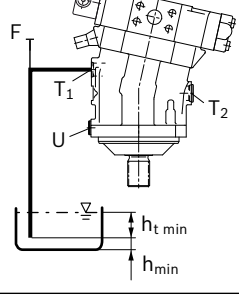
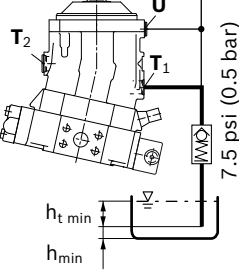
Installation position	Air bleed	Filling
<b>1</b>		<b>T<sub>1</sub></b>
		
<b>2</b>		<b>T<sub>2</sub></b>
		
<b>3</b>		<b>T<sub>1</sub></b>
		
<b>4</b>	<b>U</b>	<b>T<sub>1</sub></b>
		

**Above-reservoir installation**

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

Recommendation for installation position 8 (drive shaft upward):

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

Installation position	Air bleed	Filling
<p><b>5</b></p> 	<b>U (F)</b>	<b>T<sub>1</sub> (F)</b>
<p><b>6</b></p> 	<b>F</b>	<b>T<sub>2</sub> (F)</b>
<p><b>7</b></p> 	<b>F</b>	<b>T<sub>1</sub> (F)</b>
<p><b>8</b></p> 	<b>U</b>	<b>T<sub>1</sub> (F)</b>

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

## Project planning notes

- ▶ The motor A6VE is designed to be used in open and closed circuits.
- ▶ The project planning, installation and commissioning of the axial piston unit requires the involvement of qualified skilled personnel.
- ▶ Before using the axial piston unit, please read the corresponding instruction manual completely and thoroughly. If necessary, these 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.
- ▶ For safety reasons, controls with beginning of control at  $V_{g \min}$  (e.g. HA) are not permissible for winch drives, e.g. anchor winches.
- ▶ Depending on the operating conditions of the axial piston unit (working pressure, fluid temperature), the characteristic curve may shift.
- ▶ Preservation: Our axial piston units are supplied as standard with preservative protection for a maximum of 12 months. If longer preservative protection is required (maximum 24 months), please specify this in plain text when placing your order. The preservation periods apply under optimal storage conditions, details of which can be found in the data sheet 90312 or the instruction manual.
- ▶ Not all versions of the product are approved for use in a safety function according to ISO 13849. Please consult the responsible contact person at Bosch Rexroth if you require reliability parameters (e.g.  $MTTF_d$ ) for functional safety.
- ▶ Depending on the type of control used, electromagnetic effects can be produced when using solenoids. When a direct current is applied, solenoids do not cause electromagnetic interference nor is their operation impaired by electromagnetic interference.  
Other behavior can result when a modulated direct current (e.g. PWM signal) is applied. Potential electromagnetic interference for persons (e.g. persons with a pacemaker) and other components must be tested by the machine manufacturer.
- ▶ Please note the details regarding the tightening torques of port threads and other threaded joints in the instruction manual.
- ▶ Working ports:
  - The ports and fastening threads are designed for the specified maximum pressure. The machine or system manufacturer must ensure that the connecting elements and lines correspond to the specified application conditions (pressure, flow, hydraulic fluid, temperature) with the necessary safety factors.
  - The working ports and function ports are only intended to accommodate hydraulic lines.

## Safety instructions

- ▶ During and shortly after operation, there is a risk of getting burnt on the axial piston unit and especially on the solenoids. Take appropriate safety measures (e.g. by wearing protective clothing).
- ▶ Moving parts in control equipment (e.g. valve pistons) can, under certain circumstances get stuck in position as a result of contamination (e.g. impure 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 filter) 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 set the consumer being driven to a safe position (e.g. safe stop) and if necessary to ensure it is properly implemented.
- ▶ Moving parts in high-pressure relief valves may in certain circumstances become stuck in an undefined position due to contamination (e.g. contaminated hydraulic fluid). This can result in restriction or loss of the load holding function in lifting winches.  
The machine/system manufacturer must check whether additional measures are required on the machine for the relevant application in order to keep the load in a safe position and ensure they are properly implemented.
- ▶ When using the axial piston motor in winch drives, make certain that the technical limit values are not exceeded under all operating conditions. If the axial piston motor is extremely overloaded (e.g. if the maximum permissible rotational speeds are exceeded during weighing of the anchor while the ship is in motion), the rotary group may be damaged and, in the worst case, the axial piston motor may burst. The machine manufacturer / system manufacturer is to undertake additional measures, up to and including encapsulation.

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# Axial piston variable motor

## A6VM series 71

**RE 91610**

Edition: 11.2018

Replaces: 09.2018



- ▶ All-purpose high pressure motor
- ▶ Sizes 60 to 280
- ▶ Nominal pressure 450 bar
- ▶ Maximum pressure 530 bar (sizes 60 to 215)
- ▶ Maximum pressure 500 bar (size 280)
- ▶ Open and closed circuits

### Features

- ▶ Robust motor with long service life
- ▶ Approved for very high rotational speeds
- ▶ High starting efficiency
- ▶ Excellent slow-running characteristics
- ▶ Large variety of controls
- ▶ High control range (can be swiveled to zero)
- ▶ High torque
- ▶ Optionally with flushing and boost-pressure valve mounted
- ▶ Optionally with mounted high-pressure counterbalance valve
- ▶ Bent-axis design

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## Type code

01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	
<b>A6V</b>	<b>M</b>						<b>0</b>			<b>/</b>	<b>71</b>	<b>M</b>	<b>W</b>	<b>V</b>	<b>0</b>					<b>-</b>	

### Axial piston unit

01	Bent-axis design, variable, nominal pressure 450 bar, maximum pressure 530 bar (NG60 to 215) resp. 500 bar (NG280)	<b>A6V</b>
----	--	------------

### Operating mode

02	Motor	<b>M</b>
----	-------	----------

### Size

03	Geometric displacement, see "Technical data" on page 9	<b>060</b>	<b>085</b>	<b>115</b>	<b>150</b>	<b>170</b>	<b>215</b>	<b>280</b>
----	--	------------	------------	------------	------------	------------	------------	------------

### Control device

						<b>060</b>	<b>085</b>	<b>115</b>	<b>150</b>	<b>170</b>	<b>215</b>	<b>280</b>
04	Proportional control, hydraulic	positive control	$\Delta p_{St} = 10 \text{ bar}$	●	●	●	●	●	●	●	●	<b>HP1</b>
			$\Delta p_{St} = 25 \text{ bar}$	●	●	●	●	●	●	●	<b>HP2</b>	
		negative control	$\Delta p_{St} = 10 \text{ bar}$	●	●	●	●	●	●	●	<b>HP5</b>	
			$\Delta p_{St} = 25 \text{ bar}$	●	●	●	●	●	●	●	<b>HP6</b>	
	Proportional control, electric	positive control	$U = 12 \text{ V}$	●	●	●	●	●	●	●	●	<b>EP1</b>
			$U = 24 \text{ V}$	●	●	●	●	●	●	●	<b>EP2</b>	
		negative control	$U = 12 \text{ V}$	●	●	●	●	●	●	●	<b>EP5</b>	
			$U = 24 \text{ V}$	●	●	●	●	●	●	●	<b>EP6</b>	
	Two-point control, hydraulic	negative control		-	-	-	●	●	●	●	●	<b>HZ5</b>
				●	●	●	-	-	-	-	<b>HZ7</b>	
	Two-point control, electric	negative control	$U = 12 \text{ V}$	-	-	-	●	●	●	●	●	<b>EZ5</b>
			$U = 24 \text{ V}$	-	-	-	●	●	●	●	<b>EZ6</b>	
$U = 12 \text{ V}$			●	●	●	-	-	-	-	<b>EZ7</b>		
$U = 24 \text{ V}$			●	●	●	-	-	-	-	<b>EZ8</b>		
Automatic control high-pressure related, positive control	with minimum pressure increase	$\Delta p \leq \text{approx. } 10 \text{ bar}$	●	●	●	●	●	●	●	●	<b>HA1</b>	
	with pressure increase	$\Delta p = 100 \text{ bar}$	●	●	●	●	●	●	●	<b>HA2</b>		
Automatic control speed-related, negative control	hydr. travel direction valve		●	●	●	●	●	●	●	●	-	<b>DA0</b>
		electr. travel direction valve + electr. $V_{g \text{ max}}$ override	$U = 12 \text{ V}$	●	●	●	●	●	●	●	-	<b>DA1</b>
	$p_{St} / p_{HD} = 5/100$	hydr. travel direction valve	$U = 24 \text{ V}$	●	●	●	●	●	●	●	-	<b>DA2</b>
				-	-	-	-	-	-	-	●	<b>DA7</b>

### Pressure control/override

						<b>060</b>	<b>085</b>	<b>115</b>	<b>150</b>	<b>170</b>	<b>215</b>	<b>280</b>
05	Without pressure control/override			●	●	●	●	●	●	●	●	<b>00</b>
	Pressure control fixed setting, only for HP5, HP6, EP5 and EP6			●	●	●	●	●	●	●	●	<b>D1</b>
	Override of the HA1 and HA2 controls	Hydraulic remote control, proportional			●	●	●	●	●	●	●	<b>T3</b>
		electric, two-point	$U = 12 \text{ V}$	●	●	●	●	●	●	-	<b>U1</b>	
			$U = 24 \text{ V}$	●	●	●	●	●	●	-	<b>U2</b>	
		electric and travel direction valve, electric	$U = 12 \text{ V}$	●	●	●	●	●	●	-	<b>R1</b>	
$U = 24 \text{ V}$	●		●	●	●	●	●	-	<b>R2</b>			

### Connector for solenoids<sup>1)</sup> (see page 70)

										<b>060 to 280</b>	
06	Without connector (without solenoid, only for hydraulic control)									●	<b>0</b>
	DEUTSCH - molded connector, 2-pin, without suppressor diode										●

● = Available    ○ = On request    - = Not available

<sup>1)</sup> Connectors for other electric components may deviate

01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	
<b>A6V</b>	<b>M</b>						<b>0</b>			<b>/</b>	<b>71</b>	<b>M</b>	<b>W</b>	<b>V</b>	<b>0</b>						<b>-</b>

<b>Swivel angle detection</b> (see page 71)										<b>060</b>	<b>085</b>	<b>115</b>	<b>150</b>	<b>170</b>	<b>215</b>	<b>280</b>		
07	Without									●	●	●	●	●	●	●	●	<b>0</b>
	Neutral position switch									-	●	●	●	●	●	●	-	<b>N</b>

<b>Additional function</b>										<b>060 to 280</b>									
08	Without additional function																	●	<b>0</b>

<b>Stroking time damping</b> (for selection, see control)										<b>060 to 280</b>									
09	Without damping (standard with HP and EP)																	●	<b>0</b>
	Damping HP, EP, HP5,6D. and EP5,6D., HZ, EZ, HA with BVD/BVE counterbalance valves																	●	<b>1</b>
										One-sided in inlet to large stroking chamber (HA)								●	<b>4</b>
										One-sided in outlet from large stroking chamber (DA)								●	<b>7</b>
																		●	<b>7</b>

<b>Setting range for displacement<sup>2)</sup></b>										<b>060</b>	<b>085</b>	<b>115</b>	<b>150</b>	<b>170</b>	<b>215</b>	<b>280</b>		
10	$V_{g \max}$ setting screw		$V_{g \min}$ setting screw															
	No setting screw		short (0-adjustable)							●	●	●	●	●	●	●	-	<b>A</b>
			moderate							●	●	●	●	●	●	●	-	<b>B</b>
			long							●	●	●	●	●	●	●	-	<b>C</b>
			extra long							-	-	●	●	●	●	-	<b>D</b>	
	short		short (0-adjustable)							●	●	●	●	●	●	●	●	<b>E</b>
			moderate							●	●	●	●	●	●	●	●	<b>F</b>
			long							●	●	●	●	●	●	●	●	<b>G</b>
			extra long							-	-	●	●	●	●	●	●	<b>H</b>
	moderate <sup>3)</sup>		short (0-adjustable)							●	●	●	●	●	●	●	●	<b>J</b>
			moderate							●	●	●	●	●	●	●	●	<b>K</b>
			long							●	●	●	●	●	●	●	●	<b>L</b>
			extra long							-	-	●	●	●	●	●	●	<b>M</b>

<b>Series</b>										<b>060 to 280</b>									
11	Series 7, Index 1																	●	<b>71</b>

<b>Version of port and fastening threads</b>										<b>060 to 280</b>									
12	Metric ports according to ISO 6149 with O-ring seal, metric fastening thread according to DIN 13																	●	<b>M</b>

<b>Direction of rotation</b>										<b>060 to 280</b>									
13	Viewed on drive shaft, bidirectional																	●	<b>W</b>

<b>Sealing material</b>										<b>060 to 280</b>									
14	FKM (fluoroelastomer)																	●	<b>V</b>

<b>Drive shaft bearing</b>										<b>060 to 280</b>									
15	Standard bearing																	●	<b>0</b>

<b>Mounting flange</b>										<b>060</b>	<b>085</b>	<b>115</b>	<b>150</b>	<b>170</b>	<b>215</b>	<b>280</b>		
16	ISO 3019-2		125-4							●	-	-	-	-	-	-	-	<b>M4</b>
			140-4							-	●	-	-	-	-	-	-	<b>N4</b>
			160-4							-	-	●	-	-	-	-	-	<b>P4</b>
			180-4							-	-	-	●	●	-	-	-	<b>R4</b>
			200-4							-	-	-	-	-	●	●	<b>S4</b>	

● = Available    ○ = On request    - = Not available

<sup>2)</sup> The settings for the setting screws can be found in the table (page 84 and 85).

<sup>3)</sup>  $V_{g \max}$  for size 280 not adjustable, limitation by cap

01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	
<b>A6V</b>	<b>M</b>						<b>0</b>			<b>/</b>	<b>71</b>	<b>M</b>	<b>W</b>	<b>V</b>	<b>0</b>					<b>-</b>	

Drive shaft			060	085	115	150	170	215	280	
17	Splined shaft ANSI B92.1a	1 1/4 in 14T 12/24 DP	●	-	-	-	-	-	-	<b>S7</b>
		1 1/4 in 17T 12/24 DP	-	●	-	-	-	-	-	<b>S9</b>
		1 3/4 in 13T 8/16 DP	-	-	●	●	-	-	-	<b>T1</b>
		2 in 15T 8/16 DP	-	-	-	○	●	●	-	<b>T2</b>
		2 1/4 in 17T 8/16 DP	-	-	-	-	-	-	●	<b>T3</b>
Splined shaft DIN 5480	W35×2×16×9g	●	-	-	-	-	-	-	<b>Z8</b>	
	W40×2×18×9g	-	●	●	-	-	-	-	<b>Z9</b>	
	W45×2×21×9g	-	-	-	●	●	-	-	<b>A1</b>	
	W50×2×24×9g	-	-	-	-	-	●	-	<b>A2</b>	
	W60×2×28×9g	-	-	-	-	-	-	●	<b>A4</b>	

Working port			060	085	115	150	170	215	280	
18	SAE working ports <b>A</b> and <b>B</b> at rear		●	●	●	●	●	●	●	<b>1</b>
	SAE working ports <b>A</b> and <b>B</b> , at side, opposite		●	●	●	●	●	●	●	<b>2</b>
	SAE flange ports A and B at bottom, with integrated counterbalance valve <sup>4)</sup>		-	-	-	●	●	-	-	<b>6</b>
	Port plate for mounting a counterbalance valve, with 1-stage pressure-relief valve (pilot operated) <sup>5)</sup>	BVD 20	●	●	●	-	-	-	-	<b>7</b>
		BVD 25	-	-	●	●	●	-	-	<b>8</b>
		BVE 25	-	-	●	-	-	-	-	<b>8</b>
	Port plate for mounting a counterbalance valve, with 1-stage pressure-relief valve (direct operated) <sup>5)</sup>	BVE 25	-	-	-	●	●	●	-	<b>5</b>
		BVD 25	-	-	-	-	-	●	-	<b>5</b>
		BVD/BVE 32	-	-	-	-	-	●	● <sup>6)</sup>	<b>9</b>

Valve (see page 72 to 82)			060	085	115	150	170	215	280		
19	Without valve		●	●	●	●	●	●	●	<b>0</b>	
	With BVD/BVE counterbalance valves mounted <sup>7)</sup>		●	●	●	●	●	●	-	<b>W</b>	
	With flushing and boost-pressure valve mounted, <b>Flushing flow <math>q_v</math> [l/min]</b>										
	flushing on both sides										
	Flushing flow when:										
	$\Delta p = p_{ND} - p_G = 25 \text{ bar}$ and $v = 10 \text{ mm}^2/\text{s}$										
	$(p_{ND} = \text{low pressure, } p_G = \text{case pressure})$										
	Only possible for port plates 1 and 2										
		3.5	●	●	●	-	-	-	-	<b>A</b>	
		5	●	●	●	-	-	-	-	<b>B</b>	
		8	●	●	●	●	●	●	-	<b>C</b>	
		10	●	●	●	●	●	●	-	<b>D</b>	
		14	●	●	●	-	-	-	-	<b>F</b>	
		15	-	-	● <sup>8)</sup>	●	●	●	-	<b>G</b>	
		16	●	●	● <sup>8)</sup>	-	-	-	-	<b>H</b>	
	18	-	-	● <sup>8)</sup>	●	●	●	-	<b>I</b>		
	21	-	-	● <sup>8)</sup>	●	●	●	-	<b>J</b>		
	27	-	-	● <sup>8)</sup>	●	●	●	-	<b>K</b>		
	31	-	-	● <sup>8)</sup>	●	●	●	-	<b>L</b>		
	37	-	-	-	●	●	●	-	<b>M</b>		
	adjustable 0-60	-	-	-	-	-	-	●	<b>V</b>		

● = Available    ○ = On request    - = Not available

4) Only in combination with HZ5, EZ5, EZ6, HP or EP with respective negative control

5) Possible only in combination with HP, EP and HA control

6) A port plate for mounting the MHB32 counterbalance valve with a 1-stage pressure-relief valve (pilot operated) is available as a special version for applications without boost pressure supply

7) Type code for counterbalance valve to be quoted separately in accordance with data sheet 95522 (BVD), 95525 (BVE) and 95528 (BVD/BVE32).

Note the restrictions described on page 74.

8) Not for EZ7, EZ8 and HZ7.

01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	
<b>A6V</b>	<b>M</b>						<b>0</b>			<b>/</b>	<b>71</b>	<b>M</b>	<b>W</b>	<b>V</b>	<b>0</b>					<b>-</b>	

Speed sensor (see page 83)		060	085	115	150	170	215	280	0
20	Without speed sensor	●	●	●	●	●	●	●	●
	Prepared for HDD speed sensor	-	-	-	-	-	-	-	●
	HDD speed sensor mounted <sup>9)</sup>	-	-	-	-	-	-	-	●
	Prepared with DSM/DSA speed sensor	●	●	●	●	●	●	●	○
	With DSM/DSA speed sensor mounted <sup>9)</sup>	●	●	●	●	●	●	●	○

Standard/special version		0
21	Standard version	●
	Standard version with installation variants, e.g. <b>T</b> ports open and closed contrary to standard	●
	Special version	●

● = Available    ○ = On request    - = Not available

**Notices**  
▶ Note the project planning notes on page 87.

<sup>9)</sup> Specify the type code of sensor in accordance with data sheet 95135 (HDD), 95132 (DSM) or 95133 (DSA) and observe the requirements for the electronics.

## Hydraulic fluids

The A6VM variable motor is designed for operation with HLP mineral oil according to DIN 51524.

Application instructions and requirements for hydraulic fluid selection, behavior during operation as well as disposal and environmental protection should be taken from the following data sheets before the start of project planning:

- ▶ 90220: Hydraulic fluids based on mineral oils and related hydrocarbons
- ▶ 90221: Environmentally acceptable hydraulic fluids
- ▶ 90222: Fire-resistant, water-free hydraulic fluids (HFDR/HFDU)
- ▶ 90223: Fire-resistant, water-containing hydraulic fluids (HFC, HFB)
- ▶ 90225: Limited technical data for operation with water-free and water-containing fire-resistant hydraulic fluids (HFDR, HFDU, HFB, HFC).

### Selection of hydraulic fluid

Bosch Rexroth evaluates hydraulic fluids by means of the Fluid Rating according to data sheet 90235.

Hydraulic fluids which have been evaluated positively in the Fluid Rating are contained in the following data sheet:

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

The hydraulic fluid should be selected so the operating viscosity in the operating temperature range is within the optimal range ( $v_{opt}$ ; see selection diagram).

#### Notice

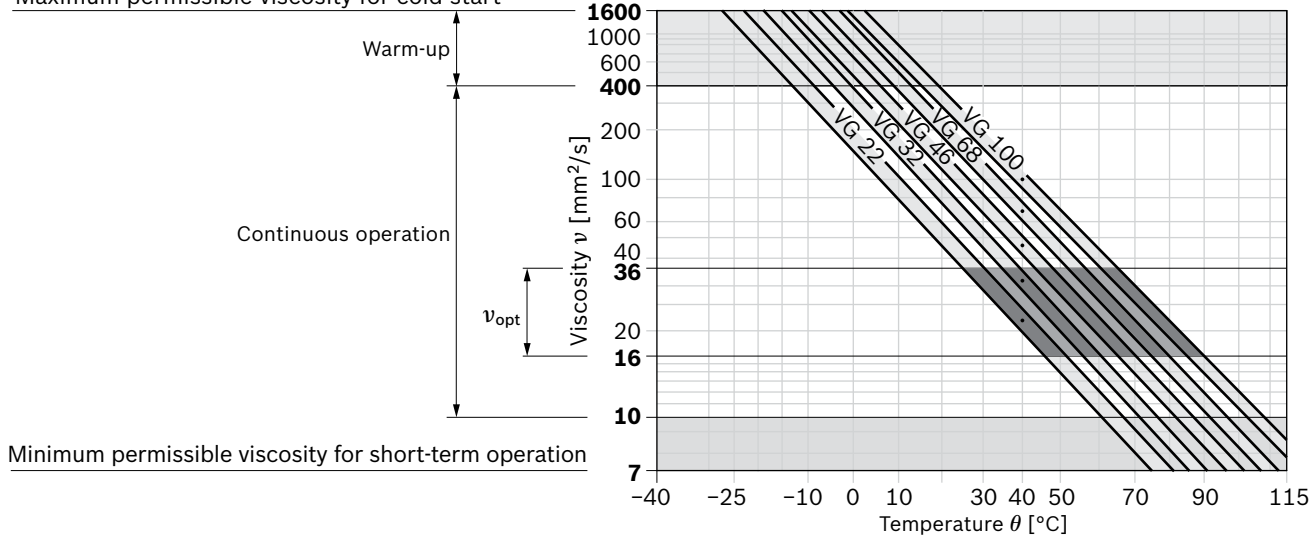
The axial piston unit is not suitable for operation with HFA hydraulic fluids. If HFB, HFC and HFD or environmentally acceptable hydraulic fluids are used, the limitations regarding technical data or other seals must be observed.

### Viscosity and temperature of hydraulic fluids

	Viscosity	Shaft seal	Temperature <sup>3)</sup>	Comment
Cold start	$v_{max} \leq 1600 \text{ mm}^2/\text{s}$	NBR <sup>2)</sup>	$\theta_{St} \geq -40 \text{ }^\circ\text{C}$	$t \leq 3 \text{ min}$ , without load ( $p \leq 50 \text{ bar}$ ), $n \leq 1000 \text{ min}^{-1}$ Permissible temperature difference between the axial piston unit and hydraulic fluid in the system maximum 25 K
		FKM	$\theta_{St} \geq -25 \text{ }^\circ\text{C}$	
Warm-up	$v = 1600 \dots 400 \text{ mm}^2/\text{s}$			$t \leq 15 \text{ min}$ , $p \leq 0.7 \times p_{nom}$ and $n \leq 0.5 \times n_{nom}$
Continuous operation	$v = 400 \dots 10 \text{ mm}^2/\text{s}^{1)}$	NBR <sup>2)</sup>	$\theta \leq +78 \text{ }^\circ\text{C}$	measured at port <b>T</b>
		FKM	$\theta \leq +103 \text{ }^\circ\text{C}$	
	$v_{opt} = 36 \dots 16 \text{ mm}^2/\text{s}$			Optimal operating viscosity and efficiency range
Short-term operation	$v_{min} = 10 \dots 7 \text{ mm}^2/\text{s}$	NBR <sup>2)</sup>	$\theta \leq +78 \text{ }^\circ\text{C}$	$t \leq 3 \text{ min}$ , $p \leq 0.3 \times p_{nom}$ , measured at port <b>T</b>
		FKM	$\theta \leq +103 \text{ }^\circ\text{C}$	

### ▼ Selection diagram

Maximum permissible viscosity for cold start



1) This corresponds, for example on VG 46, to a temperature range of +4 °C to +85 °C (see selection diagram)

2) Special version, please contact us

3) If the temperature at extreme operating parameters cannot be adhered to, please contact us.

### Hydraulic fluid filtration

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 mm<sup>2</sup>/s (e.g. due to high temperatures during short-term operation) at the drain port, a min. cleanliness level of 19/17/14 as defined in ISO 4406 is required.

For example, the viscosity 10 mm<sup>2</sup>/s at:

- ▶ HLP 32 corresponds to a temperature of 73 °C
- ▶ HLP 46 corresponds to a temperature of 85 °C.

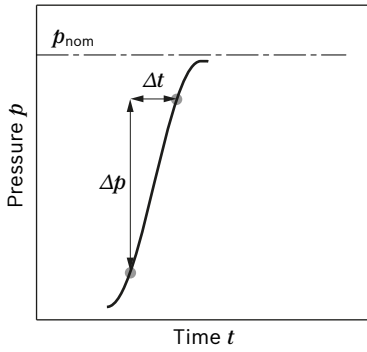
### Flow direction

Direction of rotation as viewed on drive shaft	
Clockwise	Counterclockwise
<b>A to B</b>	<b>B to A</b>

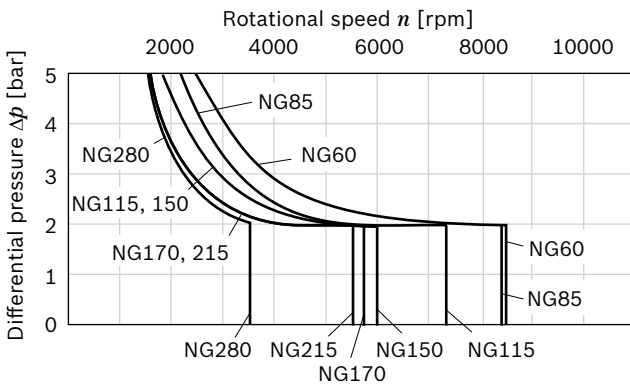
### Working pressure range

Pressure at working port A or B		Definition
Nominal pressure $p_{nom}$	450 bar	The nominal pressure corresponds to the maximum design pressure.
Maximum pressure $p_{max}$	500 bar	The maximum pressure is the maximum working pressure during 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 500 bar to 530 bar is permissible for a limited period of 50 h.
Maximum Single operating period	10 s	
Total operating period	300 h	
Maximum pressure $p_{max}$ (only valid for NG 60-215)	530 bar	Within the total operating period of 300 h, a maximum pressure of 500 bar to 530 bar is permissible for a limited period of 50 h.
Maximum Single operating period	10 s	
Total operating period	50 h	
Minimum pressure (high-pressure side)	25 bar	Minimum pressure at the high-pressure side ( <b>A</b> or <b>B</b> ) which is required to prevent damage to the axial piston unit.
Minimum pressure – pump operating mode (inlet)	see the diagram	To prevent damage to the axial piston motor in pump operating mode (change of the high-pressure side at constant direction of rotation, e.g. during brake applications) a minimum pressure has to be ensured at the working port (inlet). The minimum pressure depends on the rotational speed and displacement of the axial piston unit.
Summation pressure $p_{Su}$ (pressure <b>A</b> + pressure <b>B</b> )	700 bar	The summation pressure is the sum of the pressures at the working ports ( <b>A</b> and <b>B</b> ).
Rate of pressure change $R_{A\ max}$		Maximum permissible pressure build-up and reduction speed during a pressure change across the entire pressure range.
with built-in pressure relief valve	9000 bar/s	
without pressure relief valve	16000 bar/s	
<b>Case pressure at port T</b>		
Continuous differential pressure $\Delta p_{T\ cont}$	2 bar	Maximum, averaged differential pressure at the shaft seal (case to ambient pressure)
Maximum differential pressure $\Delta p_{T\ max}$	see the diagram	Permissible differential pressure at the shaft seal (case to ambient pressure)
Pressure peaks $p_{T\ peak}$	10 bar	$t < 0.1\ s$

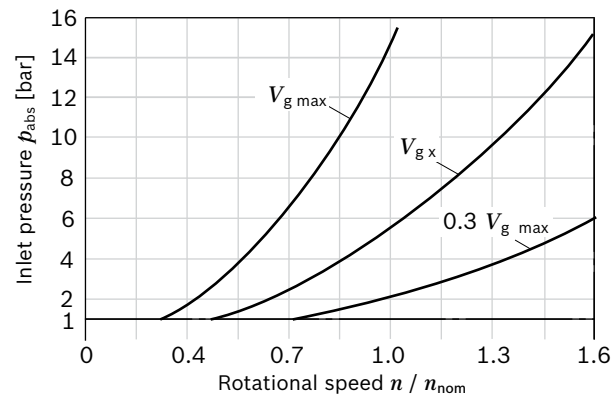
▼ **Rate of pressure change  $R_{A \max}$**



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



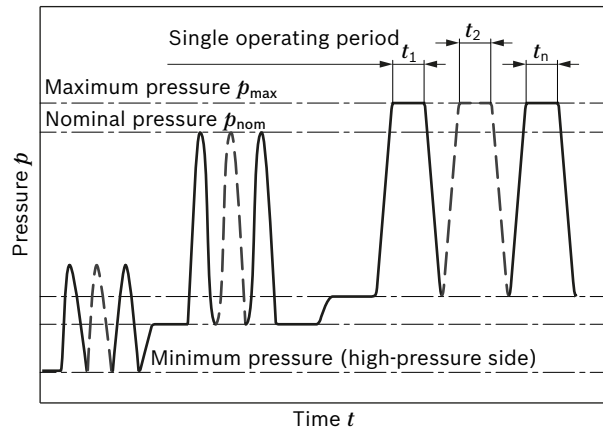
▼ **Minimum pressure – pump operating mode (inlet)**



This diagram is valid only for the optimum viscosity range from  $\nu_{opt} = 36$  to  $16 \text{ mm}^2/\text{s}$ .

If the above mentioned conditions cannot be ensured, please contact us.

▼ **Pressure definition**



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

**Notice**

- ▶ Working pressure range applies when using mineral oil-based hydraulic fluids. 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 leakage pressure in the case.
- ▶ 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 ambient pressure.

**Effect of case pressure on beginning of control**

An increase in case pressure affects the beginning of control of the variable motor when using the following control options:

HP, HA.T3: increase

DA: decrease

With the following settings, an increase in case pressure will have no effect on the beginning of control:

HA.R and HA.U, EP, HA

The factory setting of the beginning of control is made at  $p_{abs} = 2$  bar case pressure (sizes 60 to 215) resp.  $p_{abs} = 1$  bar case pressure (size 280).

## Technical data

Size	NG	60	85	115	150	170	215	280		
Displacement geometric, per revolution	$V_{g \max}$	cm <sup>3</sup>	62.0	85.2	115.6	152.1	171.8	216.5	280.1	
	$V_{g \min}$	cm <sup>3</sup>	0	0	0	0	0	0	0	
	$V_{g x}$	cm <sup>3</sup>	37	51	69	91	65	130	118	
Maximum rotational speed <sup>1)</sup> (complying with the maximum permissible inlet flow)	At $V_{g \max}$	$n_{\text{nom}}$	rpm	4450	3900	3550	3250	3100	2900	2500
	at $V_g < V_{g x}$ (see diagram)	$n_{\text{max}}$	rpm	7200	6800	6150	5600	4900	4800	3550
	at $V_{g 0}$	$n_{\text{max}}$	rpm	8400	8350	7350	6000	5750	5500	3550
Inlet flow <sup>2)</sup>	at $n_{\text{nom}}$ and $V_{g \max}$	$q_{v \max}$	l/min	275	332	410	494	533	628	700
Torque <sup>3)</sup>	at $V_{g \max}$ and $\Delta p = 450$ bar	$T$	Nm	444	610	828	1089	1230	1550	2006
Rotary stiffness	$V_{g \max}$ to $V_g/2$	$c_{\min}$	kNm/rad	15	22	37	44	52	70	72
	$V_g/2$ to 0 (interpolated)	$c_{\min}$	kNm/rad	45	68	104	124	156	196	209
Moment of inertia of rotary group	$J_{TW}$	kgm <sup>2</sup>	0.0043	0.0072	0.0110	0.0181	0.0213	0.0303	0.0479	
Maximum angular acceleration	$\alpha$	rad/s <sup>2</sup>	21000	17500	15500	11000	11000	10000	7000	
Case volume	$V$	l	0.8	1.0	1.5	1.7	2.3	2.8	3.4	
Weight approx.	$m$	kg	28	36	46	61	62	78	101	

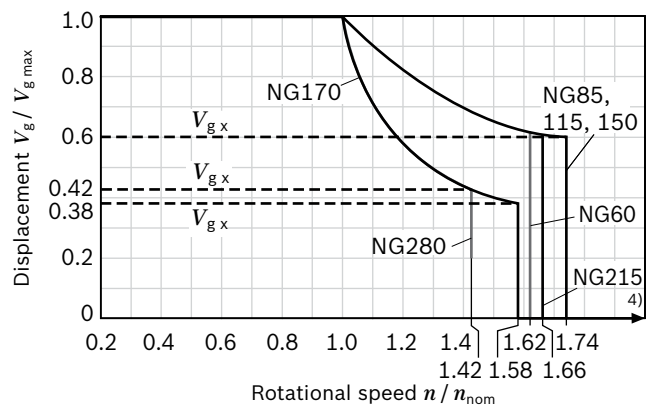
### Speed range

The minimum rotational speed  $n_{\min}$  is not limited. For applications with requirements on the evenness of the rotation at low rotational speeds, please contact us.

### Notices

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

### ▼ Permissible displacement in relation to rotational speed



### Determining characteristics

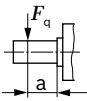
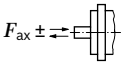
Inlet flow	$q_v = \frac{V_g \times n}{1000 \times \eta_v}$	[l/min]
Rotational speed	$n = \frac{q_v \times 1000 \times \eta_v}{V_g}$	[rpm]
Torque	$M = \frac{V_g \times \Delta p \times \eta_{hm}}{20 \times \pi}$	[Nm]
Power	$P = \frac{2 \pi \times M \times n}{60000} = \frac{q_v \times \Delta p \times \eta_t}{600}$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

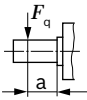
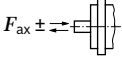
### Key

$V_g$	Displacement per revolution [cm <sup>3</sup> ]
$\Delta p$	Differential pressure [bar]
$n$	Rotational speed [rpm]
$\eta_v$	Volumetric efficiency
$\eta_{hm}$	Hydraulic-mechanical efficiency
$\eta_t$	Total efficiency ( $\eta_t = \eta_v \times \eta_{hm}$ )

- 1) The values are valid:
  - for the optimum viscosity range from  $\nu_{\text{opt}} = 36$  to  $16$  mm<sup>2</sup>/s
  - with hydraulic fluid based on mineral oils
- 2) Note input flow limitation due to counterbalance valve (page 74).
- 3) Torque without radial force, with radial force see page 10.
- 4) Values in this range on request

**Permissible radial and axial loading on the drive shafts**

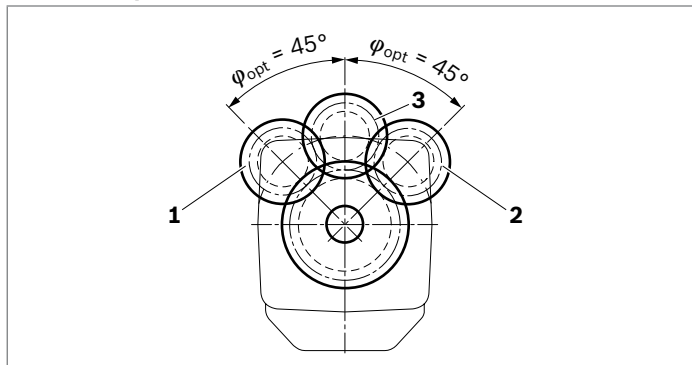
Size	NG	60	60	85	85	115	115	150	150	150		
Drive shaft		1 1/4 in	W35	1 1/2 in	W40	1 3/4 in	W40	1 3/4 in	2 in	W45		
Maximum radial force at distance a (from shaft collar)		$F_{q \max}$	N	7620	10266	12463	12323	14902	16727	15948	17424	19534
		a	mm	24.0	20.0	27.0	22.5	33.5	22.5	33.5	33.5	25.0
Maximum torque at $F_{q \max}$		$T_{q \max}$	Nm	310	444	595	610	828	828	890	1089	1089
Maximum differential pressure at $V_{g \max}$ and $F_{q \max}$		$\Delta p_{q \max}$	bar	315	450	440	450	450	450	370	450	450
Maximum axial force at standstill or depressurized operation		$+ F_{ax \max}$	N	0	0	0	0	0	0	0	0	0
		$- F_{ax \max}$	N	500	500	710	710	900	900	1300	1300	1300
Permissible axial force per bar working pressure		$+ F_{ax \text{ perm/ bar}}$	N/ bar	7.5	7.5	9.6	9.6	11.3	11.3	13.3	13.3	13.3

Size	NG	170	170	215	215	280	280		
Drive shaft		2 in	W45	2 in	W50	2 1/4 in	W60		
Maximum radial force at distance a (from shaft collar)		$F_{q \max}$	N	19370	21220	22602	25016	26821	26913
		a	mm	33.5	25.0	33.5	27.5	40.0	35.0
with permissible torque		$T_{q \max}$	Nm	1230	1200	1445	1550	1916	2005
Maximum differential pressure at $V_{g \max}$ and $F_{q \max}$		$\Delta p_{q \max}$	bar	450	440	420	450	430	450
Maximum axial force at standstill or depressurized operation		$+ F_{ax \max}$	N	0	0	0	0	0 <sup>1)</sup>	0 <sup>1)</sup>
		$- F_{ax \max}$	N	1120	1120	1250	1250	1575	1575
Permissible axial force per bar working pressure		$+ F_{ax \text{ perm/ bar}}$	N/ bar	15.1	15.1	17.0	17.0	19.4	19.4

**Effect of radial force  $F_q$  on bearing service life**

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

▼ **Gear output drive**



- 1 "Counter-clockwise" rotation, pressure at port B
- 2 "Clockwise" rotation, pressure at port A
- 3 Bidirectional direction of rotation

**Notices**

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

1) Please contact us.

## HP – Proportional hydraulic control

The proportional hydraulic control provides infinite adjustment of the displacement. The control is proportional to the pilot pressure at port **X**.

### HP1, HP2 positive control

- ▶ Beginning of control at  $V_{g \min}$  (minimum torque, maximum permissible rotational speed at minimum pilot pressure)
- ▶ End of control at  $V_{g \max}$  (maximum torque, minimum rotational speed at maximum pilot pressure)

### HP5, HP6 negative control

- ▶ Beginning of control at  $V_{g \max}$  (maximum torque, minimum rotational speed at minimum pilot pressure)
- ▶ End of control at  $V_{g \min}$  (minimum torque, maximum permissible rotational speed, at maximum pilot pressure)

### Notice

- ▶ Maximum permissible pilot pressure:  $p_{St} = 100$  bar
- ▶ The control oil is internally taken out of the high-pressure passage of the motor (**A** or **B**). For reliable control, a working pressure of at least 30 bar is necessary in **A** (**B**). If a control operation is performed at a working pressure < 30 bar, an auxiliary pressure of at least 30 bar must be applied at port **G** using an external check valve. For lower pressures, please contact us. Please keep in mind that pressures up to 530 bar (NG60 to 215) resp. 500 bar (NG280) can occur at port **G**.
- ▶ Please state the desired beginning of control in plain text when ordering, e.g.: beginning of control at 10 bar.
- ▶ The beginning of control and the HP characteristic curve are influenced by the case pressure. An increase in the case pressure causes an increase in the beginning of control (see page 7) and thus a parallel displacement of the characteristic curve.
- ▶ A leakage flow of maximum 0.3 l/min can occur at port **X** due to internal leakage (working pressure > pilot pressure). The control is to be suitably configured to avoid an independent build-up of pilot pressure.

### Stroking time damping

The stroking time damping impacts the swivel behavior of the motor and consequently the machine response speed.

### Standard

HP without damping.

HP.D with throttle pin on both sides, symmetrical (see table), size 280 with orifice  $\varnothing 1.2$

### Optional

HP with throttle pin on both sides, symmetrical (see table), size 280 with nozzle  $\varnothing 1.2$

### ▼ Throttle pin overview

Size	60	85	115	150	170	215
Groove size [mm]	0.45	0.45	0.55	0.55	0.55	0.65

### HP1, HP5 pilot pressure increase $\Delta p_{St} = 10$ bar

#### HP1 positive control

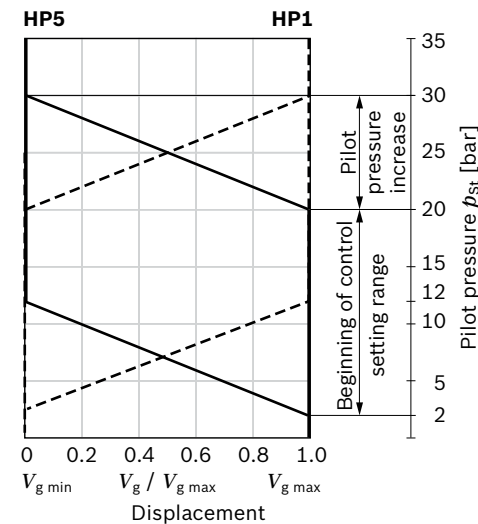
A pilot pressure increase of 10 bar at port **X** results in an increase in displacement from  $V_{g \min}$  to  $V_{g \max}$ .

#### HP5 negative control

A pilot pressure increase of 10 bar at port **X** results in a decrease in displacement from  $V_{g \max}$  to  $V_{g \min}$ .

- ▶ Beginning of control, setting range 2 to 20 bar
- ▶ Standard setting:  
Beginning of control at 3 bar (end of control at 13 bar)

### ▼ Characteristic curve



**HP2, HP6 pilot pressure increase  $\Delta p_{St} = 25$  bar**  
**HP2 positive control**

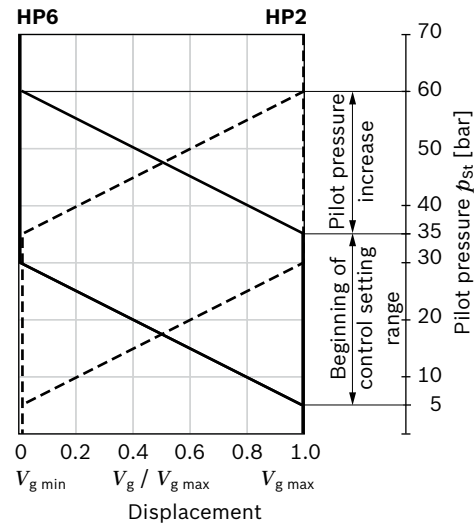
A pilot pressure increase of 25 bar at port **X** results in an increase in displacement from  $V_{g\ min}$  to  $V_{g\ max}$ .

**HP6 negative control**

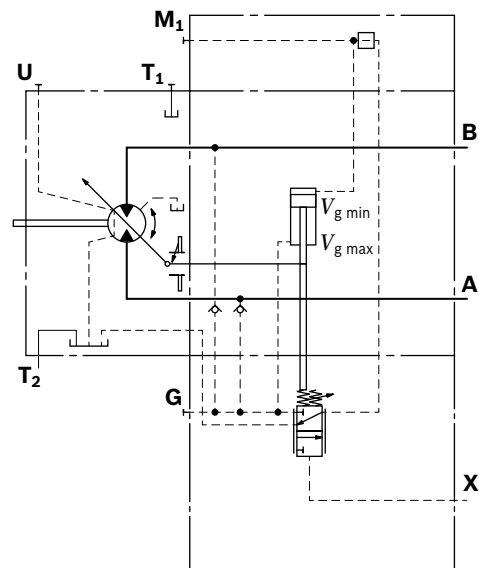
A pilot pressure increase of 25 bar at port **X** results in a decrease in displacement from  $V_{g\ max}$  to  $V_{g\ min}$ .

- ▶ Beginning of control, setting range 5 to 35 bar
- ▶ Standard setting:  
 Beginning of control at 10 bar (end of control at 35 bar)

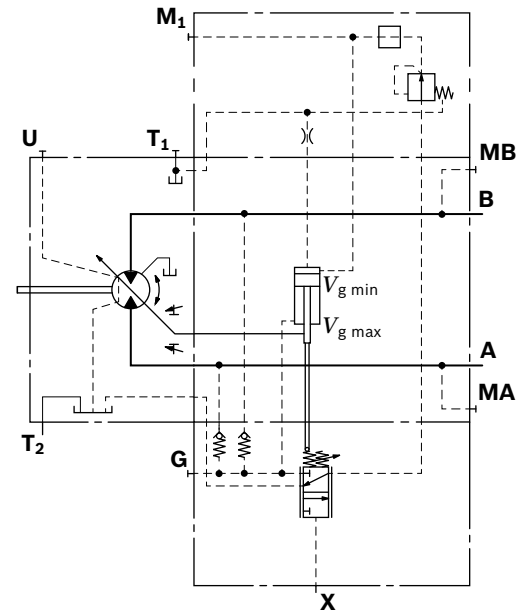
▼ **Characteristic curve**



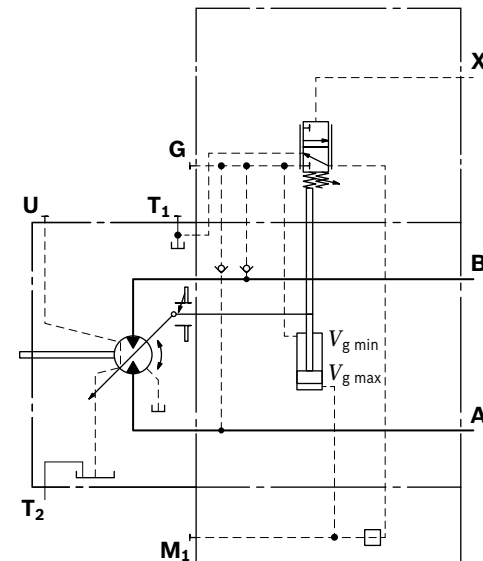
▼ **Circuit diagram HP1, HP2 size 60 to 215 (positive control)**



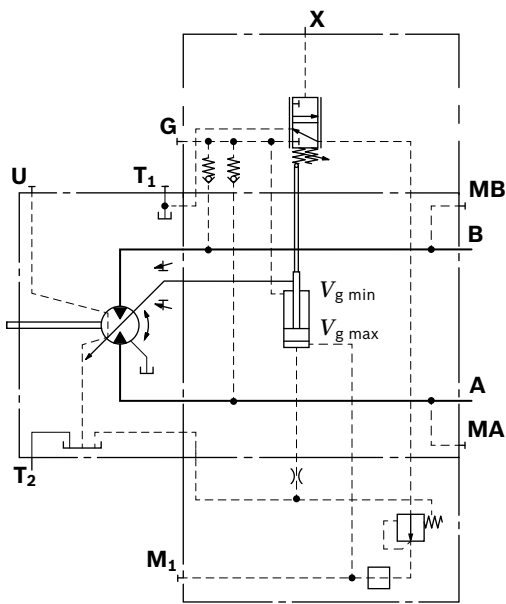
▼ **Circuit diagram HP1, HP2 size 280 (positive control)**



▼ **Circuit diagram HP5, HP6 size 60 to 215 (negative control)**



▼ **Circuit diagram HP5, HP6 size 280 (negative control)**



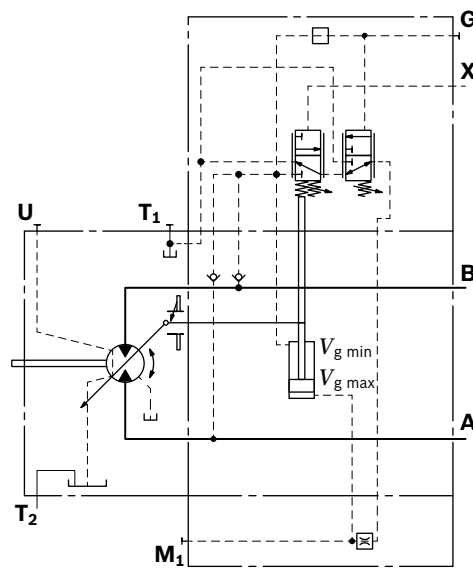
**HP5D1, HP6D1 Pressure control, fixed setting**

The pressure control overrides the HP control function. If the load torque or a reduction in motor swivel angle causes the system pressure to reach the setpoint value of the pressure control, the motor will swivel towards a larger displacement.

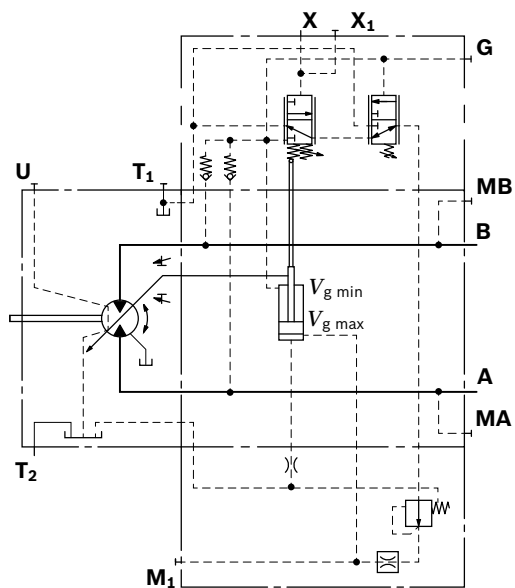
The increase in displacement and the resulting reduction in pressure cause the control deviation to decrease. With the increase in displacement the motor develops more torque, while the pressure remains constant.

Setting range of the pressure control valve 80 to 450 bar

▼ **Circuit diagram HP5D1, HP6D1 size 60 to 215 (negative control)**



▼ **Circuit diagram HP5D1, HP6D1 size 280 (negative control)**



## EP – Proportional control, electric

The proportional electric control provides infinite adjustment of the displacement. Control is proportional to the electric control current applied to the solenoid.

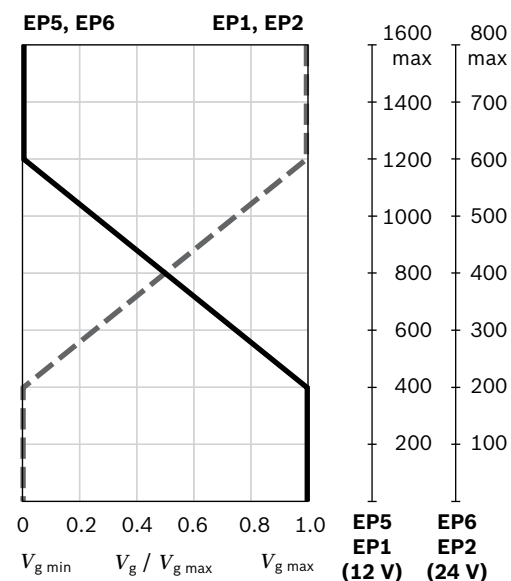
### EP1, EP2 positive control

- ▶ Beginning of control at  $V_{g \min}$  (minimum torque, maximum permissible rotational speed at minimum control current)
- ▶ End of control at  $V_{g \max}$  (maximum torque, minimum rotational speed at maximum control current)

### EP5, EP6 negative control

- ▶ Beginning of control at  $V_{g \max}$  (maximum torque, minimum rotational speed at minimum control current)
- ▶ End of control at  $V_{g \min}$  (minimum torque, maximum permissible rotational speed at maximum control current)

### ▼ Characteristic curve



### Notice

The control oil is internally taken out of the high-pressure passage of the motor (**A** or **B**). For reliable control, a working pressure of at least 30 bar is necessary in **A** (**B**). If a control operation is performed at a working pressure < 30 bar, an auxiliary pressure of at least 30 bar must be applied at port **G** using an external check valve. For lower pressures, please contact us.

Please keep in mind that pressures up to 530 bar (NG60 to 215) resp. 500 bar (NG280) can occur at port **G**.

Size 280: The beginning of control and the EP characteristic curve are influenced by the case pressure.

### Stroking time damping

The stroking time damping impacts the swivel behavior of the motor and consequently the machine response speed.

### Standard

EP without damping.

EP.D with throttle pin on both sides, symmetrical (see table), size 280 with orifice  $\varnothing 1.2$

### Optional

EP with throttle pin on both sides, symmetrical (see table), size 280 with orifice  $\varnothing 1.2$

### ▼ Throttle pin overview

Size	60	85	115	150	170	215
Groove size [mm]	0.45	0.45	0.55	0.55	0.55	0.65

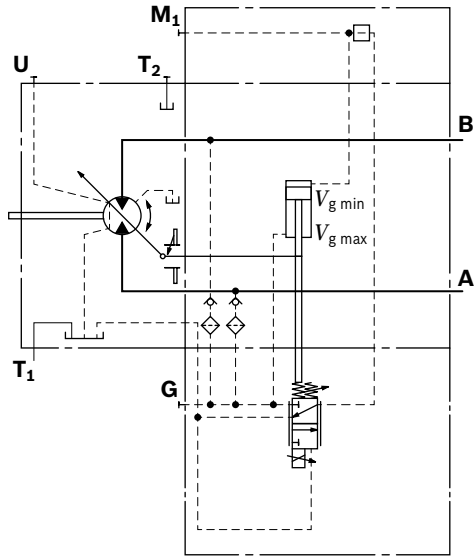
Technical data, solenoid	EP1, EP5	EP2, EP6
Voltage	12 V ( $\pm 20\%$ )	24 V ( $\pm 20\%$ )
Control current		
Beginning of control	400 mA	200 mA
End of control	1200 mA	600 mA
Current limit	1.54 A	0.77 A
Nominal resistance (at 20 °C)	5.5 $\Omega$	22.7 $\Omega$
Dither		
Frequency	100 Hz	100 Hz
minimum oscillation range <sup>1)</sup>	240 mA	120 mA
Duty cycle	100%	100%
Type of protection: see connector version page 70		

Various BODAS controllers with application software and amplifiers are available for controlling the proportional solenoids.

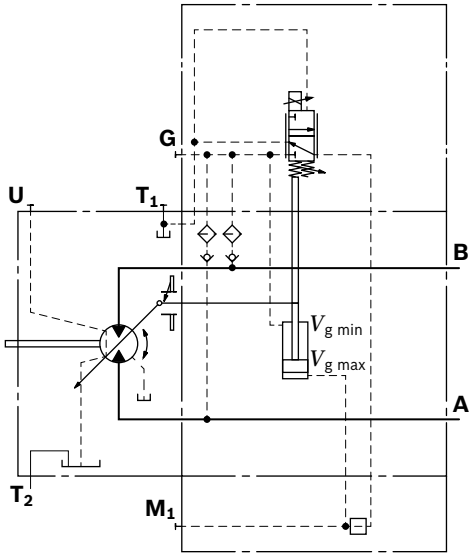
Further information can also be found on the Internet at [www.boschrexroth.com/mobilelektronik](http://www.boschrexroth.com/mobilelektronik).

<sup>1)</sup> Minimum required oscillation range of the control current  $\Delta I_{p,p}$  (peak to peak) within the respective control range (start of control to end of control)

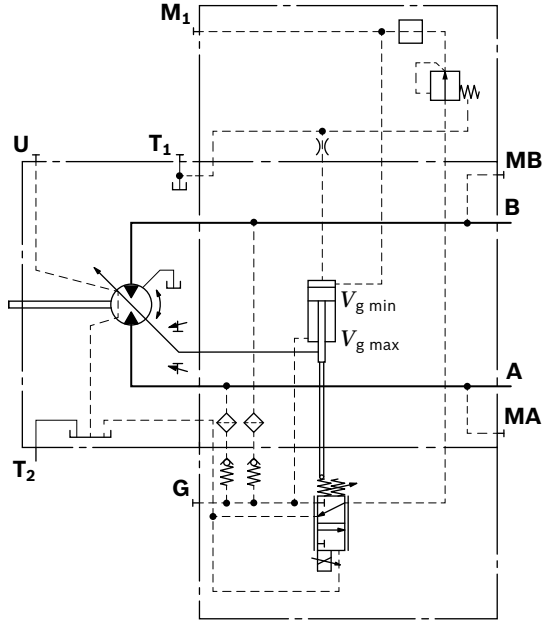
▼ Circuit diagram EP1, EP2 size 60 to 215 (positive control)



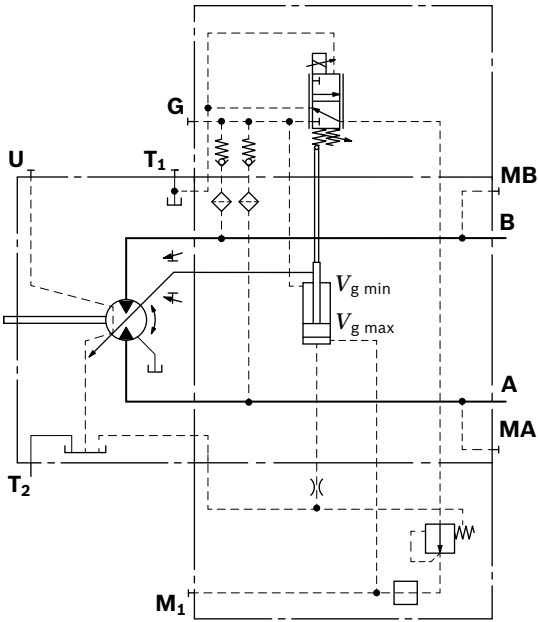
▼ Circuit diagram EP5, EP6 size 60 to 215 (negative control)



▼ Circuit diagram EP1, EP2 size 280 (positive control)



▼ Circuit diagram EP5, EP6 size 280 (negative control)



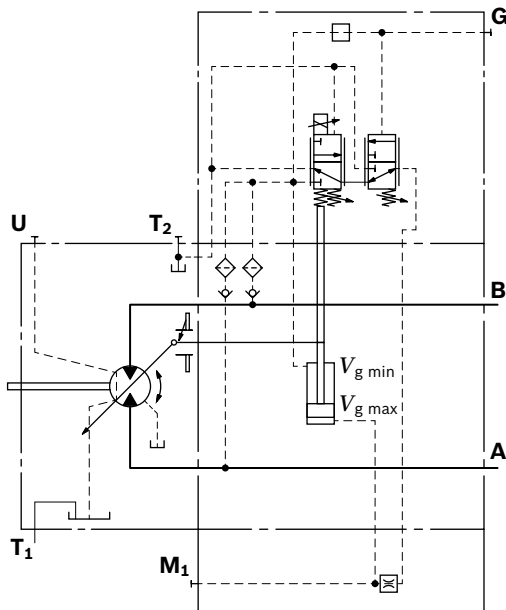
**EP5D1, EP6D1 Pressure control, fixed setting**

The pressure control overrides the EP control function. If the load torque or a reduction in motor swivel angle causes the system pressure to reach the setpoint value of the pressure control, the motor will swivel towards a larger displacement.

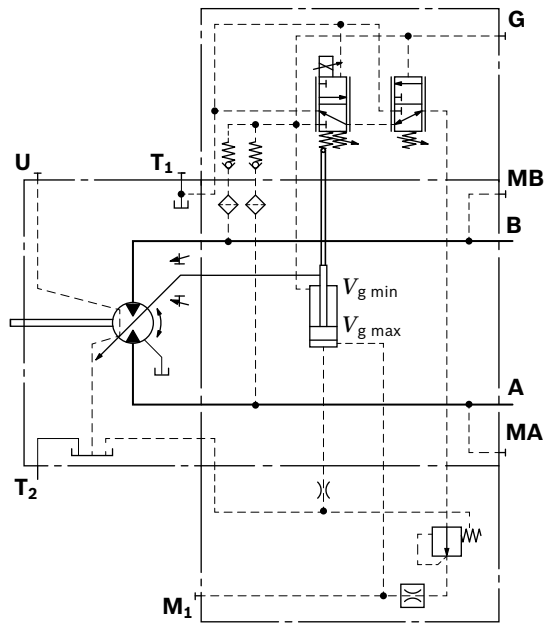
The increase in displacement and the resulting reduction in pressure cause the control deviation to decrease. With the increase in displacement the motor develops more torque, while the pressure remains constant.

Setting range of the pressure control valve 80 to 450 bar

▼ **Circuit diagram EP5D1, EP6D1 size 60 to 215 (negative control)**



▼ **Circuit diagram EP5D1, EP6D1 size 280 (negative control)**



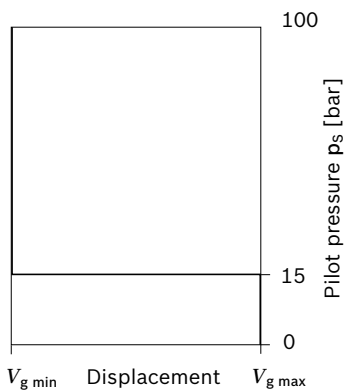
## HZ – Two-point control, hydraulic

The two-point hydraulic control allows the displacement to be set to either  $V_{g \min}$  or  $V_{g \max}$  by switching the pilot pressure at port **X** on or off.

### HZ5, HZ7 negative control

- ▶ Position at  $V_{g \max}$  (without pilot pressure, maximum torque, minimum rotational speed)
- ▶ Position at  $V_{g \min}$  (with pilot pressure > 15 bar activated, minimum torque, maximum permissible rotational speed)

### ▼ Characteristic curve HZ5, HZ7



### Notice

- ▶ Maximum permissible pilot pressure: 100 bar
- ▶ The control oil is internally taken out of the high-pressure passage of the motor (**A** or **B**). For reliable control, a working pressure of at least 30 bar is necessary in **A** (**B**). If a control operation is performed at a working pressure < 30 bar, an auxiliary pressure of at least 30 bar must be applied at port **G** using an external check valve. For lower pressures, please contact us. Please keep in mind that pressures up to 530 bar (NG60 to 215) resp. 500 bar (NG280) can occur at port **G**.
- ▶ A leakage flow of maximum 0.3 l/min occurs at port **X** (working pressure > pilot pressure). To avoid a build-up of pilot pressure, pressure must be relieved from port **X** to the reservoir.

### Stroking time damping

The stroking time damping impacts the swivel behavior of the motor and consequently the machine response speed.

### Standard for sizes 150 to 280

**HZ5** with throttle pin on both sides, symmetrical (see table), size 280 with orifice  $\varnothing 1.2$

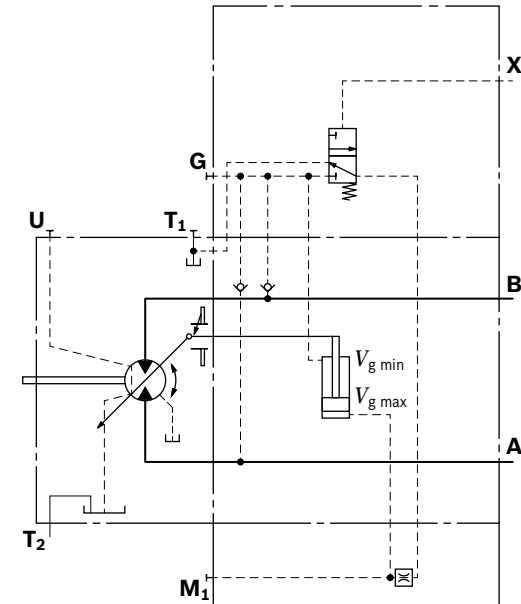
### Standard for sizes 60 to 115

**HZ7** (synchronous piston) with throttle pin on both sides, symmetrical (see table)

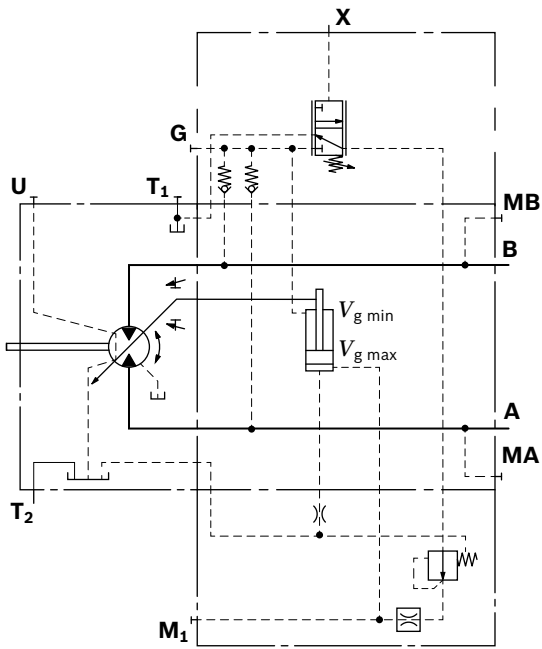
### ▼ Throttle pin overview

Size	60	85	115	150	170	215
Groove size [mm]	0.30	0.30	0.30	0.55	0.55	0.65

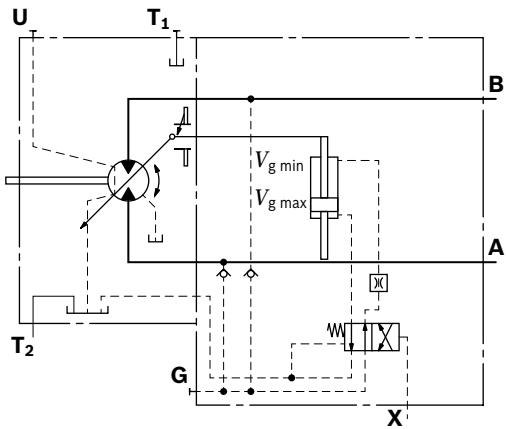
### ▼ Circuit diagram HZ5 size 150 to 215 (negative control)



▼ **Circuit diagram HZ5 size 280 (negative control)**



▼ **Circuit diagram HZ7 size 60 to 115 (negative control)**



## EZ – Two-point control, electric

The two-point electric control, type EZ, allows the motor displacement to be set to either  $V_{g\ min}$  or  $V_{g\ max}$  by switching the electric current to a switching solenoid on or off.

### Notice

The control oil is internally taken out of the high-pressure passage of the motor (**A** or **B**). For reliable control, a working pressure of at least 30 bar is necessary in **A** (**B**). If a control operation is performed at a working pressure < 30 bar, an auxiliary pressure of at least 30 bar must be applied at port **G** using an external check valve. For lower pressures, please contact us.

Please keep in mind that pressures up to 530 bar (NG60 to 215) resp. 500 bar (NG280) can occur at port **G**.

### Stroking time damping

The stroking time damping impacts the swivel behavior of the motor and consequently the machine response speed.

### Standard for sizes 150 to 280

**EZ5, EZ6** with throttle pin on both sides, symmetrical (see table), size 280 with orifice  $\varnothing 1.2$

### Standard for sizes 60 to 115

**EZ7, EZ8** (synchronous piston) with throttle pin on both sides, symmetrical (see table)

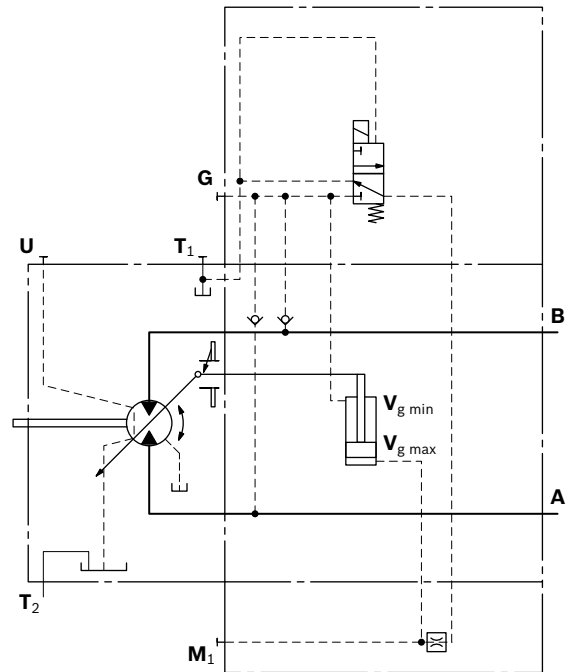
### ▼ Throttle pin overview

Size	60	85	115	150	170	215
Groove size [mm]	0.30	0.30	0.30	0.55	0.55	0.65

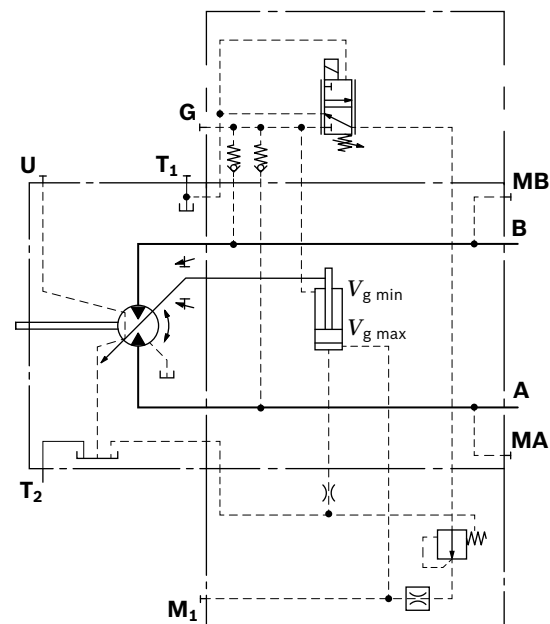
### Sizes 150 to 280

Technical data, solenoid with $\varnothing 37$	EZ5	EZ6
Voltage	12 V ( $\pm 20\%$ )	24 V ( $\pm 20\%$ )
Position $V_{g\ max}$	de-energized	de-energized
Position $V_{g\ min}$	energized	energized
Nominal resistance (at 20 °C)	5.5 $\Omega$	21.7 $\Omega$
Nominal power	26.2 W	26.5 W
Minimum active current required	1.32 A	0.67 A
Duty cycle	100%	100%
Type of protection: see connector version page 70		

### ▼ Circuit diagram EZ5, EZ6 size 60 to 215 (negative control)



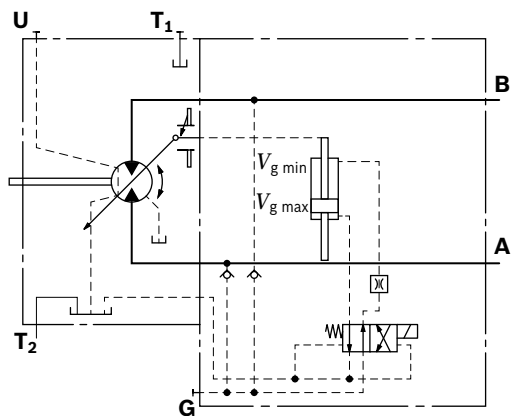
### ▼ Circuit diagram EZ5, EZ6 size 280 (negative control)



**Sizes 60 to 115**

Technical data, solenoid with $\varnothing 45$	EZ7	EZ8
Voltage	12 V ( $\pm 20\%$ )	24 V ( $\pm 20\%$ )
Position $V_{g \max}$	de-energized	de-energized
Position $V_{g \min}$	energized	energized
Nominal resistance (at 20 °C)	4.8 $\Omega$	19.2 $\Omega$
Nominal power	30 W	30 W
Minimum active current required	1.5 A	0.75 A
Duty cycle	100%	100%
Type of protection: see connector version page 70		

▼ **Circuit diagram EZ7, EZ8 size 60 to 215 (negative control)**



## HA – Automatic high-pressure related control

The automatic high-pressure related control adjusts the displacement automatically depending on the working pressure.

The displacement of the A6VM motor with HA control is  $V_{g \min}$  (maximum rotational speed and minimum torque). The control device measures internally the working pressure at **A** or **B** (no control line required) and upon reaching the set beginning of control, the controller swivels the motor with increasing working pressure from  $V_{g \min}$  to  $V_{g \max}$ . The displacement is modulated between  $V_{g \min}$  and  $V_{g \max}$  depending on the load.

### HA1, HA2 positive control

- ▶ Beginning of control at  $V_{g \min}$  (minimum torque, maximum rotational speed)
- ▶ End of control at  $V_{g \max}$  (maximum torque, minimum rotational speed)

### Notice

- ▶ For safety reasons, lifting winch drives are not permissible with beginning of control at  $V_{g \min}$  (standard for HA).
- ▶ The control oil is internally taken out of the high-pressure passage of the motor (**A** or **B**). For reliable control, a working pressure of at least 30 bar is necessary in **A** (**B**). If a control operation is performed at a working pressure < 30 bar, an auxiliary pressure of at least 30 bar must be applied at port **G** using an external check valve. For lower pressures, please contact us. Please keep in mind that pressures up to 530 bar (NG60 to 215) resp. 500 bar (NG280) can occur at port **G**.
- ▶ The beginning of control and the HA.T3 characteristic curve are influenced by case pressure. An increase in the case pressure causes an increase in the beginning of control (see page 7) and thus a parallel displacement of the characteristic curve.
- ▶ A leakage flow of maximum 0.3 l/min occurs at port **X** (working pressure > pilot pressure). To avoid a build-up of pilot pressure, pressure must be relieved from port **X** to the reservoir. **Only for HA.T control.**

### Stroking time damping

The stroking time damping impacts the swivel behavior of the motor and consequently the machine response speed.

### Standard for sizes 60 to 280

HA1,2 with one-sided throttle pin, throttling occurs from  $V_{g \min}$  to  $V_{g \max}$ . (see table) HA3 and HA3T3 with BVI and throttle pin on both sides, 0.30, symmetrical

#### ▼ Throttle pin overview

Size	60	85	115	150	170	215	280
Groove size [mm]	0.45	0.45	0.55	0.55	0.55	0.65	2×1.0

### Standard for sizes 60 to 215

HA with BVD or BVE counterbalance valve, with throttle screw (see table)

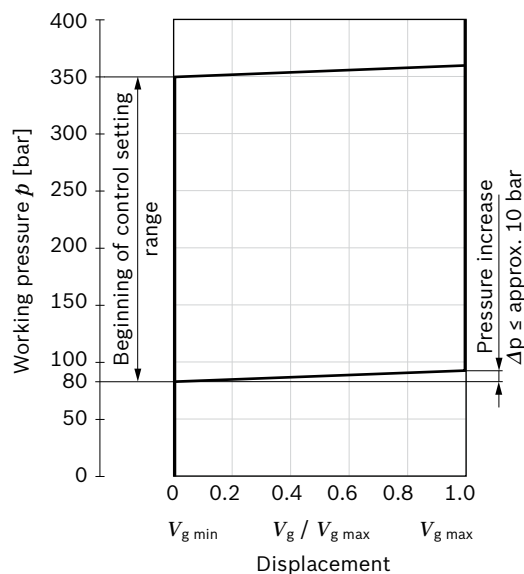
#### ▼ Throttle screw

Size	60	85	115	150	170	215
Diameter [mm]	0.80	0.80	0.80	0.80	0.80	0.80

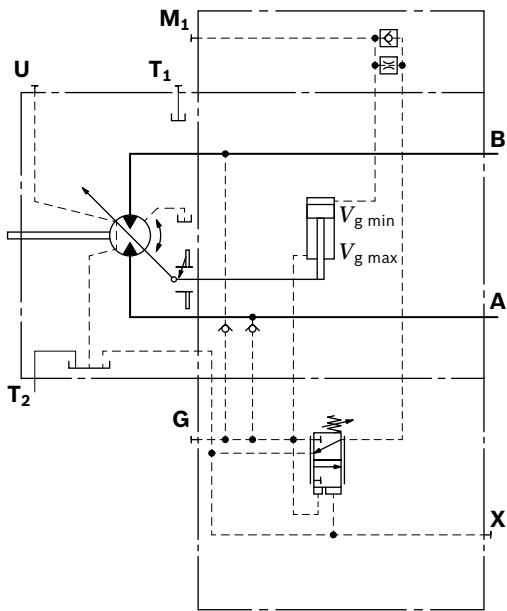
### HA1 with minimum pressure increase, positive control

A working pressure increase of  $\Delta p \leq$  approx. 10 bar results in an increase in displacement from  $V_{g \min}$  to  $V_{g \max}$ . Beginning of control, setting range 80 to 350 bar. Please state the desired beginning of control in plain text when ordering, e.g.: beginning of control at 300 bar.

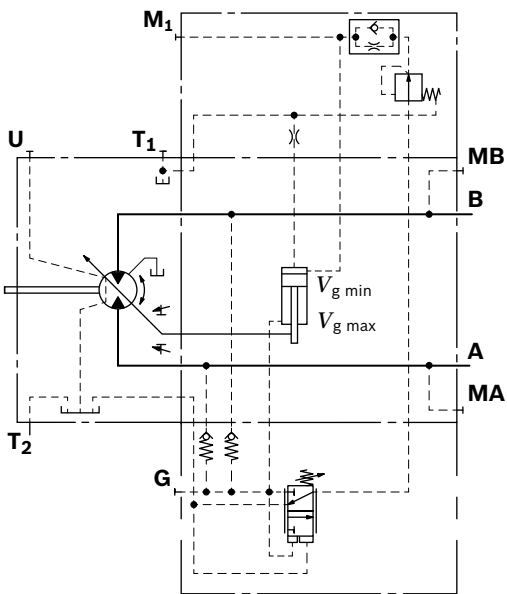
#### ▼ Characteristic curve HA1



▼ **Circuit diagram HA1 size 60 to 215**



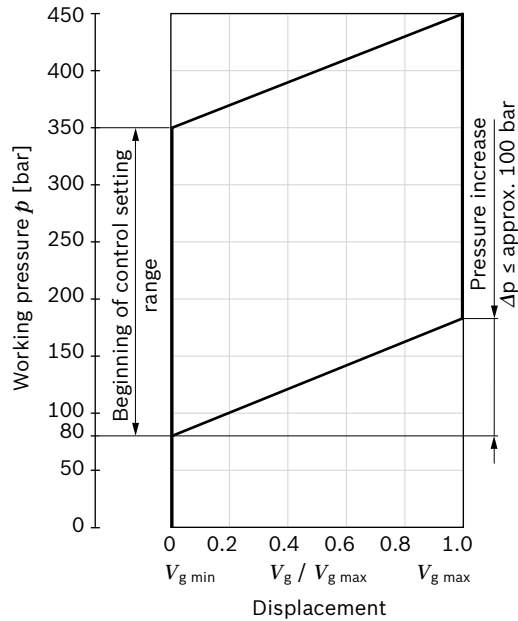
▼ **Circuit diagram HA1 size 280**



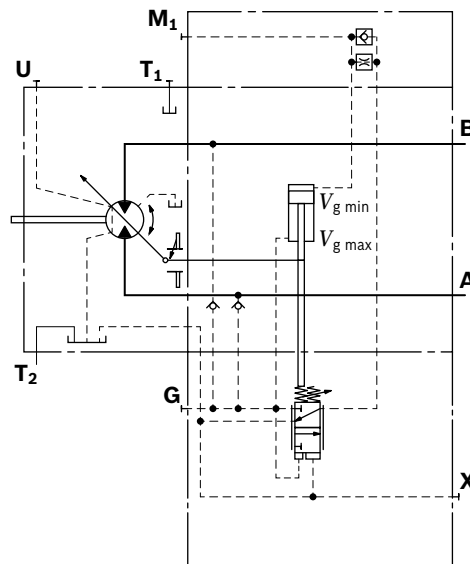
**HA2 with pressure increase, positive control**

A working pressure increase of  $\Delta p$  approx. 100 bar results in an increase in displacement from  $V_{g \text{ min}}$  to  $V_{g \text{ max}}$ . Beginning of control, setting range 80 to 350 bar Please state the desired beginning of control in plain text when ordering, e.g.: beginning of control at 200 bar.

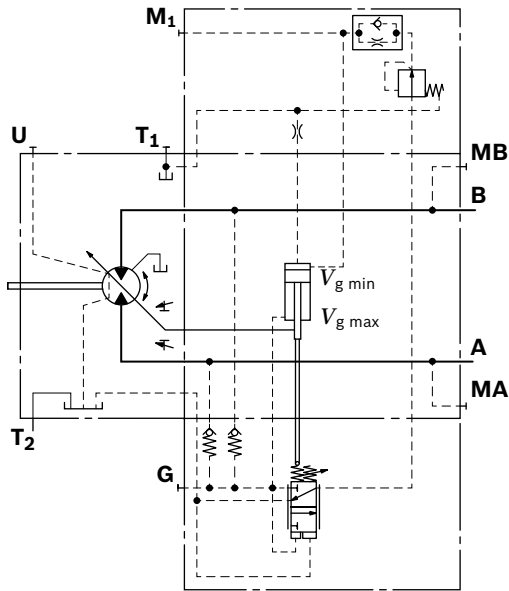
▼ **Characteristic curve HA2**



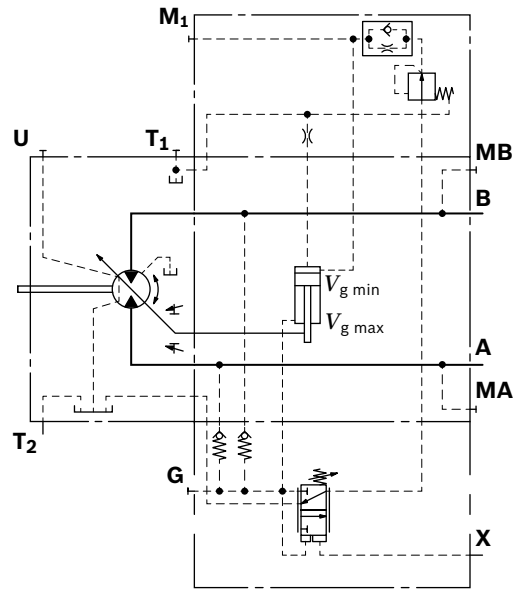
▼ **Circuit diagram HA2 size 60 to 215**



▼ **Circuit diagram HA2 size 280**



▼ **Circuit diagram HA1T3 size 280**



**HA.T3 override, hydraulic, remote controlled, proportional**

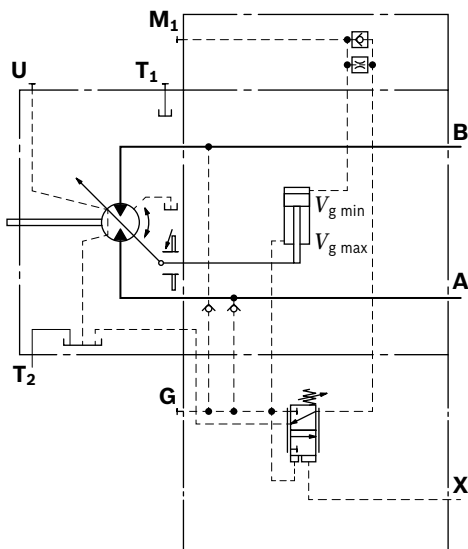
With the HA.T3 control, the beginning of control can be influenced by applying a pilot pressure to port X. The beginning of control is reduced by 17 bar or by 23 bar for size 280 per 1 bar pilot pressure.

Settings for the beginning of control	NG60 ... 215		NG280
	300 bar	300 bar	300 bar
Pilot pressure at port X	0 bar	10 bar	10 bar
Beginning of control at	300 bar	130 bar	70 bar

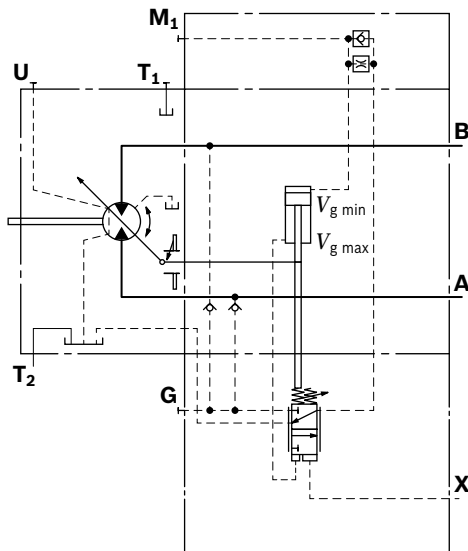
**Notice**

Maximum permissible pilot pressure 100 bar.

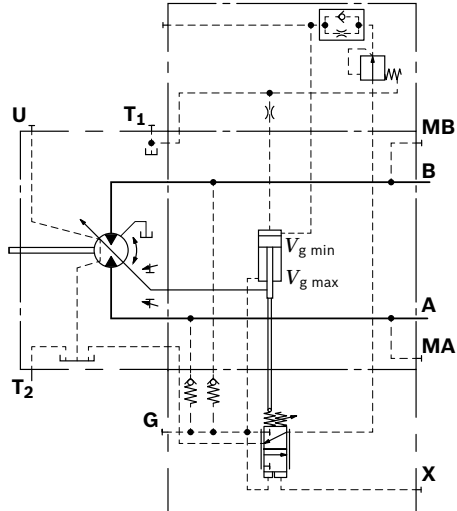
▼ **Circuit diagram HA1T3 size 60 to 215**



▼ **Circuit diagram HA2T3 size 60 to 215**



▼ **Circuit diagram HA2T3 size 280**



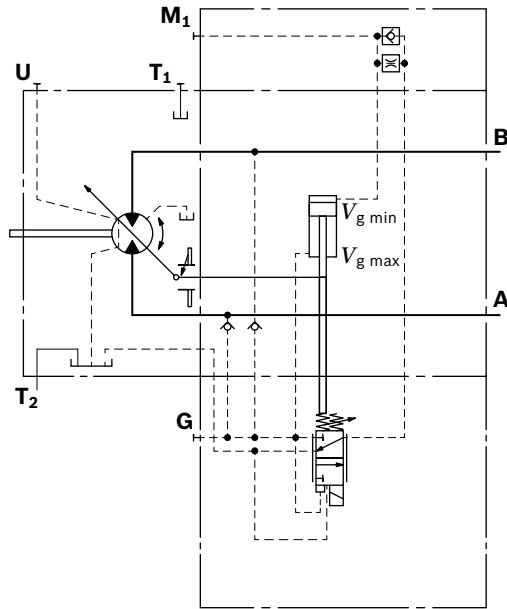
▼ **HA.U1, HA.U2 electric override, two-point**

With the HA.U1 or HA.U2 control, the beginning of control can be overridden by an electric signal to a switching solenoid. When the override solenoid is energized, the variable motor swivels to maximum swivel angle, without intermediate position.

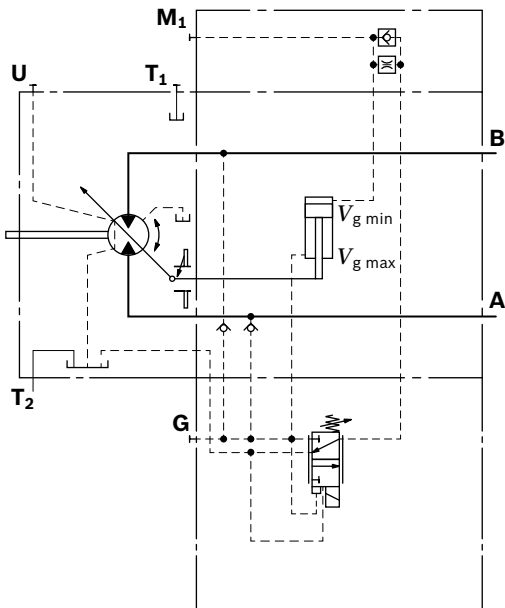
The beginning of control can be set between 80 and 300 bar (specify required setting in plain text when ordering).

Technical data, solenoid with $\varnothing 45$	U1	U2
Voltage	12 V ( $\pm 20\%$ )	24 V ( $\pm 20\%$ )
No override	de-energized	de-energized
Position $V_{g \max}$	energized	energized
Nominal resistance (at 20 °C)	4.8 $\Omega$	19.2 $\Omega$
Nominal power	30 W	30 W
Minimum active current required	1.5 A	0.75 A
Duty cycle	100%	100%
Type of protection: see connector version page 70		

▼ **Circuit diagram HA2U1, HA2U2 size 60 to 215**



▼ **Circuit diagram HA1U1, HA1U2 size 60 to 215**



**HA.R1, HA.R2 electric override, electric travel direction valve**

With the HA.R1 or HA.R2 control, the beginning of control can be overridden by an electric signal to switching solenoid **b**. When the override solenoid is energized, the variable motor swivels to maximum swivel angle, without intermediate position.

The travel direction valve ensures that the preselected pressure side of the hydraulic motor (**A** or **B**) is always connected to the HA control, and thus determines the swivel angle, even if the high-pressure side changes (e.g. travel drive during a downhill operation). This thereby prevents undesired swiveling of the variable motor to a larger displacement (jerky deceleration and/or braking characteristics).

Depending on the direction of rotation (direction of travel), the travel direction valve is actuated through the compression spring or the switching solenoid **a** (see page 28).

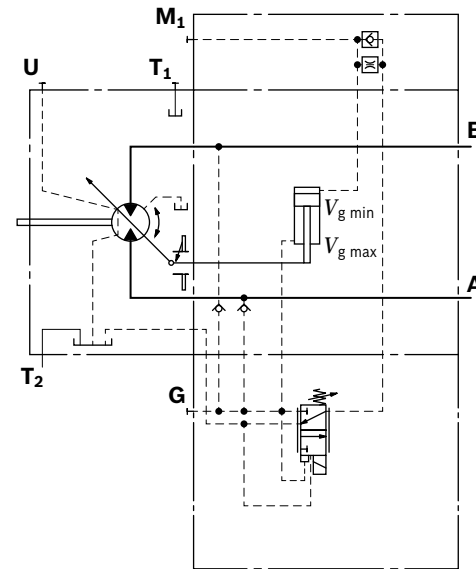
**Electric override**

Technical data, solenoid <b>b</b> with $\varnothing 45$	R1	R2
Voltage	12 V ( $\pm 20\%$ )	24 V ( $\pm 20\%$ )
No override	de-energized	de-energized
Position $V_{g \max}$	energized	energized
Nominal resistance (at 20 °C)	4.8 $\Omega$	19.2 $\Omega$
Nominal power	30 W	30 W
Minimum active current required	1.5 A	0.75 A
Duty cycle	100%	100%
Type of protection: see connector version page 70		

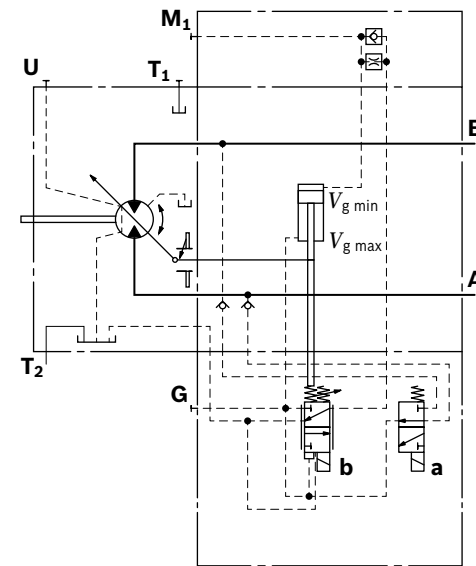
**Travel direction valve, electric**

Technical data, solenoid <b>a</b> with $\varnothing 37$	R1	R2
Voltage	12 V ( $\pm 20\%$ )	24 V ( $\pm 20\%$ )
Direction of rotation	Working pressure in	
Counterclockwise	<b>B</b>	energized
Clockwise	<b>A</b>	de-energized
Nominal resistance (at 20 °C)	5.5 $\Omega$	21.7 $\Omega$
Nominal power	26.2 W	26.5 W
Minimum active current required	1.32 A	0.67 A
Duty cycle	100%	100%
Type of protection: see connector version page 70		

▼ **Circuit diagram HA1R1, HA1R2 size 60 to 215**



▼ **Circuit diagram HA2R1, HA2R2 size 60 to 215**



## DA – Automatic control, speed related

The variable motor A6VM with automatic speed-related control is intended for use in hydrostatic travel drives in combination with the variable pump A4VG with DA control. A drive speed-related pilot pressure signal is generated by the A4VG variable pump, and that signal, together with the working pressure, regulates the swivel angle of the hydraulic motor.

Increasing drive speed, i.e. increasing pilot pressure, causes the motor to swivel to a smaller displacement (lower torque, higher rotational speed), depending on the working pressure.

If the working pressure exceeds the pressure command value of the controller, the variable motor swivels to a larger displacement (higher torque, lower rotational speed).

- ▶ Pressure ratio  $p_{St}/p_{HD} = 5/100$  (NG60 to 215)
- ▶ Pressure ratio  $p_{St}/p_{HD} = 3/100$  (NG280)

DA control is only suitable for certain types of travel drive systems and requires review of the motor and vehicle parameters to ensure that the motor is used correctly and that machine operation is safe and efficient. We recommend that all DA applications be reviewed by a Bosch Rexroth application engineer.

Our Sales department will provide you detailed information.

### Notice

The beginning of control and the DA characteristic curve are influenced by case pressure. An increase in the case pressure causes a decrease / reduction in the beginning of control (see page 8) and thus a parallel displacement of the characteristic curve.

### Stroking time damping

The stroking time damping impacts the swivel behavior of the motor and consequently the machine response speed.

### Standard for sizes 60 to 280

DA with throttle pin on one side, throttling occurs from  $V_{g \min}$  to  $V_{g \max}$ . (see table)

### ▼ Throttle pin overview

Size	60	85	115	150	170	215	280
Groove size [mm]	0.45	0.45	0.55	0.55	0.55	0.65	2×1.0

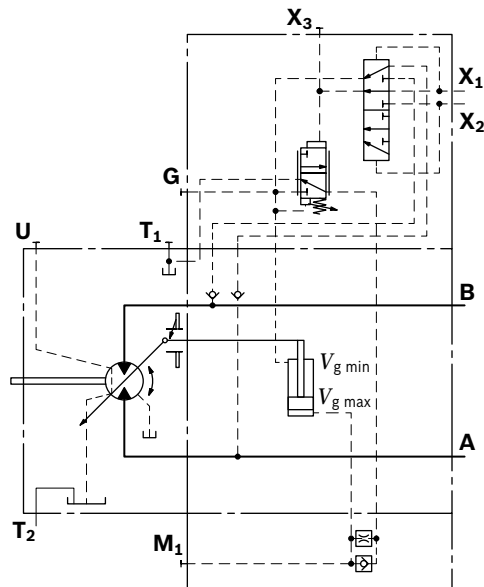
## DA0, DA7

### Hydraulic travel direction valve, negative control

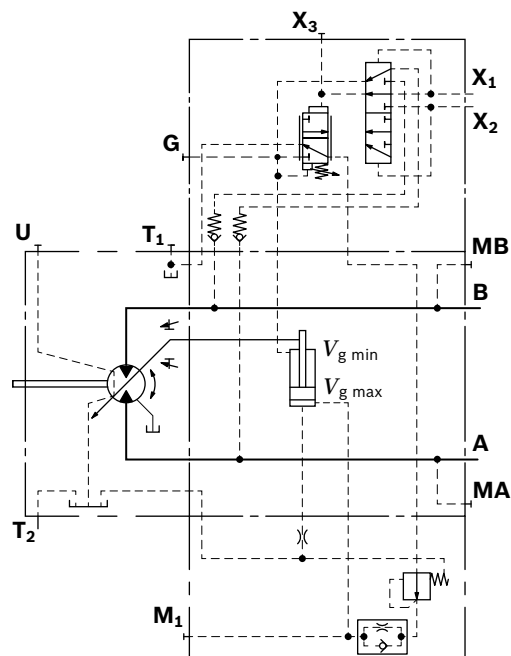
Dependent on the direction of rotation (travel direction), the travel direction valve is switched by using pilot pressure connections  $X_1$  or  $X_2$ .

Direction of rotation	Working pressure in	Pilot pressure in
Clockwise	A	$X_1$
Counterclockwise	B	$X_2$

### ▼ Circuit diagram DA0 size 60 to 215



### ▼ Circuit diagram DA7 size 280



**DA1, DA2 Electric travel direction valve + electric  $V_{g \max}$  override, negative control**

Depending on the direction of rotation (direction of travel), the travel direction valve is actuated through the compression spring or the switching solenoid **a**.

When switching solenoid **b** is energized, the control can be overridden and the motor can be swiveled to maximum displacement (high torque, lower rotational speed) (electric  $V_{g \max}$  override).

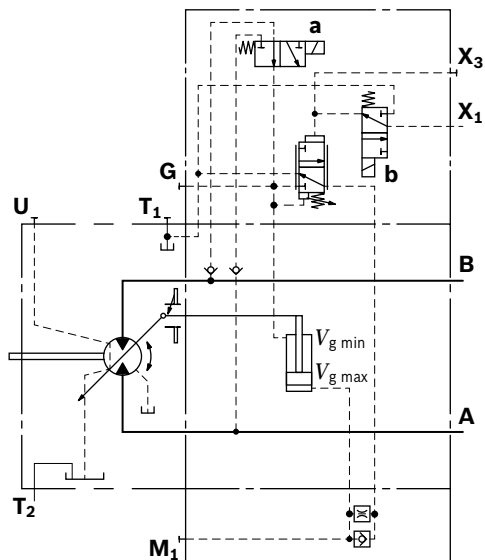
**Travel direction valve, electric**

Technical data, solenoid a with $\varnothing 37$	DA1	DA2
Voltage	12 V ( $\pm 20\%$ )	24 V ( $\pm 20\%$ )
Direction of rotation	Working pressure in	
Counterclockwise	<b>B</b>	de-energized
Clockwise	<b>A</b>	energized
Nominal resistance (at 20 °C)	5.5 $\Omega$	21.7 $\Omega$
Nominal power	26.2 W	26.5 W
Minimum active current required	1.32 A	0.67 A
Duty cycle	100%	100%
Type of protection: see connector version page 70		

**Electric override**

Technical data, solenoid b with $\varnothing 37$	R1	R2
Voltage	12 V ( $\pm 20\%$ )	24 V ( $\pm 20\%$ )
No override	de-energized	de-energized
Position $V_{g \max}$	energized	energized
Nominal resistance (at 20 °C)	5.5 $\Omega$	21.7 $\Omega$
Nominal power	26.2 W	26.5 W
Minimum active current required	1.32 A	0.67 A
Duty cycle	100%	100%
Type of protection: see connector version page 70		

▼ **Circuit diagram DA1, DA2 size 60 to 215**



## Electric travel direction valve (for DA, HA.R)

Application in travel drives in closed circuits. The travel direction valve of the motor is actuated by an electric signal that also switches the swivel direction of the travel drive pump (e.g. A4VG with DA control valve).

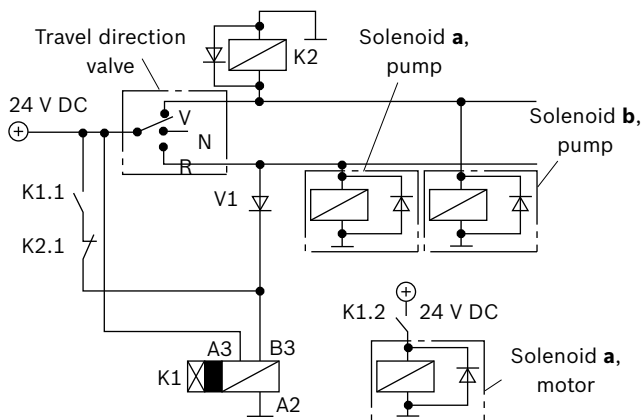
If the pump in the closed circuit is switched to the neutral position or into reverse, the vehicle may experience jerky deceleration or braking, depending on the vehicle weight and current travel speed.

When the travel direction valve of the pump (e.g. 4/3-way directional valve of the DA-control) is switched to

- ▶ the neutral position, the electric circuitry, which must be logically coordinated with the pump control system, causes the previous signal on the travel direction valve on the motor to be retained.
- ▶ Reversing, the electric circuitry causes the travel direction valve on the motor to switch to the other travel direction following a time delay (approx. 0.8 s) with respect to the pump.

As a result, jerky deceleration or braking is prevented in both cases.

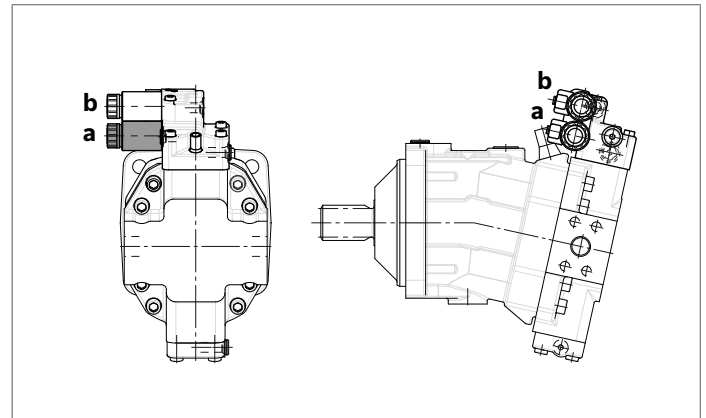
### ▼ Circuit diagram, electric travel direction valve



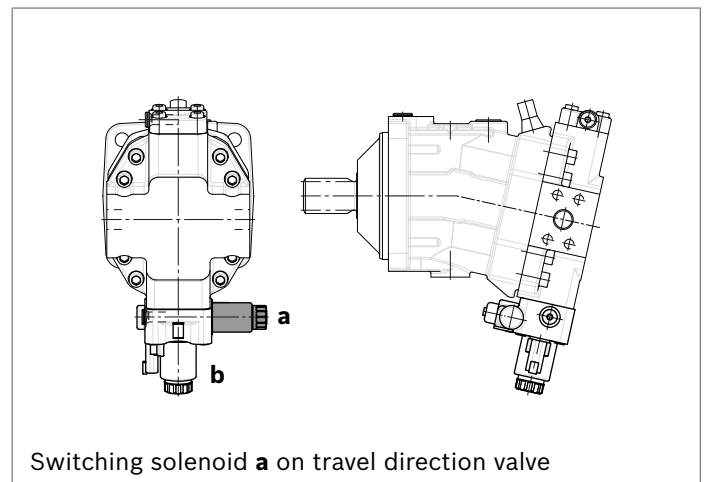
### Notice

The shown diodes and relays are not included in the scope of delivery of the motor.

### Control DA1, DA



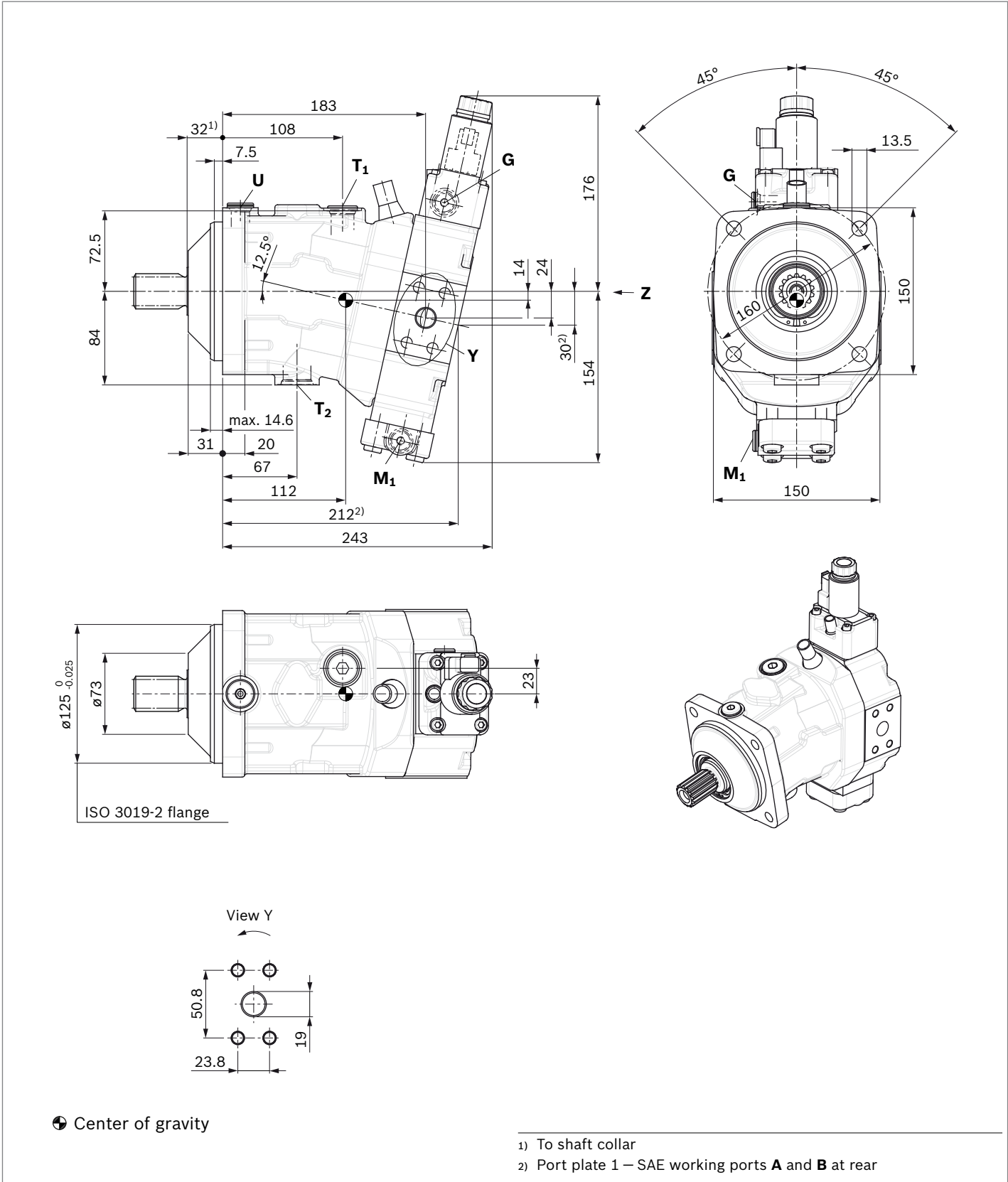
### ▼ Control, HA1R., HA2R.



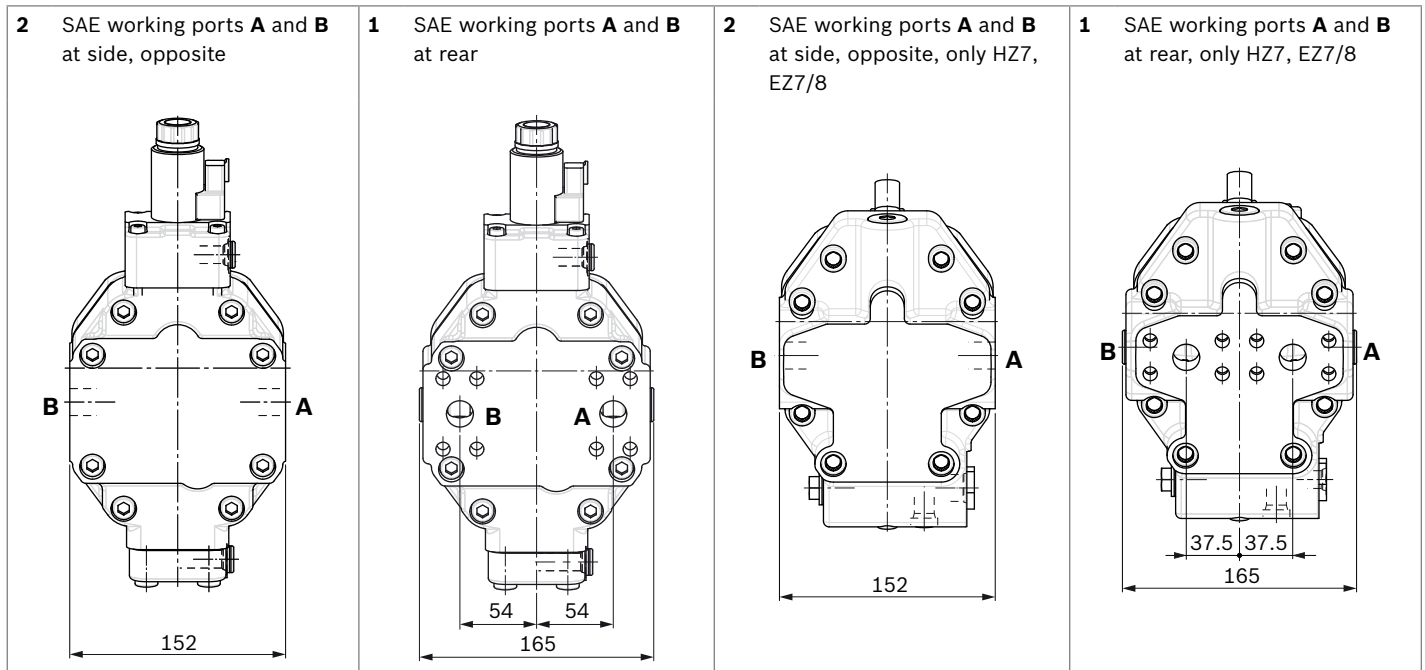
**Dimensions, size 60**

**EP5, EP6 – Proportional electric control, negative control**

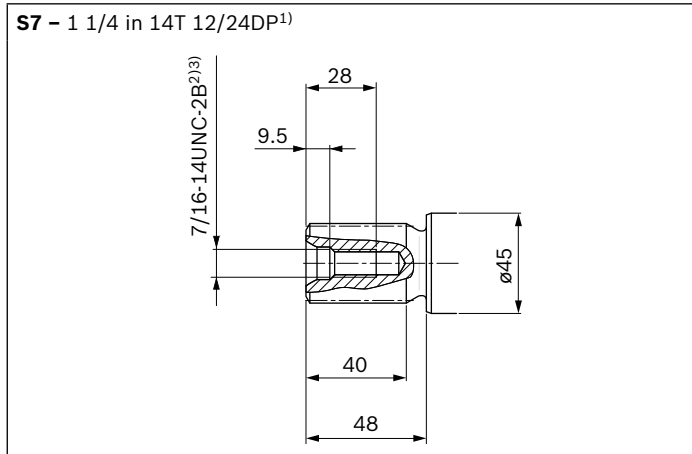
Port plate 2 – SAE working ports **A** and **B** at side, opposite



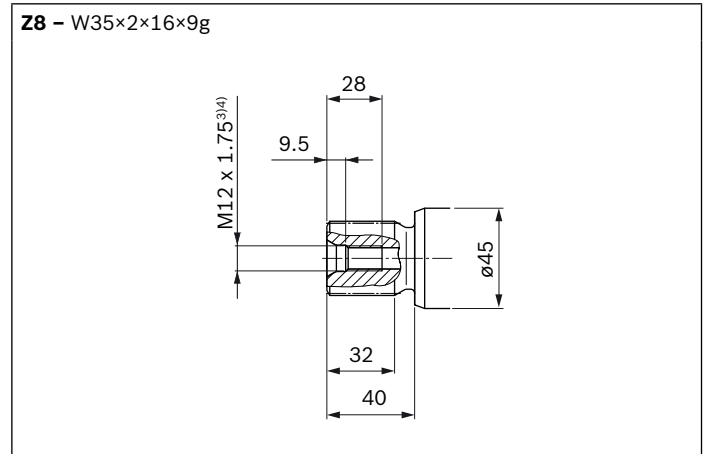
▼ **Location of working ports on the port plates (View Z)**



▼ **SAE J744 splined shaft**



▼ **DIN 5480 splined shaft**



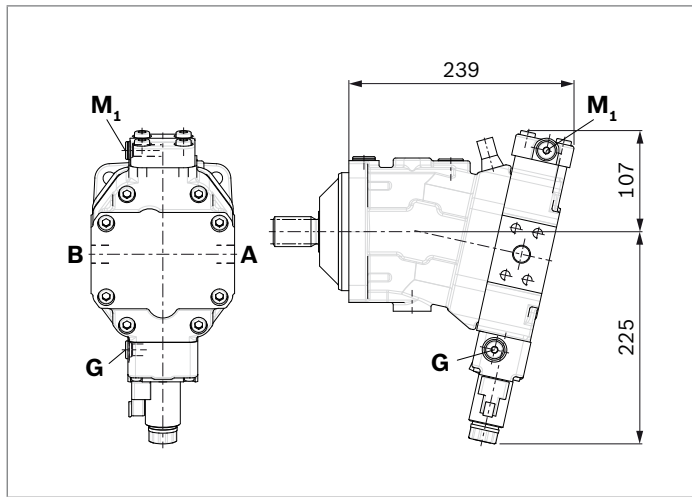
1) Involute spline according to ANSI B92.1a, 30° pressure angle, flat root, side fit, tolerance class 5  
 2) Thread according to ASME B1.1  
 3) For notes on tightening torques, see the instruction manual.  
 4) Center bore according to DIN 332 (thread according to DIN 13)

Ports		Standard	Size <sup>1)</sup>	$p_{\max}$ [bar] <sup>2)</sup>	State <sup>6)</sup>
<b>A, B</b>	Working port	SAE J518 <sup>3)</sup>	3/4 in	530	O
	Fastening thread A/B	DIN 13	M10 × 1.5; 17 deep		
<b>T<sub>1</sub></b>	Drain port	ISO 6149 <sup>5)</sup>	M22 × 1.5; 15.5 deep	3	X <sup>4)</sup>
<b>T<sub>2</sub></b>	Drain port	ISO 6149 <sup>5)</sup>	M27 × 2; 19 deep	3	O <sup>4)</sup>
<b>G</b>	Synchronous control	ISO 6149 <sup>5)</sup>	M14 × 1.5; 11.5 deep	530	X
<b>U</b>	Bearing flushing port	ISO 6149 <sup>5)</sup>	M18 × 1.5; 14.5 deep	3	X
<b>X</b>	Pilot pressure port (HP, HZ, HA1T/HA2T)	ISO 6149 <sup>5)</sup>	M14 × 1.5; 11.5 deep	100	O
<b>X</b>	Pilot pressure port (HA1, HA2)	ISO 6149 <sup>5)</sup>	M14 × 1.5; 11.5 deep	3	X
<b>X<sub>1</sub>, X<sub>2</sub></b>	Pilot pressure port (DA0)	ISO 8434-1	SDSC-L8×M12-F	40	O
<b>X<sub>1</sub></b>	Pilot pressure port (DA1, DA2)	ISO 6149 <sup>5)</sup>	M14 × 1.5; 11.5 deep	40	O
<b>X<sub>3</sub></b>	Pilot pressure port (DA1, DA2)	ISO 6149 <sup>5)</sup>	M14 × 1.5; 11.5 deep	40	X
<b>M<sub>1</sub></b>	Control pressure measuring port	ISO 6149 <sup>5)</sup>	M14 × 1.5; 11.5 deep	530	X

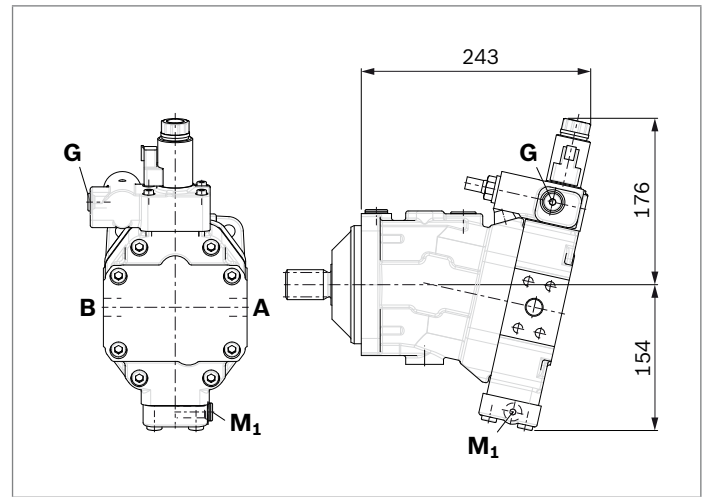
- 1) For information on tightening torques, see the instruction manual.  
2) Momentary pressure peaks can occur depending on application. Keep this in mind when selecting measuring devices and fittings.  
3) Only dimensions according to SAE J518, metric fastening thread is a deviation from the standard.

- 4) Depending on installation position, **T<sub>1</sub>** or **T<sub>2</sub>** must be connected (see also installation instructions on page 86).  
5) The countersink may be deeper than specified in the standard.  
6) O = Must be connected (plugged on delivery)  
X = Plugged (in normal operation)

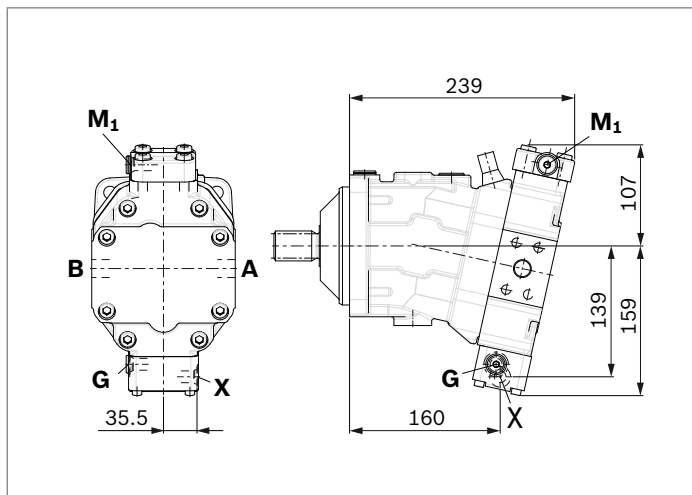
▼ **EP1, EP2** – Proportional electric control, positive control



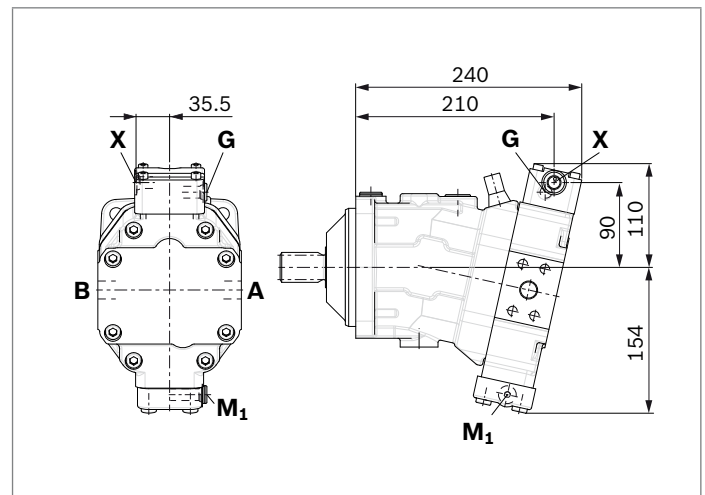
▼ **EP5D1, EP6D1** – Proportional electric control, negative control, with pressure control fixed setting



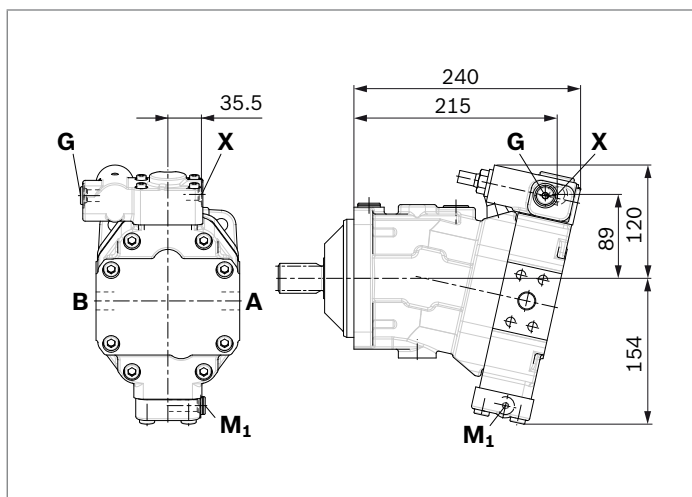
▼ **HP1, HP2** – Proportional hydraulic control, positive control



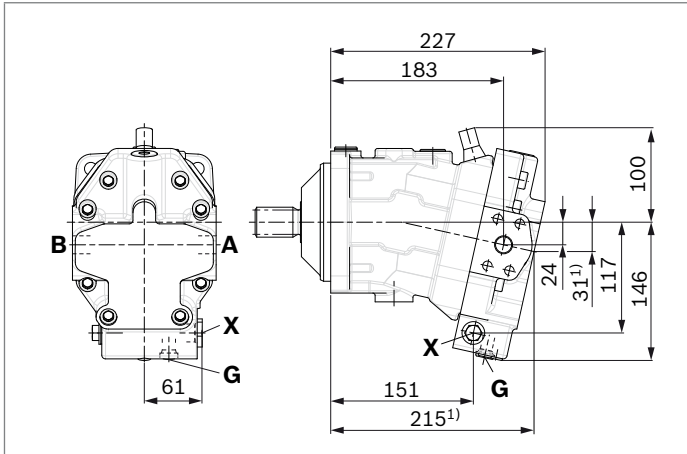
▼ **HP5, HP6** – Proportional hydraulic control, negative control



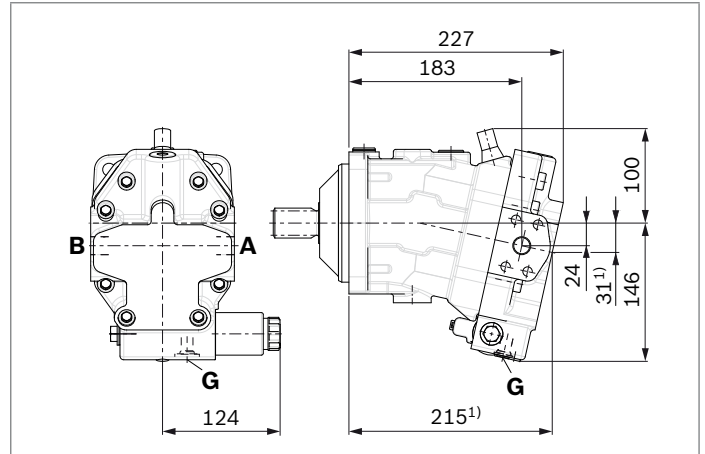
▼ **HP5D1, HP6D1** – Proportional hydraulic control, negative control, with pressure control fixed setting



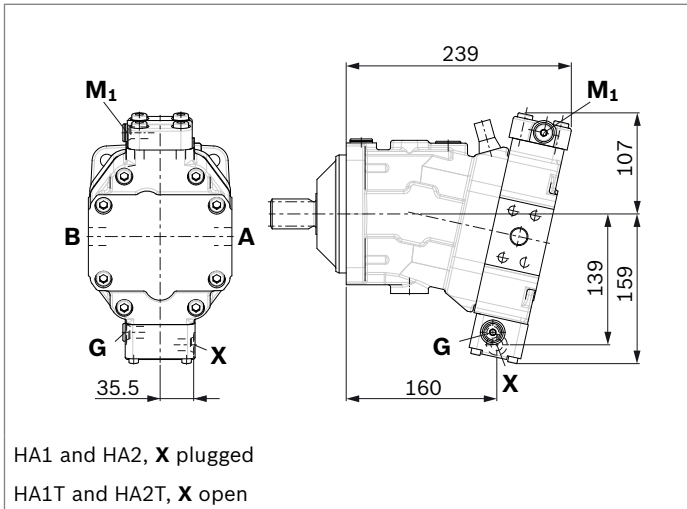
▼ **HZ7** – Two-point hydraulic control, negative control



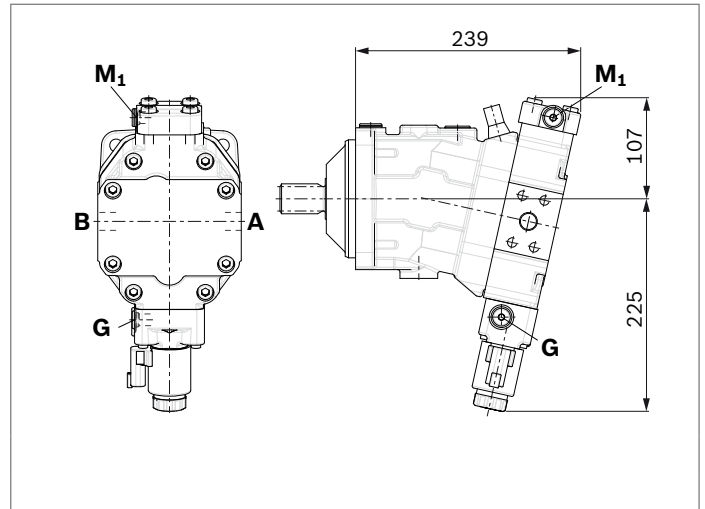
▼ **EZ7, EZ8** – Two-point electric control, negative control



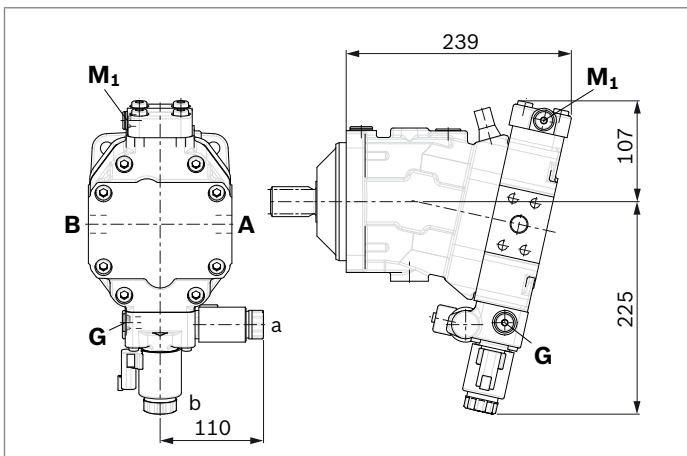
▼ **HA1, HA2 / HA1T3, HA2T3** – Automatic high-pressure related control, positive control, with hydraulic override, remote controlled, proportional



▼ **HA1U1, HA2U2** – Automatic high-pressure related control, positive control, with electric override, two-point

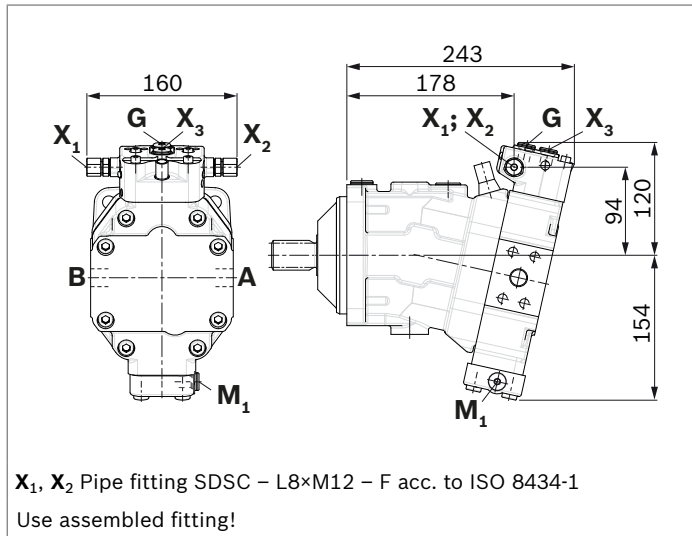


▼ **HA1R1, HA2R2** – Automatic high-pressure related control, positive control, with electric override and electric travel direction valve

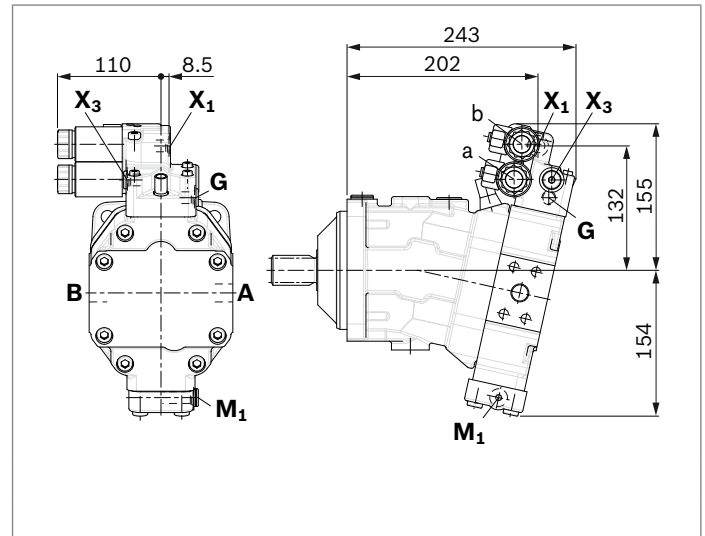


1) Port plate 1 - SAE working ports **A** and **B** at rear

- ▼ **DA0** – Automatic speed related control, negative control, with hydraulic travel direction valve



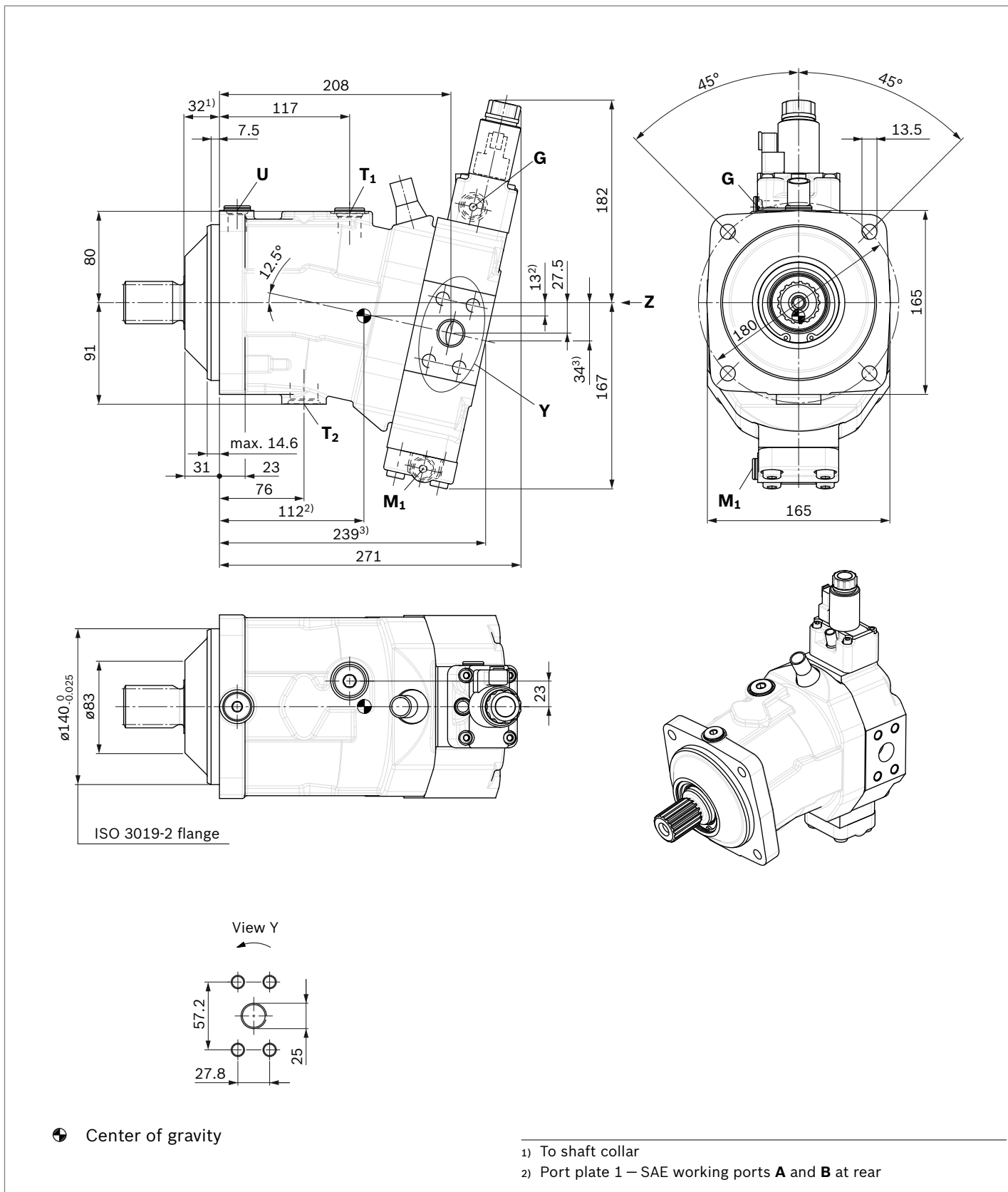
- ▼ **DA1, DA2** – Automatic speed related control, negative control, with electric travel direction valve and electric  $V_{g \max}$  override



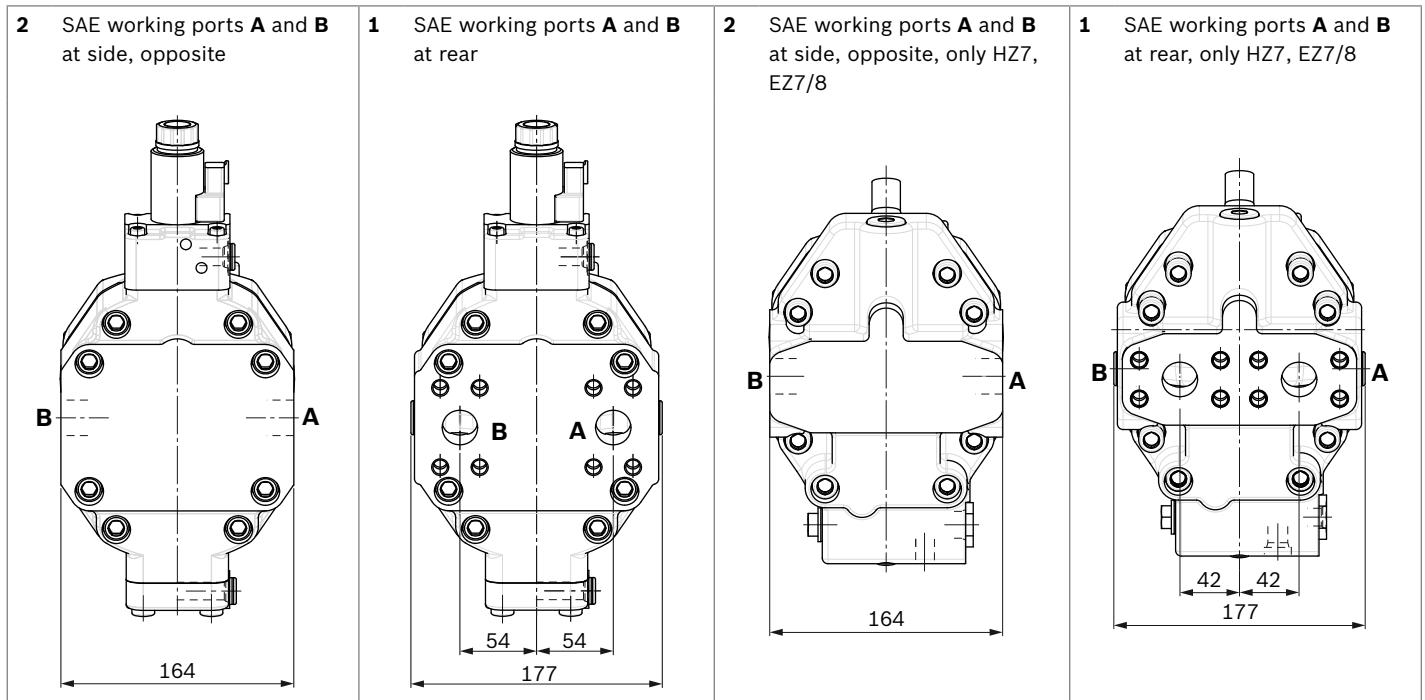
**Dimensions, size 85**

**EP5, EP6 – Proportional electric control, negative control**

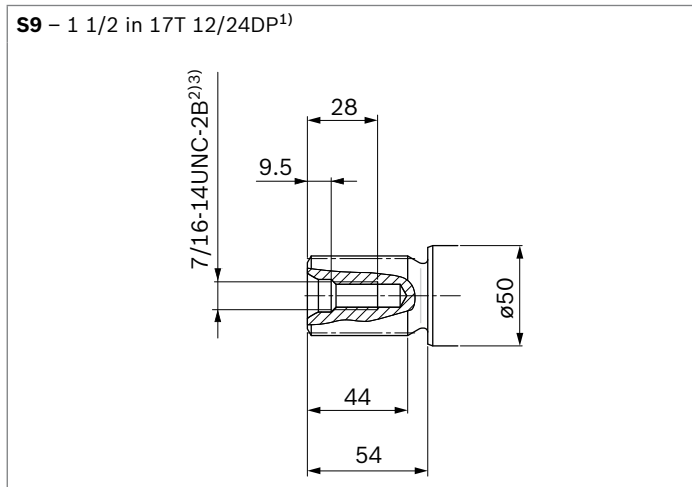
Port plate 2 – SAE working ports **A** and **B** at side, opposite



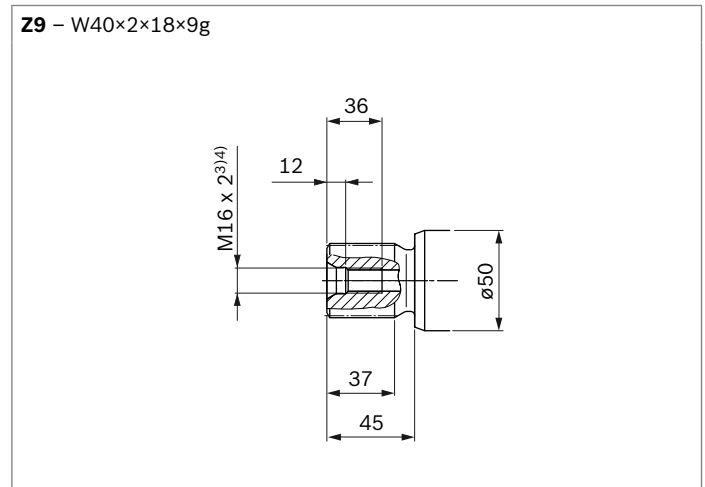
▼ **Location of the working ports on the port plates (View Z)**



▼ **SAE J744 splined shaft**



▼ **DIN 5480 splined shaft**



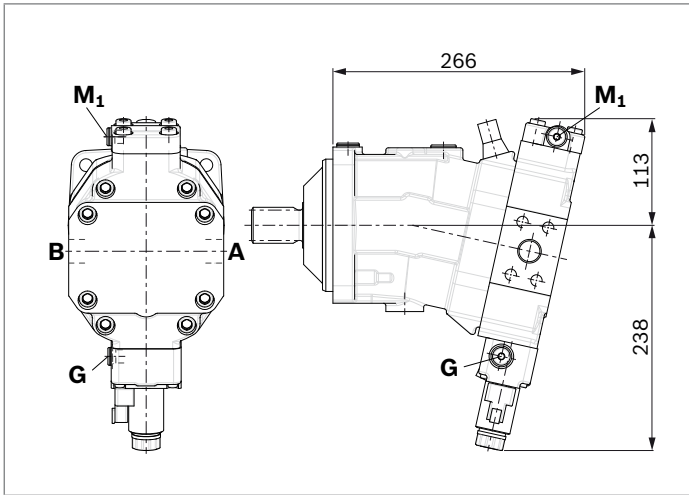
1) Involute spline according to ANSI B92.1a, 30° pressure angle, flat root, side fit, tolerance class 5  
 2) Thread according to ASME B1.1  
 3) For information on tightening torques, see the instruction manual.  
 4) DIN 332 center bore (DIN 13 thread)

<b>Ports</b>		<b>Standard</b>	<b>Size<sup>1)</sup></b>	<b><math>p_{max}</math> [bar]<sup>2)</sup></b>	<b>State<sup>6)</sup></b>
<b>A, B</b>	Working port Fastening thread A/B	SAE J518 <sup>3)</sup> DIN 13	1 in M12 × 1.75; 17 deep	530	O
<b>T<sub>1</sub></b>	Drain port	ISO 6149 <sup>5)</sup>	M22 × 1.5; 15.5 deep	3	X <sup>4)</sup>
<b>T<sub>2</sub></b>	Drain port	ISO 6149 <sup>5)</sup>	M27 × 2; 19 deep	3	O <sup>4)</sup>
<b>G</b>	Synchronous control	ISO 6149 <sup>5)</sup>	M14 × 1.5; 11.5 deep	530	X
<b>U</b>	Bearing flushing port	ISO 6149 <sup>5)</sup>	M18 × 1.5; 14.5 deep	3	X
<b>X</b>	Pilot pressure port (HP, HZ, HA1T/HA2T)	ISO 6149 <sup>5)</sup>	M14 × 1.5; 11.5 deep	100	O
<b>X</b>	Pilot pressure port (HA1, HA2)	ISO 6149 <sup>5)</sup>	M14 × 1.5; 11.5 deep	3	X
<b>X<sub>1</sub>, X<sub>2</sub></b>	Pilot pressure port (DA0)	ISO 8434-1	SDSC-L8×M12-F	40	O
<b>X<sub>1</sub></b>	Pilot pressure port (DA1, DA2)	ISO 6149 <sup>5)</sup>	M14 × 1.5; 11.5 deep	40	O
<b>X<sub>3</sub></b>	Pilot pressure port (DA1, DA2)	ISO 6149 <sup>5)</sup>	M14 × 1.5; 11.5 deep	40	X
<b>M<sub>1</sub></b>	Control pressure measuring port	ISO 6149 <sup>5)</sup>	M14 × 1.5; 11.5 deep	530	X

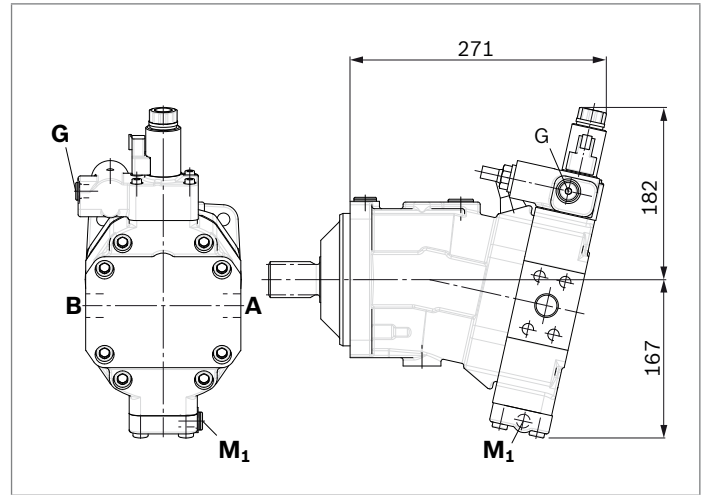
- 1) For information on tightening torques, see the instruction manual.
- 2) Momentary pressure peaks can occur depending on application. Keep this in mind when selecting measuring devices and fittings.
- 3) Only dimensions according to SAE J518, metric fastening thread is a deviation from the standard.

- 4) Depending on installation position, **T<sub>1</sub>** or **T<sub>2</sub>** must be connected (see also installation instructions on page 86).
- 5) The countersink may be deeper than specified in the standard.
- 6) O = must be connected (comes plugged)  
X = plugged (in normal operation)

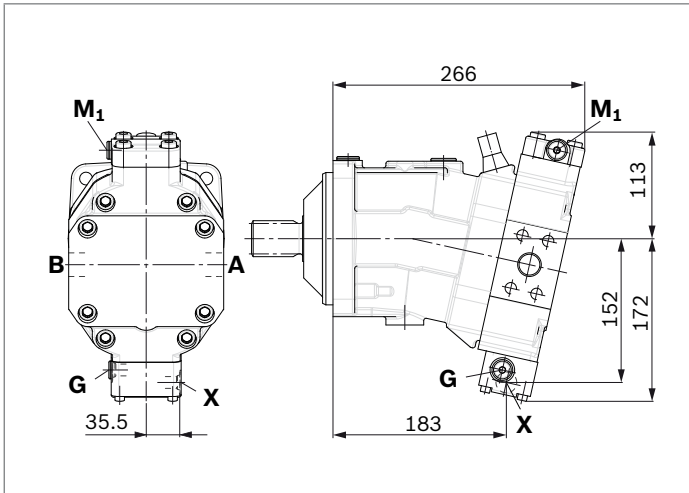
▼ **EP1, EP2** – Proportional electric control, positive control



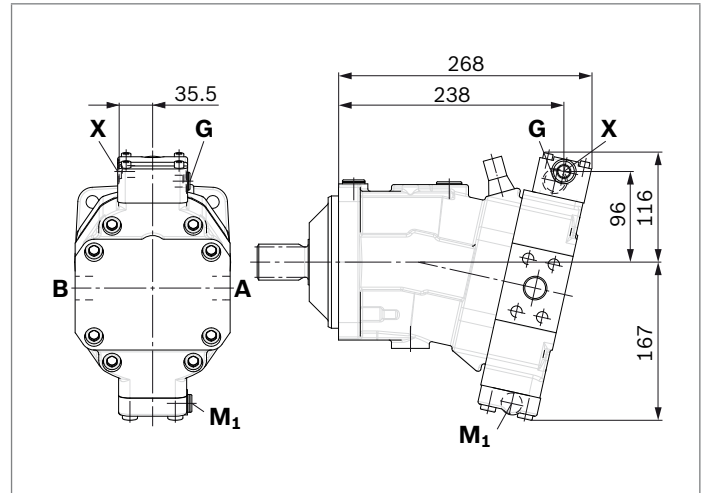
▼ **EP5D1, EP6D1** – Proportional electric control, negative control, with pressure control fixed setting



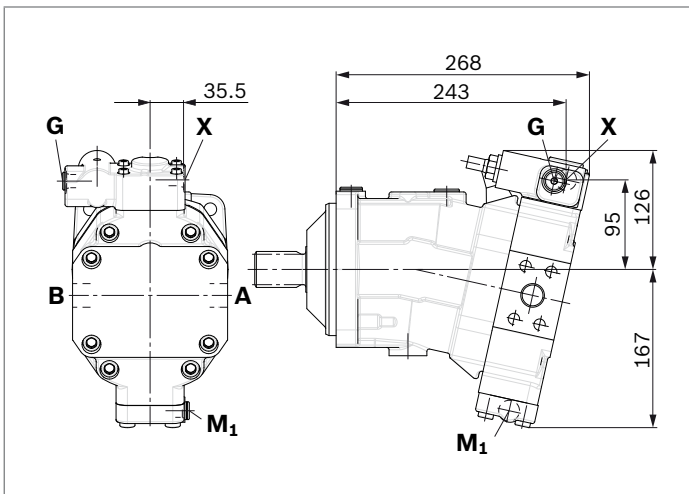
▼ **HP1, HP2** – Proportional hydraulic control, positive control



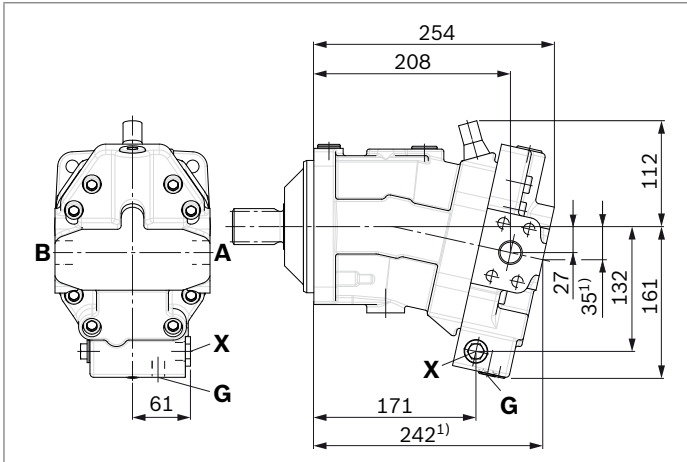
▼ **HP5, HP6** – Proportional hydraulic control, negative control



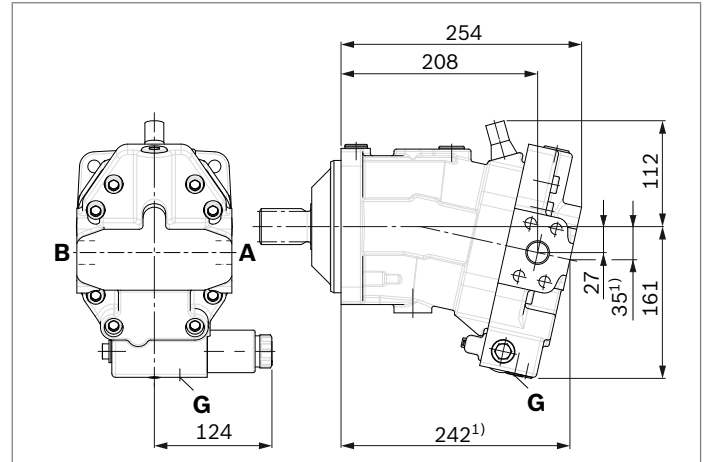
▼ **HP5D1, HP6D1** – Proportional hydraulic control, negative control, with pressure control fixed setting



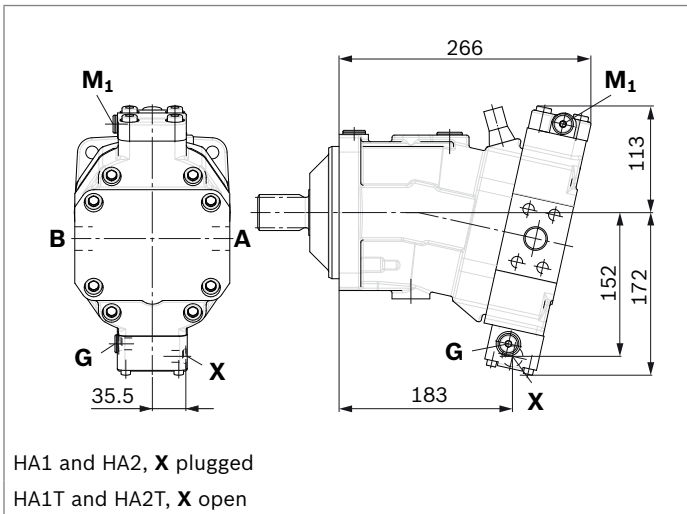
▼ **HZ7** – Two-point hydraulic control, negative control



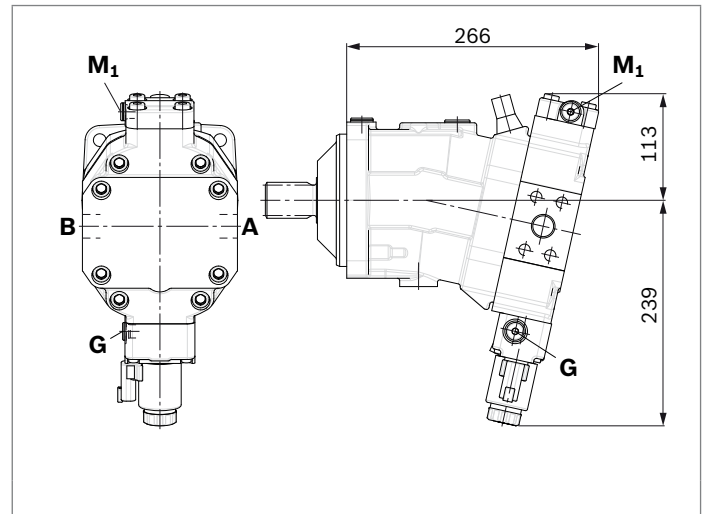
▼ **EZ7, EZ8** – Two-point electric control, negative control



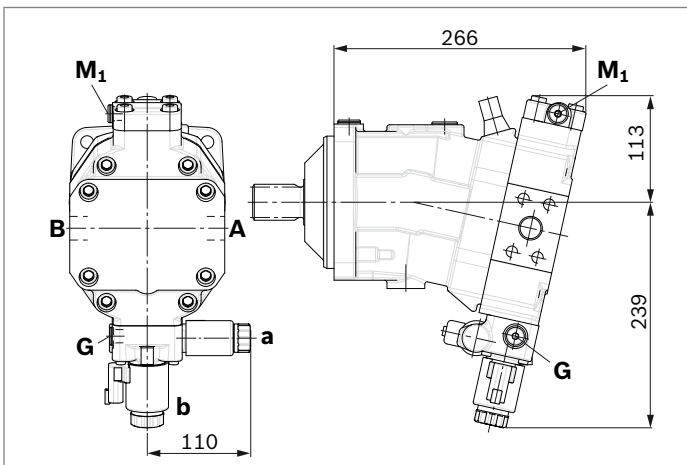
▼ **HA1, HA2 / HA1T3, HA2T3** – Automatic high-pressure related control, positive control, with hydraulic override, remote controlled, proportional



▼ **HA1U1, HA2U2** – Automatic high-pressure related control, positive control, with electric override, two-point

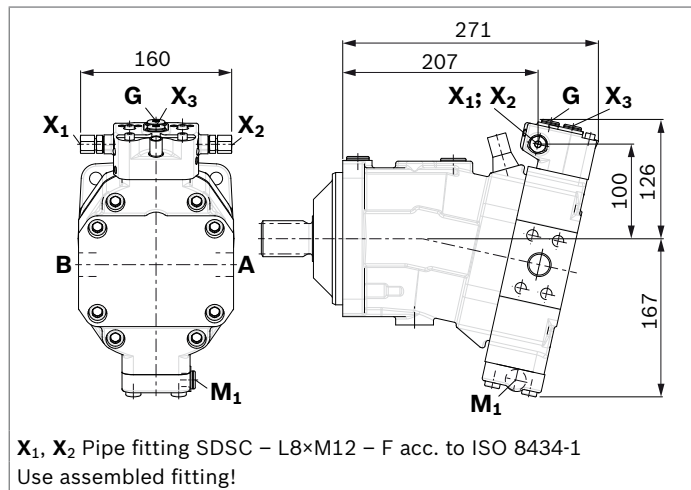


▼ **HA1R1, HA2R2** – Automatic high-pressure related control, positive control, with electric override and electric travel direction valve

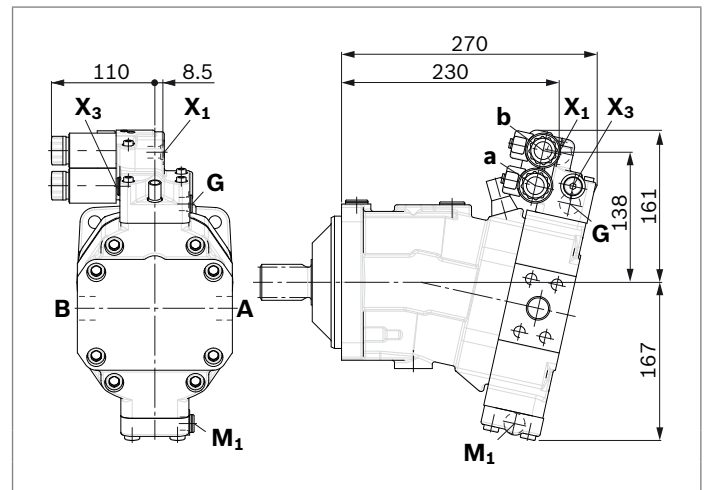


1) Port plate 1 - SAE working ports **A** and **B** at rear

- ▼ **DA0** – Automatic speed related control, negative control, with hydraulic travel direction valve



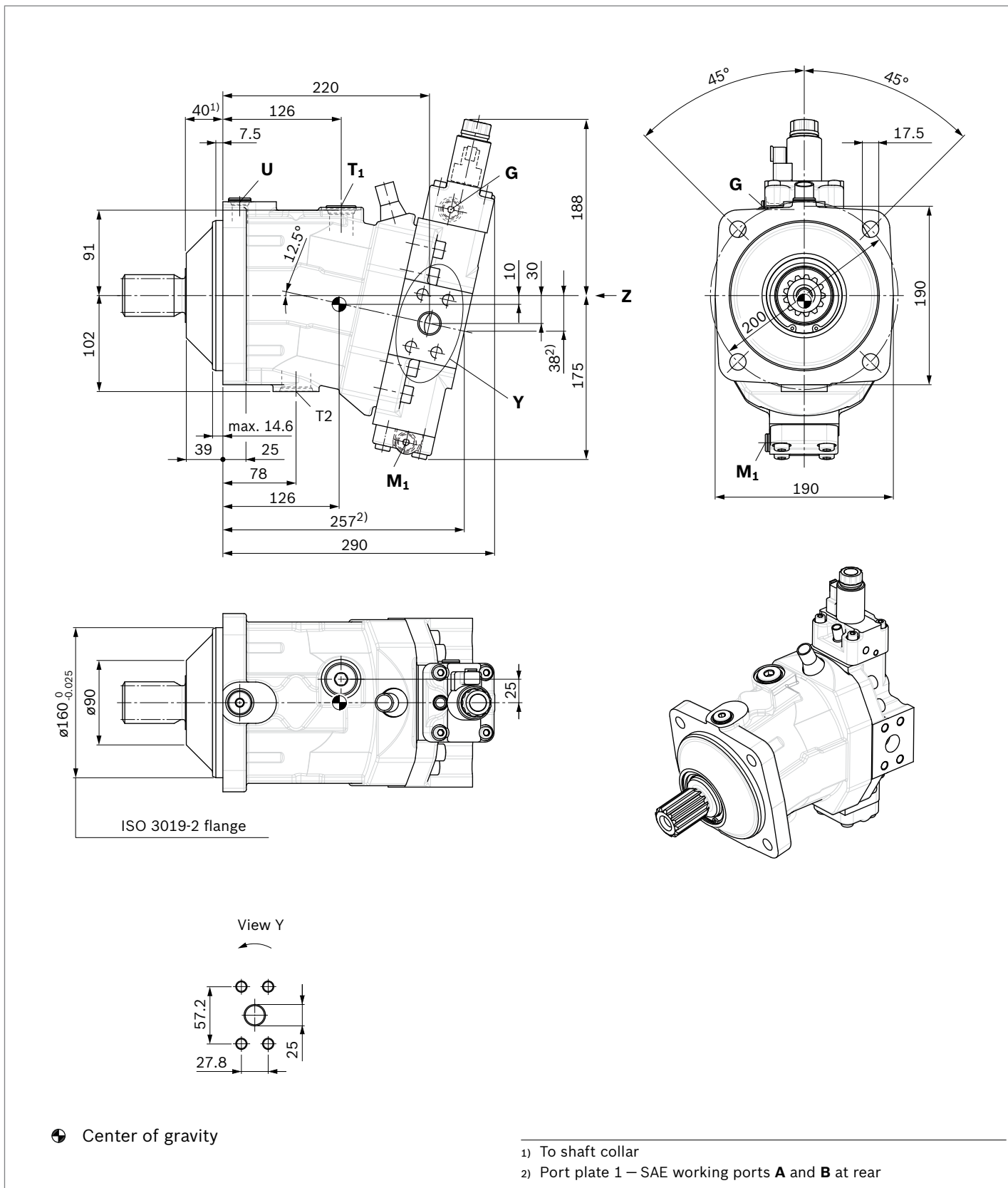
- ▼ **DA1, DA2** – Automatic speed related control, negative control, with electric travel direction valve and electric  $V_{g \max}$  override



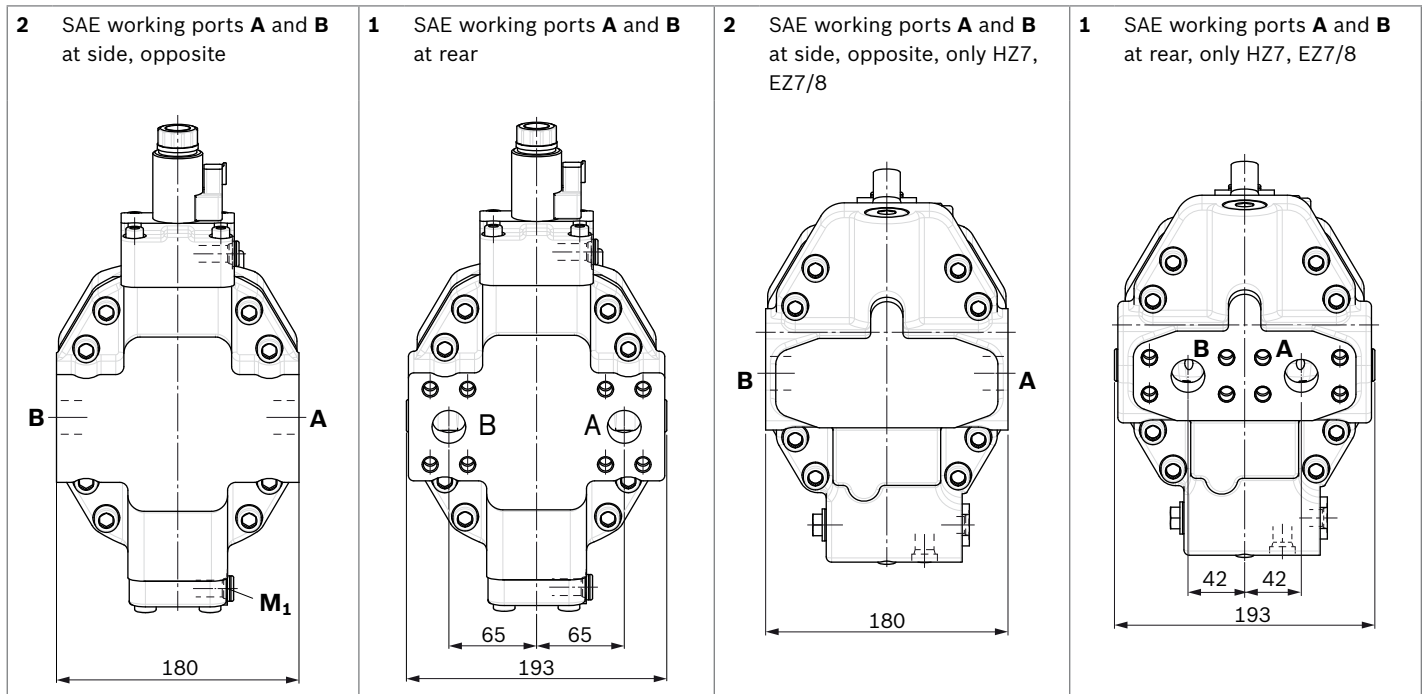
**Dimensions, size 115**

**EP5, EP6 – Proportional electric control, negative control**

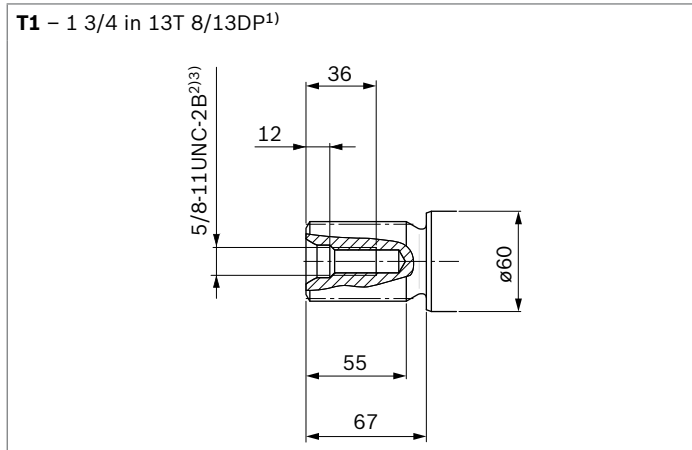
Port plate 2 – SAE working ports **A** and **B** at side, opposite



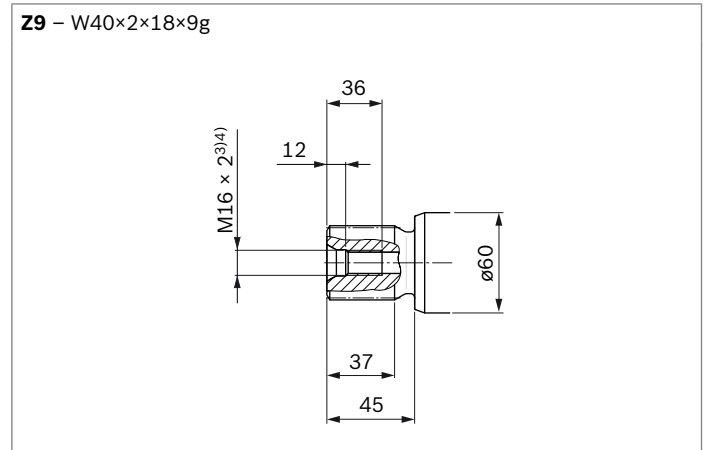
▼ **Location of the working ports on the port plates (View Z)**



▼ **SAE J744 splined shaft**



▼ **DIN 5480 splined shaft**



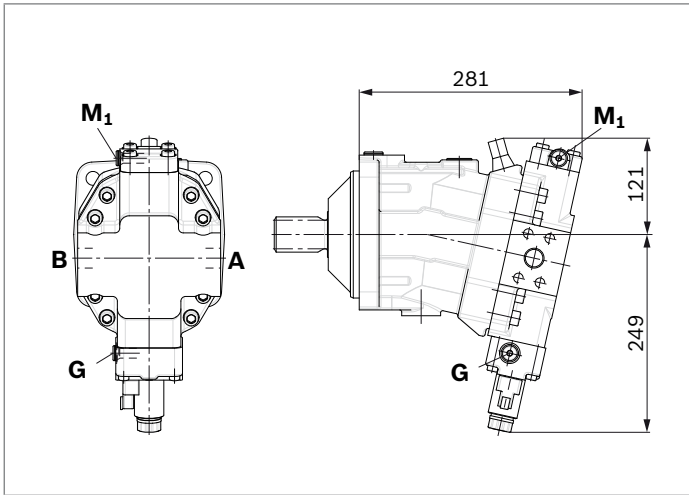
1) Involute spline according to ANSI B92.1a, 30° pressure angle, flat root, side fit, tolerance class 5  
 2) Thread according to ASME B1.1  
 3) For information on tightening torques, see the instruction manual.  
 4) DIN 332 center bore (DIN 13 thread)

Ports		Standard	Size <sup>1)</sup>	$p_{\max}$ [bar] <sup>2)</sup>	State <sup>6)</sup>
<b>A, B</b>	Working port Fastening thread A/B	SAE J518 <sup>3)</sup> DIN 13	1 in M12 × 1.75; 17 deep	530	O
<b>T<sub>1</sub></b>	Drain port	ISO 6149 <sup>5)</sup>	M27 × 2; 19 deep	3	X <sup>4)</sup>
<b>T<sub>2</sub></b>	Drain port	ISO 6149 <sup>5)</sup>	M33 × 2; 19 deep	3	O <sup>4)</sup>
<b>G</b>	Synchronous control	ISO 6149 <sup>5)</sup>	M14 × 1.5; 11.5 deep	530	X
<b>U</b>	Bearing flushing port	ISO 6149 <sup>5)</sup>	M18 × 1.5; 14.5 deep	3	X
<b>X</b>	Pilot pressure port (HP, HZ, HA1T/HA2T)	ISO 6149 <sup>5)</sup>	M14 × 1.5; 11.5 deep	100	O
<b>X</b>	Pilot pressure port (HA1, HA2)	ISO 6149 <sup>5)</sup>	M14 × 1.5; 11.5 deep	3	X
<b>X<sub>1</sub>, X<sub>2</sub></b>	Pilot pressure port (DA0)	ISO 8434-1	SDSC-L8×M12-F	40	O
<b>X<sub>1</sub></b>	Pilot pressure port (DA1, DA2)	ISO 6149 <sup>5)</sup>	M14 × 1.5; 11.5 deep	40	O
<b>X<sub>3</sub></b>	Pilot pressure port (DA1, DA2)	ISO 6149 <sup>5)</sup>	M14 × 1.5; 11.5 deep	40	X
<b>M<sub>1</sub></b>	Control pressure measuring port	ISO 6149 <sup>5)</sup>	M14 × 1.5; 11.5 deep	530	X

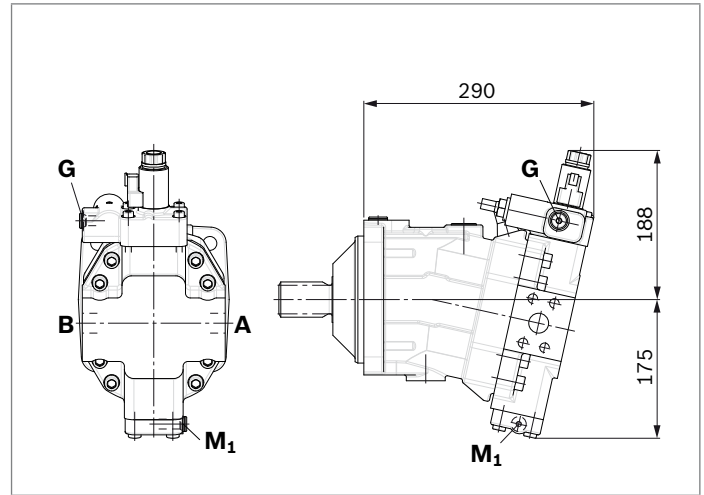
- 1) For information on tightening torques, see the instruction manual.
- 2) Momentary pressure peaks can occur depending on application. Keep this in mind when selecting measuring devices and fittings.
- 3) Only dimensions according to SAE J518, metric fastening thread is a deviation from the standard.

- 4) Depending on installation position, **T<sub>1</sub>** or **T<sub>2</sub>** must be connected (see also installation instructions on page 86).
- 5) The countersink may be deeper than specified in the standard.
- 6) O = Needs to be connected (comes plugged)  
X = Plugged (in normal operation)

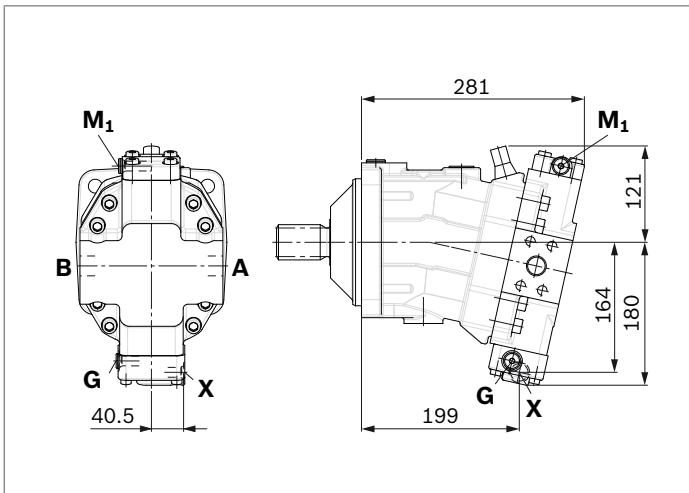
▼ **EP1, EP2** – Proportional electric control, positive control



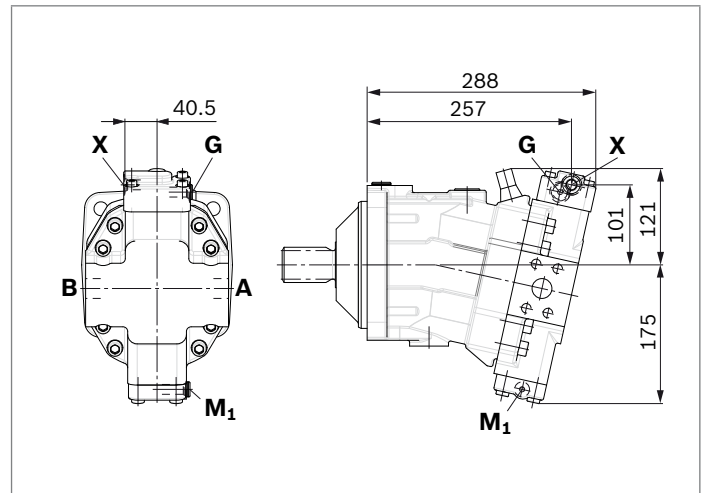
▼ **EP5D1, EP6D1** – Proportional electric control, negative control, with pressure control fixed setting



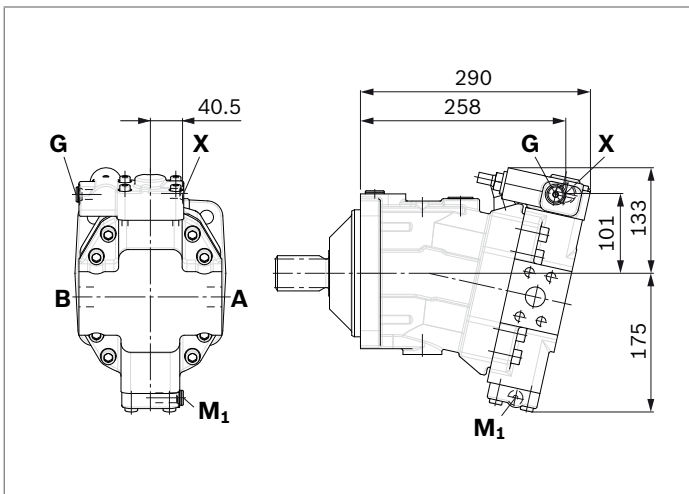
▼ **HP1, HP2** – Proportional hydraulic control, positive control



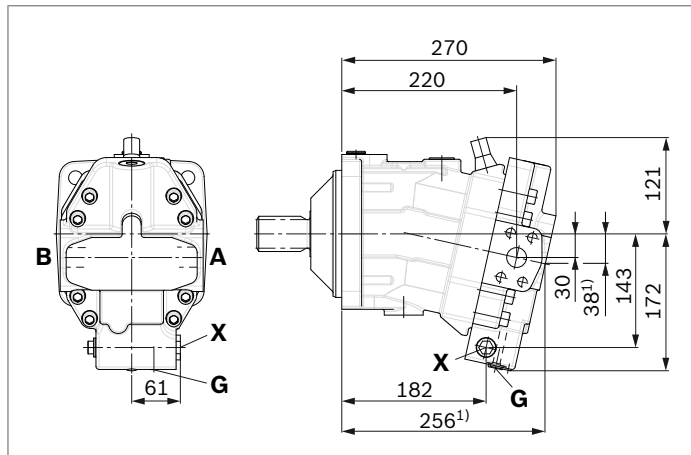
▼ **HP5, HP6** – Proportional hydraulic control, negative control



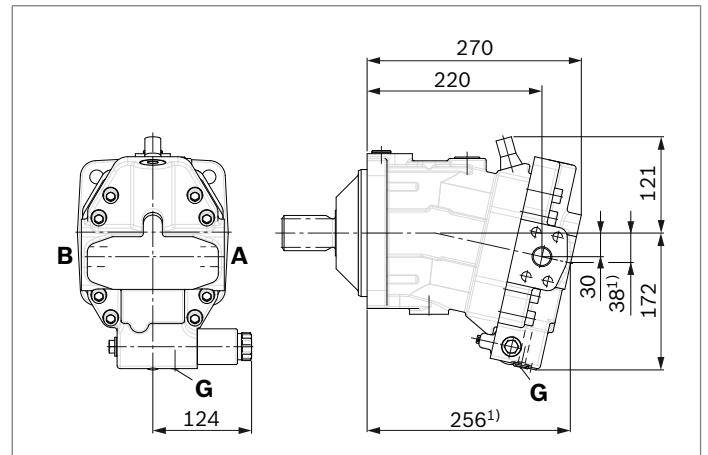
▼ **HP5D1, HP6D1** – Proportional hydraulic control, negative control, with pressure control fixed setting



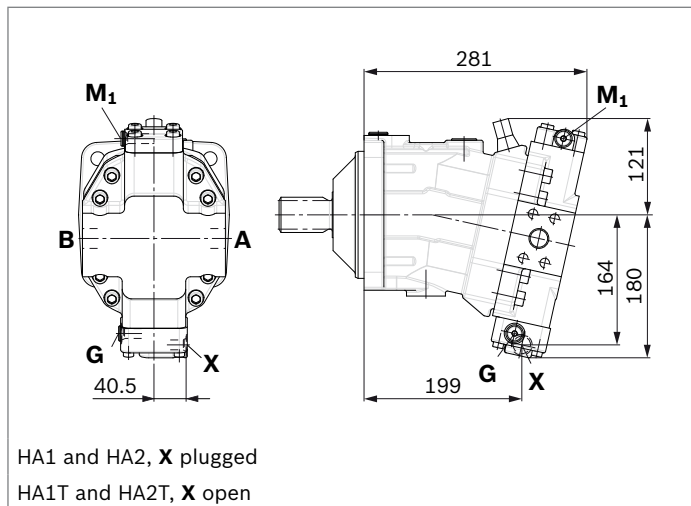
▼ **HZ7** – Two-point hydraulic control, negative control



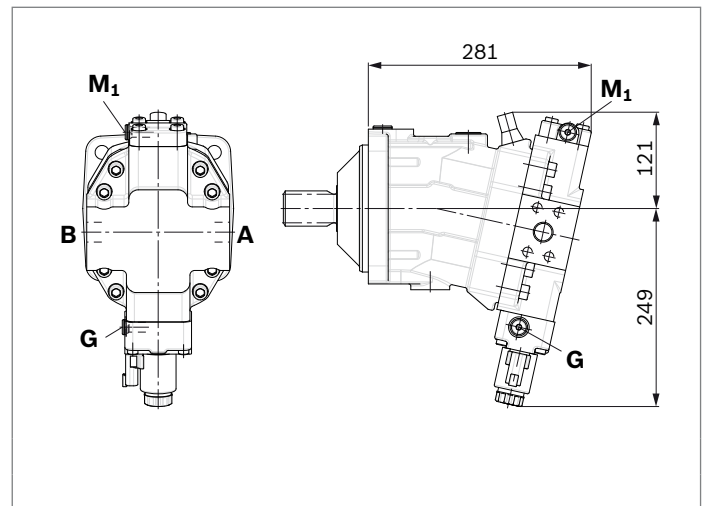
▼ **EZ7, EZ8** – Two-point electric control, negative control



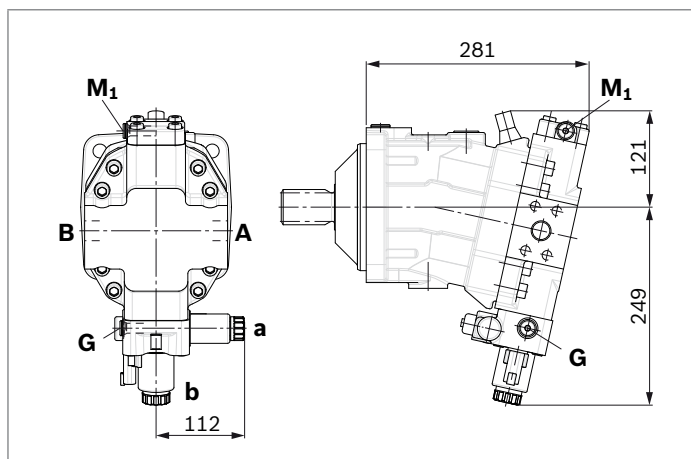
▼ **HA1, HA2 / HA1T3, HA2T3** – Automatic high-pressure related control, positive control, with hydraulic override, remote controlled, proportional



▼ **HA1U1, HA2U2** – Automatic high-pressure related control, positive control, with electric override, two-point

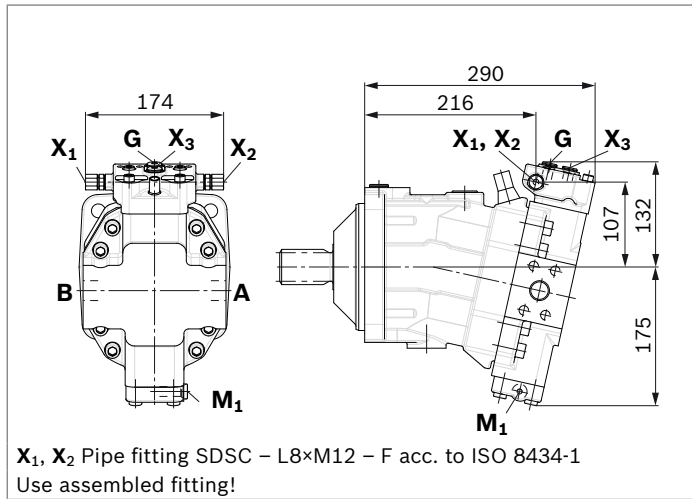


▼ **HA1R1, HA2R2** – Automatic high-pressure related control, positive control, with electric override and electric travel direction valve

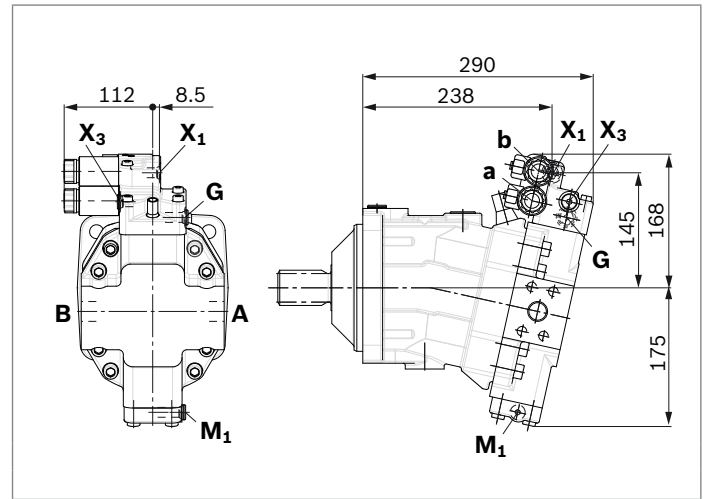


1) Port plate 1 - SAE working ports **A** and **B** at rear

- ▼ **DA0** – Automatic speed related control, negative control, with hydraulic travel direction valve



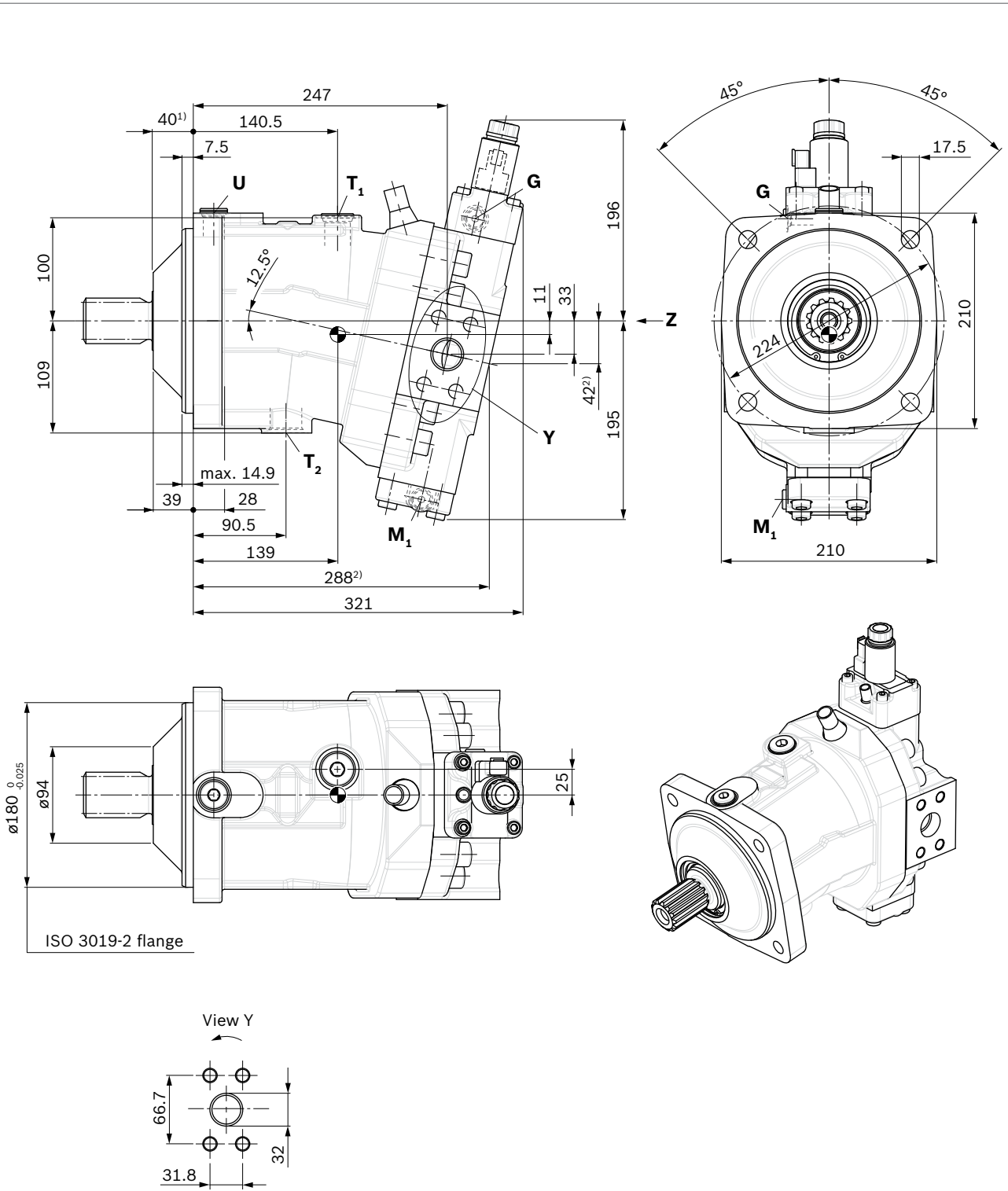
- ▼ **DA1, DA2** – Automatic speed related control, negative control, with electric travel direction valve and electric  $V_{g \max}$  override



**Dimensions, size 150**

**EP5, EP6 – Proportional electric control, negative control**

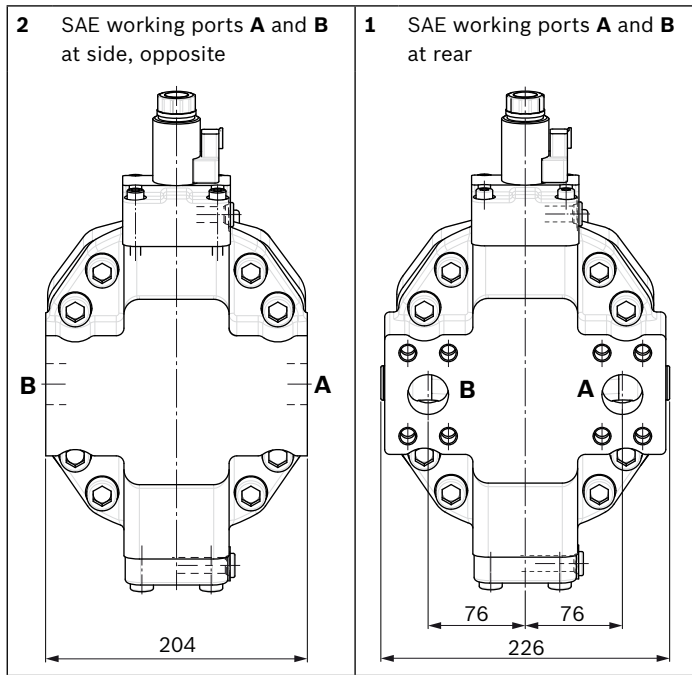
Port plate 2 – SAE working ports **A** and **B** at side, opposite



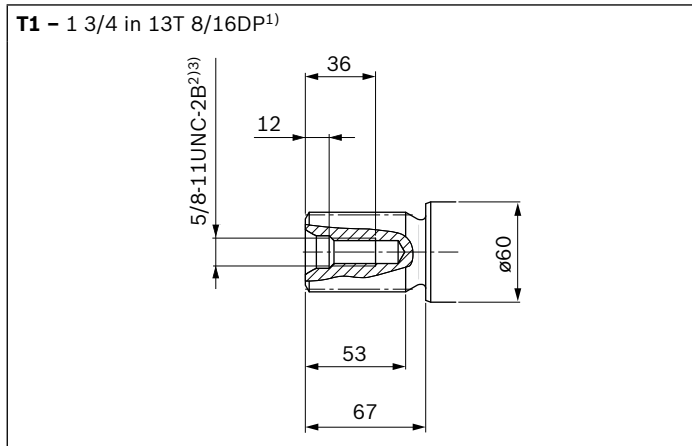
☉ Center of gravity

1) To shaft collar  
 2) Port plate 1 – SAE working ports **A** and **B** at rear

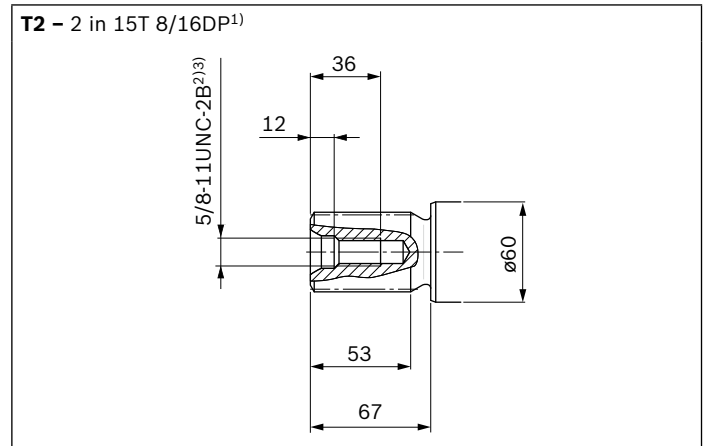
▼ **Location of working ports on the port plates (View Z)**



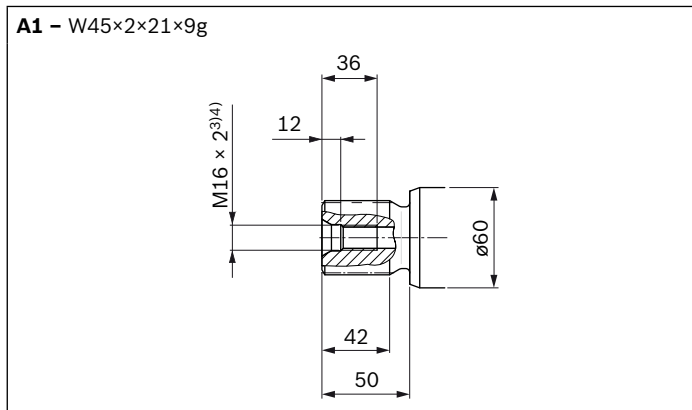
▼ **SAE J744 splined shaft**



▼ **SAE J744 splined shaft**



▼ **DIN 5480 splined shaft**



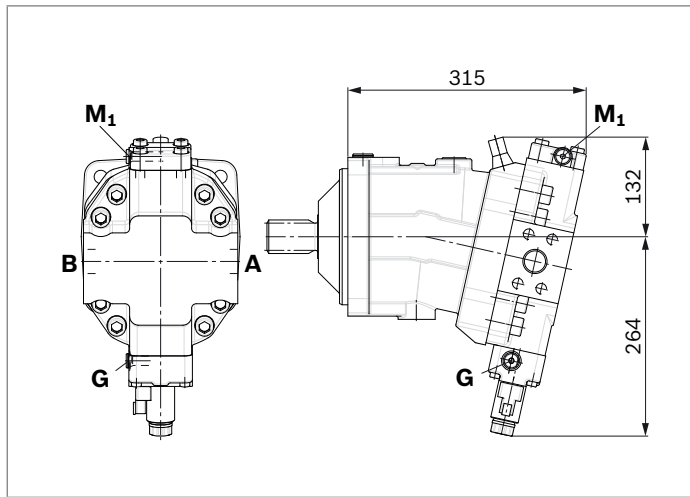
- 1) Involute spline according to ANSI B92.1a, 30° pressure angle, flat root, side fit, tolerance class 5
- 2) Thread according to ASME B1.1
- 3) For information on tightening torques, see the instruction manual.
- 4) DIN 332 center bore (DIN 13 thread)

<b>Ports</b>		<b>Standard</b>	<b>Size<sup>1)</sup></b>	$p_{max}$ [bar] <sup>2)</sup>	<b>State<sup>6)</sup></b>
<b>A, B</b>	Working port Fastening thread A/B	SAE J518 <sup>3)</sup> DIN 13	1 1/4 in M14 × 2; 19 deep	530	O
<b>T<sub>1</sub></b>	Drain port	ISO 6149 <sup>5)</sup>	M27 × 2; 19 deep	3	X <sup>4)</sup>
<b>T<sub>2</sub></b>	Drain port	ISO 6149 <sup>5)</sup>	M33 × 2; 19 deep	3	O <sup>4)</sup>
<b>G</b>	Synchronous control	ISO 6149 <sup>5)</sup>	M14 × 1.5; 11.5 deep	530	X
<b>U</b>	Bearing flushing port	ISO 6149 <sup>5)</sup>	M22 × 1.5; 15.5 deep	3	X
<b>X</b>	Pilot pressure port (HP, HZ, HA1T/HA2T)	ISO 6149 <sup>5)</sup>	M14 × 1.5; 11.5 deep	100	O
<b>X</b>	Pilot pressure port (HA1, HA2)	ISO 6149 <sup>5)</sup>	M14 × 1.5; 11.5 deep	3	X
<b>X<sub>1</sub>, X<sub>2</sub></b>	Pilot pressure port (DA0)	ISO 8434-1	SDSC-L8×M12-F	40	O
<b>X<sub>1</sub></b>	Pilot pressure port (DA1, DA2)	ISO 6149 <sup>5)</sup>	M14 × 1.5; 11.5 deep	40	O
<b>X<sub>3</sub></b>	Pilot pressure port (DA1, DA2)	ISO 6149 <sup>5)</sup>	M14 × 1.5; 11.5 deep	40	X
<b>M<sub>1</sub></b>	Control pressure measuring port	ISO 6149 <sup>5)</sup>	M14 × 1.5; 11.5 deep	530	X

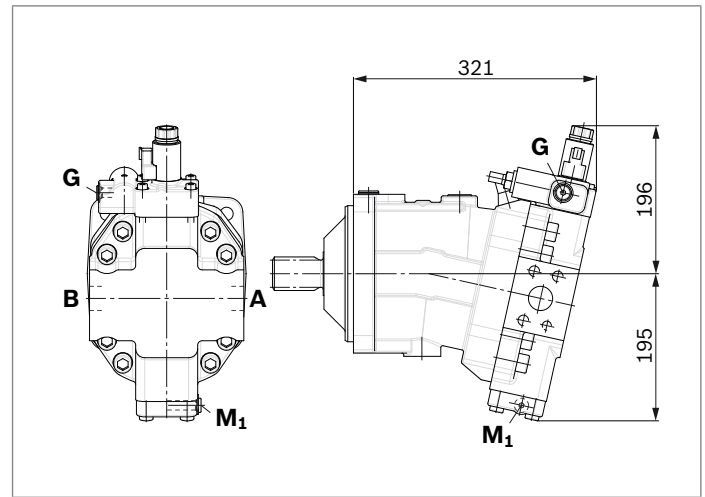
- 1) For information on tightening torques, see the instruction manual.  
2) Momentary pressure peaks can occur depending on application.  
Keep this in mind when selecting measuring devices and fittings.  
3) Only dimensions according to SAE J518, metric fastening thread is a deviation from the standard.

- 4) Depending on installation position, **T<sub>1</sub>** or **T<sub>2</sub>** must be connected (see also installation instructions on page 86).  
5) The countersink may be deeper than specified in the standard.  
6) O = Needs to be connected (comes plugged)  
X = Plugged (in normal operation)

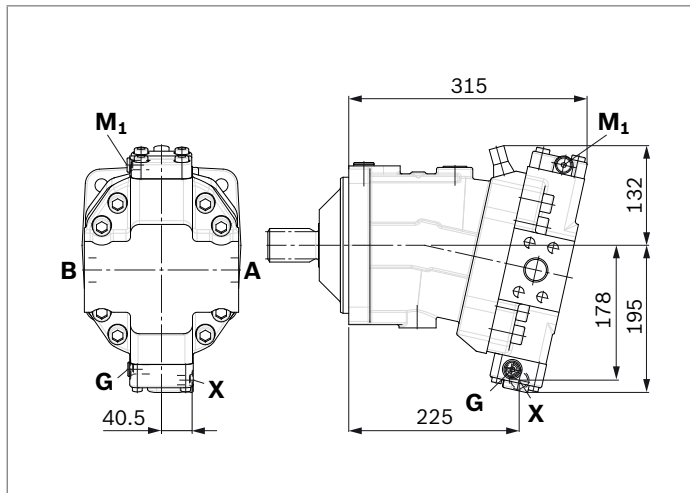
▼ **EP1, EP2** – Proportional electric control, positive control



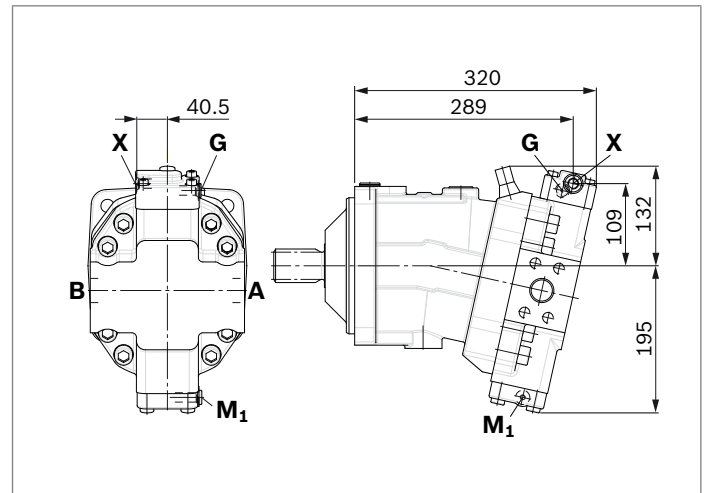
▼ **EP5D1, EP6D1** – Proportional electric control, negative control, with pressure control fixed setting



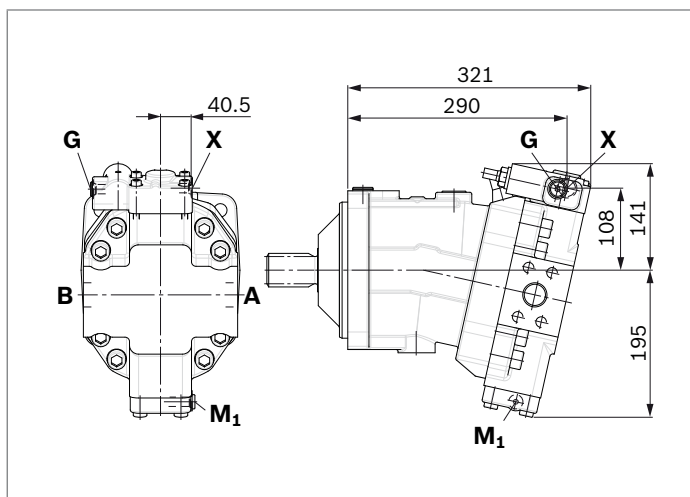
▼ **HP1, HP2** – Proportional hydraulic control, positive control



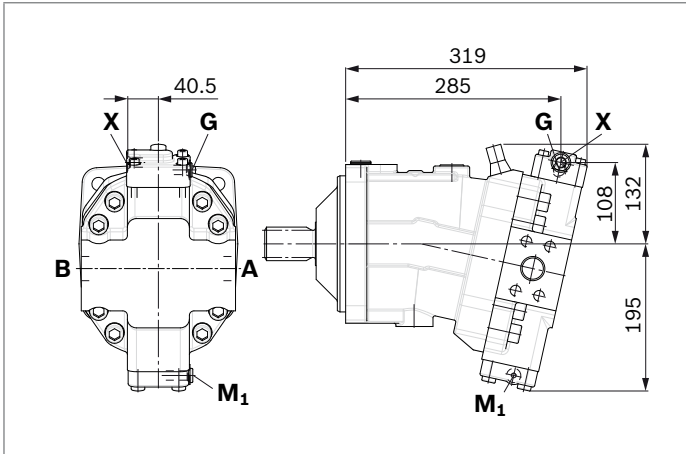
▼ **HP5, HP6** – Proportional hydraulic control, negative control



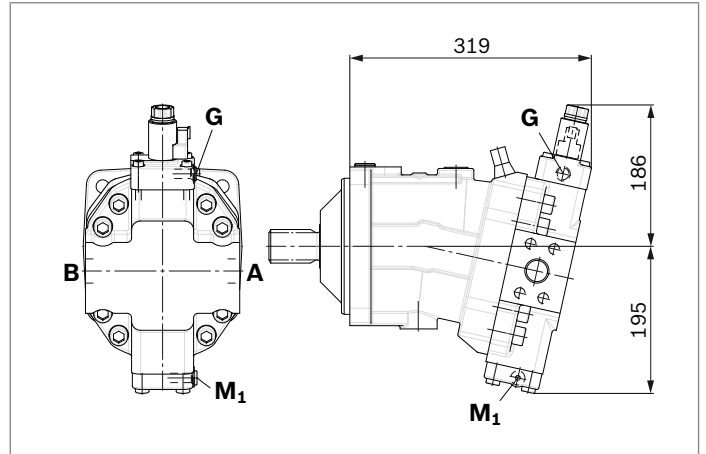
▼ **HP5D1, HP6D1** – Proportional hydraulic control, negative control, with pressure control fixed setting



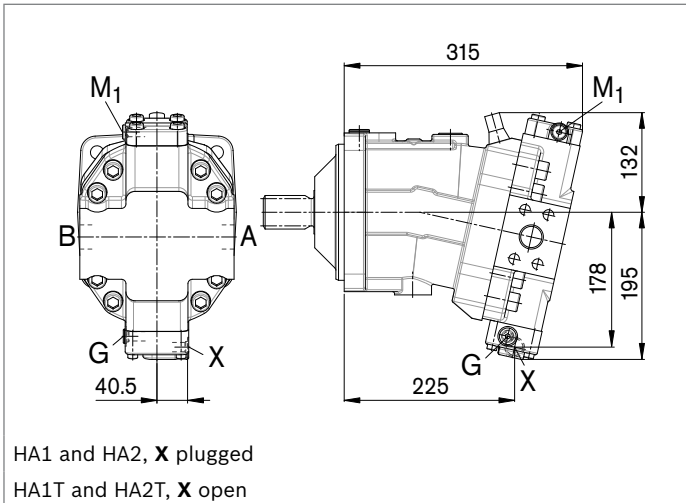
▼ **HZ5** – Two-point hydraulic control, negative control



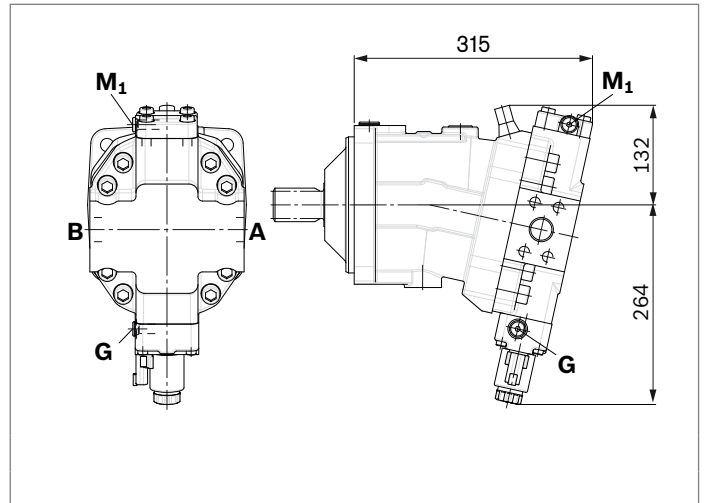
▼ **EZ5, EZ6** – Two-point electric control, negative control



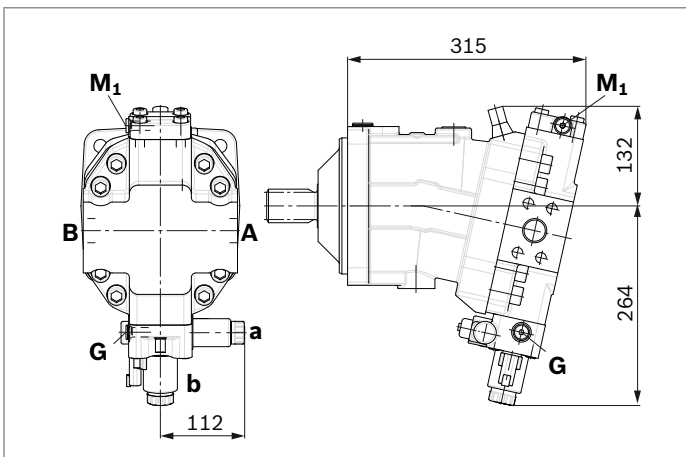
▼ **HA1, HA2 / HA1T3, HA2T3** – Automatic high-pressure related control, positive control, with hydraulic override, remote controlled, proportional



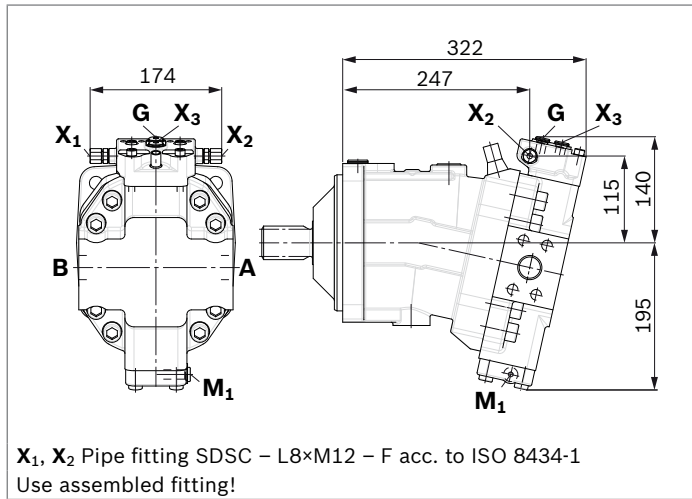
▼ **HA1U1, HA2U2** – Automatic high-pressure related control, positive control, with electric override, two-point



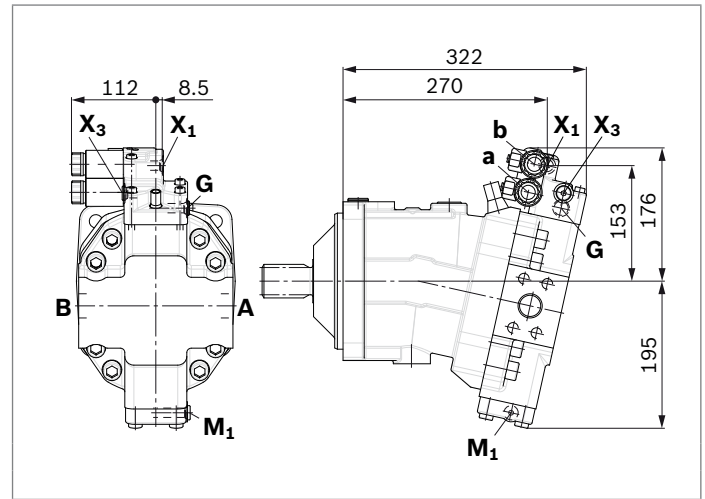
▼ **HA1R1, HA2R2** – Automatic high-pressure related control, positive control, with electric override and electric travel direction valve



- ▼ **DA0** – Automatic speed related control, negative control, with hydraulic travel direction valve



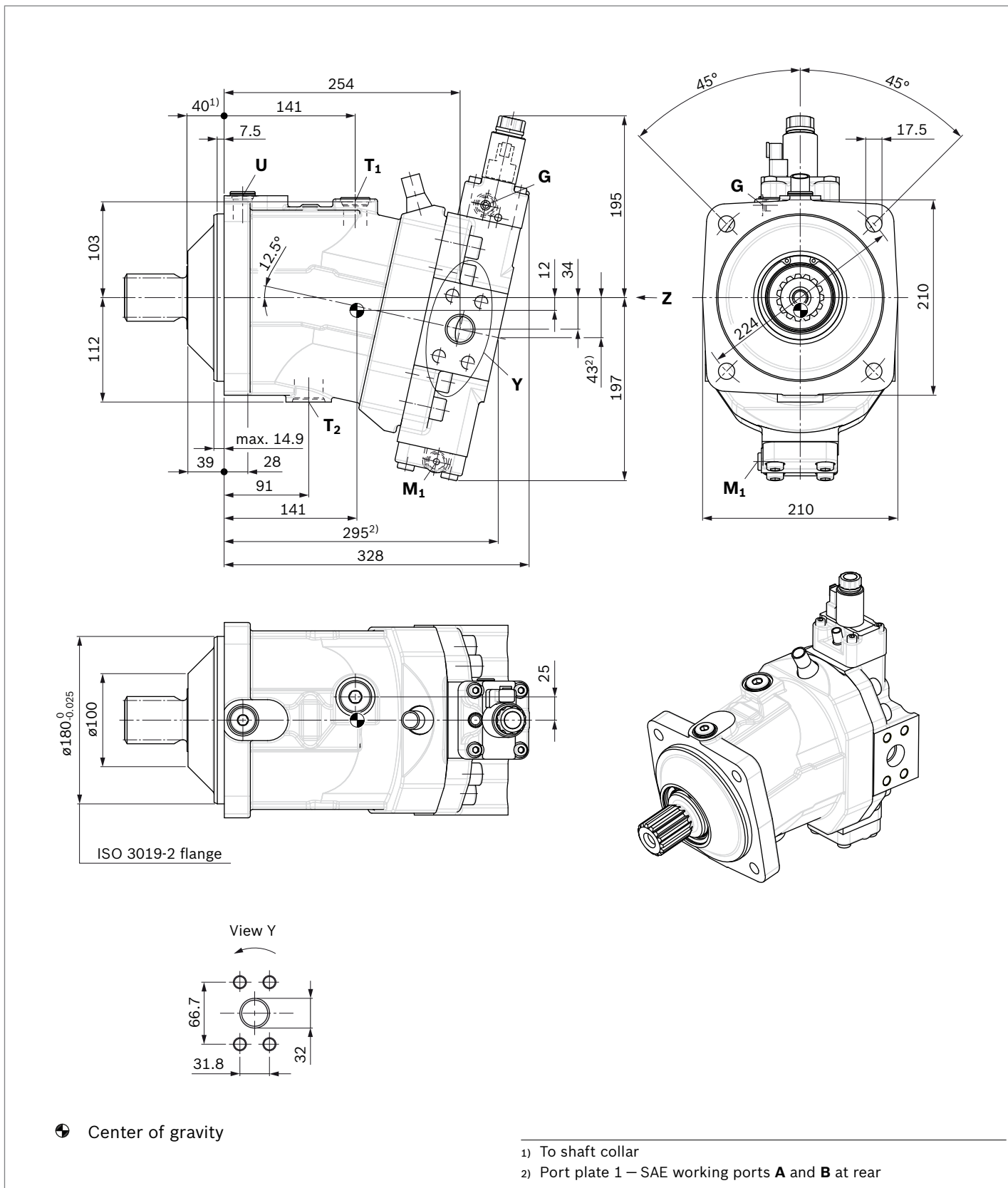
- ▼ **DA1, DA2** – Automatic speed related control, negative control, with electric travel direction valve and electric  $V_{g \max}$  override



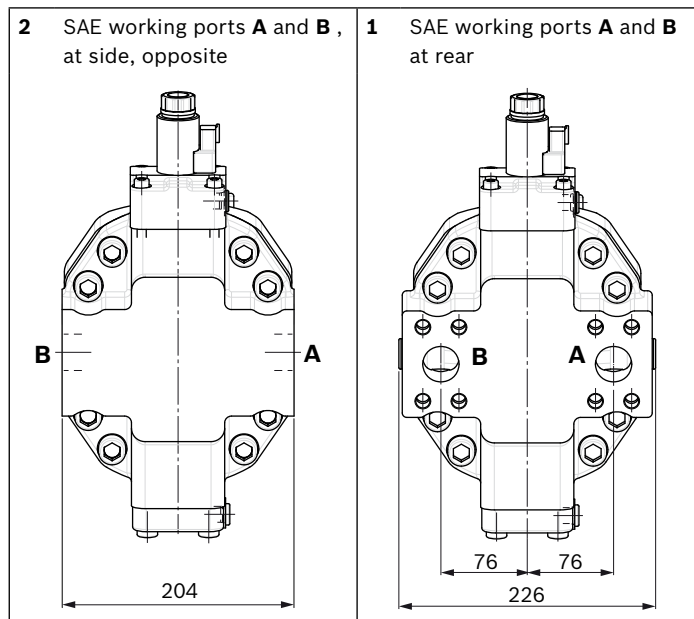
### Dimensions, size 170

#### EP5, EP6 – Proportional electric control, negative control

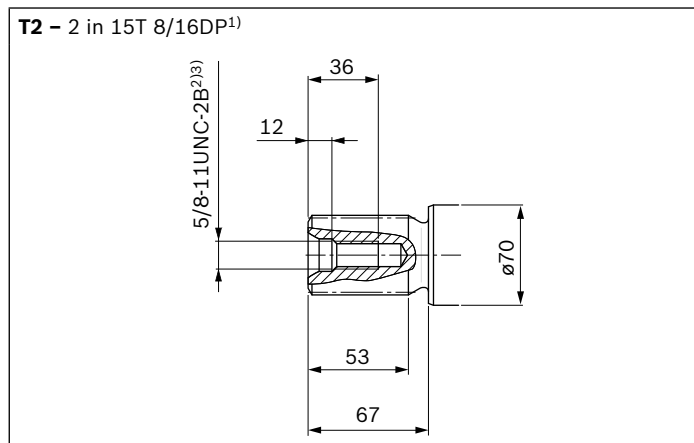
Port plate 2 – SAE working ports **A** and **B** at side, opposite



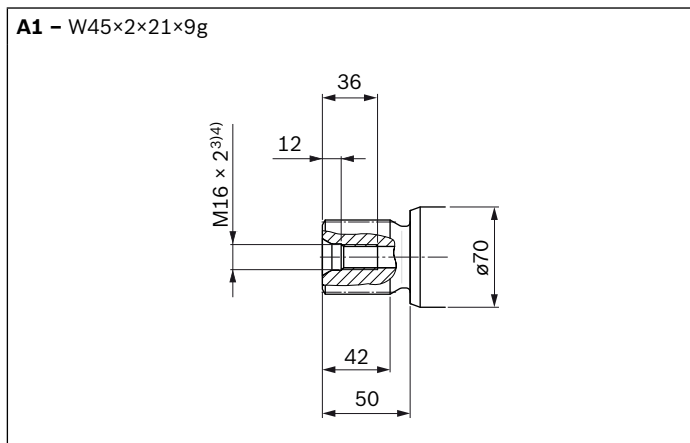
▼ **Location of working ports on the port plates (View Z)**



▼ **SAE J744 splined shaft**



▼ **DIN 5480 splined shaft**



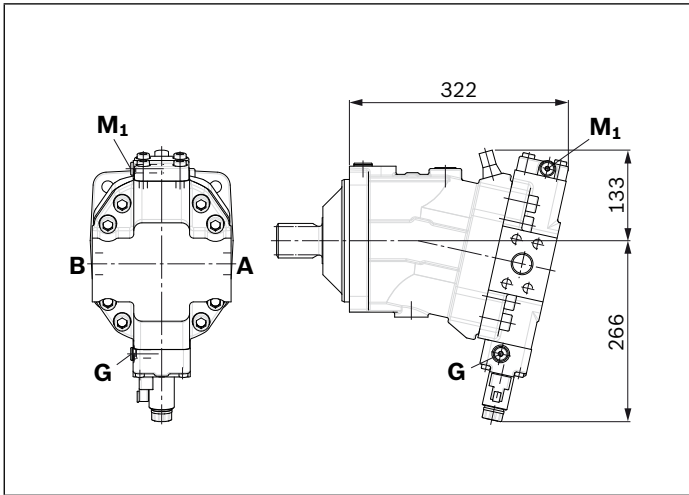
1) Involute spline according to ANSI B92.1a, 30° pressure angle, flat root, side fit, tolerance class 5  
 2) Thread according to ASME B1.1  
 3) For information on tightening torques, see the instruction manual.  
 4) DIN 332 center bore (DIN 13 thread)

<b>Ports</b>		<b>Standard</b>	<b>Size<sup>1)</sup></b>	$p_{max}$ [bar] <sup>2)</sup>	<b>State<sup>6)</sup></b>
<b>A, B</b>	Working port Fastening thread A/B	SAE J518 <sup>3)</sup> DIN 13	1 1/4 in M14 × 2; 19 deep	530	O
<b>T<sub>1</sub></b>	Drain port	ISO 6149 <sup>5)</sup>	M27 × 2; 19 deep	3	X <sup>4)</sup>
<b>T<sub>2</sub></b>	Drain port	ISO 6149 <sup>5)</sup>	M33 × 2; 19 deep	3	O <sup>4)</sup>
<b>G</b>	Synchronous control	ISO 6149 <sup>5)</sup>	M14 × 1.5; 11.5 deep	530	X
<b>U</b>	Bearing flushing port	ISO 6149 <sup>5)</sup>	M22 × 1.5; 15.5 deep	3	X
<b>X</b>	Pilot pressure port (HP, HZ, HA1T/HA2T)	ISO 6149 <sup>5)</sup>	M14 × 1.5; 11.5 deep	100	O
<b>X</b>	Pilot pressure port (HA1, HA2)	ISO 6149 <sup>5)</sup>	M14 × 1.5; 11.5 deep	3	X
<b>X<sub>1</sub>, X<sub>2</sub></b>	Pilot pressure port (DA0)	ISO 8434-1	SDSC-L8×M12-F	40	O
<b>X<sub>1</sub></b>	Pilot pressure port (DA1, DA2)	ISO 6149 <sup>5)</sup>	M14 × 1.5; 11.5 deep	40	O
<b>X<sub>3</sub></b>	Pilot pressure port (DA1, DA2)	ISO 6149 <sup>5)</sup>	M14 × 1.5; 11.5 deep	40	X
<b>M<sub>1</sub></b>	Control pressure measuring port	ISO 6149 <sup>5)</sup>	M14 × 1.5; 11.5 deep	530	X

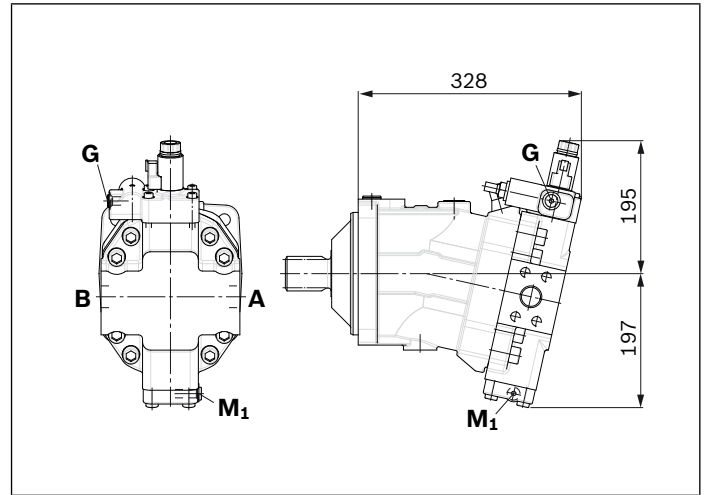
- 1) For information on tightening torques, see the instruction manual.  
2) Momentary pressure peaks can occur depending on application.  
Keep this in mind when selecting measuring devices and fittings.  
3) Only dimensions according to SAE J518, metric fastening thread is a deviation from the standard.

- 4) Depending on installation position, **T<sub>1</sub>** or **T<sub>2</sub>** must be connected (see also installation instructions on page 86).  
5) The countersink may be deeper than specified in the standard.  
6) O = Needs to be connected (comes plugged)  
X = Plugged (in normal operation)

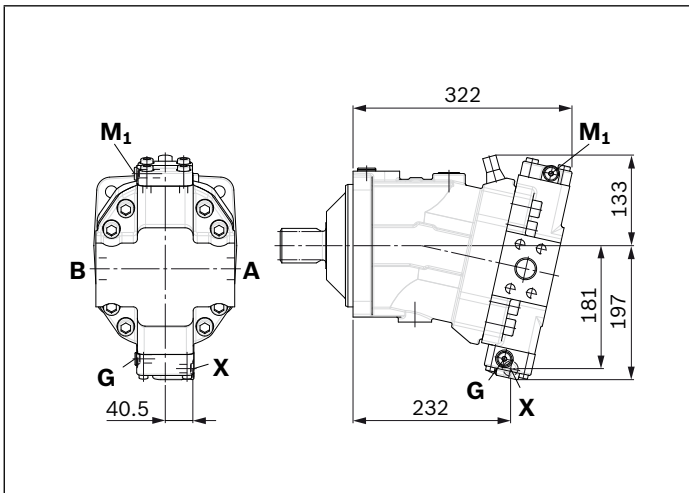
▼ **EP1, EP2** – Proportional electric control, positive control



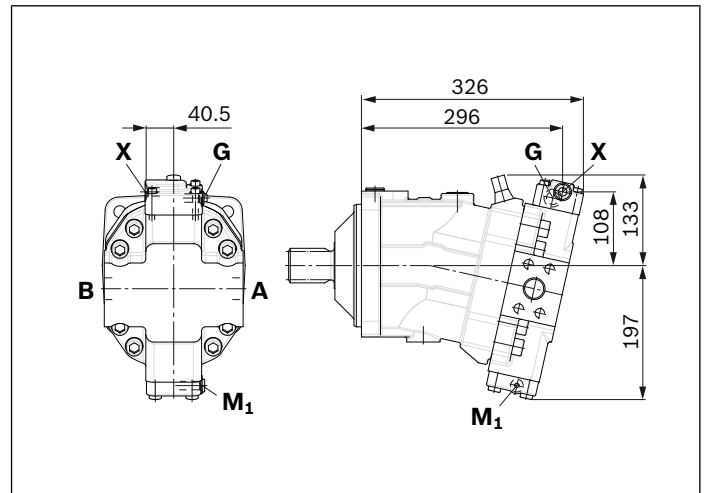
▼ **EP5D1, EP6D1** – Proportional electric control, negative control, with pressure control fixed setting



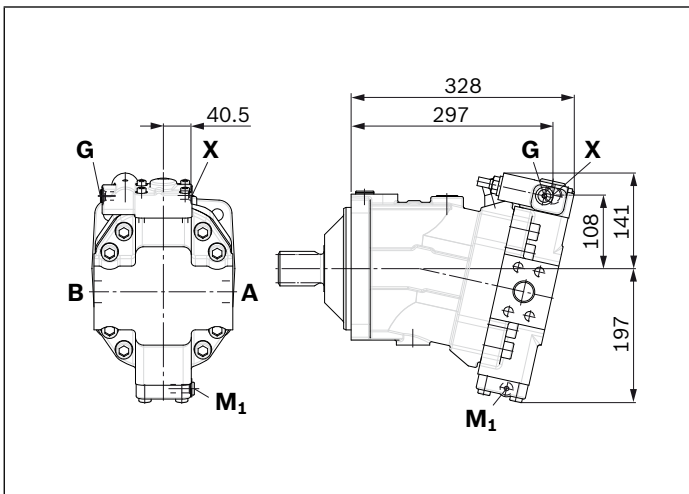
▼ **HP1, HP2** – Proportional hydraulic control, positive control



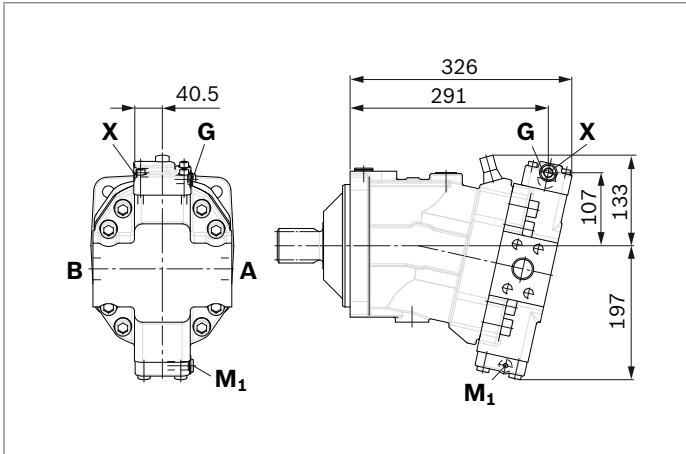
▼ **HP5, HP6** – Proportional hydraulic control, negative control



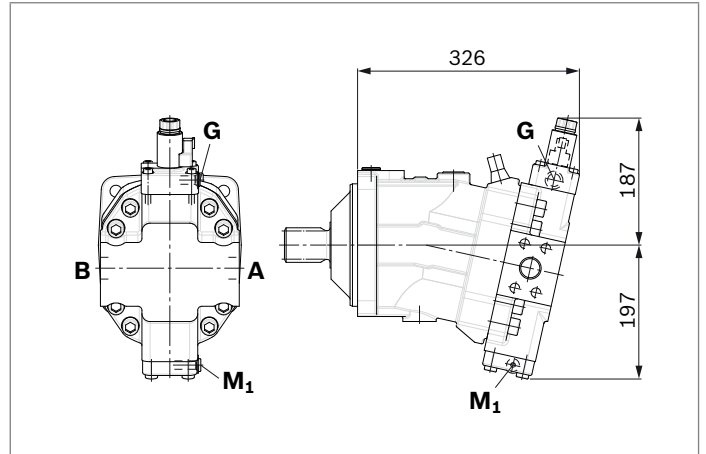
▼ **HP5D1, HP6D1** – Proportional hydraulic control, negative control, with pressure control fixed setting



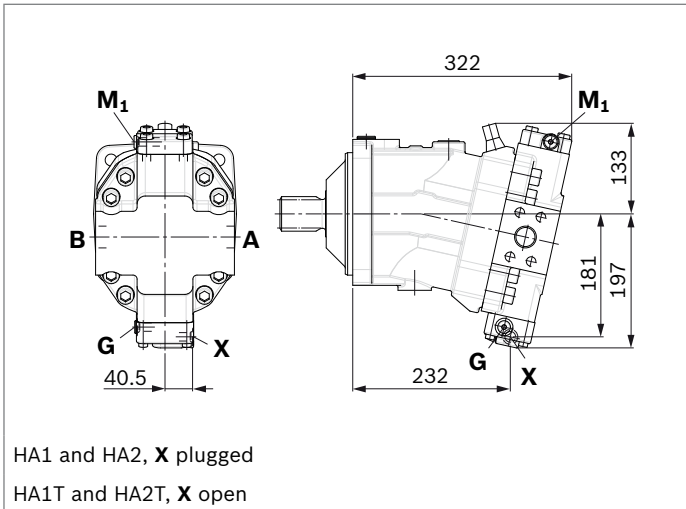
▼ **HZ5** – Two-point hydraulic control, negative control



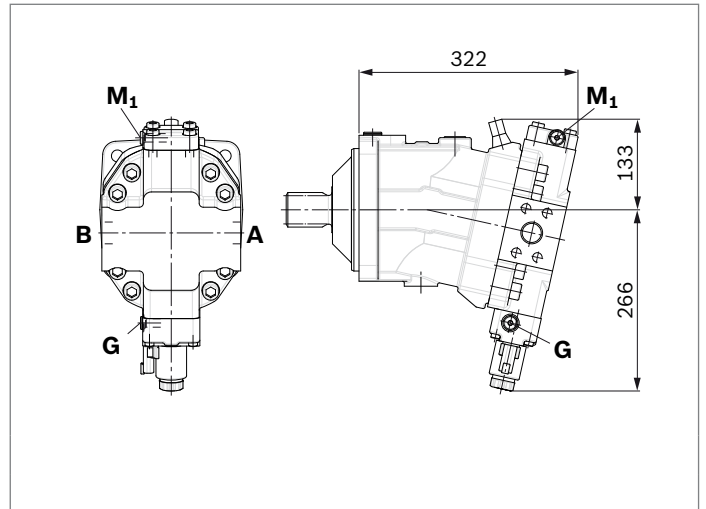
▼ **EZ5, EZ6** – Two-point electric control, negative control



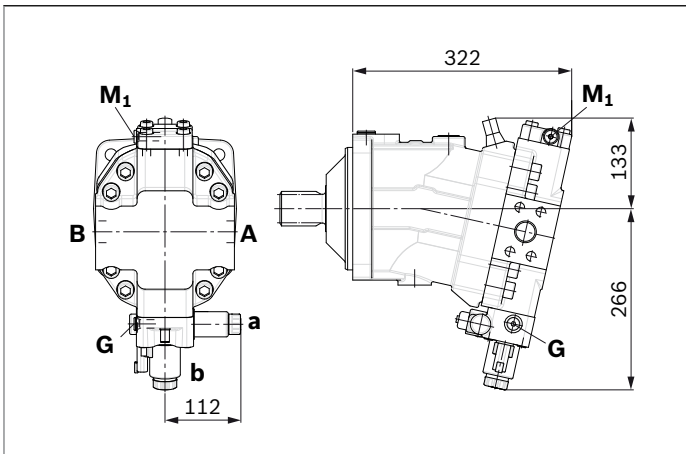
▼ **HA1, HA2 / HA1T3, HA2T3** – Automatic high-pressure related control, positive control, with hydraulic override, remote controlled, proportional



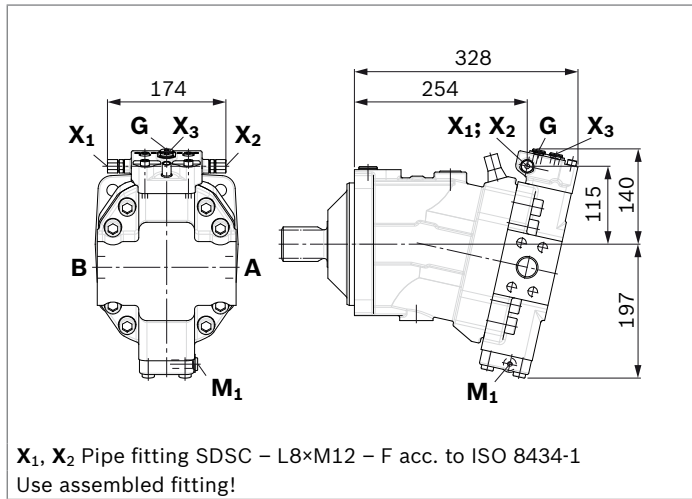
▼ **HA1U1, HA2U2** – Automatic high-pressure related control, positive control, with electric override, two-point



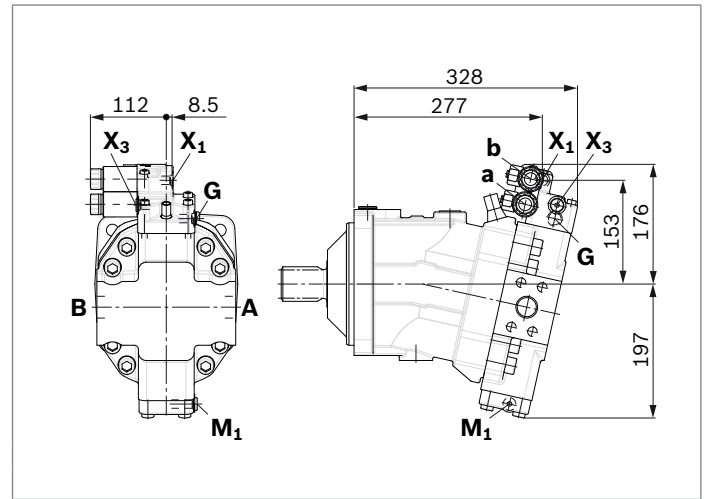
▼ **HA1R1, HA2R2** – Automatic high-pressure related control, positive control, with electric override and electric travel direction valve



- ▼ **DA0** – Automatic speed related control, negative control, with hydraulic travel direction valve



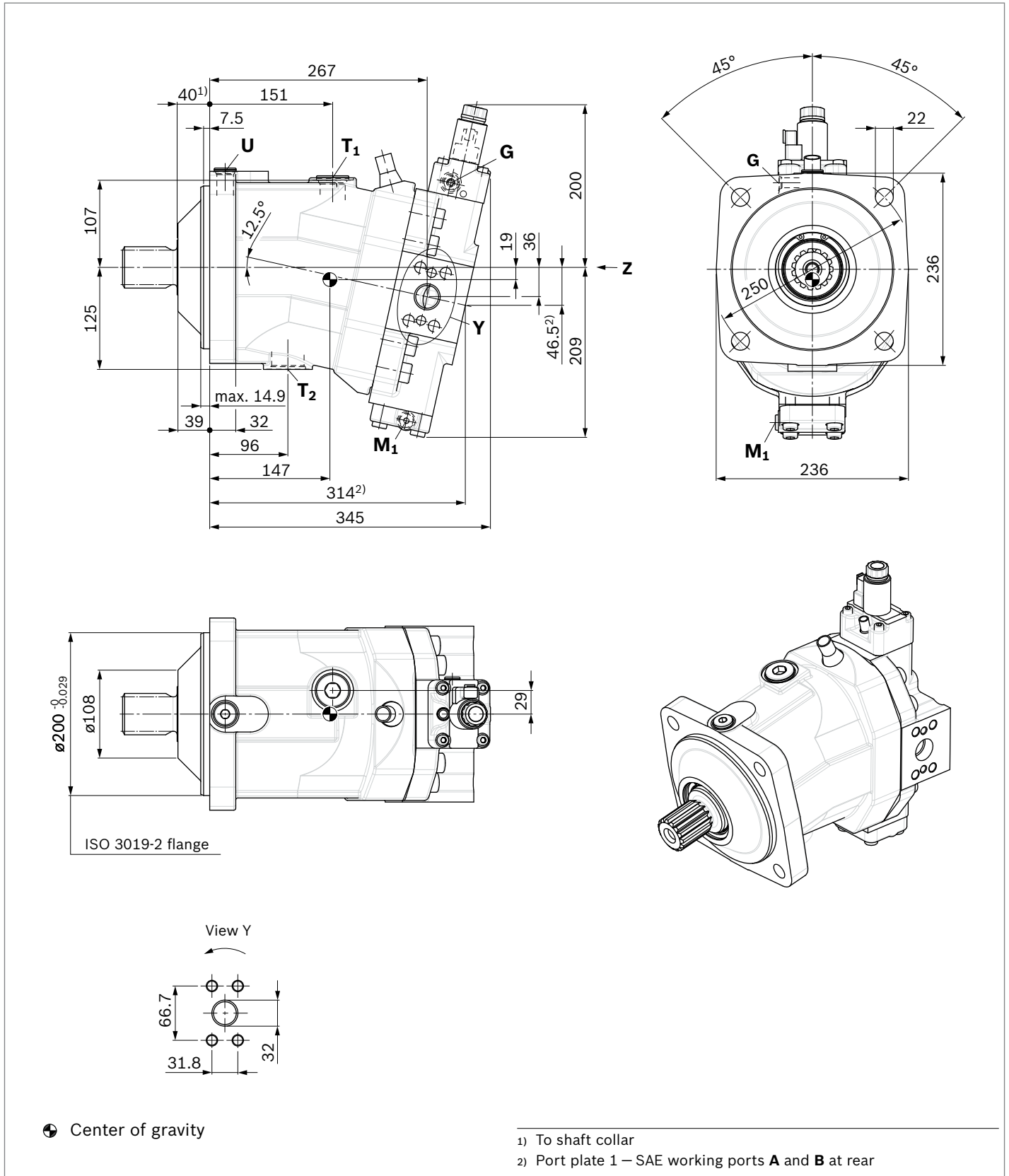
- ▼ **DA1, DA2** – Automatic speed related control, negative control, with electric travel direction valve and electric  $V_{g \max}$  override



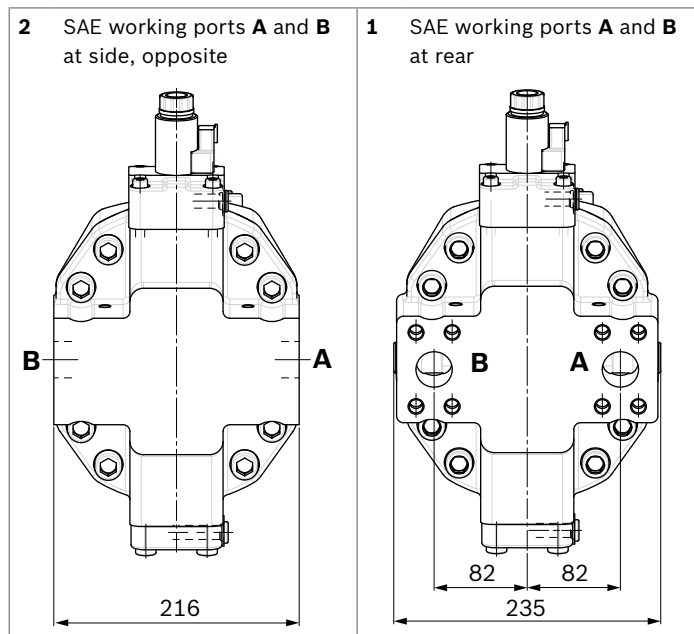
**Dimensions, size 215**

**EP5, EP6 – Proportional electric control, negative control**

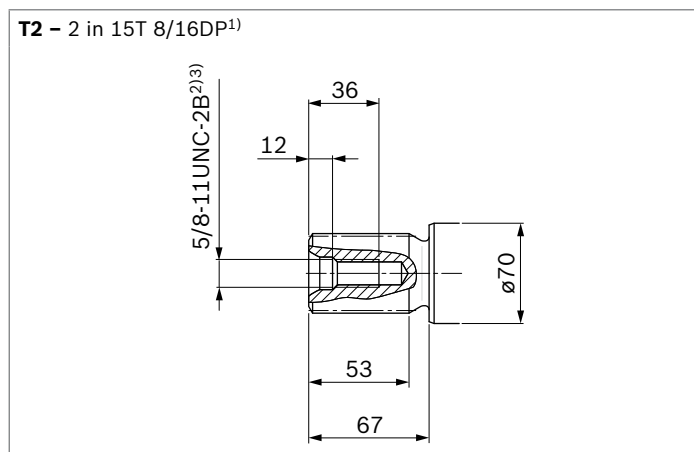
Port plate 2 – SAE working ports **A** and **B** at side, opposite



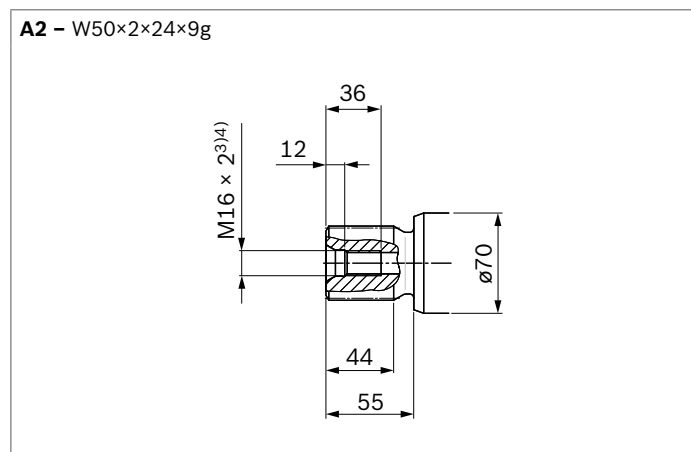
▼ **Location of working ports on the port plates (View Z)**



▼ **SAE J744 splined shaft**



▼ **DIN 5480 splined shaft**



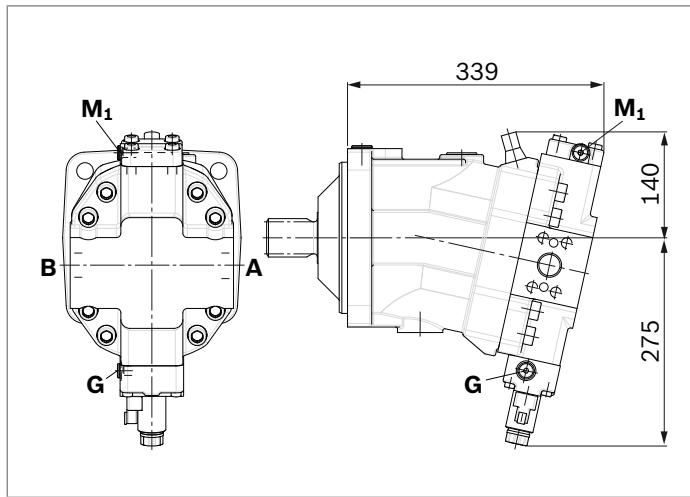
1) Involute spline according to ANSI B92.1a, 30° pressure angle, flat root, side fit, tolerance class 5  
 2) Thread according to ASME B1.1  
 3) For information on tightening torques, see the instruction manual.  
 4) DIN 332 center bore (DIN 13 thread)

Ports		Standard	Size <sup>1)</sup>	$p_{max}$ [bar] <sup>2)</sup>	State <sup>6)</sup>
<b>A, B</b>	Working port	SAE J518 <sup>3)</sup>	1 1/4 in	530	O
	Fastening thread A/B	DIN 13	M14 × 2; 19 deep		
<b>T<sub>1</sub></b>	Drain port	ISO 6149 <sup>5)</sup>	M33 × 2; 19 deep	3	X <sup>4)</sup>
<b>T<sub>2</sub></b>	Drain port	ISO 6149 <sup>5)</sup>	M42 × 2; 19.5 deep	3	O <sup>4)</sup>
<b>G</b>	Synchronous control	ISO 6149 <sup>5)</sup>	M14 × 1.5; 11.5 deep	530	X
<b>U</b>	Bearing flushing port	ISO 6149 <sup>5)</sup>	M22 × 1.5; 15.5 deep	3	X
<b>X</b>	Pilot pressure port (HP, HZ, HA1T/HA2T)	ISO 6149 <sup>5)</sup>	M14 × 1.5; 11.5 deep	100	O
<b>X</b>	Pilot pressure port (HA1, HA2)	ISO 6149 <sup>5)</sup>	M14 × 1.5; 11.5 deep	3	X
<b>X<sub>1</sub>, X<sub>2</sub></b>	Pilot pressure port (DA0)	ISO 8434-1	SDSC-L8×M12-F	40	O
<b>X<sub>1</sub></b>	Pilot pressure port (DA1, DA2)	ISO 6149 <sup>5)</sup>	M14 × 1.5; 11.5 deep	40	O
<b>X<sub>3</sub></b>	Pilot pressure port (DA1, DA2)	ISO 6149 <sup>5)</sup>	M14 × 1.5; 11.5 deep	40	X
<b>M<sub>1</sub></b>	Control pressure measuring port	ISO 6149 <sup>5)</sup>	M14 × 1.5; 11.5 deep	530	X

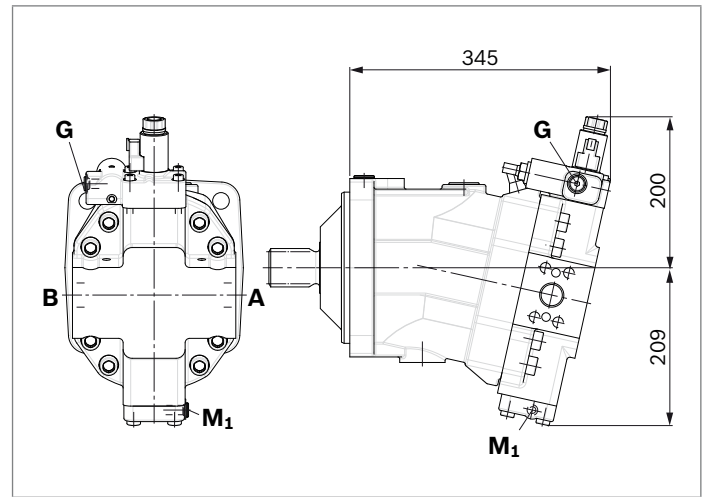
- 1) For information on tightening torques, see the instruction manual.  
2) Momentary pressure peaks can occur depending on application. Keep this in mind when selecting measuring devices and fittings.  
3) Only dimensions according to SAE J518, metric fastening thread is a deviation from the standard.

- 4) Depending on installation position, **T<sub>1</sub>** or **T<sub>2</sub>** must be connected (see also installation instructions on page 86).  
5) The countersink may be deeper than specified in the standard.  
6) O = Needs to be connected (comes plugged)  
X = Plugged (in normal operation)

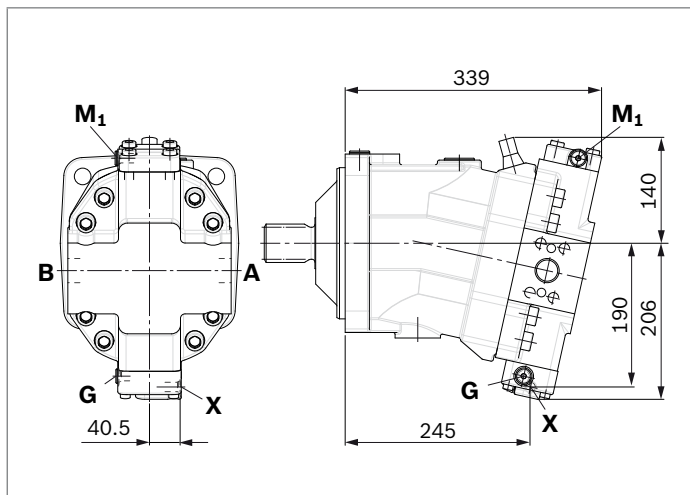
▼ **EP1, EP2** – Proportional electric control, positive control



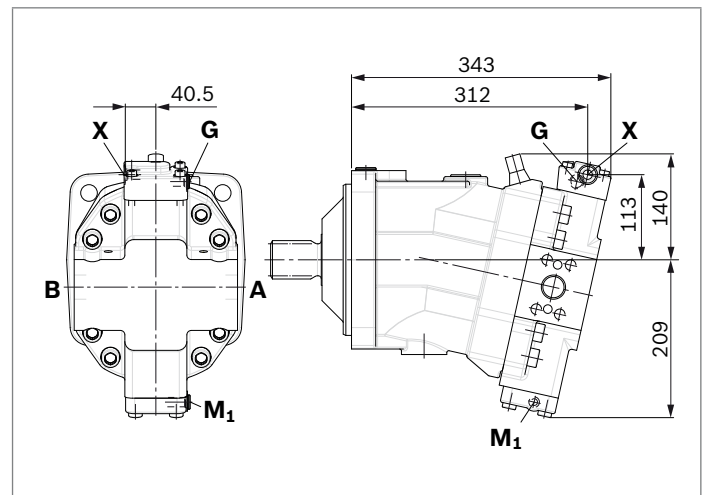
▼ **EP5D1, EP6D1** – Proportional electric control, negative control, with pressure control fixed setting



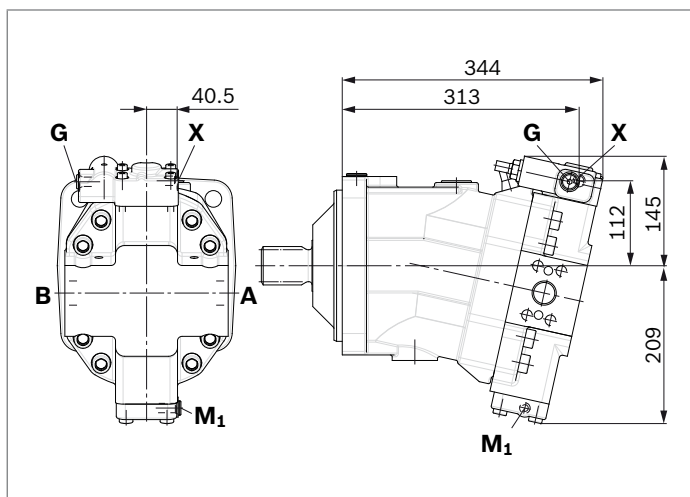
▼ **HP1, HP2** – Proportional hydraulic control, positive control



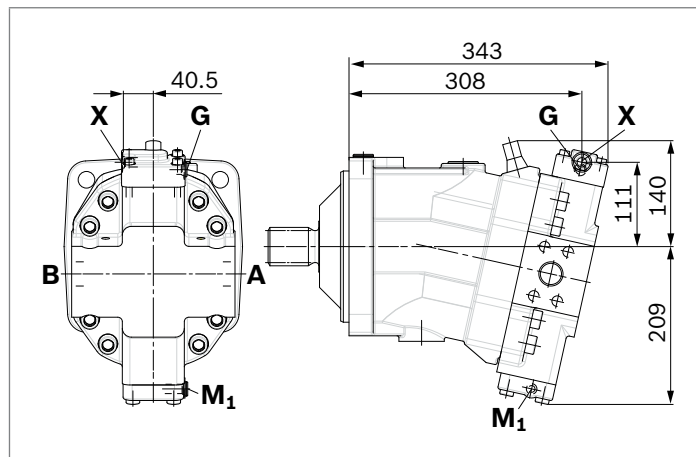
▼ **HP5, HP6** – Proportional hydraulic control, negative control



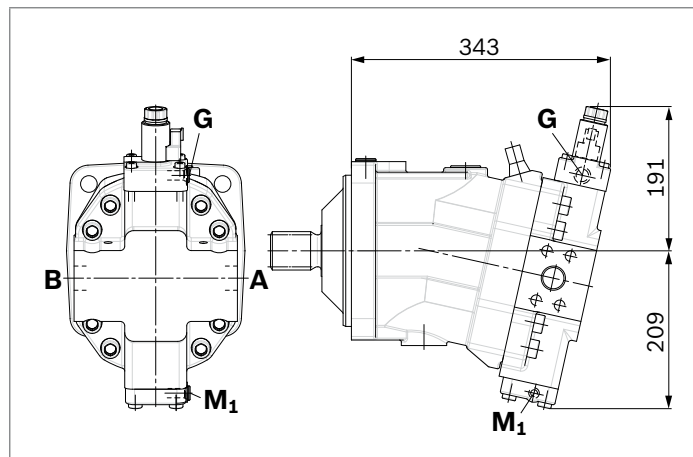
▼ **HP5D1, HP6D1** – Proportional hydraulic control, negative control, with pressure control fixed setting



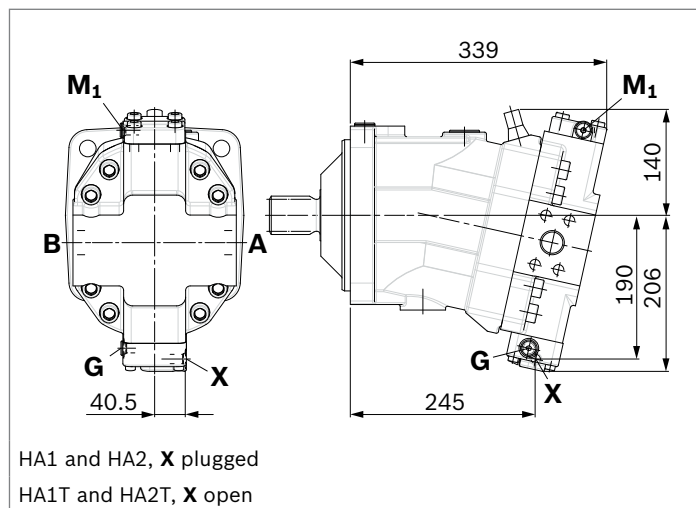
▼ **HZ5** – Two-point hydraulic control, negative control



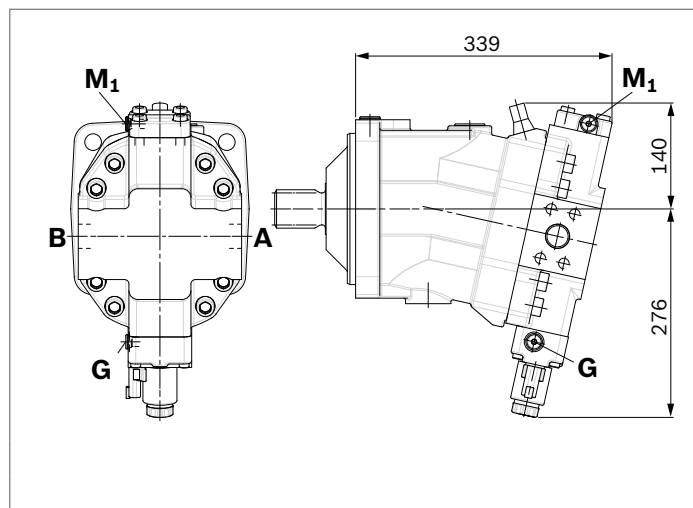
▼ **EZ5, EZ6** – Two-point electric control, negative control



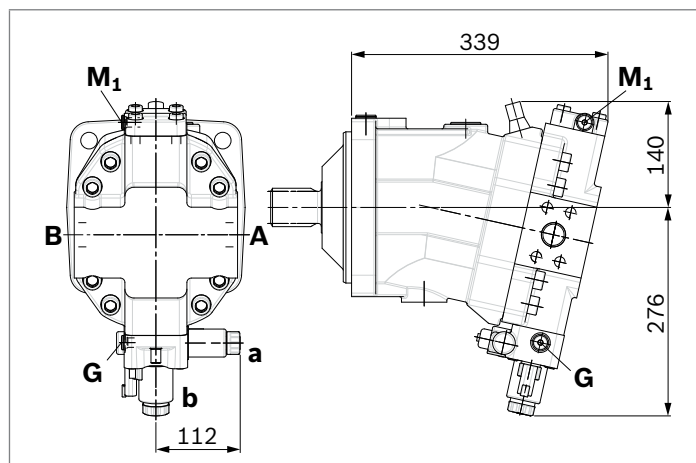
▼ **HA1, HA2 / HA1T3, HA2T3** – Automatic high-pressure related control, positive control, with hydraulic override, remote controlled, proportional



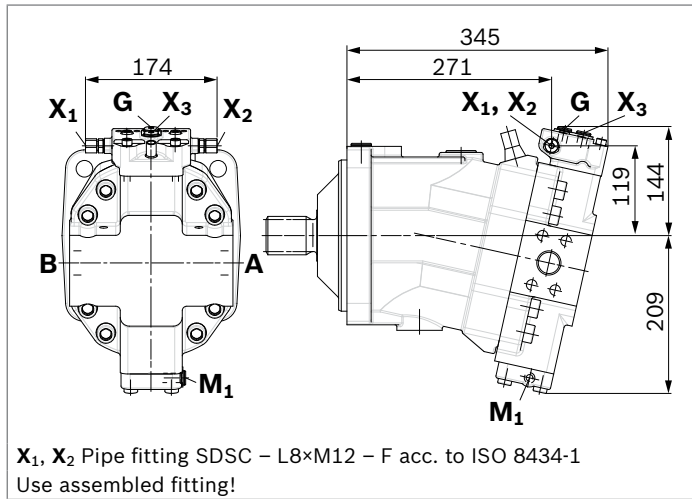
▼ **HA1U1, HA2U2** – Automatic high-pressure related control, positive control, with electric override, two-point



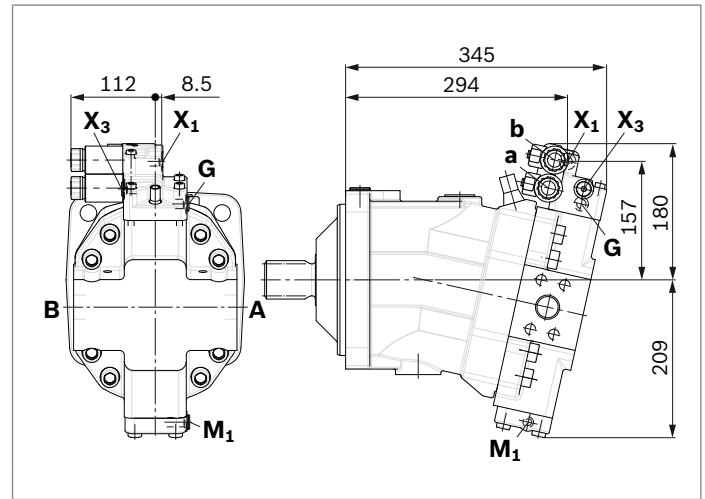
▼ **HA1R1, HA2R2** – Automatic high-pressure related control, positive control, with electric override and electric travel direction valve



- ▼ **DA0** – Automatic speed related control, negative control, with hydraulic travel direction valve

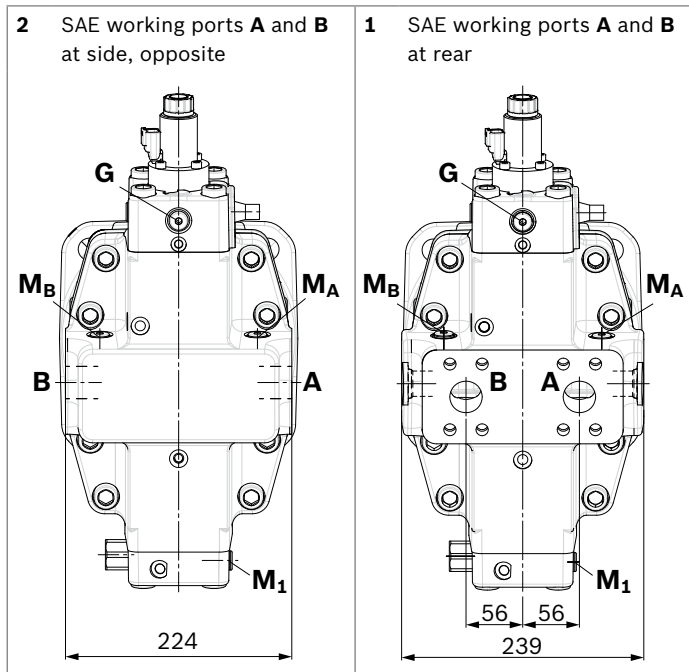


- ▼ **DA1, DA2** – Automatic speed related control, negative control, with electric travel direction valve and electric V<sub>g max</sub> override

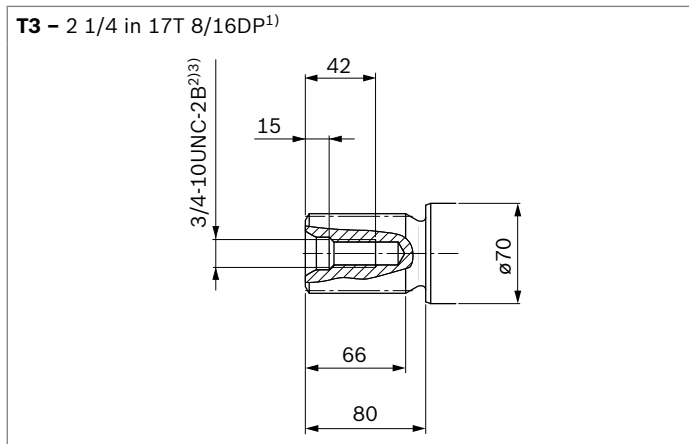




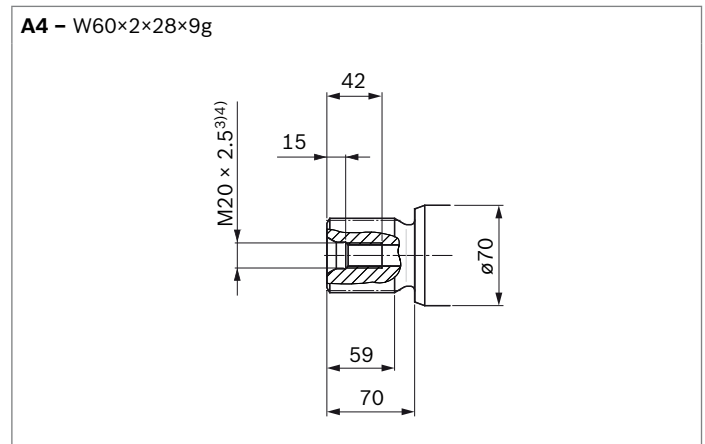
▼ **Location of working ports on the port plates (View Z)**



▼ **SAE J744 splined shaft**



▼ **DIN 5480 splined shaft**



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) For information on tightening torques, see the instruction manual.  
4) DIN 332 center bore (DIN 13 thread)

Ports		Standard	Size <sup>1)</sup>	$p_{max}$ [bar] <sup>2)</sup>	State <sup>6)</sup>
<b>A, B</b>	Working port	SAE J518 <sup>3)</sup>	1 1/4 in	500	O
	Fastening thread A/B	DIN 13	M14 × 2; 19 deep		
<b>T<sub>1</sub></b>	Drain port	ISO 6149 <sup>5)</sup>	M42 × 2; 19.5 deep	3	X <sup>4)</sup>
<b>T<sub>2</sub></b>	Drain port	ISO 6149 <sup>5)</sup>	M33 × 2; 19 deep	3	O <sup>4)</sup>
<b>G</b>	Synchronous control	ISO 6149 <sup>5)</sup>	M14 × 1.5; 11.5 deep	500	X
<b>U</b>	Bearing flushing port	ISO 6149 <sup>5)</sup>	M14 × 1.5; 11.5 deep	3	X
<b>X</b>	Pilot pressure port (HP, HZ, HA1T/HA2T)	ISO 6149 <sup>5)</sup>	M14 × 1.5; 11.5 deep	100	O
<b>X</b>	Pilot pressure port (HA1, HA2)	ISO 6149 <sup>5)</sup>	M14 × 1.5; 11.5 deep	3	X
<b>X<sub>1</sub>, X<sub>2</sub></b>	Pilot pressure port (DA7)	ISO 8434-1	SDSC-L8×M12-F	40	O
<b>X<sub>1</sub></b>	Pilot pressure port (HP.D)	ISO 6149 <sup>5)</sup>	M14 × 1.5; 11.5 deep	100	X
<b>X<sub>3</sub></b>	Pilot pressure port (DA7)	ISO 6149 <sup>5)</sup>	M14 × 1.5; 11.5 deep	40	X
<b>M<sub>1</sub></b>	Measuring port, control pressure	ISO 6149 <sup>5)</sup>	M14 × 1.5; 11.5 deep	500	X
<b>M<sub>A</sub>, M<sub>B</sub></b>	Measuring port, pressure A, B	ISO 6149 <sup>5)</sup>	M14 × 1.5; 11.5 deep	500	X

1) For information on tightening torques, see the instruction manual.

2) Momentary pressure peaks can occur depending on application. Keep this in mind when selecting measuring devices and fittings.

3) Only dimensions according to SAE J518, metric fastening thread is a deviation from the standard.

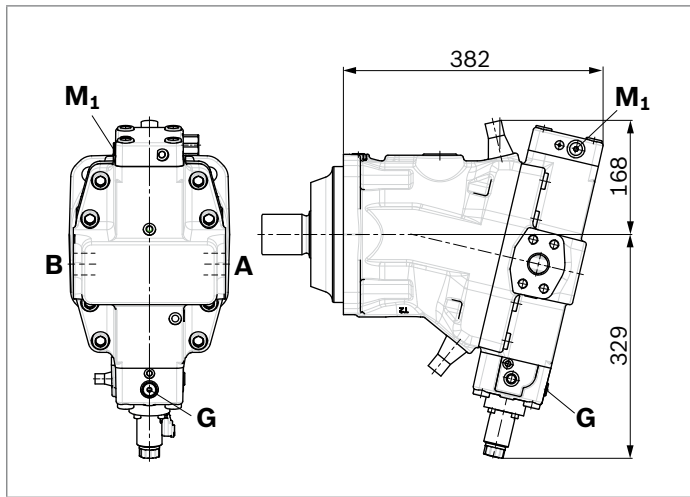
4) Depending on installation position, **T<sub>1</sub>** or **T<sub>2</sub>** must be connected (see also installation instructions on page 86).

5) The countersink may be deeper than specified in the standard.

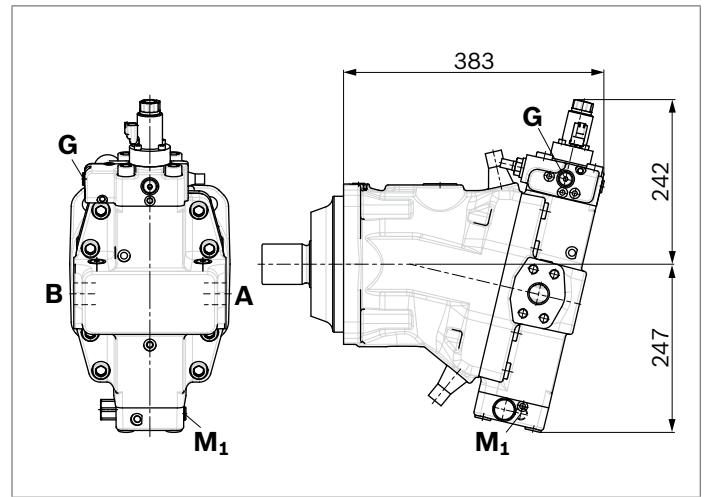
6) O = Must be connected (plugged on delivery)

X = Plugged (in normal operation)

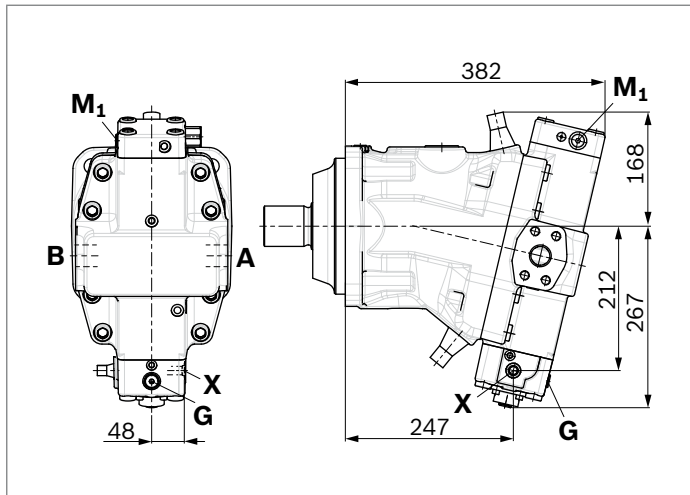
▼ **EP1, EP2** – Proportional electric control, positive control



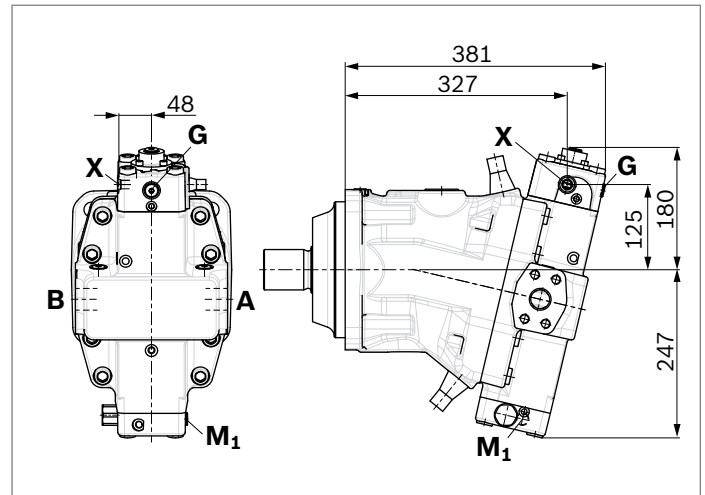
▼ **EP5D1, EP6D1** – Proportional electric control, negative control, with pressure control fixed setting



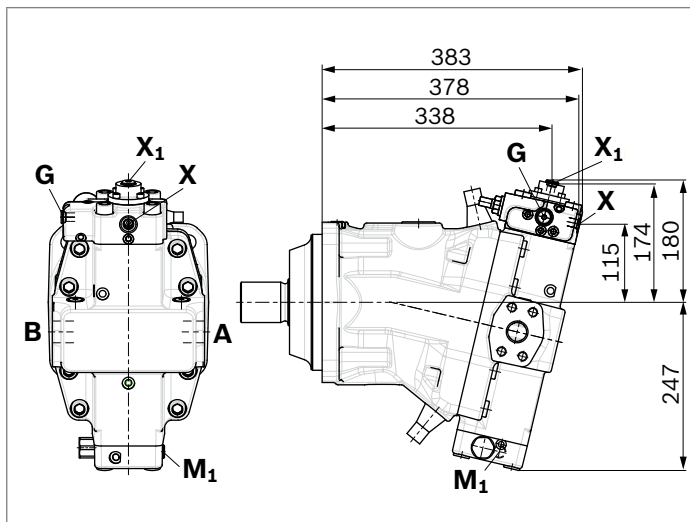
▼ **HP1, HP2** – Proportional hydraulic control, positive control



▼ **HP5, HP6** – Proportional hydraulic control, negative control



▼ **HP5D1, HP6D1** – Proportional hydraulic control, negative control, with pressure control fixed setting





## Connector for solenoids

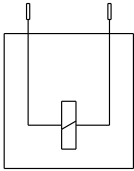
### DEUTSCH DT04-2P-EP04

Molded, 2-pin, without bidirectional suppressor diode.

There is the following type of protection with the mounted mating connector:

- ▶ IP67 (DIN/EN 60529) and
- ▶ IP69K (DIN 40050-9)

#### ▼ 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).

#### Notice

- ▶ If necessary, you can change the position of the connector by turning the solenoid body.
- ▶ The procedure is defined in the instruction manual.

## Neutral position switch

The neutral position switch NLS electronically detects the neutral position of the A6VM, thereby ensuring the torque freedom of the motor. The use of the NLS in a transmission control provides a faster switching cycle in the drive. In addition, the switch reliability is improved and thereby the service life of the drive increased.

Type code, technical data, dimensions and details on the connector, plus safety instructions about the sensor can be found in the NLS data sheet 95152.

### Technical data

Type	NLS	
Recommended operating voltage	5 V	
Maximum voltage	not actuated	32 V
	actuated	11.5 V
Minimum permissible current	0 mA	
Maximum permissible current	10 mA	
Maximum switching cycle number	1 million	
Contact type	normally open contact (open in non-actuated state)	
Type of protection (with mating connector plugged)	IP67/IP69K	
Temperature range of sensor (medium and ambient temperature) <sup>1)</sup>	-40 °C ... 125 °C	
Temperature range of thread seal ring FKM <sup>1)</sup>	-15 °C ... 125 °C	
Pressure resistance	nominal	3 bar
	max. (momentary peaks)	10 bar <sup>2)</sup>

### Notice

The minimum swivel angle is dependent on the  $V_{g \text{ min-Stop}}$

### ▼ Mating connector

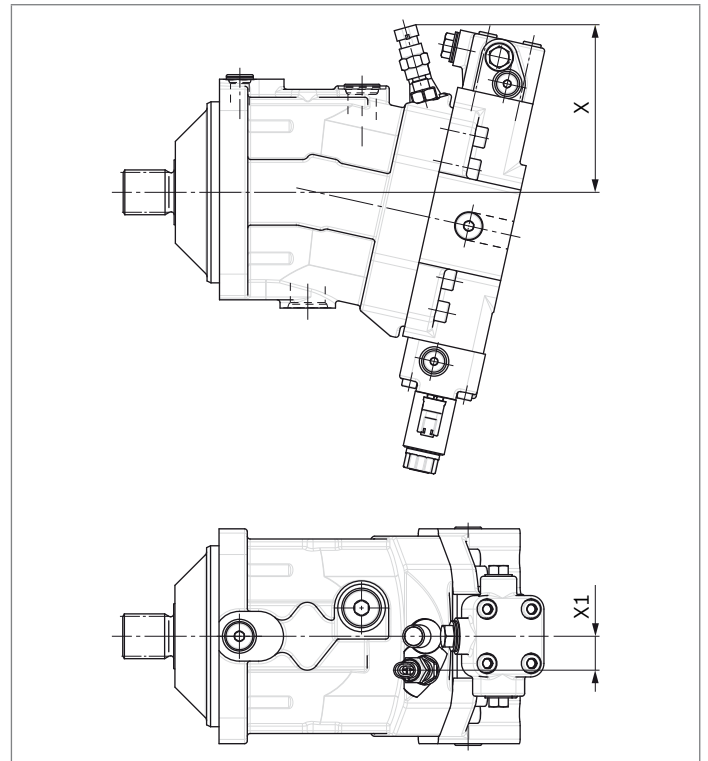
Consisting of	Material number
1 housing	282080
1 socket contact	282403-1

The mating connector is not included in the scope of delivery.

This mating connector can be ordered from AMP.

### ▼ Dimensions

Version "N" with neutral position switch mounted



Size	Adjustable angle		X [mm]		X1 [mm]
	min.	max.	at min angle	at max angle	
85	0°	2°	144.7	141.4	28.0
115	0°	4°	148.1	140.4	30.0
150	0°	1°	153.1	150.9	30.0
170	0°	0°		153.1	30.0
215	0°	0°		159.1	30.0

- 1) Observe the permissible temperature range of the axial piston motor.
- 2) Observe the permissible viscosity range of the axial piston motor. At oil viscosities >1800 mm<sup>2</sup>/s, the switch may be unintentionally actuated by case pressure peaks of >10 bar.

## Flushing and boost-pressure valve

The flushing and boost-pressure valve is used to remove heat from the hydraulic circuit.

In a closed circuit, it is used for flushing the case and safeguarding the minimum boost pressure.

Hydraulic fluid is directed from the respective low-pressure side into the motor housing. This is then fed into the reservoir, together with the leakage. In the closed circuit, the removed hydraulic fluid must be replaced by cooled hydraulic fluid supplied by the boost pump.

The valve is mounted on the port plate or integrated (depending on the control type and size).

### Cracking pressure of pressure retention valve

(observe when setting the primary valve)

- ▶ Size 60 to 215, fixed setting 16 bar
- ▶ Size 280, adjustable 15 to 35 bar

### Switching pressure of flushing spool $\Delta p$

- ▶ Size 60 to 115 (small flushing valve)  $8 \pm 1$  bar
- ▶ Size 115 to 215 (medium and large flushing valve)  $17.5 \pm 1.5$  bar
- ▶ Size 280  $8 \pm 1$  bar

### Flushing flow $q_v$

Orifices can be used to adjust the flushing flows as required. The following parameters are based on:

$$\Delta p_{ND} = p_{ND} - p_G = 25 \text{ bar and } v = 10 \text{ mm}^2/\text{s}$$

( $p_{ND}$  = low pressure,  $p_G$  = case pressure)

### Notices

- ▶ Port **S<sub>a</sub>** only for sizes 150 to 280
- ▶ For a flushing flow of 35 l/min<sup>1)</sup> it is recommended that port **S<sub>a</sub>** be connected in order to prevent an increase in case pressure. An increased case pressure reduces the flushing flow.

### Small flushing valve for sizes 60 to 115

Material number of orifice	$\varnothing$ [mm]	$q_v$ [l/min]	Code
R909651766	1.2	3.5	A
R909419695	1.4	5	B
R909419696	1.8	8	C
R909419697	2.0	10	D
R909444361	2.4	14	F

### Medium flushing valve for size 115

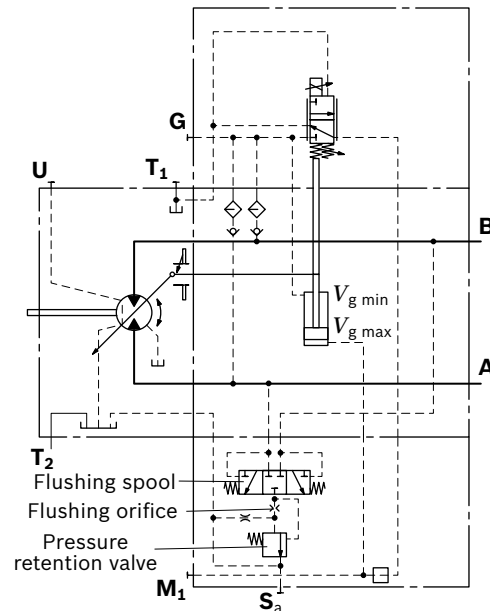
Material number of orifice	$\varnothing$ [mm]	$q_v$ [l/min]	Code
R909431310	2.8	18	I
R909435172	3.5	27	K
R909449967	5.0	37	L

1) For size 280 please contact us

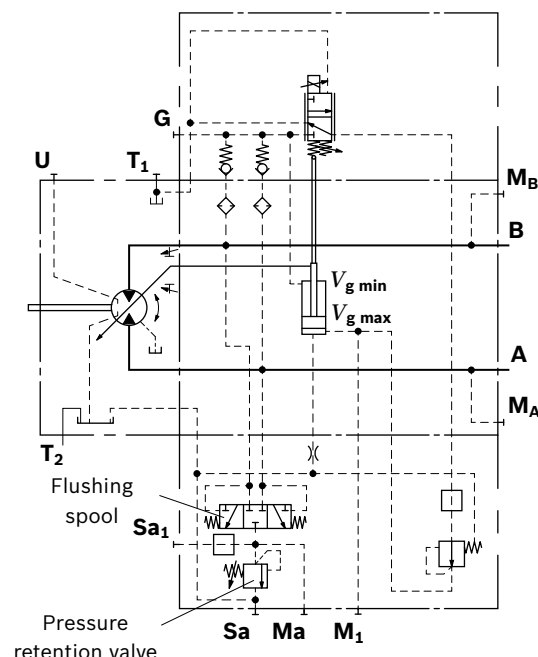
### Large flushing valve for sizes 150 to 215

Material number of orifice	$\varnothing$ [mm]	$q_v$ [l/min]	Code
R909449998	1.8	8	C
R909431308	2.0	10	D
R909431309	2.5	15	G
R909431310	2.8	18	I
R902138235	3.1	21	J
R909435172	3.5	27	K
R909436622	4.0	31	L
R909449967	5.0	37	M

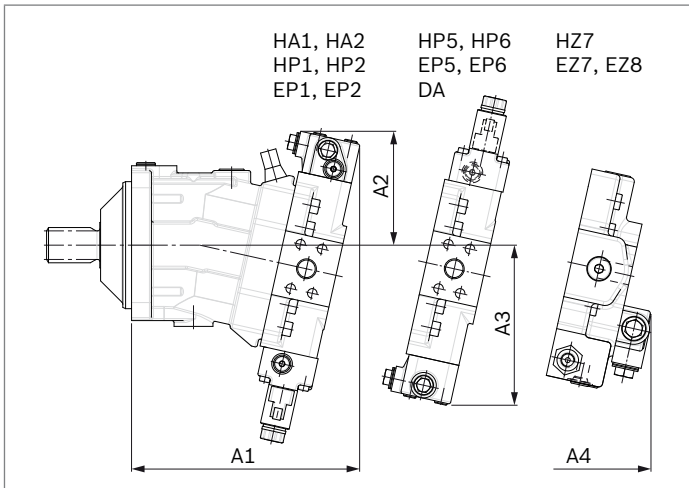
### ▼ Circuit diagram EP, sizes 60 to 215



### ▼ Circuit diagram EP, size 280

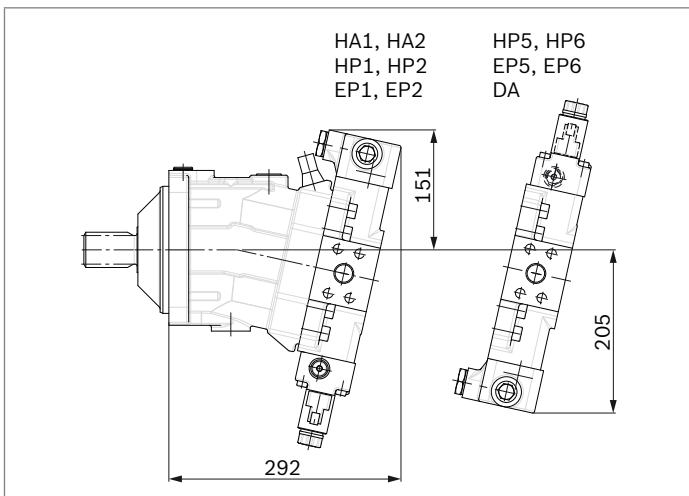


▼ **Dimensions of sizes 60 to 115 (small flushing valve)**



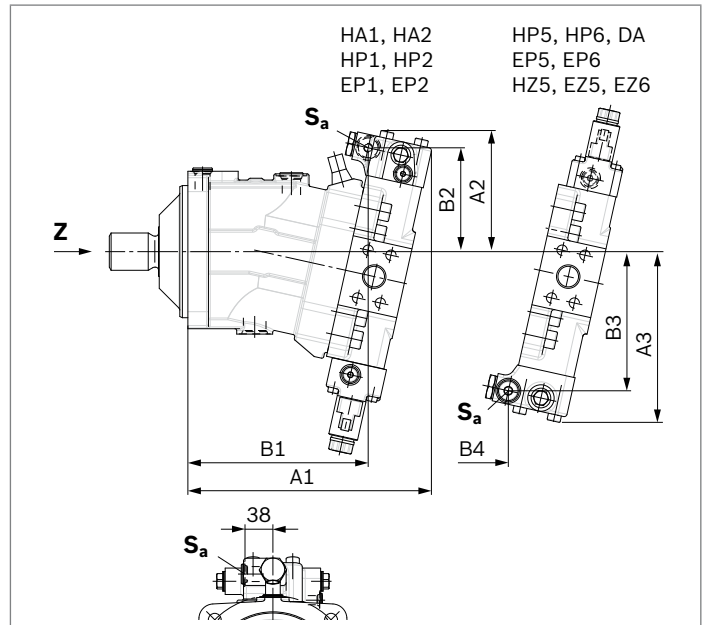
NG	A1	A2	A3	A4
60	245	137	183	236
85	273	142	194	254
115	287	143	202	269

▼ **Dimensions of size 115 (medium flushing valve)**



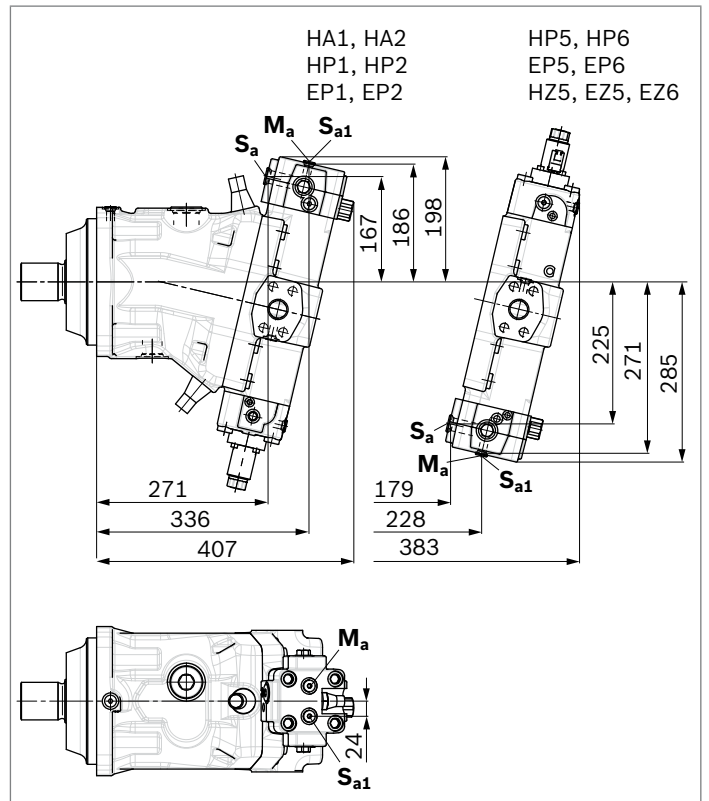
NG	S <sub>a</sub> <sup>1)</sup>	S <sub>a1</sub> <sup>1)</sup>	M <sub>a</sub> <sup>1)</sup>
150	M22 × 1.5; 15.5 deep		
170	M22 × 1.5; 15.5 deep		
215	M22 × 1.5; 15.5 deep		
280	M22 × 1.5; 15.5 deep	M14 × 1.5; 11.5 deep	M14 × 1.5; 11.5 deep

▼ **Dimensions for sizes 150 to 215 (large flushing valve)**



NG	A1	B1	A2	B2	A3	B3	B4
150	325	239	165	142	230	187	166
170	332	246	165	142	233	190	172
215	349	263	172	148	244	201	185

▼ **Dimensions, size 280**



1) ISO 6149, ports plugged (in normal operation). For notes on tightening torques, see instruction manual. The countersink may be deeper than specified in the standard.

## BVD and BVE counterbalance valve

### Function

Counterbalance valves for travel drives and winches should reduce the danger of overspeed and cavitation of axial piston motors in open circuits. Cavitation occurs if, during braking, when going downhill or during the load-lowering process, the motor speed is greater than it should be for the given inlet flow and thus the supply pressure falls sharply.

If the supply pressure falls below the level specified for the relevant counterbalance valve, the counterbalance valve spool moves into the closed position. The cross-sectional area of the counterbalance valve return passage is then reduced, creating a bottleneck in the return flow of the hydraulic fluid. The pressure increases and brakes the motor until the rotational speed of the motor reaches the specified value for the given inlet flow.

### Notice

- ▶ BVD available for sizes 60 to 280 and BVE available for sizes 115 to 280.
- ▶ The counterbalance valve must be ordered additionally. We recommend ordering the counterbalance valve and the motor as a set.

Order example: A6VM085HA1T30004A/71MWW0N4S  
97W0-0 + BVD20F27S/41B-V03K16D0400S12

- ▶ For safety reasons, controls with beginning of control at  $V_{g \min}$  (e.g. HA) are not permissible for lifting winch drives!
- ▶ Counterbalance valves must be optimized during prototype commissioning to prevent unacceptable operating conditions, and compliance with the specification must be verified.
- ▶ The counterbalance valve does not replace the mechanical service brake and holding brake.
- ▶ Observe the detailed notes on the counterbalance valve in the data sheets 95522 (BVD), 95525 (BVE) and 95528 (BVD/BVE32)!
- ▶ For the design of the brake release valve, we must know the following data for the mechanical holding brake:
  - the cracking pressure
  - the volume of the brake spool between minimum stroke (brake closed) and maximum stroke (brake released with 21 bar)
  - the required closing time for a warm device (oil viscosity approx. 15 mm<sup>2</sup>/s)

### Permissible inlet flow or pressure when using pressure relief valve and BVD/BVE

Motor NG	Without valve		Limited values when using pressure relief valves and BVD/BVE								
	$p_{nom}/p_{max}$ [bar]	$q_{V \max}$ [l/min]	PRV <sup>1)</sup> NG	$p_{nom}/p_{max}$ [bar]	$q_V$ [l/min]	Code	BVD <sup>2)/</sup> BVE <sup>3)</sup> NG	$p_{nom}/p_{max}$ [bar]	$q_V$ [l/min]	Code	
60	450/530	276	22	350/420	240	7	20 (BVD)	350/420	220	7W	
85		332									
115		410									
115		410	32		400	8	25 (BVD/BVE)	320	8W		
150		494									
170		533									
150		494					–	300/460	550	5	25 (BVE)
170		533									
215		628									
215		628									
280	700	9	32 (BVD/BVE)	350/400	628	650					9W

### Mounting the counterbalance valve

When delivered, the counterbalance valve is fastened to the motor with two tacking screws (transport lock). The tacking screws may not be removed while mounting the working lines. If the counterbalance valve and motor are delivered separately, the counterbalance valve must first be fastened to the motor port plate using the provided tacking screws.

The counterbalance valve is finally mounted to the motor by fitting the SAE flange.

The screws to be used and the instructions for mounting can be found in the instruction manual.

1) Pressure relief valve  
2) Counterbalance valve, double-acting  
3) Counterbalance valve, one-sided

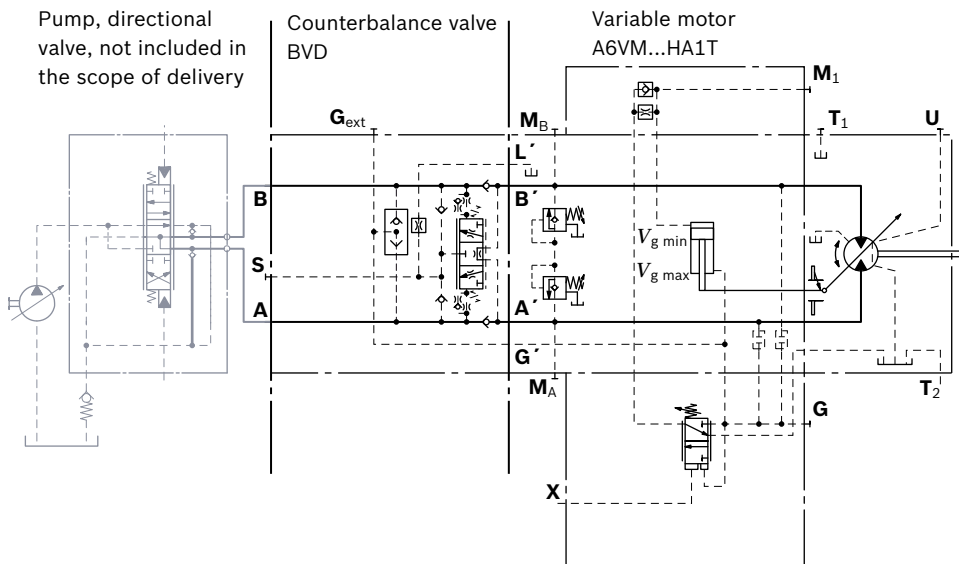
**Counterbalance valve for travel drives BVD...F**

Application option

- ▶ Travel drive for wheeled excavators (BVD and BVE)

▼ **Example circuit diagram for travel drive in wheeled excavators**

A6VM085HA1T30004A/71MWW0N4S97W0-0 + BVD20F27S/41B-V03K16D0400S12



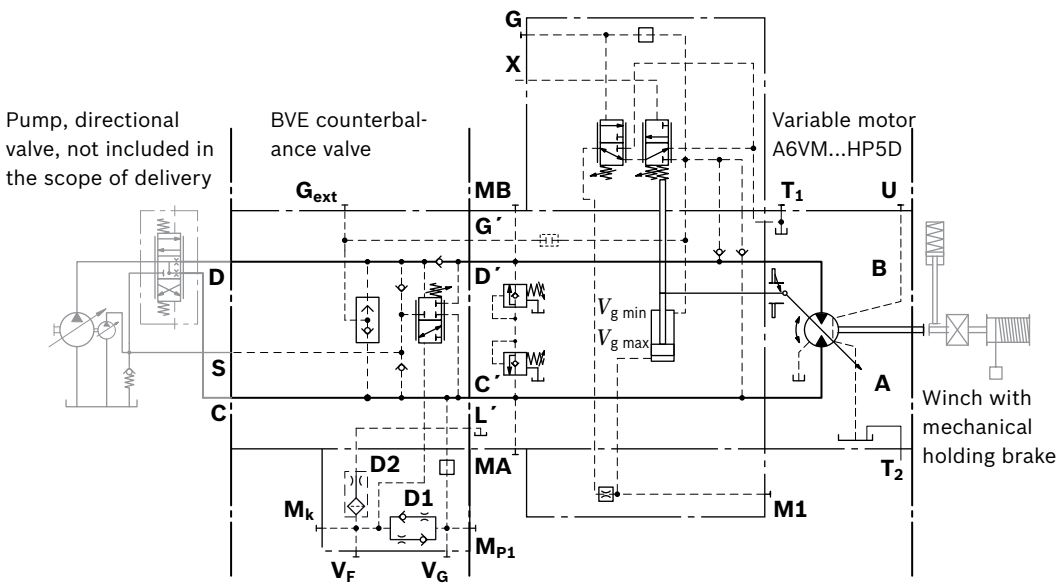
**Counterbalance valve for winches and track drive BVD...W and BVE**

Application option

- ▶ Winch drives in cranes (BVD and BVE)
- ▶ Track drive in excavator crawlers (BVD)

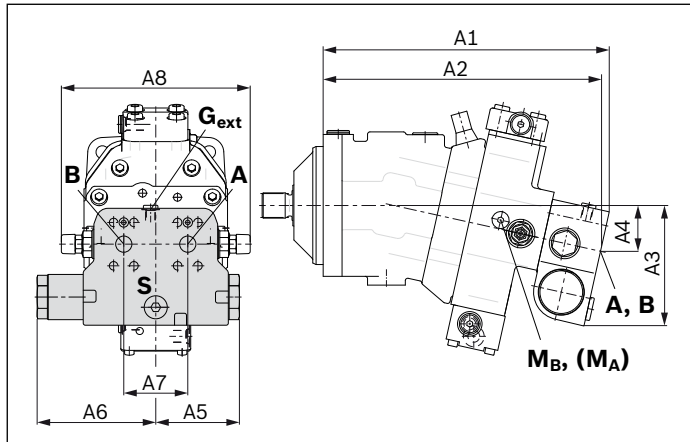
▼ **Example circuit diagram for winch drive in cranes**

A6VM085HP5D10001A/71MWW0N4S97W0-0 + BVE25W38S/51ND-V100K00D4599T30S00-0

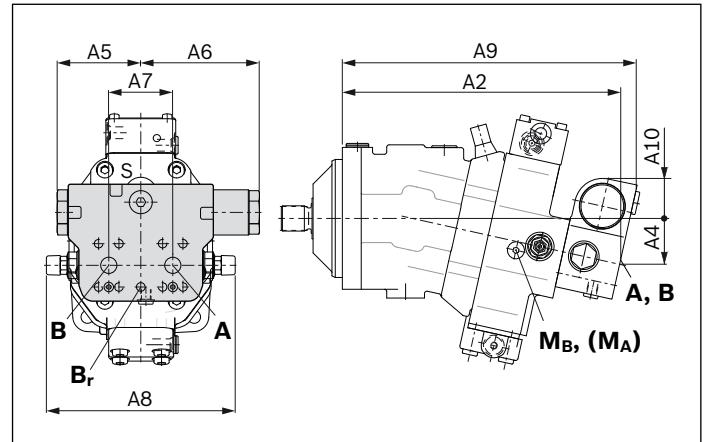


**Dimensions**

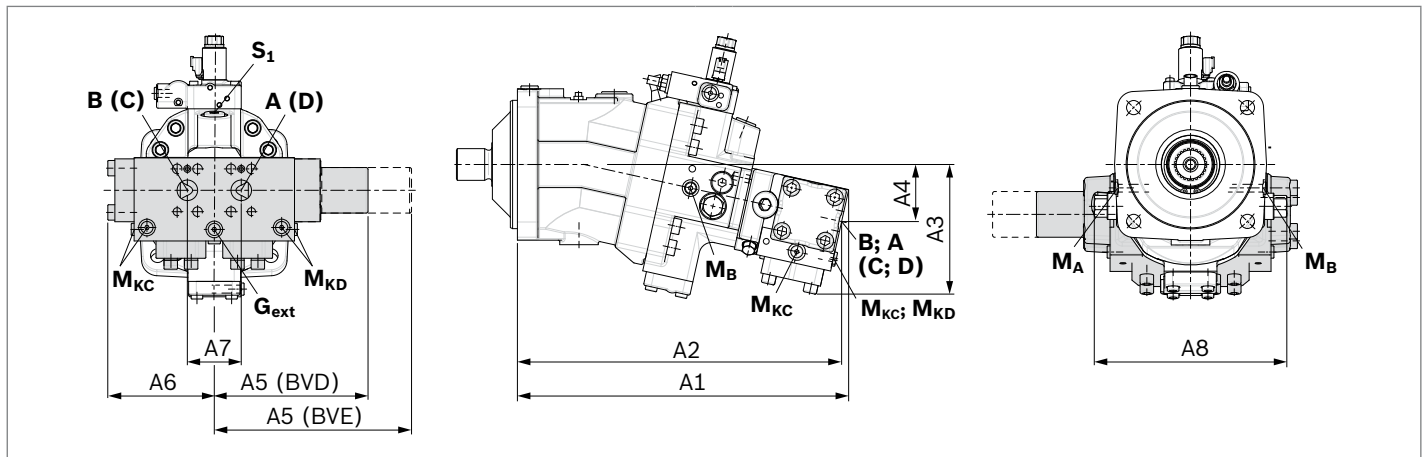
▼ **A6VM...HA, HP1, HP2 or EP1, EP2 with BVD/BVE 20/25**



▼ **A6VM...HP5, HP6 or EP5, EP6<sup>1)</sup> with BVD/BVE 20/25**



▼ **A6VM...HA, HP1, HP2 or EP1, EP2 with BVD/BVE 32**



A6VM NG...plate	Counterbalance valve		Dimensions									
	Type	Ports A, B	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10
60...7	BVD20...17	3/4 in	311	302	143	50	98	139	75	222	326	50
85...7	BVD20...27	1 in	340	331	148	55	98	139	75	222	355	46
115...7	BVD20...28	1 in	362	353	152	59	98	139	84	234	377	41
115...8	BVD25...38	1 1/4 in	380	370	165	63	120.5	175	84	238	395	56
150...8	BVD25...38	1 1/4 in	411	401	168	67	120.5	175	84	238	426	53
170...8	BVD25...38	1 1/4 in	417	407	170	68	120.5	175	84	238	432	51
215...5	BVD25...38	1 1/4 in	448	438	176	74	120.5	175	84	299	463	46
215...9	BVD32...38	1 1/4 in	516	505	202	89	240	166	84	299	-	46
280...9	BVD32...38	on request										
115...8	BVE25...38	1 1/4 in	380	370	171	63	137	214	84	238	397	63
150...5	BVE25...38	1 1/4 in	411	401	175	67	137	214	84	238	423	59
170...5	BVE25...38	1 1/4 in	417	407	176	68	137	214	84	238	432	59
215...5	BVE25...38	1 1/4 in	448	438	182	74	137	214	84	299	463	52
215...9	BVE32...38	1 1/4 in	516	505	202	89	307	166	84	299	-	46
280...9	BVE32...38	on request										

Ports		Version	A6VM plate	Standard	Size <sup>2)</sup>	$P_{\max}$ [bar] <sup>3)</sup>	State <sup>5)</sup>
A, B	Working line			SAE J518	see table above	420	O
S, S <sub>1</sub>	Boost port	BVD20, BVD32		DIN 3852 <sup>4)</sup>	M22 × 1.5; 14 deep	30	X
		BVD25, BVE25		DIN 3852 <sup>4)</sup>	M27 × 2; 16 deep	30	X
B <sub>r</sub>	Brake release port, reduced high pressure	L	7	DIN 3852 <sup>4)</sup>	M12 × 1.5; 12.5 deep	30	O
			8	DIN 3852 <sup>4)</sup>	M12 × 1.5; 12 deep	30	O
G <sub>ext</sub>	Brake release port, high pressure	S		DIN 3852 <sup>4)</sup>	M12 × 1.5; 12.5 deep	420	X
M <sub>A</sub> , M <sub>B</sub>	Measuring port, pressure A, B			ISO 6149 <sup>4)</sup>	M18 × 1.5; 14.5 deep	420	X
M <sub>C</sub>	Measuring port, pressure counterbalance spool	BVE25/53		DIN 3852 <sup>4)</sup>	M14 × 1.5; 12 deep	420	X
M <sub>K</sub>	Measuring port, pressure counterbalance spool	BVE25/53		DIN 3852 <sup>4)</sup>	M14 × 1.5; 12 deep	400	X
M <sub>KC</sub>	Measuring port, pressure counterbalance spool C	BVD32, BVE32		DIN 3852 <sup>4)</sup>	M14 × 1.5; 12 deep	400	X
M <sub>KD</sub>	Measuring port, pressure counterbalance spool D	BVE32, BVE32		DIN 3852 <sup>4)</sup>	M14 × 1.5; 12 deep	400	X
M <sub>P1</sub>	Measuring port, pressure counterbalance spool	BVE25/53		DIN 3852 <sup>4)</sup>	M14 × 1.5; 12 deep	420	X

1) At the mounting version for the controls HP5, HP6 and EP5, EP6, the cast-in port designations **A** and **B** on the counterbalance valve BVD do not correspond with the port designation of the A6VM motor.

The designation of the ports on the installation drawing of the motor is binding!

2) For information on tightening torques, see the instruction manual.

3) Momentary pressure peaks can occur depending on application. Keep this in mind when selecting measuring devices and fittings.

4) The countersink may be deeper than specified in the standard.

5) O = Needs to be connected (comes plugged)

X = Plugged (in normal operation)

## Integrated BVI counterbalance valve

### Function

The integrated counterbalance valves for track drives in crawler excavators should reduce the danger of overspeed and cavitation of axial piston motors in open circuits. Cavitation occurs if, during braking or driving downhill, the rotational speed of the motor is greater than it should be for the given inlet flow, causing the supply pressure to fall sharply.

If the supply pressure falls below the level specified for the relevant counterbalance valve, the counterbalance valve spool moves into the closed position. The cross-sectional area of the counterbalance valve return passage is then reduced, creating a bottleneck in the return flow of the hydraulic fluid. The pressure increases and brakes the motor until the rotational speed of the motor reaches the specified value for the given inlet flow.

### Notice

- ▶ BVI available for sizes 150 and 170.
- ▶ The counterbalance valve must be ordered additionally. Order example: A6VM150HP6000001A/71MWW0R4A 16Y0-0 + BVI540603002-0
- ▶ Counterbalance valves must be optimized during prototype commissioning to prevent unacceptable operating conditions, and compliance with the specification must be verified.
- ▶ The counterbalance valve does not replace the mechanical service brake and holding brake.
- ▶ For the design of the brake release valve, we require the following data for the mechanical holding brake:
  - the cracking pressure
  - the volume of the brake spool between minimum stroke (brake closed) and maximum stroke (brake released with 21 bar)
  - the required closing time for a warm device (oil viscosity approx. 15 mm<sup>2</sup>/s)

### Type code

01	02	03	04	05	06
<b>BVI</b>				-	

#### Counterbalance valve

01	Counterbalance valve integrated	<b>BVI</b>
----	---------------------------------	------------

#### Brake piston version

		$q_v$ [l/min]	Material number	
02	Volume preselection	≤ 150	R902038832	<b>51</b>
		= 150 – 210	R902038936	<b>52</b>
		= 210 – 270	R902038833	<b>53</b>
		= 270 – 330	R902038834	<b>54</b>
		= 330 – 400	R902038835	<b>55</b>
		≥ 400	R902038836	<b>56</b>

#### Throttle mounting

03	Constant throttle	R909432302	<b>0008</b>
	Throttle pin	R909651165	<b>0603</b>

#### Check valve

04	Without residual opening	<b>00</b>
----	--------------------------	-----------

#### Brake release valve

05	With brake release valve (standard HZ)	without disable function	<b>1</b>
	With brake release valve (standard HP, EP)	with disable function	<b>2</b>

#### Standard/special version

06	Standard version	<b>0</b>
	Special version	<b>S</b>

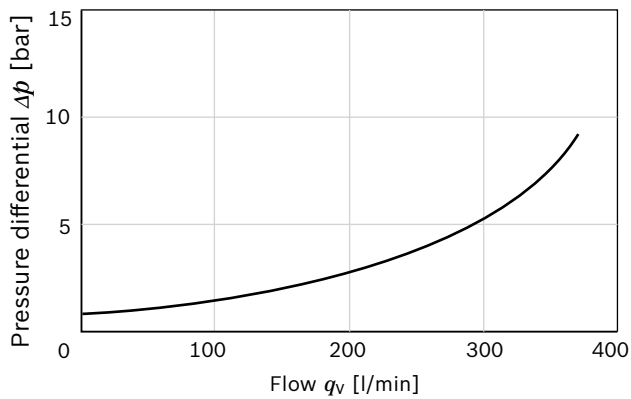
**Technical data**

Working pressure	Nominal pressure	$p$	350 bar
	Maximum pressure	$p$	420 bar
Flow, maximum		$q_{v \max}$	400 l/min
Counterbalance spool	Start of opening	$p$	12 bar
	Fully open	$p$	26 bar
Pressure reducing valve for brake release (fixed setting)	Control pressure	$p$	21 <sup>+4</sup> bar
	Beginning of control	$p$	10 <sup>+4</sup> bar

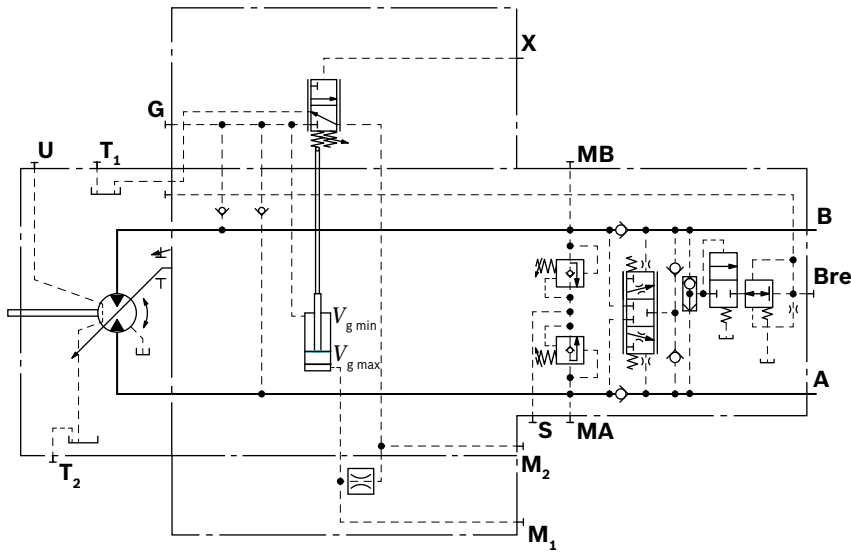
**Permissible inlet flow or pressure when using pressure relief valve and BVI**

Motor NG	Without restrictions Standard plate (1 + 2)		Limited values Plate with integrated counterbalance valve (6)	
	$p_{\text{nom}}/p_{\text{max}}$ [bar]	$q_{v \max}$ [l/min]	$p_{\text{nom}}/p_{\text{max}}$ [bar]	BVI + PRV $q_v$ [l/min]
150	450/530	410	350/420	400
170		533		

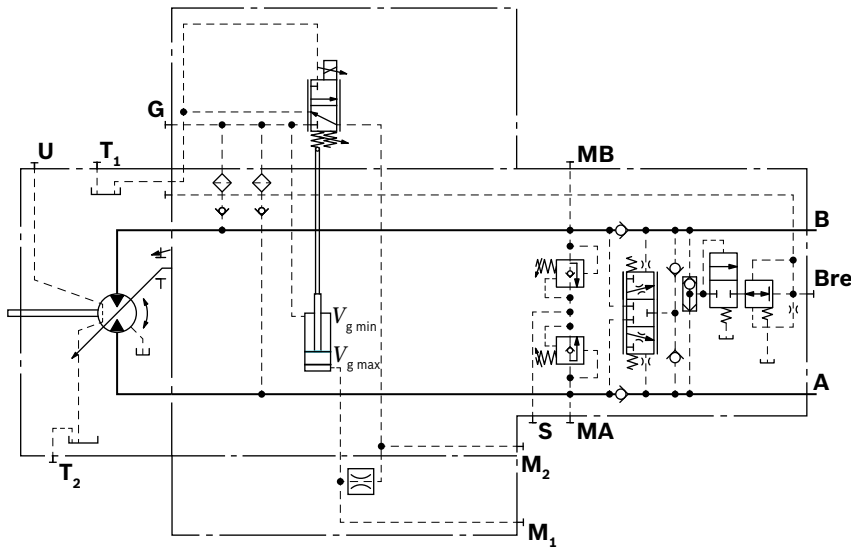
▼ **Boost characteristic**



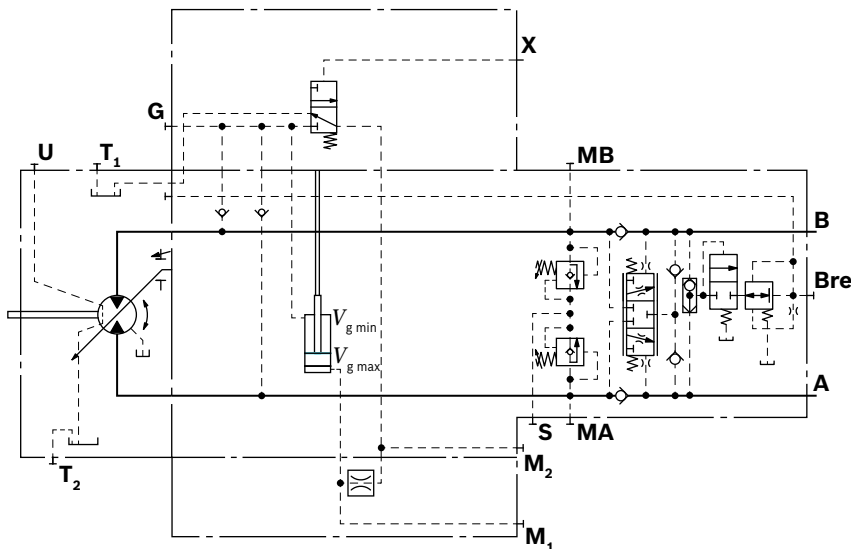
▼ **Circuit diagram HP5**



▼ **Circuit diagram EP5**



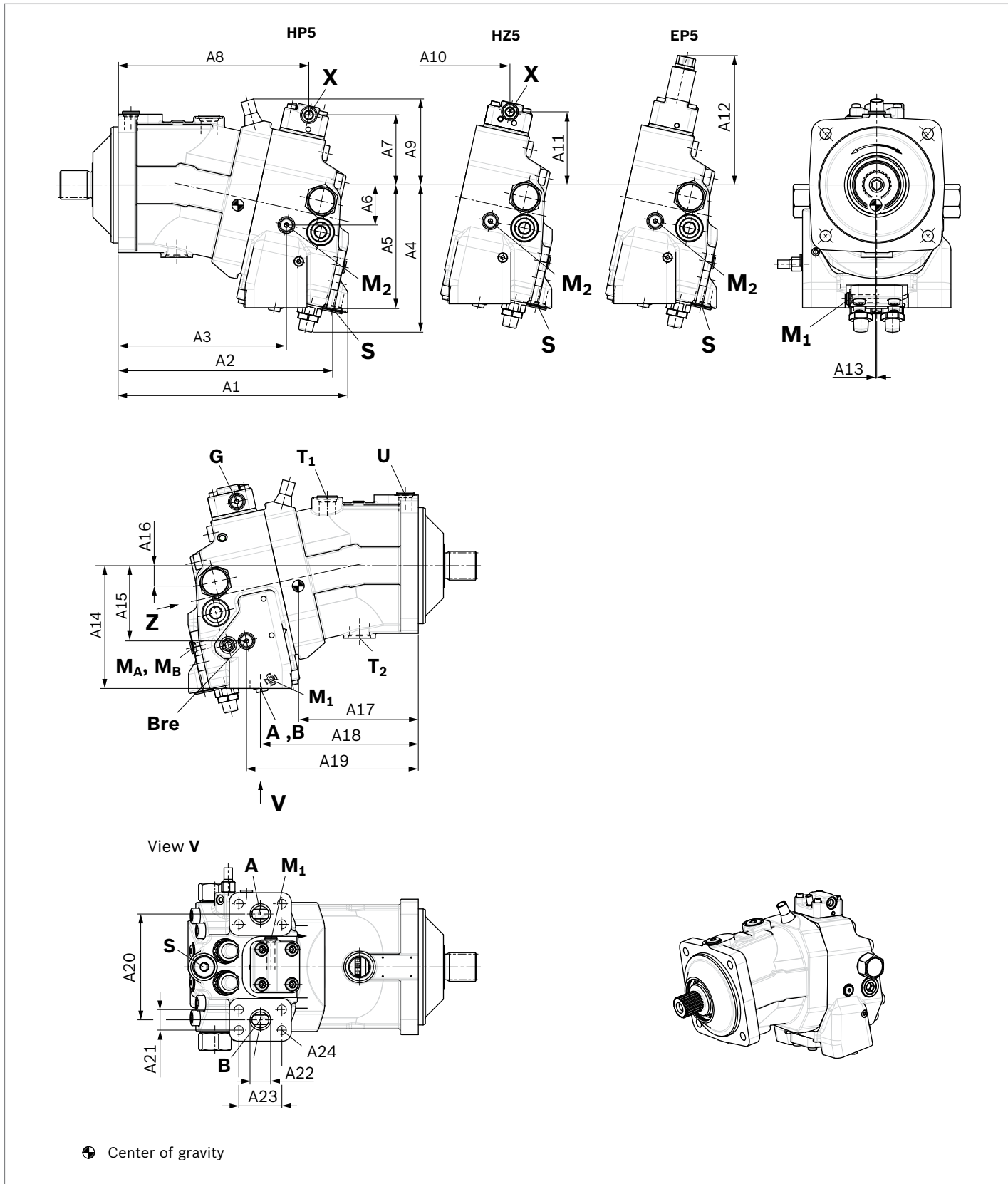
▼ **Circuit diagram HZ5**



**Integrated BVI counterbalance valve dimensions**

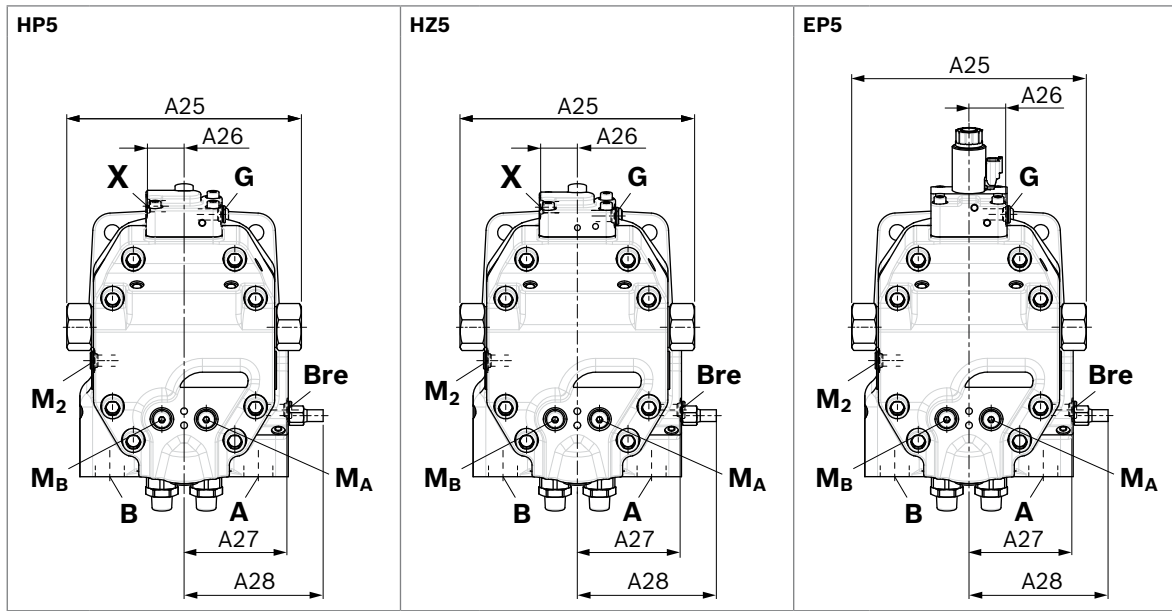
**HP5 – Two-point control, hydraulic**

Port plate 6, with integrated BVI counterbalance valve – SAE working ports **A** and **B** at bottom



☉ Center of gravity

▼ **Location of working ports on the port plates (View Z)**



A6VM														
NG	Port A, B	Dimensions												
		A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11	A12	A13
150	1 1/4 in	350	326	254	227	190	61	109	289	max. 134	285	108	196	1.0
170	1 1/4 in	357	332	261	228	192	62	108	296	max. 135	291	107	195	1.0

A6VM																
NG	Dimensions															
	A14	A15	A16	A17	A18	A19	A20	A21	A22	A23	A24 (DIN 13)	A25	A26	A27	A28	
150	189	115	25	170	238	260	164	31.8	32	66.7	M14 × 2; 19 deep	259	40.5	113.5	154	
170	190	117	29	191	245	266	164	31.8	32	66.7	M14 × 2; 19 deep	259	40.5	113.5	154	

Ports	Working line SAE J518 <sup>1)</sup>	Drain port ISO 6149 <sup>2)</sup>	Drain port ISO 6149 <sup>2)</sup>	Bearing flushing port ISO 6149 <sup>2)</sup>	Pilot pressure port ISO 6149 <sup>2)</sup>	Boost pressure supply ISO 6149 <sup>2)</sup>
NG	A, B	T <sub>1</sub>	T <sub>2</sub>	U	X	S
150	see table above	M27 × 2; 19 deep	M33 × 2; 19 deep	M22 × 1.5; 15.5 deep	M14 × 1.5; 11.5 deep	M27 × 2; 19 deep
170		M27 × 2; 19 deep	M33 × 2; 19 deep	M22 × 1.5; 15.5 deep	M14 × 1.5; 11.5 deep	M27 × 2; 19 deep
$p_{max}$ [bar] <sup>3)</sup>	420	3	3	3	100	30
State <sup>5)</sup>	O	X <sup>4)</sup>	O <sup>4)</sup>	X	O	X

Ports	Measuring port pressure A / pressure B	Control pressure measuring port	Measuring port, stroking chamber	Brake release, external	Synchronous control ISO 6149 <sup>2)</sup>
NG	M <sub>A</sub> , M <sub>B</sub>	M <sub>1</sub>	M <sub>2</sub>	Bre	G
150	M14 × 1.5; 11.5 deep	M14 × 1; 11.5 deep	M14 × 1; 11.5 deep	M14 × 1; 11.5 deep	M14 × 1; 11.5 deep
170	M14 × 1.5; 11.5 deep	M14 × 1; 11.5 deep	M14 × 1; 11.5 deep	M14 × 1; 11.5 deep	M14 × 1; 11.5 deep
$p_{max}$ [bar] <sup>3)</sup>	420	420	420	30	420
State <sup>5)</sup>	X	X	X	X/O	X

1) Only dimensions according to SAE J518, metric fastening thread is a deviation from the standard.  
2) The countersink may be deeper than specified in the standard.  
3) Momentary pressure peaks can occur depending on application. Keep this in mind when selecting measuring devices and fittings.

4) Depending on installation position, T<sub>1</sub> or T<sub>2</sub> must be connected (see also installation instructions on page 39).  
5) O = Needs to be connected (comes plugged)  
X = Plugged (in normal operation)

## Speed sensor

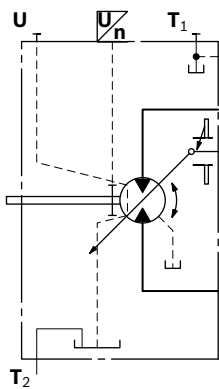
Version A6VM...U (“prepared for speed sensor”, i.e. without sensor) is equipped with a spline on the rotary group.

A signal proportional to motor speed can be generated with the mounted speed sensor HDD/DSA/DSM. The HDD/DSA/DSM sensor measures the rotational speed and direction of rotation.

Type code, technical data, dimensions and parameters for the connector, plus safety instructions about the sensor can be found in the relevant data sheet 95132<sup>1)</sup> (DSM), 95133 (DSA) or 95135 (HDD).

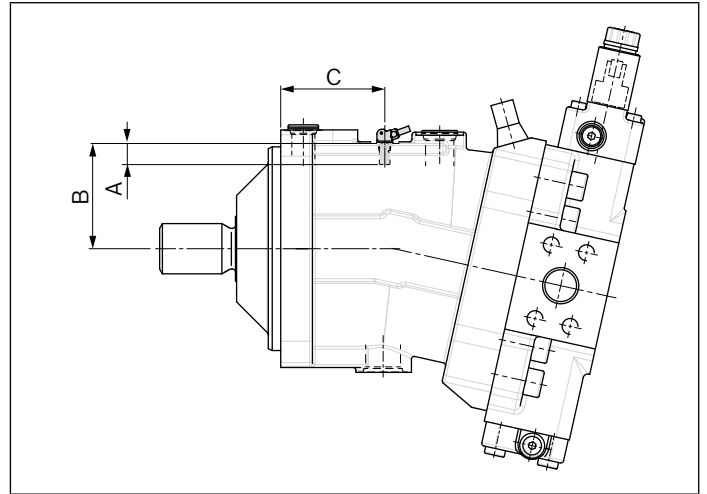
The sensor is mounted on the port provided for this purpose with a mounting bolt. On deliveries without sensor, the port is plugged with a pressure-resistant cover. We recommend ordering the A6VM variable motor complete with mounted sensor.

### ▼ Circuit diagram EP

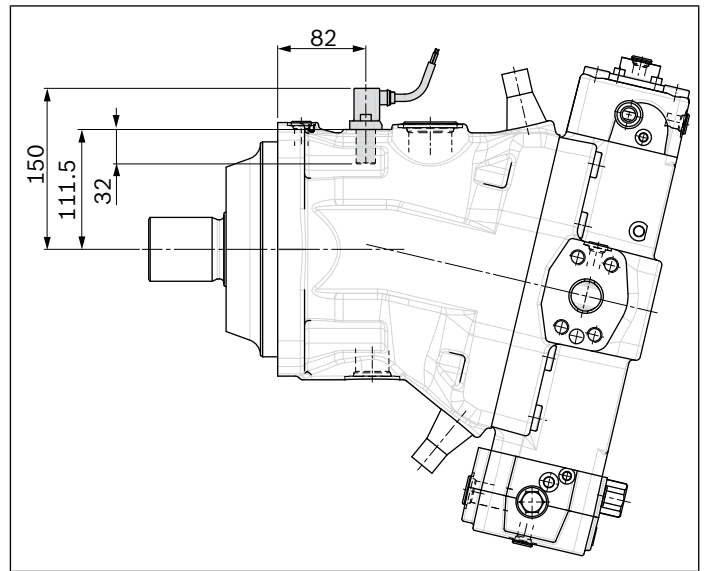


### ▼ Dimensions

Size 60 to 215 version “V”, with mounted speed sensor



Size 280 version “H”, with mounted speed sensor



Size	60	85	115	150	170	215	280
Number of teeth	54	58	67	72	75	80	78
A Insertion depth (tolerance -0.25)	18.4	18.4	18.4	18.4	18.4	18.4	32
B Contact surface	75	79	88	93	96	101	111.5
C	66.2	75.2	77.2	91.2	91.7	95.2	82

1) Maximum permissible signal frequency of DSM sensor must be observed with high motor speeds

## Setting range for displacement

	60				85				115				150			
	$V_{g\max}$ (cm <sup>3</sup> /rev)		$V_{g\min}$ (cm <sup>3</sup> /rev)		$V_{g\max}$ (cm <sup>3</sup> /rev)		$V_{g\min}$ (cm <sup>3</sup> /rev)		$V_{g\max}$ (cm <sup>3</sup> /rev)		$V_{g\min}$ (cm <sup>3</sup> /rev)		$V_{g\max}$ (cm <sup>3</sup> /rev)		$V_{g\min}$ (cm <sup>3</sup> /rev)	
	from	to	from	to	from	to	from	to	from	to	from	to	from	to	from	to
<b>A</b>	62.0	62.0	0.0	15.0	85.2	85.2	0.0	9.0	115.6	115.6	0.0	24.0	152.1	152.1	0.0	44.0
	without screw		M10 × 60 R909154690		without screw		M12 × 60 R909083530		without screw		M12 × 70 R909085976		without screw		M12 × 80 R909153075	
<b>B</b>	62.0	62.0	> 15.0	30.5	85.2	85.2	> 9.0	28.0	115.6	115.6	> 24.0	47.5	152.1	152.1	> 44.0	69.0
	without screw		M10 × 70 R909153779		without screw		M12 × 70 R909085976		without screw		M12 × 80 R909153075		without screw		M12 × 90 R909154041	
<b>C</b>	62.0	62.0	> 30.5	43.0	85.2	85.2	> 28.0	47.0	115.6	115.6	> 47.5	71.0	152.1	152.1	> 69.0	99.0
	without screw		M10 × 80 R909154058		without screw		M12 × 80 R909153075		without screw		M12 × 90 R909154041		without screw		M12 × 100 R909153975	
<b>D</b>	x		x		85.2	85.2	> 47.0	59.0	115.6	115.6	> 71.0	80.0	152.1	152.1	> 99.0	106.0
					without screw		M12 × 90 R909154041		without screw		M12 × 100 R909153975		without screw		M12 × 110 R909154212	
<b>E</b>	< 62.0	47.5	0.0	15.0	< 85.2	77.0	0.0	9.0	< 115.6	93.5	0.0	24.0	< 152.1	111.0	0.0	44.0
	M10 × 60 R909154690		M10 × 60 R909154690		M12 × 60 R909083530		M12 × 60 R909083530		M12 × 70 R909085976		M12 × 70 R909085976		M12 × 80 R909153075		M12 × 80 R909153075	
<b>F</b>	< 62.0	47.5	> 15.0	30.5	< 85.2	77.0	> 9.0	28.0	< 115.6	93.5	> 24.0	47.5	< 152.1	111.0	> 44.0	69.0
	M10 × 60 R909154690		M10 × 70 R909153779		M12 × 60 R909083530		M12 × 70 R909085976		M12 × 70 R909085976		M12 × 80 R909153075		M12 × 80 R909153075		M12 × 90 R909154041	
<b>G</b>	< 62.0	47.5	> 30.5	43.0	< 85.2	77.0	> 28.0	47.0	< 115.6	93.5	> 47.5	71	< 152.1	111.0	> 69.0	99.0
	M10 × 60 R909154690		M10 × 80 R909154058		M12 × 60 R909083530		M12 × 80 R909153075		M12 × 70 R909085976		M12 × 90 R909154041		M12 × 80 R909153075		M12 × 100 R909153975	
<b>H</b>	x		x		< 85.2	77.0	> 47.0	59.0	< 115.6	93.5	> 71.0	80.0	< 152.1	111.0	> 99.0	106.0
					M12 × 60 R909083530		M12 × 90 R909154041		M12 × 70 R909085976		M12 × 100 R909153975		M12 × 80 R909153075		M12 × 110 R909154212	
<b>J</b>	< 47.5	33.0	0.0	15.0	< 77.0	58.0	0.0	9.0	< 93.5	71.0	0.0	24.0	< 111.0	87.0	0.0	44.0
	M10 × 70 R909153779		M10 × 60 R909154690		M12 × 70 R909085976		M12 × 60 R909083530		M12 × 80 R909153075		M12 × 70 R909085976		M12 × 90 R909154041		M12 × 80 R909153075	
<b>K</b>	< 47.5	33.0	> 15.0	30.5	< 77.0	58.0	> 9.0	28.0	< 93.5	71.0	> 24.0	47.5	< 111.0	87.0	> 44.0	69.0
	M10 × 70 R909153779		M10 × 70 R909153779		M12 × 70 R909085976		M12 × 70 R909085976		M12 × 80 R909153075		M12 × 80 R909153075		M12 × 90 R909154041		M12 × 90 R909154041	
<b>L</b>	< 47.5	33.0	> 30.5	43.0	< 77.0	58.0	> 28.0	47.0	< 93.5	71.0	> 47.5	71.0	< 111.0	87.0	> 69.0	99.0
	M10 × 70 R909153779		M10 × 80 R909154058		M12 × 70 R909085976		M12 × 80 R909153075		M12 × 80 R909153075		M12 × 90 R909154041		M12 × 90 R909154041		M12 × 100 R909153975	
<b>M</b>	x		x		< 77.0	58.0	> 47.0	59.0	< 93.5	71.0	> 71.0	80.0	< 111.0	87.0	> 99.0	106.0
					M12x70 R909085976		M12 × 90 R909154041		M12 × 80 R909153075		M12 × 100 R909153975		M12 × 90 R909154041		M12 × 110 R909154212	

Specify exact settings for  $V_{g\min}$  and  $V_{g\max}$  in plain text when ordering:

▶  $V_{g\min} = \dots \text{ cm}^3$ ,  $V_{g\max} = \dots \text{ cm}^3$

Theoretical, maximum setting:

▶ for  $V_{g\min} = 0.7 \times V_{g\max}$

▶ for  $V_{g\max} = 0.3 \times V_{g\max}$

Settings that are not listed in the table may lead to damage.

Please contact us.

	170				215				280			
	$V_{g \max}$ (cm <sup>3</sup> /rev)		$V_{g \min}$ (cm <sup>3</sup> /rev)		$V_{g \max}$ (cm <sup>3</sup> /rev)		$V_{g \min}$ (cm <sup>3</sup> /rev)		$V_{g \max}$ (cm <sup>3</sup> /rev)		$V_{g \min}$ (cm <sup>3</sup> /rev)	
	from	to	from	to	from	to	from	to	from	to	from	to
<b>A</b>	171.8	171.8	0.0	35.0	216.5	216.5	0.0	44.5	-	-	-	-
	without screw		M12 × 80 R909153075		without screw		M12 × 80 R909153075		-		-	
<b>B</b>	171.8	171.8	> 35.0	63.5	216.5	216.5	> 44.5	80.0	-	-	-	-
	without screw		M12 × 90 R909154041		without screw		M12 × 90 R909154041		-		-	
<b>C</b>	171.8	171.8	> 63.5	98.0	216.5	216.5	> 80.0	115.0	-	-	-	-
	without screw		M12 × 100 R909153975		without screw		M12 × 100 R909153975		-		-	
<b>D</b>	171.8	171.8	> 98.0	120.0	216.5	216.5	> 115.0	150.0	-	-	-	-
	without screw		M12 × 110 R909154212		without screw		M12 × 110 R909154212		-		-	
<b>E</b>	< 171.8	139.0	0.0	35.0	< 216.5	175.0	0.0	44.5	280.1	230.0	0.0	55.0
	M12 × 80 R909153075		M10 × 80 R909153075		M12 × 80 R909153075		M12 × 80 R909153075		M16 × 100 R910909811		M16 × 100 R910909811	
<b>F</b>	< 171.8	139.0	> 35.0	63.5	< 216.5	175.0	> 44.5	80.0	280.1	230.0	> 55.0	98.0
	M12 × 80 R909153075		M12 × 90 R909154041		M12 × 80 R909153075		M12 × 90 R909154041		M16 × 100 R910909811		M16 × 100 R910909719	
<b>G</b>	< 171.8	139.0	> 63.5	98.0	< 216.5	175.0	> 80.0	115.0	280.1	230.0	> 98.0	141.0
	M12 × 80 R909153075		M12 × 100 R909153975		M12 × 80 R909153075		M12 × 100 R909153975		M16 × 100 R910909811		M16 × 120 R910909477	
<b>H</b>	< 171.8	139.0	> 98.0	120.0	< 216.5	175.0	> 115.0	150.0	280.1	230.0	> 141.0	184.0
	M12 × 80 R909153075		M12 × 110 R909154212		M12 × 80 R909153075		M12 × 110 R909154212		M16 × 100 R910909811		M16 × 130 R910900271	
<b>J</b>	< 139.0	112.0	0.0	35.0	< 175.0	141.0	0.0	44.5	< 230.0	188.0	0.0	55.0
	M12 × 90 R909154041		M12 × 80 R909153075		M12 × 90 R909154041		M12 × 80 R909153075		M16 × 110 R910909719		M16 × 100 R910909811	
<b>K</b>	< 139.0	112.0	> 35.0	63.5	< 175.0	141.0	> 44.5	80.0	< 230.0	188.0	> 55.0	98.0
	M12 × 90 R909154041		M12 × 90 R909154041		M12 × 90 R909154041		M12 × 90 R909154041		M16 × 110 R910909719		M16 × 110 R910909719	
<b>L</b>	< 139.0	112.0	> 63.5	98.0	< 175.0	141.0	> 80.0	115.0	< 230.0	188.0	> 98.0	141.0
	M12 × 90 R909154041		M12 × 100 R909153975		M12 × 90 R909154041		M12 × 100 R909153975		M16 × 110 R910909719		M16 × 120 R910909477	
<b>M</b>	< 139.0	112.0	> 98.0	120.0	< 175.0	141.0	> 115.0	150.0	< 230.0	188.0	> 141.0	184.0
	M12 × 90 R909154041		M12 × 110 R909154212		M12 × 90 R909154041		M12 × 110 R909154212		M16 × 110 R910909719		M16 × 130 R910900271	

Specify exact settings for  $V_{g \min}$  and  $V_{g \max}$  in plain text when ordering:

▶  $V_{g \min} = \dots \text{ cm}^3$ ,  $V_{g \max} = \dots \text{ cm}^3$

Theoretical, maximum setting:

▶ for  $V_{g \min} = 0.7 \times V_{g \max}$

▶ for  $V_{g \max} = 0.3 \times V_{g \min}$

Settings that are not listed in the table may lead to damage.

Please contact us.

## Installation instructions

### General

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

Particularly in the installation position “drive shaft upwards”, filling and air bleeding must be carried out completely as there is, for example, a danger of dry running.

The leakage in the housing area must be directed to the reservoir via the highest drain port (**T<sub>1</sub>**, **T<sub>2</sub>**).

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 operational conditions, particularly at cold start. If this is not possible, separate drain line must be laid, if necessary.

To achieve favorable noise values, decouple all connecting lines using elastic elements and avoid above-reservoir installation.

In all operating conditions, the drain line must flow into the reservoir below the minimum fluid level.

### Notice

Effects on the control system are to be expected in certain installation positions. Gravity, dead weight and case pressure can cause minor characteristic shifts and changes in response time.

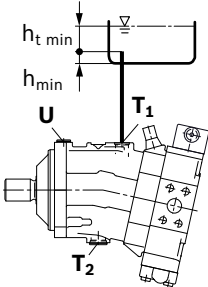
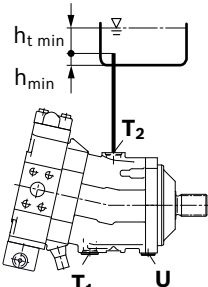
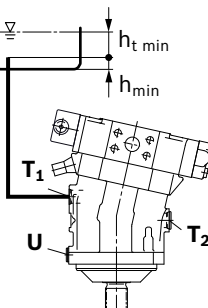
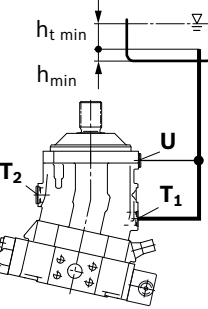
### Installation position

See the following examples **1** to **8**.

Further installation positions are possible upon request.  
Recommended installation position: **1** and **2**

### Below-reservoir installation (standard)

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

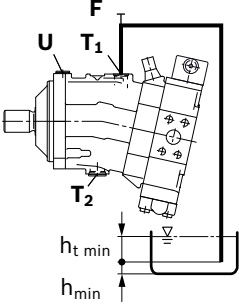
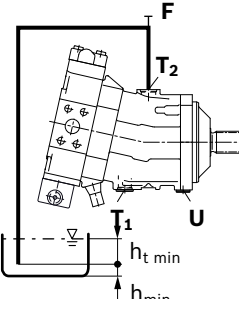
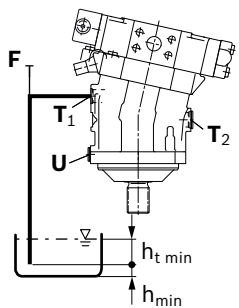
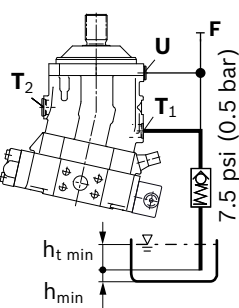
Installation position	Air bleed	Filling
<b>1</b> 		<b>T<sub>1</sub></b>
<b>2</b> 		<b>T<sub>2</sub></b>
<b>3</b> 		<b>T<sub>1</sub></b>
<b>4</b> 	<b>U</b>	<b>T<sub>1</sub></b>

### Above-reservoir installation

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

Recommendation for installation position 8 (drive shaft up):

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

Installation position	Air bleed	Filling
5	U (F)	T <sub>1</sub> (F)
		
6	F	T <sub>2</sub> (F)
		
7	F	T <sub>1</sub> (F)
		
8	U	T <sub>1</sub> (F)
		

Key	
F	Filling/air bleeding
U	Bearing flushing port/air bleeding
T <sub>1</sub> , T <sub>2</sub>	Drain port
h <sub>t min</sub>	Minimum required immersion depth (200 mm)
h <sub>min</sub>	Minimum required distance to reservoir bottom (100 mm)

### Notice

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

### Project planning notes

- ▶ The motor A6VM is designed to be used in open and closed circuits.
- ▶ The project planning, installation and commissioning of the axial piston unit require the involvement of qualified skilled persons.
- ▶ Before using the axial piston unit, please read the corresponding instruction manual completely and thoroughly. If necessary, this can be requested from Bosch Rexroth.
- ▶ Before finalizing your design, please request a binding installation drawing.
- ▶ The specified data and notes contained herein must be observed.
- ▶ For safety reasons, controls with beginning of control at  $V_{g \min}$  (e.g., HA) are not permissible for winch drives (e.g. anchor winches)!
- ▶ Depending on the operating conditions of the axial piston unit (working pressure, fluid temperature), the characteristic curve may shift.
- ▶ Preservation: Our axial piston units are supplied as standard with preservative protection for a maximum of 12 months. If longer preservation is required (maximum 24 months), please specify this in plain text when placing your order. The preservation periods apply under optimal storage conditions, which can be found in data sheet 90312 or in the instruction manual.
- ▶ Not all versions 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. MTTFD) 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.
- ▶ Please note the details regarding the tightening torques of port threads and other threaded joints in the instruction manual.
- ▶ Working ports:
  - The ports and fastening threads are designed for the specified maximum pressure. The machine or system manufacturer must ensure the connecting elements and lines correspond to the specified application conditions (pressure, flow, hydraulic fluid, temperature) with the necessary safety factors.
  - The working ports and function ports are only intended to accommodate hydraulic lines.

## Safety instructions

- ▶ During and shortly after operation, there is a risk of getting burnt 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.
- ▶ In certain conditions, moving parts in high pressure relief valves might get stuck in an undefined position due to contamination (e.g. contaminated hydraulic fluid). This can result in restriction or loss of load holding functions in lifting winches. Therefore it is the machine and/or system manufacturer's responsibility to make sure that the load can always be put in a safe mode if needed. Also, he needs to ensure that these measures are properly implemented.
- ▶ When using the axial piston motor in winch drives, make certain that the technical limit values are not exceeded under all operating conditions. If the axial piston motor is extremely overloaded (e.g., if the maximum permissible rotational speeds are exceeded during weighing of the anchor while the ship is in motion), the rotary group may be damaged and, in the worst case, the axial piston motor may burst. The machine manufacturer/system manufacturer is to undertake additional measures, up to and including encapsulation.

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