Axial piston variable motor
AA6VM series 63

Americas

RE-A 91604
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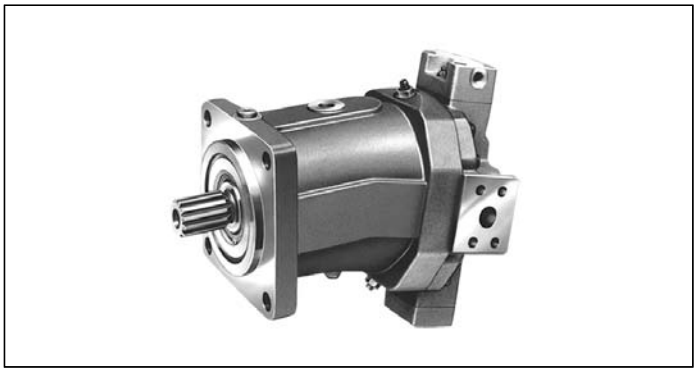


- All-purpose high pressure motor
- Size 250
- Nominal pressure 5100 psi (350 bar)
- Maximum pressure 5800 psi (400 bar)
- Open and closed circuits

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
- Bent-axis design

Contents

Type code

01	02	03	04	05	06	07	08		09	10	11		12	13	14	15	16	17	18	19		20
	AA6V		**M**	**250**				**/**	**63**	**W**		**–**	**V**	**S**	**D**						**–**	

Hydraulic fluid

01	Mineral oil and HFD. HFD only in combination with long-life bearings "L" (without code)	
	HFB, HFC hydraulic fluid only in conjunction with long-life bearings “L”	**E**

Axial piston unit

02	Bent-axis design, variable, nominal pressure 5100 psi (350 bar), maximum pressure 5800 psi (400 bar)	**AA6V**

Drive shaft bearing

03	Standard bearing (without code)	
	Long-life bearing	**L**

Operating mode

04	Motor (plug-in motor A6VE, see data sheet 91606)	**M**

Size (NG)

05	Geometric displacement, see technical data on page 7	in cm^3/rev	**250**
		in in^3/rev	**15.25**

Control device

06	Proportional control hydraulic	Δp_{St} = 145 psi (10 bar)	**HD1**
		Δp_{St} = 365 psi (25 bar)	**HD2**
		Δp_{St} = 510 psi (35 bar)	**HD3**
	Proportional control electrical[1]	U = 12 V DC	**EP1**
		U = 24 V DC	**EP2**
	Two-point control hydraulic		**HZ**
	Two-point control electrical[1]	U = 12 V DC	**EZ1**
		U = 24 V DC	**EZ2**
	Automatic control high-pressure related	with minimum pressure increase Δp ≤ approx. 145 psi (10 bar)	**HA1**
		with pressure increase Δp = 1450 psi (100 bar)	**HA2**
	Automatic control speed related p_{St} / p_{HD} = 3/100	hydraulic travel direction valve	**DA**

Pressure control/override (only for HD, EP)

07	Without pressure control/override		
	Pressure control fixed setting	fixed setting	**D**
		hydraulic override, two-point	**E**[2]
		hydraulic remote control, proportional	**G**

Overrides for the HA1 and HA2 controls

08	Without override	
	Hydraulic override, remonte control, proportinal	**T**

Series

09	Series 6, index 3	**63**

Direction of rotation

10	Viewed on drive shaft, bidirectional	**W**

Setting range for displacement[3]

11	$V_{g\,min}$ = 0 to 0.4 $V_{g\,max}$	$V_{g\,max}$ = $V_{g\,max}$ to 0.8 $V_{g\,max}$	**1**
	$V_{g\,max}$ > 0.4 $V_{g\,max}$ to 0.8 $V_{g\,max}$	$V_{g\,max}$ = $V_{g\,max}$ to 0.8 $V_{g\,max}$	**2**

● = Available ○ = On request – = Not available

1) Hirschmann connector Standard
2) Fitted as standard with version D
3) Please specify exact settings for $V_{g\,min}$ and $V_{g\,max}$ in plain text when ordering: $V_{g\,min}$ = ... in^3 (cm^3), $V_{g\,max}$ = ... in^3 (cm^3)

01	02	03	04	05	06	07	08		09	10	11		12	13	14	15	16	17	18	19		20
	AA6V		**M**	**250**				**/**	**63**	**W**		**–**	**V**	**S**	**D**						**–**	

Sealing material

12	FKM (fluoroelastomer)	**V**

Drive shaft

13	Splined shaft ANSI B92.1a	**S**

Mounting flange

14	SAE J744 – 4-bolt 165-4	**D**

Working port[4)]

15	SAE working ports **A** and **B** at rear	**51**	**0**	●	**510**
			7	●	**517**
	SAE working ports **A** and **B** at side, opposite	**52**	**0**	●	**520**
			7	●	**527**

Valves (see page 27)

Without valve	**0**
Flushing and boost-pressure valve, mounted	**7**

Speed sensor (see page 29)

16	Without speed sensor (without code)		
	Prepared for HDD speed sensor	▲	**F**
	HDD speed sensor mounted[5)]	▲	**H**

Swivel angle sensor (see page 28)

17	Without swivel angle sensor (without code)	
	Optical swivel angle sensor	**V**
	Electric swivel angle sensor	**E**

Beginning of control

18	At $V_{g\,min}$ (standard for HA)	**A**
	At $V_{g\,max}$ (standard for HD, HZ, EP, EZ, DA)	**B**

Standard / special version

19	Standard version	**0**
	Special version	**-S**

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

Notices

- Note the project planning notes on page 32.
- When ordering, please provide the relevant technical data additionally to the type code.

4) Fastening threads, SAE

5) Specify type code separately for sensor in accordance with data sheet 95135 – HDD and observe the requirements for 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 (HFAE, HFAS, HFB, HFC)
- 90225: Axial piston units for operation with water-free and water-containing fire-resistant hydraulic fluids (HFDR, HFDU, HFB, HFC).

Notes on selection of hydraulic fluid

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

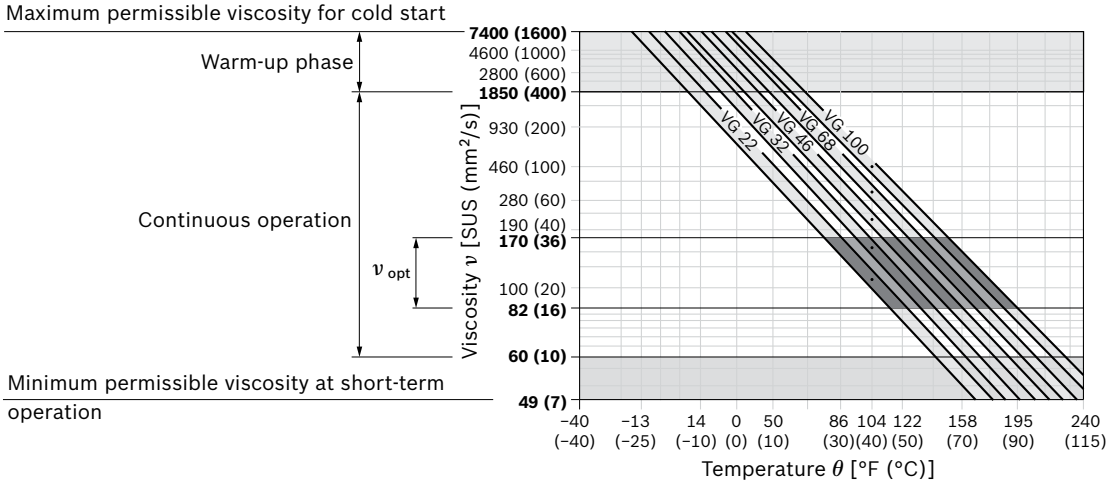
Notice

- 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.
- At no point of the component may the temperature be higher than 239 °F (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 27).

Viscosity and temperature of hydraulic fluids

	Viscosity	Shaft seal	Temperature[2]	Comment
Cold start	v_{max} ≤ 7400 SUS (1600 mm²/s)	FKM	θ_{St} ≥ −40 °F (−40 °C) θ_{St} ≥ −13 °F (−25 °C)	t ≤ 3 min, without load p ≤ 725 psi (p ≤ 50 bar), n ≤ 1000 rpm, permissible temperature difference between axial piston unit and hydraulic fluid in the system max. 45 °F (25 K)
Warm-up phase	v < 7400 ... 1850 SUS (1600 ... 400 mm²/s)			t ≤ 15 min, p ≤ 0,7 × p_{nom} and n ≤ 0,5 × n_{nom}
Continuous operation	v = 1850 ... 47 SUS (400 ... 10 mm²/s)[1]	FKM	θ ≤ +185 °F (+85 °C) θ ≤ +217 °F (+103 °C)	measured at port **T**
	v_{opt} = 16 ... 81 SUS (36 ... 16 mm²/s)			Range of optimum operating viscosity and efficiency
Short-term operation	v_{min} = 60 ... 49 SUS (10 ... 7 mm²/s)	FKM	θ ≤ +185 °F (+85 °C) θ ≤ +217 °F (+103 °C)	t ≤ 3 min, p ≤ 0,3 × p_{nom}, measured at port **T**

▼ **Selection diagram**



1) Corresponds e.g. with VG 46 a temperature range of +39 °F to +185 °F (+4 °C to +85 °C)(see selection diagram)

2) If the temperature to extreme operating parameters can not be met, please contact us.

Filtration of the hydraulic fluid

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

At very high hydraulic fluid temperatures (195 °F (90 °C) to maximum 217 °F (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 when using the following control options:

- HD, EP, HA, HA.T: 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} = 15 psi (1 bar) case pressure.

Flow direction

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

Bearing

Long-life bearing

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
$q_{v\,flush}$ [gmp (l/min)]	2.6 (10)

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

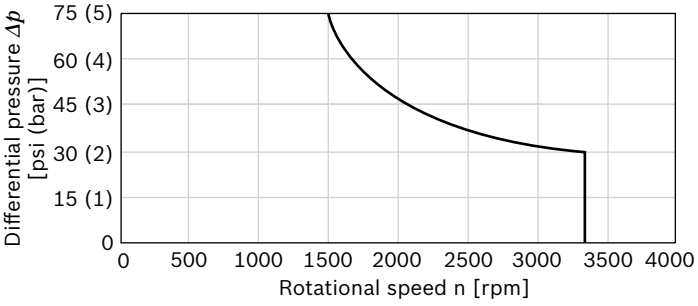
Shaft seal

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 145 psi (10 bar) are allowed. Case pressures of a continuous 30 psi (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.

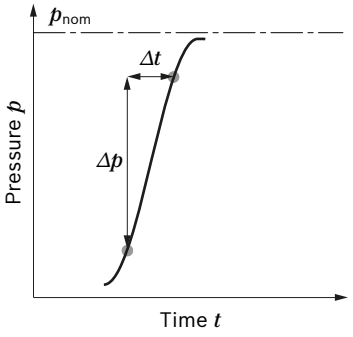


The FKM shaft seal ring may be used for leakage temperatures from -13 °F to +240 °F (-25 °C to +115 °C). For application cases below -13 °F (-25 °C), an NBR shaft seal is required (permissible temperature range: -40 °F to +195 °F (-40 °C to +90 °C).

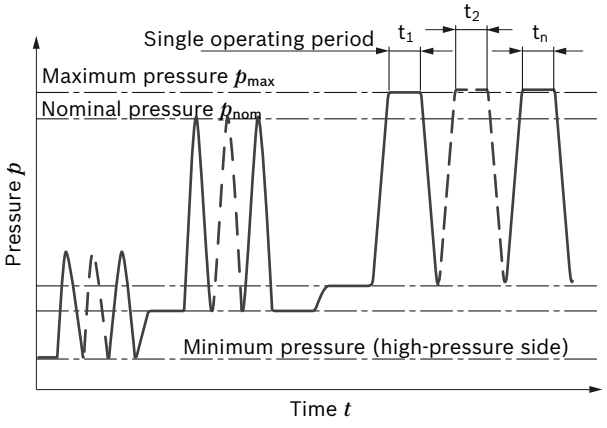
Operating pressure range

Pressure at working port A or B		Definition
Nominal pressure p_{nom}	5100 psi (350 bar)	The nominal pressure corresponds to the maximum design pressure.
Maximum pressure p_{max}	5800 psi (400 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)	365 psi (25 bar)	Minimum pressure at the high-pressure side (**A** or **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 working 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 **A** + pressure **B**)	10150 psi (700 bar)	The summation pressure is the sum of the pressures at both working ports (**A** and **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	130530 psi/s (9000 bar/s)	
Without pressure-relief valve	232060 psi/s (16000 bar/s)	

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

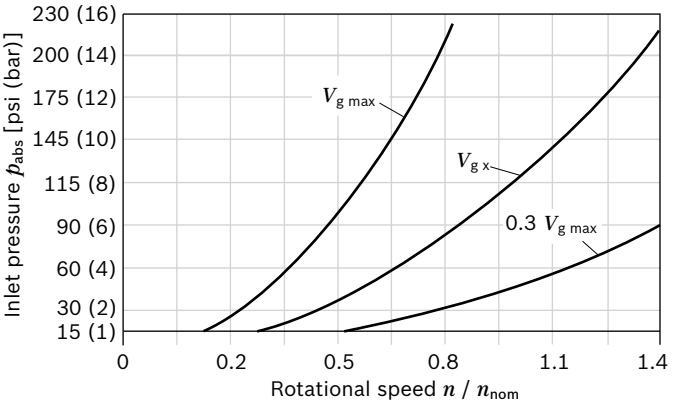


▼ **Pressure definition**



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

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



This diagram is valid only for the optimum viscosity range from v_{opt} = 170 to 73 SUS (36 to 16 mm²/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		250
Displacement geometric, per revolution[1]		$V_{g\,max}$	in³	15.26
			cm³	250
		$V_{g\,min}$	in³	0
			cm³	0
		$V_{g\,x}$	in³	12.51
			cm³	205
Maximum rotational speed[2] (while adhering to the maximum permissible inlet flow)	at $V_{g\,max}$	n_{nom}	rpm	2700
	at $V_g < V_{g\,x}$ (see diagram)	n_{max}	rpm	3300
	at $V_{g\,0}$	n_{max}	rpm	Please contact us
Inlet flow	at n_{nom} and $V_{g\,max}$	$q_{v\,max}$	gpm	178
			l/min	675
Torque[3]	at $V_{g\,max}$ and Δp = 5800 psi (400 bar)	T	lb-ft	-
			Nm	-
	at $V_{g\,max}$ and Δp = 5100 psi (350 bar)		lb-ft	1026
			Nm	1391
Rotary stiffness	$V_{g\,max}$ to $V_g/2$	c_{min}	lb-ft/rad	
			kNm/rad	60
	$V_g/2$ to 0 (interpolated)	c_{min}	lb-ft/rad	
			kNm/rad	181
Moment of inertia for rotary group		J_{TW}	lb-ft²	1.448
			kgm²	0.061
Maximum angular acceleration		α	rad/s²	10000
Case volume		V	gal	0.79
			l	3.0
Weight, approx.		m	lbs	220
			kg	100

Notes

- 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.

Determining the operating characteristics

Inlet flow	$q_v = \frac{V_g \times n}{231 \times \eta_v}$	[gpm]	$\left(\frac{V_g \times n}{1000 \times \eta_v}\right)$ [l/min]
Rotational speed	$n = \frac{q_v \times 231 \times \eta_v}{V_g}$	[rpm]	$\left(\frac{q_v \times 1000 \times \eta_v}{V_g}\right)$ [rpm]
Torque	$T = \frac{V_g \times \Delta p \times \eta_{mh}}{24 \times \pi}$	[lb-ft]	$\left(\frac{V_g \times \Delta p \times \eta_{mh}}{20 \times \pi}\right)$ [Nm]
Power	$P = \frac{2\pi \times T \times n}{33000} = \frac{q_v \times \Delta p \times \eta_t}{1714}$	[HP]	$\left(\frac{2\pi \times T \times n}{60000} = \frac{q_v \times \Delta p \times \eta_t}{600}\right)$ [kW]

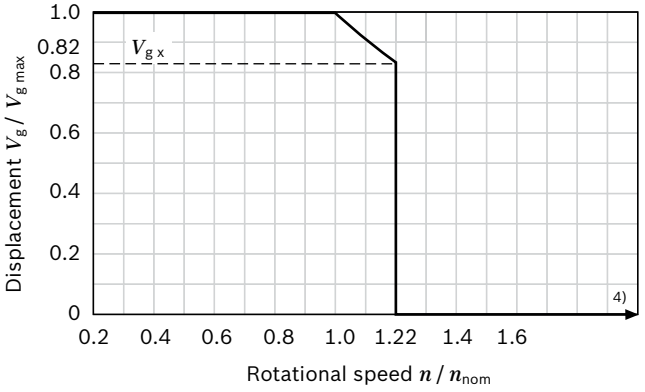
Key

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

Speed range

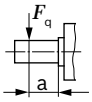
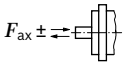
The minimum rotational speed n_{min} is not restricted. Please consult us regarding applications requiring uniformity of the rotatory motion at low speeds.

▼ **Permissible displacement in relation to speed**



1) The minimum and maximum displacement can be steplessly adjusted, see type code on page 2. (standard setting if ordering code is missing: $V_{g\,min}$ = 0.2 × $V_{g\,max}$, $V_{g\,max}$ = $V_{g\,max}$).
2) The values are applicable:
   – for the optimum viscosity range from ν_{opt} = 170 to 75 SUS (36 to 16 mm²/s)
   – with hydraulic fluid based on mineral oils
3) Torque without radial force, with radial force, see page 8.
4) Values in this range on request

Permissible radial and axial forces of the drive shafts

Size		NG		250
Drive shaft		DIA	in	2
Maximum radial force at distance a (from shaft collar)		$F_{q\,max}$	lb	270[1)]
			N	1200[1)]
		a	in	1.32
			mm	33.5
Maximum torque at $F_{q\,max}$		$T_{q\,max}$	lb-ft	2)
			Nm	2)
Maximum differential pressure at V_{gmax} and $F_{q\,max}$		$\Delta p_{q\,max}$	psi	2)
			bar	2)
Maximum axial force at standstill or depressurized operation		$+F_{ax\,max}$	lb	0
			N	0
		$-F_{ax\,max}$	lb	270
			N	1200
Permissible axial force per psi (bar) working pressure		$+F_{ax\,perm/bar}$	lb/psi	2)
			N/bar	2)

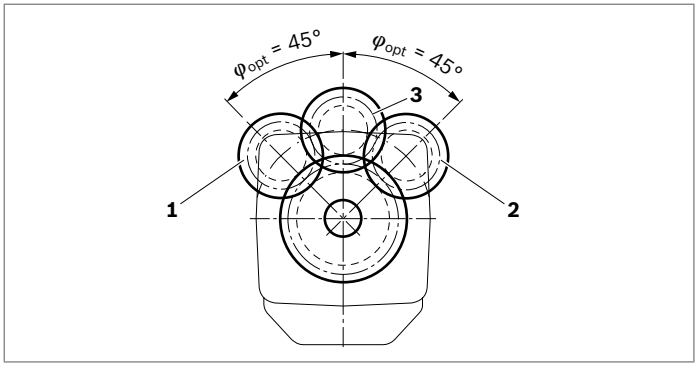
Notices

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

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. Example:

▼ **Toothed gear output drive**



1 Direction of rotation "counter-clockwise", pressure at port **B**
2 Direction of rotation "clockwise", pressure at port **A**
3 Bidirectional direction of rotation

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} = 1450 psi (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 435 psi (30 bar) is necessary in **A** (**B**). If a control operation is performed at an working pressure < 435 psi (30 bar), an auxiliary pressure of at least 435 psi (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 5800 psi (400 bar) can occur.
- Specify the desired beginning of control in plain text when ordering, e.g.: beginning of control at 145 psi (10 bar).
- The beginning of control and the HD-characteristic curve are influenced by the case pressure. An increase in the case pressure causes an increase in the beginning of control (see page 5) and thus a parallel displacement of the characteristic curve.
- A leakage flow of maximum 0.08 gpm (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 influences the stroking behavior of the motor and consequently the machine response time.

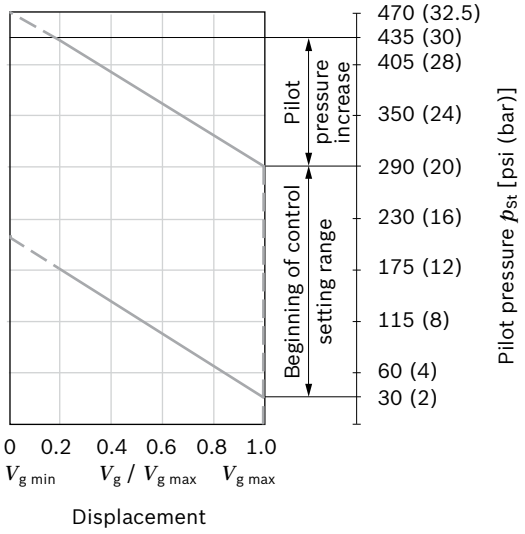
Standard

HD1, HD2 and HD3 with orifice (DIA0.0472 in (ø 1.2 mm))
HD.D, HD.E, HD.G with adjustable response time limiting valve

HD1, pilot pressure increase Δp_{St} = 145 psi (10 bar)

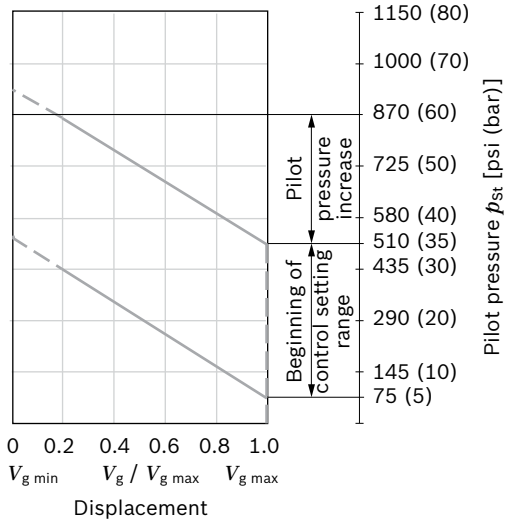
A pilot pressure increase of 145 psi (10 bar) at port **X** will cause a reduction in displacement from $V_{g\,max}$ to 0.2 $V_{g\,max}$.
Beginning of control, setting range 30 to 290 psi (2 to 20 bar)
Standard setting: beginning of control at 45 psi (3 bar) (end of control at 190 psi (13 bar))

▼ **Characteristic curve HD1**



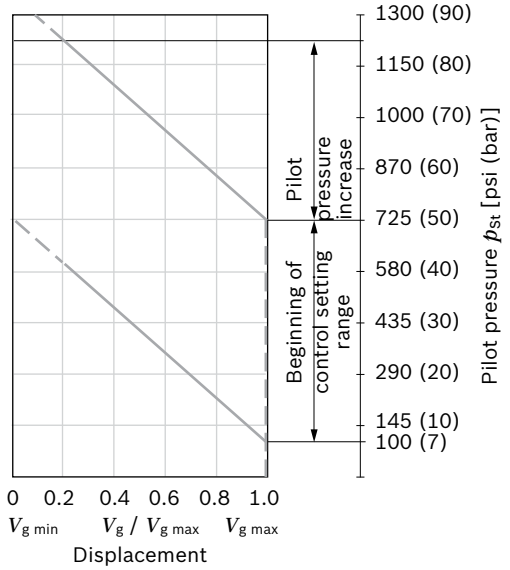
HD2, pilot pressure increase Δp_{St} = 365 psi (25 bar)
A pilot pressure increase of 365 psi (25 bar) at port **X** results in displacement from $V_{g\,max}$ to 0.2 $V_{g\,max}$.
Beginning of control, setting range 75 to 510 psi (5 to 35 bar)
Standard setting: beginning of control at 145 psi (10 bar)
(end of control at 510 psi (35 bar))

▼ **Characteristic curve HD2**

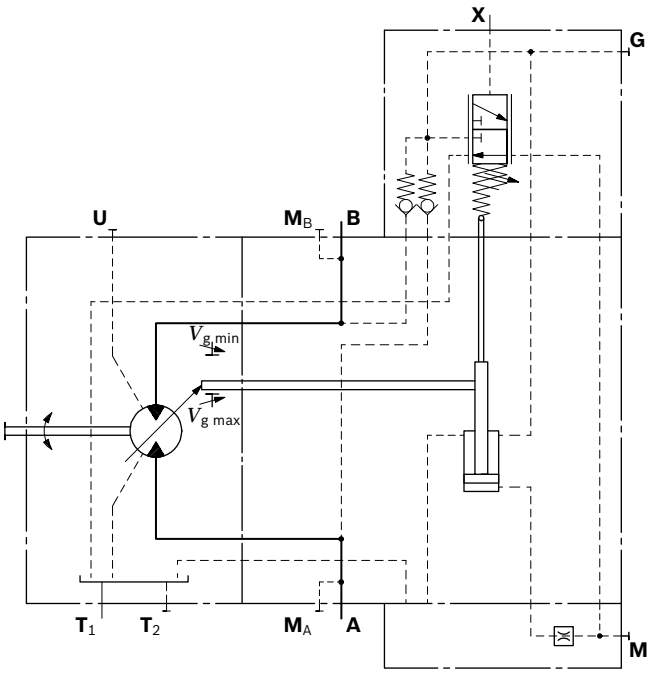


HD3, pilot pressure increase Δp_{St} = 510 psi (35 bar)
A pilot pressure increase of 510 psi (35 bar) at port **X** results in displacement from $V_{g\,max}$ to 0.2 $V_{g\,max}$.
Beginning of control, setting range 100 to 725 psi (7 to 50 bar)
Standard setting: beginning of control at 145 psi (10 bar)
(end of control at 650 psi (45 bar))

▼ **Characteristic curve HD3**



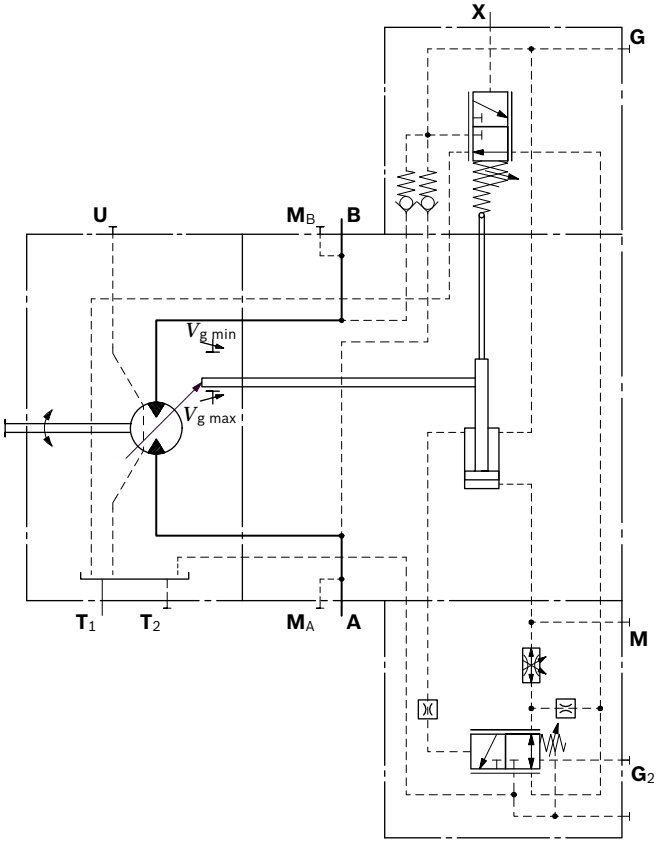
▼ **Circuit diagram HD1, HD2, HD3**



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.
Setting range of the pressure control valve 1150 to 5100 psi (80 to 350 bar)

▼ **Circuit diagram HD.D**



HD.E pressure control, hydraulic override

Pressure control with 2nd pressure setting for HD.D provided as standard.
The pressure control setting can be overridden by applying an external pilot pressure at port **G**$_2$, realizing a 2nd pressure setting.
Necessary pilot pressure at port **G**$_2$: p_{St} ≥ 1900 psi (130 bar)
When ordering, please specify the 2nd pressure setting in plain text.

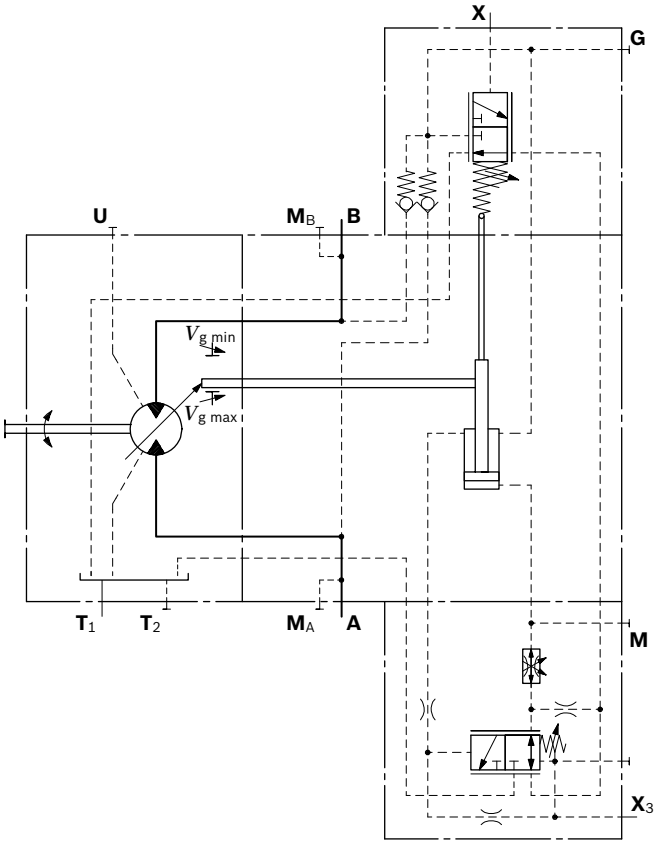
HD.G pressure control, remote controlled

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**$_3$, 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 1150 psi (80 bar) and 5100 psi (350 bar). When the pressure command value is reached at the separate pressure-relief valve, this will open, reliving 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 365 psi (25 bar). As a separate pressure relief valve, we recommend: DBD 6 (hydraulic) as per data sheet 25402; maximum line length should not exceed 6 ft (2 m).

▼ **Circuit diagram HD.G**



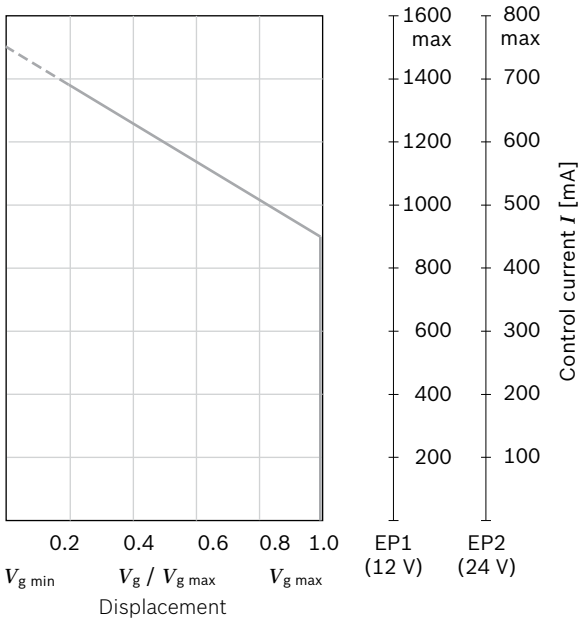
EP – Proportional control, electric

The electric control with proportional valve enable the displacement to be steplessly adjusted. Control is proportional to the electric control current applied to the solenoid.

An external pressure of p_{min} = 435 psi (30 bar) is require for the pilot oil supply to port **P** (p_{max} = 1450 psi (100 bar).

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

▼ **Characteristic curve EP**



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 435 psi (30 bar) is necessary in **A** (**B**). If a control operation is performed at an working pressure < 435 psi (30 bar), an auxiliary pressure of at least 435 psi (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 5800 psi (400 bar) can occur.
- The following only needs to be note:
  - 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 5) and thus a parallel displacement of the characteristic curve.

Response time damping

The response time damping influences the stroking behavior of the motor and consequently the machine response time.

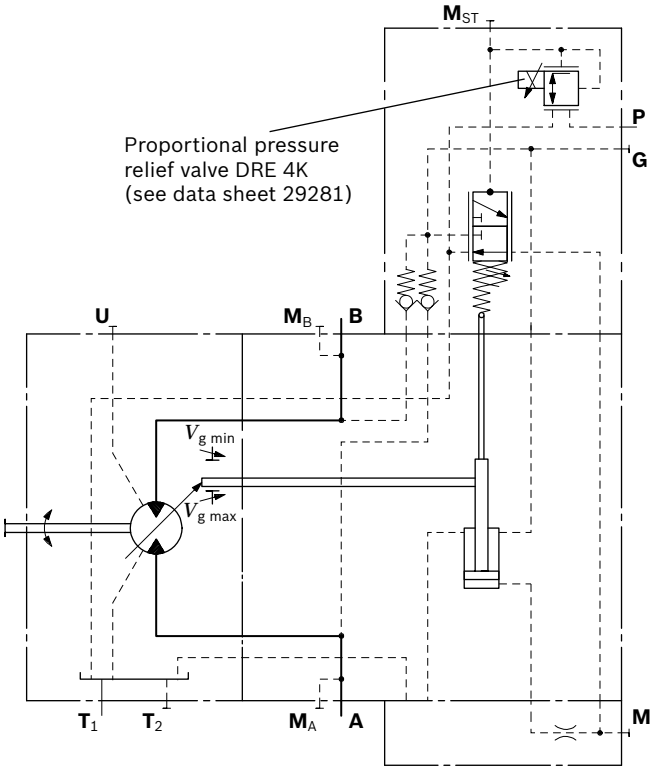
Standard

EP1, EP2 with orifice (DIA0.047 in (ø1.2 mm))

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

Technical data, proportional valve	EP1	EP2
Voltage	12 V (±20 %)	24 V (±20 %)
Control current		
Beginning of control	900 mA	450 mA
End of control	approx. 1360 mA	approx. 680 mA
Current limit	2.2 A	1.00 A
Nominal resistance (at 68 °F (20 °C))	2.4 Ω	12 Ω
Dither		
Frequency	100 Hz	100 Hz
minimum oscillation range[1)]	240 mA	120 mA
Duty cycle	100 %	100 %
See also proportional pressure reducing valve DRE 4K (data sheet 29281 – proportional pressure reducing valve)		

▼ **Circuit diagram EP**

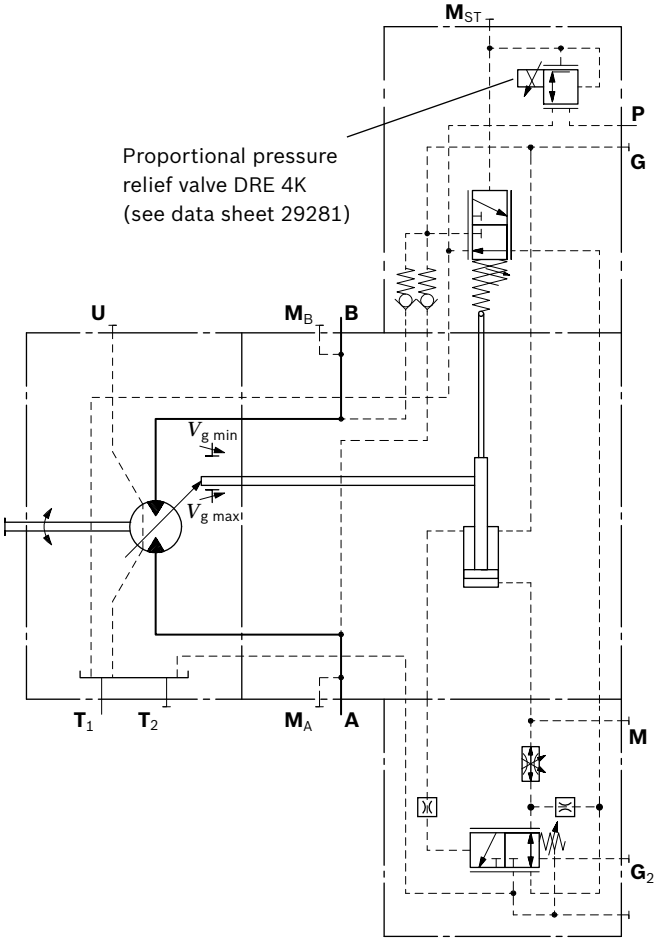


1) Setting

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.
Setting range of the pressure control valve 1150 to 5100 psi (80 to 350 bar)

▼ **Circuit diagram EP.D**



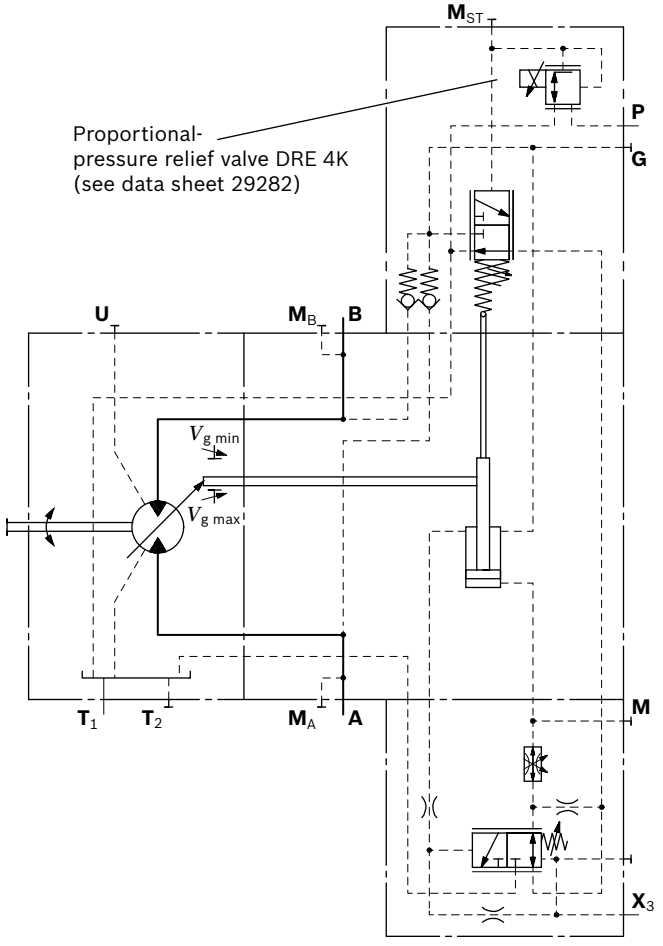
EP.E pressure control, hydraulic override, two-point
Sizes 250 (EP.D)

Pressure control with 2nd pressure setting for EP.D provided as standard (see EP.D).
The pressure control setting can be overridden by applying an external pilot pressure at port G_2, realizing a 2nd pressure setting.
Necessary pilot pressure at port G_2:
$p_{St} \geq 1900$ psi (130 bar)
When ordering, please specify the 2nd pressure setting in plain text.

EP.G pressure control, remote controlled

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_3**, 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 1145 psi (80 bar) and 5100 psi (350 bar). When the pressure command value is reached at the separate pressure-relief valve, this will open, reliving 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 365 psi (25 bar). As a separate pressure relief valve, we recommend: DBD 6 (hydraulic) as per data sheet 25402; maximum line length should not exceed 6 ft (2 m).

▼ **Circuit diagram EP.G**

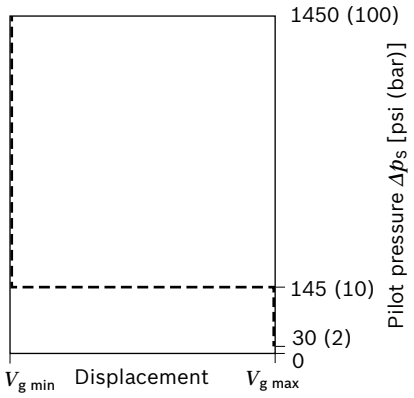


HZ – Two-point control, hydraulic

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 145 psi (10 bar) switched on, minimum torque, maximum permissible rotational speed)

▼ **Characteristic curve HZ**



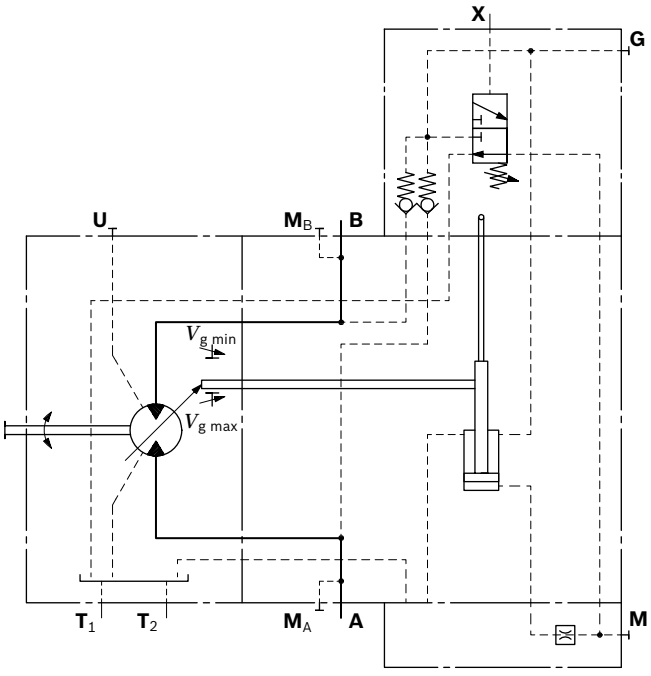
Notice

- Maximum permissible pilot pressure: 1450 psi (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 435 psi (30 bar) is necessary in **A** (**B**).
  If a control operation is performed at a working pressure < 435 psi (30 bar), an auxiliary pressure of at least 435 psi (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 5800 psi (400 bar) can occur.
- A leakage flow of maximum 0.08 gpm (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 influences the stroking behavior of the motor and consequently the machine response time.
Standard with orifice (DIA0.047 in (ø1.2 mm))

▼ **Circuit diagram HZ**



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 to a switching on or off.

Notice

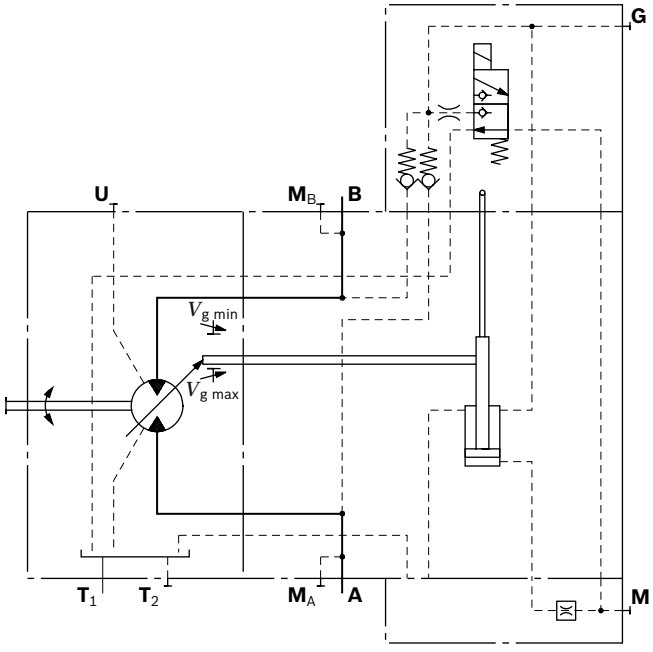
The control oil is internally taken out of the high pressure side of the motor (**A** or **B**). For reliable control, an operating pressure of at least 435 psi (30 bar) is required in **A** (**B**). If a control operation is performed at a working pressure < 435 psi (30 bar), an auxiliary pressure of at least 435 psi (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 5800 psi (400 bar) can occur.

Response time damping

The response time damping influences the stroking behavior of the motor and consequently the machine response time.
Standard with orifice (DIA0.047 in (ø1.2 mm))

Technical data, on/off valve	EZ1	EZ2
Voltage	12 V (±20%)	24 V (±20%)
Position $V_{g\,max}$	de-energized	de-energized
Position $V_{g\,min}$	energized	energized
Nominal resistance (at 20 °C)	6 Ω	23 Ω
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 EZ**



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 435 psi (30 bar) is necessary in **A** (**B**). If a control operation is performed at a working pressure < 435 psi (30 bar), an auxiliary pressure of at least 435 psi (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 5800 psi (400 bar) 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 5) and thus a parallel displacement of the characteristic curve. Only for HA1, HA2 and HA.T.
- A leakage flow of maximum 0.08 gpm (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 influences the stroking behavior of the motor and consequently the machine response time.
Standard with orifice (DIA0.047 in (ø1.2 mm))

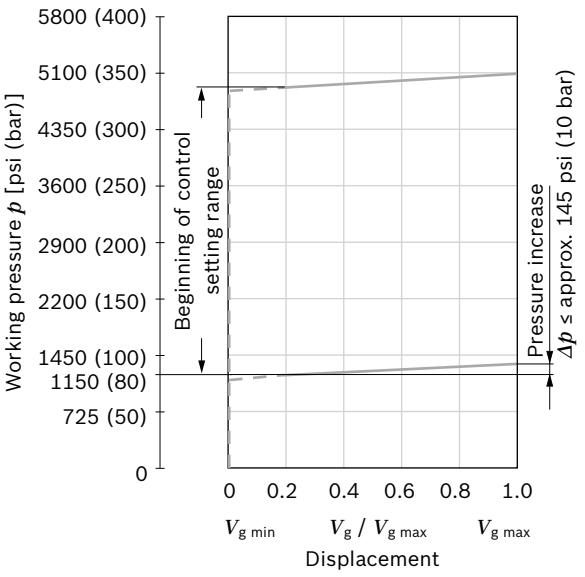
HA1 with minimum pressure increase, positive control

A working pressure increase of Δp ≤ approx. 145xpsi (10 bar) results in an increase in displacement from $V_{g\,min}$ to $V_{g\,max}$.
Setting range of the pressure control 1150 to 4950 psi (80 to 340 bar)
Please state the desired beginning of control in plain text when ordering, e.g.: beginning of control at 4350 psi (300 bar).

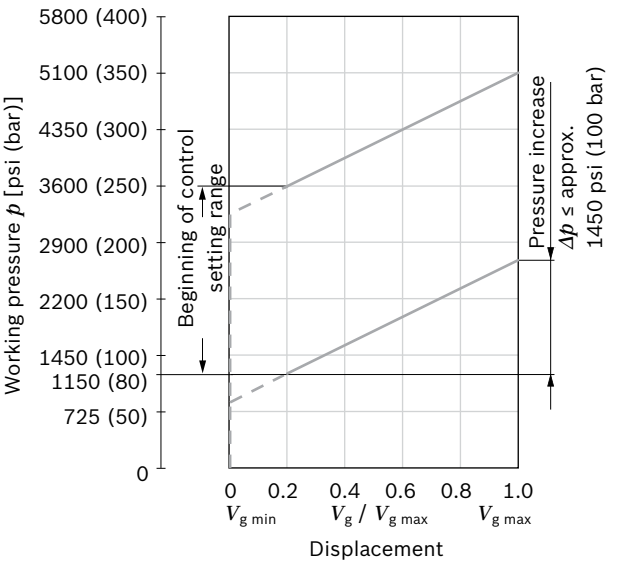
HA2 with pressure increase, positive control

A working pressure increase of Δp ≤ approx. 1450 psi (100 bar) results in an increase in displacement from $V_{g\,min}$ to $V_{g\,max}$.
Setting range of the pressure control valve 1150 to 5100 psi (80 to 350 bar)
Please state the desired beginning of control in plain text when ordering, e.g.: beginning of control at 2900 psi (200 bar)

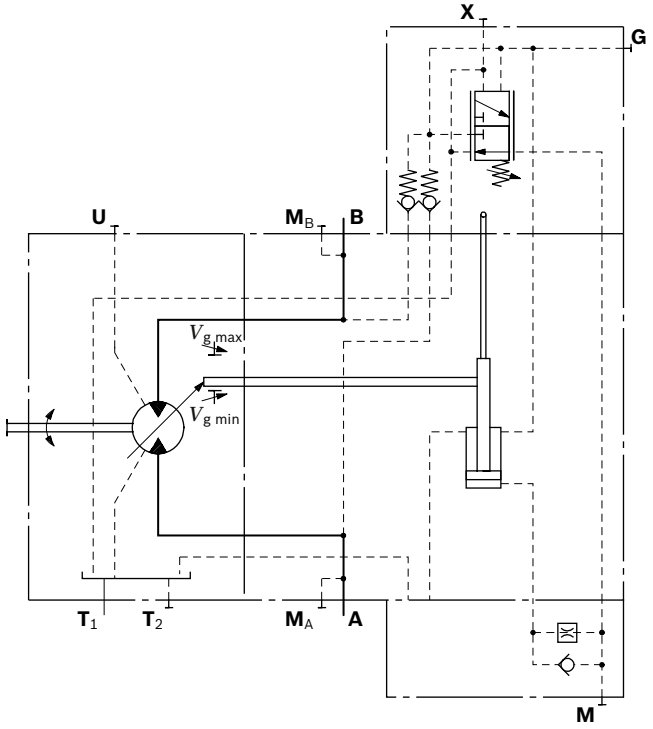
▼ **Characteristic curve HA1**



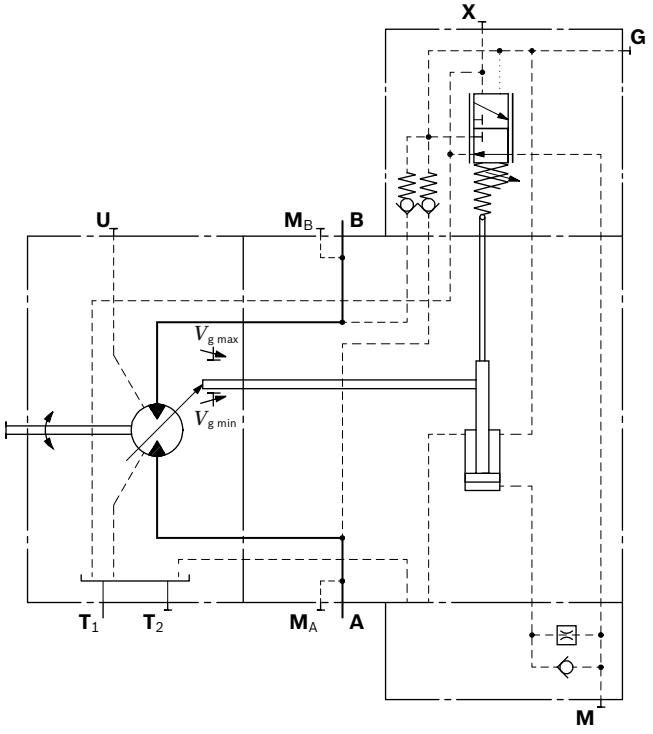
▼ **Characteristic curve HA2**



▼ **Circuit diagram HA1**



▼ **Circuit diagram HA2**

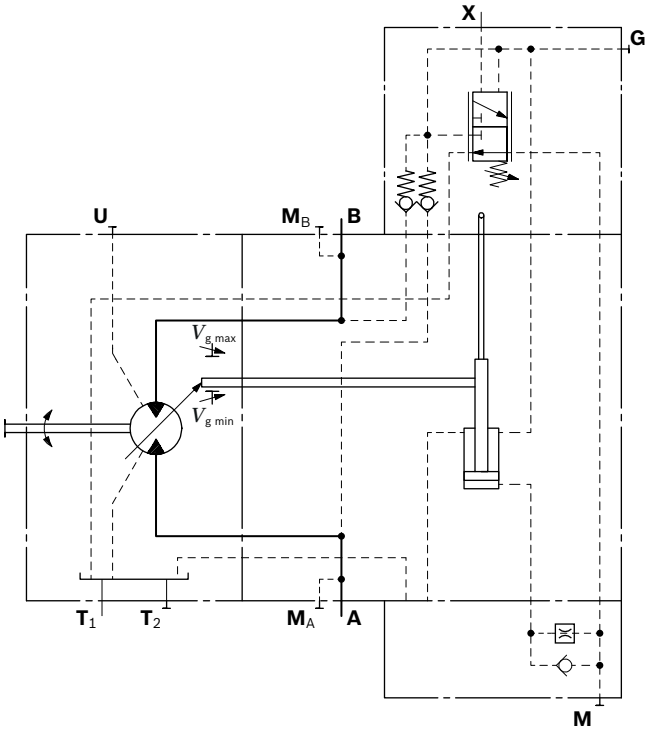


HA.T hydraulic override, remote control, proportional
With the HA.T3 control, the beginning of control can be applying a pilot pressure to port **X**.
For every 15 psi (1 bar) of pilot pressure, the beginning of control is reduced by 130 psi (9 bar).

Settings for the beginning of control	4350 psi (300 bar)	4350 psi (300 bar)
Pilot pressure at port **X**	0 psi (0 bar)	145 psi (10 bar)
Beginning of control at	4350 psi (300 bar)	1900 psi (130 bar)

Notice
Maximum permissible pilot pressure 1450 psi (100 bar).

▼ **Circuit diagram HA1T**



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

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.
Detailed information is available from our sales department.

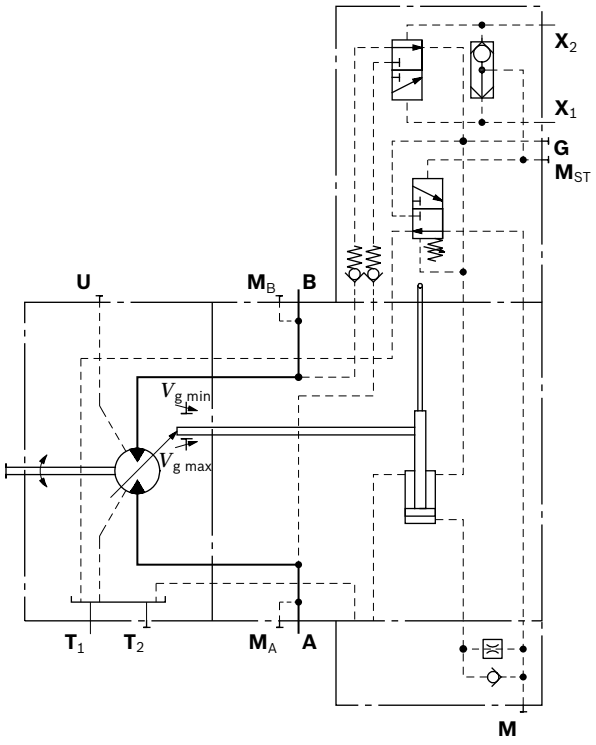
Notice
The beginning of control and the DA characteristic curve are influenced by case pressure. An increase in the case pressure causes a decrease / reduction in the beginning of control (see page 5) and thus a parallel displacement of the characteristic curve.

Response time damping
The response time damping influences the stroking behavior of the motor and consequently the machine response time.
Standard with orifice (DIA0.047 in (ø1.2 mm))

DA hydraulic travel direction valve,
Dependent on the direction of rotation (travel direction), the travel direction valve is switched by using pilot pressures $\mathbf{X_1}$ or $\mathbf{X_2}$. The maximum permissible pilot pressure is p_{st} = 365 psi (25 bar). Momentary (t < 0.1 s) pressure peaks of up to 580 psi (40 bar) are permitted.

Direction of rotation	Working pressure in	Pilot pressure in
clockwise	**A**	$\mathbf{X_1}$
counter-clockwise	**B**	$\mathbf{X_2}$

▼ **Circuit diagram DA**

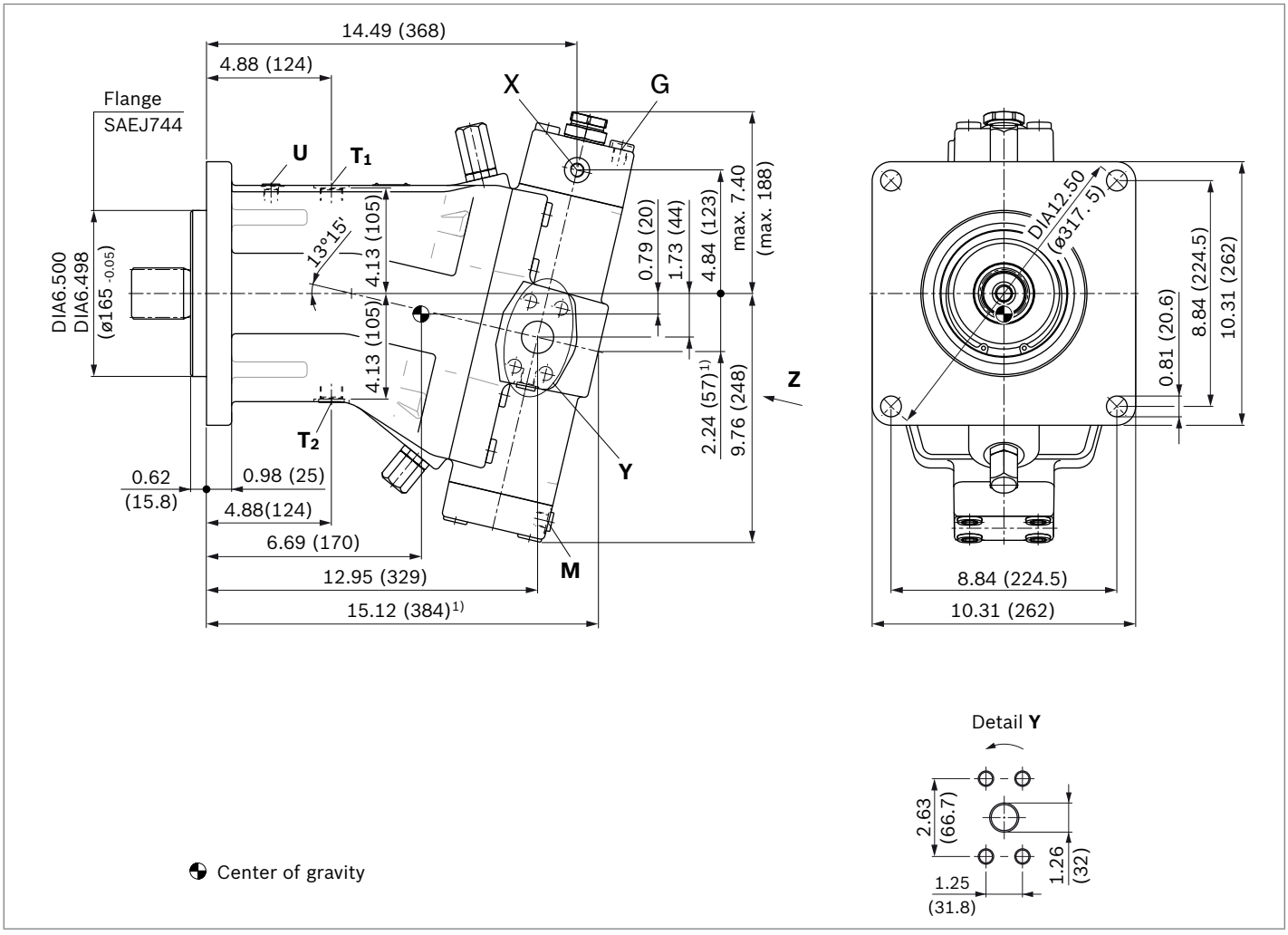


Dimensions size 250

HD1, HD2 – Proportional control, hydraulic

HZ – Two-point control, hydraulic

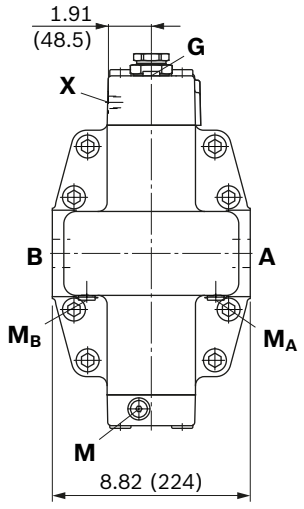
Port plate 52 — SAE working ports **A** and **B** at side, opposite



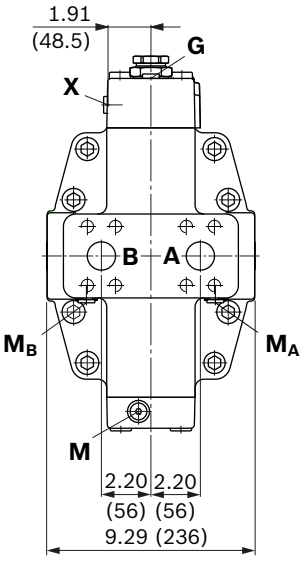
1) Port plate 51 — SAE working ports **A** and **B** at rear

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

52 SAE working port **A** and **B** at lateral, opposite

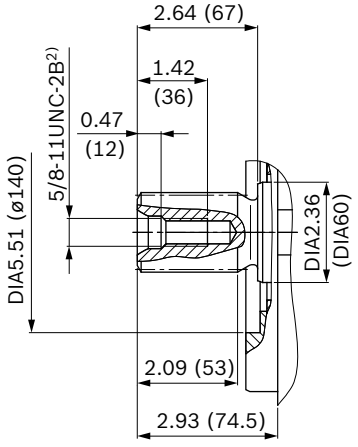


51 SAE working port **A** and **B** at rear



▼ **Splined shaft SAE J744**

S – 2 in 15T 8/16DP[1)]



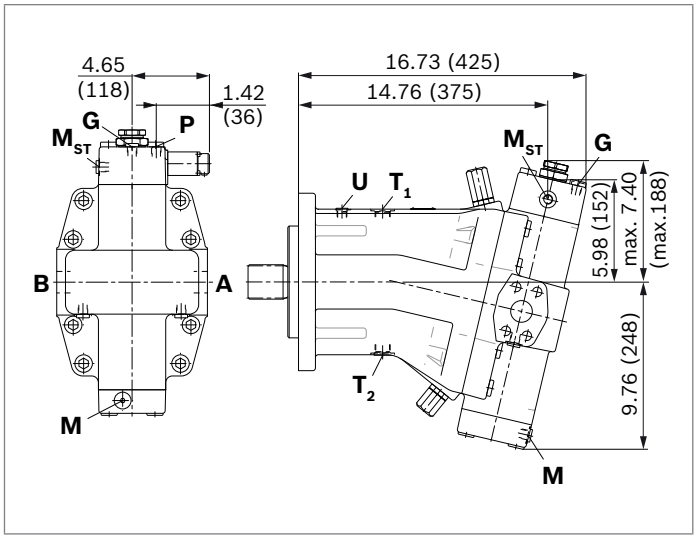
1) Involute toothing acc. to ANSI B92.1a, 30° pressure angle, flat root, side fit, tolerance class 5

2) Thread according to ASME B1.1

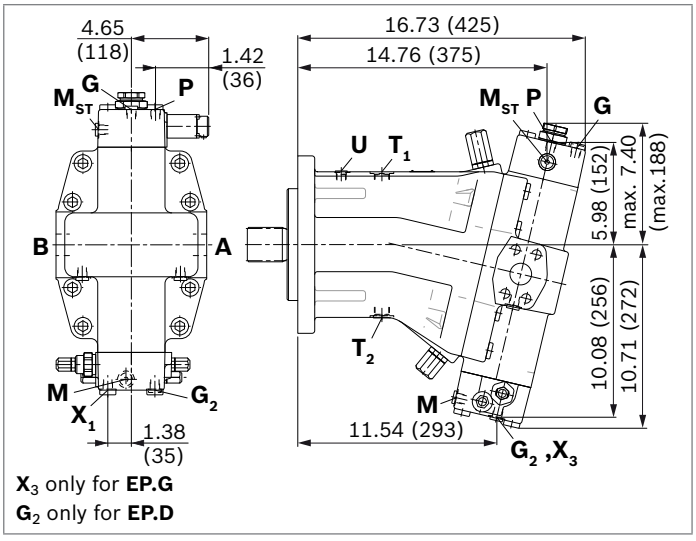
Ports		Standard	Size	p_{max} [psi (bar)][1]	Status[6]
A, B[4]	Working port Fastening thread A/B	SAE J518[2] ASME B1.1	1 1/4 in 1/2 in -13 UNC-2B; 0.75 (19) deep	5800 (400)	O
T_1	Drain port	ISO 11926[5]	7/8 in -14 UN-2B; 0.67 (17) deep	45 (3)	O[3]
T_2	Drain port	ISO 11926[5]	7/8 in -12 UN-2B; 0.67(17) deep	45 (3)	X[3]
G	Synchronous control	ISO 11926[5]	9/16 in -18 UNF-2B; 0.51 (13) deep	5800 (400)	X
G_2	2nd pressure setting (HD.D, EP.D)	ISO 11926[5]	9/16 in -18 UNF-2B; 0.51 (13) deep	5800 (400)	X
P	Pilot oil supply (EP)	ISO 11926[5]	9/16 in -18 UNF-2B; 0.51 (13) deep	1450 (100)	O
U	Bearing flushing	ISO11926[5]	9/16 in -14 UNF-2B; 0.67 (17) deep	45 (3)	X
X	Pilot signal (HD, HZ, HA1T/HA2T)	ISO 11926[5]	9/16 in -18 UNF-2B; 0.51 (13) deep	1450 (100)	O
X	Pilot signal (HA1, HA2)	ISO 11926[5]	9/16 in -18 UNF-2B; 0.51 (13) deep	45 (3)	X
X_1, X_2	Pilot signal (DA)	DIN 2353-CL	8B-ST	580 (40)	O
X_3	Pilot signal (HD.G, EP.G)	ISO 11926[5]	9/16 in -18 UNF-2B; 0.51 (13) deep	5800 (400)	O
M	Stroking chamber measurement	ISO 11926[5]	9/16 in -18 UNF-2B; 0.51 (13) deep	5800 (400)	X
M_A, M_B	Pressure measurement Measuring port pressure A, B	ISO 11926[5]	9/16 in -18 UNF-2B; 0.51 (13) deep	5800 (400)	X
M_{ST}	Pilot pressure measurement (EP, DA)	ISO 11926[5]	9/16 in -18 UNF-2B; 0.51 (13) deep	5800 (400)	X

1) Momentary pressure spikes may occur depending on the application. Keep this in mind when selecting measuring devices and fittings.
2) Only dimensions according to SAE J518.
3) Depending on installation position, T_1 or T_2 must be connected (see also installation instructions on page 30).
4) For the maximum utilization of pressure, only grade 8 screws and hardened washers are to be used to tighten the SAE flange shells.
5) The spot face can be deeper than as specified in the standard.
6) O = Must be connected (plugged on delivery)
X = Plugged (in normal operation)

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

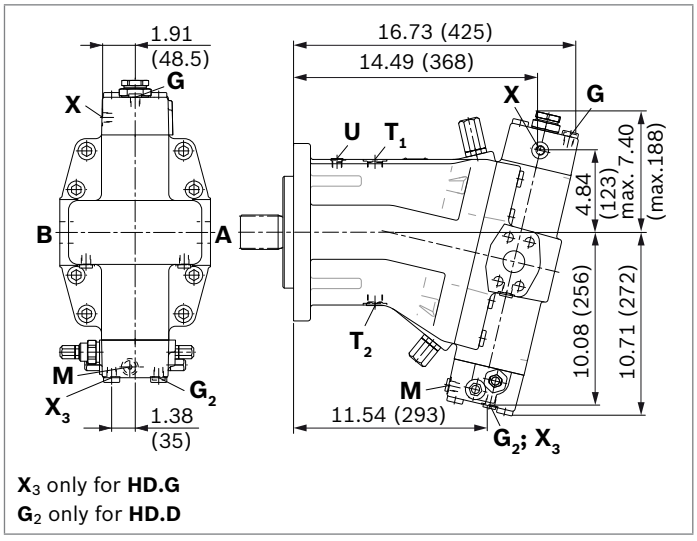


▼ **EP.D, EP.P** – Proportional control, electric
with pressure control fixed setting; remote controlled (EP.G)



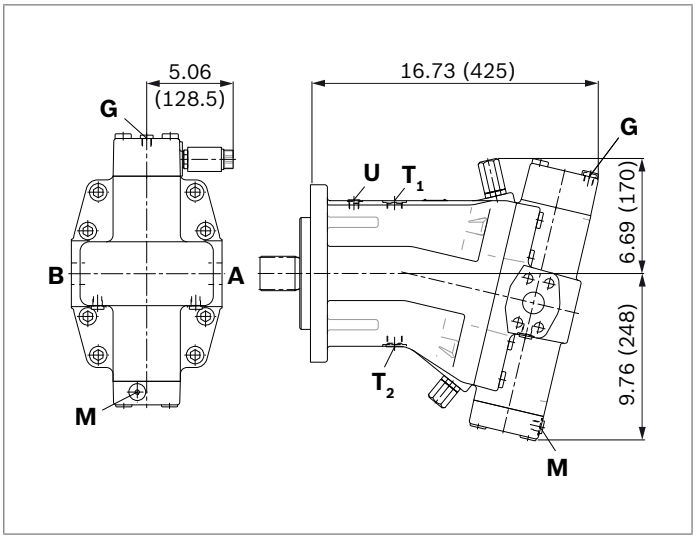
X_3 only for **EP.G**
G_2 only for **EP.D**

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

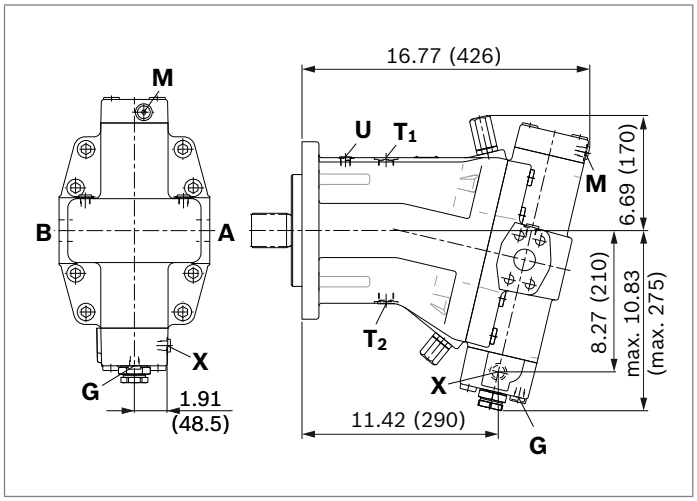


X_3 only for **HD.G**
G_2 only for **HD.D**

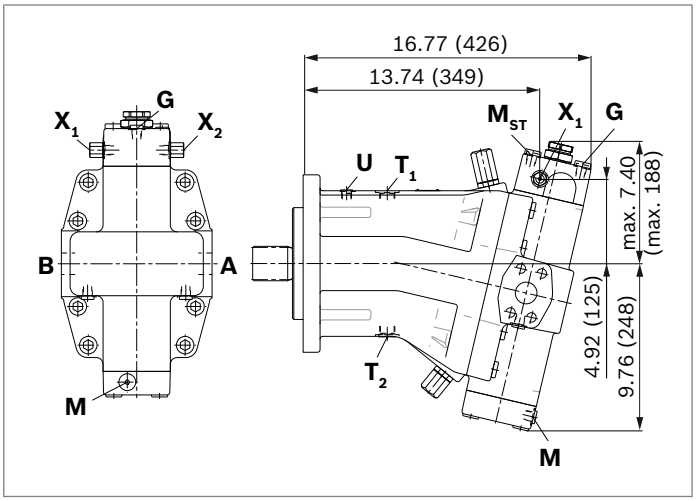
▼ **EZ1, EZ2** – Two-point control, electric



▼ **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



Connector for solenoids

HIRSCHMANN DIN EN 175 301-803-A/ISO 4400
Without bidirectional suppressor diode
Type of protection:
- IP65 (DIN/EN 60529)

The seal ring in the cable fitting is suitable for lines of diameter 0.18 in to 0.39 in (4.5 mm to 10 mm).
The mating connector is included in the scope of delivery.

Notice
- If necessary, you can change the position of the connector by turning the solenoid.
- The procedure is defined in the operating instructions.

Flushing and boost pressure valve

The flushing and boost pressure valve is used to remove heat from a closed hydraulic circuit and for flushing the motor housing.
It is also a safeguarding the minimum boost pressure. In open loops it only used for flushing the motor housing. 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.

Cracking pressure of pressure retaining valve
(observe when adjusting the primary valve)

- fixed setting 230 psi (16 bar)

Switching pressure of flushing spool Δp

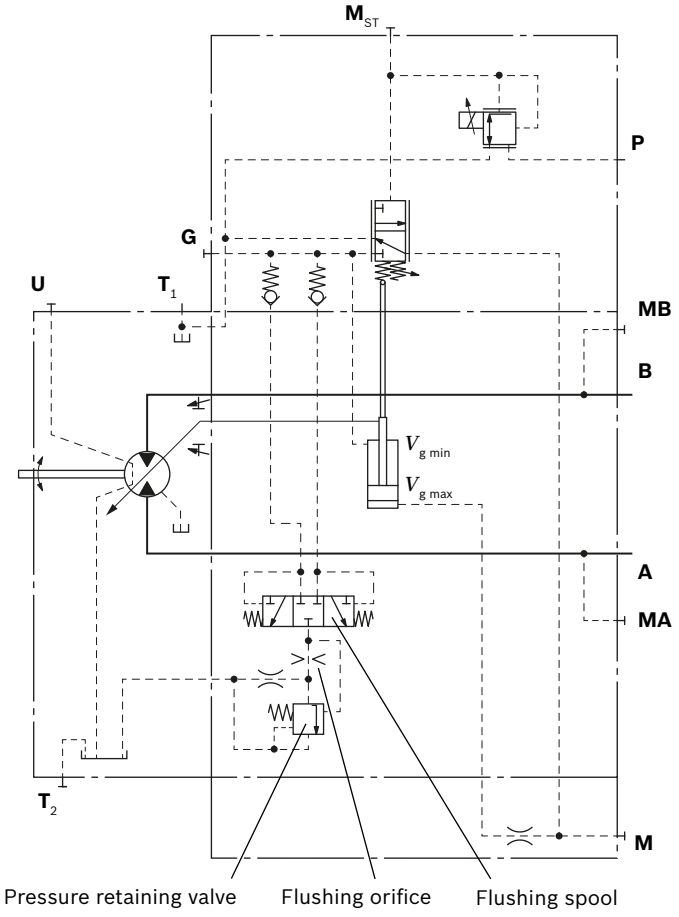
- 115±15 psi (8±1 bar)

Flushing flow q_v
Orifices can be used to adjust the flushing flows as required. The following information is based on:
$\Delta p_{ND} = p_{ND} - p_G$ = 365 psi (25 bar) and ν = 60 SUS (10 mm²/s)
(p_{ND} = low pressure, p_G = case pressure)

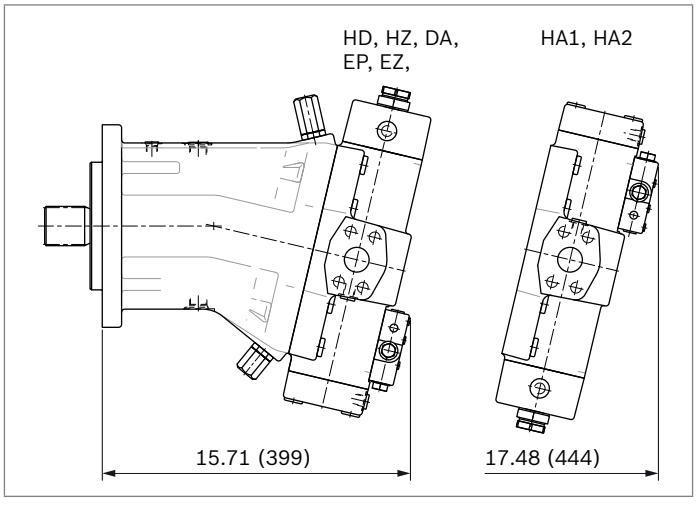
Flushing valve

Material number of orifice	ø [in (mm)]	q_v [gmp (l/min)]
R909419697	0.079 (2.0)	2.6 (10)

▼ **Circuit diagram EP**



▼ **Dimension**

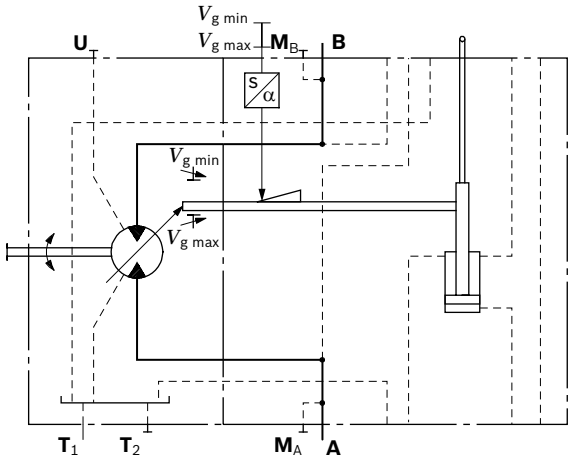


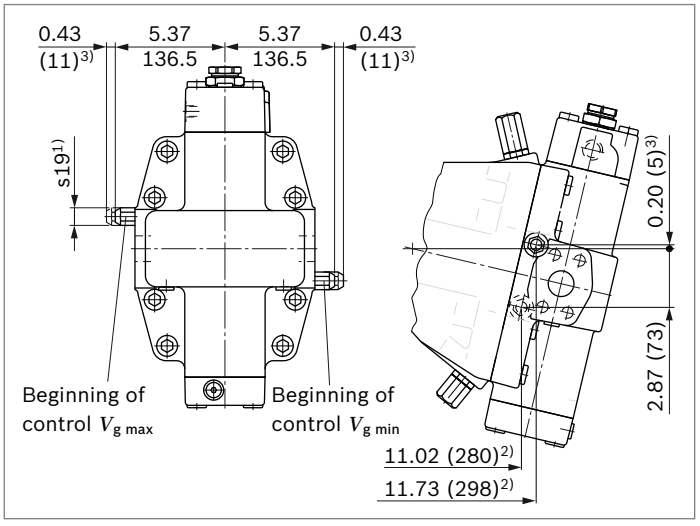
Swivel angle indicator

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 0.31 in (8 mm) (visible after removing the cap nut).

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



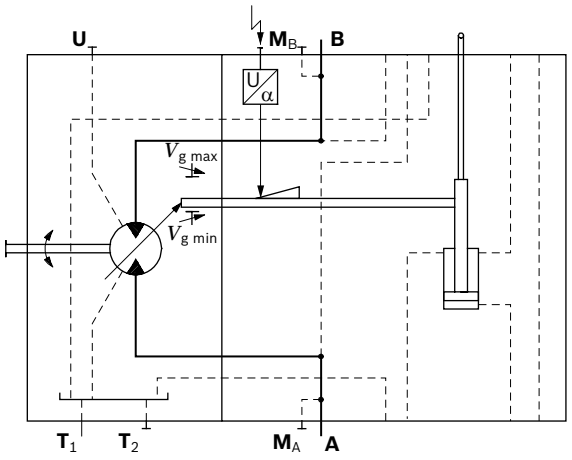


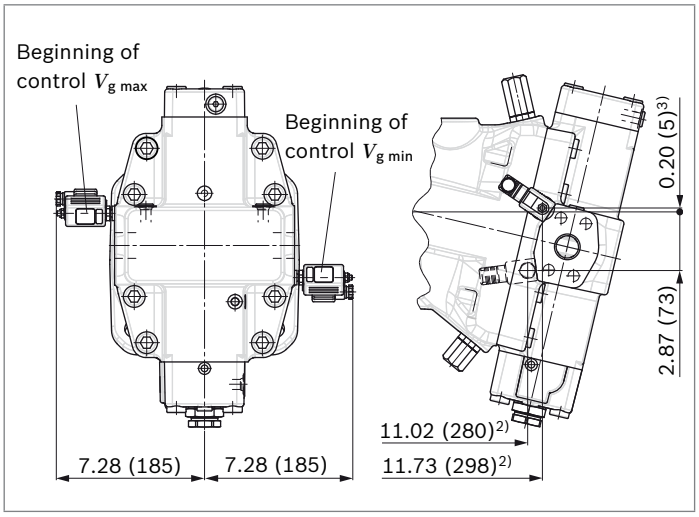
Electric (E)

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 $V_{g\,max}$**



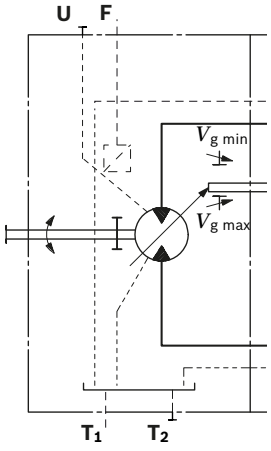


1) Width across flats
2) Dimension to mounting flange
3) Required clearance for removal of cap nut

Speed sensor

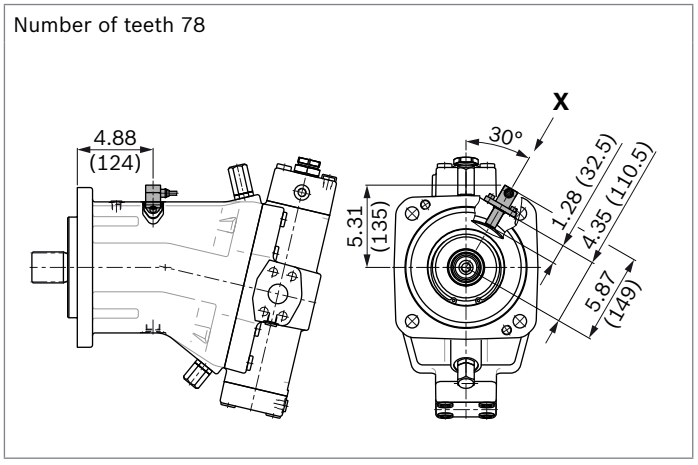
Version AA6VM...F (“prepared for speed sensor”, i.e. without sensor) is equipped with a spline on the rotary group. A signal proportional to motor rotational speed can be generated with the HDD speed sensor mounted. The sensor registers the rotational speed and direction of rotation. Type code, technical data, dimensions and parameters for the connector, plus safety instructions about the sensor can be found in the relevant data sheet 95135 – HDD. The sensor is mounted on the port provided for this purpose with two mounting bolts. On deliveries without sensor, the port is plugged with a pressure-resistant cover. We recommend ordering the AA6VM variable motor complete with mounted sensor.

▼ **Circuit diagram**

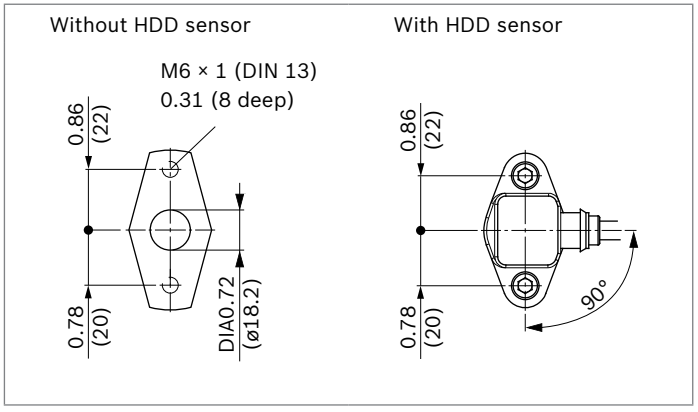


▼ **Dimensions**

Version “H” with HDD sensor



View X



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 empty via the hydraulic lines.
Particularly in the installation position “drive shaft upwards”, filling and air bleeding must be carried out completely as there is, for example, a danger of dry running.
The leakage in the housing area must be directed to the reservoir via the highest drain port (**T_1**, **T_2**).
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 characteristics can be expected. Gravity, dead weight and case pressure can cause minor shifts in control characteristic curves and changes in response time.

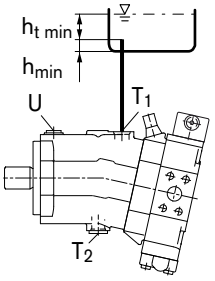
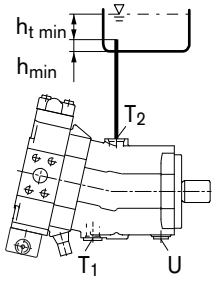
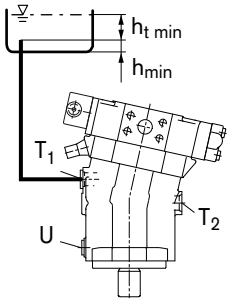
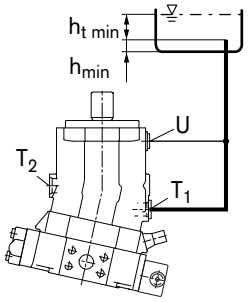
Key	
U	Bearing flushing / air bleed port
F	Filling / air bleeding
T_1, T_2	Drain port
$h_{t\ min}$	Minimum required immersion depth (7.87 inch (200 mm))
h_{min}	Minimum required distance to tank base (3.94 inch (100 mm))

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)

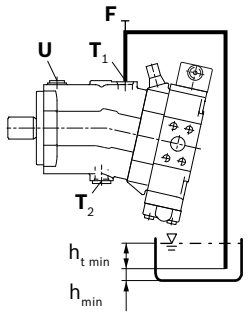
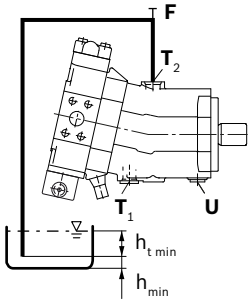
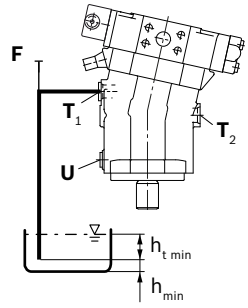
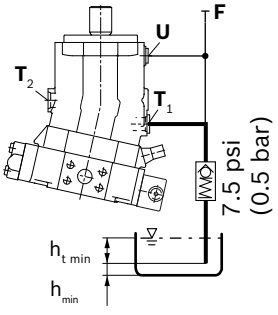
Below-reservoir installation means that the axial piston unit is installed outside of the reservoir below the minimum fluid level.

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

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 7.5 psi (0.5 bar)) can prevent draining of the motor housing.

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

Notice

Port **F** is not part of the motor and can be provided by the customer 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 person.
- 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, request a binding installation drawing.
- The data and notes contained herein must be adhered to.
- For safety reasons, control systems 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 condition of the axial piston unit (operating pressure, fluid temperature), the characteristic may shift.
- Preservation: Our axial piston units are supplied as standard with preservative protection for a maximum of 12 months. If longer preservative protection is required (maximum 24 months), please specify this in plain text when placing your order. The preservation times apply under optimal storage conditions, details of these conditions can be found in the data sheet 90312 or the instruction manual.
- Not all variants of the product are approved for use in safety functions according to ISO 13849. Please consult the responsible contact person at Bosch Rexroth if you require reliability parameters (e.g. $MTTF_d$) for functional safety.
- Depending on the type of control used, electromagnetic effects can be produced when using solenoids. Applying the recommended 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 proportional electrohydraulic coil with a Pulse Width Modulated (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
- Working ports
  - The ports and fixing threads are designed for the specified peak pressure. The machine or system manufacturer must ensure that the connecting elements and lines correspond to the specified operating conditions (pressure, volume flow, hydraulic fluid, temperature) with the required safety factors.
  - The service and function ports are only designed to accommodate hydraulic lines

Safety instructions

- During and shortly after operation, there is a risk of burns on the axial piston unit and especially on the solenoids. Take appropriate safety measures (e.g., by wearing protective clothing).
- Moving parts in control equipment (e.g. valve pistons) 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 flow of hydraulic fluid and the build-up of momentum in the axial piston unit can no longer meet the operator's specifications. Even the use of various filter elements (external or internal flow filtering) cannot rule out errors, but can only help minimize risks. The machine/system manufacturer must check whether additional measures are required on the machine for the relevant application in order to bring the powered load into a safe position (e.g. safe stop) and ensure any measures are properly put into practice.
- In certain conditions, moving parts in high pressure relief valves might get stuck in an undefined position due to contamination. This can result in restriction or loss of load holding functions in lifting winches. Therefore it is the machine and/or system manufacturers 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.

Bosch Rexroth Corporation
Mobile Applications
8 Southchase Court
Fountain Inn, SC 29644-9018, USA
Telephone (864) 967-2777
Facsimile (864) 967-8900
www.boschrexroth-us.com