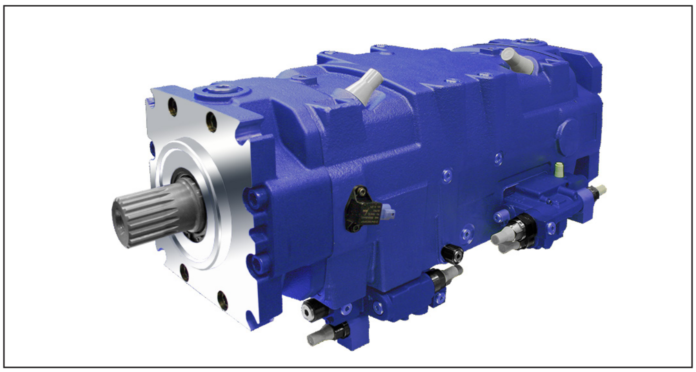
Axial piston variable double pump A28VLO series 12



- High-pressure double pump for mobile machines with multi-circuit system
- Sizes 280
- Nominal pressure 350 bar
- Maximum pressure 420 bar
- Open circuit

Features
- Variable double pump with axial piston rotary group in a swashplate design for hydrostatic drives in open circuit.
- For use preferably in mobile applications
- Flow is proportional to the drive speed and displacement.
- The flow can be infinitely varied by adjusting the swashplate angle.
- One suction port, two pressure ports.
- Special control devices program for mobile applications, with different control and regulation functions.
- Compact design
- High efficiency
- High power density
- Low noise level

Contents

Type code

01	02	03	04	05	06	07	08	09	10		11	12	13	14	15	16	17	18	19	20
	LO	280								/	12	M	R	V	E4		P	N000	0	

Axial piston unit

			280	
01	Variable swashplate design, nominal pressure 350bar, maximum pressure 420 bar	Unpainted	●	**A28V**
		Painted	●	**LA28V**

Operating mode

			280	
02	Pump, open circuit	With charge pump	●	**LO**

Size (NG)

03	Geometric displacement, see table of values on page 9	**280**

Position 04, 05, 06 with the relevant control axis combination option, controller group a) to e) is described below

Type code position	04	05	06
Combination options	a) Power controller	No further controller, with code 00	
		b) Pressure controller	No further controller, with code 00
			c) Stroke control
			d) Load-sensing
			e) Override DG
		c) Stroke control	No further controller, with code 00
			d) Load-sensing
		d) Load-sensing	No further controller, with code 00
	b) Pressure controller	No further controller, with code 00	
		b) Pressure controller[3)]	No further controller, with code 00
			e) Override DG
		d) Load-sensing	No further controller, with code 00
		e) Override DG	No further controller, with code 00
	c) Stroke control	No further controller, with code 00	
		b) Pressure controller	No further controller, with code 00
			e) Override DG
		d) Load-sensing	No further controller, with code 00

● = Available ○ = On request – = Not available

01	02	03	04	05	06	07	08	09	10		11	12	13	14	15	16	17	18	19	20
	LO	**280**								**/**	**12**	**M**	**R**	**V**	**E4**		**P**	**N000**	**0**	

1st pump control device: Controller group a)

					280	
a)	**Power controller**	Fixed setting			●	**LR**
		Override electric-proportional	Negative control	U = 12 V	●	**L3**
				U = 24 V	●	**L4**
		Hydraulic-proportional	Negative control		●	**L5**
			Positive control		●	**L6**
	Summation power controller	Override hydraulic-proportional, high pressure	Negative control	With stop	●	**CR**
				Without stop	○	**PR**
		Combination of CR and L5 = C5			●	**C5**

1st pump controller group b)

					280	
b)	Without additional controller				●	**00**
	Pressure controller with one-side swiveling	Fixed setting			●	**DR**
		Remote controlled hydraulically	Positive control		●	**DG**
		Electric-proportional with integrated pilot valve for external pilot pressure supply **not combinable with other controllers**	Positive control	U = 24 V	○	**D2**

1st pump controller group c)

					280	
c)	Without additional controller				●	**00**
	Stroke control	Electric-proportional	Positive control	U = 12 V	●	**E1**
				U = 24 V	●	**E2**
		Electric, two-point	Positive control	U = 24 V	○	**E6**
		Hydraulic-proportional, pilot pressure	Negative control	Δp = 20 bar	●	**H3**
			Positive control		●	**H4**
			Negative control	Δp = 35 bar	●	**H5**
			Positive control		●	**H6**

1st pump controller group d)

					280	
d)	Without additional controller				●	**00**
	Load-sensing, pump pressure, internal	Fixed setting			●	**S0**
		Electric-proportional	Positive control	U = 12 V	○	**S3**
			Positive control	U = 24 V	○	**S4**
	Pressure controller	Remote controlled hydraulically	Positive control		●	**DG**

1st pump controller group e)

					280	
e)	Without additional controller				●	**00**
	Electric directional valve and pressure relief valve mounted	Only in combination with DG	De-energized standby	U = 24 V	○	**V2**
	Override DG electric-proportional	With integrated pilot control valve and only in combination with DG	Positive control	U = 24 V	●	**T6**
			Negative control	U = 24 V	●	**T8**

2nd pump control device

		280	
07	Identical to 1st pump	●	**1**
	Various controls, please contact us	●	**2**

● = Available ○ = On request – = Not available

01	02	03	04	05	06	07	08	09	10		11	12	13	14	15	16	17	18	19	20
	LO	**280**								**/**	**12**	**M**	**R**	**V**	**E4**		**P**	**N000**	**0**	

Depressurized basic position and external control pressure supply[1)]

			280	
08	Basic position maximum swivel angle ($V_{g\ max}$)			
	Without external control pressure supply (standard for power and pressure controllers)		●	**A**
	With external control pressure supply (integrated shuttle valve, standard for negative stroke control)		●	**B**
	Basic position minimum swivel angle ($V_{g\ min}$)			
	With external control pressure supply (integrated shuttle valve, standard for positive stroke control)		●	**C**

Connector for solenoids[2)]

			280	
09	Without connector (without solenoid, only for hydraulic control)		●	**0**
	DEUTSCH - molded connector, 2-pin, without suppressor diode		●	**P**
	HIRSCHMANN connector		●	**H**

Swivel angle sensor

			280	
10	Without swivel angle sensor		●	**0**
	With electric swivel angle sensor[3)] (as per data sheet 95150)	Power supply 5 V DC	●	**B**
		Power supply 8 V – 32V DC	●	**K**

Series

11	Series 1, index 2			**12**

Version of port and fastening threads

			280	
12	Metric connections, with O-ring seal based on ISO 6149 metric fastening threads according to DIN 13		●	**M**

Direction of rotation

			280	
13	Viewed on drive shaft	Clockwise	●	**R**

Sealing material

			280	
14	FKM (fluorocarbon rubber)		●	**V**

Mounting flange

			280	
15	SAE J744	165-4	●	**E4**

Drive shaft (permissible input torque, see page 10)

			280	
16	Splined shaft ANSI B92.1a	2 1/4 in 17T 8/16 DP	●	**T3**
	Splined shaft DIN 5480	W60x2x28x9g	●	**A4**

Rotary group version

			280	
17	Premium version, efficiency and speed optimized		●	**P**

● = Available ○ = On request – = Not available

1) For description, please refer to "Control device" and the tables from page 11
2) Connectors for other electric components may deviate
3) Please contact us if the swivel angle sensor is used for control

01	02	03	04	05	06	07	08	09	10		11	12	13	14	15	16	17	18	19	20
	LO	**280**								**/**	**12**	**M**	**R**	**V**	**E4**		**P**	**N000**	**0**	

Through drives[4)]

		280	
18	Without through drive	●	**N000**

Speed sensor

		280	
19	Without sensor	●	**0**

Standard/special version

		280	
20	Standard version	●	**0**
	Special version	●	**S**

● = Available ○ = On request – = Not available

Notice
- Note the project planning notes on page 43.
- In addition to the type code, please specify the relevant technical data when placing your order.

4) With through drive on request

Hydraulic fluids

The A28VLO variable double pump is designed for operation with HLP mineral oil according to DIN 51524. Application instructions and requirements for hydraulic fluids should be taken from the following data sheets before the start of project planning:

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

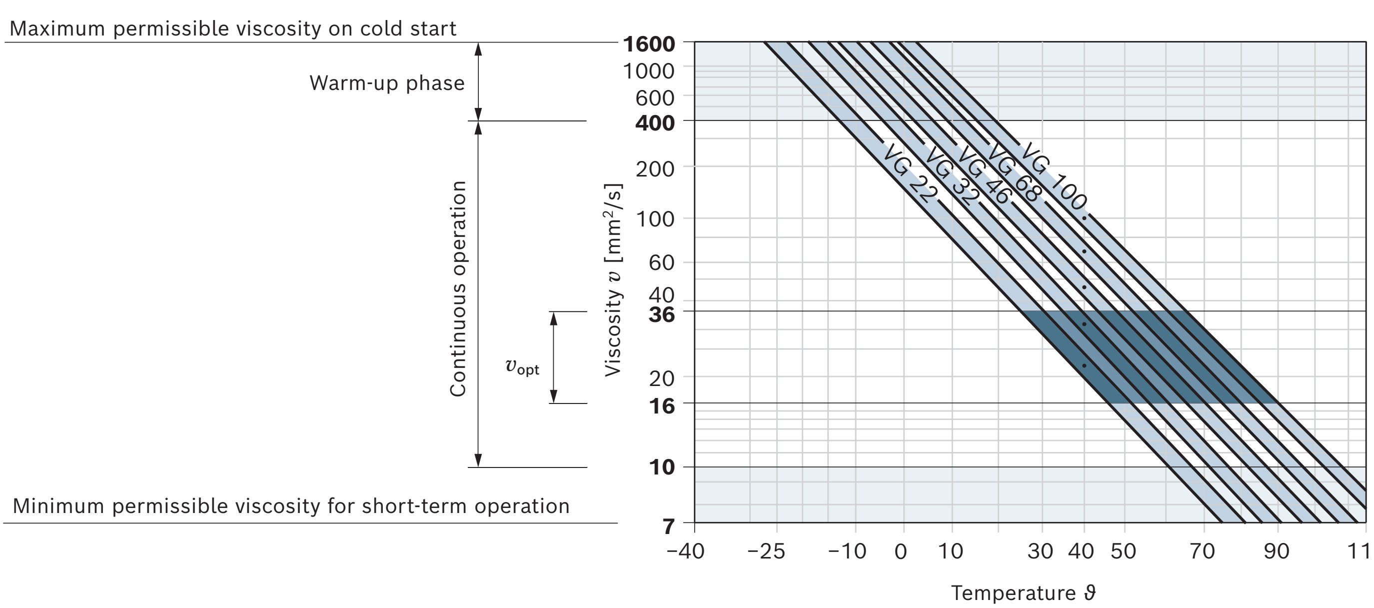
Selection of hydraulic fluid
Bosch Rexroth evaluates hydraulic fluids on the basis of the Fluid Rating according to the technical data sheet 90235. Hydraulic fluids with positive evaluation in the Fluid Rating are provided in the following technical data sheet:
90245: Bosch Rexroth Fluid Rating List for Rexroth hydraulic components (pumps and motors)

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

Viscosity and temperature of hydraulic fluids

	Viscosity	Shaft seal	Temperature[3]	Remarks
Cold start	$\nu_{max} \le 1600\ mm^2/s$	NBR[2]	$\vartheta_{St} \ge -40$ °C	$t \le 3$ min, without load ($p \le 50$ bar), $n \le 1000$ rpm
		FKM	$\vartheta_{St} \ge -25$ °C	Permissible temperature difference between axial piston unit and hydraulic fluid in the system maximum 25 K
Warm-up phase	$\nu = 1600 \ldots 400\ mm^2/s$			$t \le 15$ min, $p \le 0.7 \times p_{nom}$ and $n \le 0.5 \times n_{nom}$
Continuous operation	$\nu = 400 \ldots 10\ mm^2/s$[1]	NBR[2]	$\vartheta \le +85$ °C	Measured at port **T**
		FKM	$\vartheta \le +110$ °C	
	$\nu_{opt} = 36 \ldots 16\ mm^2/s$			Optimal operating viscosity and efficiency range
Short-term operation	$\nu_{min} = 10 \ldots 7\ mm^2/s$	NBR[2]	$\vartheta \le +85$ °C	$t \le 3$ min, $p \le 0.3 \times p_{nom}$, measured at port **T**
		FKM	$\vartheta \le +110$ °C	

Selection diagram



1) This corresponds, for example on the VG 46, to a temperature range of +4 °C to +85 °C (see selection diagram)

2) Special version, please contact us

3) If the temperature at extreme operating parameters cannot be adhered to, please contact us.

Filtration of the hydraulic fluid

Finer filtration improves the cleanliness level of the hydraulic fluid, which increases the service life of the axial piston unit.

A cleanliness level of at least 20/18/15 under ISO 4406 should be maintained.

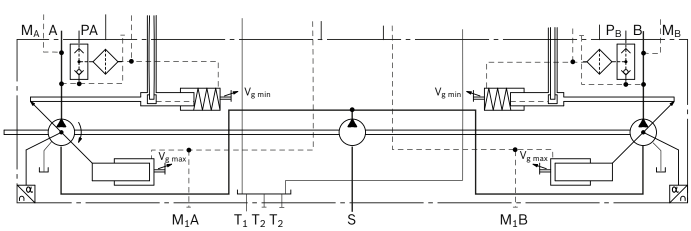
At a hydraulic fluid viscosity of less than 10 mm²/s (e.g. due to high temperatures during short-term operation) at the drain port, a cleanliness level of at least 19/17/14 under ISO 4406 is required.

For example, viscosity corresponds to 10 mm²/s at:

- HLP 32 a temperature of 73 °C
- HLP 46 a temperature of 85 °C

Charge pump (impeller)

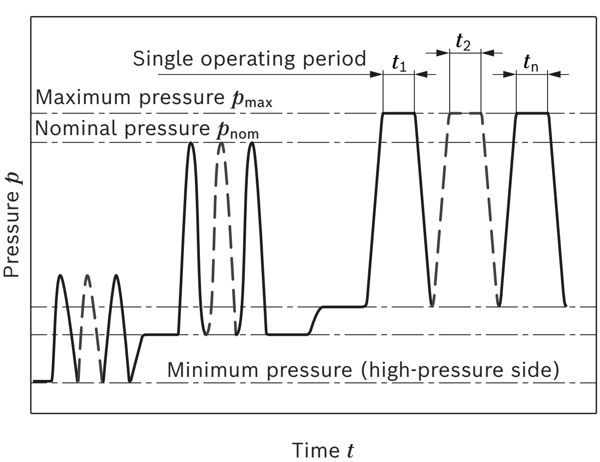
The charge pump is a centrifugal pump with which the A28VLO 280 is filled and therefore can be operated at higher rotational speeds. This also facilitates cold starting at low temperatures and high viscosity of the hydraulic fluid. Externally increasing the inlet pressure is therefore unnecessary in most cases. Charging the reservoir with compressed air is not permissible.



Working pressure range

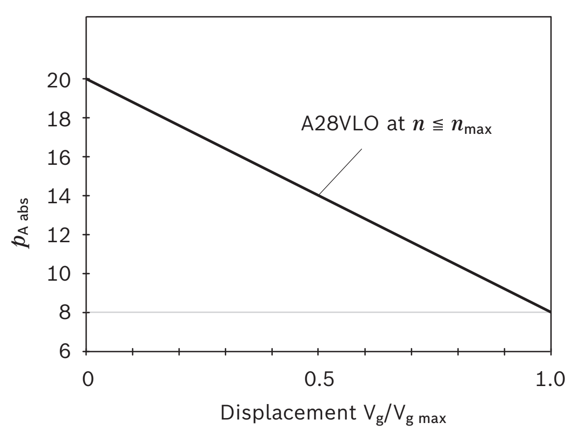
Pressure at working port A		**Definition**
Nominal pressure p_{nom}	350 bar	The nominal pressure corresponds to the maximum design pressure.
Maximum pressure p_{max}	420 bar	The maximum pressure corresponds to the maximum working pressure within a single operating period. The sum of single operating periods must not exceed the total operating period of 300 h.
Single operating period	< 1 s	
Load cycles	< 1 million	
Minimum pressure $p_{A\ absolute}$ (high-pressure side)	15 bar	Minimum pressure at the high-pressure side (**A**) which is required in order to prevent damage to the axial piston unit. The minimum pressure depends on the rotational speed and the swivel angle (see diagram "Minimum pressure" on this page).
Rate of pressure change $R_{A\ max}$	16000 bar/s	Maximum permissible speed of pressure build-up and reduction during a pressure change across the entire pressure range.
Pressure at suction port S (inlet)		
Minimum pressure $p_{S\ min}$	≥ 0.7 bar absolute	Minimum pressure at suction port **S** (inlet) which is required to prevent damage to the axial piston unit. The minimum pressure depends on the rotational speed and displacement of the axial piston unit.
Maximum pressure $p_{S\ max}$	≤ 2 bar absolute	
Case pressure at port T_1, T_2, T_3		
Max. static pressure $p_{L\ max}$	3 bar	Maximum 1.2 bar higher than inlet pressure at port **S**, but not higher than $p_{L\ max}$. A drain line to the reservoir is required.
Pressure peaks $p_{L\ peak}$	5 bar	t< 0.1 s
External control pressure P (type code position 08 version B and C)		
Minimum pressure $p_{P nom}$	30 bar	Control systems with external control pressure supply need a control pressure appropriate to the adjustment time and size.
Maximum pressure $p_{P max}$	50 bar	

▼ **Pressure definition**



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

▼ **Minimum pressure** (high-pressure side)



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

Technical data

With charge pump (A28VLO)

Size		NG		280
Displacement, geometric, per revolution by rotary group		$V_{g\,max}$	cm^3	280
		$V_{g\,min}$	cm^3	0
Maximum rotational speed[1]	at $V_{g\,max}$[2]	n_{nom}	rpm	2100
	at $V_g \le V_{g\,max}$[3]	n_{max}	rpm	2100
Flow	at n_{nom} and $V_{g\,max}$	q_v	L/min	2 x 588
Power	at n_{nom}, $V_{g\,max}$ and Δp = 350 bar	P	kW	2 x 343
Torque	at $V_{g\,max}$ and Δp = 350 bar[2]	M	Nm	2 x 1560
Rotary stiffness of drive shaft	2 1/4 in 17T 8/16DP T3	c	kNm/rad	519
	W60x2x28x9g A4	c	kNm/rad	645
Moment of inertia of the rotary group		J_{TW}	kgm^2	0.198
Maximum angular acceleration[4]		α	rad/s^2	4200
Case volume		V	L	9.5
Weight (without through-drive) approx.		m	kg	305

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. We recommend checking loads through tests or calculation/simulation and comparing them with the permissible values.
- ▶ Special requirements apply in the case of belt drives. Please contact us.

External control pressure supply (type code position 08 B and C)

Control systems with external control pressure supply need a flow appropriate to the adjustment time and size.

Size	Flow [l/min] at 100 ms swivel time
280	22

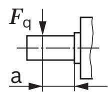
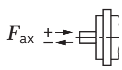
Determination of the operating characteristics		
Flow	$q_v = \dfrac{V_g \times n \times \eta_v}{1000}$	[l/min]
Torque	$M = \dfrac{V_g \times \Delta p}{20 \times \pi \times \eta_{hm}}$	[Nm]
Power	$P = \dfrac{2\,\pi \times M \times n}{60000} = \dfrac{q_v \times \Delta p}{600 \times \eta_t}$	[kW]

Key

V_g	=	Displacement per revolution [cm^3]
Δp	=	Differential pressure [bar]
n	=	Rotational speed [rpm]
η_v	=	Volumetric efficiency
η_{hm}	=	Hydraulic-mechanical efficiency
η_t	=	Total efficiency ($\eta_t = \eta_v \times \eta_{hm}$)

1) The values are applicable:
   - for the optimum viscosity range from ν_{opt} = 36 to 16 mm^2/s
   - with hydraulic fluid based on mineral oils
2) The values apply at absolute pressure p_{abs} = 1 bar at suction port **S**.
3) Maximum rotational speed (speed limit) for increased inlet pressure p_{abs} at suction port **S** and $V_g < V_{g\,max}$.
4) The data are valid for values between the minimum required and maximum permissible rotational speed. Valid for external excitation (e.g. diesel engine 2 to 8 times rotary frequency; cardan shaft twice the rotary frequency). The limit value is only valid for a single pump. The load capacity of the connection parts must be considered.

Permissible radial and axial loading on the drive shafts

Size		NG		280	280
Drive shaft				2 1/4	W60
Maximum radial force at distance a (from shaft collar)		$F_{q\,max}$	N	18000	23600
		a	mm	40	29
Maximum axial force		$+ F_{ax\,max}$	N	1800	1800
		$− F_{ax\,max}$	N	850	850

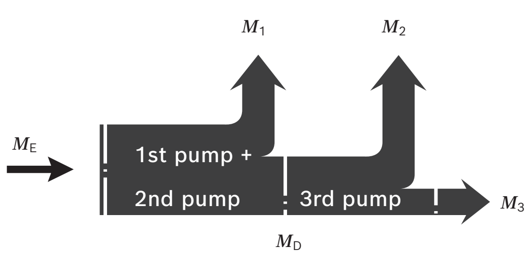
Notice

- The values given are maximum values and do not apply to continuous operation. All loads of the drive shaft reduce the bearing service life!

Permissible input torques

Size			NG		280
Torque at $V_{g\,max}$ and Δp = 350 bar[1]			M_{max}	Nm	3120
Maximum input torque on drive shaft[2]					
	T3	2 1/4 in	$M_{E\,max}$	Nm	4380
	A4	W60	$M_{E\,max}$	Nm	5780
Maximum through-drive torque			$M_{D\,max}$	Nm	–

▼ **Distribution of torques**



Torque 1st pump + 2nd pump	M_1		
Torque at 3rd Pump	M_2		
Torque at 4th Pump	M_3		
Input torque	M_E	=	$M_1 + M_2 + M_3$
	M_E	<	$M_{E\,max}$
Through-drive torque	M_D	=	$M_2 + M_3$
	M_D	<	$M_{D\,max}$

1) Efficiency not considered
2) For drive shafts free of radial force

Power controller

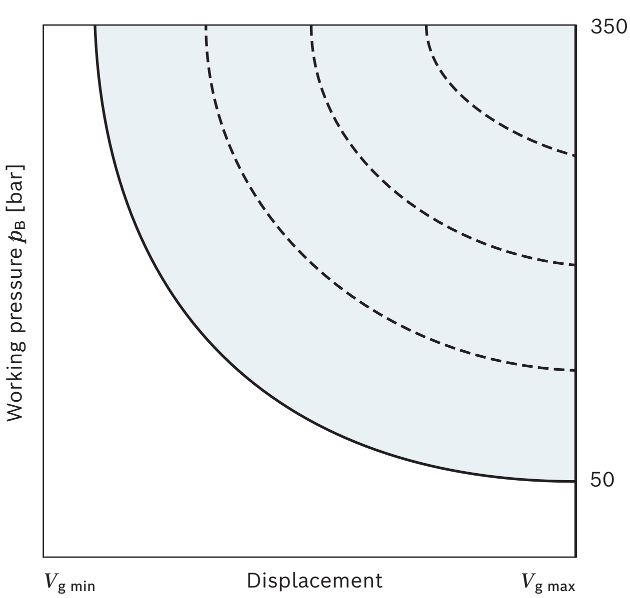
LR – Power controller, fixed setting

The power controller regulates the displacement of the pump depending on the working pressure so that a given drive power is not exceeded at constant drive speed.
The precise control with a hyperbolic characteristic curve, provides an optimum utilization of available power.
The working pressure acts on a rocker via a measuring spool moved together with the control. An externally adjustable spring force counteracts this, it determines the power setting. The depressurized basic position is $V_{g\,max}$.
If the working pressure exceeds the set spring force, the control valve will be actuated by the rocker and the pump will swivel back from the basic setting $V_{g\,max}$ toward $V_{g\,min}$. Here, the lever length at the rocker is shortened and the working pressure can increase at the same rate as the displacement is reduced
($p_B \times V_g$ = constant; p_B = working pressure; V_g = displacement).
The hydraulic output power (characteristic curve LR) is influenced by the efficiency of the pump.
Setting range for beginning of control 50 to 350 bar
When ordering, state in plain text:

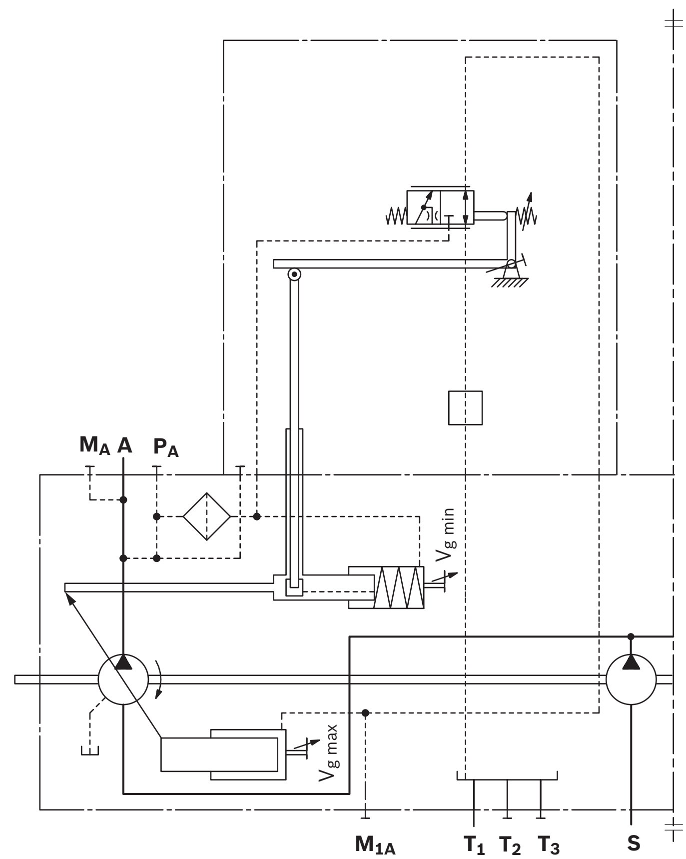
- Drive power P [kW]
- Drive speed n [rpm]
- Maximum flow $q_{V\,max}$ [l/min]

Please contact us if you need a power diagram.

▼ **Characteristic curve LR**



▼ **Circuit diagram LR**



Illustrated for purposes of clarity, only pump A

	Rotational speed [rpm]		
	1000	**1500**	**1800**
Size	Minimum adjustable drive power [kW] (at 50 bar beginning of control)		
280	26	39	47

L3/L4 – Power controller, electric-proportional override (negative control)

A control current acts against the adjustment spring of the power controller via a proportional solenoid. The mechanically adjusted basic power setting can be reduced by means of different control current settings. Increasing control current = reduced power.
If the control current signal is adjusted by a load limiting control, the power reduction of all consumers is reduced to match the available power from the diesel engine.

Technical data, solenoid	L3	L4
Voltage	12 V (±20%)	24 V (±20%)
Control current		
Start of control	400 mA	200 mA
End of control	1200 mA	600 mA
Current limit	1.3 A	0.65 A
Nominal resistance (at 20 °C)	5.5 Ω	22.7 Ω
Dither frequency	100 Hz	100 Hz
Duty cycle	100%	100%
Type of protection: see connector version page 40		

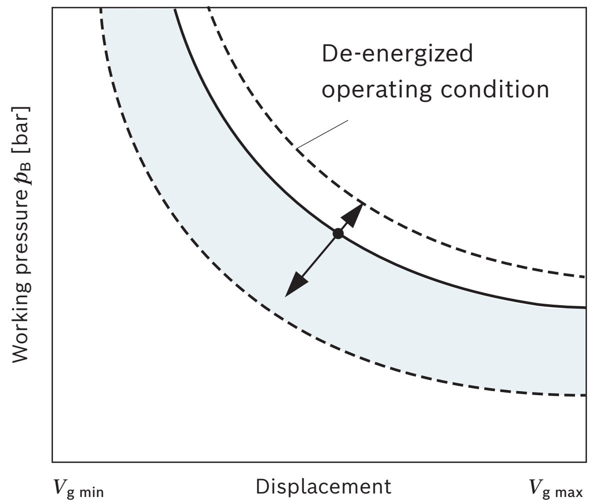
The following electronic control units and amplifiers are available for controlling the proportional solenoids:

BODAS controllers RC Series	Data sheet
30	95205
31	95206
40	95207 and 95208
And application software	
Analog amplifier RA	95230

When ordering, state in plain text:

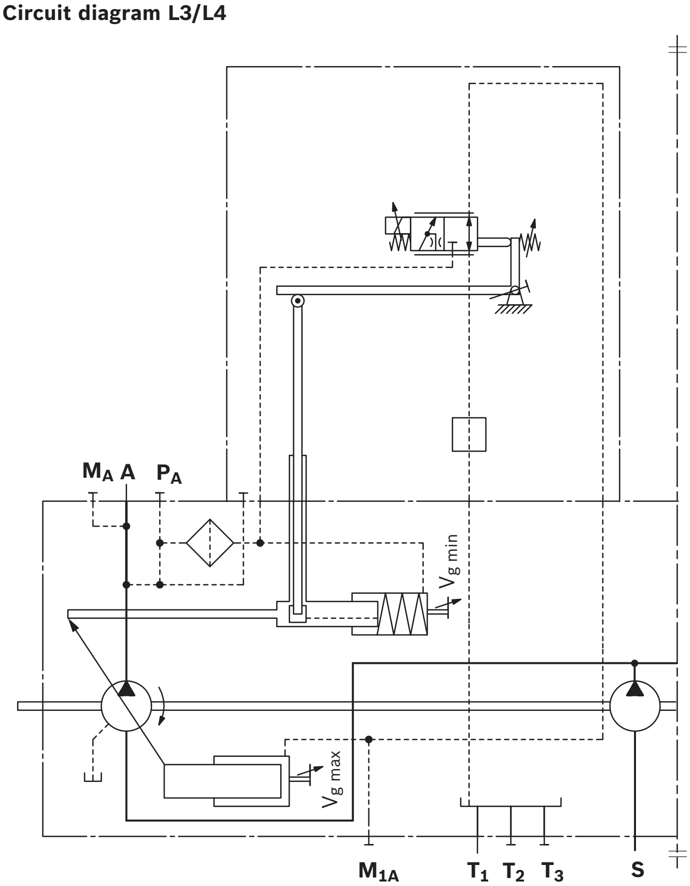
- Drive power P [kW] at beginning of control
- Drive speed n [rpm]
- Maximum flow $q_{V\ max}$ [l/min]

▼ **Effect of power override through current increase or de-energized operating condition**



Notice
In operating condition **L3** de-energized (jump 400 to 0 mA): Power increase by a factor of 2 of the table values.
In operating condition **L4** de-energized (jump 200 to 0 mA): Power increase by a factor of 1 of the table values.

Circuit diagram L3/L4



Illustrated for purposes of clarity, only pump A

Reduction of power by control current to the proportional solenoids with L3[1)]

LR3 – Power reduction/control current [kW /100 mA]

	Rotational speed [rpm]		
Size	**1000**	**1500**	**1800**
280	11.4	17.1	20.5

Reduction of power by control current to the proportional solenoids with L4[1)]

LR4 – Power reduction/control current [kW/100 mA]

	Rotational speed [rpm]		
Size	**1000**	**1500**	**1800**
280	22.9	34.4	41.2

1) Values in the tables are reference points. Determination of the exact power override on request.

L5 – Power controller, hydraulic-proportional override (negative control)

A pilot pressure acts against the adjustment spring of the power controller via a valve.

The mechanically adjusted basic power setting can be reduced by means of different pilot pressure settings.

Increasing pilot pressure = reduced power.

- Maximum permissible pilot pressure $p_{St\ max}$ = 100 bar

If the pilot pressure signal is adjusted by a load limiting control, the power reduction of all consumers is reduced to match the available power from the diesel engine.

Reduction of power by pilot pressure at port **L5**

Power reduction/pilot pressure [kW/bar]

	Rotational speed [rpm]		
Size	**1000**	**1500**	**1800**
280	4.4	6.6	7.9

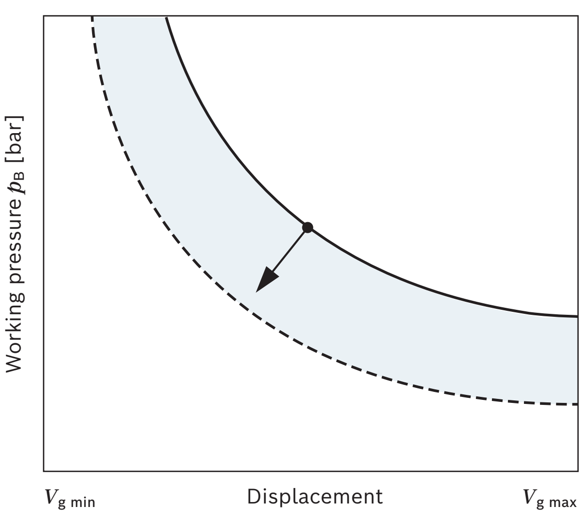
Values in the tables are reference points.

Determination of the exact power override on request.

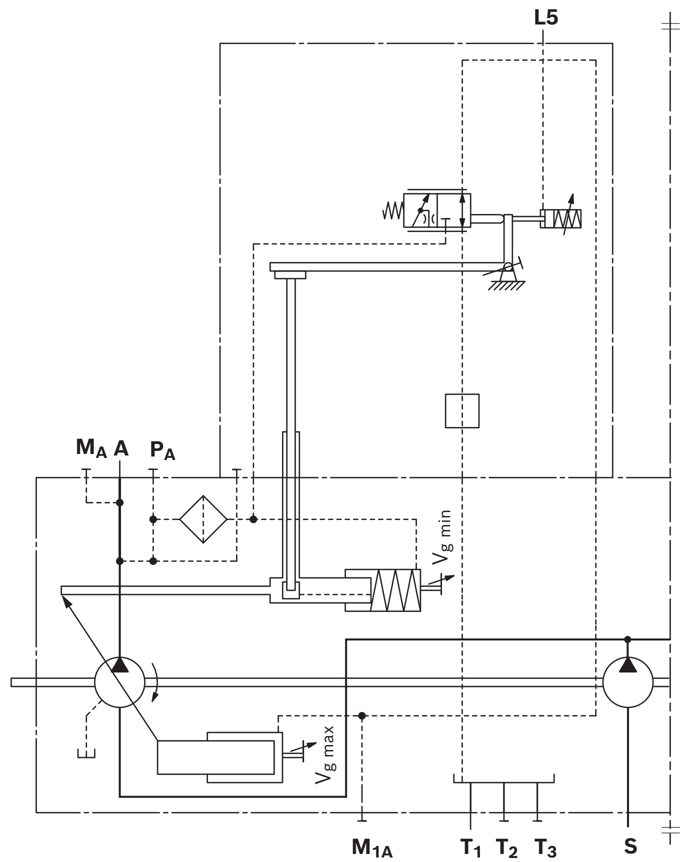
When ordering, state in plain text:

- Drive power P [kW] at a pilot pressure p_{st} in **L5** of 5 bar
- Drive speed n [rpm]
- Maximum flow $q_{V\ max}$ [l/min]

▼ **Effect of power override through pilot pressure increase**



▼ **Circuit diagram L5**



Illustrated for purposes of clarity, only pump A

L6 – Power controller, hydraulic-proportional override (positive control)

A pilot pressure acts together with the adjustment spring of the power controller via a valve.
The mechanically adjusted basic power setting can be increased by means of different pilot pressure settings.
Increasing pilot pressure = increased power.

- ▶ Maximum permissible pilot pressure $p_{St\ max}$ = 100 bar

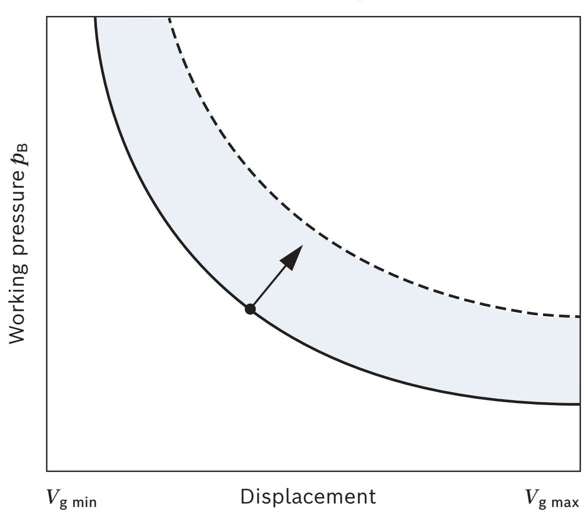
If the pilot pressure signal is adjusted by a load limiting control, the power increase of all consumers is increased to match the available power from the diesel engine.
Power increase by pilot pressure at port **L6**
Power reduction/pilot pressure [kW/bar]

	Rotational speed [rpm]		
Size	**1000**	**1500**	**1800**
110	2.4	3.6	4.3
145	2.9	4.3	5.2
175	3.3	4.9	5.9
210	3.7	5.6	6.7
280	4.5	6.8	8.1

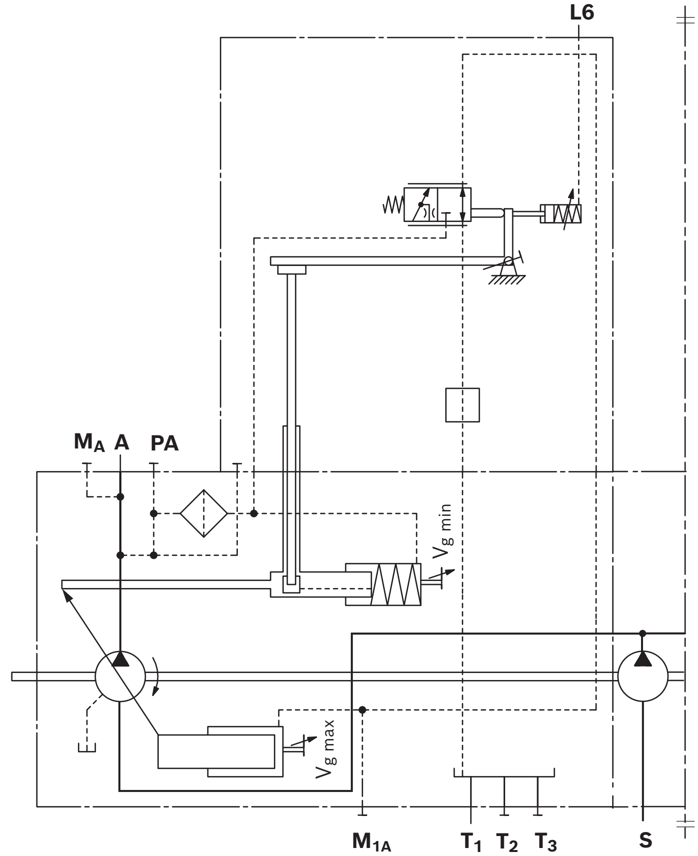
Values in the table are reference points.
Determination of the exact power override on request.
When ordering, state in plain text:

- ▶ Drive power P [kW] at a pilot pressure p_{st} in **L6** of 5 bar
- ▶ Drive speed n [rpm]
- ▶ Maximum flow $q_{V\ max}$ [l/min]

▼ **Effect of power override through pilot pressure increase**



▼ **Circuit diagram L6**



Illustrated for purposes of clarity, only pump A

CR – Summation power control of two power-controlled pumps, high-pressure-related override (with stop)

With two pumps of the same size working in different operating circuits, the CR controller limits the overall power.

The CR works like the normal LR with a fixed maximum power setting along the power hyperbola.

The high-pressure-related override reduces the power setpoint in dependence on the working pressure of the other pump. That happens proportionally below the beginning of control and is blocked by a stop when the minimum power is reached. Here, the **CR** port of the one pump has to be connected to the $\mathbf{M}_A$ port of the other pump.

The maximum power of the first pump is reached when the second pump is working at idle when depressurized. When defining the maximum power, the idle power of the second pump has to be taken into account.

The minimum power of each pump is reached when both pumps are working at high pressure. The minimum power usually equates to 50% of the total power.

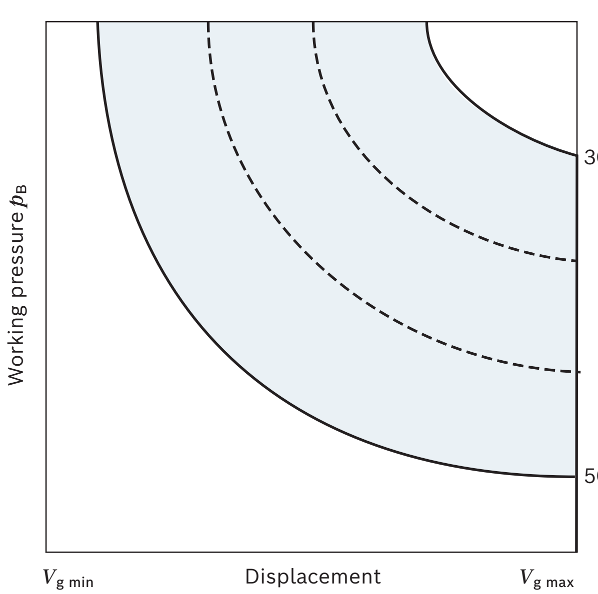
Power that is released by the pressure controller or other overrides remains unconsidered.

Setting range for beginning of control is 50 bar to 300 bar.

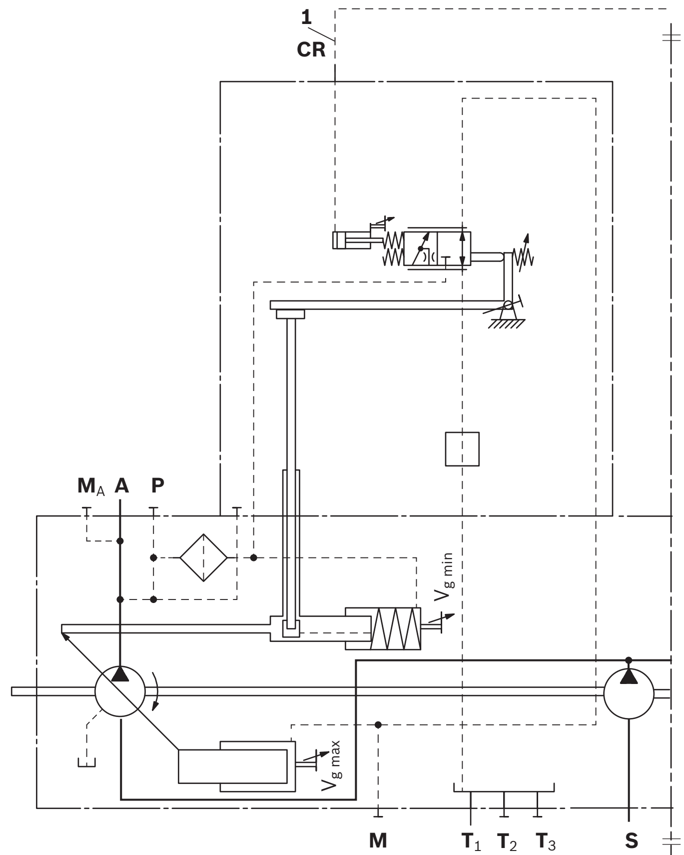
When ordering, please specify separately for each pump:

- Maximum drive power P_{max} [kW]
- Minimum drive power P_{min} [kW]
- Drive speed n [rpm]
- Maximum flow $q_{V\,max}$ [l/min]

▼ Characteristic curve CR



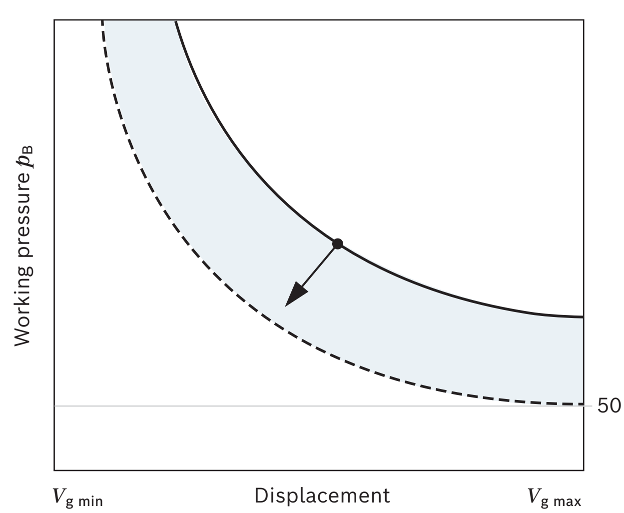
▼ Circuit diagram CR



1 Piping is not included in the scope of delivery.

Illustrated for purposes of clarity, only pump A

▼ Effect of power override of a pump with increasing pressure in the 2nd pump

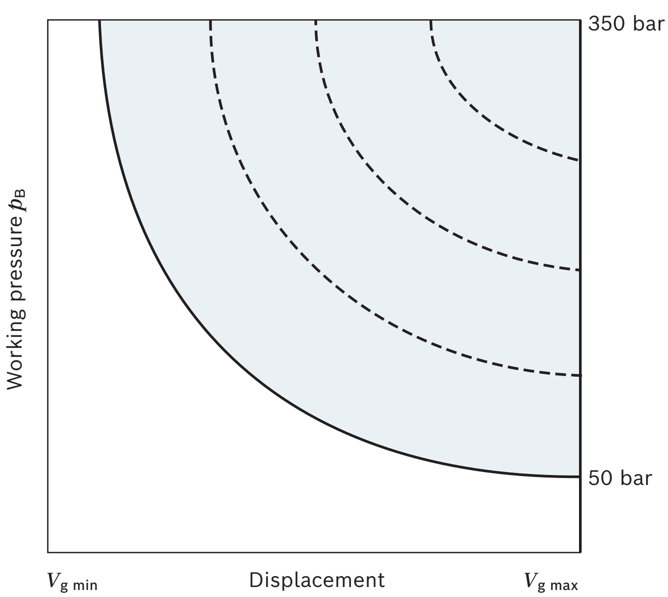


PR – Summation power control of a power-controlled pump and a constant pump

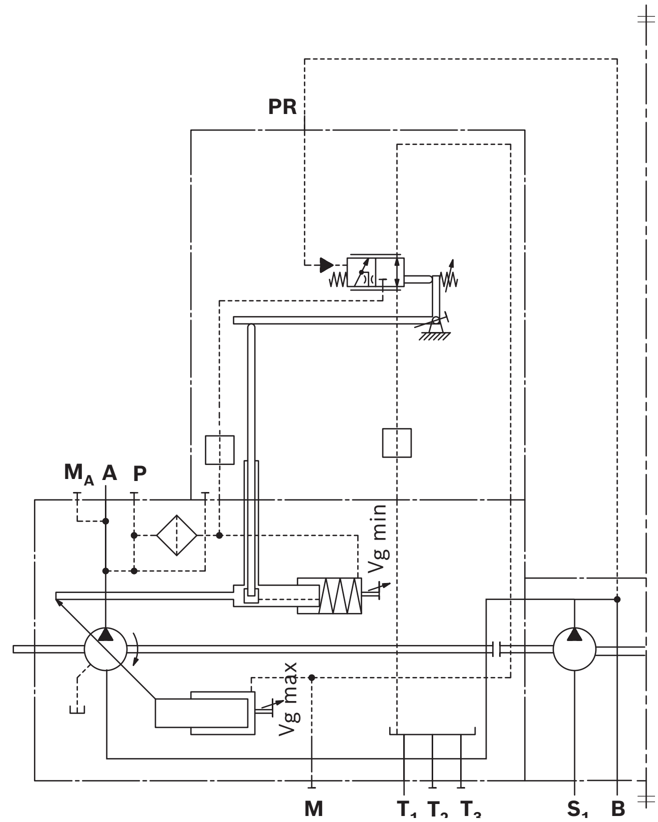
Together with a mounted fixed pump, the PR controller limits the overall power on an A28VLO.
The PR works like the normal LR with a fixed maximum power setting along the power hyperbola.
The high-pressure-dependent override reduces the power specification in proportion to the working pressure of the fixed pump. To do this, port **PR** of the A28VLO must be connected to the operating pressure of the fixed pump.
The power of the controlled pump can then be reduced to zero in a borderline case.
The maximum power of the controlled pump is reached when the fixed pump works at idle when depressurized.
When defining the maximum power, the idle power of the fixed pump has to be taken into account.
Power that is released by the pressure controller or other overrides remains unconsidered.
Setting range for beginning of control is 50 bar to 350 bar.
When ordering, state in plain text:

- Maximum drive power P_{max} [kW]
- Drive speed n [rpm]
- Maximum flow $q_{V\,max}$ [l/min]
- Size of the fixed pump

▼ **Characteristic curve PR**

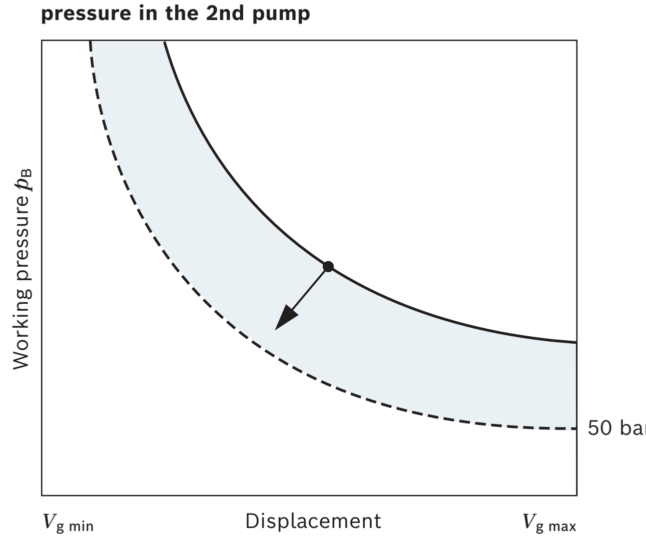


▼ **Circuit diagram PR**



Illustrated for purposes of clarity, only pump A

▼ **Effect of power override of a pump with increasing pressure in the 2nd pump**



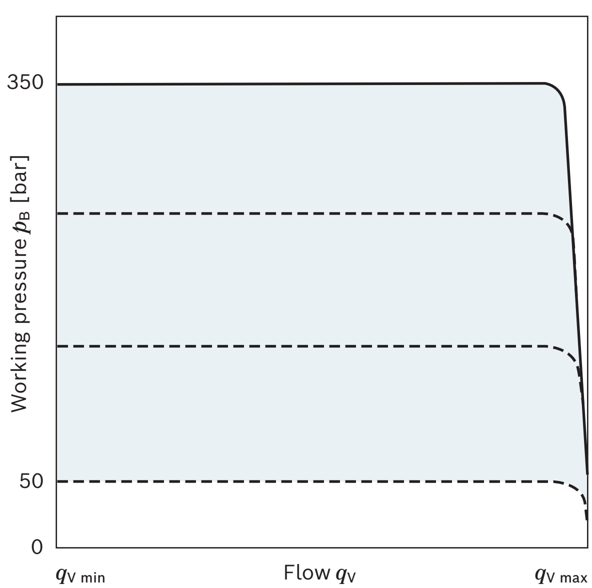
Pressure controller

DR – Pressure controller with one-sided swiveling, fixed setting

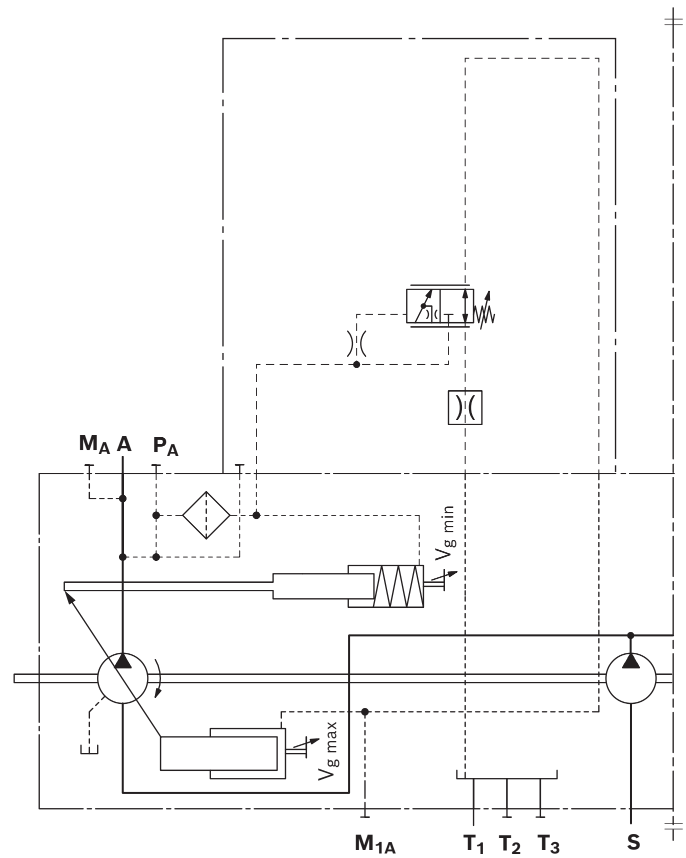
The pressure controller limits the maximum pressure at the pump outlet within the control range of the variable pump. The variable pump only supplies as much hydraulic fluid as is required by the consumers.
If the working pressure exceeds the pressure command value at the pressure valve, the pump will regulate to a smaller displacement to reduce the control differential.

- Basic position in depressurized state: $V_{g\,max}$
- Setting range for pressure control: 50 to 350 bar.
  350 bar is standard.

▼ **Characteristic curve DR**



▼ **Circuit diagram DR**



Illustrated for purposes of clarity, only pump A

DG – Pressure controller with one-sided deflection, hydraulically remote controlled (positive control)

The remote controlled pressure controller has a fixed setting Δp value. A separately connected pressure relief valve at port **X** (**1**) enables the pressure controller to be remotely controlled.

- Setting range Δp 14 to 25 bar
- Recommended value 20 bar (standard)
- Control volume at **X**: approx. 1.6 l/min (static) at Δp 20 bar

In addition a separately configured 2/2 directional valve (**2**) can be actuated to start the pump with low working pressure (standby pressure).

Both functions can be used individually or in combination (see circuit diagram).

The external valves are not included in the scope of delivery.

As a separate pressure relief valve (**1**) we recommend:

- DBD.6, see data sheet 25402
- Working pressure p in bar (test pressure for DG)
- Differential pressure Δp in bar
- Drive speed n in rpm
- Maximum flow q V_{max} in l/min

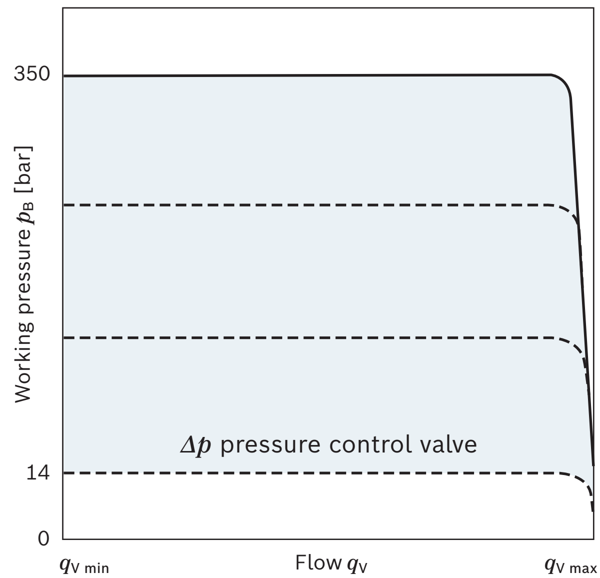
Note for setting remote-controlled pressure control

The setting value for the external pressure relief valve plus the differential pressure value at the pressure control valve determines the level of pressure control.

Example:

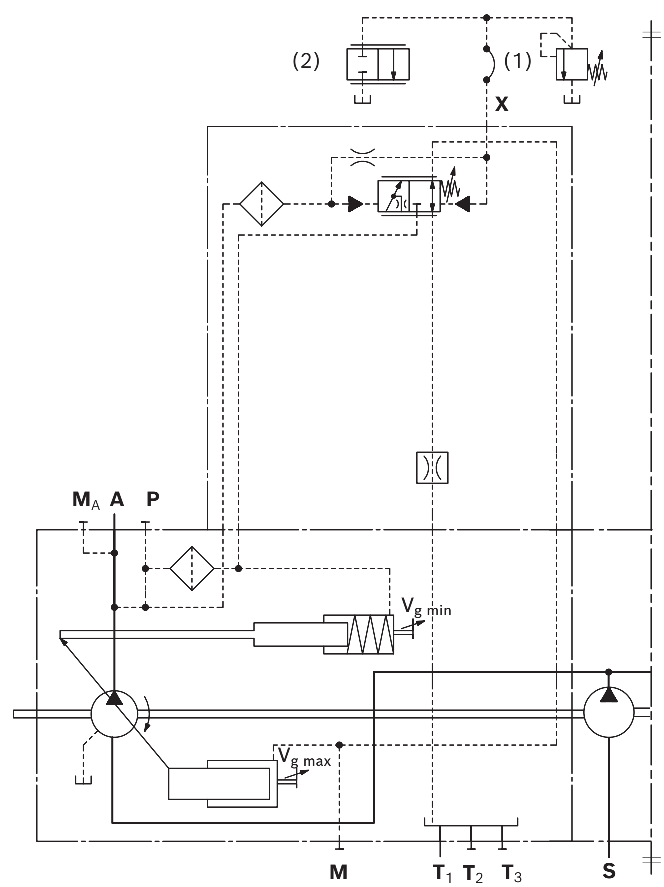
- External pressure relief valve 330 bar
- Differential pressure on pressure control valve 20 bar
- Resulting pressure control of 330 + 20 = 350 bar

▼ **Characteristic curve DG**



For function and description of pressure control DR, see page 18

▼ **Circuit diagram DG**



1 Pressure relief valve (not included in the scope of delivery)

2 2/2 directional valve (not included in the scope of delivery)

D2 – Proportional pressure controller with one-side swiveling, electric override (positive control)

The pressure controller keeps the pressure in a hydraulic system constant within its control range even under varying flow conditions. The variable pump only supplies as much hydraulic fluid as is required by the consumers.

If the working pressure exceeds the setting at the integrated pressure control valve, the pump is automatically swiveled back to reduce the control differential.

- Initial position in depressurized state: $V_{g\,max}$
- Pressure controller basic setting: 32 bar/300 mA

The basic setting of the pressure controller can be overridden. The pressure controller value is proportional to the electrical current acting on the solenoids of the pressure reducing valve.

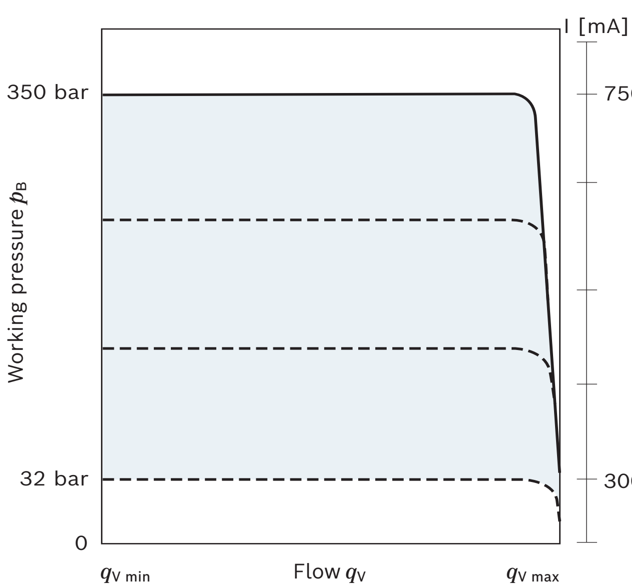
- Pressure setting overridden:
  32 bar/300 mA to 350 bar/750 mA
- Auxiliary pressure for controlling D2 at port **Y**:
  p_{min} = 40 bar; p_{max} = 50 bar.
  Port **X** acts solely as a measuring port (p_{max} 50 bar). Pressurization leads to an impermissible increase in pressure.

Notice

Applying current above the limit of 750 mA to the proportional solenoid results in an impermissible increase in pressure.

Make sure that currents above the permissible limit are not applied to the proportional solenoid.

▼ **Characteristic curve D2**

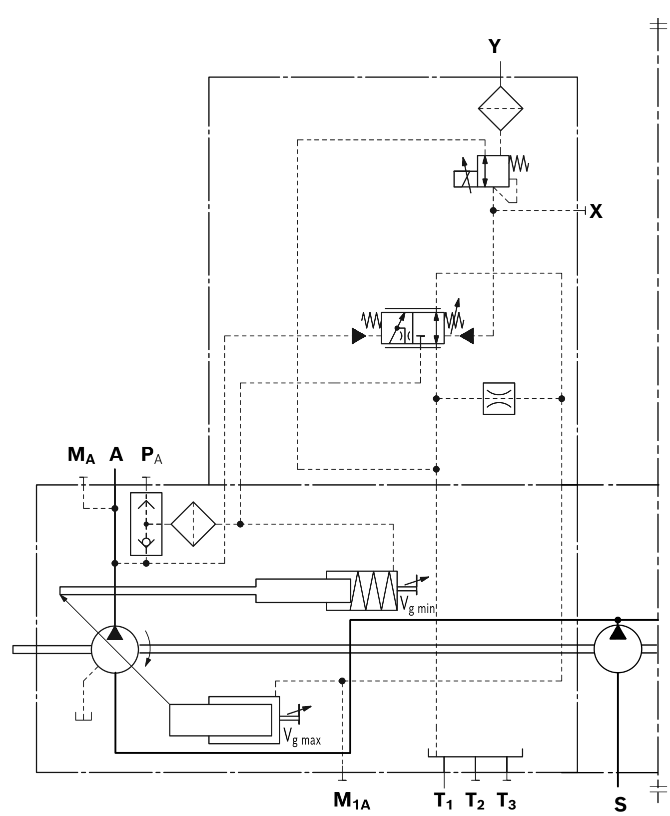


Technical data, solenoid	D2
Voltage	24 V
Control current	
Start of control at $V_{g\,min}$	300 mA
End of control at $V_{g\,max}$	750 mA
Current limit	750 mA
Nominal resistance (at 20 °C)	12 Ω
Dither frequency	200 Hz
Duty cycle	100%
Type of protection: see connector version page 40	

The following electronic control units and amplifiers are available for controlling the proportional solenoids:

BODAS controllers RC Series	Data sheet
30	95205
31	95206
40	95207 and 95208
And application software	
Analog amplifier RA	95230

▼ **Circuit diagram D2**



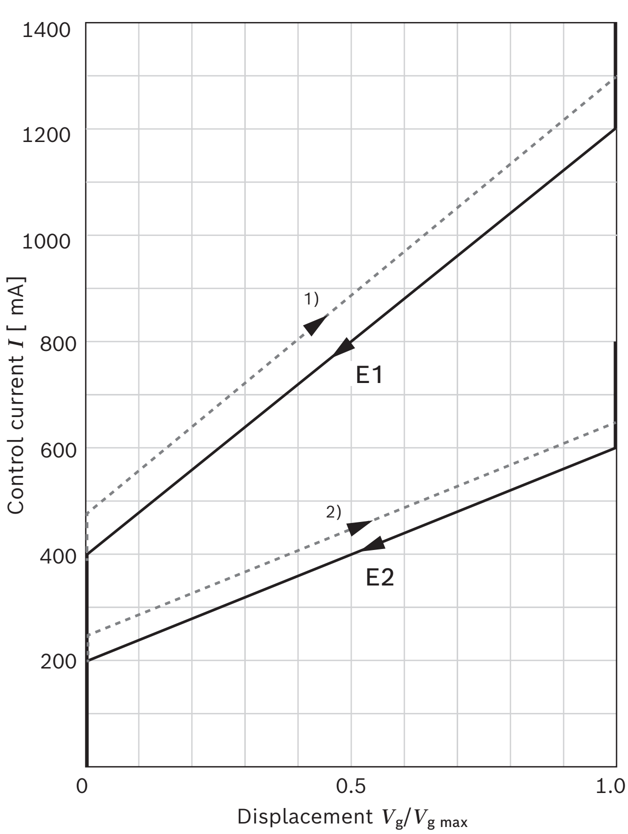
Stroke control

E1/E2 – Stroke control, electric, proportional (positive control)

With the electrical stroke control with proportional solenoid, the pump displacement is steplessly adjusted in proportion to the current via the magnetic force.
Basic position without pilot signal is $V_{g\ min}$, which includes the mechanically depressurized basic position $V_{g\ min}$ (see type code digit 08).
With increasing control current the pump swivels to a greater displacement (from $V_{g\ min}$ to $V_{g\ max}$).
The required control fluid is taken from the working pressure or the external control pressure applied to port **P**.
If the pump is to be adjusted from the basic position $V_{g\ min}$ or from a low working pressure, port **P** must be supplied with an external control pressure of at least 30 bar, maximum 50 bar.

Notice
If there is no external control pressure applied to **P**, the version "Maximum swivel angle ($V_{g\ max}$), without external control pressure supply" must be ordered (see type code position 08, A).

▼ **Characteristic curve E1/E2**



Technical data, solenoid	E1	E2
Voltage	12 V (±20%)	24 V (±20%)
Control current		
Start of control at $V_{g\ min}$	400 mA	200 mA
End of control at $V_{g\ max}$	1200 mA[1)]	600 mA[2)]
Current limit	1.3 A	0.65 A
Nominal resistance (at 20 °C)	5.5 Ω	22.7 Ω
Dither frequency	100 Hz	100 Hz
Duty cycle	100%	100%
Type of protection: see connector version page 40		

The following electronic control units and amplifiers are available for controlling the proportional solenoids:

BODAS controllers RC Series	Data sheet
30	95205
31	95206
40	95207 and 95208
And application software	
Analog amplifier RA	95230

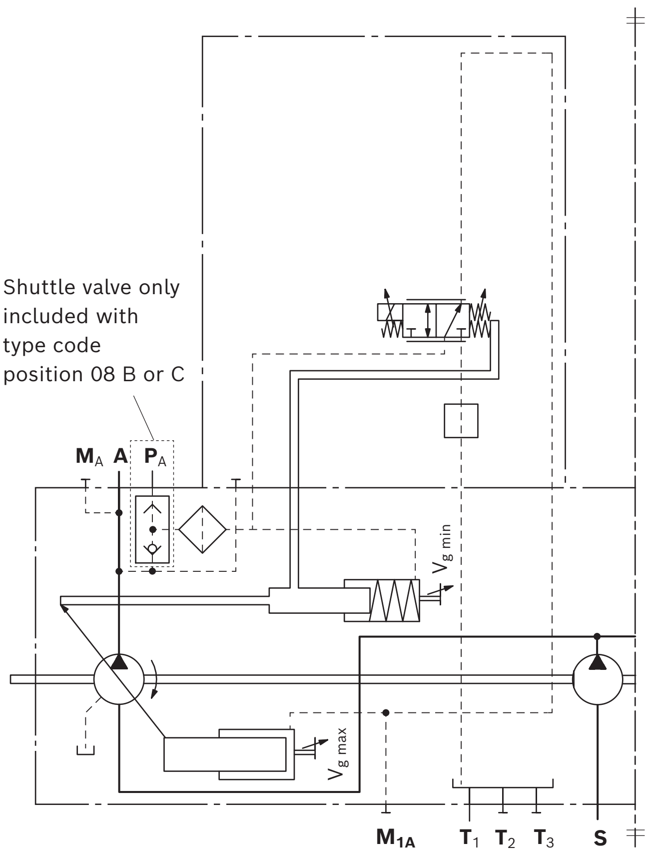
When ordering, state in plain text:
- Drive speed n [rpm]
- Maximum flow $q_{V\ max}$ [l/min]
- Minimum flow $q_{V\ min}$ [l/min]

See circuit diagram on page 22

Notice!
The spring feedback in the controller is not a safety device.
The controller can stick in an undefined position due to internal contamination (contaminated hydraulic fluid, abrasion or residual contamination from system components). As a result, the flow in the axial piston unit will no longer respond correctly to the operator's specifications.
Check whether the application on your machine requires additional safety measures to bring the driven consumer to a safe position (immediate stop). If necessary, make sure these are appropriately implemented.

1) Because of the control hysteresis, a control current of up to 1300 mA may be required for the $V_{g\ max}$ position.
2) Because of the control hysteresis, a control current of up to 650 mA may be required for the $V_{g\ max}$ position.

▼ **Circuit diagram E1/E2; Basic position A/B depressurized at maximum swivel angle ($V_{g\,max}$)**



E6 – Stroke control, electric, proportional (positive control)

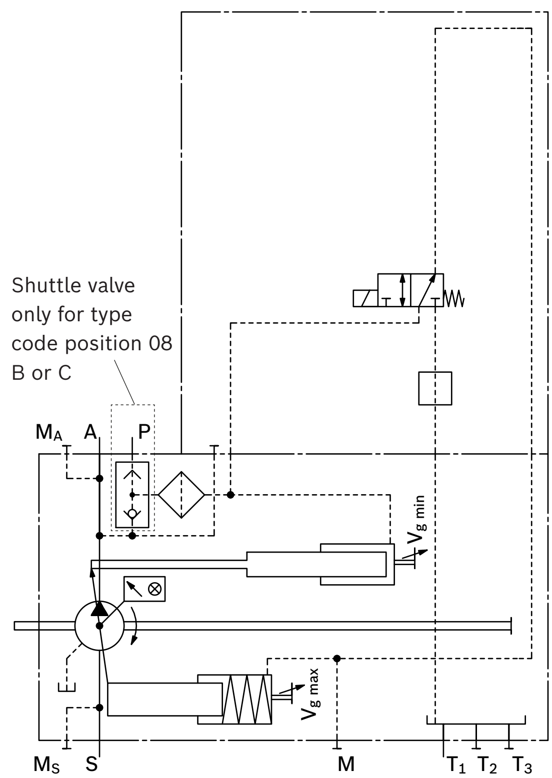
With the electric two-point stroke control with switching solenoid, the displacement of the pump is adjusted between $V_{g\ min}$ and $V_{g\ max}$.
Basic setting without current is $V_{g\ min}$. This includes the mechanically depressurized basic setting $V_{g\ min}$ (see type code digit 08).
When the solenoid is energized, the pump swivels from $V_{g\ min}$ to $V_{g\ max}$.
The required control power is taken from the working pressure or the external control pressure applied to port **P**.
To enable the pump to be adjusted from the basic setting $V_{g\ min}$ or from a low working pressure, port **P** must be supplied with an external control pressure of at least 30 bar, maximum 50 bar.

Notice

If no external control pressure is connected to **P**, the version "Maximum swivel angle ($V_{g\ max}$), without external control pressure supply" must be ordered (see type code digit 08, A).

Technical data, solenoid	E6
Voltage	24 V
Nominal resistance (at 20 °C)	21.7 Ω
Nominal power	26.5 W
Test current	0.67 A
Duty cycle	100%
Type of protection: see connector version page 40	

▼ **Circuit diagram E6**



Notice

The spring feedback in the controller is not a safety device.
The controller can stick in an undefined position due to internal contamination (contaminated hydraulic fluid, abrasion or residual contamination from system components). As a result, the flow in the axial piston unit will no longer respond correctly to the operator's specifications.
Check whether your application requires that remedial measures be taken on your machine in order to bring the driven consumer into a safe position (e.g. immediate stop). If necessary, make sure these are appropriately implemented.

H3 – Stroke control, hydraulic-proportional, pilot pressure (negative control)

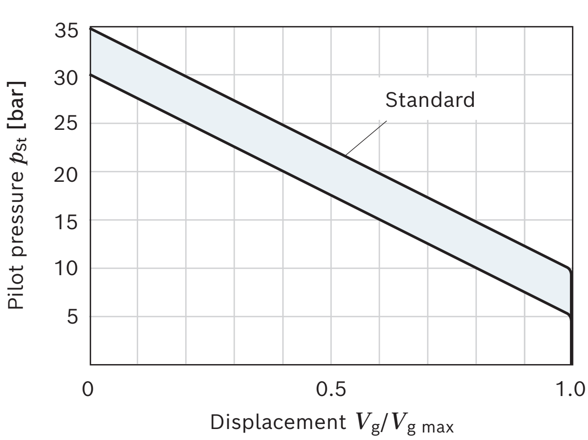
With pilot-pressure related control, the pump displacement is adjusted in proportion to the pilot pressure applied at port **H3**.
Basic position without pilot signal is $V_{g\ max}$.
The mechanical depressurized basic position is $V_{g\ max}$ (see type code 09, letter B).

- Control from $V_{g\ max}$ to $V_{g\ min}$
  with increasing pilot pressure the pump swivels to a smaller displacement.
- Setting range for start of control (at $V_{g\ max}$)
  7 bar to 10 bar, standard is 10 bar.
  Setting range 5 bar to 7 bar upon request.
  State the beginning of control in plain text in the order.
- Maximum permissible pilot pressure $p_{St\ max}$ = 100 bar

The required control fluid is taken from the working pressure or the external control pressure applied to port **P**.
If the pump is to be adjusted from the basic position $V_{g\ min}$ or from a low working pressure, port **P** must be supplied with an external control pressure of at least 30 bar, maximum 50 bar.

Notice
If there is no external control pressure applied to **P**, the version "Maximum swivel angle ($V_{g\ max}$), without external control pressure supply" must be ordered (see type code position 09, letter A).

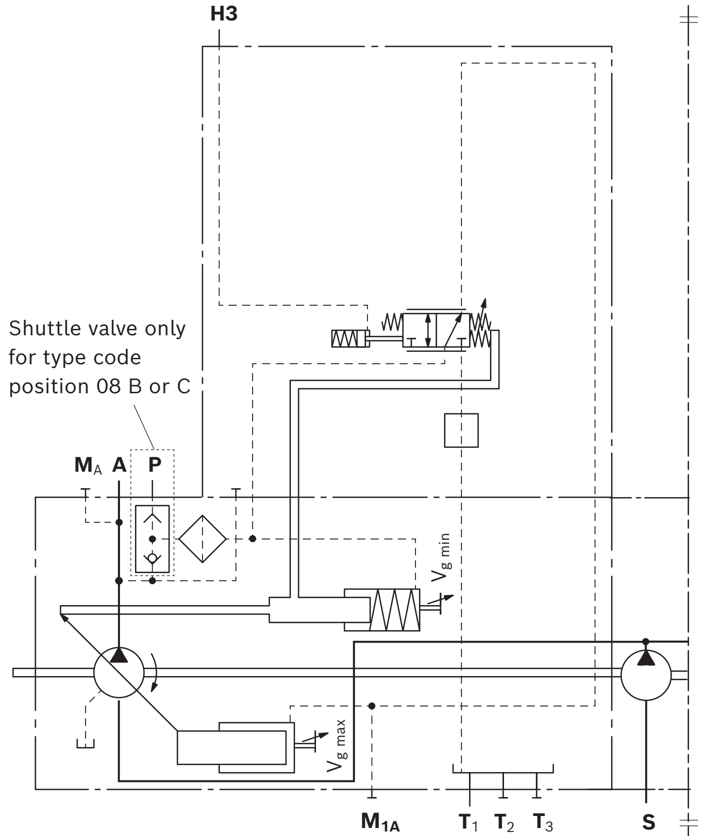
Characteristic curve H3 (negative)



Pilot pressure increase $V_{g\ max}$ to $V_{g\ min}$: Δp = 25 bar
When ordering, state in plain text:

- Beginning of control [bar] at $V_{g\ max}$

Circuit diagram H3



Illustrated for purposes of clarity, only pump A

H4 – Stroke control, hydraulic-proportional, pilot pressure (positive control)

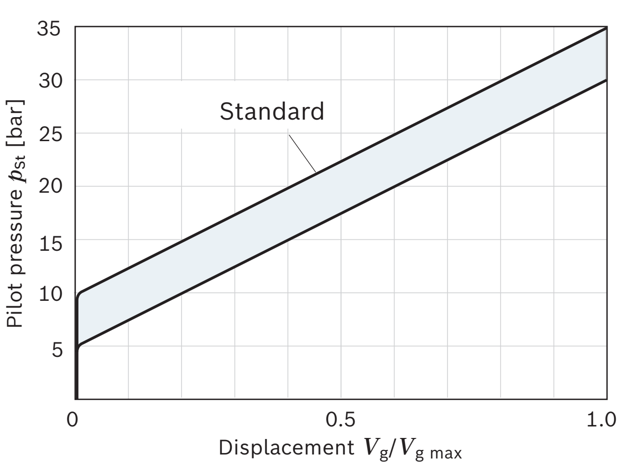
With pilot-pressure related control, the pump displacement is adjusted proportionally and continuously with a pilot pressure applied at port **H4**.
Basic position without pilot signal is $V_{g\,min}$.
The mechanical depressurized basic position is $V_{g\,min}$ (see type code position 08, letter C).

- Control from $V_{g\,min}$ to $V_{g\,max}$
  with increasing pilot pressure the pump swivels to a greater displacement.
- Setting range for start of control (at $V_{g\,min}$)
  is 5 bar to 10 bar, standard is 10 bar.
  State the beginning of control in plain text in the order.
- Maximum permissible pilot pressure $p_{St\,max}$ = 100 bar

The required control fluid is taken from the working pressure or the external control pressure applied to port **P**.
If the pump is to be adjusted from the basic position $V_{g\,min}$ or from a low working pressure, port **P** must be supplied with an external control pressure of at least 30 bar, maximum 50 bar.

Notice
If there is no external control pressure applied to **P**, the version "Maximum swivel angle ($V_{g\,max}$), without external control pressure supply" must be ordered (see type code position 08, letter A).

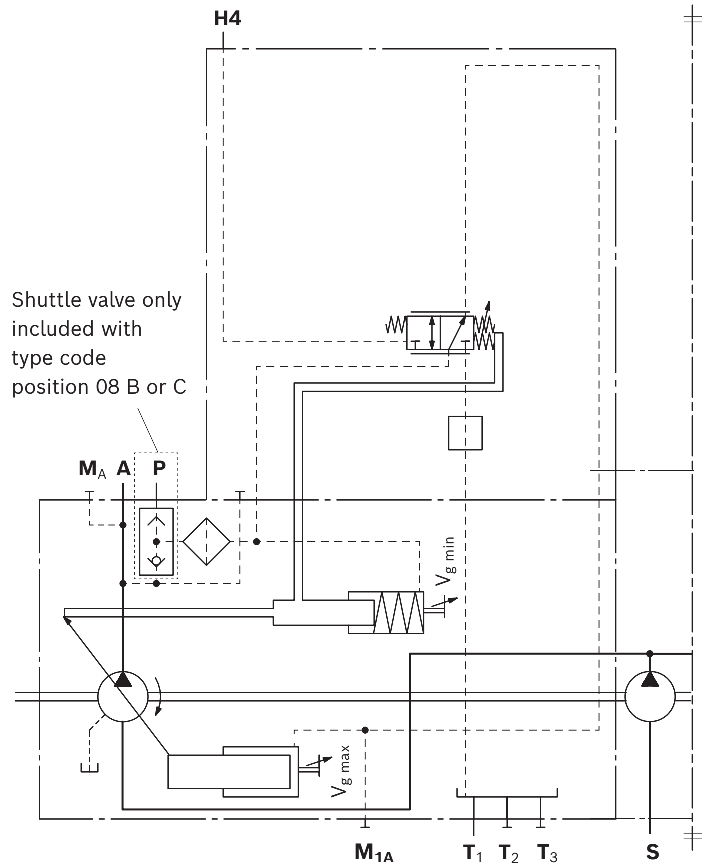
▼ **Characteristic curve H4 (positive)**



Pilot pressure increase $V_{g\,min}$ to $V_{g\,max}$: Δp = 25 bar
When ordering, state in plain text:

- Beginning of control [bar] at $V_{g\,min}$

▼ **Circuit diagram H4**



Illustrated for purposes of clarity, only pump A

Notice!
The spring feedback in the controller is not a safety device.
The controller can stick in an undefined position due to internal contamination (contaminated hydraulic fluid, abrasion or residual contamination from system components). As a result, the flow in the axial piston unit will no longer respond correctly to the operator's specifications.
Check whether the application on your machine requires additional safety measures to bring the driven consumer to a safe position (immediate stop).
If necessary, make sure these are appropriately implemented.

H5 – Stroke control, hydraulic-proportional, pilot pressure (negative control)

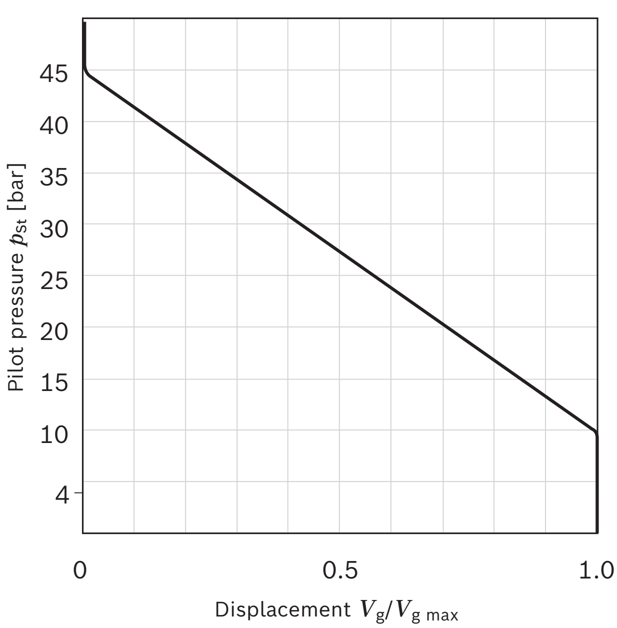
With pilot-pressure related control, the pump displacement is adjusted in proportion to the pilot pressure applied at port **H5**.
Basic position without pilot signal is $V_{g\ max}$, which includes the mechanically depressurized basic position $V_{g\ max}$ (see type code digit 08).

- Maximum permissible pilot pressure $p_{St\ max}$ = 100 bar
- Control from $V_{g\ max}$ to $V_{g\ min}$
  With increasing pilot pressure the pump swivels to a smaller displacement.
- Beginning of control (at $V_{g\ max}$) 10 bar

The required control power is taken from the working pressure or the external control pressure applied to port **P**.
If the pump is to be adjusted at low working pressure, port **P** must have an external control pressure supply of at least 30 bar, maximum 50 bar.

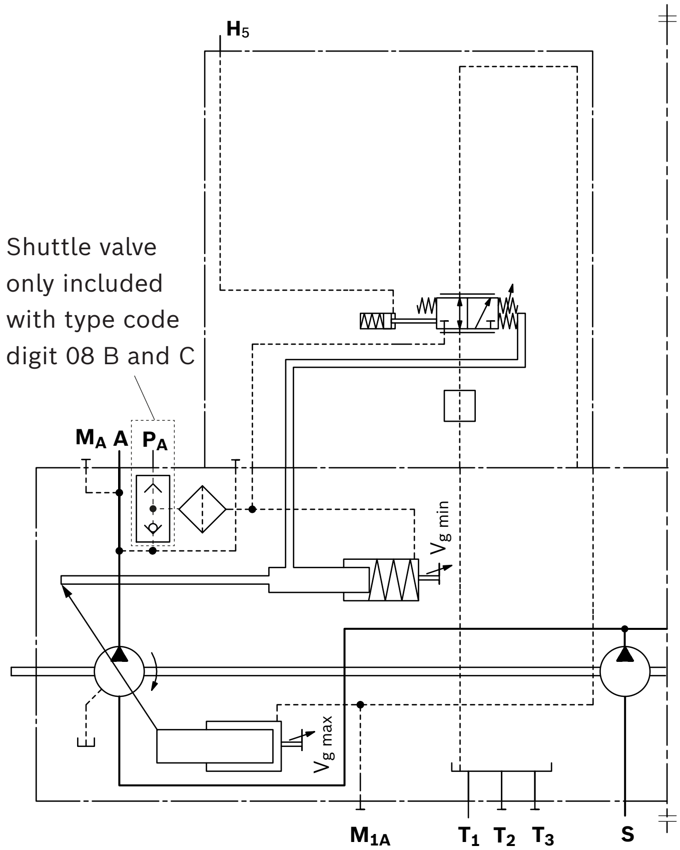
Notice
If no external control pressure is connected to **P**, the version "Maximum swivel angle ($V_{g\ max}$), without external control pressure supply" must be ordered (see type code digit 08, A).

▼ **Characteristic curve H5 (negative)**



Pilot pressure increase $V_{g\ max}$ to $V_{g\ min}$: Δp = 35 bar

▼ **Circuit diagram H5**



Illustrated for purposes of clarity, only pump A

H6 – Stroke control, hydraulic-proportional, pilot pressure (positive control)

With pilot-pressure related control, the pump displacement is adjusted in proportion to the pilot pressure applied at port **H6**.

Basic position without pilot signal is $V_{g\,min}$, which includes the mechanically depressurized basic position $V_{g\,min}$ (see type code digit 08).

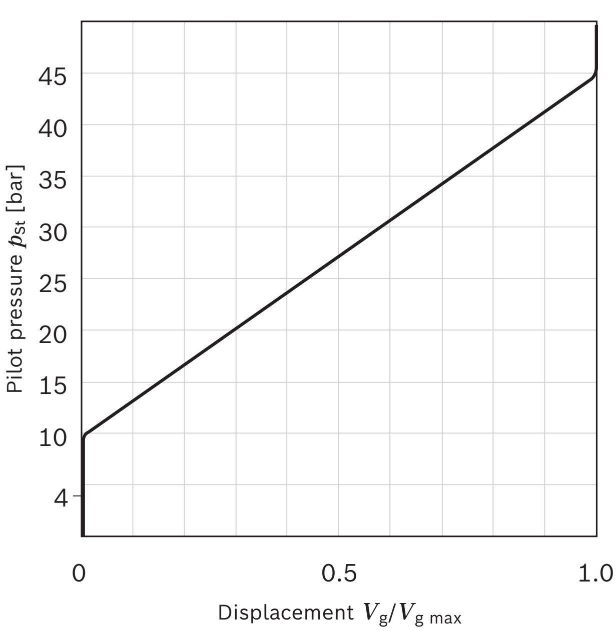
- Maximum permissible pilot pressure $p_{St\,max}$ = 100 bar
- Control from $V_{g\,min}$ to $V_{g\,max}$
  With increasing pilot pressure the pump swivels to a higher displacement.
- Beginning of control (at $V_{g\,min}$) 10 bar.

The required control power is taken from the working pressure or the external control pressure applied to port **P**.

If the pump is to be adjusted from the zero basic setting or from a low working pressure, port **P** must be supplied with an external control pressure of at least 30 bar, maximum 50 bar.

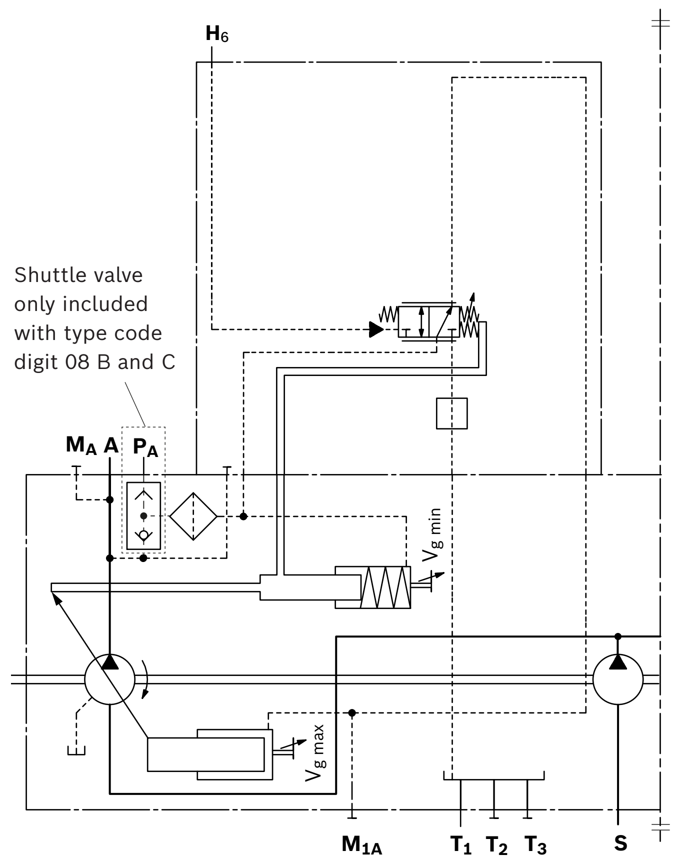
Notice
If no external control pressure is connected to **P**, the version "Maximum swivel angle ($V_{g\,max}$), without external control pressure supply" must be ordered (see type code digit 08, A).

▼ **Characteristic curve H6 (positive)**



Pilot pressure increase $V_{g\,min}$ to $V_{g\,max}$: Δp = 35 bar

▼ **Circuit diagram H6**



Illustrated for purposes of clarity, only pump A

DRS0 – Pressure controller with load-sensing

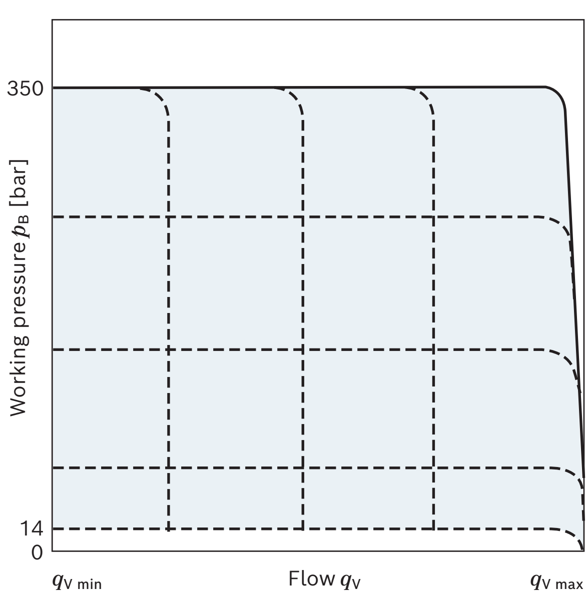
The load-sensing controller works as a load-pressure controlled flow controller and adjusts the displacement of the pump to the volume required by the consumer.
The flow of the pump is then dependent on the cross section of the external metering orifice (**1**), which is located between the pump and the consumer.
Below the setting of the pressure controller and within the control range of the pump, the flow is not dependent on the load pressure.
The metering orifice is usually a separately located load-sensing directional valve (control block).
The position of the directional valve spool determines the opening cross-section of the metering orifice and thus the flow of the pump.
The load-sensing controller compares the pressure upstream the metering orifice to the one downstream the orifice and keeps the pressure drop (differential pressure Δp) occurring here and thus the flow constant.
If the differential pressure Δp at the metering orifice rises, the pump is swiveled back (toward $V_{g\,min}$). If the differential pressure Δp drops, the pump is swiveled out (toward $V_{g\,max}$) until equilibrium at the metering orifice is restored.

$\Delta p_{metering\ orifice} = p_{pump} - p_{consumer}$

- Setting range for Δp 14 to 30 bar (please state in plain text)
- Standard setting 14 bar

The stand-by pressure in zero-stroke operation (metering orifice closed) is slightly higher than the Δp setting.

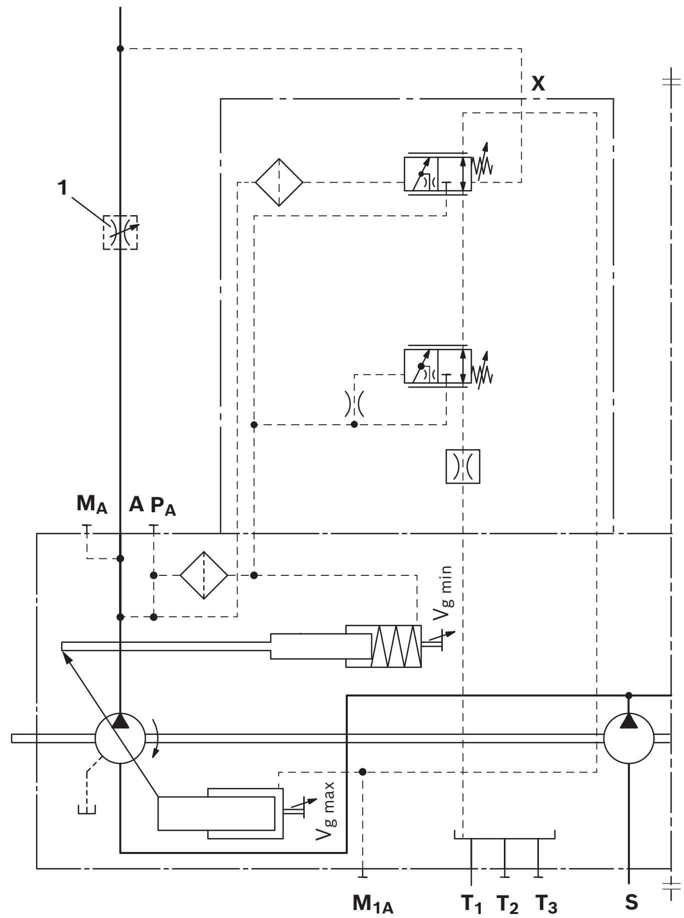
▼ **Characteristic curve DRS0**



When ordering, state in plain text:

- Pressure setting p [bar] at pressure controller DR
- Differential pressure Δp [bar] at load-sensing controller S0

▼ **Circuit diagram DRS0**



Illustrated for purposes of clarity, only pump A

1 The metering orifice (control block) is not included in the scope of delivery.

S3/S4 – Load-sensing controller, electric-proportional override (negative control)

A control current acts against the adjustment spring of the load-sensing controller via a proportional solenoid.
The mechanically adjusted differential pressure can be reduced by means of different control current settings.
Increasing control current = reduced differential pressure.

- Reduced differential pressure/control current =
  at S3: 3.1 bar/ 200 mA
  at S4: 3.1 bar/ 100 mA

Technical data, solenoid	S3	S4
Voltage	12 V (±20%)	24 V (±20%)
Control current		
Start of control	400 mA	200 mA
End of control	1200 mA	600 mA
Current limit	1.3 A	0.65 A
Nominal resistance (at 20 °C)	5.5 Ω	22.7 Ω
Dither frequency	100 Hz	100 Hz
Duty cycle	100%	100%
Type of protection: see connector version page 40		

The following electronic control units and amplifiers are available for controlling the proportional solenoids:

BODAS controllers RC Series	Data sheet
30	95205
31	95206
40	95207 and 95208
And application software	
Analog amplifier RA	95230

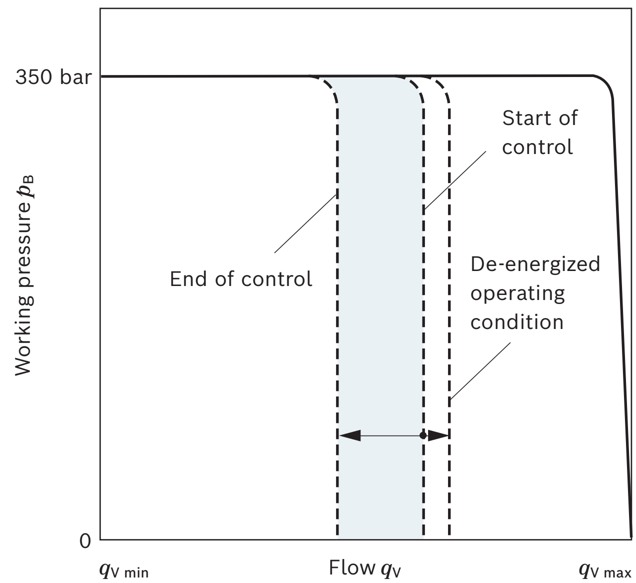
When ordering, state in plain text:

- Differential pressure setting Δp [bar] with control current 200 mA.

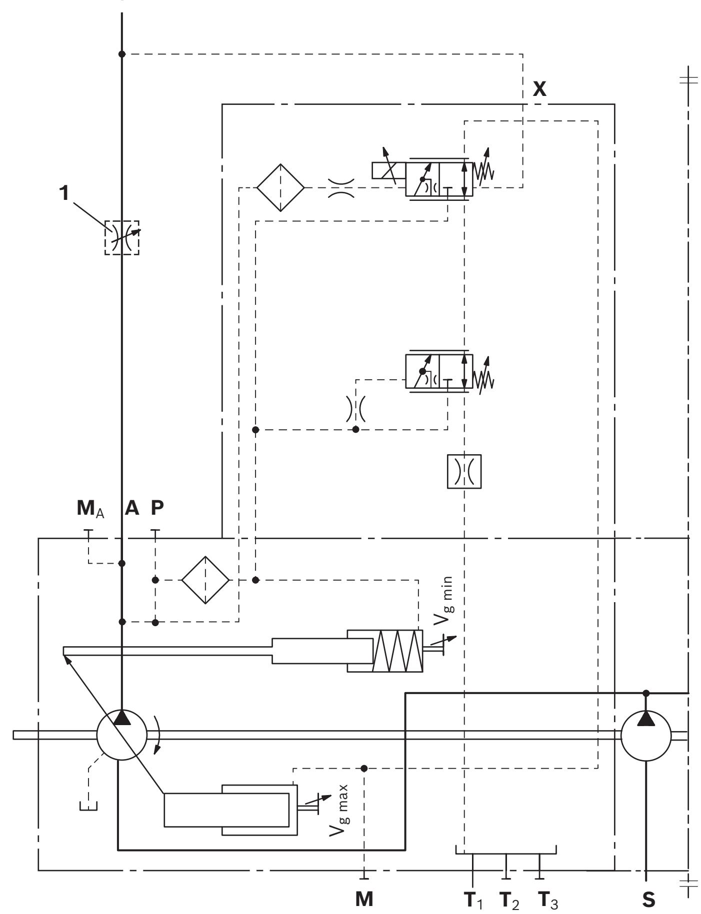
$\Delta p_{\text{metering orifice}} = p_{\text{pump}} - p_{\text{consumer}}$

- Setting range for Δp 20 bar to 30 bar for 200 mA
- Standard setting 20 bar at 200 mA

▼ **Characteristic curve DRS4**



Circuit diagram DRS4



1 The metering orifice (control block) is not included in the scope of delivery.

Notice

- In operating condition S3 de-energized (jump 400 to 0 mA): Increased differential pressure by 3.2 bar.
- In operating condition S4 de-energized (jump 200 to 0 mA): Increased differential pressure by 3.2 bar.

DGV2 – With integrated pressure relief valve and electric 2/2 directional seat valve (de-energized standby)

The remote controlled pressure controller has a fixed setting Δp value. A pressure relief valve (pilot valve) integrated in the control valve allows for a fixed pressure control with switch-off through to standby = Δp value due to the integrated electric 2/2 directional seat valve.

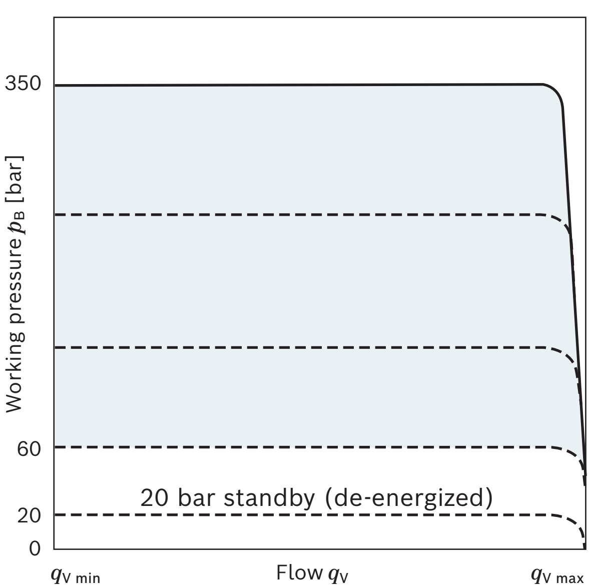
- Setting range Δp 14 bar to 25 bar
- Recommended value 20 bar (standard)
- Setting range for pressure control is 60 bar to 350 bar
- Standard is 350 bar

When ordering, state in plain text:

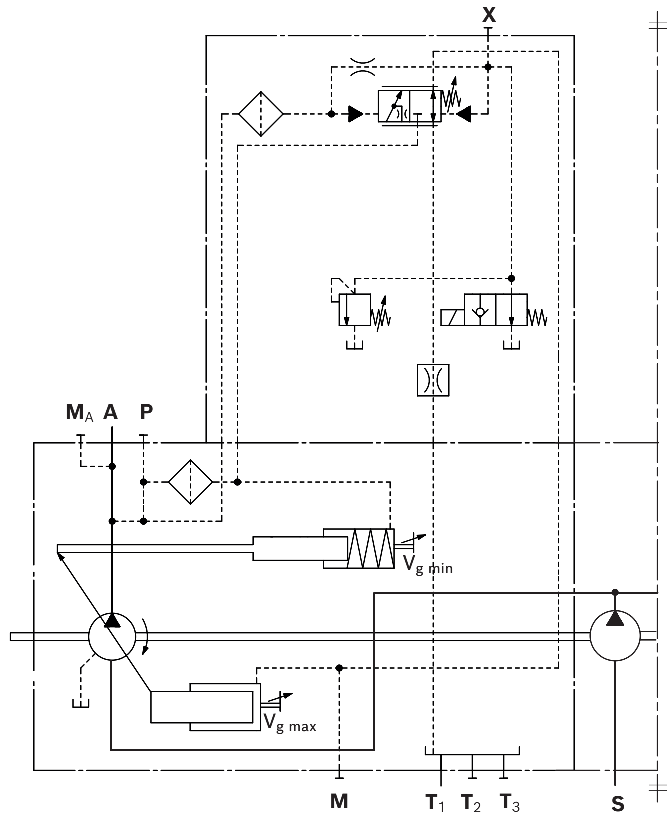
- Differential pressure Δp in bar
- Pressure setting p in bar
  (working pressure at port **A**)

Technical data, solenoid	DGV2
Voltage	24V ±10%
Current	900 mA
Nominal resistance (at 20-25 °C)	28.2 Ω
Power consumption	20 W
Type of protection: see connector version page 40	

▼ **Characteristic curve DGV2**



▼ **Circuit diagram DGV2**



Illustrated for purposes of clarity, only pump A

C5H3 – Cross-sensing control with power-controlled double pumps, stroke control, hydraulic-proportional, pilot-pressure related

The method of function is made up of controllers L5 and CR to C5.

For the operation, refer to chapters "L5 – Power controller, hydraulic-proportional override (negative control)" on page 14 and "CR – Summation power control of two power-controlled pumps, high-pressure-related override (with stop)" on page 16.

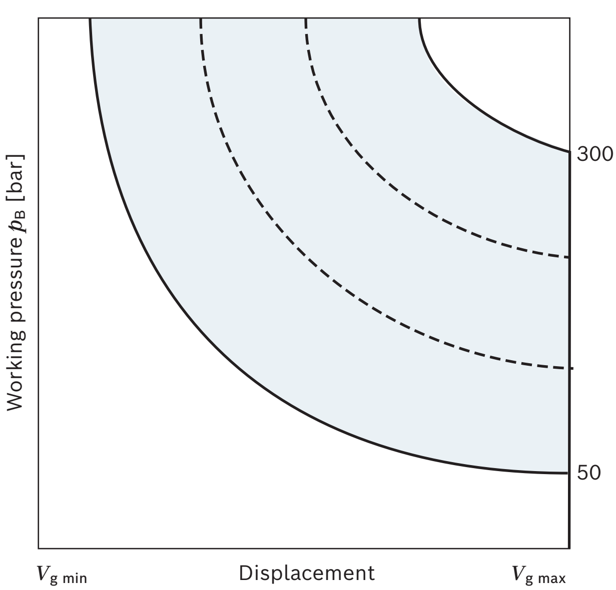
The function of H3 controller "H3 – Stroke control, hydraulic-proportional, pilot pressure (negative control)" can be found on page 24.

Setting range for beginning of control 50 to 300 bar

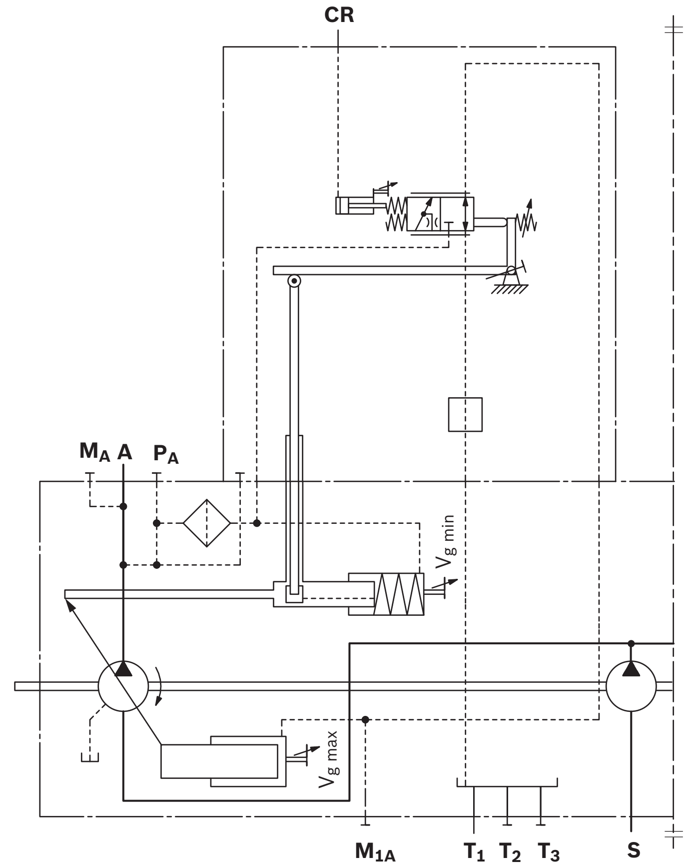
When ordering, please specify:

- Maximum drive power P_{max} [kW]
- Minimum drive power P_{min} [kW]
- Drive speed n [rpm]
- Maximum flow $q_{V\ max}$ [l/min]

▼ **Characteristic curve CR**

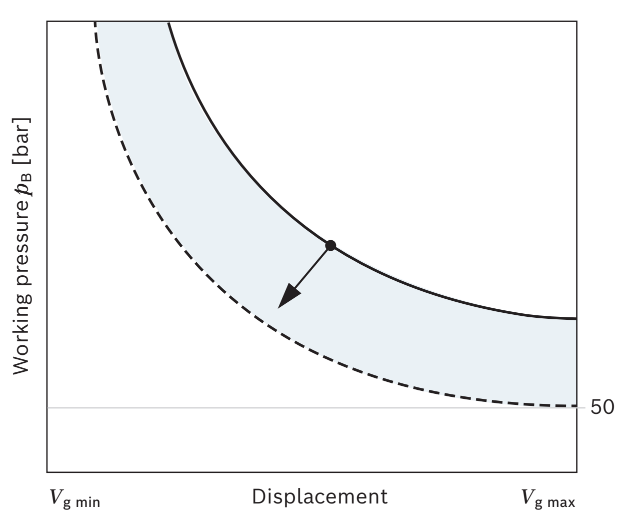


▼ **Circuit diagram CR**



Illustrated for purposes of clarity, only pump A

▼ **Effect of power override of a pump with increasing pressure in the 2nd pump**



DGT6 – With integrated pilot control valve, electric-proportional override (positive control)

The remote controlled pressure controller has a fixed-setting Δp value. An electric pressure relief valve (pilot valve) integrated in the control valve enables remote pressure control.

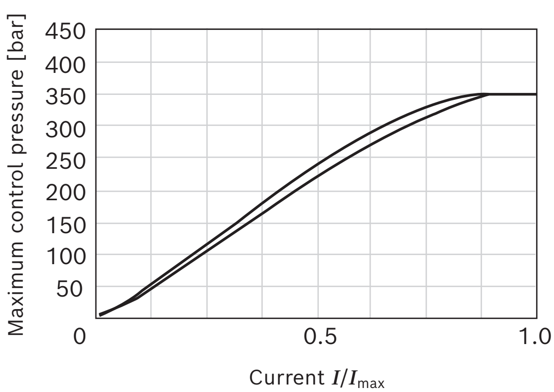
- Fixed value at Δp 14 bar.
- Pilot valve pressure, fixed setting: 336 bar
- Maximum pressure p_{max} [bar] (pressure on port **A**) with 1200 mA current: 350 bar

Pilot valve T6

The electro proportional pressure relief valve is directly controlled with a positive control as cartridge version (see data sheet 18139-04).
Electric proportional valve:
350 bar: KBPS**R**8AA/HCG24K40V

Notes and explanations for the DG controller can be found on page 19.

▼ **Characteristic curve T6**

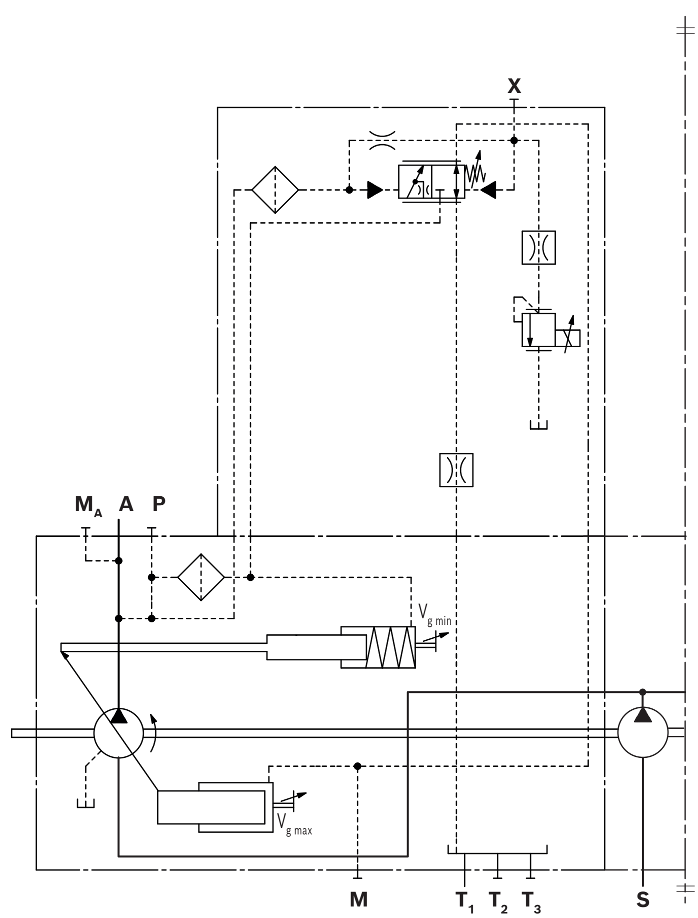


Technical data, solenoid	T6
Voltage	24 V
Control current	
Minimum pressure p_{min}	0 mA
Maximum pressure p_{max}	1200 mA
Maximum rated current	1200 mA
Nominal resistance (at 20 °C)	4.8 Ω
Dither frequency	200 Hz
Duty cycle	100%
Type of protection: see connector version page 40	

The following electronic control units and amplifiers are available for controlling the proportional solenoids:

BODAS controllers RC Series	Data sheet
30	95205
31	95206
40	95207 and 95208
And application software	
Analog amplifier RA	95230

▼ **Circuit diagram DGT6**



DGT8 – With integrated pilot control valve, electric-proportional override (negative control)

The remote controlled pressure controller has a fixed-setting Δp value. An electric pressure relief valve (pilot valve) integrated in the control valve enables remote pressure control.

- Fixed value at Δp 14 bar.

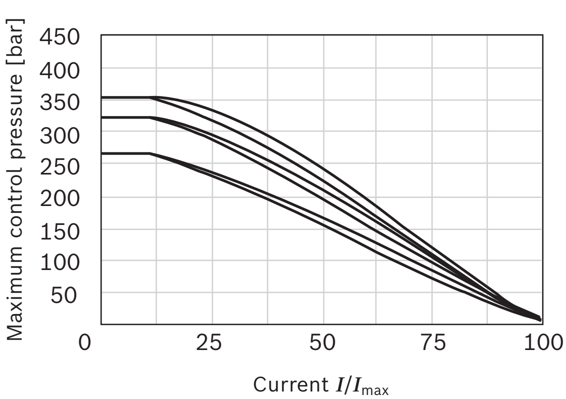
When ordering, state pressure setting in plain text:

- Maximum pressure p_{max} [bar] (pressure on port **A**) with 0 mA current.
  Standard is 350 bar

Pilot valve T8

The electro proportional pressure relief valve is directly controlled with a negative control as cartridge version (see data sheet 18139-05).
Due to the pressure settings stated in plain text, the following electro proportional pressure relief valves are used:
200...250 bar (2900...3600 psi): KBPS**N**8BA/HCG24K40V
251...315 bar (3640...4550 psi): KBPS**P**8BA/HCG24K40V
316...350 bar (4580...5100 psi): KBPS**R**8BA/HCG24K40V
Notes and explanations for the DG controller can be found on page 19.

▼ **Characteristic curve T8**

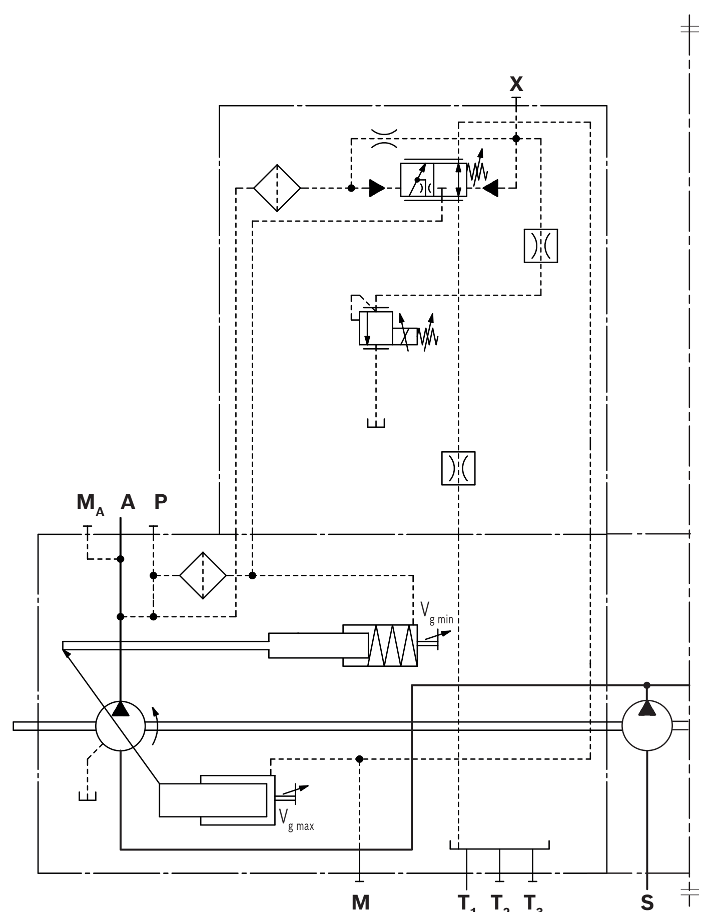


Technical data, solenoid	**T8**
Voltage	24 V
Control current	
Maximum pressure p_{max}	0 mA
Minimum pressure p_{min}	1200 mA
Maximum rated current	1200 mA
Nominal resistance (at 20 °C)	4.8 Ω
Dither frequency	200 Hz
Duty cycle	100%
Type of protection: see connector version page 40	

The following electronic control units and amplifiers are available for controlling the proportional solenoids:

BODAS controllers RC Series	**Data sheet**
30	95205
31	95206
40	95207 and 95208
And application software	
Analog amplifier RA	95230

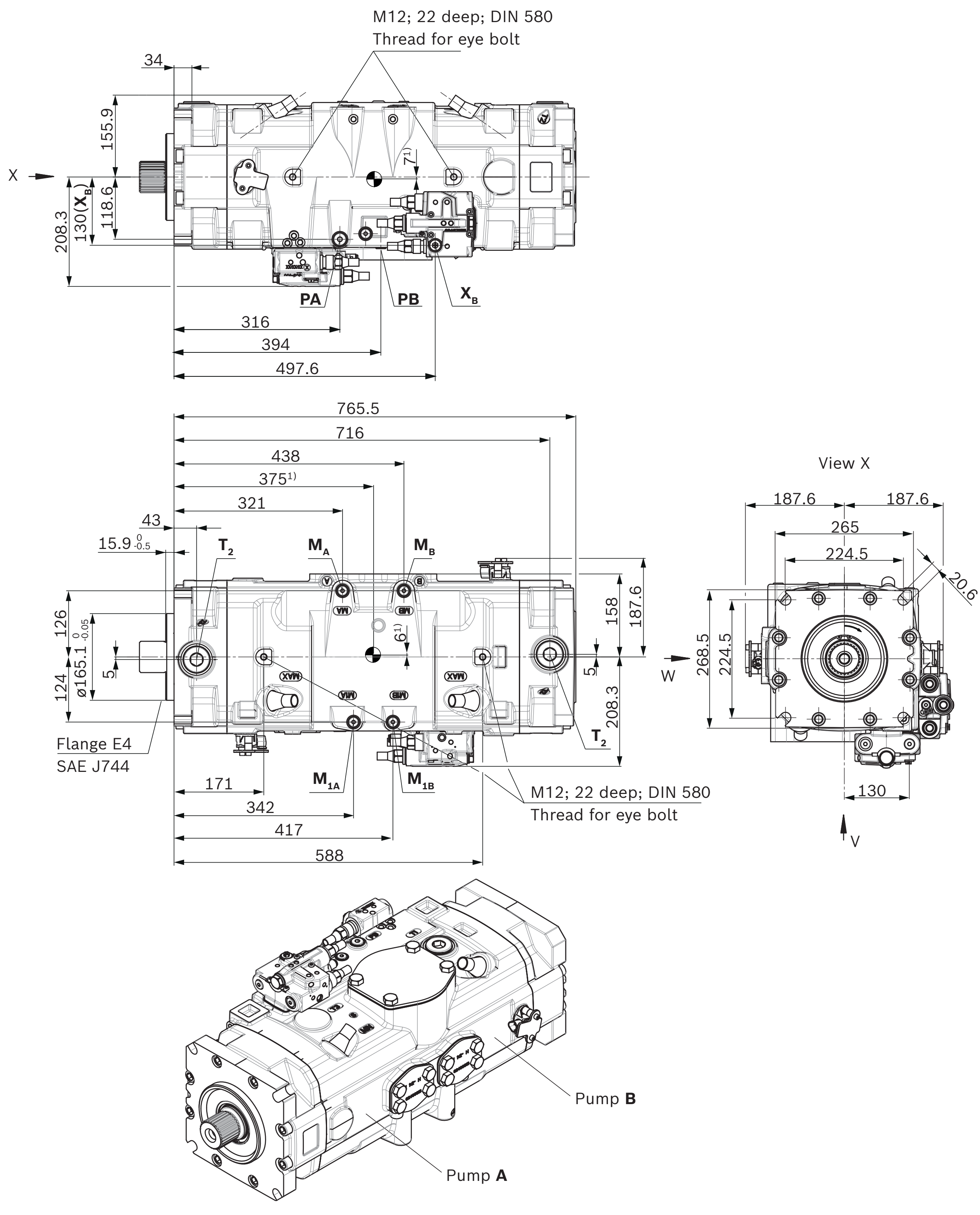
▼ **Circuit diagram DGT8**



Dimensions, size 280

LRDRS0 – Power controller with pressure controller, load-sensing and with electric swivel angle sensor (Part 1/2)

Clockwise rotation

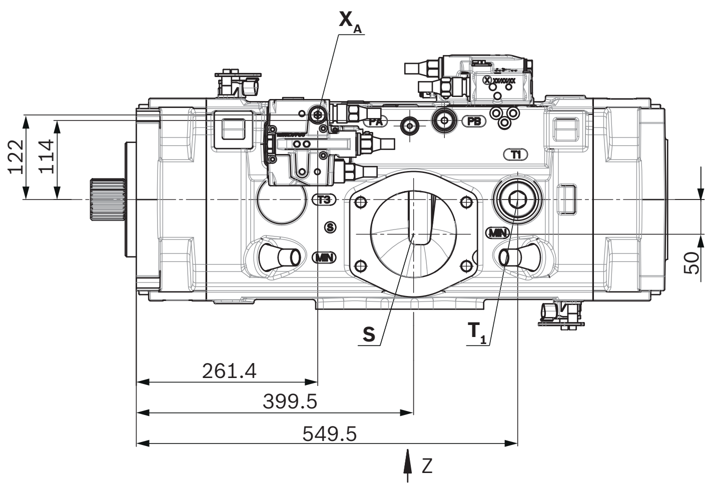


1) Center of gravity

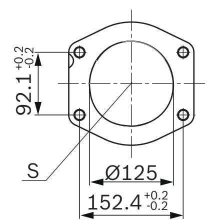
LRDRS0 – Power controller with pressure controller, load-sensing and with electric swivel angle sensor (Part 2/2)

Clockwise rotation

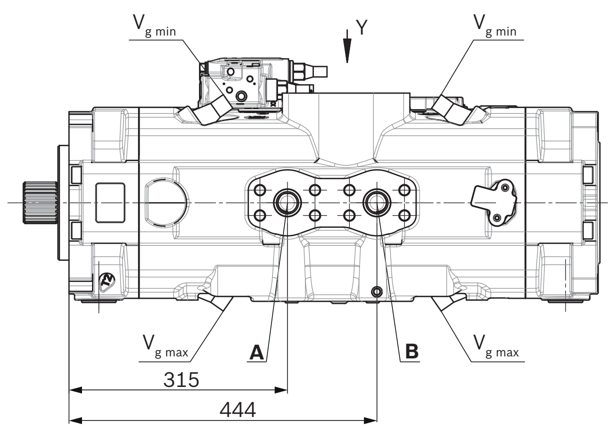
View V



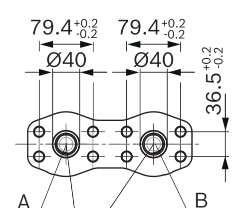
Detail Y



View W



Detail Z



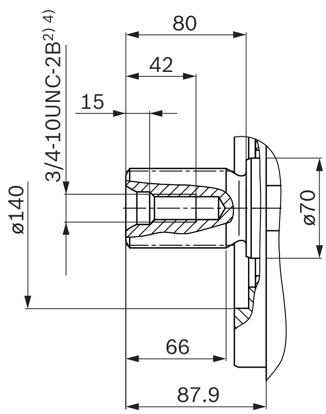
The maximum inside diameter of the fitted pressure flange must not exceed Ø36 mm.

Additional information about ports and shaft ends can be found on page 36

Ports			**Standard**	**Size**[2)]	p_{max} **[bar]**[7)]	**State**[9)]	
Pump A	**Pump B**					**Pump A**	**Pump B**
A	**B**	Working port fastening thread	SAE J518[5)] DIN 13	1 1/2 in M16 x 2; 24 deep	420	O	O
S		Suction port fastening thread	SAE J518[5)] DIN 13	5 in M16 x 2; 24 deep	30	O	
$\mathbf{T_1}$	–	Drain port	ISO 6149[6)]	M42 x 2; 19.5 deep	10	X[8)]	–
$\mathbf{T_2}$	$\mathbf{T_2}$	Drain port	ISO 6149[6)]	M42 x 2; 19.5 deep	10	O[8)]	O[8)]
CR	**CR**	Pilot signal (CR only)	ISO 6149	M14 x 1.5; 11.5 deep	420	O	O
H.	**H.**	Pilot signal (only on H3, H4, H5, H6)	ISO 6149	M14 x 1.5; 11.5 deep	100	O	O
L.	**L.**	Override power control (only with L3, L4, L5, L6)	ISO 6149	M14 x 1.5; 11.5 deep	100	O	O
$\mathbf{M_{1A}}$	$\mathbf{M_{1B}}$	Measuring control pressure	ISO 6149[6)]	M14 x 1.5; 11.5 deep	420	X	X
$\mathbf{M_A}$	$\mathbf{M_B}$	Measuring, operating pressure A, B	ISO 6149[6)]	M14 x 1.5; 11.5 deep	420	X	X
$\mathbf{X_A}$	$\mathbf{X_B}$	Measurement of pilot pressure A, B	ISO 6149[6)]	M14 x 1.5; 11.5 deep	50	X	X
$\mathbf{Y_A}$	$\mathbf{Y_B}$	Measurement of pilot pressure A, B (only for D2)	ISO 6149[6)]	M14 x 1.5; 11.5 deep	50	X	X
$\mathbf{P_A}$	$\mathbf{P_B}$	External control pressure (type code digit 9 version B or C = with external control pressure supply)	ISO 6149[6)]	M14 x 1.5; 11.5 deep	50	O	O
		Port **P** is without function (type code position 9 version A = without external control pressure supply)	ISO 6149[6)]	M18 x 1.5; 14.5 deep	420	X	X

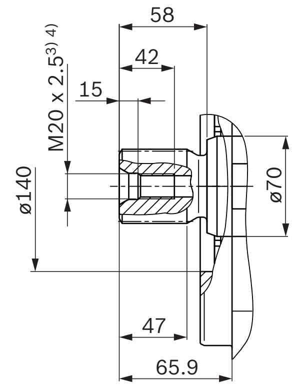
▼ **Splined shaft SAE J744**

T3 – 2 1/4 in 17T 8/16DP[1)]



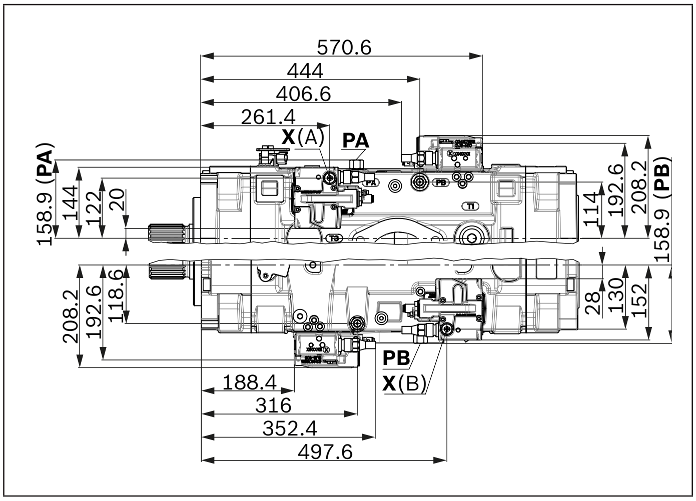
▼ **Splined shaft DIN 5480**

A4 – W60x2x28x9

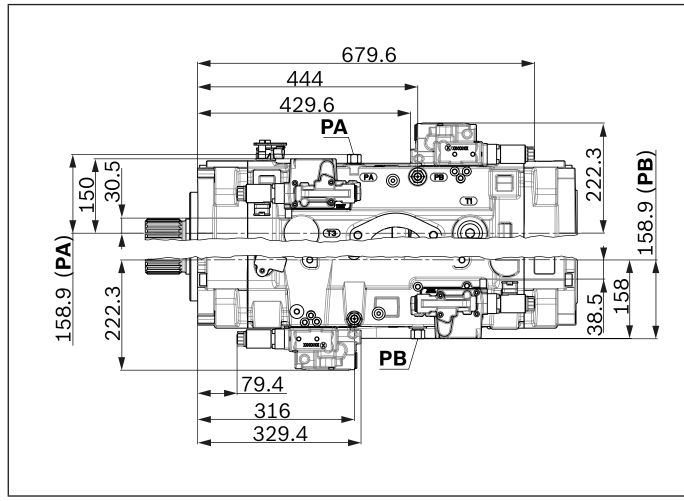


1) ANSI B92.1a, 30° pressure angle, flat root, side fit, tolerance class 5
2) Thread according to ASME B1.1
3) Center bore according to DIN 332 (thread according to DIN 13)
4) Observe the general notices on page 43 concerning the maximum tightening torques.
5) Metric fastening thread is a deviation from standard.
6) The countersink may be deeper than specified in the standard.
7) Depending on the application, momentary pressure peaks can occur. Keep this in mind when selecting measuring devices and fittings.
8) Depending on installation position, T_1, T_2 or T_3 must be connected (see also Installation instructions on pages 41 and 42).
9) O = Must be connected (plugged on delivery)
X = Plugged (in normal operation)

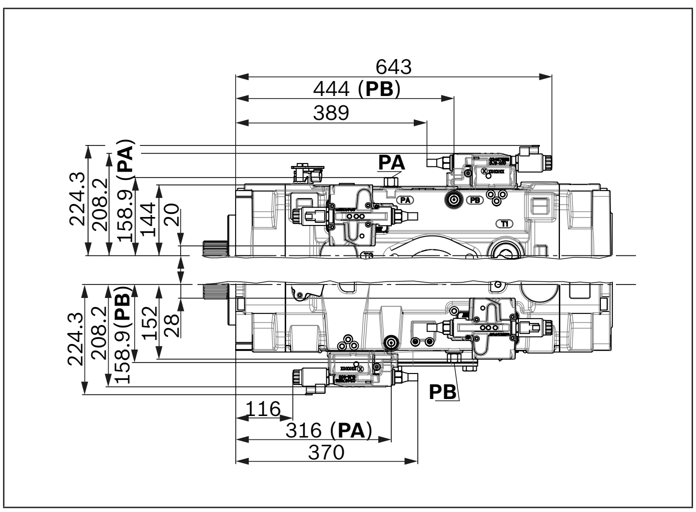
▼ **xxS0 – Additional controller; Load-sensing, internal pump pressure, fixed setting**



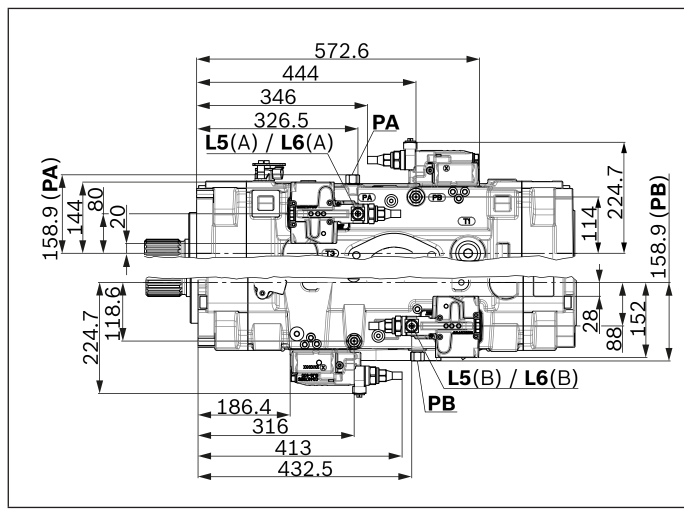
▼ **E1/E2 – Stroke control electric-proportional**



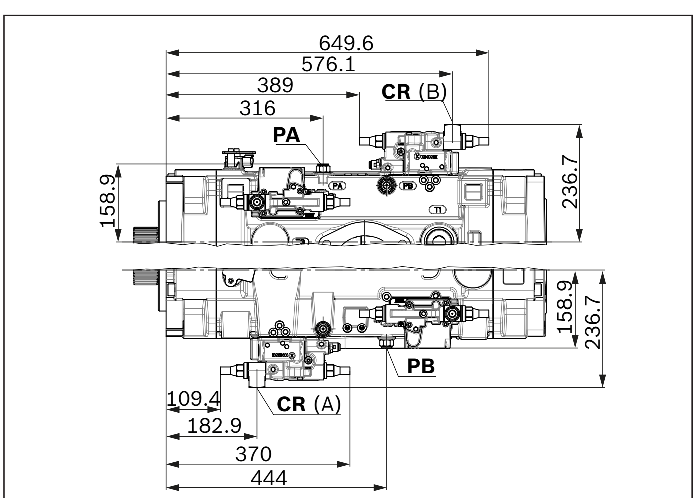
▼ **L3/L4 – Power controller, electric-proportional override**



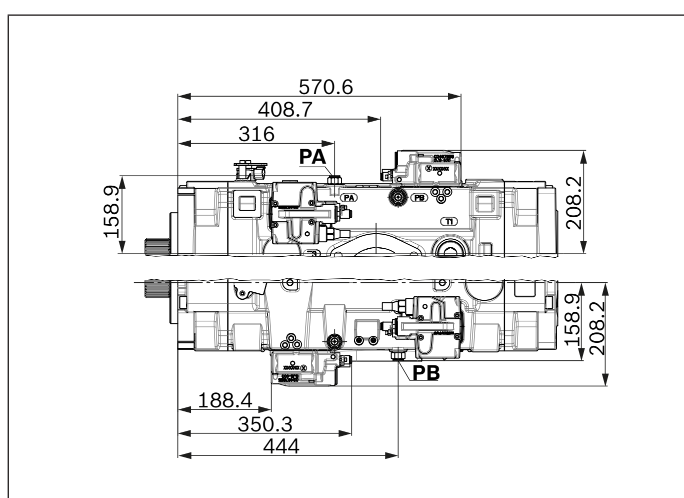
▼ **L5/L6 – Power controller, hydraulic-proportional override**



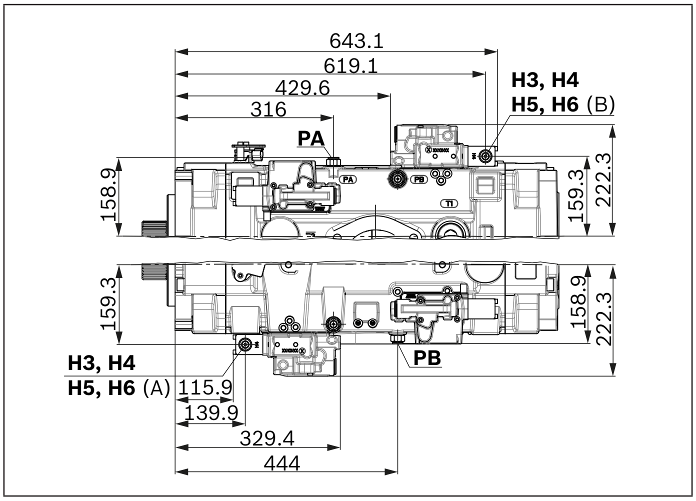
▼ **CR – Power controller, hydraulic-proportional override, high pressure, with stop**



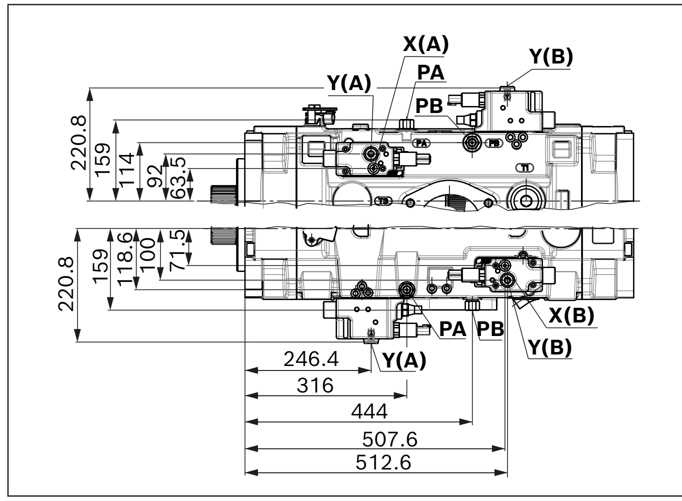
▼ **DR – Pressure controller**



▼ **H3/H4/H5/H6 – Stroke control, hydraulic-proportional, pilot pressure**



▼ **D2 – pressure control, electric-proportional with integrated pilot valve for external pilot pressure supply**



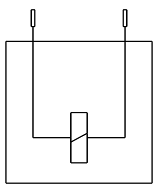
Connector for solenoids

DEUTSCH DT04-2P-EP04

Molded, 2-pin, without bidirectional suppressor diode
The following type of protection ensues with the installed mating connector:

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

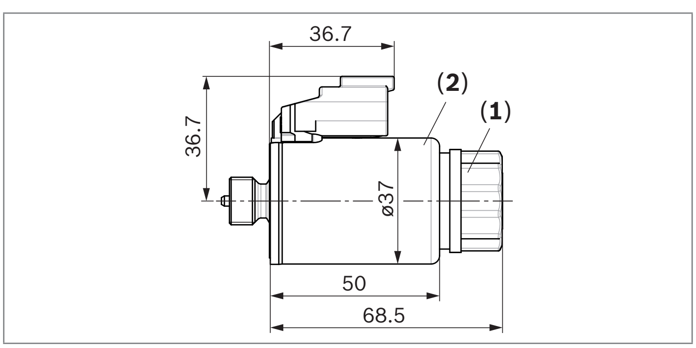
▼ Switching symbol



▼ 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).



Changing connector position

If necessary, you can change the position of the connector by turning the solenoid body.
To do this, proceed as follows:

- Loosen the mounting nut (**1**) of the solenoid. To do this, turn the mounting nut (**1**) one revolution to the left.
- Turn the solenoid body (**2**) to the desired position.
- Re-tighten the mounting nut. Tightening torque: 5+1 Nm. (Width across flats 26, 12-sided DIN 3124)

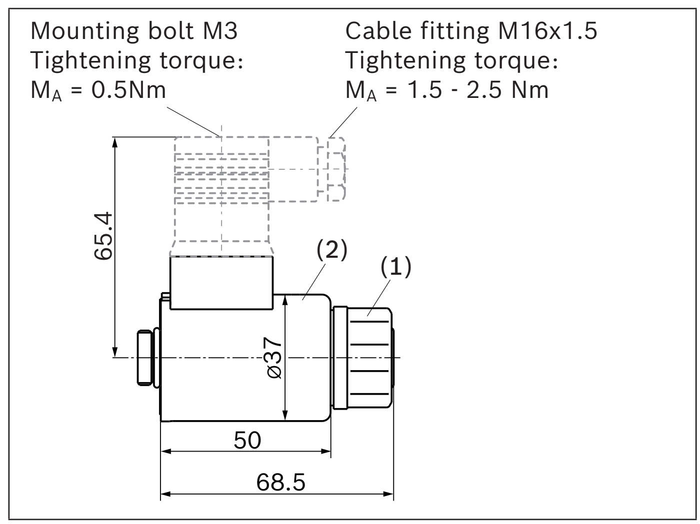
On delivery, the position of the connector may differ from that shown in the brochure or drawing.

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

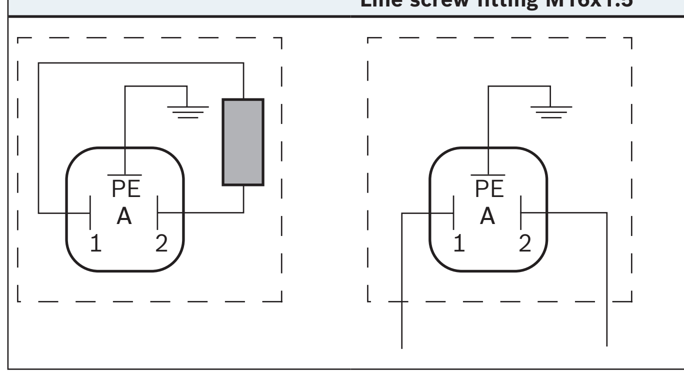
Without bidirectional suppressor diode ______________ H

Type of protection according to DIN/EN 60529______IP65

The seal ring in the cable fitting is suitable for lines of diameter 4.5mm to 10mm.
The plug-in connector is not included in the scope of delivery.
This can be supplied by Bosch Rexroth on request (material number: R902602623).



Device plug on solenoid according to DIN 43650	Plug-in connector DIN EN 175301-803-A Line screw fitting M16x1.5



Notice
If necessary, you can change the position of the connector by turning the solenoid body.
The procedure is defined in the instruction manual 90300-01-B.

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 housing area leakage in the case interior must be directed to the reservoir via the highest drain port (**T_1**, **T_2**, **T_3**).
For combinations of multiple units, the leakage must be drained off at each pump. If a shared drain line is used for this purpose, make sure that the case pressure in each pump 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 minimum permissible case pressure of all connected units is not exceeded in any situation. If this is not possible, separate drain lines must be laid if necessary.
To prevent the transmission of structure-borne noise, use elastic elements to decouple all connecting lines from all vibration-capable components (e.g. reservoir, frame parts).
Under all operating conditions, the suction and drain lines must flow into the reservoir below the minimum fluid level. The permissible suction height h_S results from the total pressure loss. However, it must not be higher than $h_{S\ max}$ = 800 mm. The minimum suction pressure at port **S** must also not fall below 0.8 bar absolute (without charge pump) or 0.7 bar absolute (with charge pump) during operation and during a cold start.
Make sure to provide adequate distance between suction line and drain line for the reservoir design.
This prevents the heated return flow from being drawn directly back into the suction line.

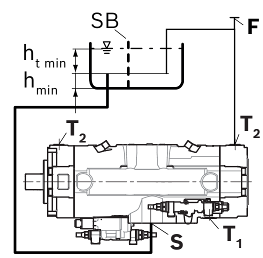
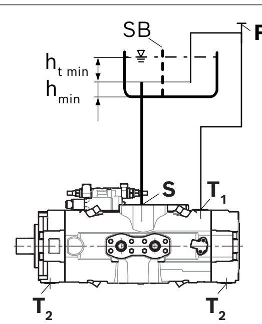
Notice
In certain installation positions, an influence on the adjustment or control can be expected.
Gravity, dead weight and case pressure can cause minor characteristic shifts and changes in actuating time.

Installation position

See the following examples **1** to **6**.
Further installation positions are available upon request.
Recommended installation position: **1** and **2**

Below-reservoir installation (standard)

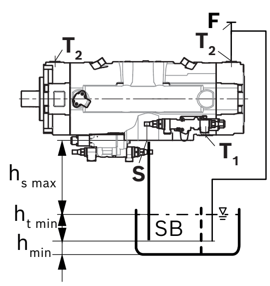
Below-reservoir installation means that the axial piston unit is installed outside of the reservoir below the minimum fluid level.

Installation position	Air bleed	Filling
1 	**T_2**	**S** + **T_2**
2 	**T_1**	**S** + **T_1**

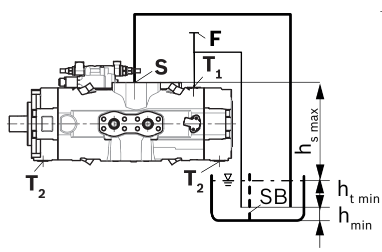
Above-reservoir installation

Above-reservoir installation means that the axial piston unit is installed above the minimum fluid level of the reservoir. To prevent the axial piston unit from draining, a height difference $h_{ES\ min}$ of at least 25 mm at port $\mathbf{T_2}$ is required in position 6.
Observe the maximum permissible suction height $h_{S\ max}$ = 800 mm.
Port **F** is part of the external piping and must be provided on the customer side to simplify the filling and air bleeding.

Installation position	Air bleed	Filling
3	**F**	$\mathbf{T_2}$ (**F**)



Installation position	Air bleed	Filling
4	**S** (**F**)	$\mathbf{T_1}$ (**F**)



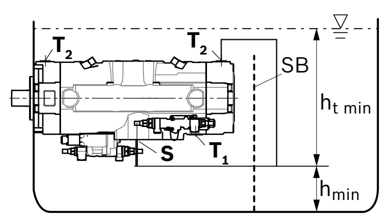
Key	
F	Filling / Air bleeding
S	Suction port
T	Drain port
SB	Baffle (baffle plate)
$h_{t\ min}$	Minimum required immersion depth (200 mm)
h_{min}	Minimum required distance to reservoir bottom (100 mm)
$h_{ES\ min}$	Minimum height required to prevent axial piston unit from draining (25 mm)
$h_{S\ max}$	Maximum permissible suction height (800 mm)

Inside-reservoir installation

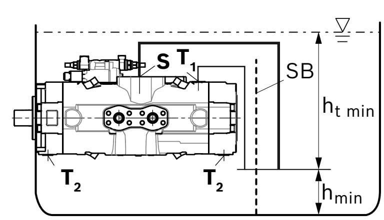
Inside-reservoir installation is when the axial piston unit is installed in the reservoir below the minimum fluid level. The axial piston unit is completely below the hydraulic fluid.
If the minimum fluid level is equal to or below the upper edge of the pump, see chapter **"Above-reservoir installation"**.
Axial piston units with electrical components (e.g., electric control, sensors) may not be installed in a reservoir below the fluid level.
Exception: Installation of the pump with E2/E6 control only with HIRSCHMANN connector and if mineral hydraulic fluids are used and the fluid temperature in the reservoir does not exceed 80 °C

Notice
- We recommend to provide the suction port **S** with a suction pipe and to pipe the drain port $\mathbf{T_1}$ or $\mathbf{T_2}$ to be piped. In this case, the other drain port must be plugged. The housing of the axial piston unit must be filled before fitting the piping and filling the reservoir with hydraulic fluid.

Installation position	Air bleed	Filling
5	$\mathbf{T_2}$	The housing of the axial piston unit is to be filled via $\mathbf{T_1}$ before attachment of the piping



Installation position	Air bleed	Filling
6	$\mathbf{T_1}$	The housing of the axial piston unit is to be filled via $\mathbf{T_1}$ before attachment of the piping



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 A28VLO variable pump is designed to be used in an open circuit.
- The project planning, installation and commissioning of the axial piston unit requires the involvement of skilled personnel.
- Before using the axial piston unit, please read the corresponding instruction manual completely and thoroughly. If necessary, this can be requested from Bosch Rexroth.
- Before finalizing your design, please request a binding installation drawing.
- The specified data and notes contained herein must be observed.
- Depending on the operating conditions of the axial piston unit (working pressure, fluid temperature), the characteristic curve may shift.
- The characteristic curve may also shift due to the dither frequency or control electronics.
- Preservation: Our axial piston units are supplied as standard with preservation protection for a maximum of 12 months. If longer preservation protection is required (maximum 24 months), please specify this in plain text when placing your order. The preservation periods apply under optimal storage conditions, details of which can be found in the data sheet 90312 or the instruction manual.
- Not all configuration variants of the product are approved for use in safety functions according to ISO 13849. Please consult the proper contact 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. Use of the recommended direct current (DC) on the electromagnet does not produce any electromagnetic interference (EMI) nor is the electromagnet influenced by EMI. A possible electromagnetic interference (EMI) exists if the solenoid is supplied with modulated direct current (e.g. PWM signal). The machine manufacturer should conduct appropriate tests and take appropriate measures to ensure that other components or operators (e.g. with a pacemaker) are not affected by this potentiality.
- Pressure controllers are not safeguards against pressure overload. Be sure to add a pressure relief valve to the hydraulic system.
- For controllers requiring external pilot pressure, sufficient control fluid must be provided to the associated ports to ensure the required pilot pressures for the respective controller function. These controllers are subject to leakage due to their design. An increase in control fluid demand has to be anticipated over the total operating time. The design of the control fluid supply must thus be sufficiently large. If the control fluid is too low, the respective controller function may be impaired and undesired system behavior may result.
- Please note that a hydraulic system is an oscillating system. This can lead, for example, to the stimulation the natural frequency within the hydraulic system during operation at constant rotational speed over a long period of time. The excitation frequency of the pump is 9 times the rotational speed frequency. This can be prevented, for example, with suitably designed hydraulic lines.
- Please note the details regarding the tightening torques of port threads and other threaded joints in the general instruction manual 90300-01-B.
- The ports and fastening threads are designed for the p_{max} permissible pressures of the respective ports, see the connection tables. The machine or system manufacturer must ensure that the connecting elements and lines correspond to the specified application conditions (pressure, flow, hydraulic fluid, temperature) with the necessary safety factors.
- The service ports and function ports are only intended to accommodate hydraulic lines.
- Abrupt closing of valves in the hydraulic system may cause pressure surges in pressure lines and/or control lines (water hammer effect). These pressure surges may reduce the service life of the pump already above a pressure in the working line of p_{max} 380 bar. In this case, please contact us.

Safety instructions

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

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