RE 91706/2020-11-04
Replaces: 2019.11.04

rexroth
A Bosch Company

Axial piston variable motor A10VER Series 52

- Reversible axial piston motor for fan drives
- Sizes 18 to 45
- Nominal pressure 280 bar
- Maximum pressure 350 bar
- Open circuit

Features

- Variable motor with axial piston rotary group in swashplate design for hydrostatic fan drives in open circuits
- The output speed is proportional to the inlet flow
- The output torque increases proportionally with the pressure difference between the high- and low-pressure sides and increasing displacement
- Specially developed for hydrostatic fan drives
- The A10VER variable motor is equipped with an overcenter rotary group with a maximum displacement of +/-100% $V_{g\,max}$. This allows reversing operation without the need for costly additional components to reverse the air flow and to clean the cooler from contaminations which leads to fuel savings due to improved cooling performance.
- The energy efficiency of hydraulic fan drives is increased due to the elimination of external reversing valves.
- Stable bearing for long service life
- High maximum permissible output speed
- Favorable power-to-weight ratio – compact dimensions
- Low noise

Contents

Type code

01	02	03	04		05	06	07		08	09	10	11	12	13
A10V	**ER**			**/**	**52**	**R**	**–**	**V**		**F**				**P**

Axial piston unit

		18...45	
01	Swashplate design, variable, nominal pressure 280 bar, maximum pressure 350 bar	●	**A10V**

Operating mode

		18...45	
02	Motor, plug-in version, open circuit; reversible +/– 100%	●	**ER**

Size (NG)[1)]

		18	23	28	37	45
03	For geometric displacement, see table of values, page 6					

Control device

				18...45	
04	Two-point control	U = 12 V	with shifting time orifice	●	**EZ6**
	electric with switching solenoid	U = 24 V	with shifting time orifice	●	**EZ7**

Series

		18...45	
05	Series 5, index 2	●	**52**

Direction of rotation[2)]

			18...45	
06	Viewed on drive shaft	clockwise (cooling operation)	●	**R**

Sealing material

		18...45	
07	FKM (fluoroelastomer)	●	**V**

Drive shaft

		18...45	
08	Conical shaft with woodruff key and UNF threaded bolt	●	**C**
	Conical shaft with woodruff key and metric threaded bolt	●	**Y**

Mounting flange

			18	23	28	37	45	
09	Special flange similar to SAE J744 101-2 (B)	Version with hole	○	○	○	●	●	**F**
	Special flange similar to SAE J744 101-2 (B)	Version with slotted hole	●	●	●	○	○	**U**

Working port

			18	23	28	37	45	
10	SAE flange ports fastening thread, metric	same side	●	●	●	●	●	**10N00**
	Threaded port, metric	same side	○	○	○	○	○	**16N00**
	SAE flange ports fastening thread, UNF	same side	●	●	●	●	●	**60N00**
	Threaded port, UNF	same side	○	○	○	○	○	**66N00**

Valves

		18	23	28	37	45	
11	without	●	●	●	●	●	**0**
	integrated anti cavitation valve	●	●	●	●	●	**2**
	integrated anti cavitation valve and pressure relief valve	○	○	○	○	○	**4**

Speed sensing

		18	23	28	37	45	
12	without speed sensing	●	●	●	●	●	
	Hall speed sensor mounted DSA[3)]	–	–	–	●	●	**B**
	Hall speed sensor mounted DSM[3)]	–	–	–	●	●	**M**

Connector for solenoids

		18...45	
13	DEUTSCH – molded connector, 2-pin – without suppressor diode (for electric controls)	●	**P**

● = Available ○ = On request – = Not available

Notes

Observe the project planning notes on page 18 or the project planning and commissioning instructions 90363.

1) Additional sizes available on request
2) Additional directions of rotation available on request
3) Specify type code of sensor in accordance with data sheet 95132 – DSM or 95133 – DSA separately and observe the requirements for the electronics.

Hydraulic fluids

The A10VER variable pump is designed for operation with HLP mineral oil according to DIN 51524.
See the following data sheets for application instructions and requirements for hydraulic fluids before the start of project planning:

- 90220: Hydraulic fluids based on mineral oils and related hydrocarbons
- 90221: Environmentally acceptable hydraulic fluids

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:

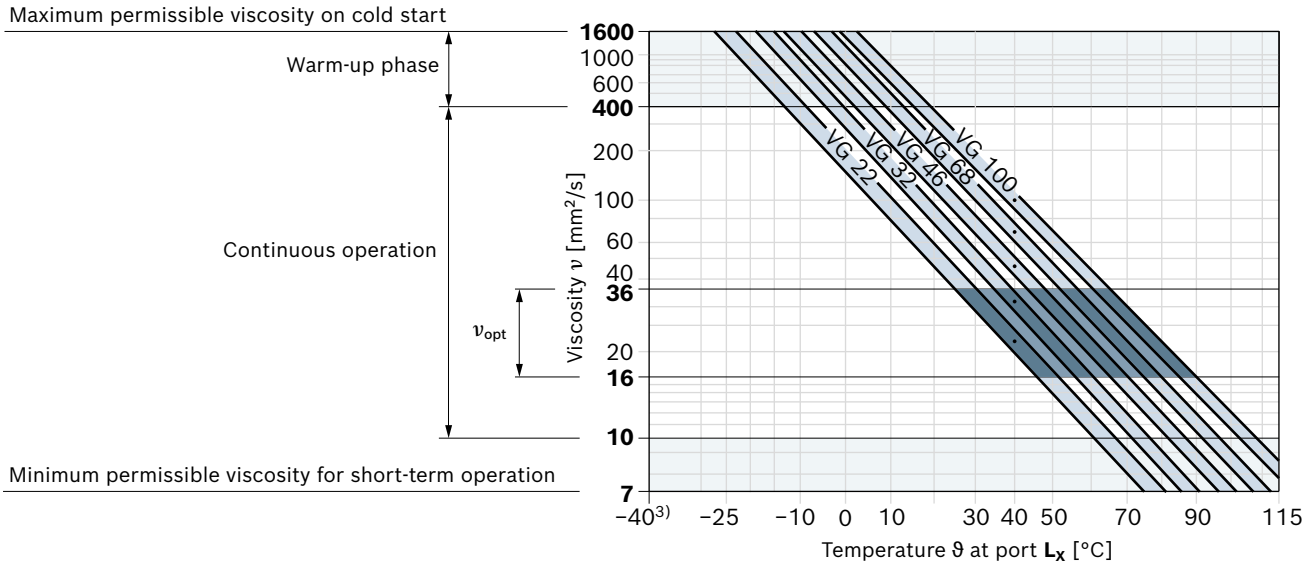
- 90245: Bosch Rexroth Fluid Rating List for Rexroth hydraulic components (pumps and motors)

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

Viscosity and temperature of hydraulic fluids

	Viscosity	Shaft seal	Temperature[2]	Comment
Cold start	v_{max} ≤ 1600 mm²/s	FKM	ϑ_{St} ≥ -25 °C	t ≤ 3 min, without load (p ≤ 50 bar), n ≤ 1000 rpm Permissible temperature difference between axial piston unit and hydraulic fluid in the system maximum 25 K
Warm-up phase	v = 1600 ... 400 mm²/s			t ≤ 15 min, p ≤ 0.7 × p_{nom} and n ≤ 0.5 × n_{nom}
Continuous operation	v = 400 ... 10 mm²/s[1]	FKM	ϑ ≤ +110 °C	measured at port **L_x**
	v_{opt} = 36 ... 16 mm²/s			optimal operating viscosity and efficiency range
Short-term operation	v_{min} = 10 ... 7 mm²/s	FKM	ϑ ≤ +110 °C	t ≤ 3 min, p ≤ 0.3 × p_{nom}, measured at port **L_x**

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

3) For applications in the low-temperature range, 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 mm^2/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.

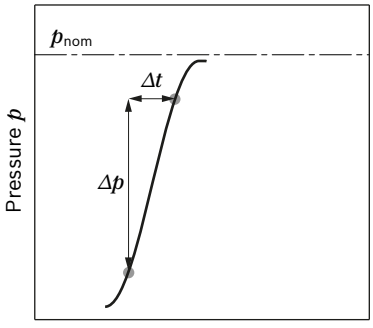
For example, viscosity is 10 mm^2/s:

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

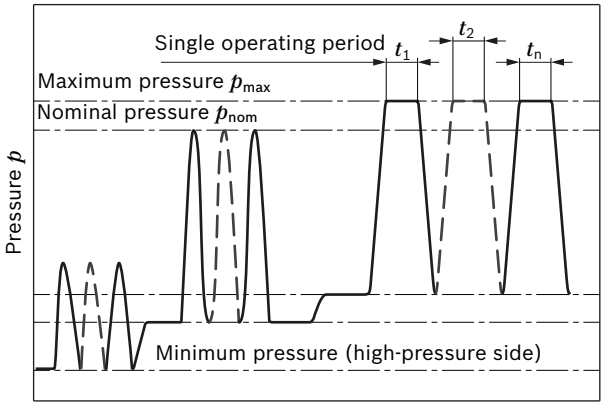
Working pressure range

Pressure at working port B		**Definition**
Nominal pressure p_{nom}	280 bar	The nominal pressure corresponds to the maximum design pressure. **The series control of motors is not permissible.**
Maximum pressure p_{max}	350 bar	The maximum pressure corresponds to the maximum working pressure during a single operating period. The sum of single operating periods must not exceed the total operating period.
Single operating period	2.5 ms	
Total operating period	300 h	
Minimum pressure $p_{MD\ abs}$ (high-pressure side)	20 bar	Minimum pressure on the high-pressure side (**B**) which is required in order to prevent damage to the axial piston unit.
Reversing pressure $p_{Rev\ abs}$ (high-pressure side)	<50 bar	The Δ pressure between **A** and **B** at which the system switches from fan operation to reversing operation and then from reversing operation back to fan mode is between 30 and 45 bar (relative). The pressure in **B** must be less than 50 bar.
Rate of pressure change $R_{A\ max}$	16000 bar/s	Maximum permissible pressure build-up and reduction speed during a pressure change across the entire pressure range.
Pressure at low-pressure port A		
Minimum pressure $p_{ND\ min}$ Standard	2 bar abs.	Minimum pressure at low-pressure port **A** (outlet) that is required in order to avoid damage to the axial piston unit.
Maximum pressure $p_{ND\ max}$	30 bar abs.	
Leakage pressure at port L		
Maximum pressure $p_{L\ max}$ Operation as a motor, open circuit	2 bar abs.	

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



▼ **Pressure definition**



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

Notice

- Working pressure range applies when using mineral oil-based hydraulic fluids. Please contact us for values for other hydraulic fluids.
- In addition to the hydraulic fluid and the temperature, the service life of the shaft seal is influenced by the rotational speed of the axial piston unit and the case pressure.
- The case pressure must be greater than the ambient pressure.

Flow direction

Direction of rotation **Motor with unchanged pressure side B**	**at $V_{g\ max+}$** **+ 100%**	**$V_{g\ max-}$** **- 100%**
(de-energized) clockwise	**B** to **A**	
(energized) counter-clockwise		**B** to **A**

Technical data

Size		NG		18	23	28	37	45
Displacement geometric, per revolution		+ 100 % $V_{g\,max}$	cm^3	18	23	28	37	45
		– 100 % $V_{g\,max}$	cm^3	18	23	28	37	45
Maximum rotational speed[1]	at $V_{g\,max}$	n_{nom}	rpm	3000	3000	3000	2200	2000
Rotational speed minimum[1]	at continuous operation	n_{nom}	rpm	250	250	250	250	250
Torque	at $V_{g\,max}$ and Δp = 280 bar	M	Nm	80	102	125	165	200
Rotary stiffness Drive shaft	C	c	Nm/rad	24160	24160	24160	32380	32380
	Y	c	Nm/rad	24160	24160	24160	32380	32380
Moment of inertia of the rotary group		J_{TW}	kgm^2	0.0017	0.0017	0.0017	0.0033	0.0033
Maximum angular acceleration[2]		α	rad/s^2	5500	5500	5500	4000	4000
Case volume		V	l	0.6	0.6	0.6	0.7	0.7
Weight without through drive (approx.)		m	Kg	14	14	14	18	18

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

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 ($\eta_t = \eta_v \times \eta_{hm}$)
M_K	=	Torque constant

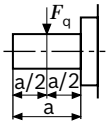
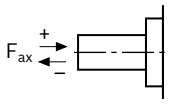
Notice

- Theoretical values, without efficiency and tolerances; values rounded
- Operation above the maximum values or below the minimum values may result in a loss of function, a reduced service life or in the destruction of the axial piston unit. Bosch Rexroth recommends testing the load by means of experiment or calculation / simulation and comparison with the permissible values.

1) The following values apply:
– at abs. pressure p_{abs} = 2 bar at the low-pressure port **A**
– for the optimum viscosity range from v_{opt} = 36 to 16 mm^2/s
– with hydraulic fluid on the basis of mineral oils

2) The data are valid for values between the minimum required and maximum permissible rotational speed. It applies for external stimuli (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 of the drive shafts

Size		NG		18	23	28	37	45
Maximum radial force at a/2		$F_{q\ max}$	N	1200	1200	1200	1500	1500
Maximum axial force		$\pm F_{ax\ max}$	N	1000	1000	1000	1500	1500

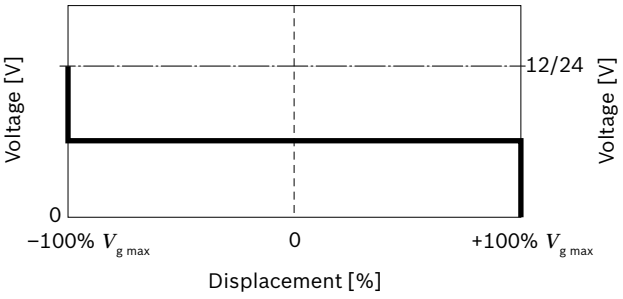
Notice

- The values given are maximum values and do not apply to continuous operation.
- For drives with radial loading (pinion, V-belt drives), please contact us!

EZ – Two-point control, electric

The variable motor is set to $V_{g\,max}$ +100 % or $V_{g\,max}$ –100 % by actuating the switching solenoid. When de-energized, the axial piston units swivels to $V_{g\,max}$ +100 %, when energized to $V_{g\,max}$ –100 %.
The response time is extended via the in-built orifice, thus enabling smooth swiveling.
With each direction of rotation of the motor, the control pressure is taken at the high-pressure side **B**.

▼ **Characteristic curve EZ**



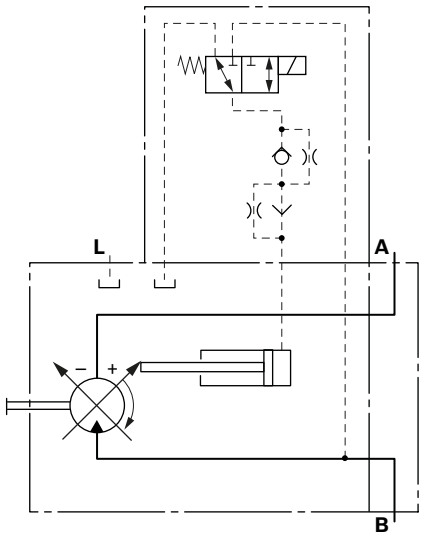
Influencing the swivel position

Swivel direction +100%		**Swivel cradle position**
De-energized	≙	$+V_{g\,max}$
Swivel direction –100%		
Energized	≙	$-V_{g\,max}$

Notice

- The A10VER variable speed motor can only be used in fan mode for reversing at -100 % $V_{g\,max}$. Use at -100 % $V_{g\,max}$ is not permitted for a longer period of time. If you have any questions, please contact your Bosch Rexroth contact.
- Observe the project planning notes on page 18 or the project planning and commissioning instructions 90363.

▼ **Circuit diagram EZ6/EZ7**



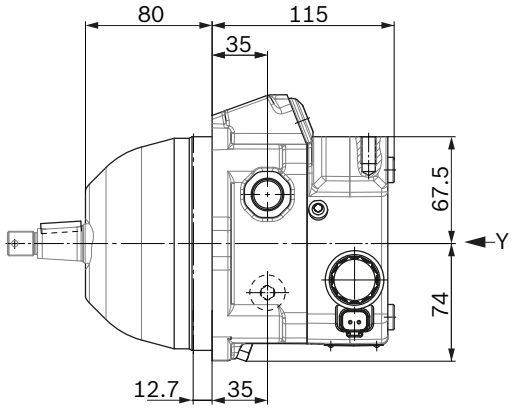
Solenoid data

Technical data, solenoids	**EZ6**	**EZ7**
Nominal voltage	12 V DC	24 V DC
Nominal current (at 20 °C)	1.5 A	0.8 A
Duty cycle	100 %	100 %
Type of protection: see connector version page 15		
Ambient temperature range -20 °C to +60 °C Please contact us if these temperatures cannot be observed.		

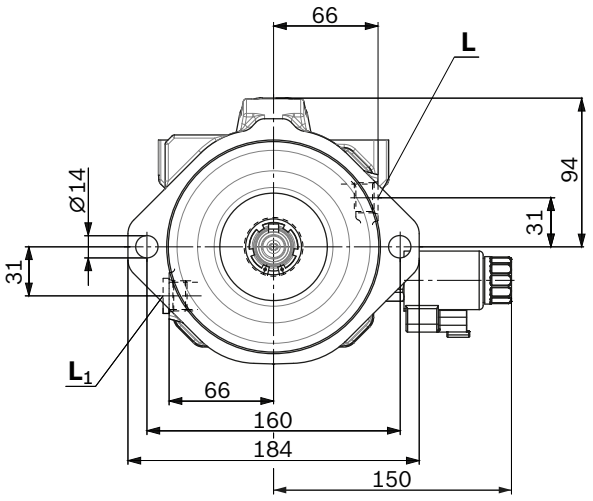
Dimensions, sizes 18, 23, 28

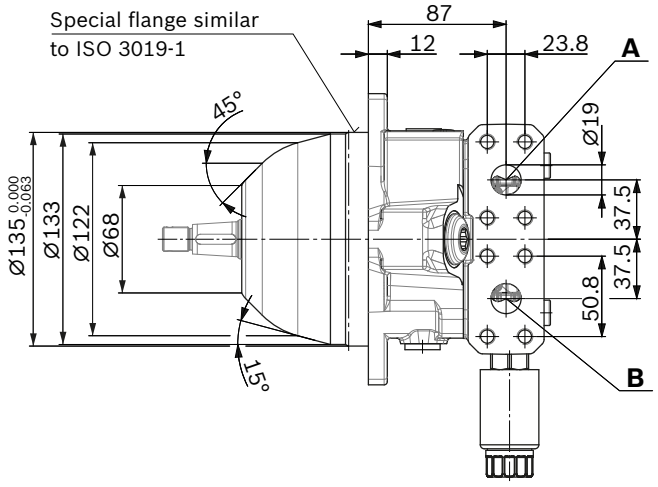
EZ6/EZ7 – Two-point control, electric with DEUTSCH connector, clockwise rotation, series 52

▼ **Port plate 10N00/60N00**

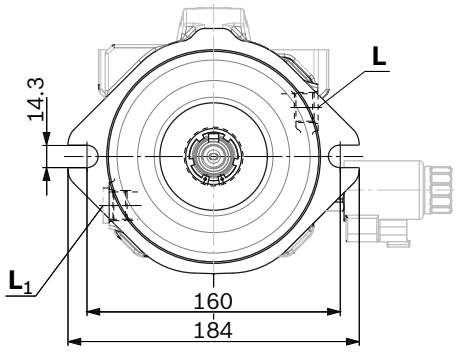


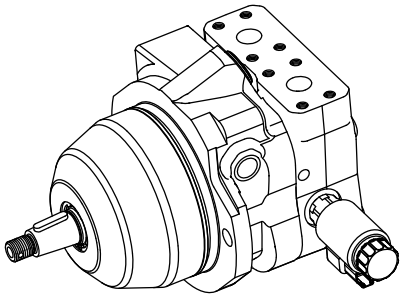
▼ **Mounting flange F**



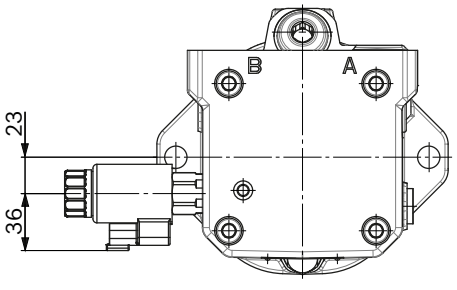


▼ **Mounting flange U**



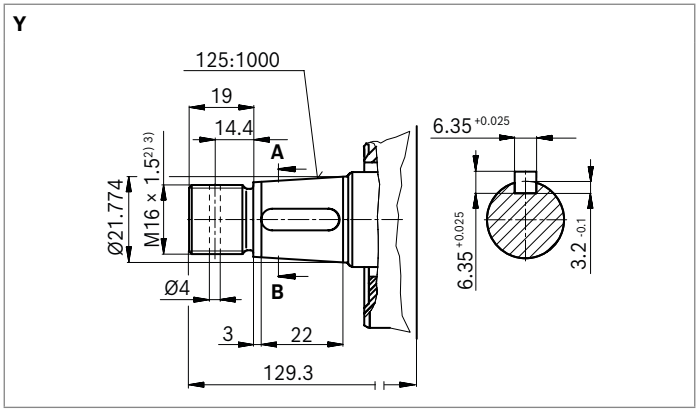


View Y



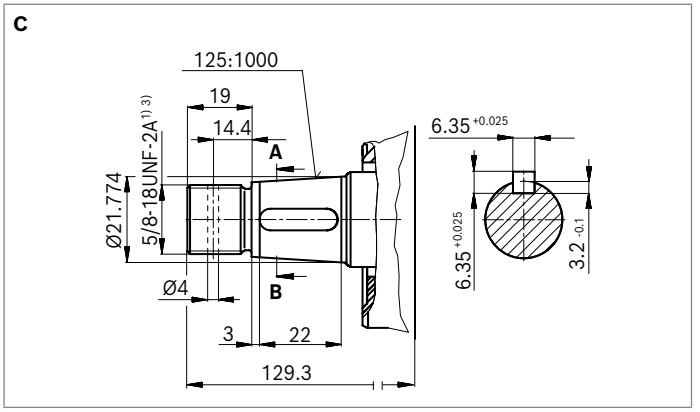
▼ **Tapered shaft with shaft key, metric threaded bolt**

Y



▼ **Tapered shaft with shaft key, imperial threaded bolt**

C



Ports

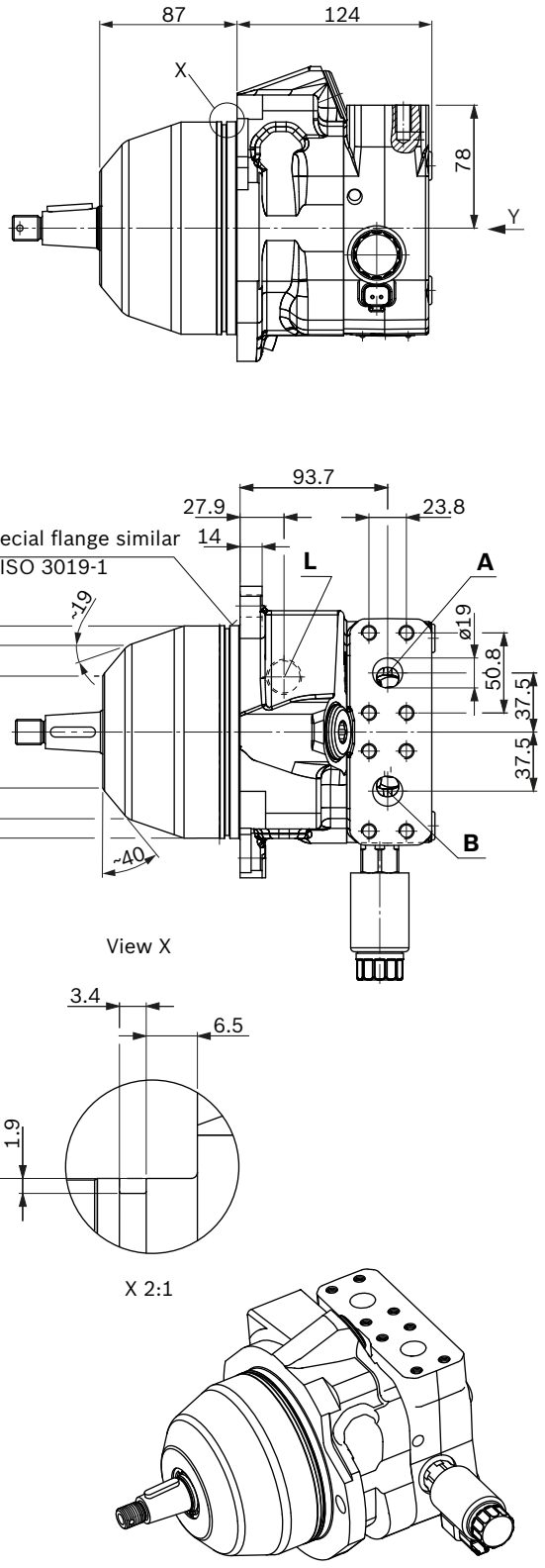
Port plate 10		**Standard**	**Size**[3]	p_{max} **[bar]**[4]	**State**[7]
A	Working port (high-pressure series) Fastening thread	SAE J518[5] DIN 13	3/4 in M10 × 1.5; 17 deep	30	O
B	Working port (high-pressure series) Fastening thread	SAE J518[5] DIN 13	3/4 in M10 × 1.5; 17 deep	350	O
L or $\mathbf{L_1}$	Drain port	ISO 11926[6]	3/4-16UNF-2B; 15 deep	2	O
Port plate 60					
A	Working port (high-pressure series) Fastening thread	SAE J518 ASME B1.1	3/4 in 3/8-16UNC-2B; 21 deep	30	O
B	Working port (high-pressure series) Fastening thread	SAE J518 ASME B1.1	3/4 in 3/8-16UNC-2B; 21 deep	350	O
L or $\mathbf{L_1}$	Drain port	ISO 11926[6]	3/4-16UNF-2B; 15 deep	2	O

1) Thread according to ASME B1.1
2) Thread according to DIN 13
3) For the maximum tightening torques, see instruction manual.
4) Depending on the application, momentary pressure peaks can occur.
Keep this in mind when selecting measuring devices and fittings.
5) Metric fastening thread is a deviation from standard.
6) The countersink may be deeper than specified in the standard.
7) O = Must be connected (comes plugged)
X = Plugged (in normal operation)

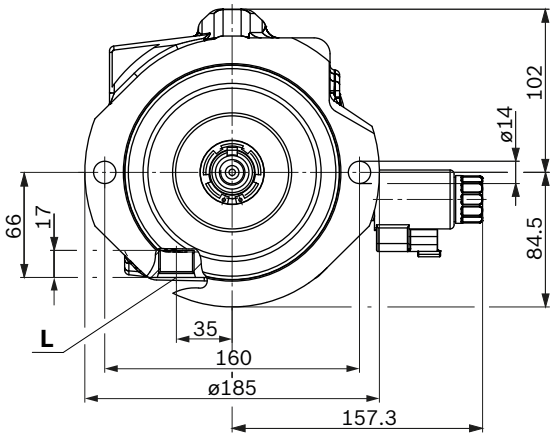
Dimensions, sizes 37 and 45

EZ6/EZ7 – Two-point control, electric with DEUTSCH connector, clockwise rotation, series 52

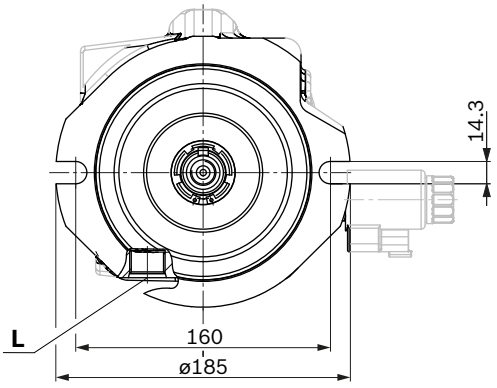
▼ **Port plate 10N00/60N00**



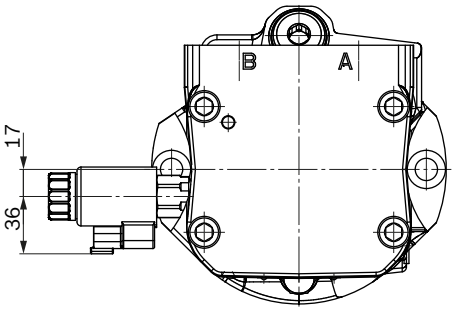
▼ **Mounting flange F**



▼ **Mounting flange U**

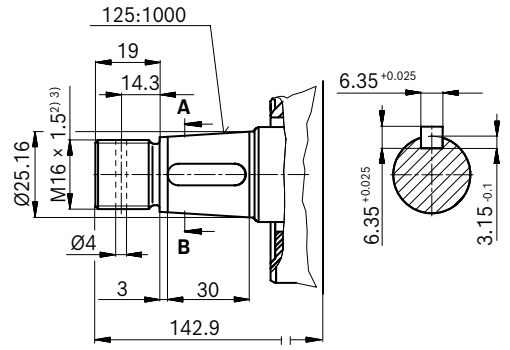


View Y



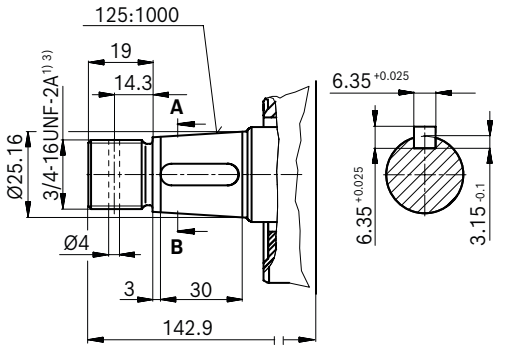
▼ **Tapered shaft with shaft key, metric threaded bolt**

Y



▼ **Tapered shaft with shaft key, imperial threaded bolt**

C



Ports

Port plate 10		**Standard**	**Size**[3)]	p_{max} **[bar]**[4)]	**State**[7)]
A	Working port (high-pressure series) Fastening thread	SAE J518[5)] DIN 13	3/4 in M10 × 1.5; 17 deep	30	O
B	Working port (high-pressure series) Fastening thread	SAE J518[5)] DIN 13	3/4 in M10 × 1.5; 17 deep	350	O
L	Drain port	ISO 11926[6)]	7/8-14UNF-2B; 17 deep	2	O
Port plate 60					
A	Working port (high-pressure series) Fastening thread	SAE J518 ASME B1.1	3/4 in 3/8-16UNC-2B; 21 deep	30	O
B	Working port (high-pressure series) Fastening thread	SAE J518 ASME B1.1	3/4 in 3/8-16UNC-2B; 21 deep	350	O
L	Drain port	ISO 11926[6)]	7/8-14UNF-2B; 17 deep	2	O

1) Thread according to ASME B1.1
2) Thread according to DIN 13
3) For the maximum tightening torques, see instruction manual.
4) Depending on the application, momentary pressure peaks can occur.
Keep this in mind when selecting measuring devices and fittings.
5) Metric fastening thread is a deviation from standard.
6) The countersink may be deeper than specified in the standard.
7) O = Must be connected (comes plugged)
X = Plugged (in normal operation)

Anti cavitation valve

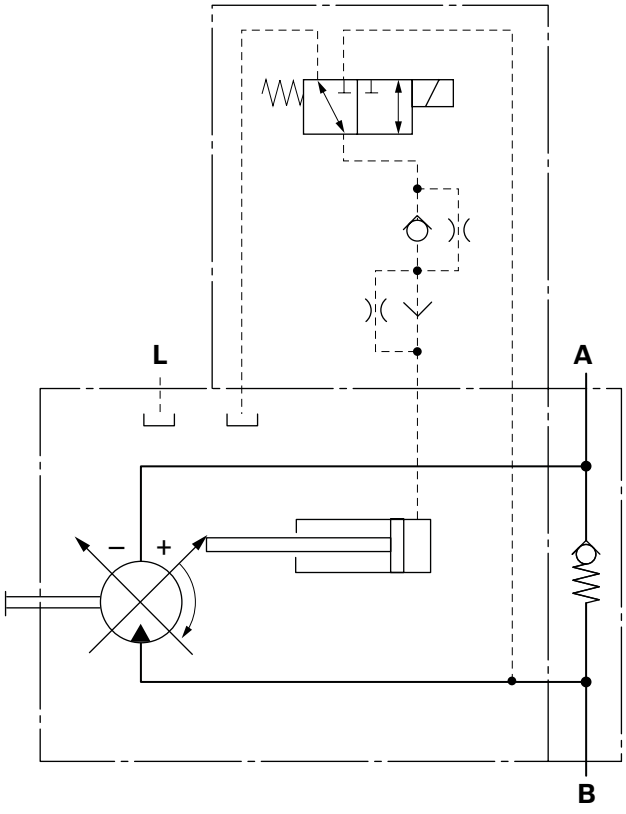
Without pressure cut-off
Order option ...N002
When switching off the system, the anti cavitation valve ensures the motor of heavy-duty drives (e.g. hydrostatic fan drives) is supplied with hydraulic fluid until it comes to a standstill.
The valve is integrated in the port plate.

Notes
- Observe the direction of rotation of the unit during project planning.
- The standard direction of rotation is clockwise. Please contact us regarding counter-clockwise rotation.

The external unit dimensions correspond to the standard version, see the unit dimensions for the length dimensions.

▼ **Circuit diagram**

Clockwise rotation, pressure in port **B**

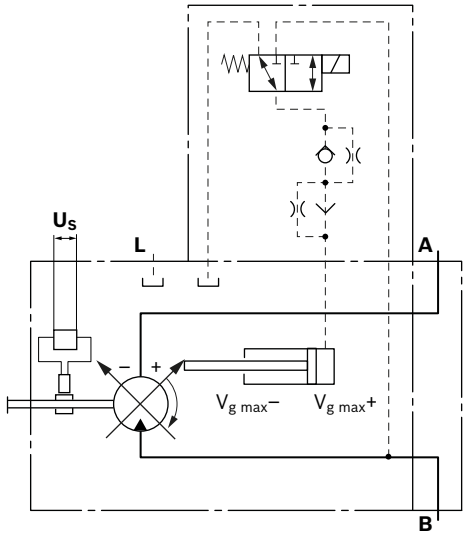


Speed sensing

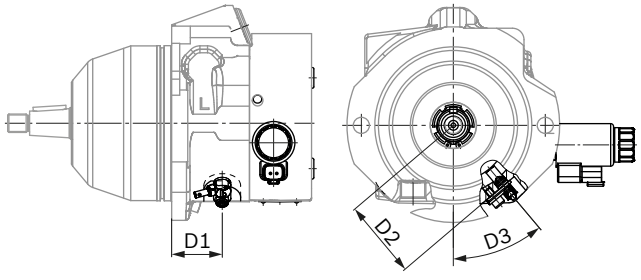
Order option ...B or M

A signal proportional to the motor speed can be generated with the mounted DSA (B)/DSM (M) rotational speed sensor. The DSA/DSM sensor registers the rotational speed and/or direction of rotation.
Type code, technical data, dimensions and details on the connector plus safety instructions about the sensor can be found in the relevant data sheet 95132 – DSM or 95133 – DSA.
The sensor is mounted on the port provided for this purpose with a mounting bolt.

▼ **Circuit diagram**



▼ **Dimensions**



NG	D1	D2	D3
18, 23, 28	–	–	–
37, 45	44	68.5	35°

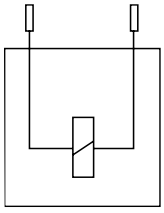
Connector for solenoids

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).

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

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. The drain in the housing area must be discharged to the reservoir via the highest available leckage port (**L**). If this is not possible, separate drain lines must be laid if necessary.
To achieve favorable noise values, decouple all connecting lines using elastic elements and avoid above-reservoir installation.
In all operating conditions, the drain line must flow into the reservoir below the minimum fluid level.

Notice
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.

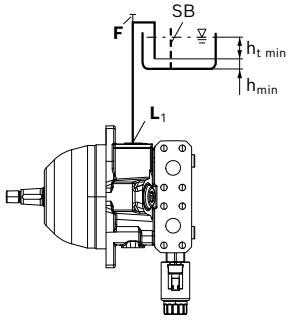
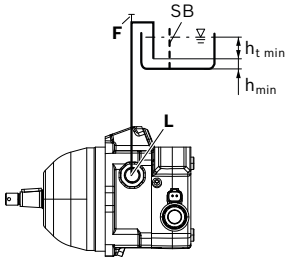
For key, see page 17.

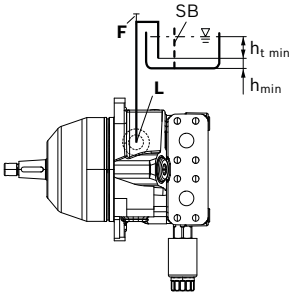
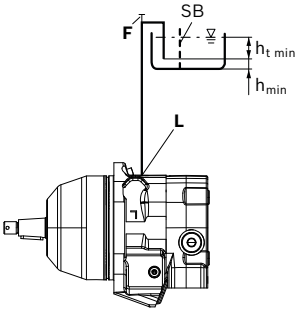
Installation position

See the following examples **1** to **8**.
Further installation positions are available upon request.
Recommended installation position: **2** and **4**

Below-reservoir installation (standard)

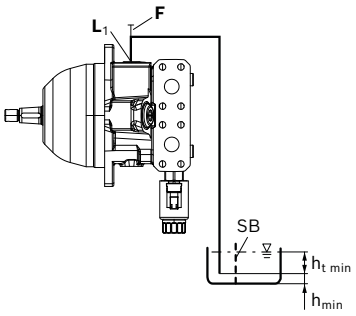
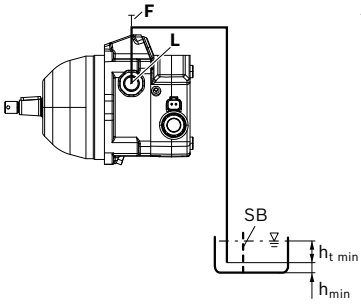
Below-reservoir installation is when the axial piston unit is installed outside of the reservoir below the minimum fluid level.

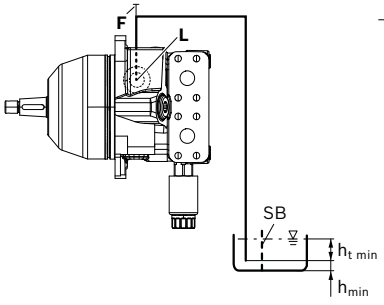
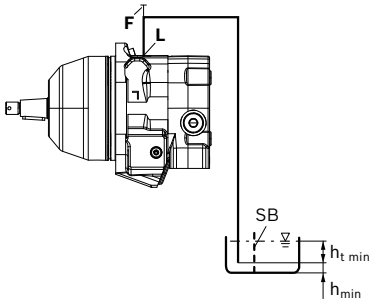
Installation position NG 18 to 28	Air bleed	Filling
1 	**F**	**L_1**
2 	**F**	**L**

Installation position NG 37 and 45	Air bleed	Filling
3 	**F**	**L**
4 	**F**	**L**

Above-reservoir installation

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

Installation position NG 18 to 28	Air bleed	Filling
5 	**F**	**L1**
6 	**F**	**L**

Installation position NG 37 and 45	Air bleed	Filling
7 	**F**	**L**
8 	**F**	**L**

Key	
F	Filling / Air bleeding
L, L1	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)

Notice

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

Project planning notes

- The A10VER axial piston variable pump is designed to be used in open circuit.
- The project planning, assembly and commissioning of the axial piston unit require the involvement of qualified skilled persons.
- Before using the axial piston unit, please read the corresponding instruction manual completely and thoroughly. If necessary, this can be requested from Bosch Rexroth.
- Before finalizing your design, please request a binding installation drawing. If you need a 3D installation model, please consult the responsible contact person at Bosch Rexroth.
- 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 preservative protection for a maximum of 12 months. If longer preservation is required (maximum 24 months), please specify this in plain text when placing your order. The preservation periods apply under optimal storage conditions, which can be found in data sheet 90312 or in the instruction manual.
- Not all versions of the product are approved for use in a safety function 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. The use of the direct current (DC) on the electromagnet does not produce any electromagnetic interference (EMI), nor is the electromagnet influenced by EMI. Potential electromagnetic interference (EMI) exists if the solenoid is energized with a 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. A pressure relief valve is to be fitted in the hydraulic system.
- For drives that are operated for a long period with constant rotational speed, the natural frequency of the hydraulic system can be stimulated by the excitation frequency of the pump (rotational speed frequency ×9). This can be prevented with suitably designed hydraulic lines.
- Please note the details regarding the tightening torques of port threads and other threaded joints in the instruction manual.
- Working ports:
  - The ports and fastening threads are designed for the specified maximum pressure. The machine or system manufacturer must ensure the connecting elements and lines correspond to the specified application conditions (pressure, flow, hydraulic fluid, temperature) with the necessary safety factors.
  - The working ports and function ports are only intended to accommodate hydraulic lines.

System solution for hydrostatic fan drives with reversing function

AFC30 software

The BODAS AFC30 is a standard software solution integrated in the RC4-5/30 control unit from Rexroth for controlling hydrostatic fan drives with fixed or variable hydraulic pumps. The AFC30 is designed to control a fan drive in an open hydraulic circuit. The performance requirement of the fan can be modified for up to 6 temperature signals (analog/J1939). The AFC30 can be used with 12 V and 24 V systems. As the AFC30 provides the cooling output according to requirements, fuel consumption is significantly reduced compared with fan drive systems that are not proportionally controlled. Further information on this can be found in data sheets

- 95362 (application software fan speed control AFC30) and
- 95205 (BODAS controller RC4-5, series 30)

Safety instructions

- During and shortly after operation, there is a risk of burning on the axial piston unit, 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 get stuck in an undefined position due to contamination (e.g. impure hydraulic fluid, abrasion or residual dirt from components). As a result, the hydraulic fluid flow and the build-up of torque in the axial piston unit can no longer respond correctly to the operator's specifications. Even the use of various filter elements (external or internal flow filtration) will not rule out a fault but merely reduce the risk. The machine/system manufacturer should test whether additional measures are required on the machine for the relevant application in order to bring the driven consumer into a safe position (e.g. safe stop) and make sure any measures are properly implemented.

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