The Drive & Control Company

Rexroth
Bosch Group

Axial piston variable double pump
A8VO225 Series 72

RE 93013
Edition: 03.2014

- Size 225
- Nominal pressure 380 bar
- Maximum pressure 420 bar
- Open circuit

Features

- Variable double pump with two axial tapered piston rotary groups with bent-axis design for open-circuit hydrostatic drives
- Flow is proportional to drive speed and displacement
- Adjusting the swashplate rotary group enables the volume flow to be steplessly varied
- The pump is suitable for direct attachment to the fly-wheel case of a diesel engine
- A common suction port for both circuits and the auxil-iary pump
- Integrated auxiliary pump with pressure-relief valve
- Power take-off variants for attachment of axial piston and gear pumps
- Very favorable power-to-weight ratio
- Long service life

Contents

Ordering code

01	02	03	04	05		06	07	08		09	10	11	12	13	14	15	16		17
A8V	**O**	**225**		**0**	**/**	**72**	**M**	**R**	**–**	**N**	**1**	**G1**	**A2**	**5**				**–**	

Axial piston unit

01	Bent-axis design, variable, nominal pressure 380 bar, maximum pressure 420 bar	**A8V**

Operating mode

02	Double pump (parallel design), open circuit	**O**

Size (NG)

03	Geometrical displacement per rotary group, see Technical data on page 6	**225**

Control devices

04	Individual power controller with pilot pressure power override, with hydraulic power coupling and hydraulic lift limitation	Negative control	**LA1KH1**
		Positive control, external pilot pressure supply	**LA1KH2**

Swivel angle indicator

05	Without swivel angle indicator	**0**

Series

06	Series 7, index 2	**72**

Configuration of ports and fastening threads

07	Metric, port threads with O-ring seal according to ISO 6149	**M**

Direction of rotation

08	Viewed on drive shaft, right	**R**

Sealing material

09	NBR (nitrile rubber), FKM (fluoroelastomer)	**N**

Transmission ratio (n_{drive} / $n_{rotary\ groups}$)

10	i = 1	**1**

Mounting flange

11	Suitable for the flywheel case (acc. to SAE J617) of the combustion engine	**G1**

Drive shaft

12	Splined shaft DIN 5480	**A2**

Service line ports

13	SAE flange ports **A_1** and **A_2** on opposite sides (metric fastening thread) SAE flange port **S** at rear (metric fastening thread)	**5**

Auxiliary pump

14	Without integrated auxiliary pump		**U**
	With integrated auxiliary pump	Standard	**F**
		Large	**B**

01	02	03	04	05		06	07	08		09	10	11	12	13	14	15	16		17
A8V	**O**	**225**		**0**	**/**	**72**	**M**	**R**	**–**	**N**	**1**	**G1**	**A2**	**5**				**–**	

Power take-offs

15	Without power take-off	**0000**

Valves

16	Without valves (only for the version **without** auxiliary pump, U)	**0**
	With pressure-relief valve (only for versions **with** auxiliary pump, F)	**A**
	With pressure limitation and pressure reducing valve, U = 24 V (only for versions with auxiliary pump, F)	**C**

Standard / special version

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

Note

Preservation:
- up to 12 months as standard
- up to 24 months long-term
  (state in plain text when ordering)

Hydraulic fluids

The A8VO 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)

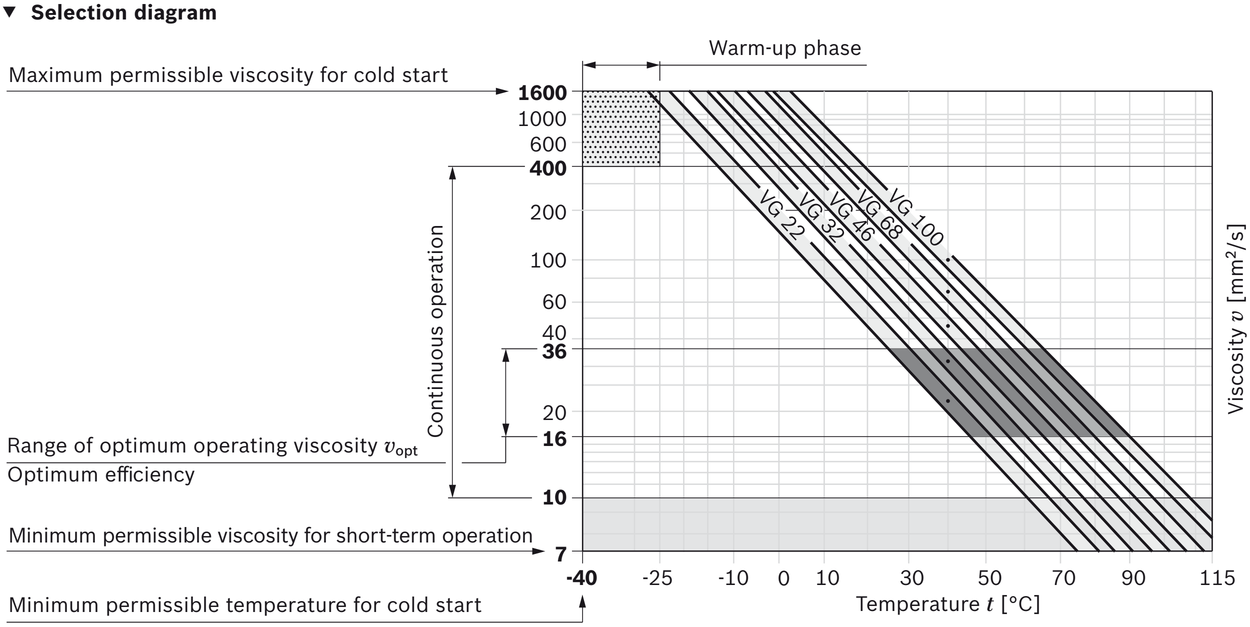
Details regarding the selection of hydraulic fluid
The hydraulic fluid should be chosen such that the operating viscosity in the operating temperature range is within the optimum range (ν_{opt} see selection diagram).

Note
At no point of the component may the temperature be higher than 115 °C. The temperature difference specified in the table is to be taken into account when determining the viscosity in the bearing.
If the above conditions cannot be maintained due to extreme operating parameters, please contact the responsible member of staff at Bosch Rexroth.

Viscosity and temperature of hydraulic fluids

	Viscosity	Temperature	Comment
Cold start	ν_{max} ≤ 1600 mm²/s	θ_{St} ≥ -40 °C	t ≤ 3 min, n ≤ 1000 rpm, without load p ≤ 50 bar
Permissible temperature difference		ΔT ≤ 25 K	between axial piston unit and hydraulic fluid in system
Warm-up phase	ν < 1600 to 400 mm²/s	θ = -40 °C to -25 °C	At $p \leq 0.7 \cdot p_{nom}$, $n \leq 0.5 \cdot n_{nom}$ and t ≤ 15 min
Continuous operation	ν = 400 to 10 mm²/s		This corresponds, for example on the VG 46, to a temperature range of +5 °C to +85 °C (see selection diagram)
		θ = -25 °C to +103 °C	measured at port **R** Note the permissible temperature range of the shaft seal (ΔT = approx. 12 K between the bearing/shaft seal and port **R**)
	ν_{opt} = 36 to 16 mm²/s		Range of optimum operating viscosity and efficiency
Short-term operation	ν_{min} ≥ 7 mm²/s		t < 3 min, $p < 0.3 \cdot p_{nom}$

▼ **Selection diagram**



Filtration of the hydraulic fluid

Finer filtration improves the cleanliness level of the hydraulic fluid, which increases the service life of the axial piston unit.
A cleanliness level of at least 20/18/15 is to be maintained according to ISO 4406.
At very high hydraulic fluid temperatures (90 °C to maximum 103 °C, measured at port **R**), a cleanliness level of at least 19/17/14 according to ISO 4406 is necessary.

Shaft seal

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

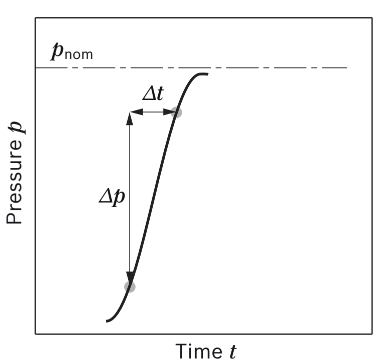
Drive

Via elastic coupling.

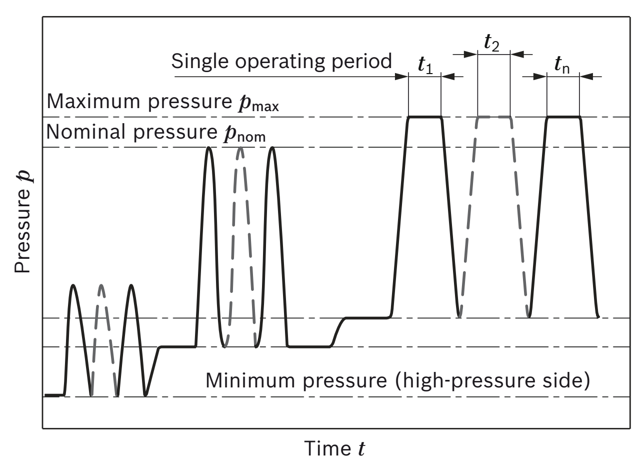
Operating pressure range

Pressure at service line port A_1 or A_2		**Definition**
Nominal pressure p_{nom}	380 bar absolute	The nominal pressure corresponds to the maximum design pressure.
Maximum pressure p_{max}	420 bar absolute	The maximum pressure corresponds to the maximum operating pressure within the single operating period. The sum of the single operating periods must not exceed the total operating period.
Single operating period	10 s	
Total operating period	300 h	
Minimum pressure (high-pressure side)	25 bar absolute	Minimum pressure on the high-pressure side (**A**$_1$ and **A**$_2$) that is required in order to prevent damage to the axial piston unit.
Rate of pressure change $R_{A\ max}$	9000 bar/s	Maximum permissible rate of pressure build-up and reduction during a pressure change over the entire pressure range.
Pressure at suction port S (inlet)		
Minimum pressure $p_{S\ min}$	0.8 bar absolute	Minimum pressure at suction port **S** (inlet) that is required in order to avoid damage to the axial piston unit. The minimum pressure depends on the speed and displacement of the axial piston unit.
Maximum pressure $p_{S\ max}$	1.5 bar absolute	
Auxiliary pump		
Maximum pressure p_{max}	40 bar absolute	

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



▼ **Pressure definition**



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

Note

- Valid when using hydraulic fluids based on mineral oils
- Values for other hydraulic fluids, please contact us.

Formulas			
Flow	$q_v = \dfrac{V_g \cdot n \cdot \eta_v}{1000}$		[l/min]
Torque	$T = \dfrac{V_g \cdot \Delta p}{20 \cdot \pi \cdot \eta_{mh}}$		[Nm]
Power	$P = \dfrac{2\,\pi \cdot T \cdot n}{60000}$	$= \dfrac{q_v \cdot \Delta p}{600 \cdot \eta_t}$	[kW]

Key

V_g = Displacement per revolution [cm³]

Δp = Differential pressure [bar]

n = Rotational speed [rpm]

η_v = Volumetric efficiency

η_{mh} = Mechanical-hydraulic efficiency

η_t = Total efficiency ($\eta_t = \eta_v \cdot \eta_{mh}$)

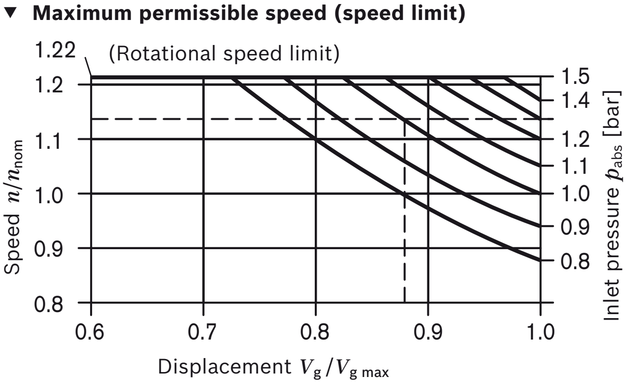
Note

- Theoretical values, without efficiency levels and tolerances; values rounded
- Operation above the maximum values or below the minimum values may result in a loss of function, a reduced service life or in the destruction of the axial piston unit. Other permissible limit values, such as speed variation, reduced angular acceleration as a function of the frequency and the permissible angular acceleration at start (lower than the maximum angular acceleration) can be found in data sheet 90261.
- Transport and storage
  $\theta_{min} \geq -50$ °C, θ_{opt} = +5 °C to +20 °C

Technical data

Size		**NG**		**225**
Displacement geometric, per revolution		$V_{g\,max}$	cm³	2 x 224.6
		$V_{g\,min}$	cm³	0
Transmission ratio $i = n_{drive}/n_{rotary\ groups}$				1.0
Maximum rotational speed	at $V_{g\,max}$ 1)	n_{nom}	rpm	2050
	at $V_g < 0.74 \cdot V_{g\,max}$ 2)	n_{max}	rpm	2300
Flow	at n_{nom} and $V_{g\,max}$	q_v	l/min	2 x 460
Power	At n_{nom}, $V_{g\,max}$ and Δp = 250 bar	P	kW	384
Torque	at $V_{g\,max}$ and Δp = 250 bar (both pumps)	T 3)	Nm	1788
Rotary stiffness of individual rotary group	$V_{g\,max}$ to $0.5 \cdot V_{g\,max}$	c_{min}	Nm/rad	72995
	$0.5 \cdot V_{g\,max}$ bis $0_{(interpolated)}$	c_{max}	Nm/rad	318679
Moment of inertia for rotary group	with power take-off, without attachment pump	J_{TW}	kgm²	0.0879
	without power take-off	J_{TW}	kgm²	0.0708
Angular acceleration of individual rotary group		α	rad/s²	10000
Weight (approx.)		m	kg	194
Variation: with integrated auxiliary pump, F0000, F..				
Displacement with integrated auxiliary pump		$V_{g\,max}$	cm³	11 (19)
Displacement effective		$V_{g\,max}$	cm³	13.6 (23.6)
Transmission ratio $i = n_{drive}/n_{auxiliary\ pump}$				0.804
Variation: with power take-offs, U...., F....				
Maximum torque at power take-off		$T_{T3\,max}$	Nm	800
Transmission ratio $i = n_{drive}/n_{auxiliary\ pump}$				0.804

▼ **Maximum permissible speed (speed limit)**



1) The values are applicable:
– at absolute pressure p_{abs} = 1 bar at suction port **S**
– for the optimal viscosity range of ν_{opt} = 36 to 16 mm²/s
– for hydraulic fluid based on mineral oils

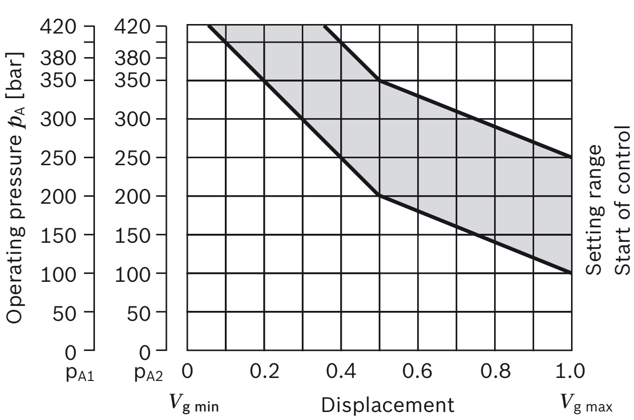
2) Maximum rotational speed (limit speed) for increased inlet pressure p_{abs} at suction port **S** and $V_g < V_{g\,max}$, see diagram.

3) Input torque T is the sum of the individual torques of rotary group 1 (T_{T1}), rotary group 2 (T_{T2}) and power take-off (T_{T3})
– T_{T1} = Torque of rotary group 1 (V_g, Δp)
– T_{T2} = Torque of rotary group 2 (V_g, Δp)
– T_{T3} = Torque of power take-off
– Condition for all operating conditions: $T_{T1} + T_{T2} + T_{T3} \leq T$

Individual power control

The two rotary groups of the variable double pump mit individual power controller LA1 are not mechanically coupled, i.e. each rotary group is equipped with a separate power controller.
The power control regulates the displacement of the pump depending on the operating pressure so that a given drive power is not exceeded.
Power is set individually for each controller and may differ, whereby each pump can be set to 100% drive power.
The hyperbolic power curve is approximated with two mass springs. The operating pressure acts on the measurement area of a differential piston against the mass springs and of a spring force that can be varied from the outside, which determines the power setting.
If the sum of the hydraulic forces exceeds the forces of the springs, the control fluid is fed to the stroking piston, swiveling the pump back and setting it to a smaller volume flow.
In a depressurized state, the pump is swiveled to its initial position to $V_{g\ max}$ by a return spring.

▼ **Characteristic LA1**



The hydraulic output power (characteristic LR) is influenced by the efficiency of the double pump.
When ordering, state in plain text:

- Application: e.g. excavator
- Drive power P [kW]
- Drive speed n [rpm]
- Maximum volume flow $q_{V\ max}$ [l/min]
- Maximum working pressure (primary pressure valve setting)

After clarifying the details a power diagram can be created by our computer.

LA1

Individual power controller with power override through pilot pressure

The third measuring area of the differential piston is charged with an external pilot pressure (port **X**$_3$, allowing the set power to be reduced (negative power override).
The mechanically adjusted basic setting can be hydraulically adjusted by means of different pilot pressure settings. This makes different power setting possible.
If the pilot pressure signal is variably controlled via a load limiting control, the sum of the hydraulic powers equals the drive power. The pilot pressure for power override is generated by an external control element or by the mounted pressure reducing valve (see page 13).
The electric signal for controlling the pressure reducing valve must be generated in an external control electronic circuit. Various BODAS controllers RC in conjunction with LLC software are available for this purpose.
Further information can also be found on the internet at www.boschrexroth.com/mobile-electronics.

Note!
If there is no power override, port **X**$_3$ to the reservoir must be relieved.

LA1K

Individual power controller mit hydraulic coupling

The hydraulic coupling of the two individual controllers is the result of the accumulated power control function. However, the two rotary groups are not coupled mechanically, but rather hydraulically.

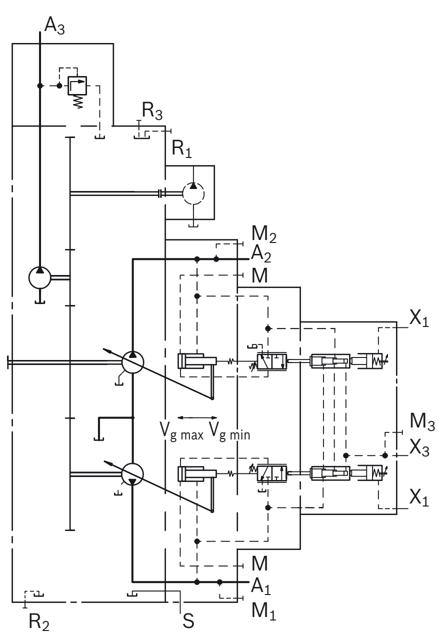
The operating pressures of the two circuits each act on the differential piston of the two individual controllers, swiveling the two rotary groups out and back together.

If one pump is working with less than 50% of the total drive power, the power that is set free can be additionally transmitted to the other pump, in borderline cases up to 100% of the total drive power.

Note

With the additional function hydraulic stroke limiter, each rotary group can be swiveled back independently of a smaller V_g than that currently specified by the power control.

▼ **Schematic LA1KH1**



LA1H

Individual power controller with hydraulic stroke limiter

The hydraulic stroke limiter allows the displacement to be steplessly varied or limited over the entire adjustment range of $V_{g\,max}$ to $V_{g\,min}$.

The displacement is set by a pilot pressure p_{st} applied to port $\mathbf{X_1}$ (maximal 40 bar).

The power control overrides the hydraulic stroke limiter control, i.e. below the power characteristic, the displacement is controlled by the pilot pressure. If the set flow or operating pressure exceeds the power characteristic, the power control overrides and reduces the displacement following the spring characteristic.

Instructions

The H1/H2 characteristic is influenced by the design of the power controller!

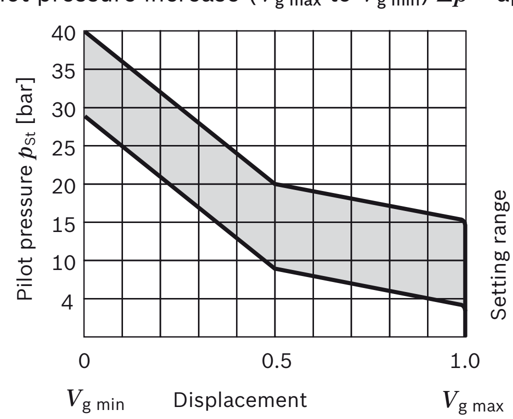
LA1H1

Hydraulic stroke limiter (negative control)

- Control from $V_{g\,max}$ to $V_{g\,min}$.
  With increasing pilot pressure the pump swivels to a smaller displacement.
- Start of control (at $V_{g\,max}$), adjustable of 4 to 15 bar.
  Start of control depends on the setting of the power controller. State start of control in clear text in the order.
- Initial position in depressurized state: $V_{g\,max}$

▼ **Characteristic LA1H1**

Pilot pressure increase ($V_{g\,max}$ to $V_{g\,min}$) Δp = approx. 25 bar



Note

A pressure of ≥ 30 bar is needed for control. The necessary positioning fluid is taken from the high-pressure line. If negative control directional valves are used, control pressure supply from the negative control system is ensured via the high-pressure line

LA1H2

Hydraulic stroke limiter and external pilot pressure supply (positive control)

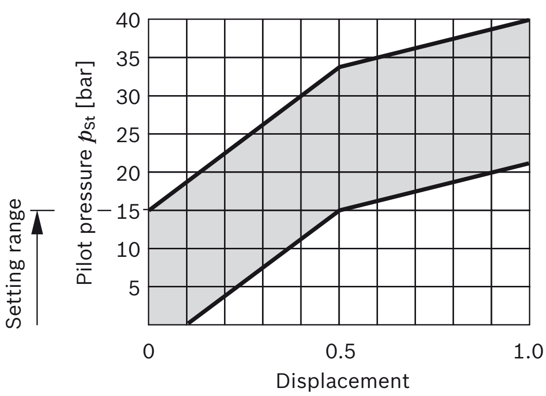
- Control from $V_{g\,min}$ to $V_{g\,max}$.
  With increasing pilot pressure the pump swivels to a higher displacement.
- Start of control (at $V_{g\,min}$), adjustable of 0 to 15 bar. State start of control in clear text in the order.
- Initial position in depressurized state: $V_{g\,max}$

Note

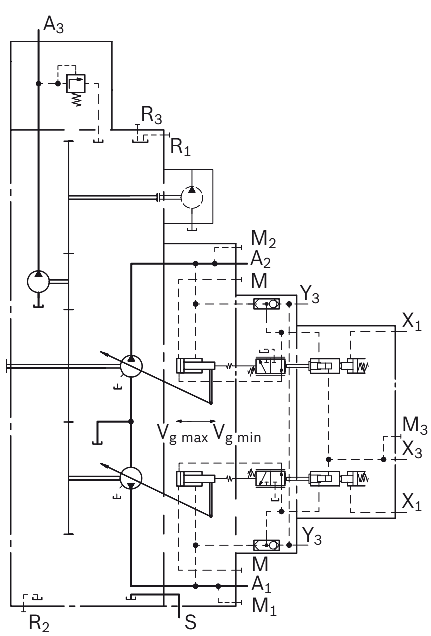
- To adjust from $V_{g\,max}$ to $V_{g\,min}$, a pressure of ≥ 30 bar is needed. The necessary control power is taken from the high pressure or the remote control pressure (≥ 30 bar) acting on port **Y**$_3$
  (pilot pressure < start of control).
- If there is a **Y**$_3$ port (H2) this must always be connected to a remote control pressure. Without a remote control pressure supply, this port to the reservoir must be relieved.

▼ **Characteristic LA1H2**

Pilot pressure increase ($V_{g\,min}$ – $V_{g\,max}$) Δp = approx. 25 bar

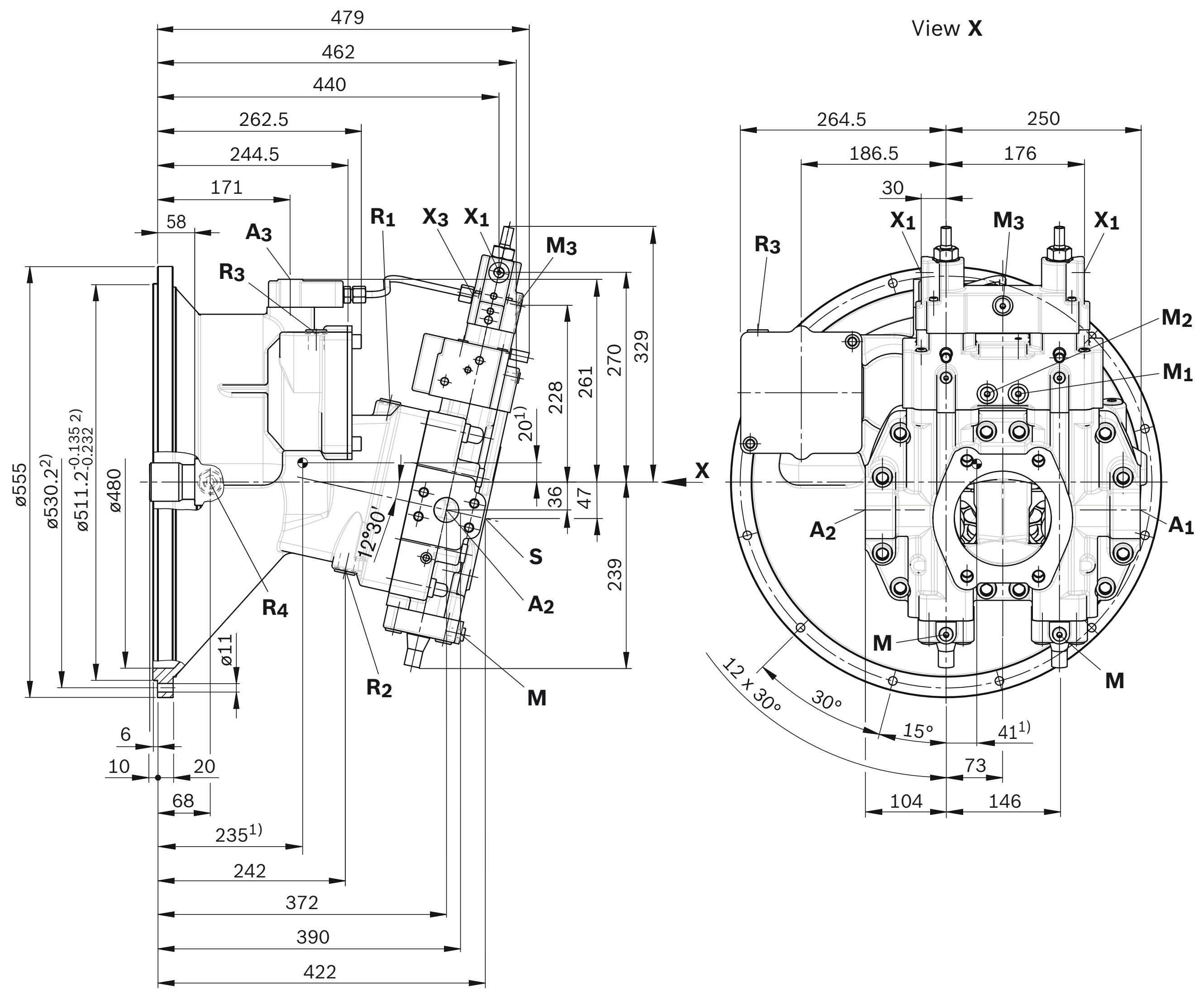


▼ **Schematic LA1H2**



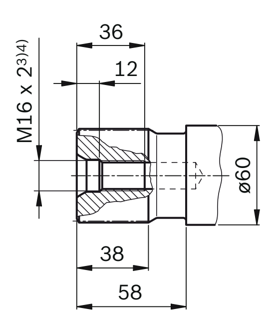
Dimensions size 225

LA1KH1 – Individual power controller, negative control



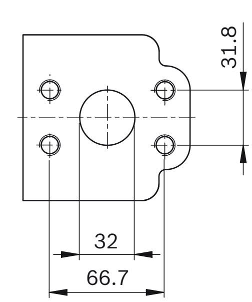
▼ **Splined shaft DIN 5480**

W50x2x24x9g

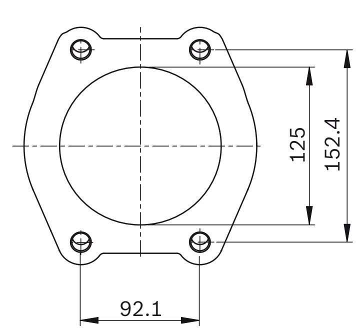


▼ **Partial views**

Partial view **A**$_1$, **A**$_2$

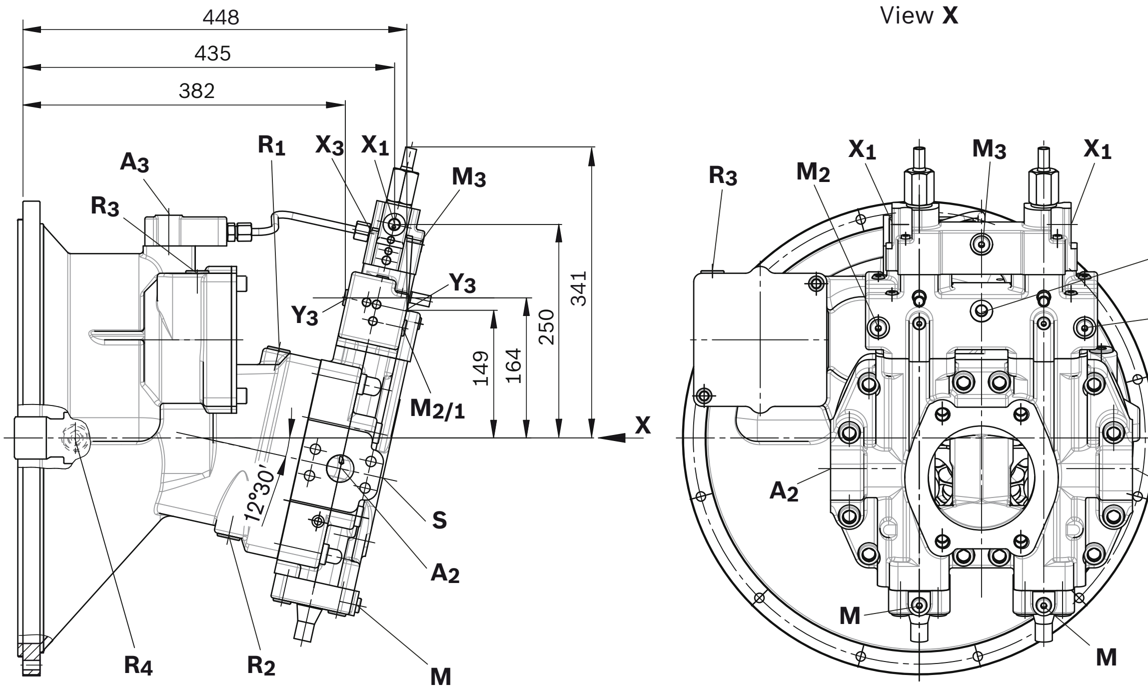


Partial view **S**



1) Center of gravity
2) Dimensions according to SAE J617-No. 1, for connection to the flywheel case of the combustion engine
3) Center bore according to DIN 332 (thread according to DIN 13)
4) Observe the general instructions on page 15 for the maximum tightening torques.

LA1KH2 – Individual power controller, negative control

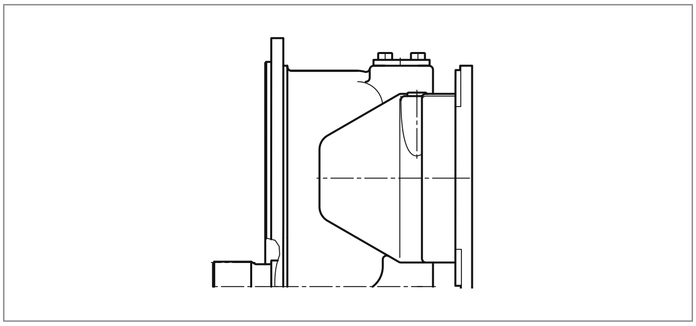


Ports		Standard	Size[1]	$p_{max\ abs}$ [bar][2]	Status[6]
A$_1$, **A**$_2$	Service line port (high-pressure series) Fastening thread	SAE J518[3] DIN 13	1 1/4 in M12 x 1.75; 19 deep	420	O
S	Suction port (standard pressure series) Fastening thread	SAE J518[3] DIN 13	5 in M16 x 2; 23 deep	1.5	O
A$_3$	Service line port for auxiliary pump	DIN 3852[4]	M18 x 1.5; 12 deep	40	O
R$_1$, **R**$_3$	Air bleed	DIN 3852[4]	M22 x 1.5; 12 deep	1.5	X
R$_2$	Oil drain	DIN 3852[4]	M22 x 1.5; 12 deep	1.5	X
R$_4$	Flow port	ISO 11926[4]	3/4-16 UNF-2B; 12 deep	1.5	O
M	Measurement of stroking chamber pres-sure	DIN 3852[4]	M12 x 1.5; 12 deep	420	X
M$_1$	Pressure measurement **A**$_1$	DIN 3852[4]	M14 x 1.5; 12 deep	420	X
M$_2$	Pressure measurement **A**$_2$	DIN 3852[4]	M14 x 1.5; 12 deep	420	X
M$_3$	Power override measurement	DIN 3852[4]	M14 x 1.5; 12 deep	40	X
X$_1$	Stroke limiter pilot pressure	DIN 3852[4]	M14 x 1.5; 12 deep	40	O
X$_3$	Power override pilot pressure	DIN 3852[4]	M14 x 1.5; 12 deep	40	P
Y$_3$	Auxiliary pressure[5]	DIN 3852[4]	M14 x 1.5; 12 deep	40	O

1) Observe the general instructions on page 15 for the maximum tightening torques.
2) Momentary pressure spikes may occur depending on the application. Keep this in mind when selecting measuring devices and fittings.
3) Metric fastening thread, deviating from standard.
4) The spot face can be deeper than specified in the appropriate standard.
5) Only with version LA...H2
6) O = Must be connected (plugged on delivery)
X = Plugged (in normal operation)
P = Piped

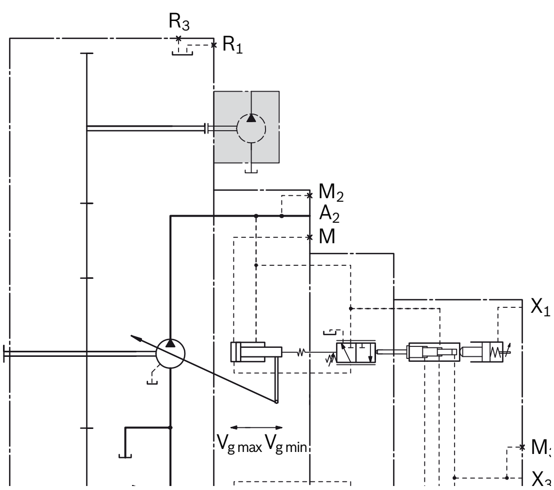
Power take-offs, auxiliary pump and valves

**with power take-off,
without integrated auxiliary pump, U....0**

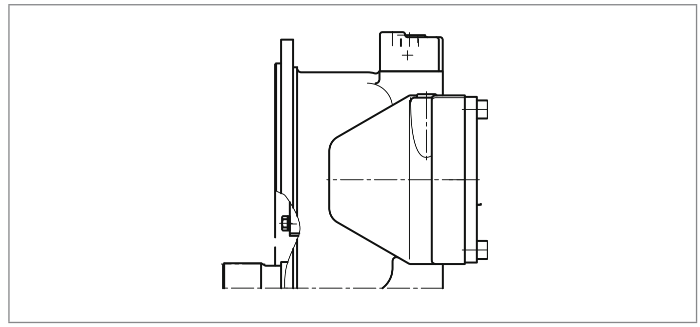


- Technical data, see page 6.
- Attachable to the power take-off: axial piston pumps and gear pumps.

▼ **Schematic**

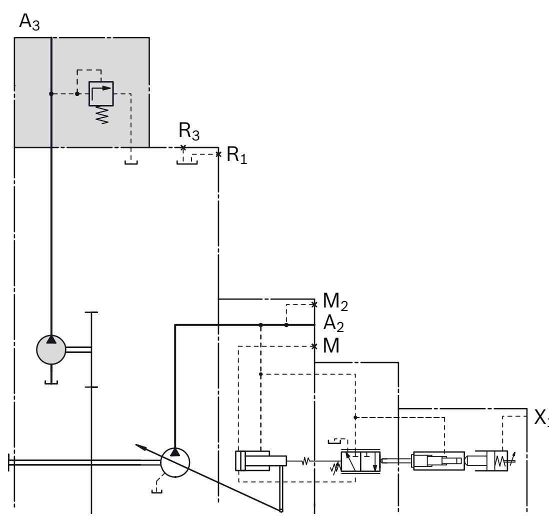


Without power take-off, with integrated auxiliary pump (control fluid pump) and pressure-relief valve, F0000A

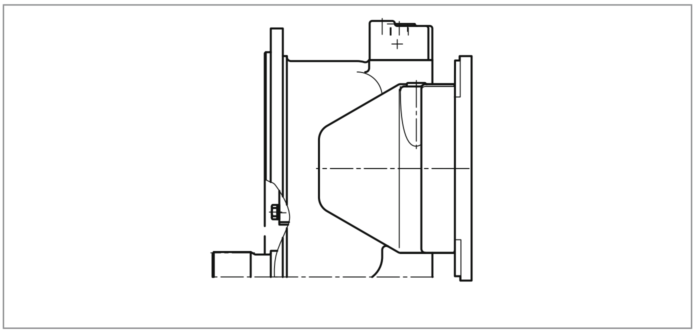


- Technical data, see page 6.
- The pressure-relief valve installed as a pressure safeguard for the integrated auxiliary pump is permanently set at a value of 30 bar.

▼ **Schematic**

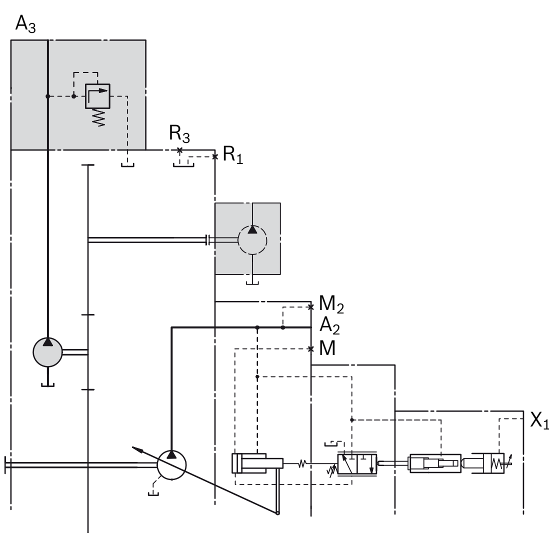


With power take-off, mit integrated auxiliary pump (pilot fluid pump) and pressure-relief valve, F....A

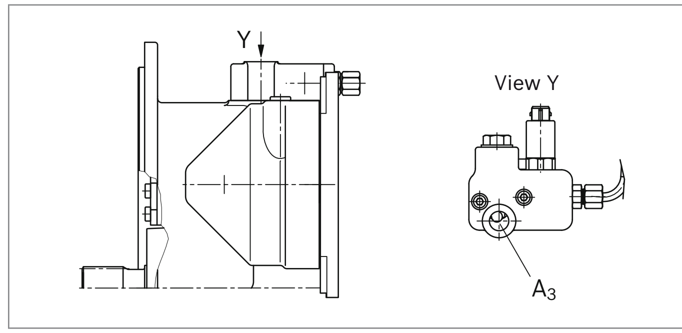


- Technical data, see page 6.
- The pressure-relief valve installed as a pressure safeguard for the integrated auxiliary pump is permanently set at a value of 30 bar.
- Attachable to the power take-off: axial piston pumps and gear pumps

▼ **Schematic**

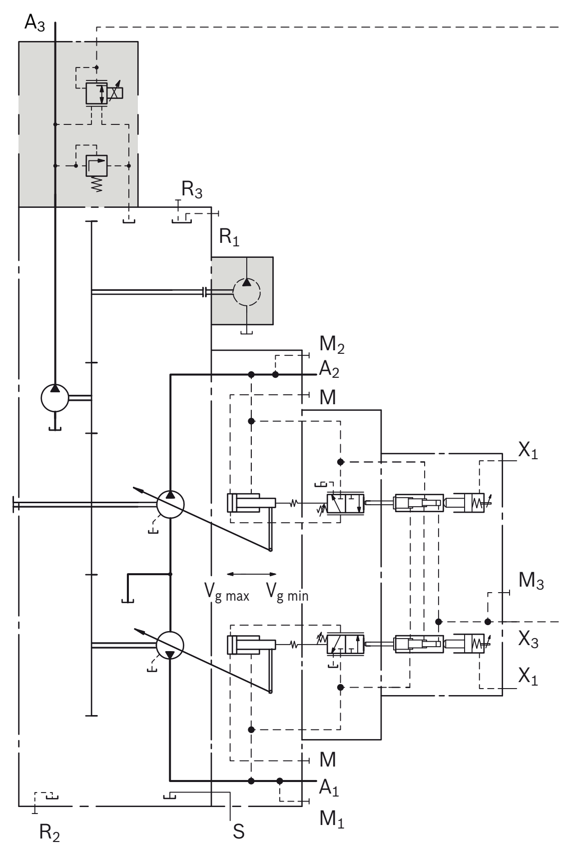


With power take-off, mit integrated auxiliary pump (pilot fluid pump), mit pressure limitation valve and pressure reducing valve, F....C



- Technical data, see page 6.
- The pressure-relief valve installed as a pressure safeguard for the integrated auxiliary pump is permanently set at a value of 30 bar.
- An electrically variable pressure reducing valve can be used, for example to override the power setting (load limiting control) (see below).
- Can be fitted to the power take-off: axial piston pump and gear pump

▼ **Schematic**



Pressure reducing valve

- Control voltage: 24 V DC
- Recommended frequency: ≥150 Hz
- Connector AMP Junior Timer, 2-pin,
  type of protection according to DIN 40050-9: IP69k
- Mating connector
  The mating connector is not included in the delivery contents. This can be supplied by Bosch Rexroth on request.
  - Material number R901022127
  - Please refer to data sheet 08006.
  - Conductor outer diameter 2.2 to 3.0 mm

Installation instructions

General

The axial piston unit and in particular the pressure reducing valve must be completely filled with hydraulic fluid and air-bled before electrical connections are made. This must also observed following a relatively long standstill as the axial piston unit may drain back to the reservoir via the hydraulic lines.
In all operating conditions, the suction and drain lines must flow into the reservoir below the minimum fluid level. The minimum suction pressure at port **S** must not exceed 0.8 bar absolute during operation, even after a cold start.
When designing the reservoir, ensure adequate space between the suction line and the case drain line. This prevents the heated, return flow from being drawn directly back into the suction line.

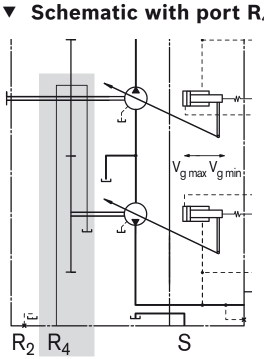
Installation position

See the following examples 1 and 2.

External connection for flush oil

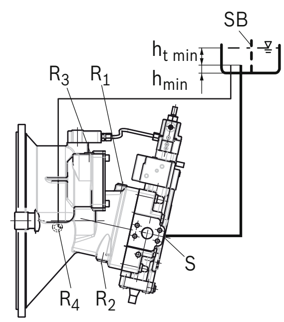
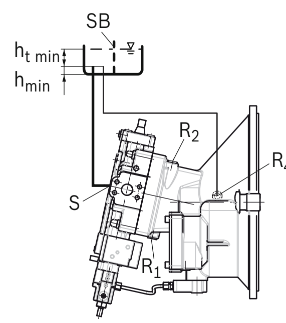
A8VO variable double pumps of **nominal size 225 must have** an external connection from port **R_4** to the reservoir. Flush oil for cooling and lubrication of the bearings is drawn via this port **R_4**.
The internal diameter of this line shall be ≥ 15mm.

▼ **Schematic with port R_4**



Below-reservoir installation

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 	**R_1 + R_3**	**S + R_4**
2 	**R_2**	**S + R_4**

Key	
R_1, R_3	Port for air bleeding
R_2	Port for oil draining
R_4	Flow port
S	Suction port
SB	Baffle (baffle plate)
$h_{t\,min}$	Minimum required immersion depth (200 mm)
h_{min}	Minimum required distance to reservoir bottom (100 mm)

General instructions

- The A8VO pump is designed to be used in open circuits.
- The project planning, installation and commissioning of the axial piston unit requires the involvement of 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.
- 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).
- Depending on the operating conditions of the axial piston unit (operating pressure, fluid temperature), the characteristic may shift.
- Service line ports:
  - The ports and fastening threads are designed for the specified maximum pressure. The machine or system manufacturer must ensure that the connecting elements and lines correspond to the specified application conditions (pressure, flow, hydraulic fluid, temperature) with the necessary safety factors.
  - The service line ports and function ports can only be used to accommodate hydraulic lines.
- The data and notes contained herein must be adhered to.
- Before finalizing your design, request a binding installation drawing.
- 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.
- Pressure controls are not backups against pressure overload. A separate pressure-relief valve is to be provided in the hydraulic system.
- The following tightening torques apply:
  - Fittings:
    Observe the manufacturer's specifications regarding the tightening torques of the fittings used.
  - Mounting bolts:
    For mounting bolts with metric ISO threads according to DIN 13, we recommend checking the tightening torque individually according to VDI 2230.
  - Female thread of the axial piston unit:
    The maximum permissible tightening torques $M_{G\ max}$ are maximum values of the female threads and must not be exceeded. For values, see the following table.
  - Threaded plugs:
    For the metallic threaded plugs supplied with the axial piston unit, the required tightening torques of threaded plugs M_V apply. For values, see the following table.

Ports Standard	Thread size	Maximum permissible tightening torque of the female threads $M_{G\ max}$	Required tightening torque of the threaded plugs M_V	WAF hexagon socket for the threaded plugs
DIN 3852[1]	M12 x 1.5	50 Nm	25 Nm[2]	6 mm
	M14 x 1.5	80 Nm	35 Nm	6 mm
	M18 x 1.5	140 Nm	60 Nm	8 mm
	M22 x 1.5	210 Nm	80 Nm	10 mm
ISO 11926	3/4-16 UNF-2B	160 Nm	70 Nm	5/16 in

1) The tightening torques apply for screws in the "dry" state as received on delivery and in the "lightly oiled" state for installation.
2) In the “lightly oiled” state, the M_V is reduced to 17 Nm for M12 x 1.5.

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